

# Neutron Sources

*Robert McGreevy*

ISIS, Rutherford Appleton Laboratory, UK



Science & Technology Facilities Council

**ISIS**

# Who am I?

*Robert McGreevy*



Oxford University, UK,  
Physics Department

Neutron scattering studies of liquids  
and glasses

Reverse Monte Carlo method for  
structural modelling

Fast ion conductors, high  $T_c$   
superconductors, colossal  
magnetoresistance



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# Who am I?

*Robert McGreevy*



Dido and Pluto, Harwell



Institut Laue Langevin



Harwell Linac (Helios)



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# Who am I?

*Robert McGreevy*



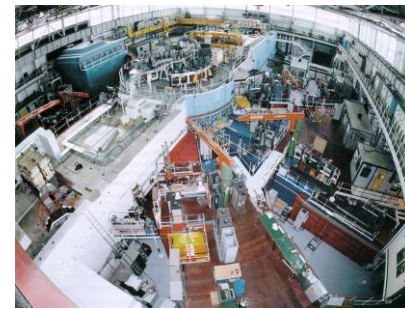
Oxford University, UK,  
Physics Department



Uppsala University, Sweden,  
Studsvik Neutron Research Laboratory



Oak Ridge National Laboratory, USA,  
Neutron Sciences Directorate



ISIS, UK



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# Neutron Sources

*Robert McGreevy*

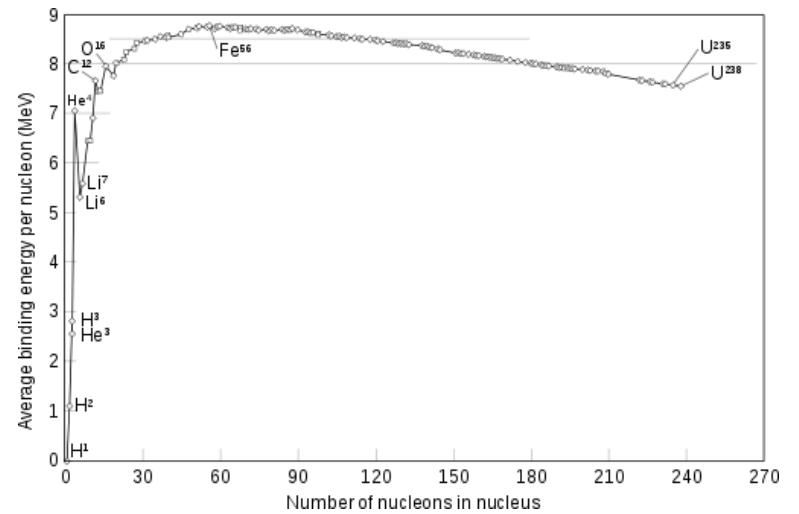
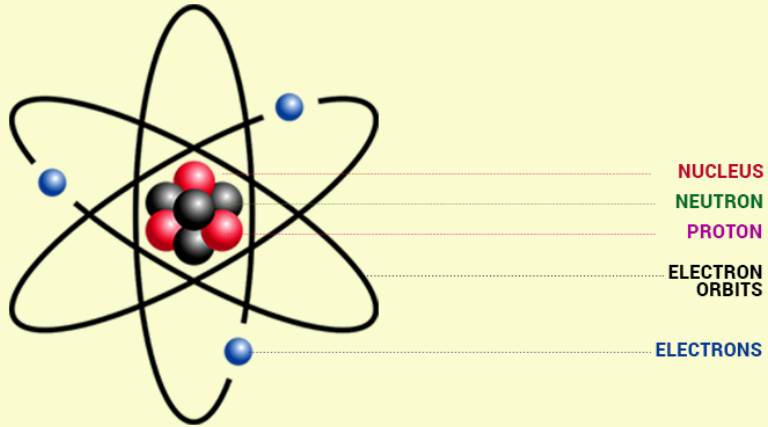
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## Rutherford's Model Of Atoms





## Spontaneous Fission

e.g.  $^{252}\text{Cf}$  (mainly  $\alpha$  decay) Half life 2.65 years

## Radioactive sources

$^{241}\text{Am} \rightarrow ^{237}\text{Np} + ^4\text{He}$  (5.6 MeV)  $^9\text{Be} + ^4\text{He} \rightarrow ^{12}\text{C} + \text{n}$  (few MeV) Half life 433 y

## 'Small' accelerator based sources ('D-T')

$^2\text{H}$  (~ 150 keV) +  $^3\text{H} \rightarrow ^4\text{He} + \text{n}$  (14.2 MeV)

## Fission

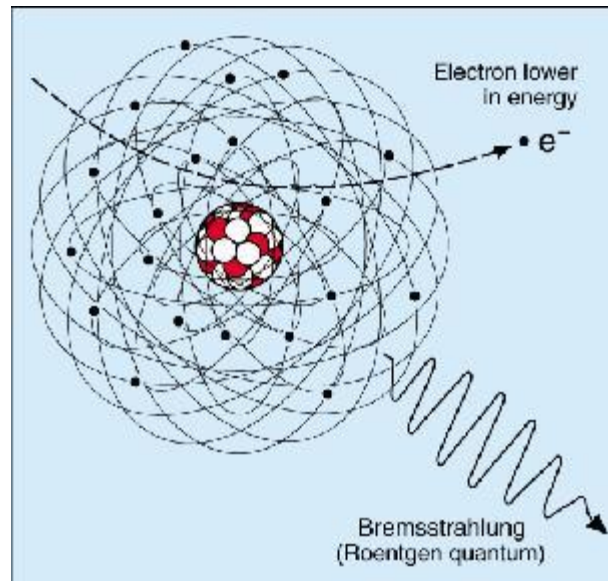
$^{235}\text{U} + \text{n} \rightarrow \text{X} + \text{Y} + 2.5\text{n}$  (~200 MeV total energy release, ~ 2 MeV per neutron)



## Electron accelerator based sources

10-100 MeV electrons on heavy metal target  
Produces bremsstrahlung photons which are absorbed by nuclei

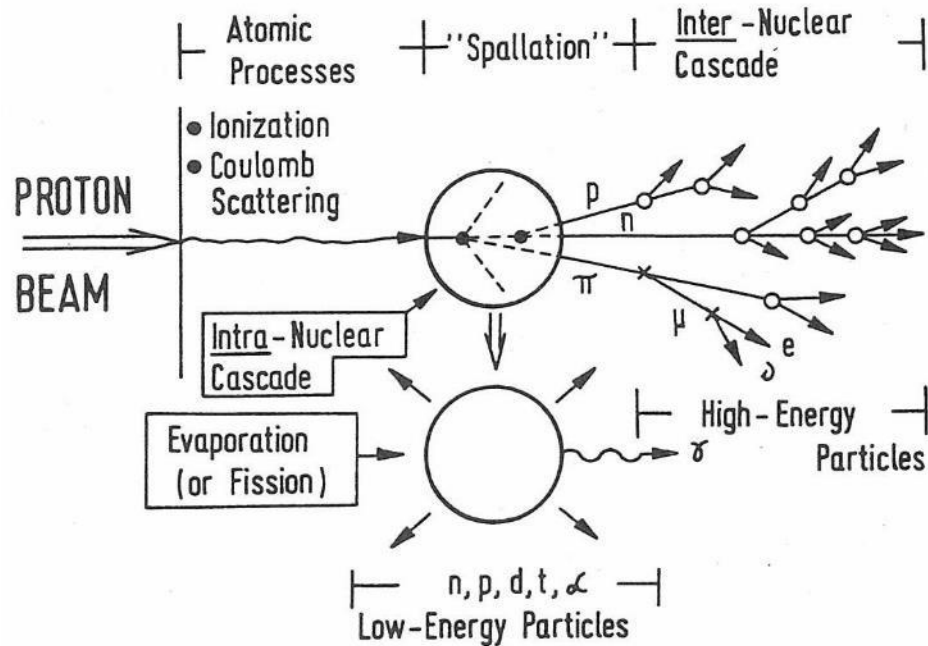
Electron accelerators are cheap but power is limited by large amount of heat to dissipate in the target, ~ 6 MeV per neutron



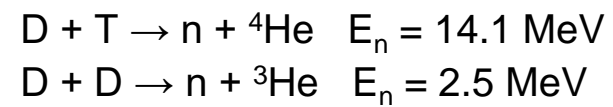
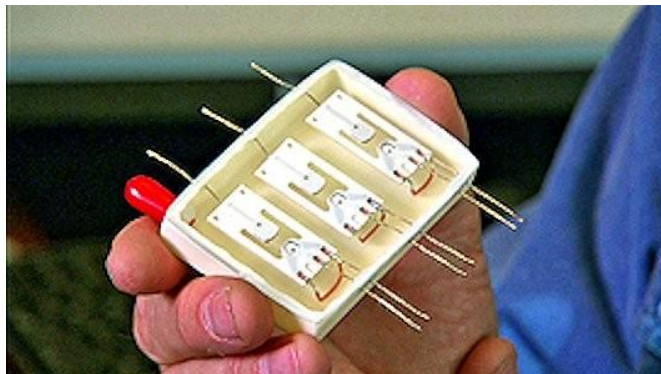
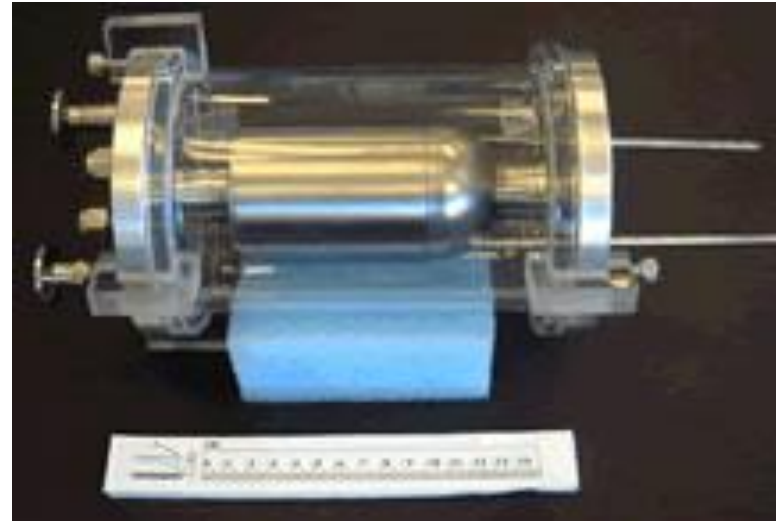


## High energy proton accelerator based spallation sources

> 100 MeV protons on heavy metal target  
~ 25 neutrons/proton, 30 MeV per neutron compared to fission

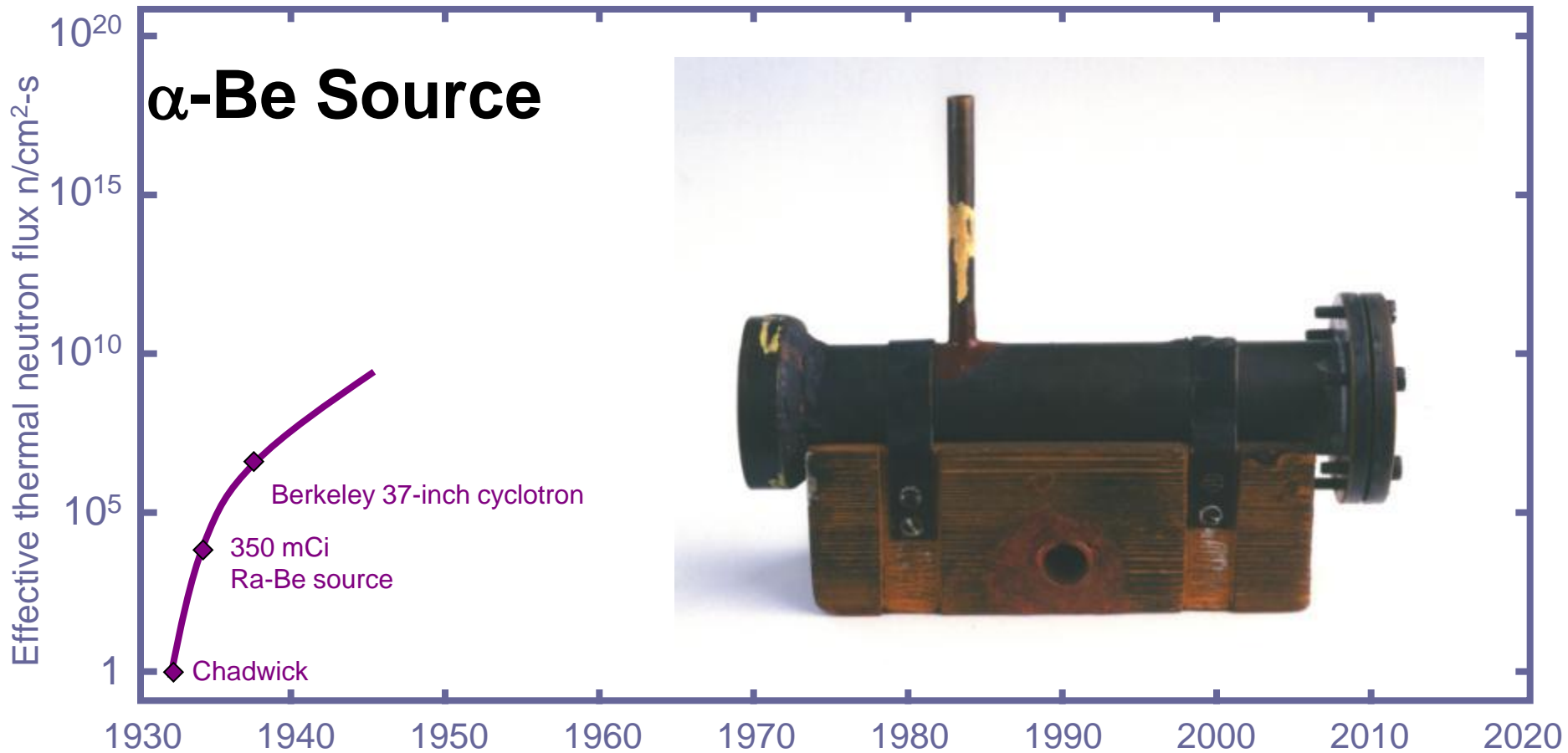




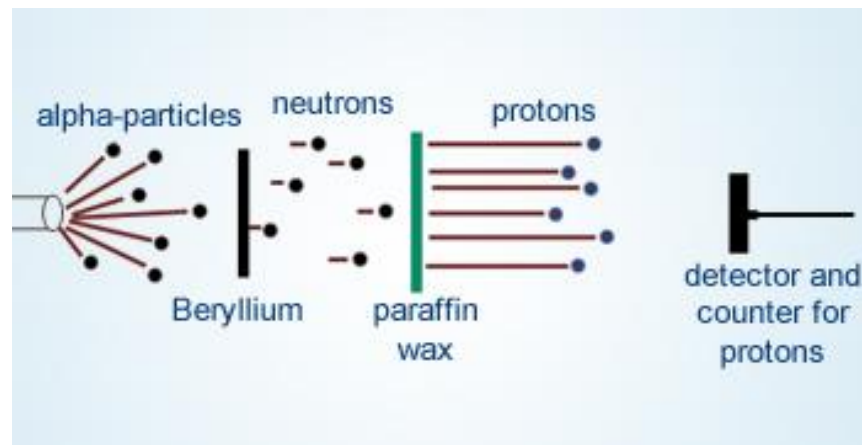


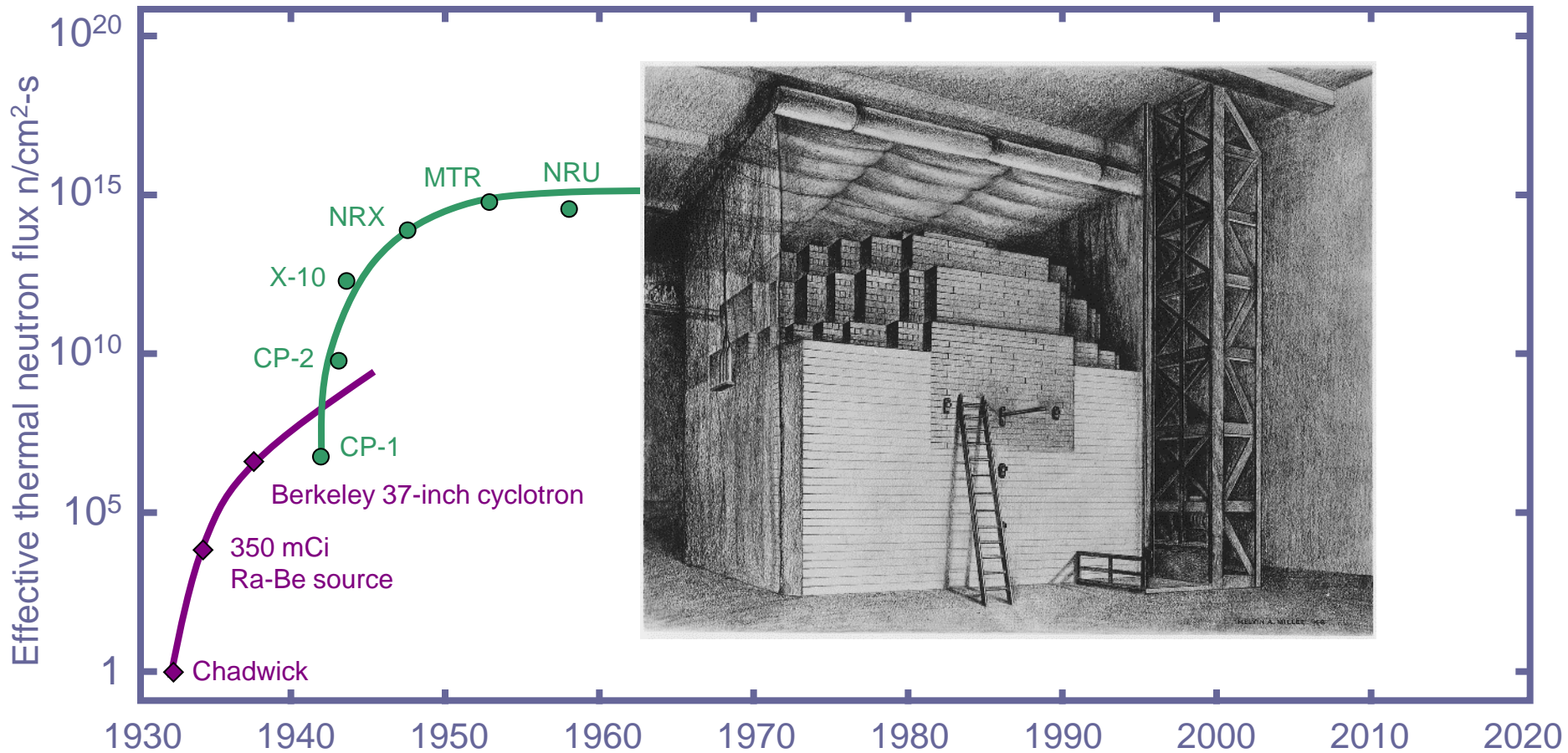
Oil industry  
Security  
Structure evaluation





(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)





(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)

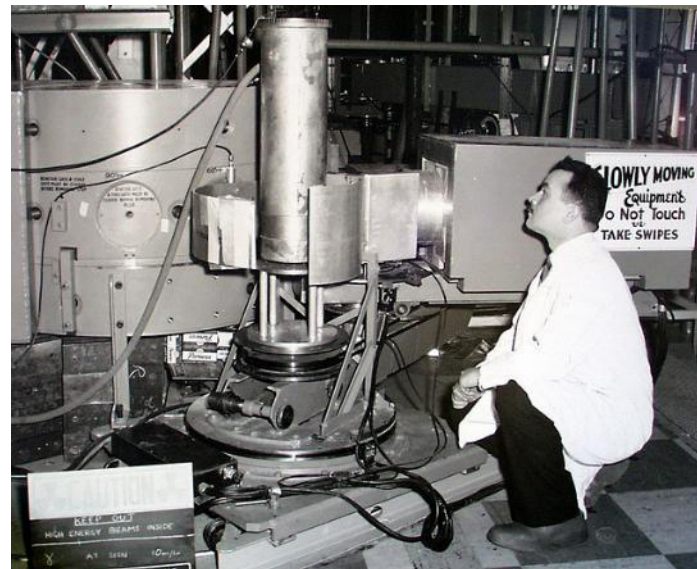




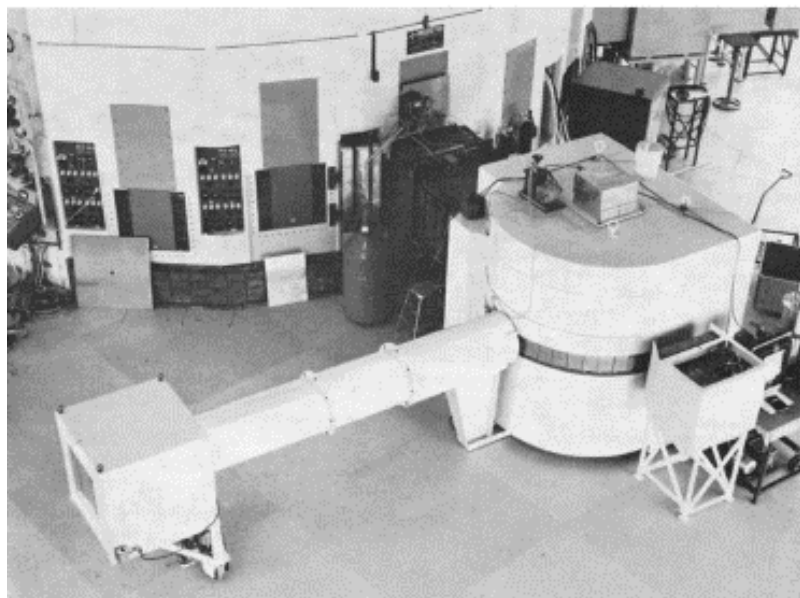
## Some neutron history ...



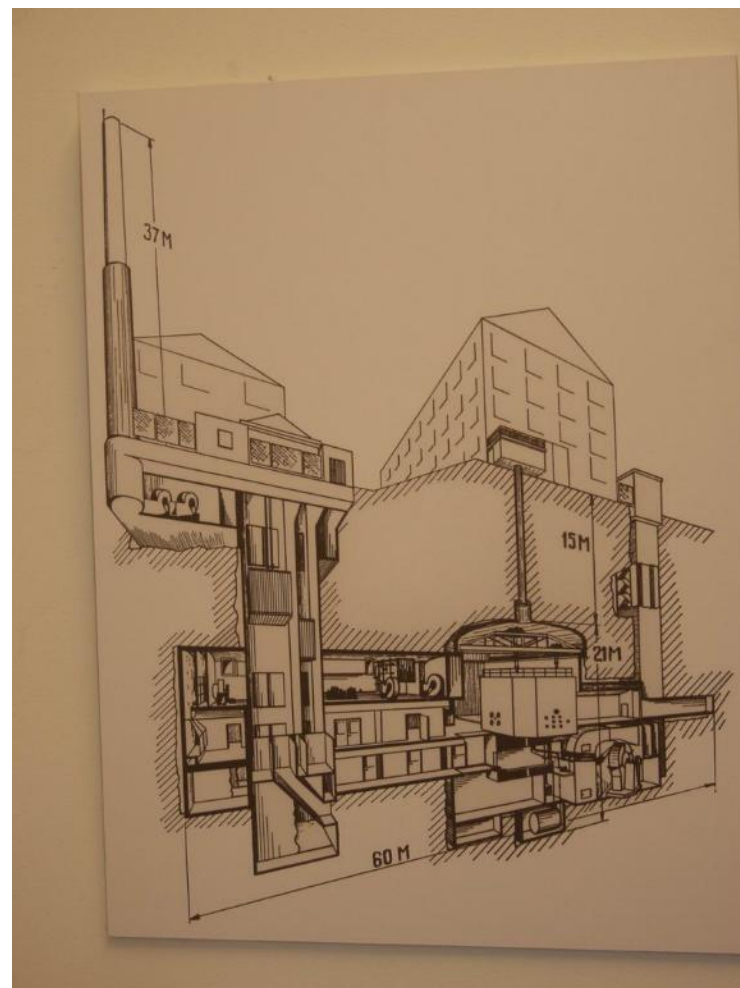
Ernie Wollan and Cliff Shull  
Neutron diffraction  
Oak Ridge, USA



Bert Brockhouse  
Triple axis spectroscopy  
Chalk River, Canada



Karl-Erik Larsson  
TOF spectroscopy  
Stockholm, Sweden





## PLUTO and DIDO (1956/7-1990)



DIDO class reactors also built at HIFAR (Australia),  
DR-3 (Denmark), FRJ-II (Juelich)





Peter Egelstaff

## User programmes

Early programmes 'parasitic' at materials testing reactors

Mainly used by local scientists (staff)

UK Neutron Beam Research Committee (1966) expanded access to the broader university research community

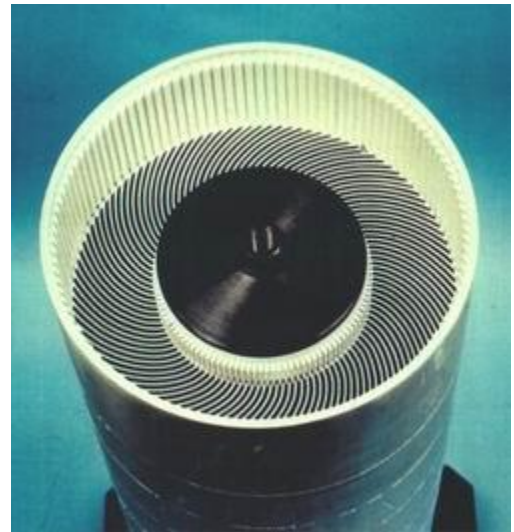
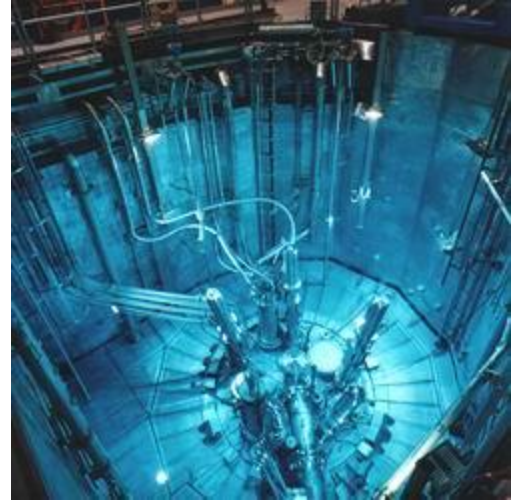
Institut Laue Langevin (1971) first research reactor purpose built for an external user community. Also pioneered the use of neutron guides.

User programmes now common at synchrotrons etc.

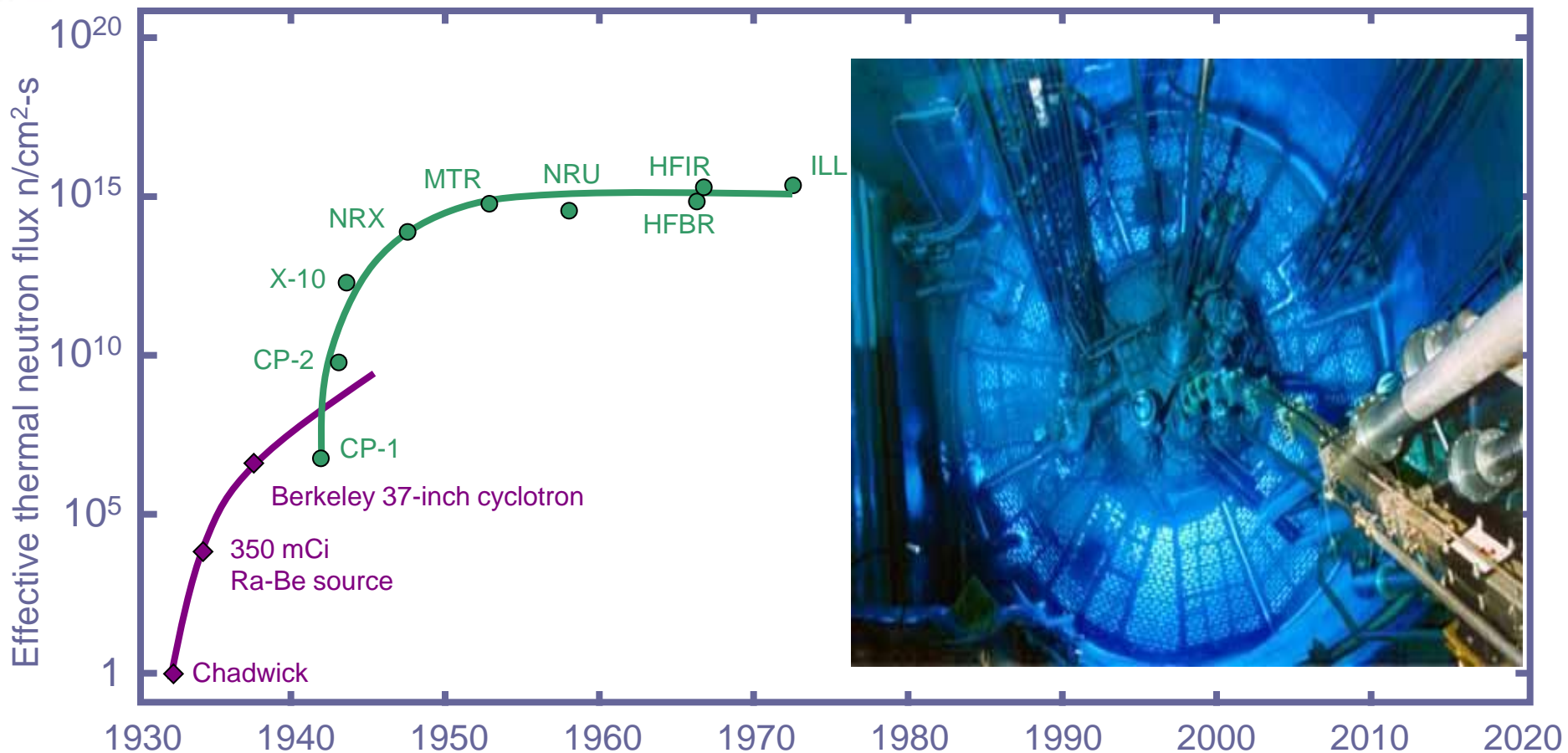


A survey of the users' community in evidence during the past year indicated 102 FTE users and 284 part-time users, of which the numbers 70 and 255, respectively, indicate approximately the user activity at the national laboratories, including the National Bureau of Standards. (1978)

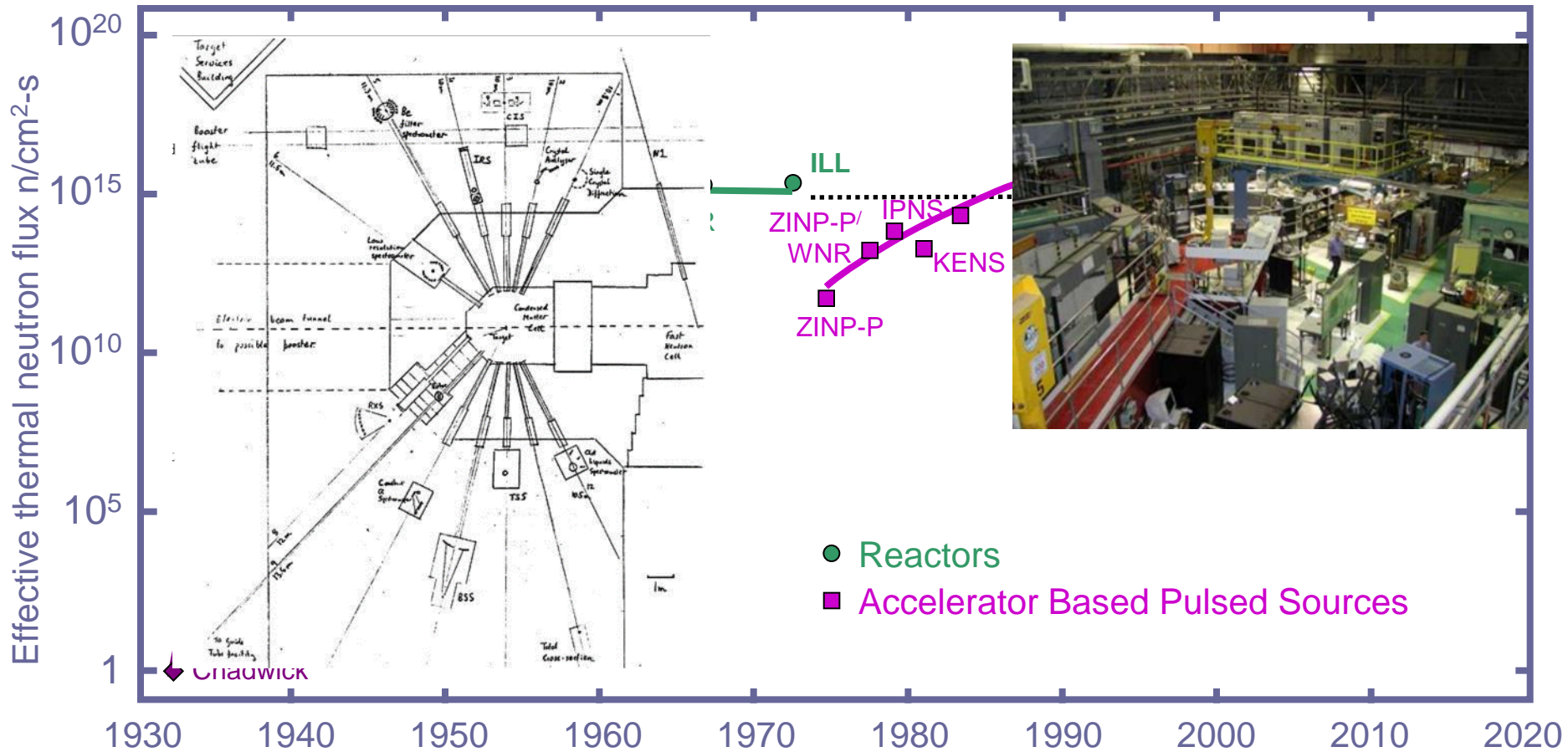




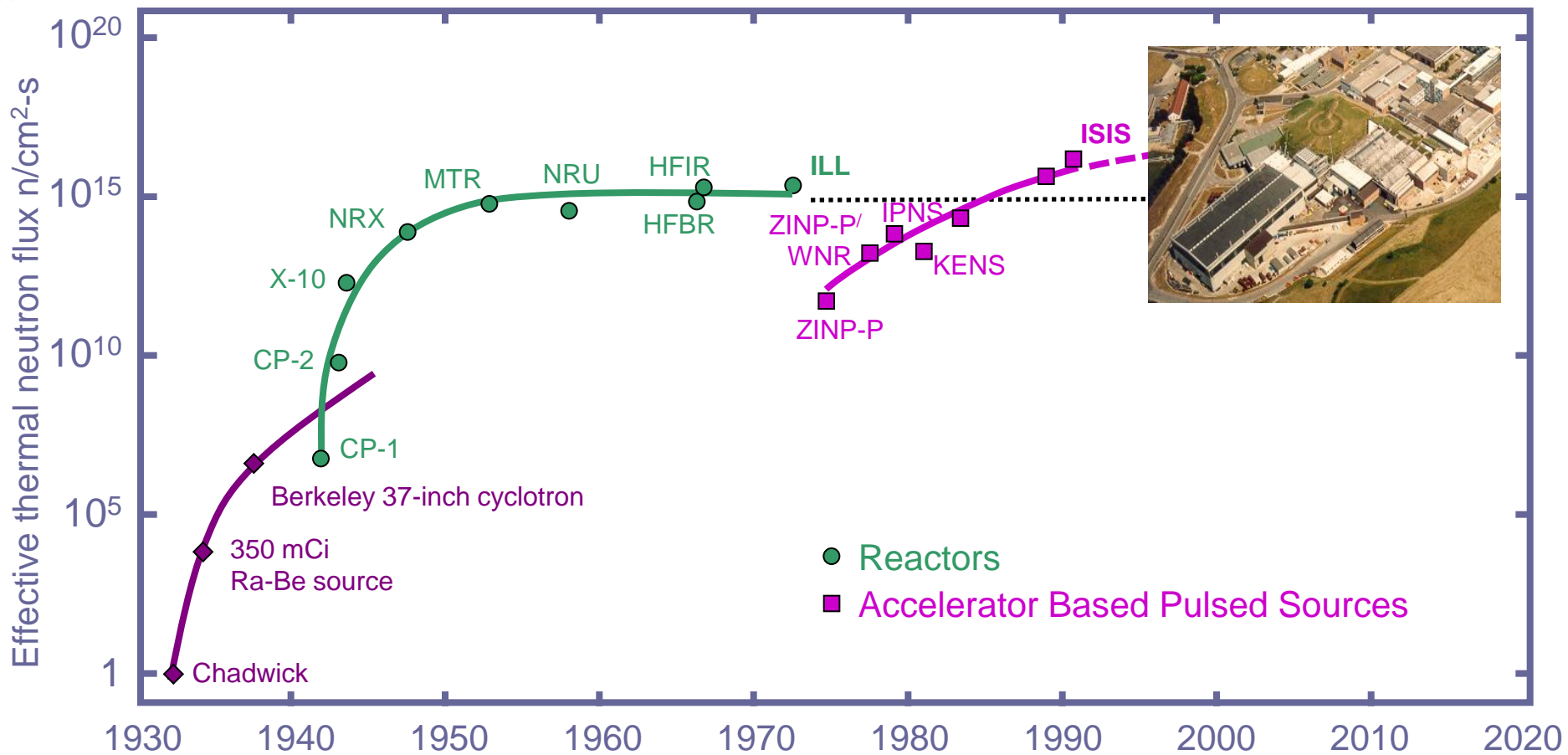




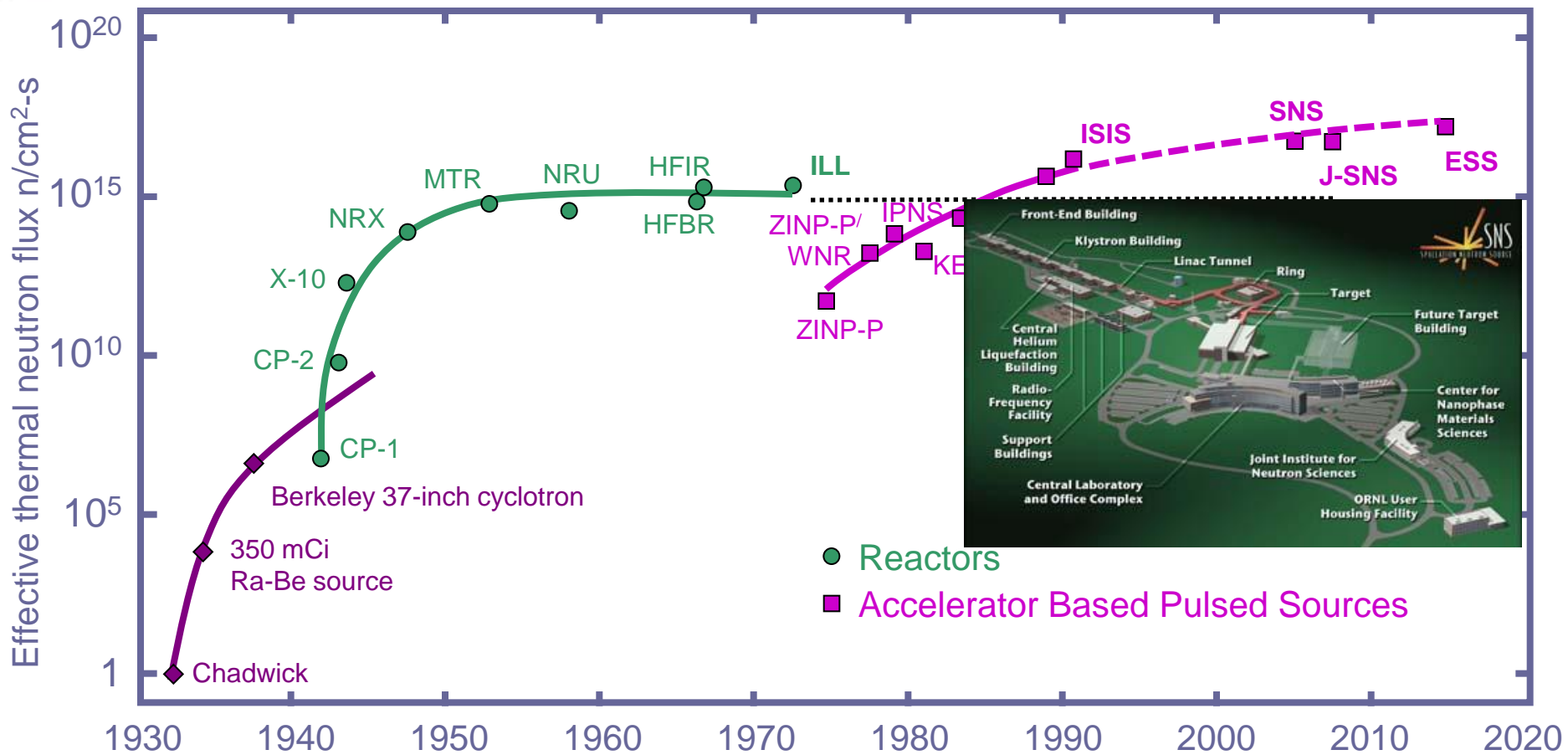
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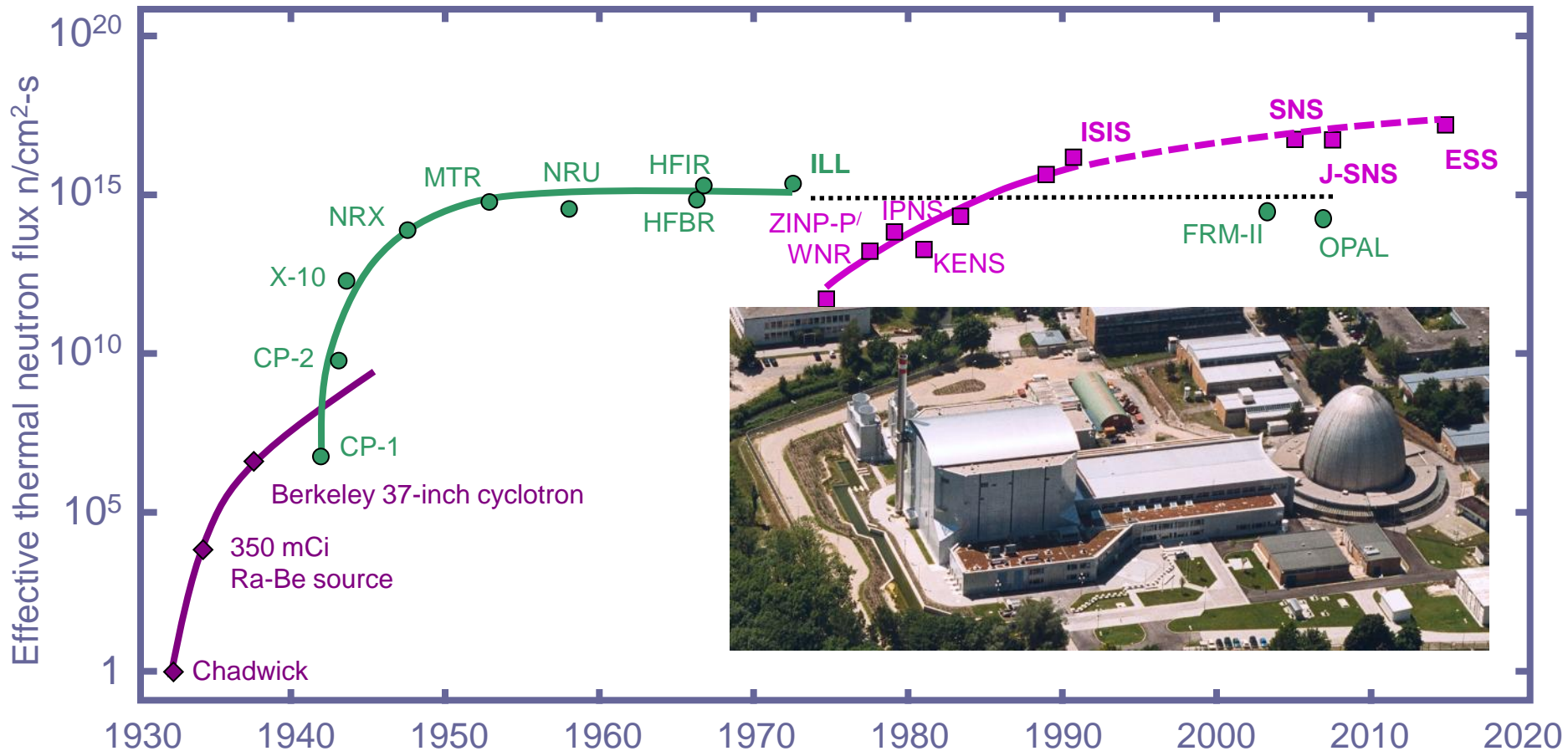


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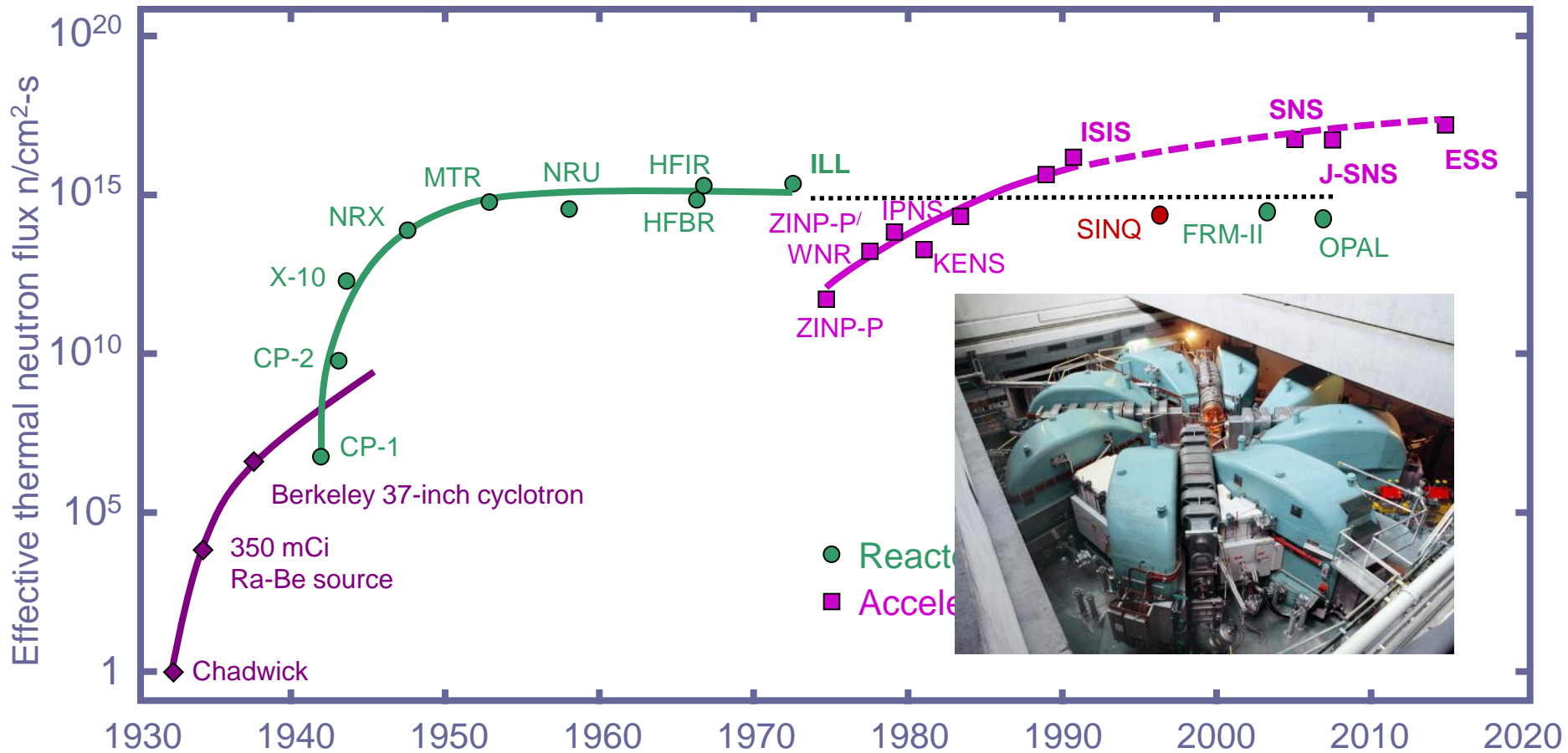
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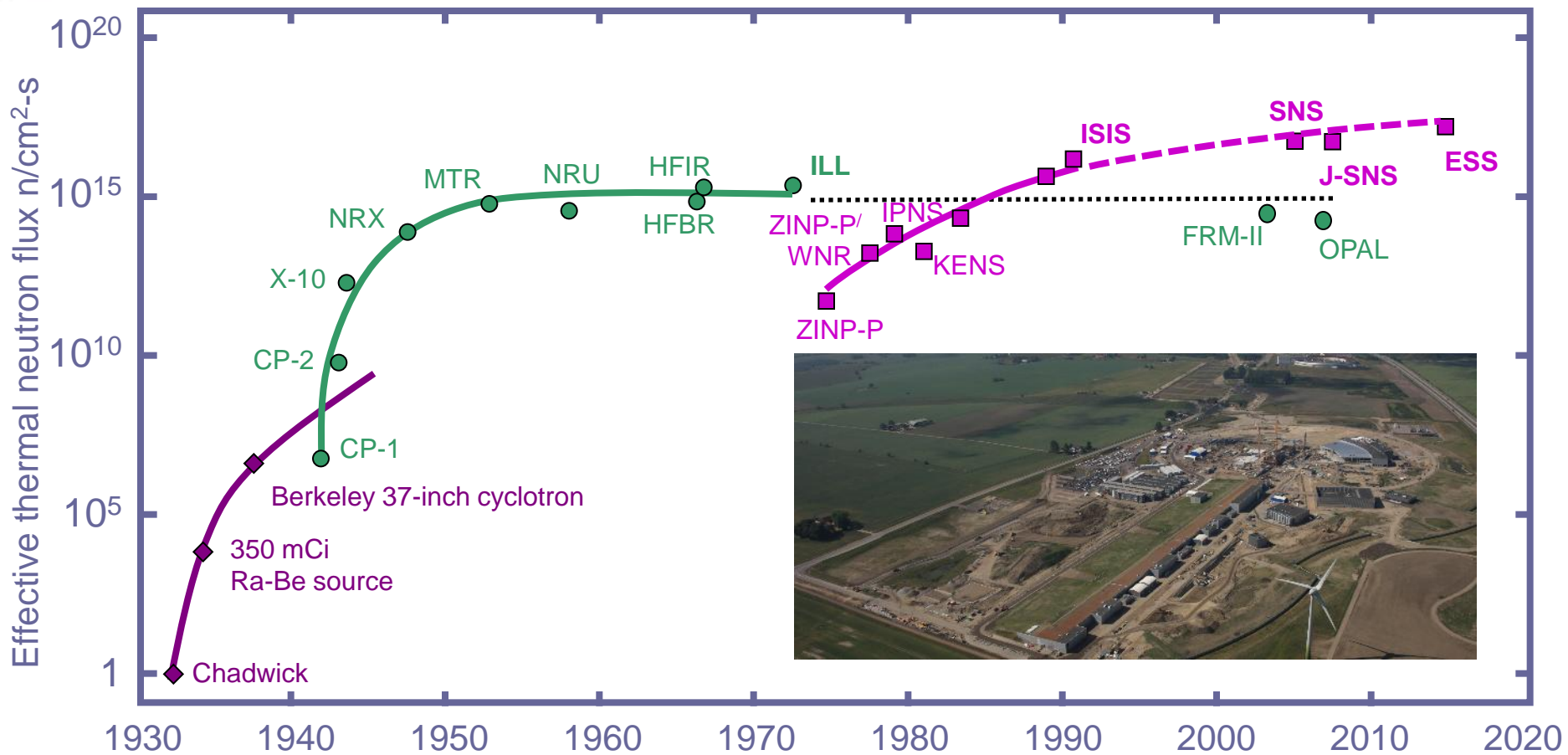


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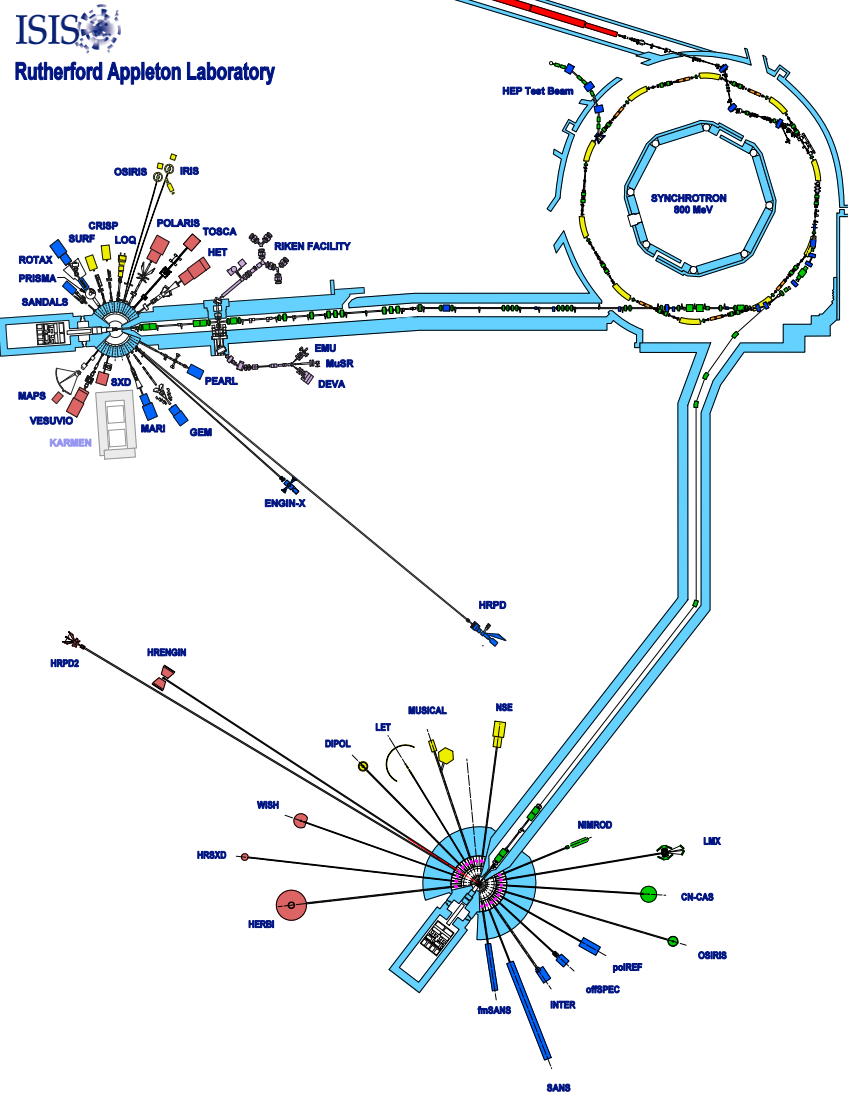
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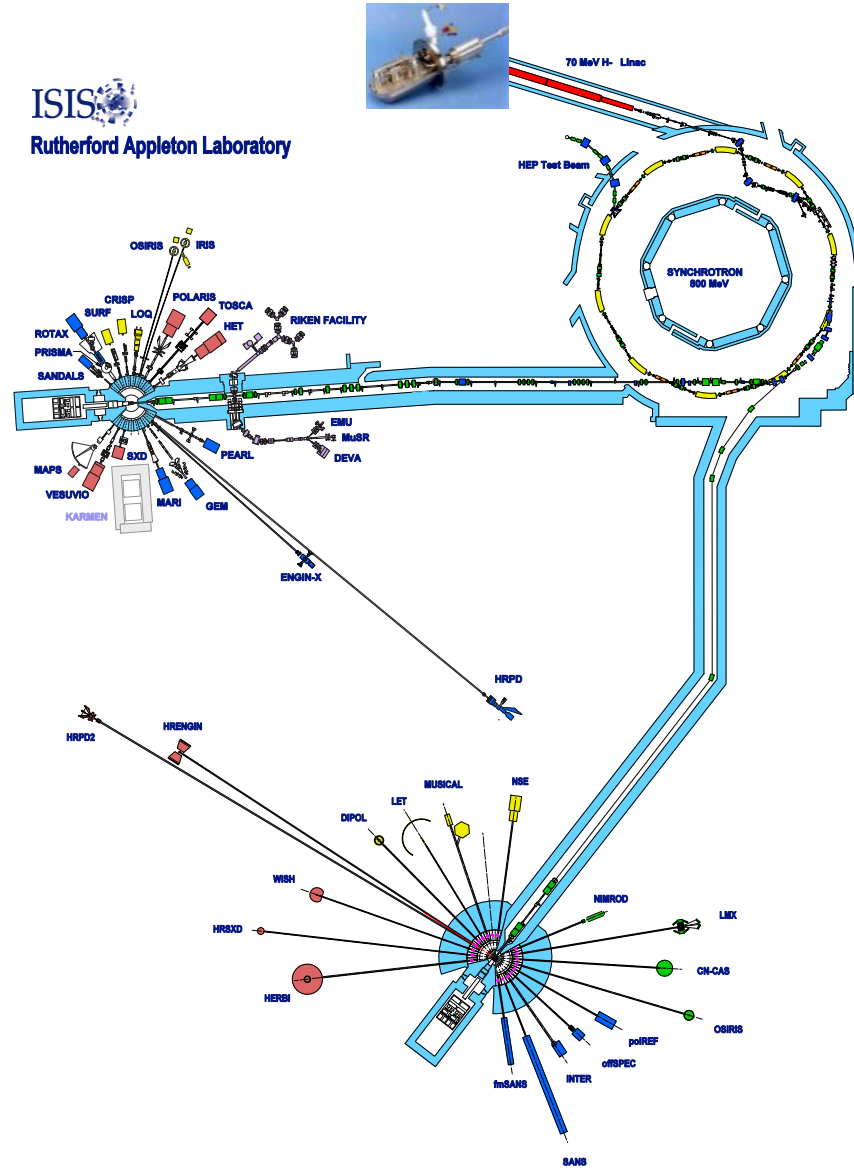


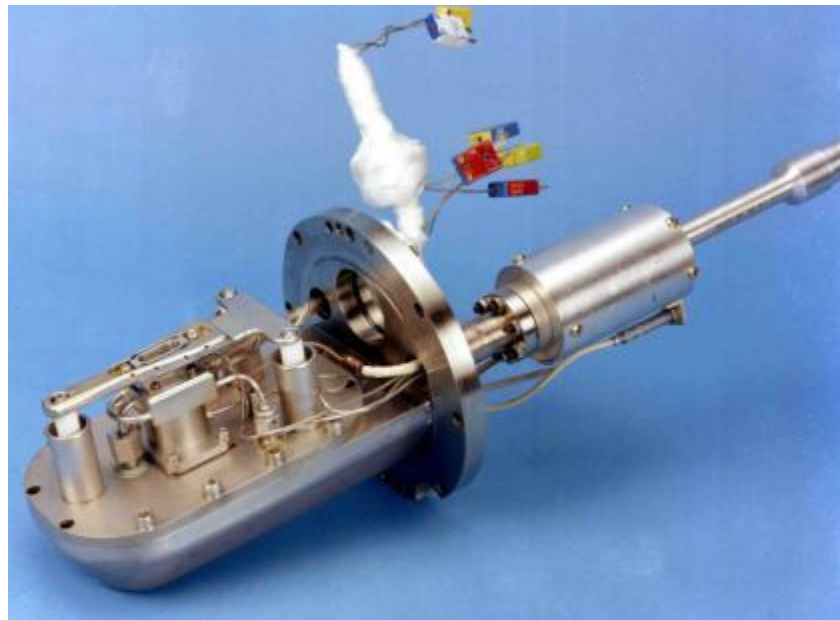
## Short pulse spallation source





## ISIS Rutherford Appleton Laboratory

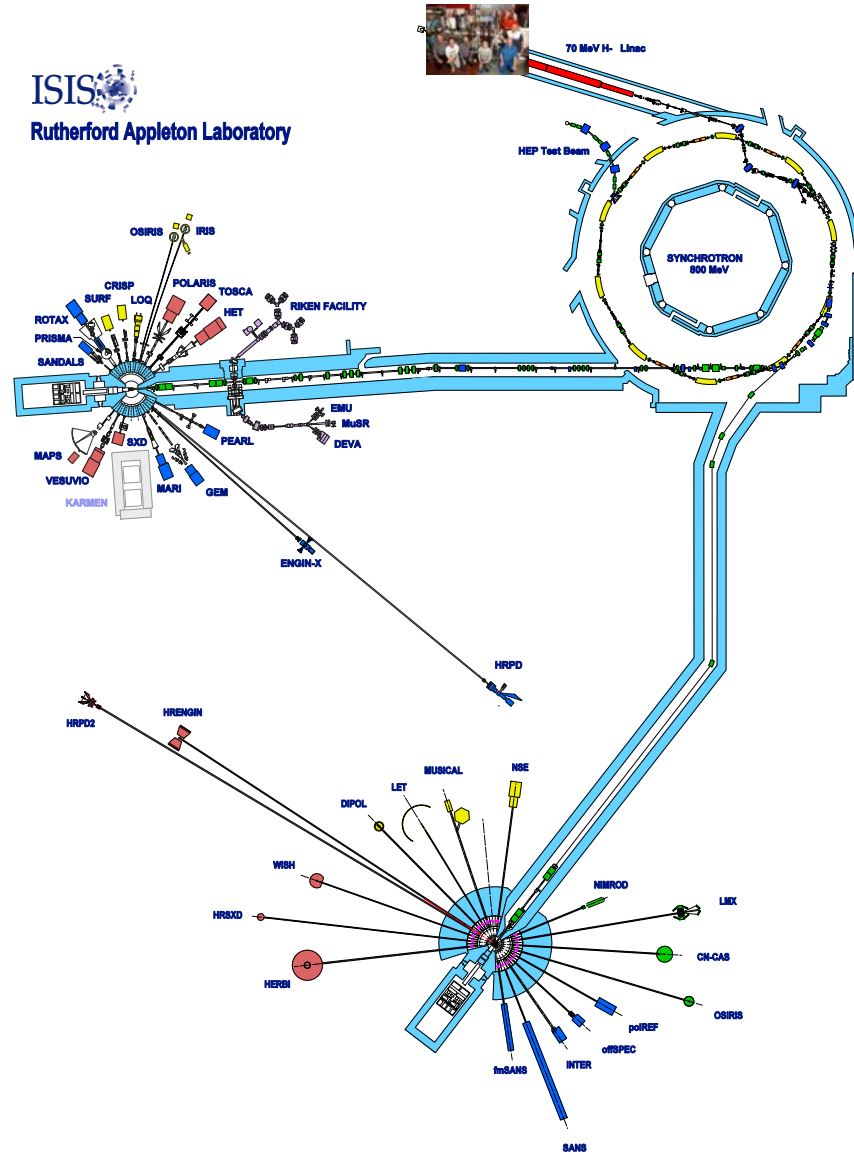


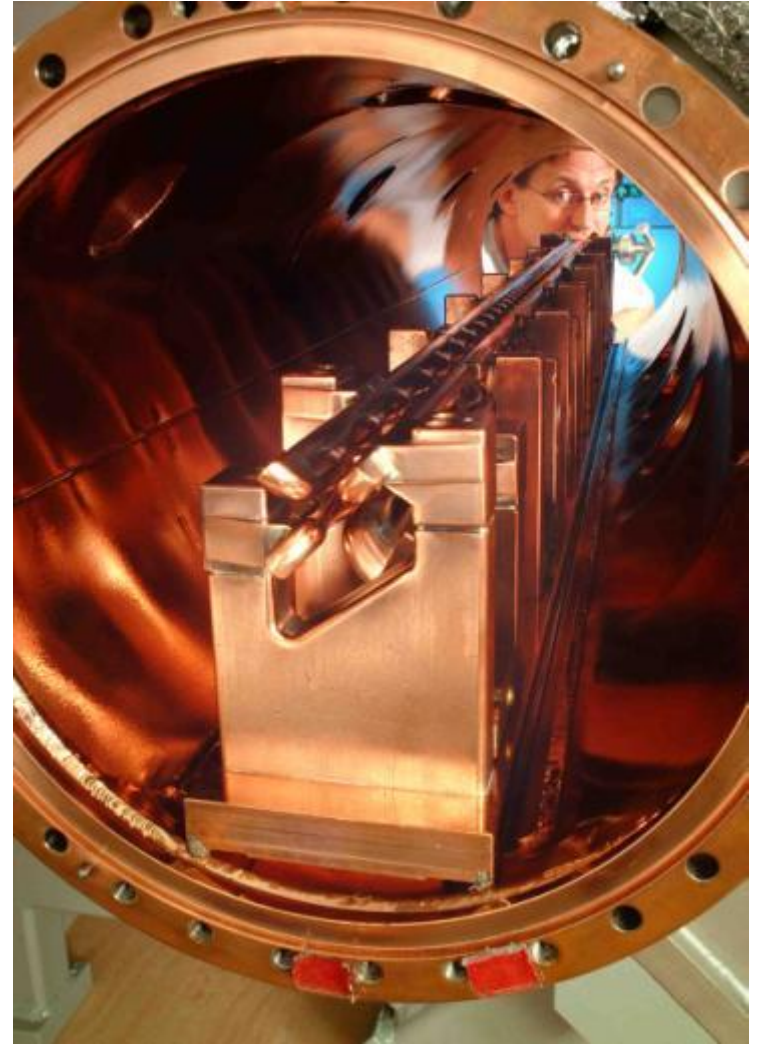






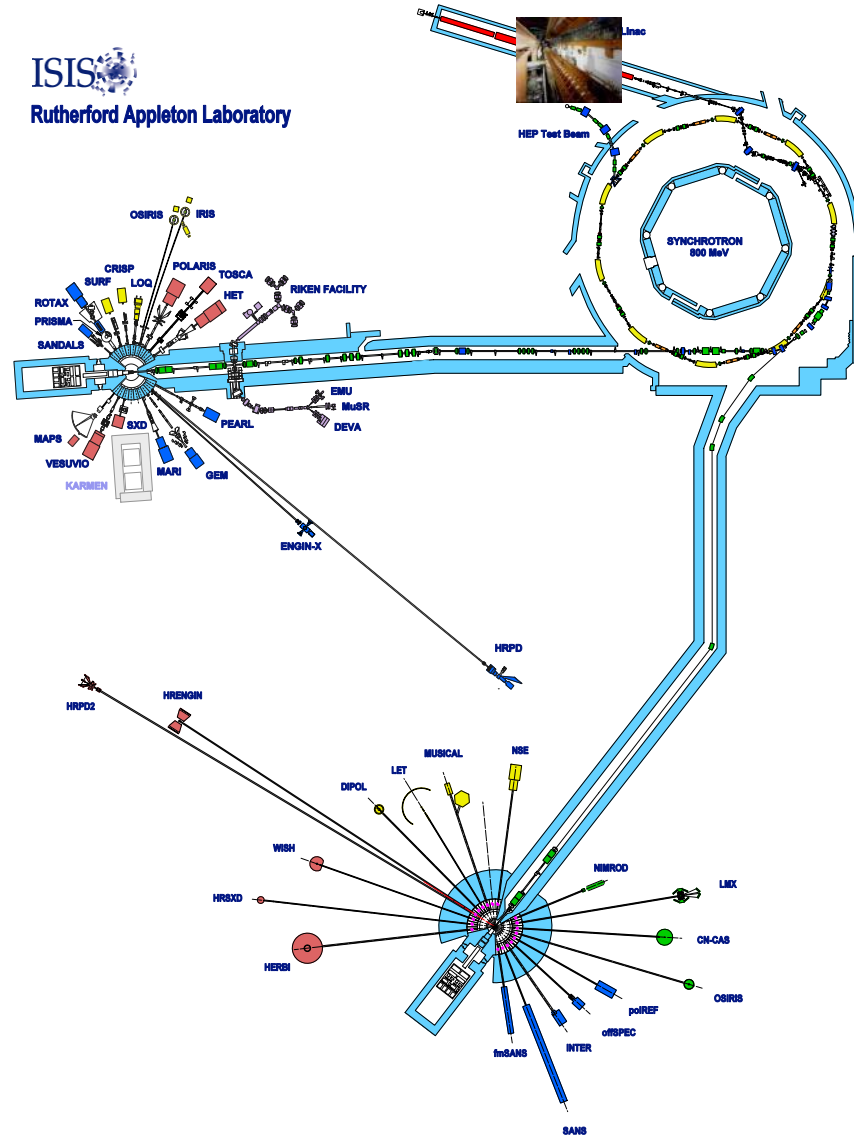
## ISIS Rutherford Appleton Laboratory







## ISIS Rutherford Appleton Laboratory







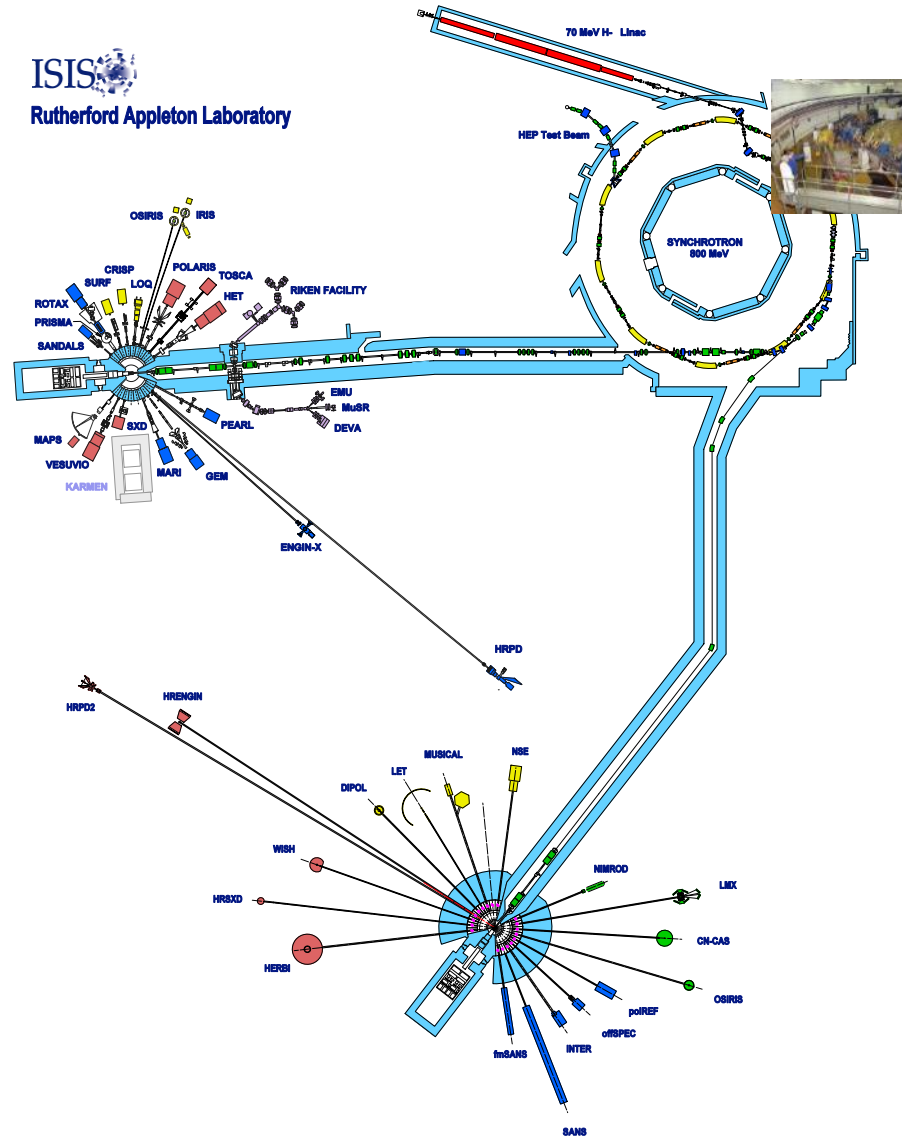
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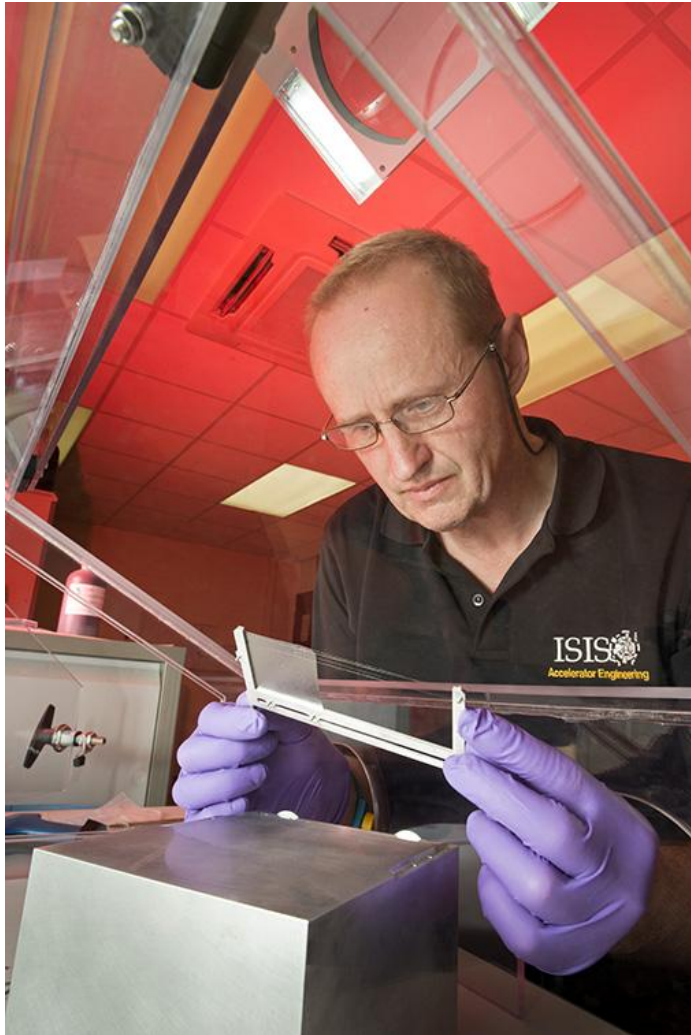
## ISIS Rutherford Appleton Laboratory







# Carbon Stripping Foils



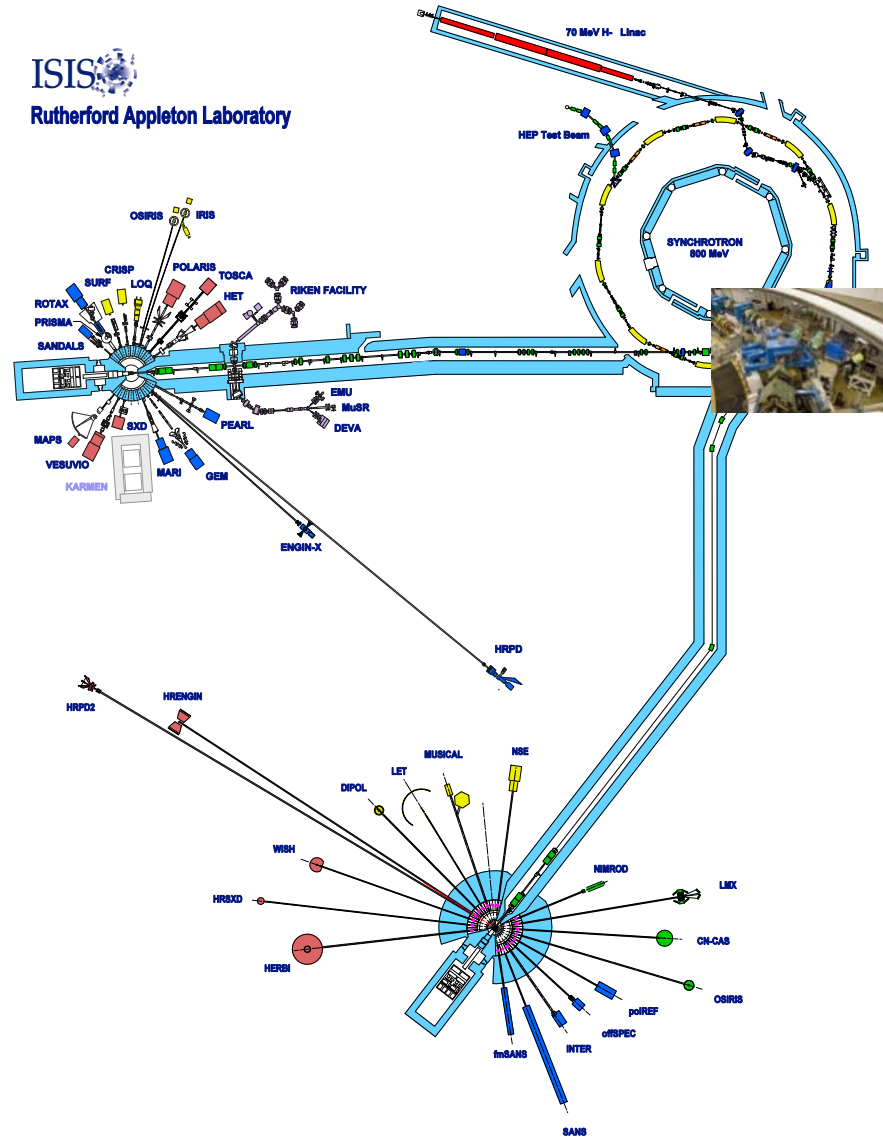
- $H^+$  stripped to  $p^+$  at injection
- Originally alumina foils
- Diamond-like foils supported by carbon fibres
  - Last  $\frac{1}{2}$  a user cycle
- Graphene foil tested
  - Lasted whole cycle unsupported

*Cheaper, faster, safer solution*





## ISIS Rutherford Appleton Laboratory

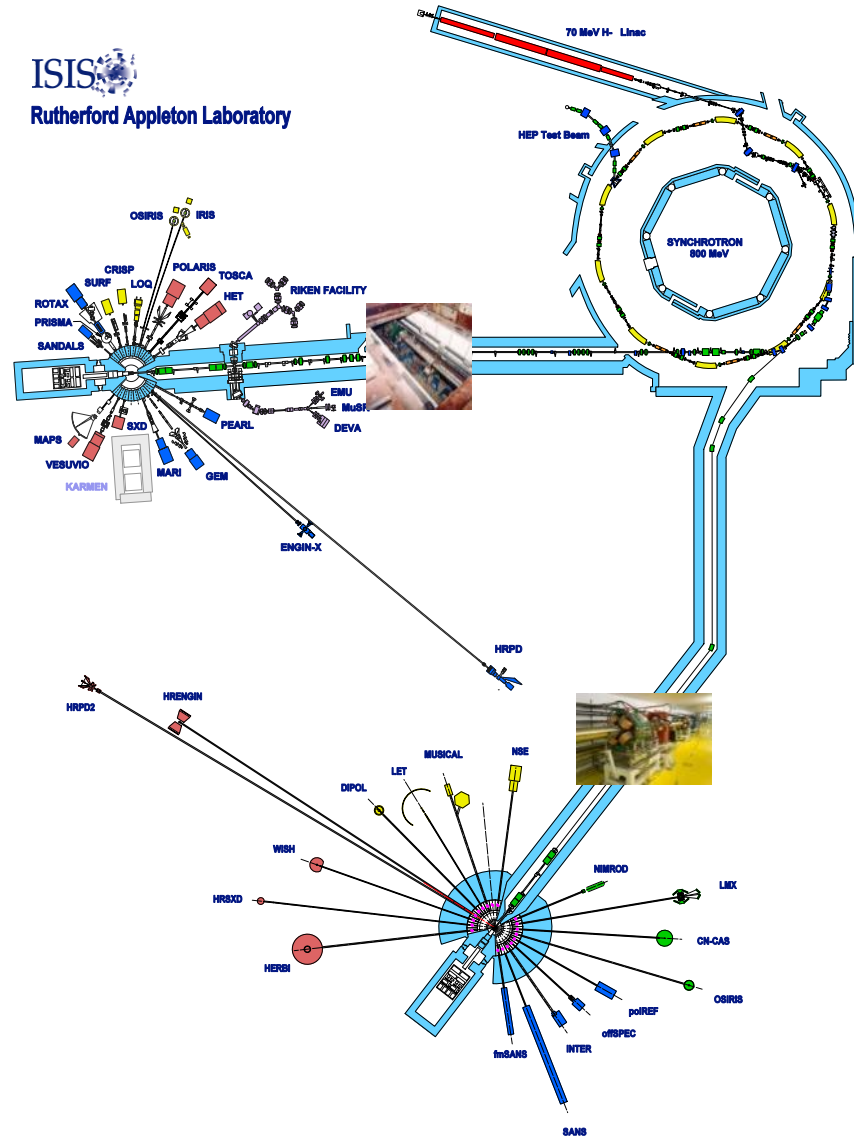








## ISIS Rutherford Appleton Laboratory

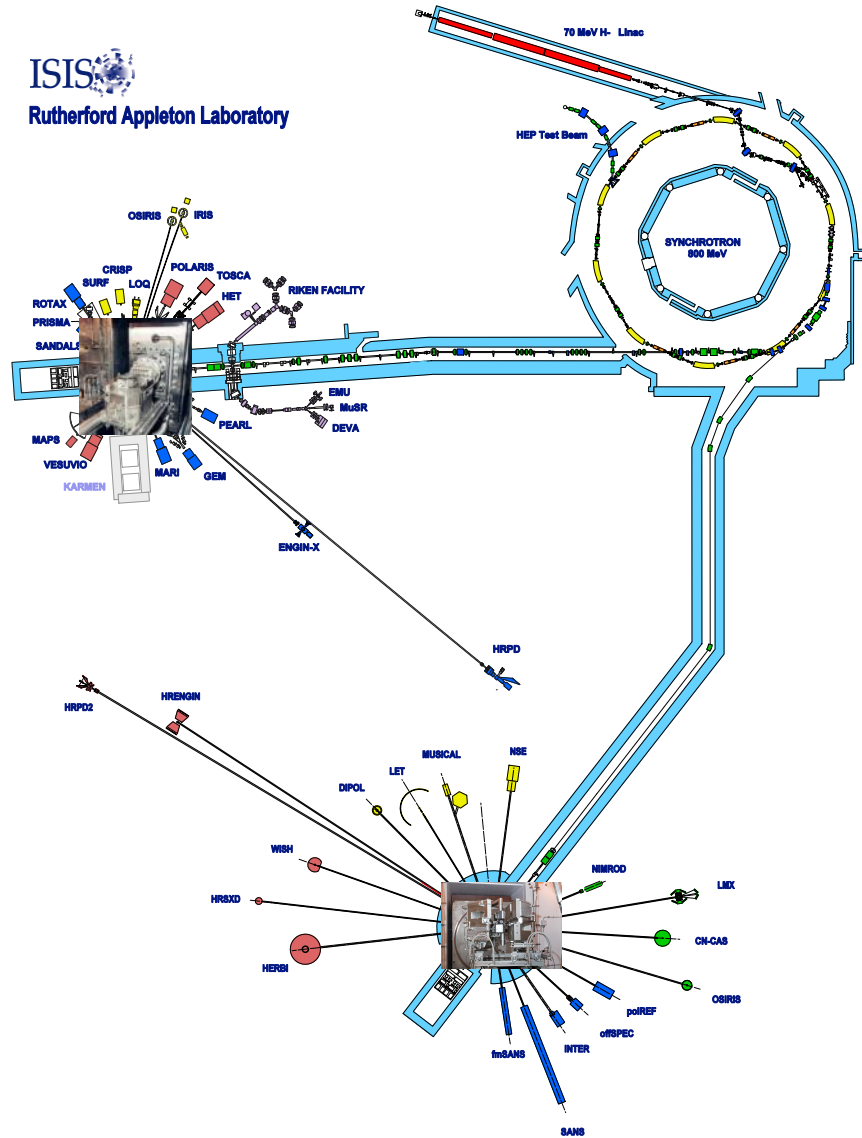








## ISIS Rutherford Appleton Laboratory



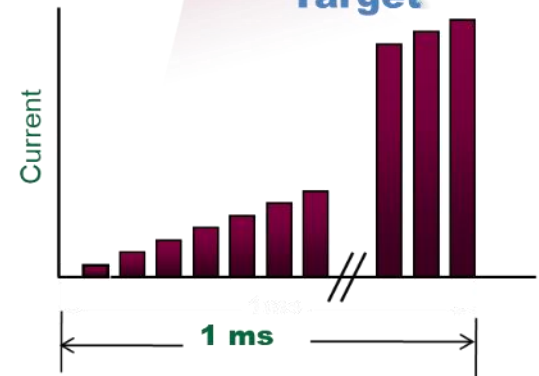
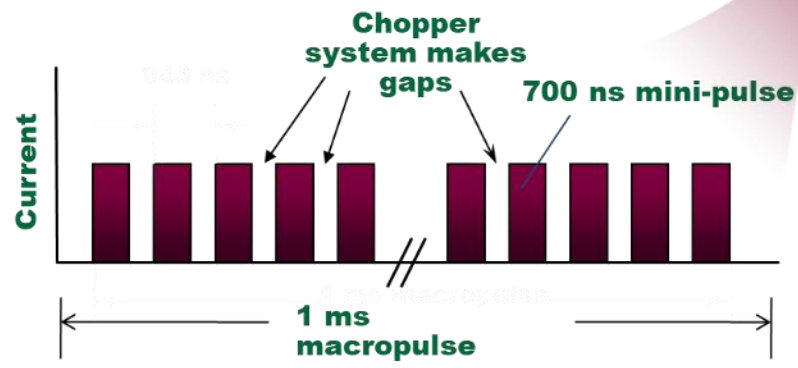
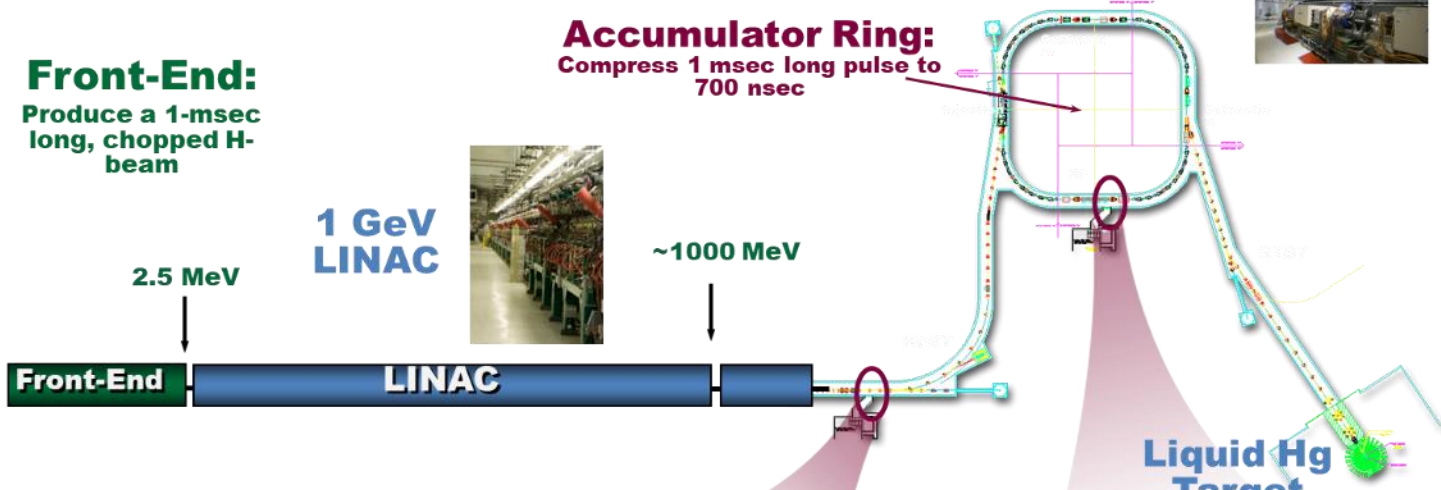


## SNS Accelerator Complex

**Front-End:**  
Produce a 1-msec long, chopped H-beam

**1 GeV LINAC**

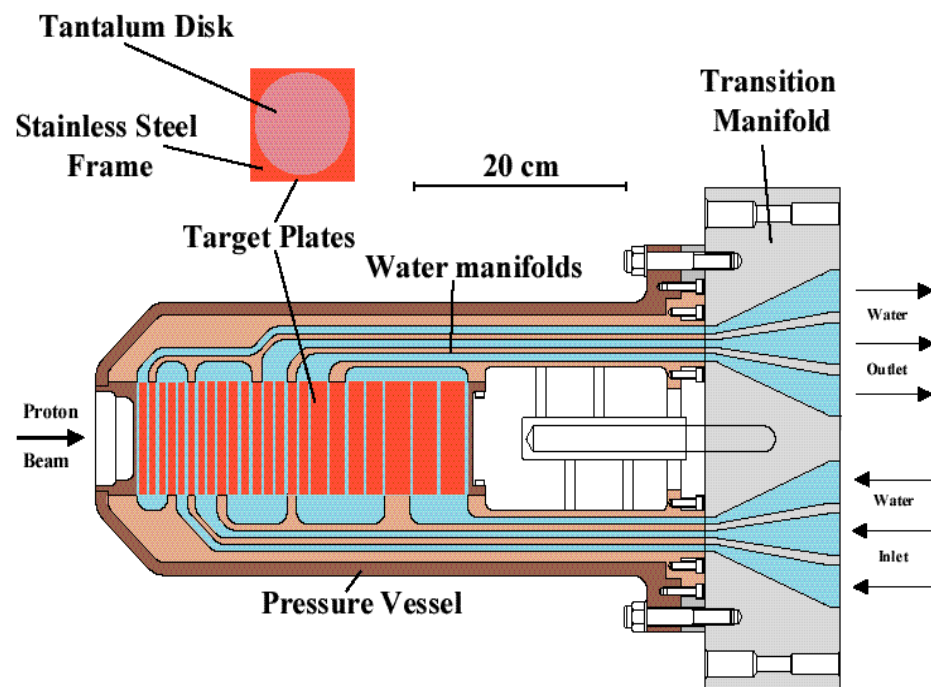
**Accumulator Ring:**  
Compress 1 msec long pulse to 700 nsec





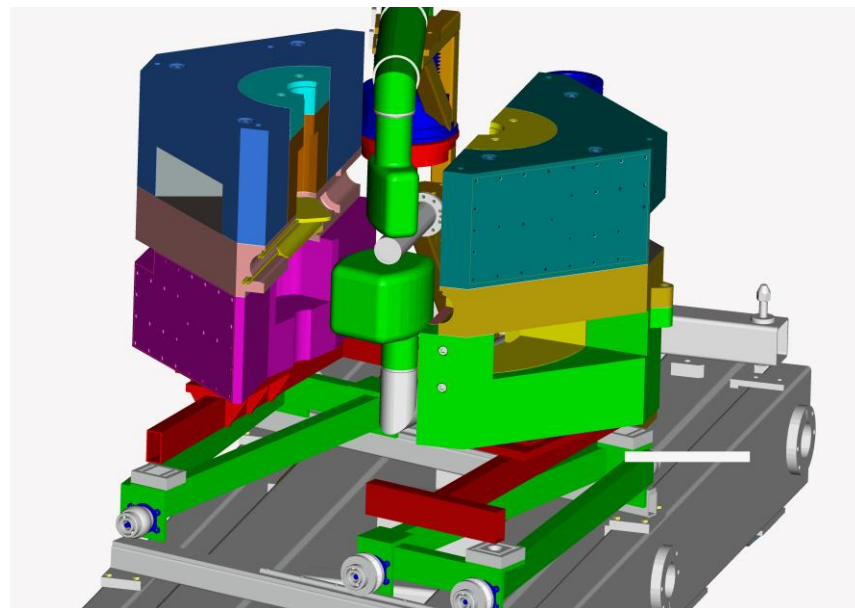
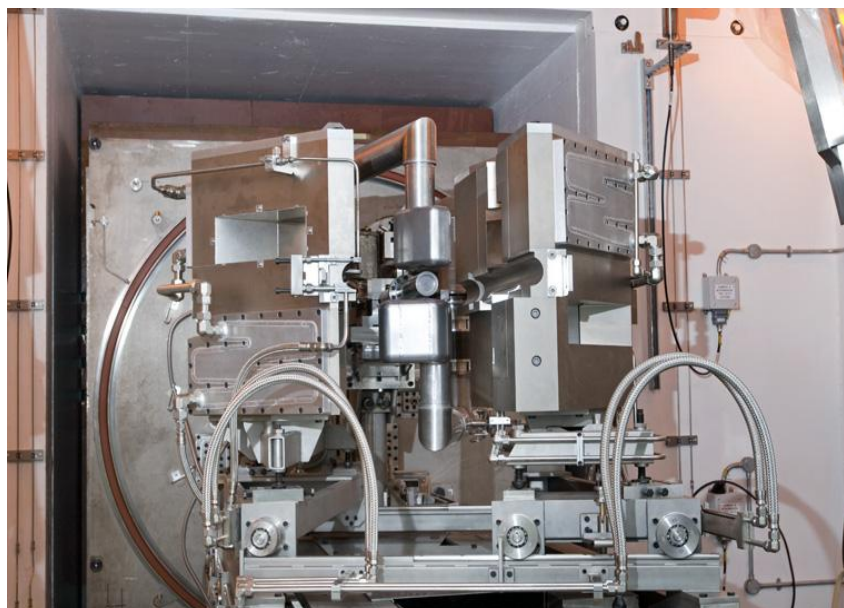


## Targets



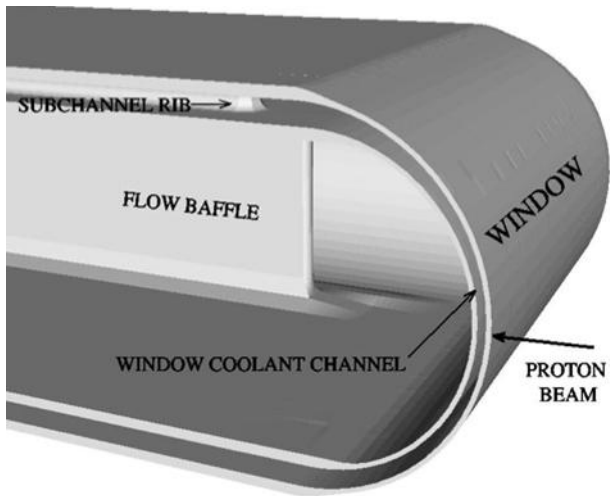
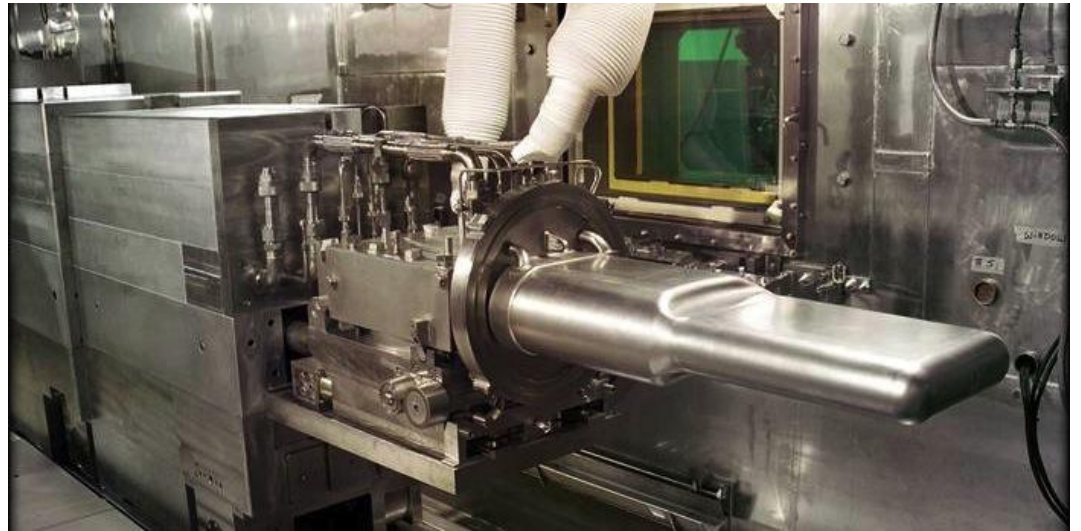


# Targets

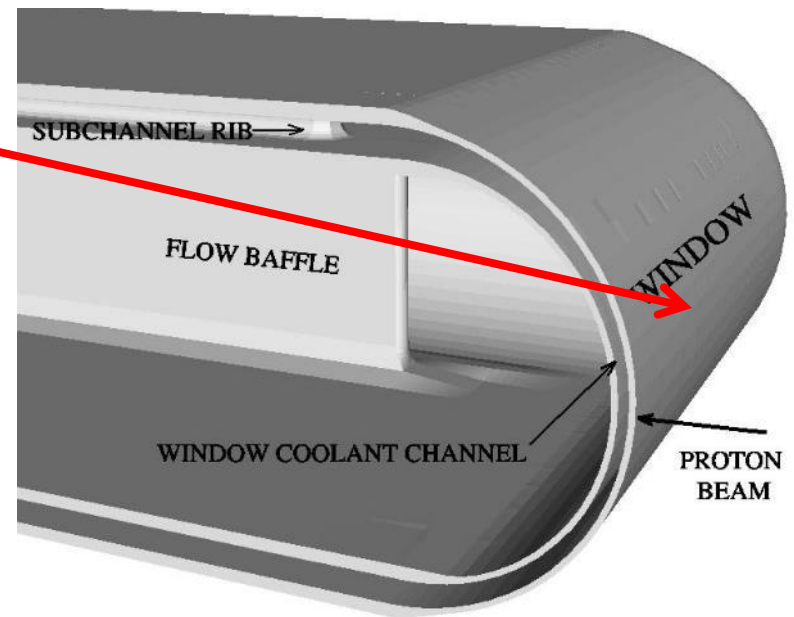
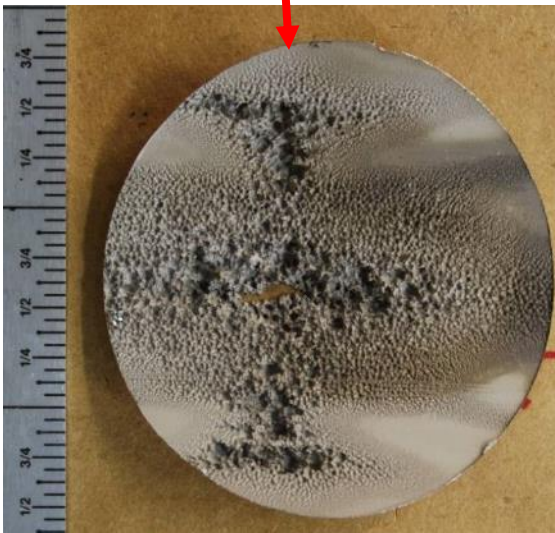
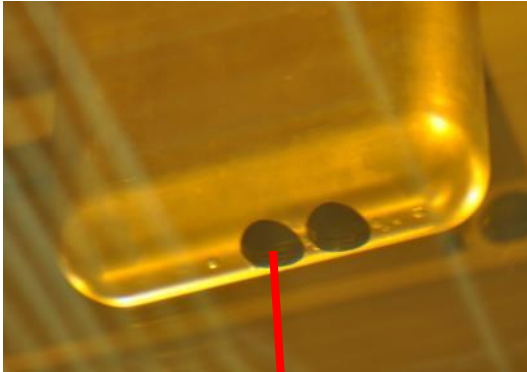




# Liquid Hg target (SNS, JPARC)

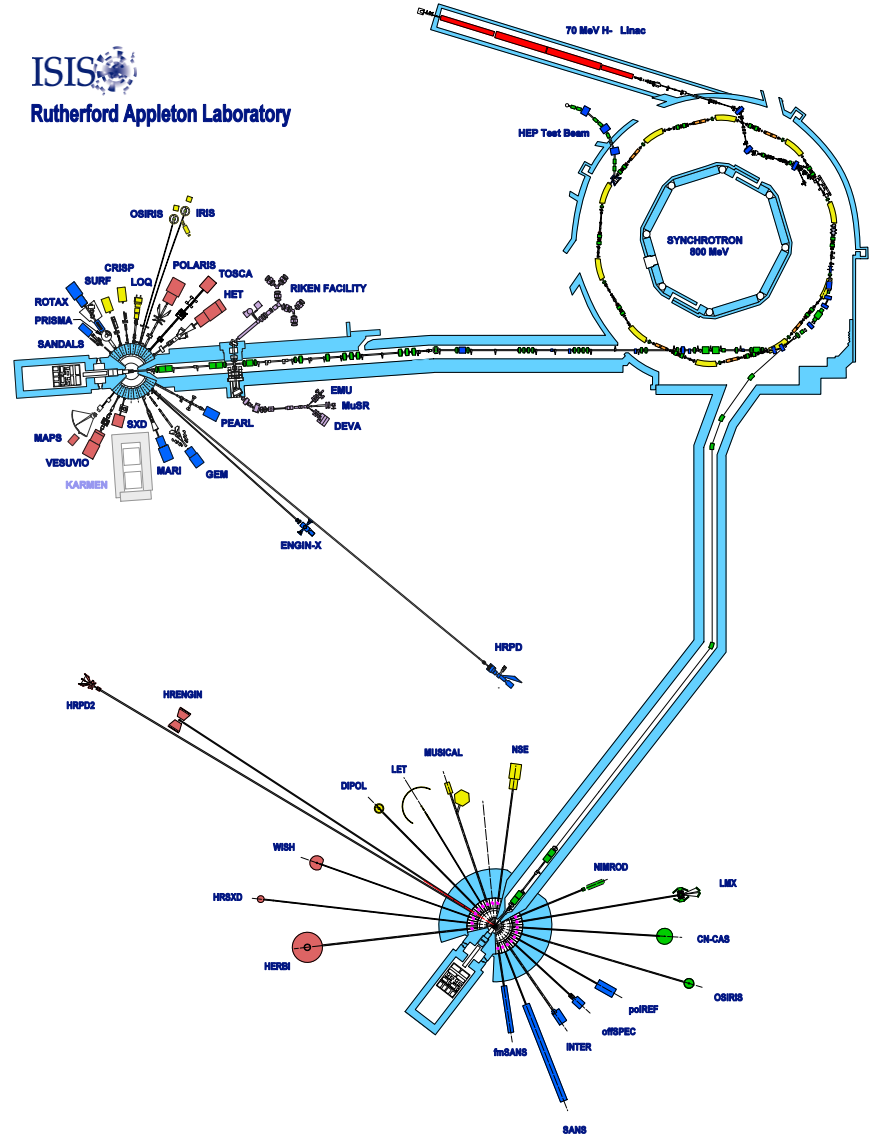
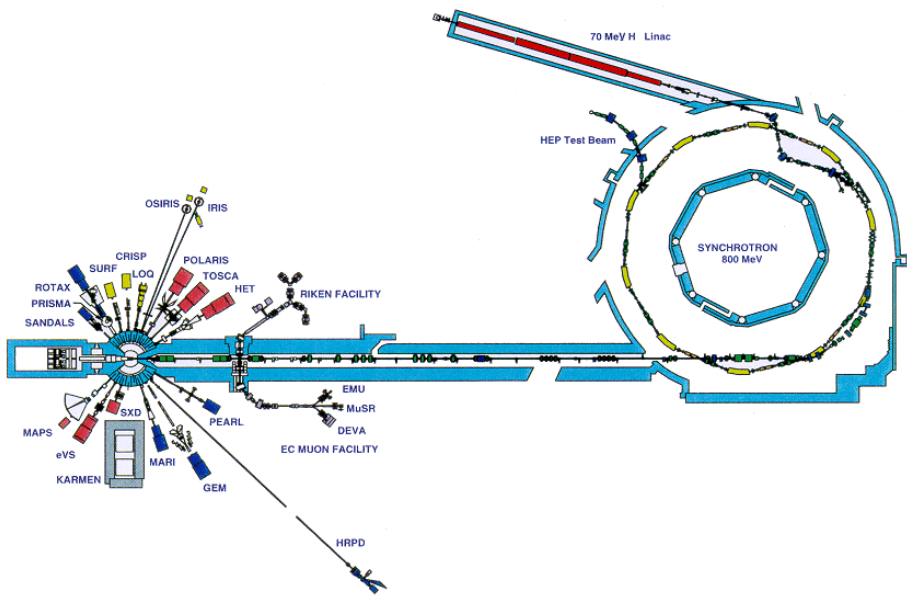


# Liquid Hg target (SNS)





## ISIS Rutherford Appleton Laboratory

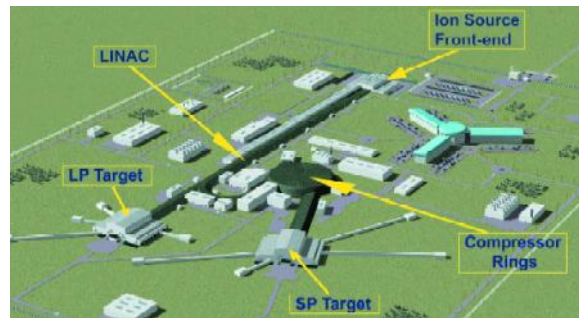


## ESS: The European Spallation Source

ESS workshops: 1991 Juelich, 1992 Cosener's House



1997 4+1 MW 50/10 Hz



2002 5+5 MW 50 Hz SP/16 Hz LP

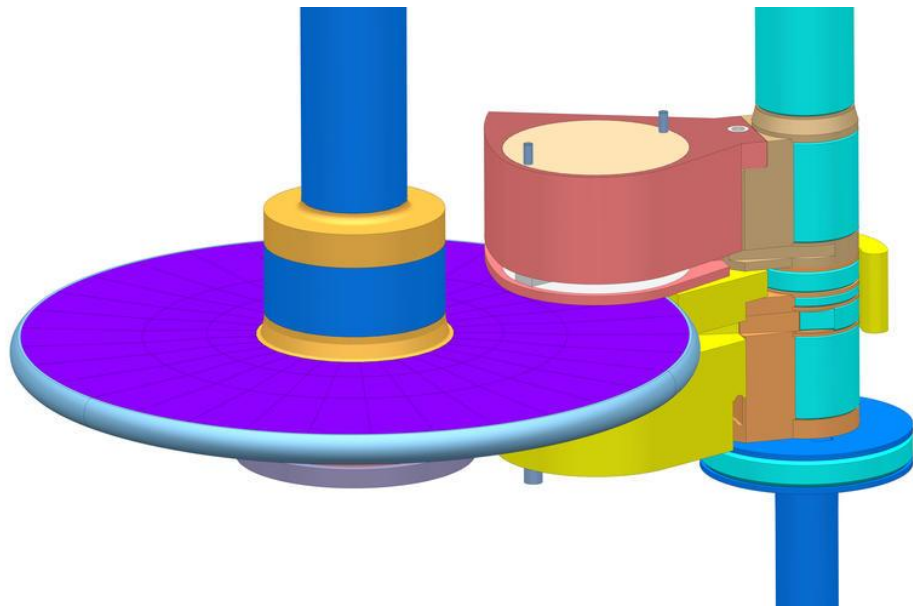
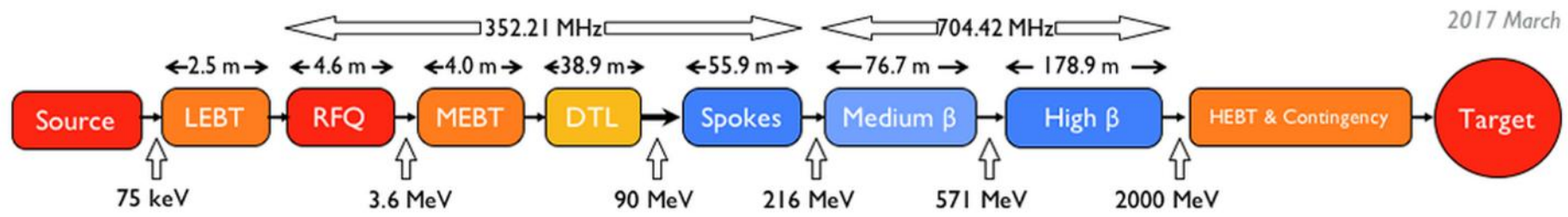


2016 5 MW 16 Hz LP



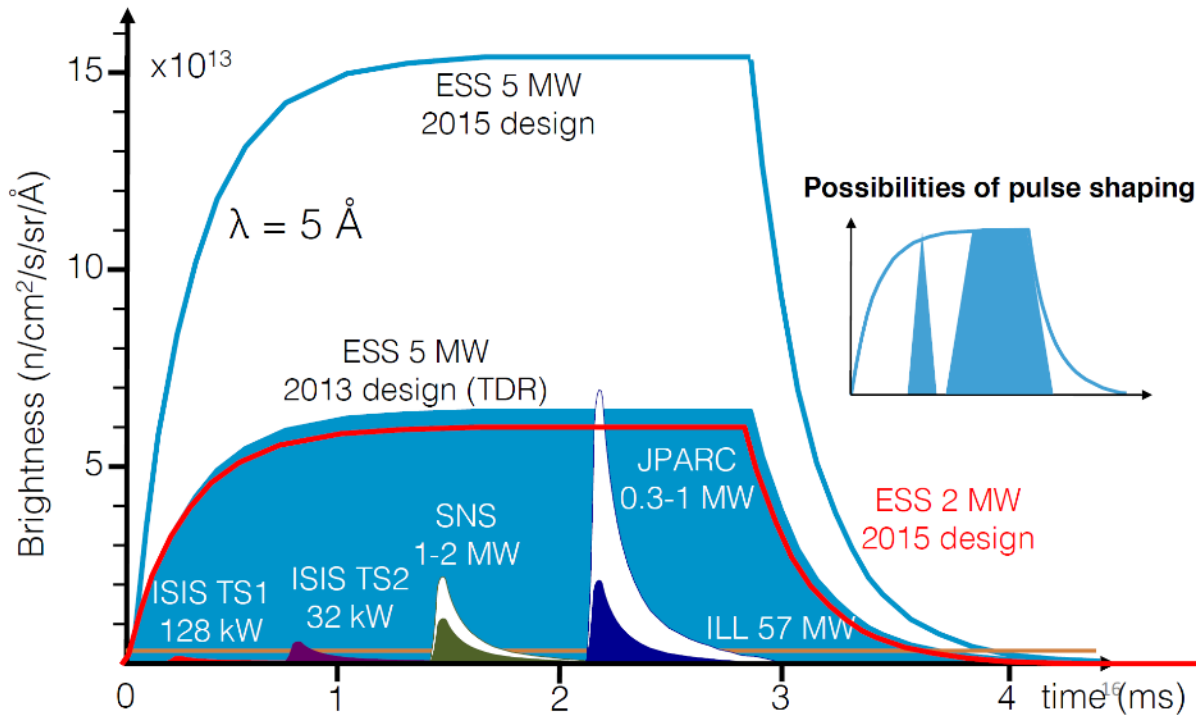


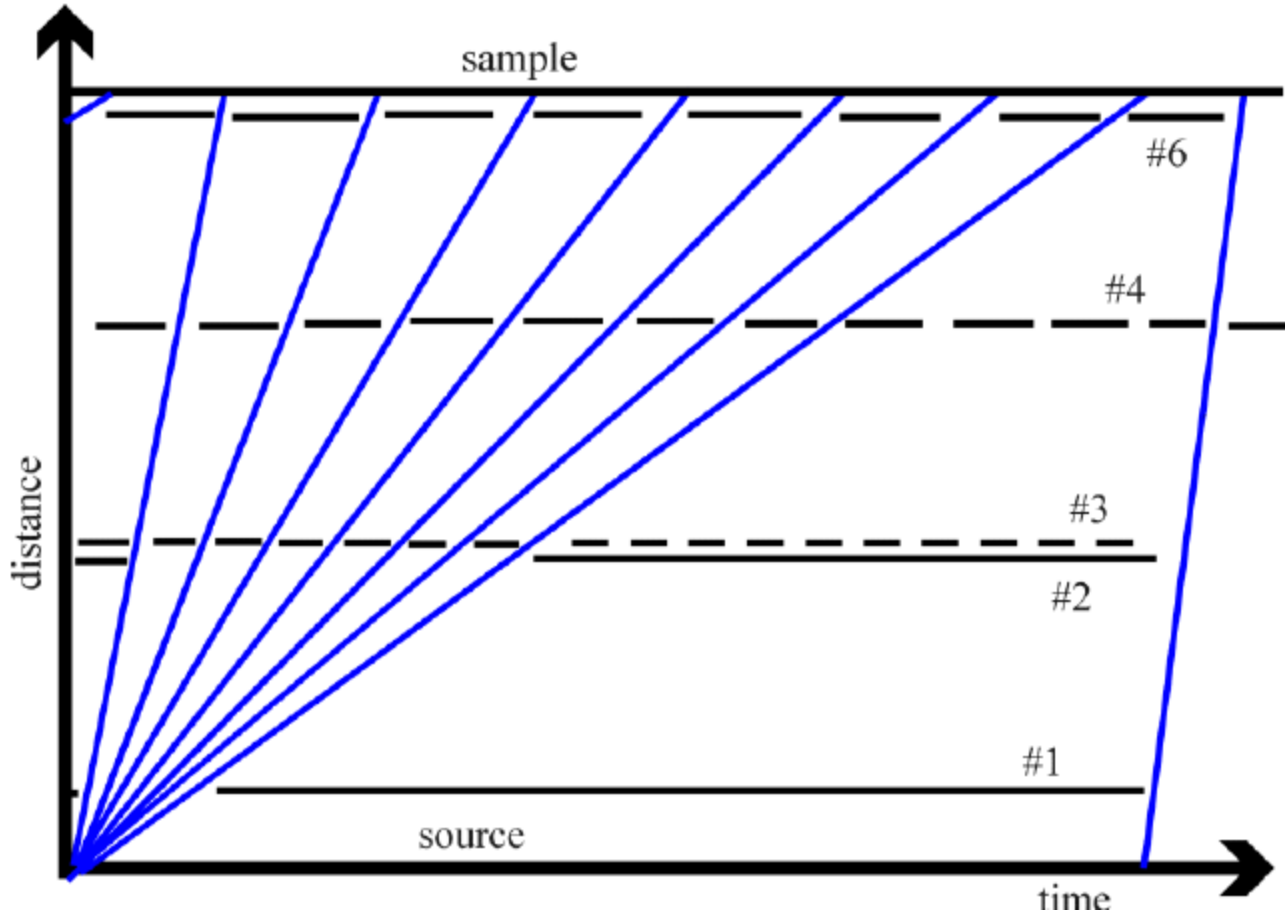






# Long-pulse performance

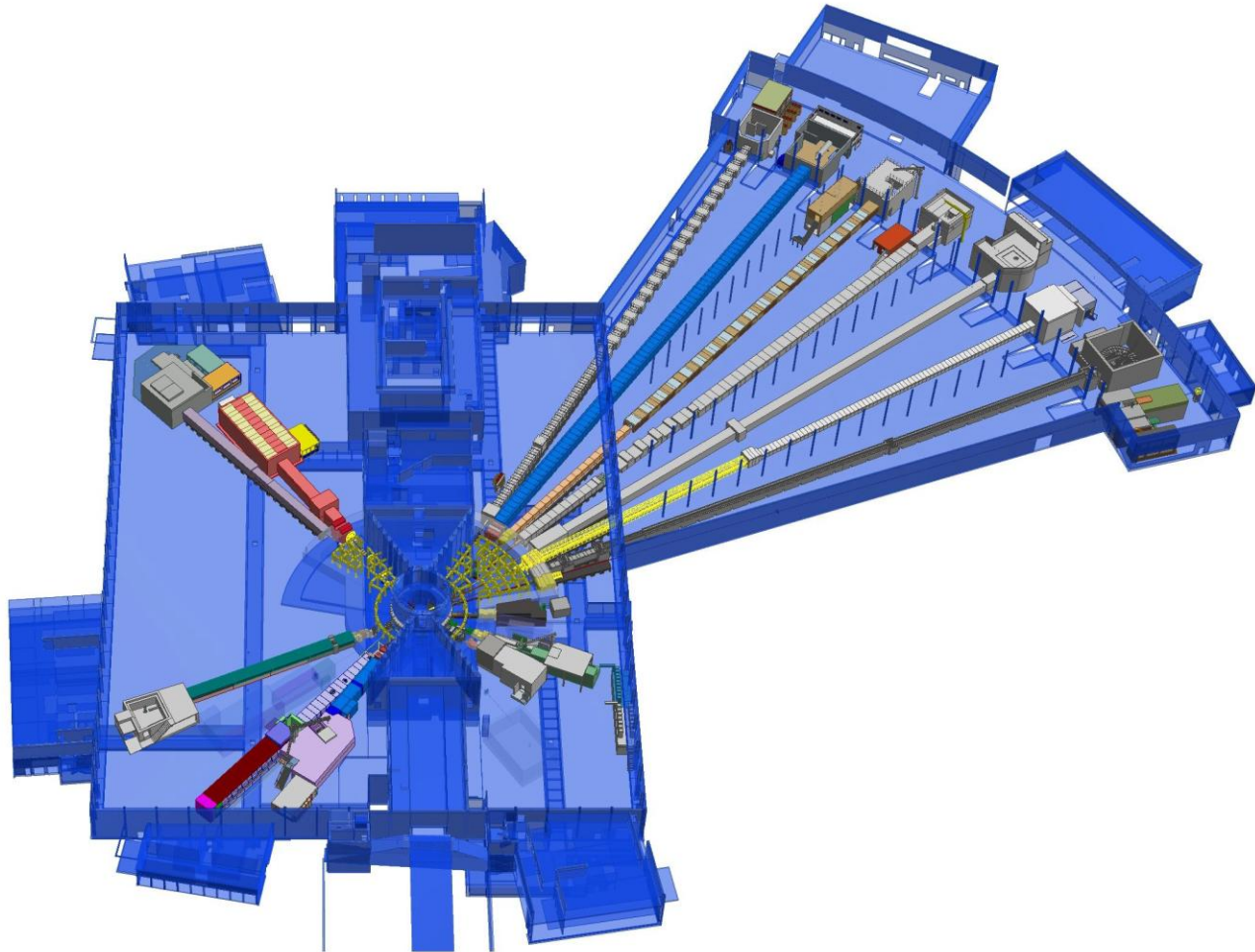




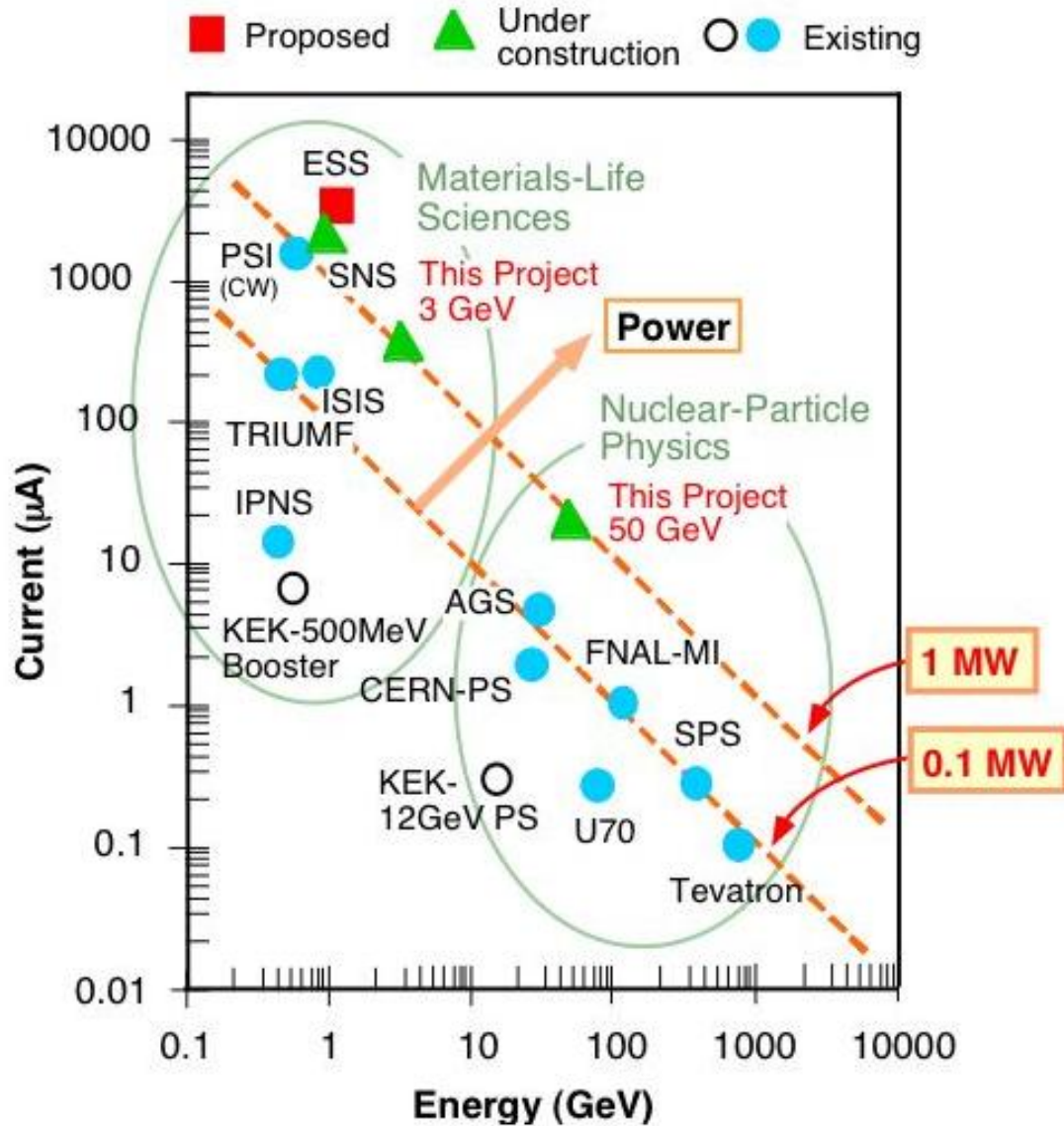


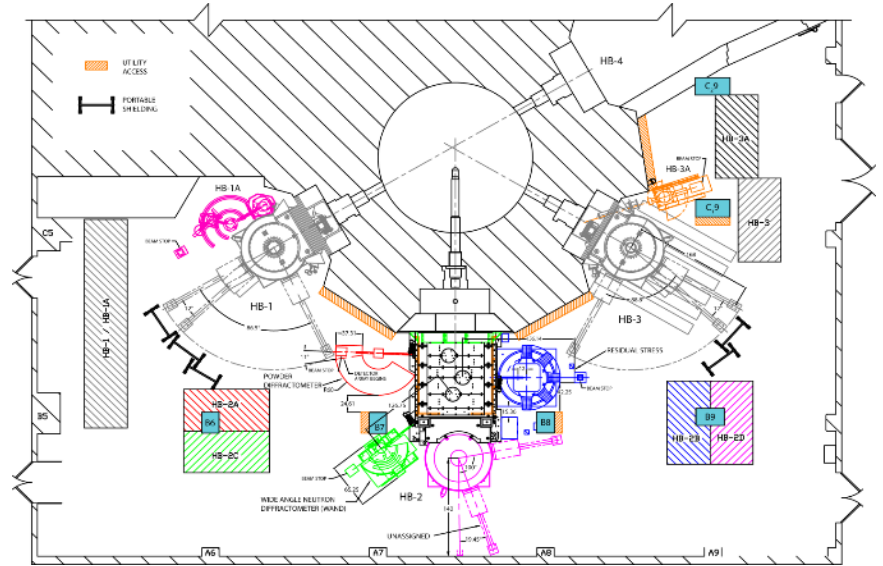
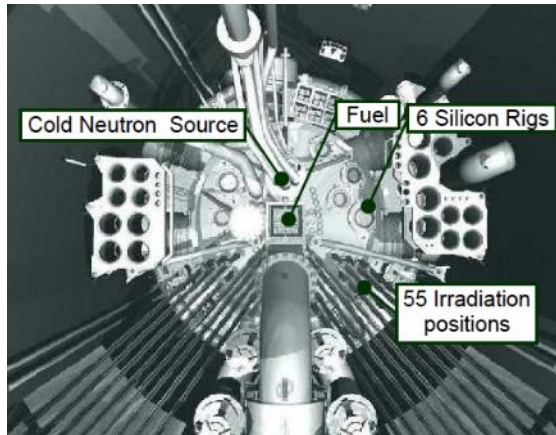
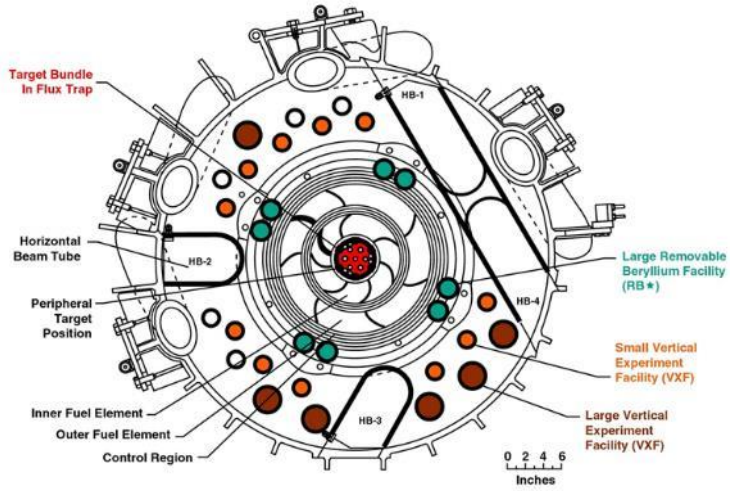
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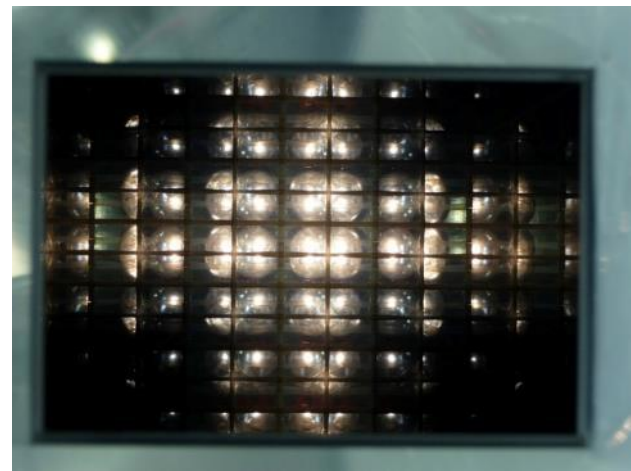
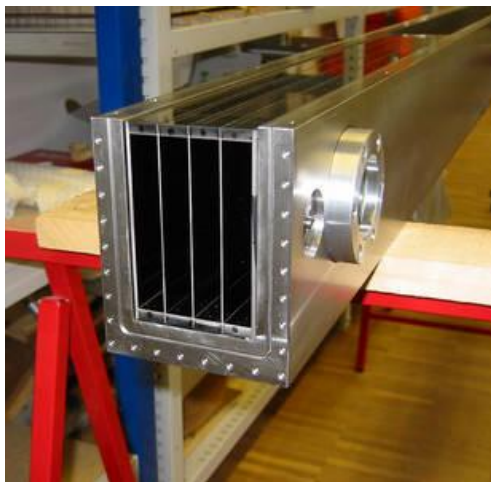
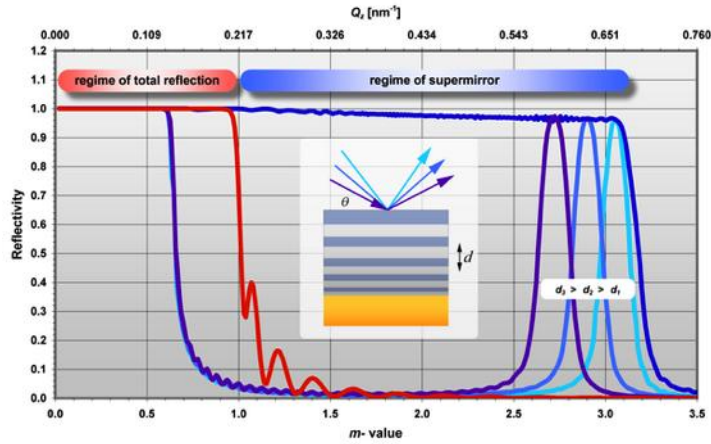






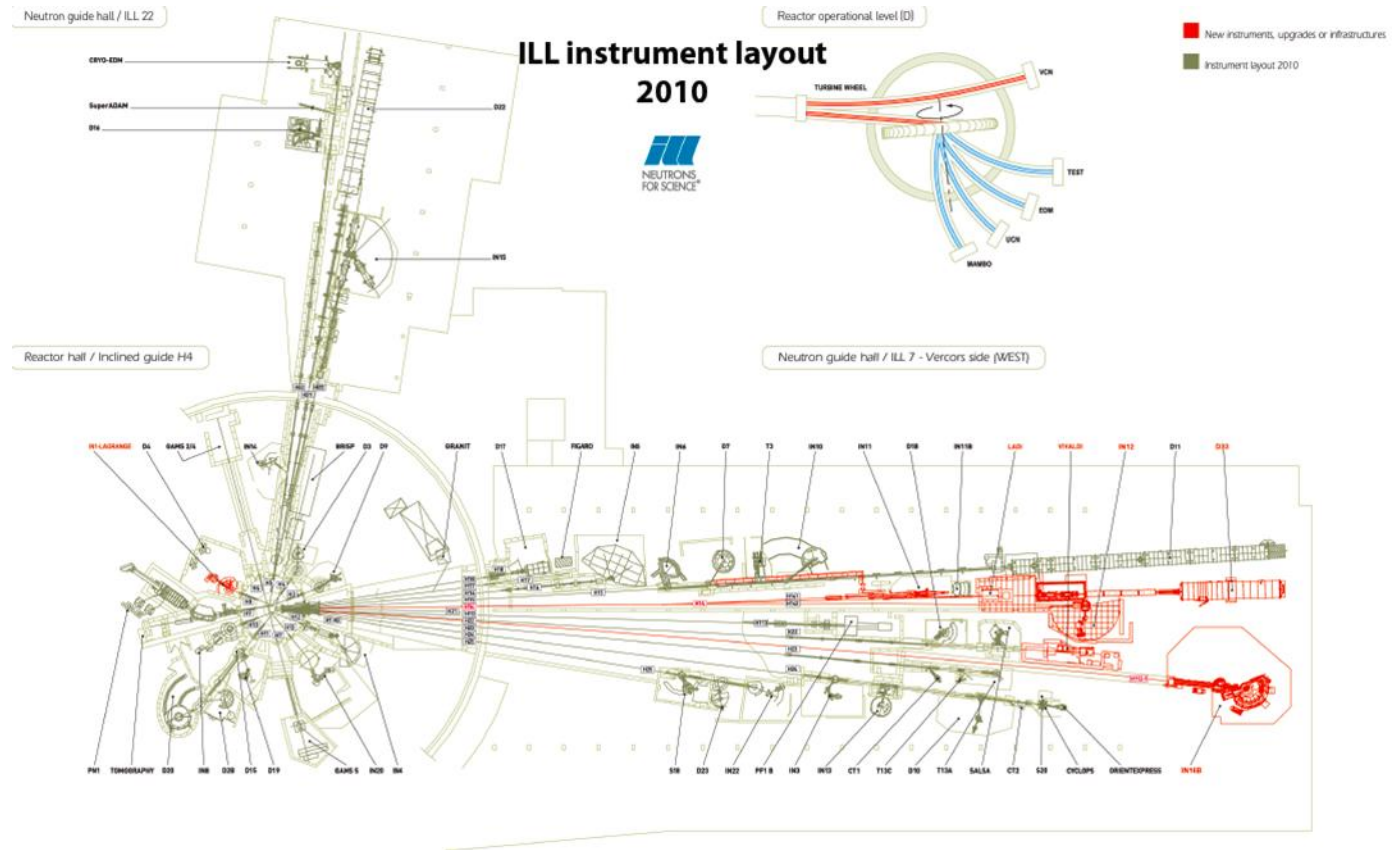


# Guides transformed neutron scattering





# Guides transformed neutron scattering



Continuous sources can build multiple (narrow bandwidth) instruments on a single beamline, for short pulsed sources you can't, for long pulse sources you could





## Where should I go to get neutrons?

<http://neutronsources.org/>

Neutronsources.org  
Your entry into the neutron world

Home About News **Neutron centres** Resources Calendar  
Africa, Asia and Oceania Americas Europe

### Neutron centres

Research centres worldwide use neutrons as probes to investigate diverse properties of a wide range of materials.

Neutron associations support scientists who perform neutron research. These associations can be organised by country or be a joint collaboration between different countries.

Here you can find a dedicated webpage with information about each research centre and neutron association worldwide. Please browse them by continent through the tabs above or by clicking on the map below.



# Europe

## Reactors

Institut Laue Langevin – ILL (France – *member countries or collaborations only*)

Heinz Maier-Leibnitz Zentrum – MLZ (Germany)

- Julich Centre for Neutron Science – JCNS
- Forschungs-Neutronenquelle Heinz Maier-Leibnitz - FRM-II

Laboratoire Leon Brillouin – LLB (France)

Helmholtz-Zentrum Berlin – HZB (Germany)

Budapest Neutron Centre – BNC (Hungary)

Nuclear Physics Institute – NPI (Czech Republic)

## Spallation sources

ISIS (UK)

Swiss Spallation Neutron Source – SINQ (Switzerland)

European Spallation Source – ESS (Sweden – *under construction*)



# ILL (France)

(Access only available for PIs from partner countries)

ILL :: Neutrons for science : The world's flagship centre for neutron science - Internet Explorer

https://www.ill.eu/

ILL :: Neutrons for science : ... x

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More than simply neutrons

NEUTRONS FOR SCIENCE  
Welcome to the Institut Laue-Langevin  
The world leader in neutron science and technology

The Institut Laue-Langevin is an international research centre based in Grenoble, France.

At the leading edge of neutron science and technology, it operates one of the most intense neutron sources in the world. [more]

To know more about ILL, see the FAQ

Site entrance  
The site entrance is now located at 71 avenue des Martyrs. See interactive map of the site below, and more information here.

New brochure on 'Neutrons and energy'  
The main challenge for the COP21 conference in Paris next December is the transition to a lower-carbon economy. To combat global warming we need more efficient means of harnessing natural energy. The solutions often involve advanced materials with complex structures - and to understand these we need neutrons and neutron technology. You can find examples of the ILL's work in this domain in its recently published "Neutrons and energy" brochures.

Colloquia at ILL  
The ILL runs a colloquium series at which prestigious speakers are asked to give exciting and accessible talks of general interest to scientists having a wide range of backgrounds. In the past, ILL colloquia have included the Astronomer Royal, the editor of Nature or Hélène Langevin-Joliot. More information on past and future colloquia here.

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Scientific news

05.08.15 Solving a long-standing atomic mass difference puzzle paves way to the neutrino mass [more]

05.08.15 Superionic conductor for fuel cells  
An alternative material for use in fuel cells has been probed by the ILL. A publication in Physical... [more]

08.07.15 Sizing up for spintronics  
Neutrons have been used to directly observe the behaviour of tiny magnetic 'chains' that could find... [more]

General information

18.06.15 Revised 2015 reactor schedule [more]

25.05.15 EU supports the neutron science community: SINE2020 granted [more]

ILL general presentation film



# ILL (France)

(Access only available for PIs from partner countries)







# ILL (France)

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https://www.ill.eu/fileadmin/users\_files/Other\_Sites/YellowBook2008CDRom/page/pg.htm?rub=1\_3 - Internet Explorer

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The Yellow Book 2008 Contents > The ILL Instruments

Experimental facilities at the ILL

Reactor operational level (D)

Neutron guide hall ILL 22

Reactor hall Inclined guide H4

Reactor hall ILL 5 Experimental level (C)

Neutron guide hall - ILL 7 Vercors side (WEST)

Neutron guide hall - ILL 7 Chartreuse side (EAST)

Layout

Start

10:29 29/08/2015



## MLZ (Germany)

Home - MLZ - Heinz Maier-Leibnitz Zentrum - Internet Explorer

MLZ http://www.mlz-garching.de/englisch

File Edit View Favorites Tools Help

Google miz germany

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

**MLZ** Heinz Maier-Leibnitz Zentrum  
Neutrons for Research, Industry and Medicine

- Collaborating Institutes
- Neutron source FRM II
- Getting to MLZ
- Phone Book
- Imprint

MLZ is a cooperation between:

- TUM Technische Universität München
- Heimholtz-Zentrum Geesthacht
- JÜLICH FUSIONENERGIE-KOLLEKTOR

About MLZ News & Media Neutron Research Instruments Science & Projects Industry & Medicine User Office

29.08.2015 Source: Forschungs-Neutronenquelle Heinz Maier-Leibnitz

### Neutrons decrypt the dynamics of magnetic helices

Manganese silicon is the preferred crystal of scientists going in for magnetic research: it can be manufactured for some time as relatively large single crystal, and is particularly suited to investigate the magnetic properties. Now theoretical and experimental physicists from the TU Munich, the MLZ and the University of Cologne managed to pull off a special coup with this material.

[read more](#)

28.08.2015 Source: ESS, European Spallation Source, Lund, Sweden

### Brilliant Future for Neutron Research

As of today, the European Union rises the neutron source European Spallation Source (ESS) in Lund, Sweden, which is under construction, to a European Research Infrastructure Consortium (ERIC).

Events

- Conference: 35th Symposium on Dynamical Properties of Solids (DyProSo2015) 13.09.2015 - 17.09.2015
- School: MATRAC Schools - Application of Neutrons and Synchrotron Radiation in Engineering Materials Science 21.09.2015
- Workshop: JCMS Workshop 2015 05.10.2015 - 08.10.2015
- Workshop: Soft Matter & Neutrons GO Energy 08.10.2015 - 09.10.2015

[Show all](#)

Third edition of "Experimental facilities" available

The essential guide for all users and those aspiring to be!

Start | 10:32 29/08/2015



## MLZ (Germany)

MLZ Instrument Suite

Legend:

- FZJ (red)
- TUM (orange)
- HZG (green)
- HZG/TUM (light green)
- MPG (pink)
- FZJ/TUM (light red)

Neutron Guide Hall West

Experimental Hall

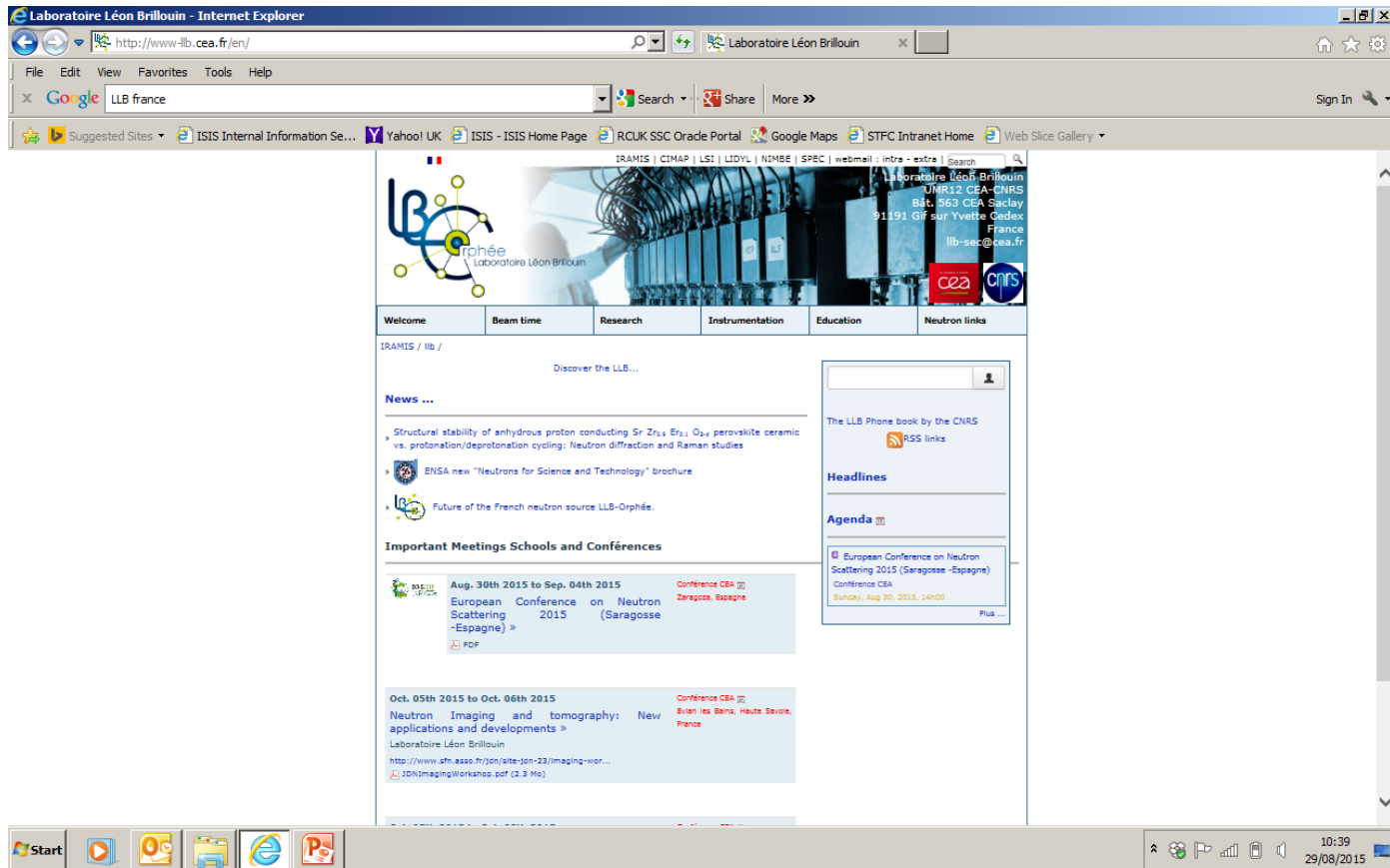
Neutron Guide Hall East

MLZ Instruments according to partners (FZJ - Forschungszentrum Jülich, TUM - Technische Universität München, HZG - Helmholtz-Zentrum Geesthacht, MPG - Max Planck Society)

Start | 10:38 | 29/08/2015



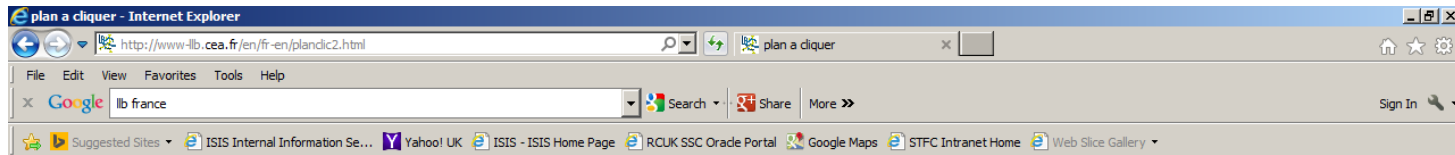
## LLB (France) (reduced operation from 2016, closed from 2019)



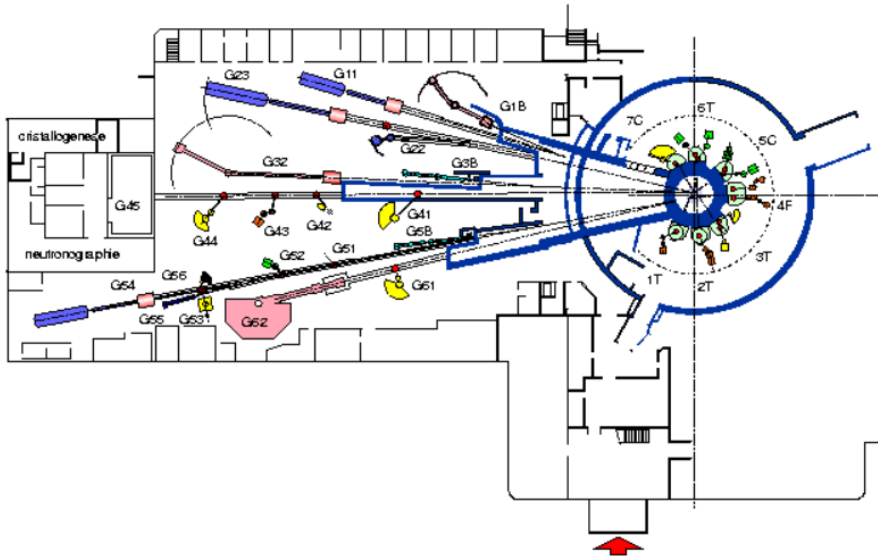




# LLB (France) (reduced operation from 2016, closed from 2019)



## IMPLANTATION GENERALE DES SPECTROMETRES





## HZB (Germany) (reduced operation from 2016, closed from 2019)

The screenshot shows the HZB website in Internet Explorer. The browser address bar displays [https://www.helmholtz-berlin.de/index\\_en.html](https://www.helmholtz-berlin.de/index_en.html). The page features the HZB logo (Helmholtz Zentrum Berlin) and a search bar with the placeholder text "enter search item, press return". Navigation tabs include Overview, Neutron and photon source, Research, User Access, Offers, News, and Media Centre. The main content area includes a large photograph of the BESSY II facility and a text block titled "BESSY II" describing it as a Berlin-based electron storage ring. A sidebar titled "Quick Access for Visitors" contains dropdown menus for Users Information, Industry and Public Institutions, Press Information, Vacancies, Proton Therapy, Visitors, Students and PhD, Perspective, and Research for Society. The footer includes a "Social Media" section with links to Facebook, Twitter, YouTube, RSS, Instagram, and a blog. A central "Welcome to the Helmholtz-Zentrum Berlin" section provides an overview of the facility's research focus on materials and complex material systems. A "Media Centre" section offers a gallery of images and videos. The Windows taskbar at the bottom shows the Start button, several application icons, and the system tray with the date 29/08/2015 and time 10:43.



# HZB (Germany) (reduced operation from 2016, closed from 2019)

Instruments BER II - Internet Explorer

https://www.helmholtz-berlin.de/quellen/ber/instruments-neutrons/index\_en.html

File Edit View Favorites Tools Help

Google hzb germany

Suggested Sites: ISIS Internal Information Se..., Yahoo! UK, ISIS - ISIS Home Page, RCLUK SSC Orade Portal, Google Maps, STFC Intranet Home, Web Slice Gallery

[Sitemap](#)
[Contact](#)
[Imprint](#)
[My Intranet](#)

**HZB** Helmholtz Zentrum Berlin

- Neutron and photon source
- Neutron source
- Research Reactor BER II
- Instruments BER II**
  - Experimental Hall
  - Neutron Guide Hall
  - Operation BER II
  - High Field Magnet

**Complex neutron experiments under extreme conditions at BER II**

HZB offers access to a great variety of **neutron instruments** for complex experiments under extreme conditions. Both thermal and cold neutrons are available. Instruments provided with thermal neutrons are located in the **Experimental Hall**, instruments provided with cold neutrons are located in the **Neutron Guide Hall**. An exception is the diffractometer EXED in the Neutron Guide Hall, which can be operated both with thermal and cold neutrons.

Users who are unsure which is the most appropriate **instrument** for their experiment should contact the User Office for help.


In order to achieve those extreme conditions, HZB is placing a special emphasis on **sample environment** for e.g. high magnetic fields, high pressures, high to ultra low temperatures – and combinations thereof.

**Downloads**

- [Floorplan 2011](#) (PDF, 637 KB)
- [the complete BENSIC instrumentation brochure \(April 2007\)](#) (PDF, 6 MB)

**Beamtime Coordination**

**Dr. Astrid Brandt**

 ☎ (030) 8062-42100 ☎ (030) 8062-14732 ✉ [Email](#)

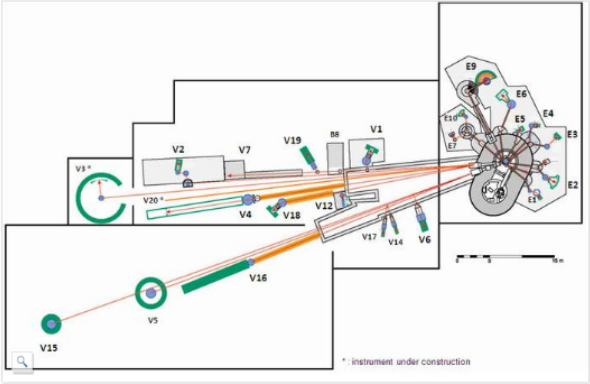
**Links**

- [User Access](#)
- [Sample Environment](#)
- [Badge](#)

**Social Media**

- [HZBde Facebook](#)
- [HZBde Twitter](#)
- [HZB Youtube](#)
- [RSS](#)
- [HZB Instagram](#)
- [HZBlog](#)

**Floorplan BER II**



\* Instrument under construction

Floorplan BER II

Start | 10:44 | 29/08/2015



## BNC (Hungary)

**Budapest Neutron Centre ...for research, science and innovation!**  
Association of the KFKI Research Institutes Centre for Energy Research – Wigner Research Centre for Physics

Facebook Youtube DENIM 2015

- Neutron Source
- Instruments
- Science at BNC
- About us
- Partners

SEARCH

Search

- Events
- Schedule
- User's Area
- Publications
- Gallery
- Accomodation
- How to reach KFKI Campus/BNC
- Restaurants

CONTACT

10:49  
29/08/2015





## BNC (Hungary)

Instruments | Budapest Neutron Centre ...for research, science and innovation! - Internet Explorer

http://www.bnc.hu/?q=node/7

File Edit View Favorites Tools Help

Google Search Share More Sign In


Suggested Sites: ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Orade Portal Google Maps STFC Intranet Home Web Slice Gallery

PGAA; Prompt Gamma Activation Analysis

REF; Polarisated Beam Neutron Reflectometer

GINA; Polarized Reflectometer

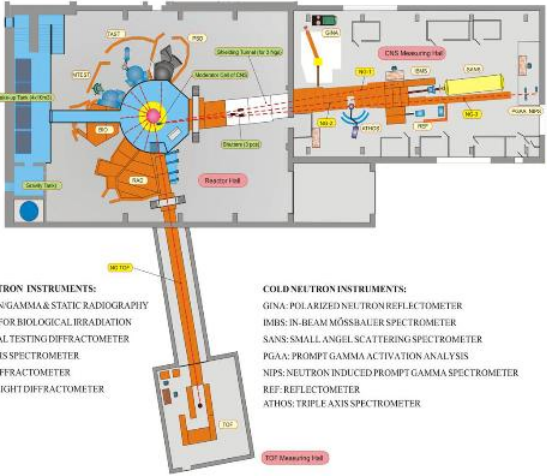
NRAD; Dynamic n/y Radiography, Static Radiography



ADMINISTRATOR

Request new password

in



**THERMAL NEUTRON INSTRUMENTS:**

- RAD-DYNAMIC N/GAMMA & STATIC RADIOGRAPHY
- BIO-PORT USED FOR BIOLOGICAL IRRADIATION
- MTEST: MATERIAL TESTING DIFFRACTOMETER
- TAST: TRIPLE AXIS SPECTROMETER
- PSD: POWDER DIFFRACTOMETER
- TOF: TIME-OF-FLIGHT DIFFRACTOMETER

**COLD NEUTRON INSTRUMENTS:**

- GINA: POLARIZED NEUTRON REFLECTOMETER
- IMBS: IN-BEAM MÖSSBAUER SPECTROMETER
- SANS: SMALL ANGLE SCATTERING SPECTROMETER
- PGAA: PROMPT GAMMA ACTIVATION ANALYSIS
- NIPS: NEUTRON INDUCED PROMPT GAMMA SPECTROMETER
- REF: REFLECTOMETER
- ATHOS: TRIPLE AXIS SPECTROMETER

10:50  
29/08/2015



# NPI (Czech Republic)

Internet Explorer browser window showing the website for the Nuclear Physics Institute, ASCR, Department of Neutron Physics. The browser address bar shows the URL <http://neutron.ujf.cas.cz/>. The search bar contains the text "npi czech republic".

The website header includes the logo of the Nuclear Physics Institute, ASCR, Department of Neutron Physics, and the logo of The Academy of Sciences of the Czech Republic. A search bar and a "Login" link are also present.

The navigation menu includes: HOME, NEUTRON PHYSICS, NUCLEAR ANALYTICAL METHODS, EXPERIMENTAL FACILITIES, CONTACTS, PROJECTS, EVENTS, LINKS.

The main content area features a "Department of Neutron Physics" section with the following text:

The activity of the Neutron Physics Department has been focusing basically in two directions:

- *Fundamental and Applied Research with Thermal Neutrons at the Reactor LWR-15*
- *Nuclear Analytical Methods with Charged Particles at the Van de Graaff and Tandatron accelerators*

**Fundamental and Applied Research with Thermal Neutrons**

The neutron research has been carried out at five horizontal beam channels of the reactor LWR-15 which are hired at the Research Centre Řež, Ltd. Scattering of neutrons is used to study structure of materials in various size scales, from ordering of atoms in crystal lattice to microscopic heterogeneities on nano- and microscopic scales. High penetration of neutrons in most materials permits to carry out these tests non-destructively in the bulk and/or inside special sample environment (low and high temperatures, mechanical load). Nuclear reactions of neutrons with matter are employed to analyze concentration profiles of light elements in solids. Our experimental facilities are opened to external users. Neutron Physics Laboratory participates in the *Transnational Access to Large Facilities* programme in the frame of FP7 NM3 project where we have offered to European neutron community 5 experimental facilities: Neutron strain scanning, Small-angle neutron scattering, Neutron depth profiling and Neutron activation analysis and Radiative thermal neutron capture.

**Nuclear Analytical Methods with Charged Particles**

Two electrostatic accelerators, old Van de Graaff and new Tandatron 4130 MC are used for modification and characterization of micro- a nano structured materials. Installation of new analytical devices in the Tandatron laboratory is in progress. The RBS-channeling device for analyses of crystalline materials and ERDA-TOP device for depth profiling of light elements were put into routine operation. Ion microprobe, unique in CR, was installed in 2009. The Tandatron based device for high energy ion implantation has been in routine use. The research activities of the group has mainly been concentrated on preparation, modification and characterization of polymer-metal composites (collaboration with Institute of Chemical technology-Prague, the University of J.E Purkyně-Ustí nad Labem and Kazan Physical-Technical Institute-Russia), chalcogenide glasses (University of Pardubice), optical coatings (Institute of Physics AS), B-C-N-Si based hard coatings (University of West Bohemia), bioactive materials (Institute of Physiology AS), diamond-like and siloxan based coatings (Masaryk University, TU Brno). Other activities include the study of diffusion of water solutions in minerals (Nuclear research Institute), development of ion beam based analytical techniques (collaboration with FZR Rosendorf-Germany) and testing of position sensitive detectors (Institute of Technical and Experimental Physics-Prague).

The left sidebar contains a "NEWS" section with a link to "ESS Science Symposium 2012" and a "NEUTRON INSTRUMENTS" section listing various facilities:

- Tandatron
- Research reactor LWR-15
- HK3 - Neutron Analytical Methods
- HK4 - Strain Scanner
- MEREDIT - Powder Diffraction
- MAUD - High Resolution SANS
- HK3b - Neutron Optics
- HK9 - Strain Diffractometer

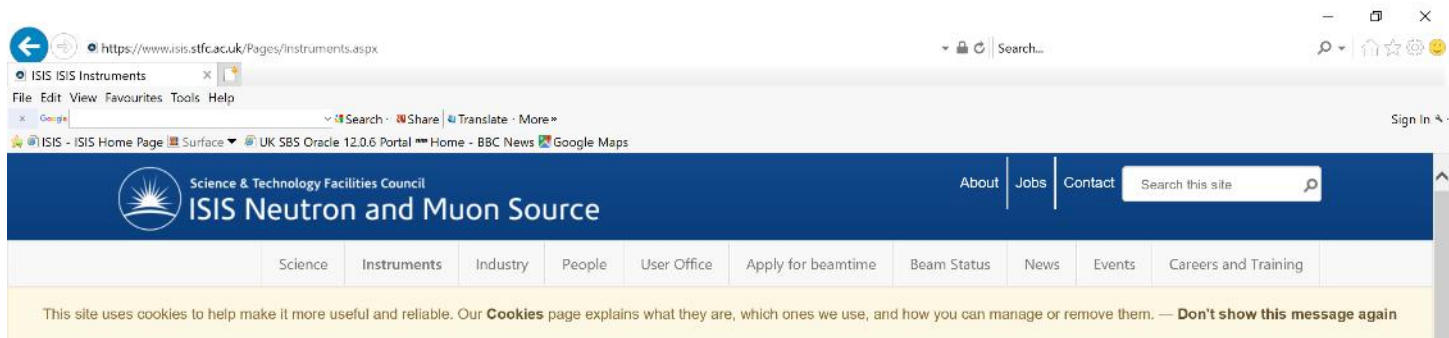
The Windows taskbar at the bottom shows the Start button, several application icons, and the system tray with the date and time: 17:13 29/08/2015.



## ISIS (UK)



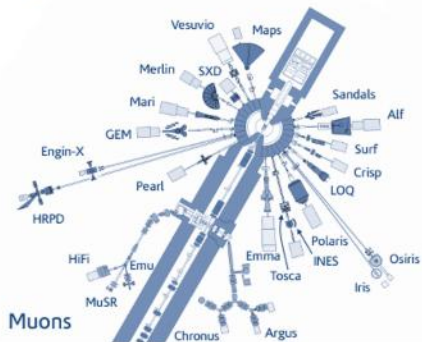
## ISIS (UK)



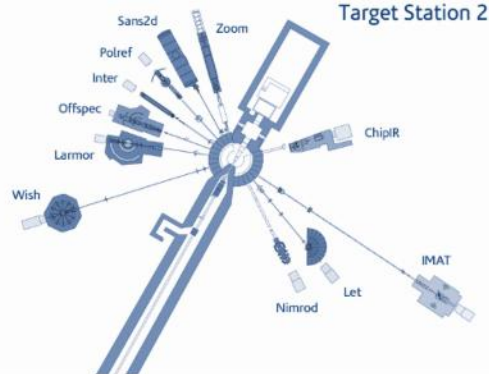
### ISIS Instruments

ISIS Neutron and Muon Source currently has over 30 neutron and muon instruments.

#### Target Station 1



#### Target Station 2







## SINQ (Switzerland)

Paul Scherrer Institut (PSI) :: Swiss Spallation Neutron Source - SINQ - Internet Explorer

http://www.psi.ch/sinq/

File Edit View Favorites Tools Help

Google search:  Search Share More >> Sign In

Suggested Sites: ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

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PUBLIC & MEDIA Explore the world of PSI SCIENTISTS & USERS For the scientific community INDUSTRY & THE ECONOMY Transfer and collaboration opportunities

SINQ PSI Home » Research with Neutrons and Muons (NUM) » SINQ

EDUCATION & JOBS EVENTS INFORMATION MATERIAL EN

Instrumentation  
Access to SINQ  
SINQ Live  
Safety Regulations  
Publications  
The Neutron Source  
Contact



**SINQ: The Swiss Spallation Neutron Source**

Neutron scattering is one of the most effective ways to obtain information on both, the structure and the dynamics of condensed matter. A wide scope of problems, ranging from fundamental to solid state physics and chemistry, and from materials science to biology, medicine and environmental science, can be investigated with neutrons. Aside from the scattering techniques, non-diffractive methods like imaging techniques can also be applied with increasing relevance for industrial applications.

The spallation neutron source SINQ is a continuous source - the first of its kind in the world - with a flux of about  $10^{14}$  n/cm<sup>2</sup>/s. Beside thermal neutrons, a cold moderator of liquid deuterium (cold source) slows neutrons down and shifts their spectrum to lower energies. These neutrons have proved to be particularly valuable in materials research and in the investigation of biological substances. SINQ is a user facility. Interested groups can apply for beamtime on the various instruments by using the SINQ proposal system.

Latest scientific SINQ highlights:

**A new class of chiral materials hosting magnetic skyrmions beyond room temperature**  
Y. Tokunaga et al

Call for Proposals  
Next submission deadline:  
November 15, 2015, 23:59 (CET)  
[More information](#)

SINQ OPERATION STATUS

- Accelerator Status
- Experiment Schedule

NUM  
LNS  
LDM  
SINQ operation

PSI User Facilities Newsletter  
Current News from PSI photon, neutron and muon user facilities

Start | 10:56 29/08/2015



# SINQ (Switzerland)

Paul Scherrer Institut (PSI) - Instrumentation - Internet Explorer

http://www.psi.ch/sinq/instrumentation

File Edit View Favorites Tools Help

Google sinq psi Search Share More >> Sign In

Suggested Sites: ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

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SINQ EDUCATION & JOBS EVENTS INFORMATION MATERIAL EN

PSI Home » Research with Neutrons and Muons (NUM) » SINQ » Instrumentation

**Instrumentation**

- Access to SINQ
- SINQ Live
- Safety Regulations
- Publications
- The Neutron Source
- Contact

**Instrumentation**

Neutron Scattering and Imaging Instruments at SINQ

Floor plan of the Instruments located in the two SINQ halls.

**Diffractometers**

HRPT High resolution powder diffractometer (thermal neutrons)

FURTHER INFORMATION

- Information about SINQ sample environment equipment
- Information about SINQ computing, software, manuals and instrument control systems
- All methods offered at the PSI User Facilities, please make use of the filter options.

SINQ OPERATION STATUS

- Accelerator Status
- Experiment Schedule

User Contacts

- User Office
- DUO Login

PSI User Facilities Newsletter

Current News from PSI photon, neutron and muon user facilities

Open Positions

Start [Icons] 10:56 29/08/2015



## ESS (Sweden – under construction)

Home | ESS

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Search · Share · Translate · More

ISIS - ISIS Home Page Surface UK SBS Oracle 12.0.6 Portal Home - BBC News Google Maps

CONTACT PRESS PRIVACY BEHIND ESS

EUROPEAN SPALLATION SOURCE

About ESS Science & Instruments Technology Building ESS Partners & Industry Careers

**CROSS BORDER SCIENCE & SOCIETY**

### Mapping Quantum Phase Transitions and Her Future

#### Researching with Neutrons: Interview with Sofie Janas

In her MAX4ESSFUN research project to explore quantum phase transitions in cobalt chloride, young researcher Sofie Janas is finding ways to strengthen both the science of novel materials and her neutron scattering research network.

JUL 2, 2018

VIDEO

Take a video tour of ESS under construction

JUL 2, 2018

EVENT

Delivering ESS: BrightnESS Closing Conference Celebrates Unique Project's Achievements

JUN 25, 2018

NEWS

LENS: A New Consortium

ESS ACTIVITY REPORT 2017

NEUTRON USERS IN EUROPE: Facility-Based Insights and Scientific Trends

DOWNLOAD

PUBLICATIONS

Type here to search

20:48 03/07/2018





## ESS (Sweden – under construction)

The screenshot shows a web browser window displaying the 'Instruments' page of the European Spallation Source (ESS). The browser's address bar shows the URL 'https://europeanspallationsource.se/instruments'. The page features a blue navigation bar with links for 'CONTACT', 'PRESS', 'PRIVACY', and 'BEHIND ESS'. Below this is a secondary navigation menu with links for 'About ESS', 'Science & Instruments', 'Technology', 'Building ESS', 'Partners & Industry', and 'Careers'. A left-hand sidebar contains a vertical menu with the following items: 'Science Using Neutrons', 'Instruments', 'Instrument Technologies', 'Data Management & Software Centre', 'Science Support Systems', and 'Workshops & Facilities'. The main content area is dominated by a large 3D rendering of the ESS instrument layout, with the word 'Instruments' overlaid in large white text. Below the rendering, a text block states: 'Fifteen instruments for science are included in the ESS construction project. Each instrument is unique, optimised for obtaining particular kinds of scientific data.' A button labeled 'Science Using Neutrons' is positioned below this text. Further down, another text block reads: 'The instruments selected for construction at the European Spallation Source are versatile, and most serve several different scientific communities. Developed and built by teams across Europe, they are each designed to be world-leading from day one.' To the right of this text is a technical diagram of the instrument layout. The Windows taskbar at the bottom shows the system tray with the date '03/07/2018' and time '20:49'.





# Americas

## Reactors

[NIST Centre for Neutron Research - NCNR \(USA\)](#)

[High Flux Isotope Reactor – HFIR \(USA\)](#)

[Canadian Neutron Beam Centre - CNBC \(Canada - \*closed\*\)](#)

[Laboratorio Argentina de Haces de Neutrones – LAHN \(Argentina – \*under construction\*\)](#)

## Spallation sources

[Spallation Neutron Source – SNS \(USA\)](#)

[Los Alamos Neutron Science Centre - LANSCE \(USA – \*reduced user programme\*\)](#)



# NCNR (USA)

**NIST Center for Neutron Research - Internet Explorer**

Address bar: <https://www.ncnr.nist.gov/>

Search:  Search

Suggested Sites: [ISIS Internal Information Se...](#) [Yahoo! UK](#) [ISIS - ISIS Home Page](#) [RCUK SSC Orade Portal](#) [Google Maps](#) [STFC Intranet Home](#) [Web Slice Gallery](#)

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**NIST Center for Neutron Research**  
National Institute of Standards and Technology

-- a national resource for industry, universities, and government agencies

**Coming to the NCNR?**  
[Click Here.](#)  
[Visa question?](#)  
[Logon to your NCNR-IMS account](#)

**NCNR SiteMap**


**About the NCNR**  
[What We Do](#)  
[Informal History](#)  
[Staff](#)  
[Annual Report](#)  
[2015 Summer Schools](#)

- [Neutron Spectroscopy](#)

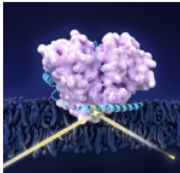
[Working at the NCNR](#)

**Facility Information**  
[Live Data](#)  
[Instrumentation](#)  
[Instrument Contacts](#)  
[Schedules](#)  
[Center for High Resolution Neutron Scattering \(CHRNS\)](#)  
    > [Education and Outreach](#)  
[Sample Environment](#)  
[NCNR Staff Forms](#)  
[Sample Prep Labs](#)

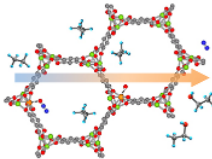
**User Information**  
[Planning Your Experiment](#)  
[Obtaining BeamTime](#)  
[Data Reduction/Analysis](#)  
[Shipping Samples](#)  
[Publishing Your Results](#)  
[Financial Assistance](#)  
[Travel & Lodging](#)  
[NCNR User Group](#)



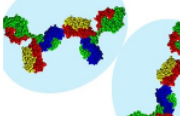
**RECENT RESEARCH HIGHLIGHTS**



Neutron beams reveal how two pieces of Parkinson's puzzle fit  
[details](#)



From separation to transformation: metal-organic framework shows new talent  
[details](#)



NIST helps cancer treatment drugs get past their sticking point  
[details](#)  
[C&E News item](#)

**NEWS FOR NCNR USERS**

**NCNR Seminar Schedule**

**CALL FOR PROPOSALS**  
The new deadline for proposals for NCNR instrument time is June 16, 2015. Successful proposals will be allocated instrument time from September 2015 through March 2016.  
[details](#)

We have posted some [proposal statistics](#) summarizing the last five calls.

**IMPORTANT CHANGE!!**  
**NEW ACCESS CONTROL POLICY**  
Starting July 21, 2014, driver's licenses from 7 states/territories will not be accepted as valid ID for NCNR access. Only US citizen users are affected.  
[details](#)

**INSTRUMENT DEVELOPMENT MEETING**  
A workshop on future directions for neutron instrument development for the benefit of the scientific community was held in Potomac, MD on Aug. 21-22, 2014.  
[details](#)  
[Executive Summary of outcome](#)

**TRAINING FROM OTHER LABS**  
NIST now accepts basic radiation safety training from other U.S. neutron facilities in place of the NIST offered on-line training.  
[details](#)

Taskbar: Start, Internet Explorer, Mail, Calendar, Photos, Windows Explorer, PowerPoint

System Tray: 11:00, 29/08/2015



## NCNR (USA)

NIST Center for Neutron Research (NCNR) Instruments - Internet Explorer

https://www.ncnr.nist.gov/instruments/NCNRInstruments.html

File Edit View Favorites Tools Help

Google ncnr nist

Suggested Sites: ISIS Internal Information Se..., Yahoo! UK, ISIS - ISIS Home Page, RCUK SSC Orade Portal, Google Maps, STFC Intranet Home, Web Slice Gallery

**NIST Center for Neutron Research** National Institute of Standards and Technology

Home Instruments Science Experiments SiteMap

### NIST Center for Neutron Research (NCNR) Instruments

Plan view of the NCNR Instruments

BT9 MACS II  
BT8 DARTS  
BT7 3-AXIS  
BT1 HRPD  
BT2 NIF  
BT4 FANS  
BT5 USANS

NGA  
NGBu  
NGC  
NGD

NG1  
NG2  
NG3  
NG4  
NG5  
NG6  
NG7

NSE  
nSOFT  
NGB 30m SANS  
aCORN  
PGAA  
MAGIK  
PBR  
DET  
CNDP  
HFBS  
DCS  
SPINS  
NIOFa  
NIOF  
MDM  
PHYS  
NG7 30m SANS

Start

11:01  
29/08/2015



## HFIR (USA)





# HFIR (USA)

Neutron Science Instruments | Neutron Science at ORNL - Internet Explorer

https://neutrons.ornl.gov/instruments

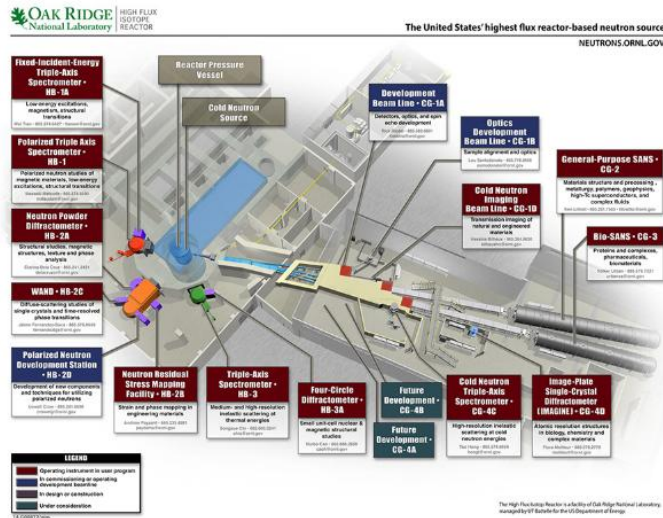
File Edit View Favorites Tools Help

Google Search

Suggested Sites: ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

Before submitting a proposal for a specific instrument, please contact the appropriate instrument scientist to make sure your research is feasible for that instrument.

## Instrument Beam Line Layouts by Facility



- Scattering Diffractometer
- CG-3 | BIO-SANS  
Biological Small-Angle Neutron Scattering Instrument
- CG-4C | CTAX  
Cold Neutron Triple-Axis Spectrometer
- CG-4D | IMAGINE  
Laue Diffractometer
- HB-1 | PTAX  
Polarized Triple-Axis Spectrometer
- HB-1A | FIE-TAX  
Fixed-Incident-Energy Triple-Axis Spectrometer
- HB-2A | POWDER  
Neutron Powder Diffractometer
- HB-2B | NRSF2  
Neutron Residual Stress Mapping Facility
- HB-2C | WAND  
Wide-Angle Neutron Diffractometer
- HB-3 | TAX  
Triple-Axis Spectrometer
- HB-3A | FOUR-CIRCLE  
Four-Circle Diffractometer

## SNS Instruments



# CNBC (Canada – closed March 2018)

Canadian Neutron Beam Centre - Internet Explorer

http://www.cnl.ca/en/home/facilities-and-expertise/cnbc.aspx

File Edit View Favorites Tools Help

Google CNBC neutron Search Share More >> Sign In

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Français Contact Additional Resources

Enter keyword Search

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Home » Facilities & Expertise » Canadian Neutron Beam Centre

**Canadian Neutron Beam Centre**

Share this

The Canadian Neutron Beam Centre (CNBC) is a unique and versatile element of Canada's research infrastructure. The CNBC enables academia, government and industry to use neutron beams as tools for world-class materials research, providing new understanding of materials and improving products for businesses. Each year, over 200 scientists, engineers, and students participate in research that depends on access to the CNBC's six neutron beamlines.

**Why work with us**

Improved safety and reliability, reduced costs, or opening of markets are a few of the benefits industrial clients have gained from employing neutron beams as part of their research

**Facilities & Expertise**

- All Facilities
- Canadian Neutron Beam Centre
- National Research Universal
- ZED-2 Research Reactor

**Contact**

Email: [cnbc@cnl.ca](mailto:cnbc@cnl.ca)

Start [Taskbar icons] 17:08 29/08/2015



## LAHN (Argentina)

The screenshot shows a web browser window displaying the website for the Laboratorio Argentino de Haces de Neutrones (LAHN). The browser's address bar shows the URL <http://www.lahn.cnea.gov.ar/>. The website header features the LAHN logo (LABORATORIO ARGENTINO DE HACES DE NEUTRONES) and the CNEA logo (Comisión Nacional de Energía Atómica). A navigation menu includes links for Inicio, Eventos, Instrumentación, Novedades, Contacto, and Material de Difusión, along with a search bar. The main content area displays a large 3D architectural rendering of the LAHN facility, a modern building with a distinctive curved roof, set in a green landscape. The text 'LABORATORIO ARGENTINO DE HACES DE NEUTRONES' is overlaid on the rendering. The CNEA logo is also visible in the bottom left corner of the rendering. The browser's taskbar at the bottom shows the Windows Start button, a search bar, and various application icons, with the system tray displaying the time as 20:52 on 03/07/2018.





## SNS (USA)

The screenshot shows a web browser window displaying the Neutron Sciences website. The browser's address bar shows the URL <https://neutrons.ornl.gov/>. The website header includes the Oak Ridge National Laboratory logo and a navigation menu with links for 'FOR USERS', 'ABOUT', 'SCIENCE', 'INSTRUMENTS & SUPPORT', 'PUBLICATIONS', 'NEWS', and 'CAREERS'. A search bar is also present. The main content area features a large photograph of three workers in hard hats and safety gear working on a large, curved piece of scientific equipment. Below the photograph is a green banner with the text 'HYSPEC Gets High-Performance Upgrade'. Underneath the banner are five small black dots, with the first one being larger, indicating the current slide in a sequence. Below the photograph and banner, there is a paragraph of text: 'Neutron Sciences at ORNL is home to the High Flux Isotope Reactor (HFIR) and Spallation Neutron Source (SNS), providing researchers with unmatched capabilities for understanding the structure and properties of materials, macromolecular and biological systems, and the fundamental physics of the neutron.'







# SNS (USA)

Neutron Science Instruments | Neutron Science at ORNL - Internet Explorer

https://neutrons.ornl.gov/instruments

sns usa - Google Search

File Edit View Favorites Tools Help

Search

Suggested Sites

ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

**OAK RIDGE NATIONAL LABORATORY** SPALLATION NEUTRON SOURCE

World's most intense pulsed, accelerator-based neutron source

NEUTRONS.ORNL.GOV

**Backscattering Spectrometer (BASIS) - BL-2**  
Dynamics of nanoscale, disordered molecular systems, polymers, biology, planetary science

**Nanoscale-Ordered Materials Diffractometer (NOMAD) - BL-1B**  
Liquids, molecular systems, polymers, heterostructures and partially ordered complex materials

**Wide Angular-Range Chopper Spectrometer (WACS) - BL-1B**  
Excited-state dynamics in molecular systems, chemistry, condensed matter systems

**Fine-Resolution Fermi Chopper Spectrometer (FEQUA) - BL-1F**  
Excitation of structural quantum fluids, superconductors, condensed matter, materials science

**Spallation Neutrons and Pressure Diffractometer (SNAP) - BL-3**  
Materials science, geology, earth and planetary science

**Wide-Small-Angle Neutron Scattering Instrument (USANS) - BL-1A**  
Liquids, molecular systems, polymers, heterostructures, earth and environmental sciences

**Vibrational Spectrometer (VISION) - BL-1B**  
Vibrational dynamics in molecular systems, chemistry

**Neutron Spin Echo Spectrometer (NSE) - BL-1E**  
High-resolution dynamics of slow processes, polymers, biological macromolecules

**Magnetism Reflectometer (MR) - BL-4A**  
Chemistry, magnetism of layered materials and thin films

**Liquids Reflectometer (LR) - BL-4B**  
Interfaces in complex fluids, polymers, chemistry

**Cold Neutron Chopper Spectrometer (CNCS) - BL-5**  
Condensed matter physics, materials science, chemistry, biology, environmental science

**Extended Q-Range Small-Angle Neutron Scattering Diffractometer (EQ-SANS) - BL-6**  
Life science, polymer and crystal systems, materials science, earth and environmental sciences

**Engineering Materials Diffractometer (EMD) - BL-7**  
Polymers, composites, nanotechnology, materials processing

**Single-Crystal Diffractometer (SCD) - BL-12**  
Structural studies, materials science, condensed matter physics

**Powder Diffractometer (POWGEN) - BL-1A**  
Structural studies, polymers, materials science, and condensed matter physics (including inorganic, organometallic, and molecular)

**Other instruments shown:** Elastic Diffuse Scattering Instrument (EDSI) - BL-9, Versatile Neutron Imaging Instrument (VNI) - BL-5, Macromolecular Neutron Diffractometer (MND) - BL-11B, Fundamental Neutron Physics Beam Line (FNBL) - BL-13, Neutron Spin Echo Spectrometer (NSE) - BL-1E, Wide-Small-Angle Neutron Scattering Instrument (USANS) - BL-1A, Spallation Neutrons and Pressure Diffractometer (SNAP) - BL-3, Magnetism Reflectometer (MR) - BL-4A, Liquids Reflectometer (LR) - BL-4B, Cold Neutron Chopper Spectrometer (CNCS) - BL-5, Extended Q-Range Small-Angle Neutron Scattering Diffractometer (EQ-SANS) - BL-6, Engineering Materials Diffractometer (EMD) - BL-7, Single-Crystal Diffractometer (SCD) - BL-12, Powder Diffractometer (POWGEN) - BL-1A.

Legend:  
 ■ Operating instrument in user program  
 ■ Development build-out in design or construction  
 ■ Under installation

© 2009 STFC

## SNS Instruments

- BL-1A | USANS  
Ultra-Small-Angle Neutron Scattering Instrument
- BL-1B | NOMAD  
Nanoscale-Ordered Materials Diffractometer
- BL-2 | BASIS  
Backscattering Spectrometer
- BL-3 | SNAP  
Spallation Neutrons and Pressure Diffractometer
- BL-4A | MR  
Magnetism Reflectometer
- BL-4B | LR  
Liquids Reflectometer
- BL-5 | CNCS  
Cold Neutron Chopper Spectrometer
- BL-6 | EQ-SANS  
Extended Q-Range Small-Angle Neutron Scattering Diffractometer
- BL-7 | VULCAN  
Engineering Materials Diffractometer
- BL-9 | CORELLI

Start

11:09 29/08/2015



# Lujan Centre (USA – no longer accepting external proposals)

**Los Alamos NATIONAL LABORATORY**  
EST. 1947

**Lujan Center at LANSCE**

**Lujan Center Mission**  
The Lujan Center delivers science by exploiting the unique characteristics of intense beams of moderated pulsed neutrons for academia, national security, and industry.

**Lujan Center Vision**  
The Lujan Center will operate a world class user program in the service of the nation. Lujan Center scientists will be recognized for their leadership and innovation in neutron scattering.

**Lujan Center at LANSCE**  
The Lujan Center is one of five user facilities supported by the LANSCE accelerator which is stewarded by NNSA. Together these instruments provide capability for basic and applied neutron science relevant to academia, national security and industry.

**Lujan Center User Capabilities**  
The Lujan Center instruments operate in time of flight mode receiving neutrons from a tungsten spallation target. Four moderators provide epi-thermal, thermal and cold neutrons to specialized beamlines. The facility operates for a total of 3,000 hours per year. At the core of the Lujan Center is a 20Hz spallation neutron target and the LANSCE proton accelerator, which operates at an energy of 500 MeV with typical beam currents of 100 – 125  $\mu$ A. The Lujan Center's highly optimized tungsten spallation target provides a high peak flux with a broad wavelength bandwidth per frame. Two liquid hydrogen moderators provide high intensity cold neutron beams ideally suited for nuclear physics, reflectometry, inelastic scattering and small angle scattering. Water moderators provide thermal neutrons for neutron imaging, nuclear physics and diffraction beamlines. In addition, because of its low repetition rate, long wavelength neutrons can be used without significant frame overlap allowing the collection of data over a broad range of time constants and length scales, ideally suited for Total scattering and diffraction studies. The Lujan Center offers access to a large variety of specialized sample environments, including low temperatures down to 40mK, magnetic fields up to 7T, high temperature furnaces up to 2400C and uniaxial stress ( $F_{max}=250kN$ ) and fluid as well as anvil cell pressure capabilities (30GPa-2000K).

**Instrument Suite**  
 Crystallography: NPFD, HIPD, HIPPO, PCS  
 Engineering and Strain: HIPPO, SMARTS, NPFD  
 Disordered Materials: NPFD, HIPD, HIPPO  
 Large Scale Structures: LQD, ASTERIX  
 Magnetism: ASTERIX, HIPD, HIPPO  
 Biology: PCS, LQD  
 Neutron Imaging: HIPPO, SMARTS, NPFD  
 Nuclear Science and Technology: DANCE, FP5, FP12



# Asia-Oceania-Africa

## Reactors

Japan Research Reactor 3 - JRR3 (Japan - *awaiting permission to restart*)

Australia Nuclear Science and Technology Organisation – ANSTO, OPAL reactor (Australia)

High flux Advanced Neutron Application Reactor - HANARO (South Korea)

Bombay Atomic Research Centre - BARC (India)

South Africa Nuclear Energy Corporation – NECSA, Safari reactor (South Africa)

China Advanced Research Reactor (CARR – *not yet operational*)

China Mianyang Research Reactor (CMRR)

## Spallation sources

J-PARC Materials and Life Science Facility - MLF (Japan)

China Spallation Neutron Source (CSNS)



# JRR-3 (Japan – awaiting permission to restart)

Research reactors and Accelerators / Japan Atomic Energy Agency / Nuclear Science Research Inst - Internet Explorer

https://www.jaea.go.jp/english/04/ntokai/kasokuki/kasokuki\_01.html

File Edit View Favorites Tools Help

Google JRR-3 Search Share More >> Sign In

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Orade Portal Google Maps STFC Intranet Home Web Slice Gallery

**JAEA** Japan Atomic Energy Agency  
Tokai Research and Development Center  
Nuclear Science Research Institute

JAEA home / Japanese font size S M L

site search search

Home About us Resident divisions Publish Users' offices Access

## JRR-3

JRR-3 achieved its first criticality in 1962 as the first research reactor constructed with domestic technology and has been utilized by a multitude of researchers since the dawn of nuclear research and industry. In 1990, JRR-3 was modified to improve its performance, and it resumed operation as a high-performance and multipurpose research reactor with thermal power of 20 MW. JRR-3 has several facilities for neutron beam experiments, irradiation experiments for nuclear fuel and material, and production of RI and silicon semiconductors. Cold neutron (very low energy neutron) beams are available and utilized for research of life phenomena by analyzing the structure of polymer molecules, for example.



An outside view of the JRR-3 reactor building



A bird's-eye view of the JRR-3 reactor building

**Research reactors and Accelerators**

- JRR-3
- JRR-4
- NSRR
- Tandem Accelerator & Tandem Booster

**Publish**

- JAEA Reports
- Peer-reviewed papers

**Users office**

- JRR-3 Users Office
- J-PARC Center Users Office

Start | 09:53 29/08/2015





## JRR-3 (Japan – awaiting permission to restart)

Japan Atomic Energy Agency JRR-3 - Internet Explorer

http://jrr3.jaea.go.jp/jrr3e/2/21.htm

File Edit View Favorites Tools Help

Google jrr-3

Suggested Sites: ISIS Internal Information Se..., Yahoo! UK, ISIS - ISIS Home Page, RCUK SSC Orade Portal, Google Maps, STFC Intranet Home, Web Slice Gallery

Japan Atomic Energy Agency **JRR-3** Japanese

Search

Japan Research Reactor-3

About JRR-3 Utilization facilities Applications Gallery

Utilization facilities of JRR-3 PAGE TOP

The JRR-3 has been utilized as a top-level high performance research reactor in the world for beam experiments and neutron irradiations. There are 9 irradiation facilities for irradiation tests on nuclear fuel and material, production of RI and silicon semiconductor and neutron activation analysis. Furthermore, there are total 31 instruments for neutron beam experiments including 13 and 18 instruments belonging to universities and the JAEA, respectively. List of neutron irradiation facilities and instruments are shown below.

Reactor room

Beam hall

JAEA: Thermal neutron beam, Cold neutron beam

UNIV: Thermal neutron beam, Cold neutron beam

3G, 2G, 1G, 4G

RG-2, SI-1, BR-1, PN-1, CNS, RG-1

Start

10:19 29/08/2015



## OPAL (Australia)

The screenshot shows the ANSTO website in Internet Explorer. The browser address bar displays <http://www.ansto.gov.au/ResearchHub/Bragg/Facilities/OPALReactor/index.htm>. The search bar contains the text "opal ansto". The website header includes the ANSTO logo and navigation links for News & Media, Visiting ANSTO, Careers, and Safety at ANSTO. A search bar is also present. The main navigation menu includes HOME, ABOUT ANSTO, EVENTS, NUCLEAR FACTS, BUSINESS SERVICES, RESEARCH HUB, RESOURCES, and CONTACT US. The left sidebar contains a tree view with categories like Bragg Institute, Facilities, and OPAL reactor. The main content area is titled "OPAL Reactor" and contains the following text:

ANSTO's Open Pool Australian Lightwater (OPAL) reactor is a state-of-the-art 20 Megawatt reactor that uses low enriched uranium (LEU) fuel to achieve a range of research, scientific, industrial and production goals.

Opened by the Prime Minister in 2007, OPAL is one of a small number of reactors with the capacity for the commercial production of radioisotopes. This capacity, combined with the open pool design, the use of LEU fuel and the wide range of applications, places OPAL among the best research reactors in the world.

While OPAL is the centrepiece of ANSTO's research facilities, the suite of neutron beam instruments housed next to the reactor building and operated by the Bragg Institute represent a significant addition to ANSTO's research capabilities. Former Minister for Industry, Innovation, Science, Research and Tertiary Education, Senator Kim Carr, described ANSTO's contribution to Australian science by saying:

"Having started out as a specialist organisation...at Lucas Heights, ANSTO is now driving innovation in nuclear science and technology right around the country. The Government is very aware of how important this work is."

OPAL is operated and maintained by the Reactor Operations group within the Nuclear Operations division.

**The role of research reactors**

While virtually every research reactor is unique, OPAL is one of a number of similar production facilities around the world, including the Safari-1 reactor in South Africa, the HFR reactor at Petten in the Netherlands and the NRU reactor at Chalk River in Canada. These reactors play a vital role in

The page also features a photograph of the reactor core and a Windows taskbar at the bottom showing the Start button and system tray with the date 29/08/2015 and time 09:57.



# OPAL (Australia)

Internet Explorer - Instruments - ANSTO

http://www.ansto.gov.au/ResearchHub/Bragg/Facilities/Instruments/

File Edit View Favorites Tools Help

Google opal reactor neutron instruments

Suggested Sites: ISIS Internal Information Se..., Yahoo! UK, ISIS - ISIS Home Page, RCUK SSC Orade Portal, Google Maps, STFC Intranet Home, Web Slice Gallery

Australian Government **Ansto** Australian Nuclear Science and Technology Organisation

News & Media | Visiting ANSTO | Careers | Safety at ANSTO

Search... [YouTube] [Facebook] [Twitter] [LinkedIn]

HOME ABOUT ANSTO EVENTS NUCLEAR FACTS BUSINESS SERVICES RESEARCH HUB RESOURCES CONTACT US

**Instruments**

Thirteen neutron beam instruments are either operational or commissioning at the new OPAL reactor. ANSTO expects to add more instruments within five years. The facility has the capacity for further expansion, including potential for a second neutron guide hall.

A suite of [sample-environment equipment](#) allows studies at different temperatures, pressures and magnetic fields. [Scientific references](#) are available for most of our instruments.

**11 Operational Instruments (named after Australian and overseas fauna):**

- [ECHIDNA High-Resolution Powder Diffractometer \(\*Tachylossus aculeatus\*\)](#)
- [WOMBAT High-Intensity Powder Diffractometer \(\*Vombatus ursinus\*\)](#)
- [KOALA Laue Diffractometer \(\*Phascogaleus cinereus\*\)](#)
- [KOWARI Strain Scanner \(\*Dasyuroides byrnei\*\)](#)
- [PLATYPUS Neutron Reflectometer \(\*Ornithorhynchus anatinus\*\)](#)
- [QUOKKA Small-Angle Neutron Scattering \(\*Setonix Brachyurus\*\)](#)
- [TAIPAN Thermal Neutron 3-Axis Spectrometer \(\*Oxyranus scutellatus\*\)](#)  
[Beryllium-filter option on TAIPAN - completed in 2014, currently in commissioning](#)
- [KOOKABURRA Ultra Small-Angle Neutron Scattering \(\*Dacelo novaeguineae\*\)](#)
- [PELICAN Time-of-Flight Spectrometer \(\*Pelecanus conspicillatus\*\)](#)
- [DINGO Neutron Radiography/Imaging/Tomography \(\*Canis lupus dingo\*\)](#)
- [SIKA Cold Neutron 3-Axis Spectrometer \(\*Cervus nippon\*\)](#)

Start [Taskbar icons] 10:18 29/08/2015



## Hanaro (South Korea)

korea Atomic Energy Research Institute -> Research Reactor Utilization - Internet Explorer

https://www.kaeri.re.kr/english/sub/sub03\_04\_01\_01.jsp

hanaro reactor korea instruments

Suggested Sites: ISIS Internal Information Se..., Yahoo! UK, ISIS - ISIS Home Page, RCUK SSC Orade Portal, Google Maps, STFC Intranet Home, Web Slice Gallery

- Reactor Research
- Fuel Cycle Research
- Innovative Tech. Research
- Radiation Research
- Research Reactor Utilization

**Neutron Beam Facilities**

- Cold Neutron Research Facilities
- On-site Irradiation Test Facility
- Fuel Test Loop

**Neutron Beam Facilities**

Neutron Radiography Facility(NRF), High Resolution Powder Diffractometer(HRPD), Four Circle Neutron Diffractometer (FCD), Residual Stress Instrument(RSI), Vertical Neutron Reflectometer(REF-V), Horizontal Neutron Reflectometer(REF-H), High Intensity Powder Diffractometer(HIPD), Ex-core Neutron Irradiation Facility(ENF) and Prompt Gamma Neutron Activation Analysis system(PGAA) are operating at the HANARO reactor hall. In addition there is a Neutron Activation Analysis system (NAA) consisting of the irradiation facility and the radiation measurement equipment in the HANARO reactor. A 9m SANS instrument installed at ON horizontal port was dismantled and moved to the Cold Neutron Laboratory and currently the cold neutron guide system is installed at ON port area. The Bio-Diffractometer(Bio-D) at ST3 port and Triple Axis Spectrometer (TAS) at ST4 are scheduled to be installed at the reactor hall. Three new cold neutron scattering instruments will be developed and installed in the cold neutron guide hall and three neutron instruments currently existing in the reactor hall will be moved after upgrades. Three new instruments are 40M Small Angle Neutron Scattering Instrument(40M-SANS), Cold Triple Axis Spectrometer(Cold-TAS) and Disk Chopper Time of Flight(DO-TOF) and three upgrade instruments are 12M-SANS, REF-V and Bio-REF.

Port	Instrument	Status / Date
In-service	NR Port Neutron Radiography Facility (NRF)	1997 Upgrade
ST4 Port	Tripole Axis Spectrometer (TAS)	2010
ST4 Port	Neutron Reflectometer (REF-V)	2006 To be moved 2010
Bio-Diffractometer	Bio-Diffractometer (Bio-D)	2010
ST2 Port	Neutron Reflectometer (REF-H)	2008 To be moved 2010
ST2 Port	High Intensity Powder DIF (HIPD)	2008
ST2 Port	Four Circle Diffractometer (FCD)	1999 Upgrade '05-'06
ST2 Port	High Resolution Powder DIF (HRPD)	1998
III Port	En-Core Neutron Irradiation Facility (ENF)	2005
ST1 Port	Prompt Gamma Neutron Activation Analysis (PGAA)	2005
Test Station	Test Station (TS) & Residual Stress Instrument (RSI)	2003
CN Port	Small Angle Neutron Scattering (SANS)	2001 Currently dismantled
Cold Neutron Guide	Cold Neutron Guide	2009

Start | 10:01 29/08/2015





# BARC (India)

Reactors - Internet Explorer

http://barc.gov.in/reactor/index.html


Reactors

File Edit View Favorites Tools Help

Google Search barc india dhruva

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

### DHRUVA REACTOR



During early 1970s a strong need was felt for building a research reactor with higher neutron flux to meet the growing demand of radioisotopes and advanced research in basic sciences. This led to the setting up of a research reactor at BARC which was named Dhruva by Dr. Giani Zail Singh, the then President of India. Construction of DHRUVA was an important milestone in the development and implementation of indigenous nuclear technology in India. The reactor incorporates several features catering to the requirements of a broad-based multidisciplinary user community as also in the production of radioisotopes of high specific activity. Dhruva has been declared as a National Facility for Neutron Beam Research to cater to the needs of Indian scientific community where scientists from BARC, other units of the Department of Atomic Energy (DAE), universities and national laboratories work under collaborative projects. Many of the collaborations are supported by the University Grants Commission - DAE Consortium for Scientific Research (UGC-DAE-CSR), the Board of Research in Nuclear Sciences (BRNS) and other agencies. At present there are about 40 active projects running under the UGC-DAE-CSR scheme.

No.	Item	Description
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Start | 10:09 | 29/08/2015



## BARC (India)

BHABHA ATOMIC RESEARCH CENTRE  
MUMBAI, INDIA

**DHRUVA REACTOR**

During early 1970s a strong need was felt for building a research reactor with higher neutron flux to meet the growing demand of radioisotopes and advanced research in basic sciences. This led to the setting up of a research reactor at BARC which was named Dhruva by Dr. Giani Zail Singh, the then President of India. Construction of DHRUVA was an important milestone in the development and implementation of indigenous nuclear technology in India. The reactor incorporates several features catering to the requirements of a broad-based multidisciplinary user community as also in the production of radioisotopes of high specific activity. Dhruva has been declared as a National Facility for Neutron Beam Research to cater to the needs of Indian scientific community where scientists from BARC, other units of the Department of Atomic Energy (DAE), universities and national laboratories work under collaborative projects. Many of the collaborations are supported by the University Grants Commission - DAE Consortium for Scientific Research (UGC-DAE-CSR), the Board of Research in Nuclear Sciences (BRNS) and other agencies. At present there are about 40 active projects running under the UGC-DAE-CSR scheme.

No.	Item	Description
-----	------	-------------

Start | 10:09 | 29/08/2015



## Safari (South Africa)

Products and Services - Internet Explorer

http://www.necsa.co.za/Products-and-Services

File Edit View Favorites Tools Help

Google safari reactor south africa

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Orade Portal Google Maps STFC Intranet Home Web Slice Gallery

**necsa**  
We're in your world  
South African Nuclear Energy Corporation SOC Limited

Necsa Visitor Centre **Products and Services** Skills Training Centre Public Information About US

### Analytical and Calibration Services (ACS)

The ACS laboratories consist of three specialised laboratories with nuclear licenced and SANAS accredited services:

- [Radio Analysis Laboratories](#) - radioactivity analysis
- [Pelindaba Analytical Services](#) - chemical analysis, and
- [Calibration Service](#) - calibration of ionising radiation and contamination monitoring/protection equipment

### Office of Technology Transfer

The Necsa Office of Technology Transfer is responsible to cultivate the innovation ecosystem, record and evaluate new ideas, management, legal protection and licensing of intellectual property (IP). Read more about:

- [Services](#)
- [News](#)
- [Technologies](#)

[Contacts](#)

### Nuclear Manufacturing

Specialises in the design, repair and manufacturing of the following:

- Pressure Vessels
- Heat Exchangers
- Tanks and Piping Systems
- Hi-Tech fabrication

High quality components

[Read more](#)

### Research

The Research and Development Division of the South African Nuclear Energy Corporation, the anchor for nuclear energy research, development and innovation in South Africa.

What we do:

- Radiopharmaceuticals & Radiotracers
- Material Characterisation
- Heritage Studies
- Agriculture
- Geology
- Mineral Beneficiation
- Waste Handling, Treatment and Disposal Technology
- Uranium Beneficiation


Start | 10:04 29/08/2015



# CARR (China – not in regular operation)

The screenshot shows the CIAE website in Internet Explorer. The browser address bar displays <http://www.ciae.ac.cn/eng/Researchprograms/05.htm>. The search bar contains the text "carr china". The website header features the CIAE logo and the text "China Institute of Atomic Energy". A navigation menu includes links for Home, Organization, Publications, News, Cooperation, Contact Us, and Chinese Version. A left sidebar lists various categories such as About CIAE, Science & Technology, R&D Results, and Products & Techniques. The main content area is titled "First Phase Neutron Scattering Instrumentation at the China Advanced Research Reactor" and contains the following text:

After 50 years of service for the Research & Development in neutron science and technology, the Heavy Water Research Reactor (HWRR) (maximum power 10 MW) at China Institute of Atomic Energy (CIAE) was shut down in 2007. The 60MW China Advanced Research Reactor (CARR) at CIAE has taken over this role, which has reached the first criticality in May, 2010. It is a tank-in-pool type reactor using a  $D_2O$  reflector for inverse neutron trap, and the designed optimal undisturbed thermal neutron flux is  $8 \times 10^{14} \text{ n/cm}^2\text{s}$ . The reactor experiment hall houses a set of instruments connecting to 7 horizontal thermal neutron beam tubes, two of which are dual beam ports. Additionally, cold neutrons produced by a liquid hydrogen cold source are transported via 4 guide systems to the  $30 \times 60\text{m}^2$  guide hall, where a suite of scattering instruments are placed.



Guide hall

CARR is devoted to fundamental and applied research, of which the Neutron Scattering Laboratory (NSL) is responsible for neutron scattering and radiography research programs open to users in China

The Windows taskbar at the bottom shows the Start button, several application icons, and the system tray with the date and time: 10:05 29/08/2015.





## CMRR (China)

Chinese Neutron Scattering Society - Internet Explorer

http://english.ihep.cas.cn/isis/cnss/zsszz/201406/t20140620\_123024.html

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Google cmrr china neutron Search Share More >> Sign In

Suggested Sites ISIS Internal Information Se... Yahoo! UK ISIS - ISIS Home Page RCUK SSC Oracle Portal Google Maps STFC Intranet Home Web Slice Gallery

**CNSS**  
Chinese Neutron Scattering Society

Home | About CNSS | Organization | Meetings&Events | Newsletters | Contact Us | Chinese

**China Mianyang Research Reactor**

**Chinese Neutron Facilities**

**China Spallation Neutron Source (CSNS)**

**China Advanced Research Reactor (CARR)**

**China Mianyang Research Reactor (CMRR)**

The China Mianyang Research Reactor (CMRR) with the power of 20 MW is located in the NP campus of Institute of Nuclear Physics and Chemistry, Mianyang city, Sichuan Province. It was open to users officially from 2012, including the thermal and cold neutron halls. The liquid hydrogen cold neutron source began to work from September 2013. The measured thermal and cold fluxes for neutron scattering experiments are  $2.4 \times 10^{14} \text{ n/cm}^2 \cdot \text{s}$  and  $10^9 \text{ n/cm}^2 \cdot \text{s}$ , respectively.

NP campus of Institute of Nuclear Physics and Chemistry

CMRR is devoted to both fundamental and applied research. Its spectrometer layout is shown in the figure. In the first phase, eight neutron scattering instruments have been installed and start operation from the middle of 2014. Four thermal neutron instruments were installed in the reactor hall: a high resolution neutron diffractometer (HRND), a residual stress neutron diffractometer (RSND), a thermal

Start [Icons] 10:06 29/08/2015



## J-PARC MLF (Japan)



# J-PARC MLF (Japan)

Material and Life Science Experimental Facility | Facilities at J-PARC | J-PARC - Internet Explorer

http://www.j-parc.jp/researcher/MatLife/en/instrumentation/ns.html

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**J-PARC** J-PARC HOME

Japan Proton Accelerator Research Complex

HOME Facilities at J-PARC Materials and Life Science Experimental Facility HOME Japanese

### Materials and Life Science Experimental Facility

Neutron Instruments

(as of April, 2014)

BL08 SuperHRPD  
BL09 SPICA  
BL10 NOBORU  
BL11 PLANET  
BL12 HRC  
BL14 AMATERAS  
BL15 TAIKAN  
BL16 SOFIA  
BL17 SHARAKU  
BL06 VIN ROSE  
BL05 NOP  
BL04 ANNRI  
BL03 IBIX  
BL02 DNA  
BL01 4SEASONS  
BL23 POLANO  
BL22 RADEN  
BL21 NOVA  
BL20 IMATERIA  
BL19 TAKUMI  
BL18 SENJU

CM Coupled moderator DM Decoupled moderator PM Polarized moderator

News & Events

MLF Operational Status

For MLF Users

- Inquiry
- Call for Proposals
- J-PARC Center Users Office
- Call for LOI on Neutron Instruments
- Instruments
- Accepted Proposals / Experimental Reports
- Post-visit Procedures

Research Achievements

Committees / Meetings

Publications

Neutron/Muon Calendar

available on 1-Sept

- J-PARC Operation Status
- JLAN (Internal Use Only)
- MLF-intra (JLAN only, Japanese)

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## CSNS (China)

China Spallation Neutron Source - Internet Explorer

http://cns.ihep.ac.cn/english/

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**SNS China Spallation Neutron Source**

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Photo & Videos

Quick Links to

- .. J-PARC
- .. SNS
- .. PSI
- .. KEK

**College students visit CSNS**

49 college students from the School of Sciences, South China University of Technology, visited the China Spallation Neutron Source (CSNS) on April 24.

[More>>](#)

**Upcoming Events**

**The Second Announcement of The 5th AONSA Neutron School**

**Program of 5th AONSA Neutron School**

- The Sixth OCPA Accelerator School

will be held in Beijing from Jul 29 to Aug 7, 2010

• (NEW!) CSNS Parameter List

**Conference**

- ▶ OCPA-2010
- ▶ SIAN-2008
- ▶ ICANS-XVIII

**Contact Us**

CSNS project office,  
Institute of High Energy Physics,  
Chinese Academy of Sciences,  
19B Yuqianlu,  
Shijingshan District,  
Beijing,  
China,  
100049  
FAX: 86-10-88235967  
TEL: 86-10-88235967

**News & Events** [more>>](#)

- ▶ **CSNS review meeting held in Dongguan**
- The CSNS Project held its Fifth Review Meeting of the International Advisory Committee at the construction site of the China Spallation Neutron Source (CSNS) Project in Dongguan... [details...](#)
- ▶ **CSNS inflatable seal developed**
- The China Spallation Neutron Source (CSNS) Project invited experts to the Institute of High Energy Physics (IHEP) to witness and test the CSNS inflatable seal on September 4... [details...](#)

• College students visit CSNS	04/24/2014
• CSNS review meeting held at IHEP	11/21/2013
• CSNS neutron beamline shutter system prototype pre-reviewed	07/31/2012
• Important progress made on CSNS digital low level RF control system	06/27/2012
• Joint CSNS Advanced Material Laboratory established	05/09/2012
• WANG Yifang inspects CSNS Project	05/09/2012
• China Spallation Neutron Source celebrates its groundbreaking	10/24/2011

[more...](#)

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## Compact Neutron Sources


UCANS - Microsoft Internet Explorer provided by STFC

http://www.ucans.org/ UCANS

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The Official Web Page of  
Union for Compact Accelerator-driven Neutron Sources  
(UCANS)

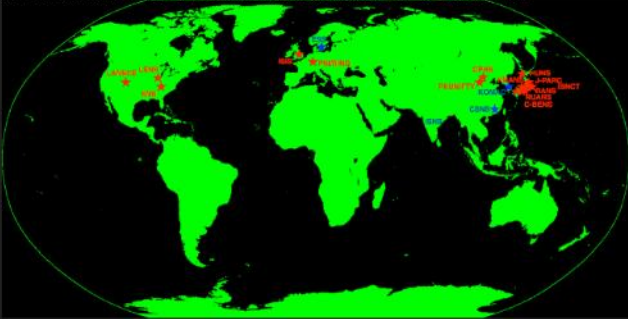
**NEW UCANS-V** May 12-15, 2015 @ Padova, Italy

### UCANS

Union for Compact Accelerator-driven Neutron Sources

The Union for Compact Accelerator-driven Neutron Sources (UCANS) was formed in 2009 to support the ongoing development of small accelerator based neutron sources around the world, and to promote the exchange of information on emerging science and novel applications relevant to long-pulsed and/or medium-flux neutron sources.

Accelerator-driven Neutron Sources for Science (this map is under construction)



UCANS  
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# Compact Neutron Sources

## Member Institutes



Part of the [Center for the Exploration of Energy and Matter](#), a [OVPR Center](#) at [Indiana University](#)



The Compact Pulsed Hadron Source at [Tsinghua University](#)



Hokkaido University Neutron Source, [Laboratory of Quantum Beam System Engineering](#) of Hokkaido University



RIKEN Accelerator-driven Neutron Source, [RIKEN](#)



Neutron Science Division of [KEK](#)



ESS Bilbao, Spain



[Sun Yat-Sen University](#)



INFN ([Istituto Nazionale di Fisica Nucleare](#)), Italy



Neutron Imaging Facility at [Peking University](#), Part of the [State Key Laboratory of Nuclear Physics and Technology](#)



[Kyoto University](#) Accelerator-driven Neutron Source, Japan



[Nagoya University](#) Accelerator-driven Neutron Source, Japan



## Compact Neutron Sources



Center for Exploration of Energy and Matter  
an OVPR Research Center  
at **Indiana University**

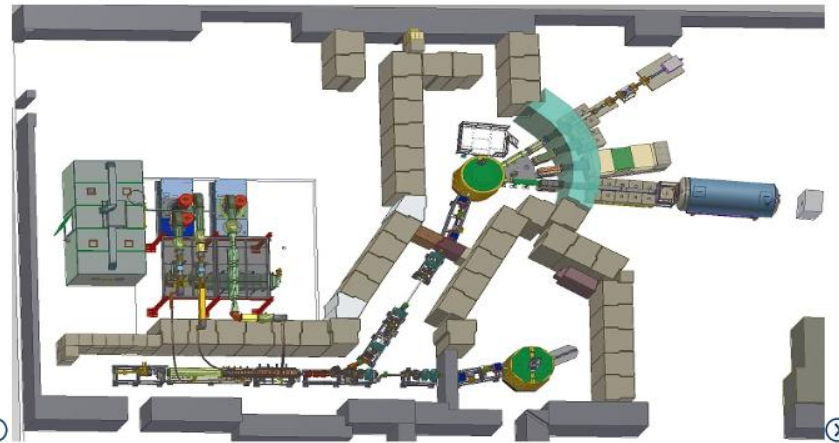
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### News and Events

- LENS Operations Schedule
- Recent News
- Conferences and Workshops

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- Apply for Beamtime
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- LENS Sponsors
- Employment opportunities
- Center for Exploration of Energy and Matter (CEEM)
- IU Department of Physics
- IU Office of Vice Provost for Research (OVPR)
- Neutron Radiation Effects (NREF) at LENS



### Welcome!

The Low Energy Neutron Source (LENS) is a pulsed neutron source at the **Indiana University** Center for Exploration of Energy and Matter (**CEEM**). The source utilizes a low energy p-n reaction in Be coupled with a high-current, variable-pulse-width proton accelerator to produce either short or long neutron pulses. A highly optimized moderator produces cold neutrons for use by a suite of neutron scattering instruments and development facilities.

Major on-going activities include the development of new neutron instrumentation (in particular for **neutron spin manipulation** and improved **moderators**), large scale structure studies in materials using **SANS**, **SESAME**, and **neutron radiation effects**.



# Compact Neutron Sources



## Hokkaido University Neutron Source

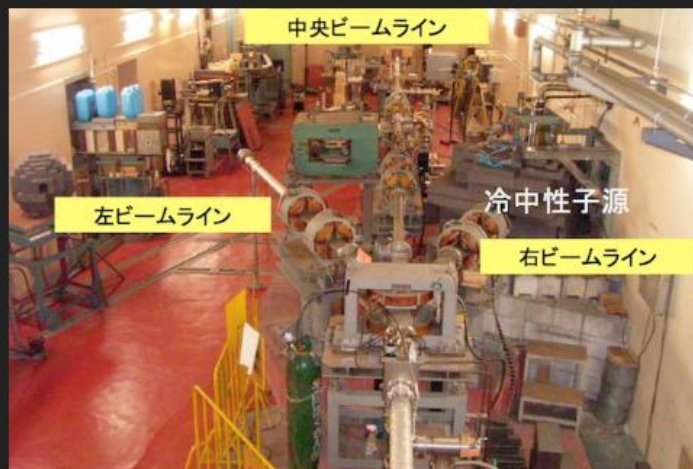
HUNS is an accelerator-driven neutron source at Hokkaido University.  
Now HUNS is in operation.

(Details)

### Specification

Accelerator	Electron LINAC (s-band RF)
Accelerated Particle	electrons
Max. Acc. Energy	45 MeV
Max. Current	140 $\mu$ A
Repetition	single - 200 Hz
Pulse width	10 ns ~ 3 $\mu$ s
Neutron Target	Pb
Neutron Energy	eV - Thermal - Cold
Moderator	Water, Solid Methane
Neutron Flux	

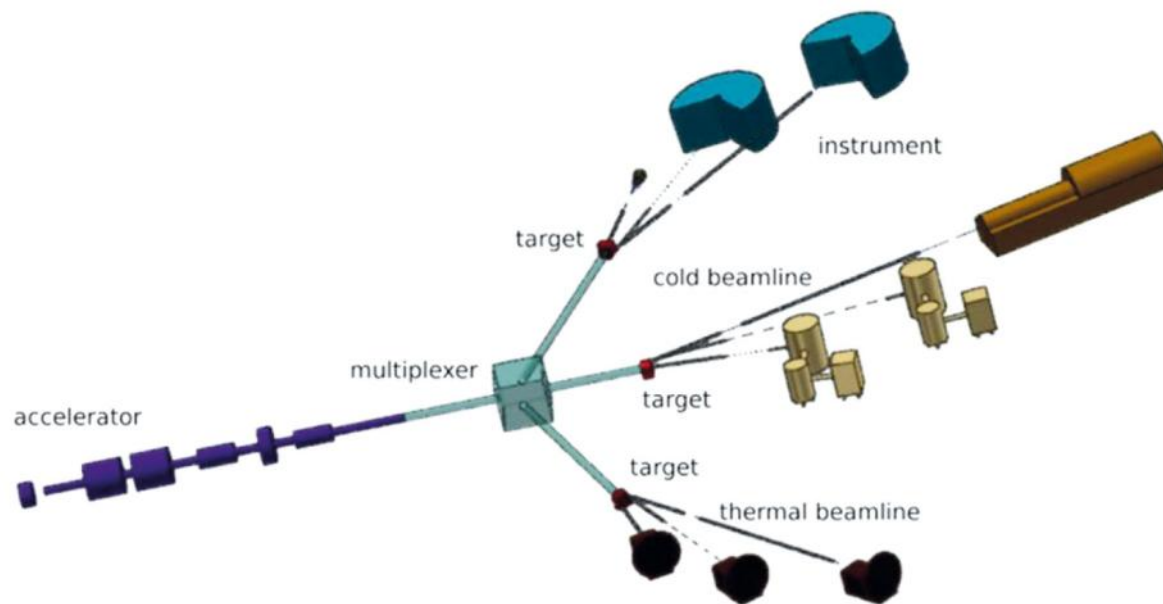
-> Ohnuma's Lab.  
-> Furusaka's Lab.





# Compact Neutron Sources

The Jülich high-brilliance neutron source project



**Fig. 16.** Schematic layout of a future accelerator-driven high-brilliance neutron source.