

# **Scienza con i neutroni al CNR: stato e prospettive.**

G. Gorini

# **Comunità Italiana e Scienza con i Neutroni:**

**statistiche, uso sorgenti,  
collaborazioni, impatto**



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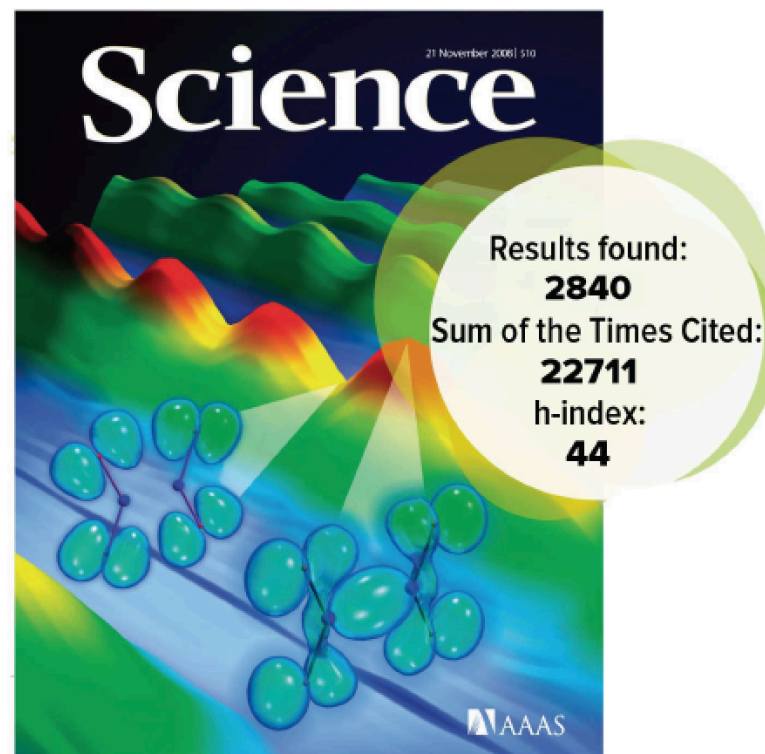
Acknowledgements:

**ILL** Scientific Coordination Office  
**ISIS** User Office

Anne Dale (ILL), Andrew Kaye (ISIS), Cirino Vasi (CNR-IPCF), Giovanna Cicognani (ILL), Giovanna Fragneto (ILL), Giulia Festa (Univ. Milano Bicocca), Ushi Steigenberger (ISIS), Roberto Senesi (Univ. Roma Tor Vergata).

## ITALIAN NEUTRON USER COMMUNITY SCIENTIFIC IMPACT (2001-2011)

Output of the Italian neutron community in the last  
**10 years\***

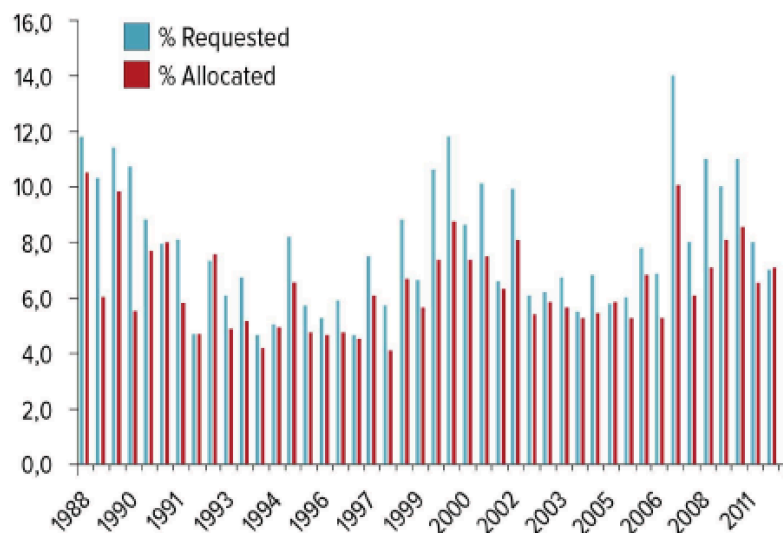


**\*NOTE:**

data extracted from a comprehensive list of publications gathered using WOK, SCOPUS, GOOGLE SCOLAR etc, with different keywords and manually checked for accuracy.

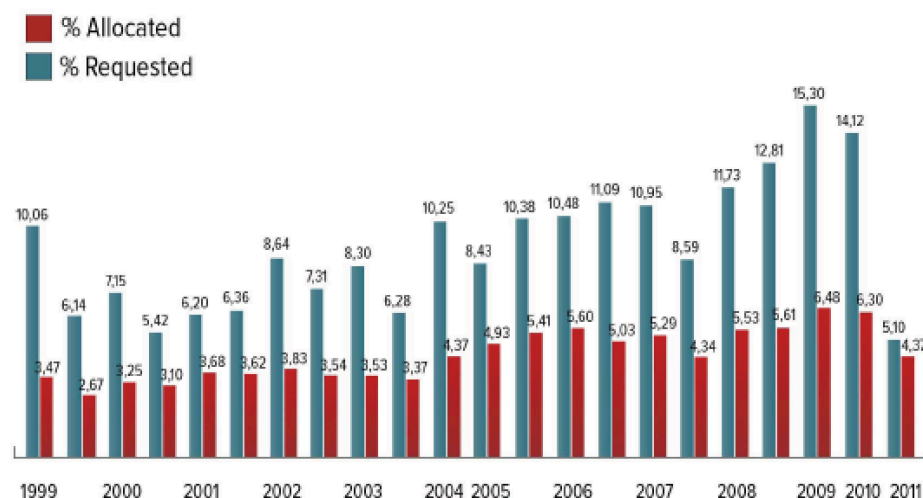
## ITALY % ISIS TIME

Courtesy of ISIS & CLF User Programme and Business Information Manager

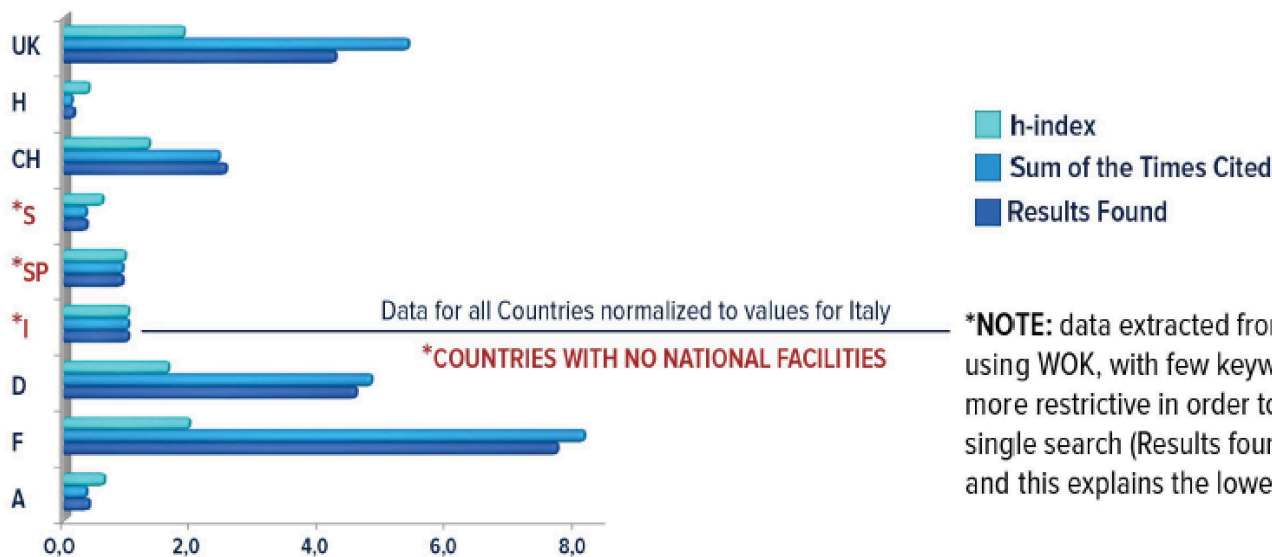


## ITALY % ILL TIME

Courtesy of ILL Scientific Coordination Manager



## COMPARATIVE ANALYSIS OF SELECTED NATIONAL NEUTRON COMMUNITY OUTPUTS IN THE LAST 10 YEARS\*



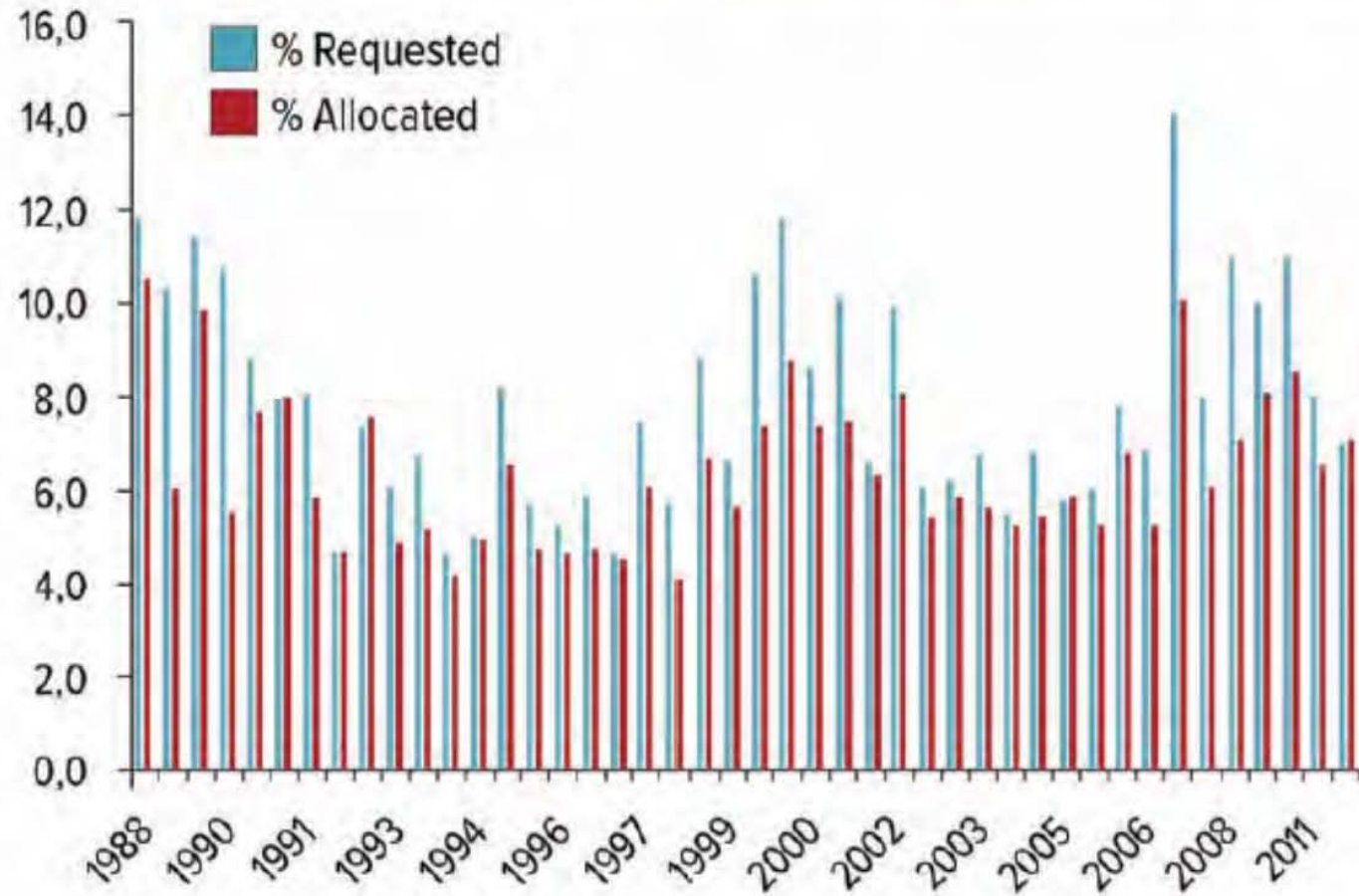
**\*NOTE:** data extracted from a comprehensive list of publications gathered using WOK, with few keywords. Criteria in this comparative analysis are more restrictive in order to maximize the likelihood of significant hits in a single search (Results found : 670, Sum of the Times Cited: 6357, h-index: 37), and this explains the lower value of h-index for Italy.

**\*NOTE:** Output is generally proportional to the number of experiments performed. Scientists in countries with no national facilities (\*) have limited beamline access and perform fewer experiments. Italy's has the highest output among (\*) Countries.

**ISIS**

# ITALY % ISIS TIME

Courtesy of ISIS & CLF User Programme and Business Information Manager



## Italian figures at March 2012:

- ❖ Typically ~700 experiments are carried out at ISIS each year;
  - ❖ up to 2000 user visits per year, 400 – 500 publications per year;
  - ❖ Use of 25 + 1 neutron instruments (includes INES) + 3 muon spectrometers
- Apart from INES, all other instruments are completely in the public domain, no CRGs

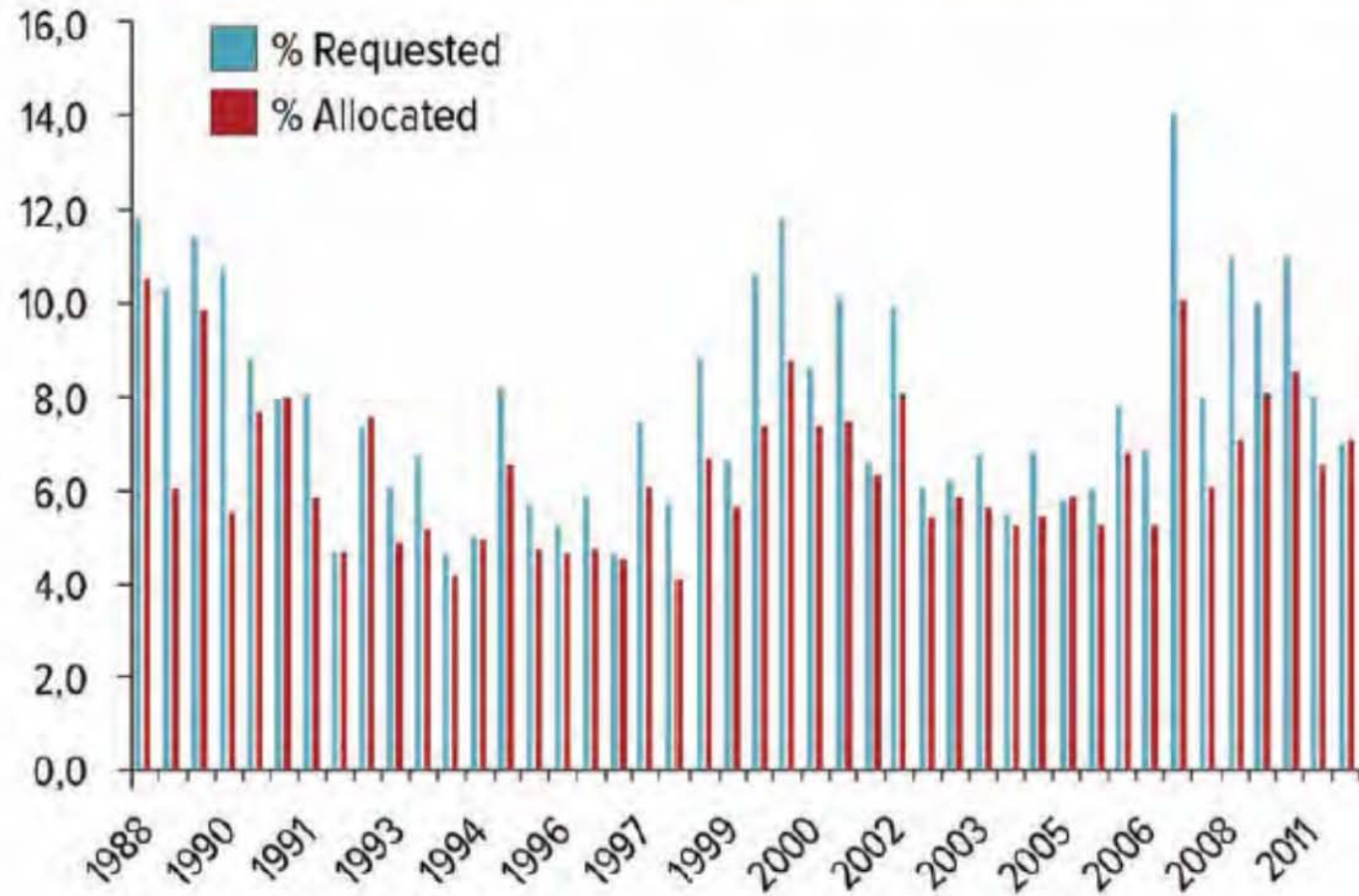
CNR 90<sup>th</sup> Anniversary, ROADSHOW 2013



Use of ISIS

# ITALY % ISIS TIME

Courtesy of ISIS & CLF User Programme and Business Information Manager



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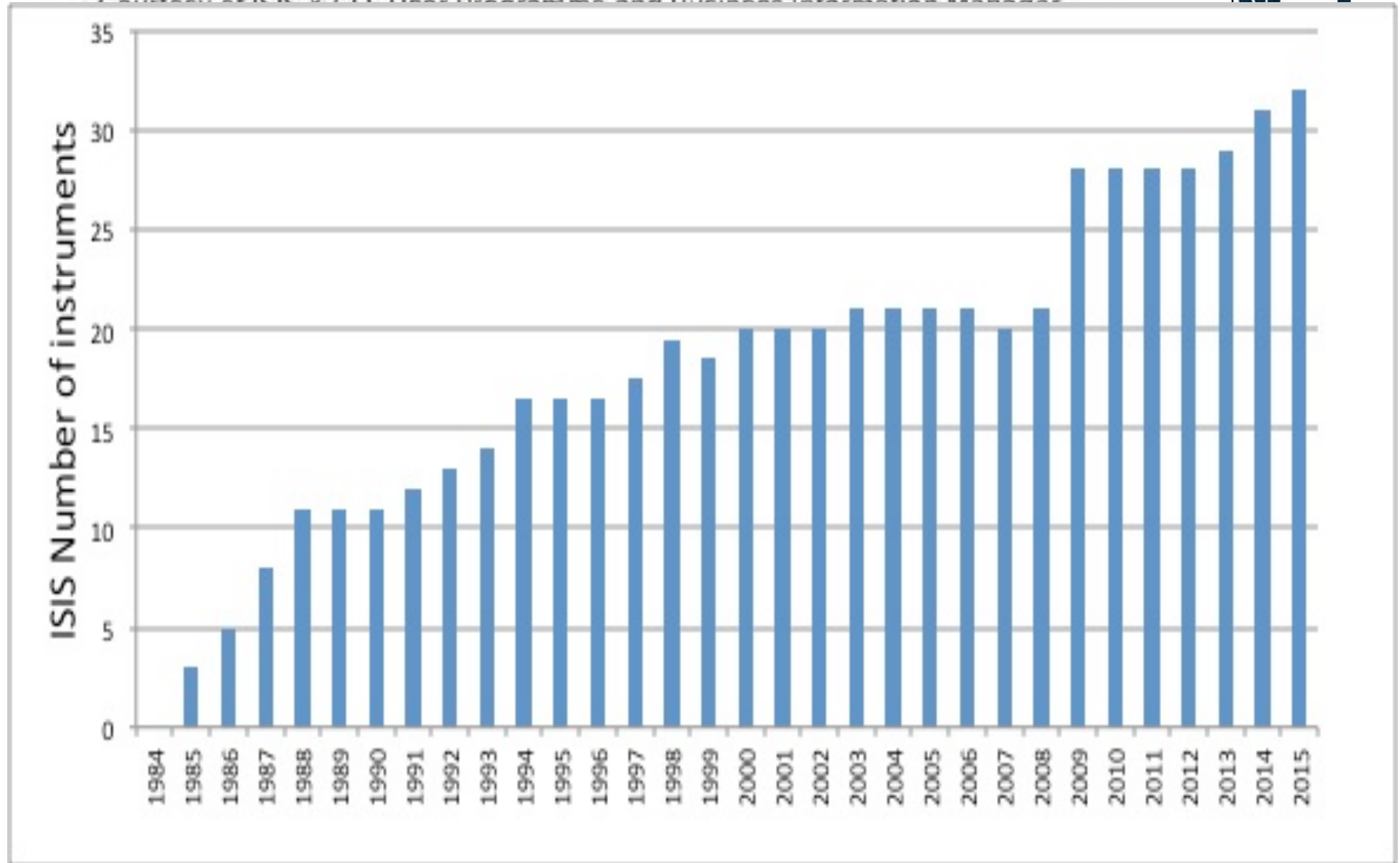
CNR 90<sup>th</sup> Anniversary, ROADSHOW 2013



Use of ISIS

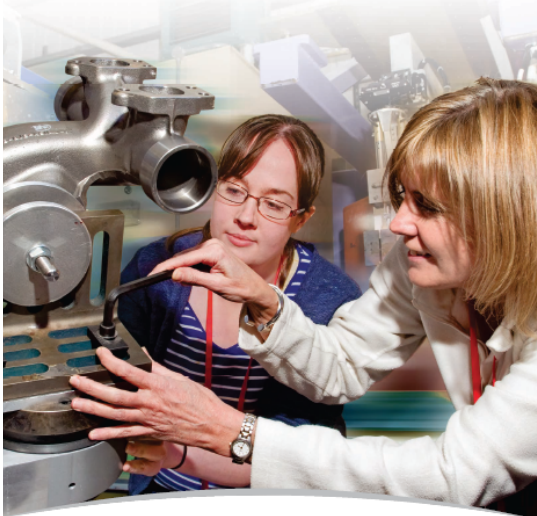
# ITALY % ISIS TIME

Courtesy of ISIS & CLE User Programs and Business Information Manager



CNR 90<sup>th</sup> Anniversary, ROADSHOW 2013





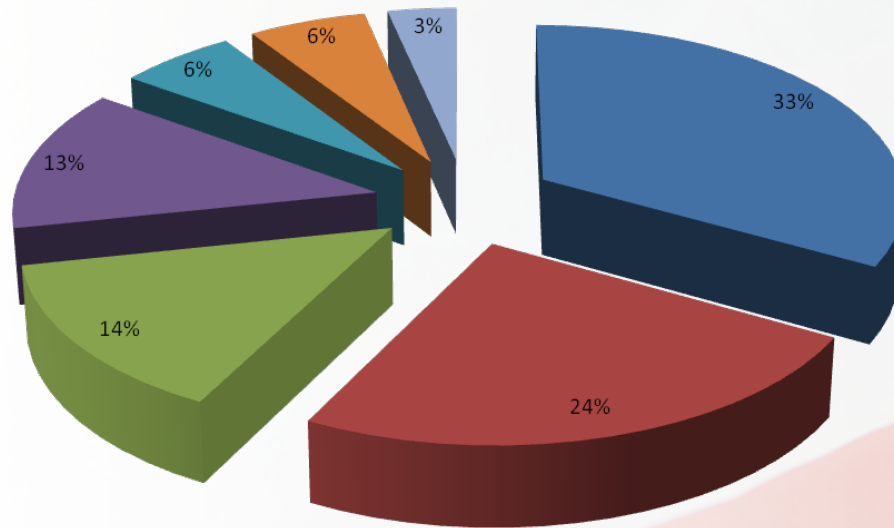
#### ■ Interdisciplinary Research Centre

- Physics
- Chemistry
- Materials science
- Earth sciences
- Engineering
- Pharmaceutical science
- Biomolecular science
- Cultural heritage

- ~1200 individual users/year  
(70% UK, 6% Italy, 24% RotW)
- Italy (Japan) 2<sup>nd</sup> nation in terms of  
N. of users
- ~3500 user visits
- ~1500 other visitors
- > 700 different experiments/year
- ~400 publications per year  
(~130 in high impact journals)
- 150 days accelerator operation
- 32 instruments (1 Italy (INES), 3  
Japan)
- >1000 different items of sample  
environment

# Italy @ ISIS

- 300 Italian Users on Data base
- 200 publications in last 5 years
- Italian PI's have received 1128 days of beamtime since 2007

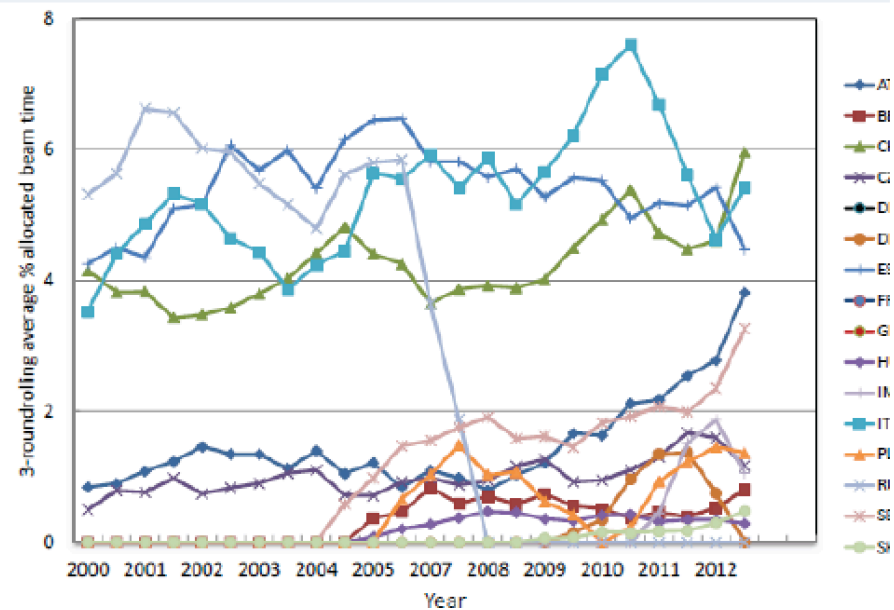
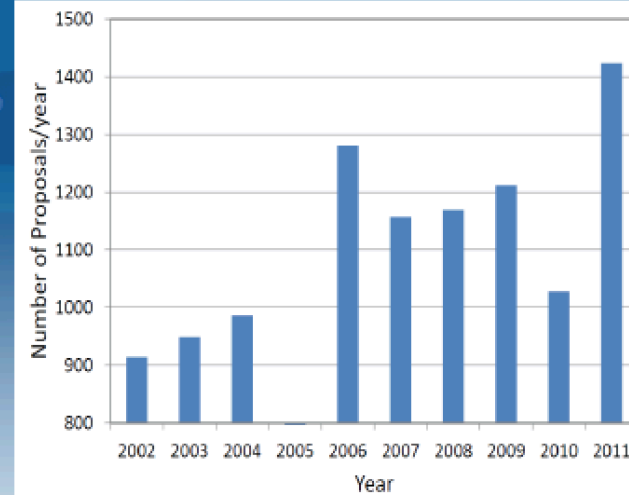


- Fundamental science
- Cultural heritage and archaeometry
- Technique development
- Biomaterials
- Energy
- Engineering
- Environment & geology

**ILL**

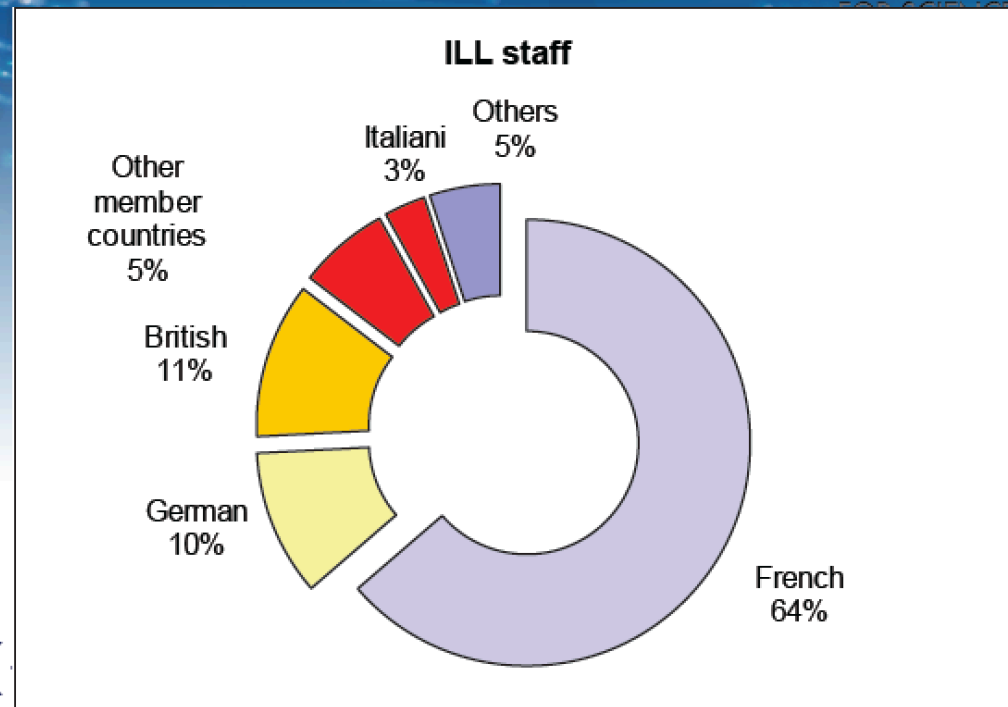
- 500 staff
- 4500 users (It 300, 130 labs)
- 1400 Proposals\*
- 2000 User visits\*
- 800 Experiments\*
- 200 reactor days\* (It 5-6 %)
- 27 (+10) instruments (+CRG)
- 600 Refereed papers\*

\* In 2011



- 500 staff (**3% Italian**)
- 4500 users
- 1400 Proposals\*
- 2000 User visits\*
- 800 Experiments\*
- 200 reactor days\*
- 27 (+10) instruments (
- 600 Refereed papers\*

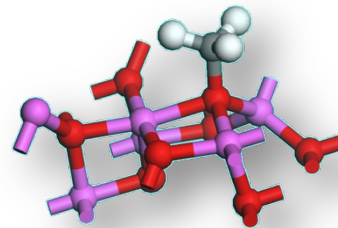
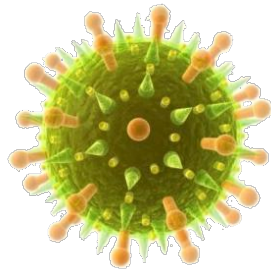
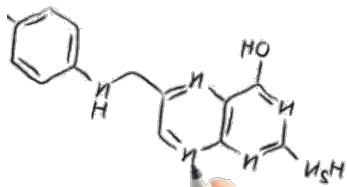
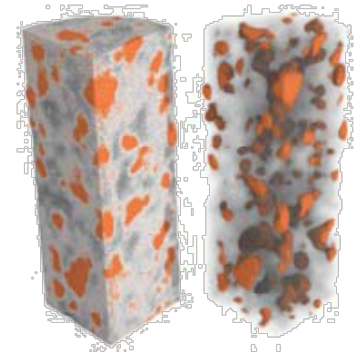
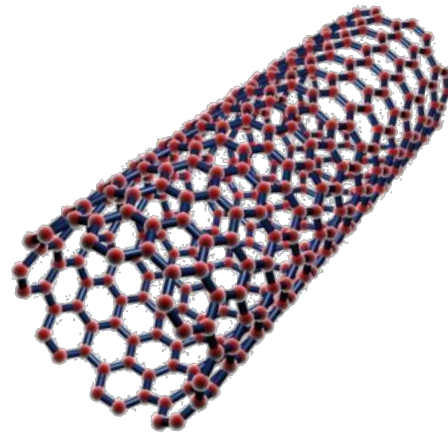
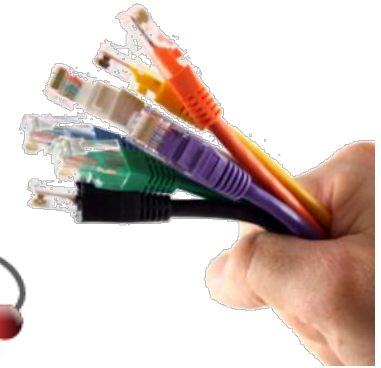
\* In 2011



# Scienza, Esempi

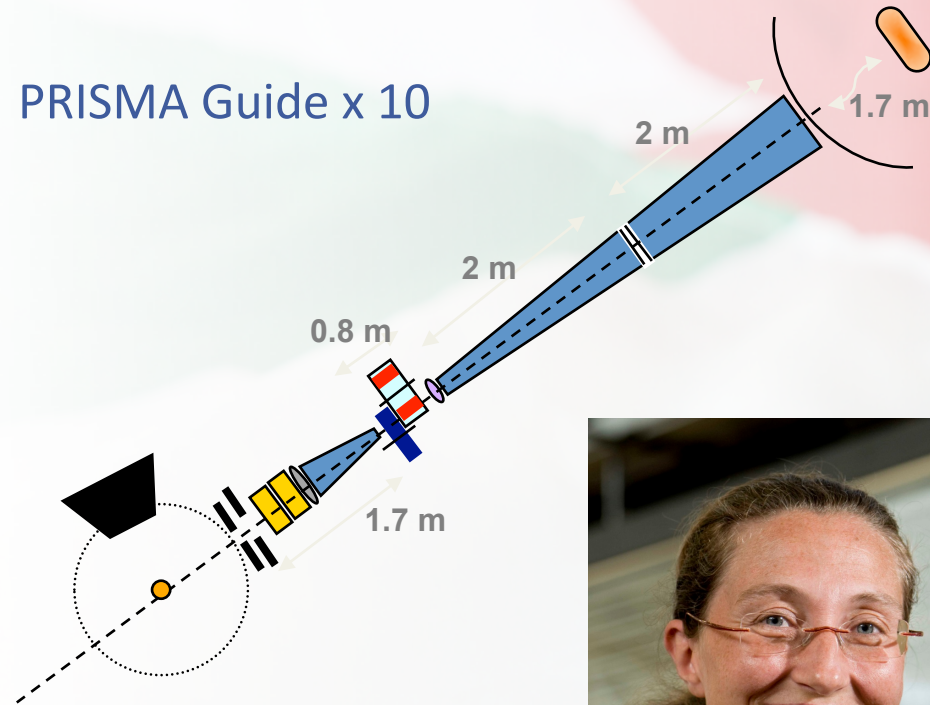
# Scientific Applications

- Energy/environment
- Engineering
- Cultural Heritage
- Healthcare
- Physics
- Food Security
- Materials

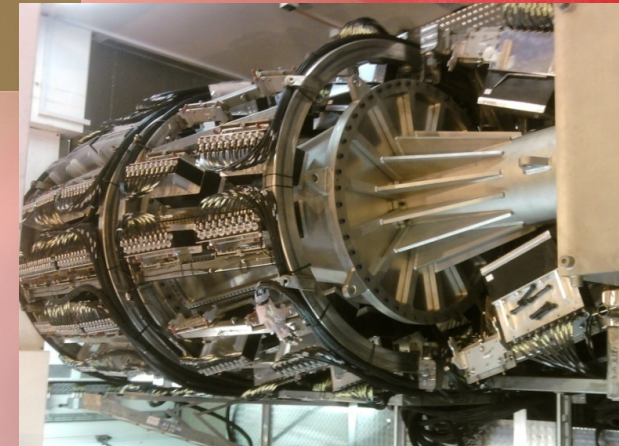


# Italian led projects @ ISIS

PRISMA Guide x 10



## TOSCA Upgrade

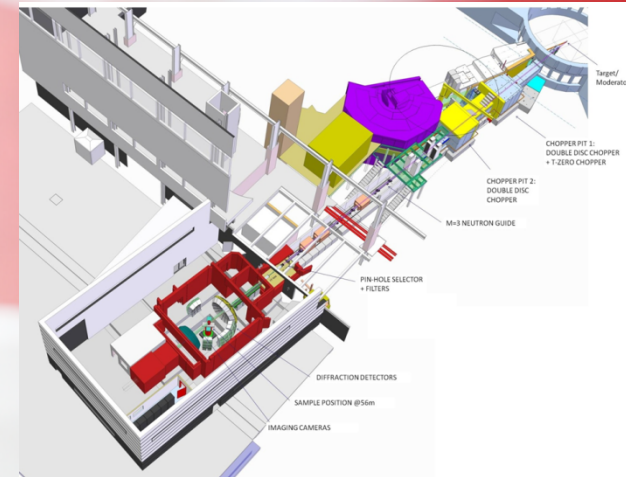


- VESUVIO, INES, NIMROD
- Detector Development
- Ancient Charm Initiative

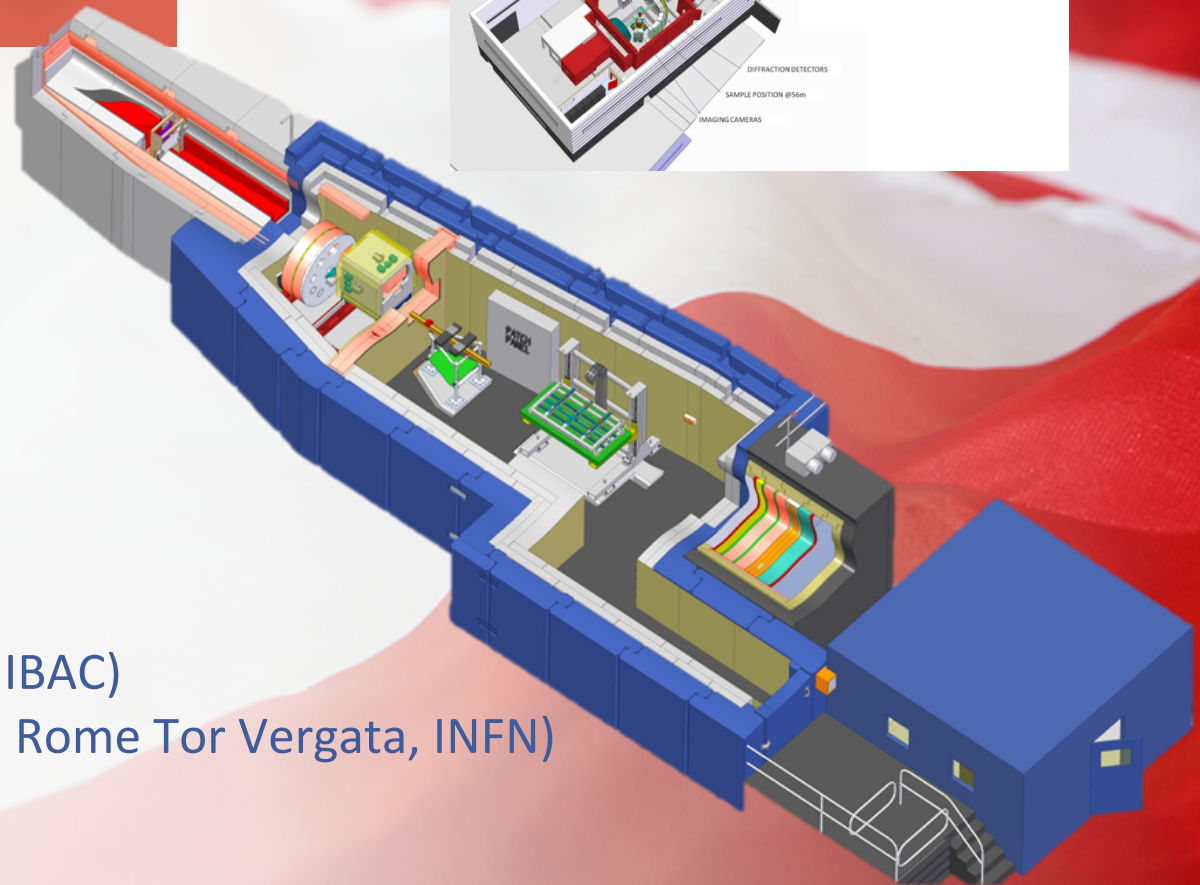


# Involvement in phase 2 : (CNR, Panarea project (in kind))

ZOOM	Focusing SANS
IMAT	Imaging/materials
CHIPIR	Chip Irradiation
LARMOR	SESANS, High Res diffraction, MISANS, MIEZE



- IMAT (CNR-IPCF, CNR-ICS, MIBAC)
- ChipIr facility (Milan-Bicocca, Rome Tor Vergata, INFN)
- Larmor (CNR-ICS), Zoom



# Italy and ISIS muons

First instrument in 1987

Complementary to neutrons (35% use both)

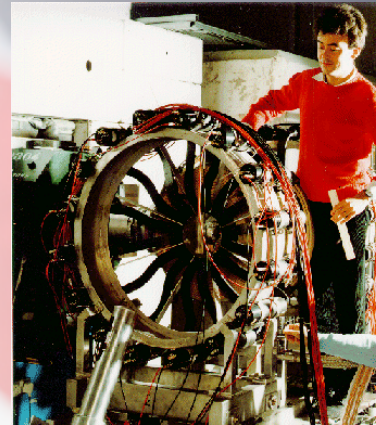
Non-destructive

Sensitive magnetic probes

4 muon instruments

Broad range of science:

- hydrogen storage
- chemistry/molecular studies
- inorganic magnetism and superconductivity
- charge transport and diffusion
- organic magnetism and superconductivity

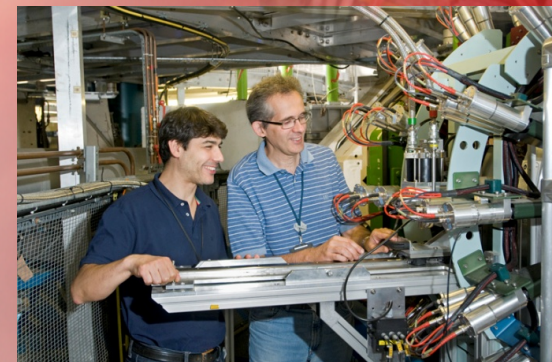


Roberto de Renzi (Parma) setting up the MuSR muon spectrometer in 1987.

Stefano Carretta, Paolo Santini, Università di Parma, Italy, using HIFi



Samuele Sanna and Pietro Carretta (Pavia) using EMU



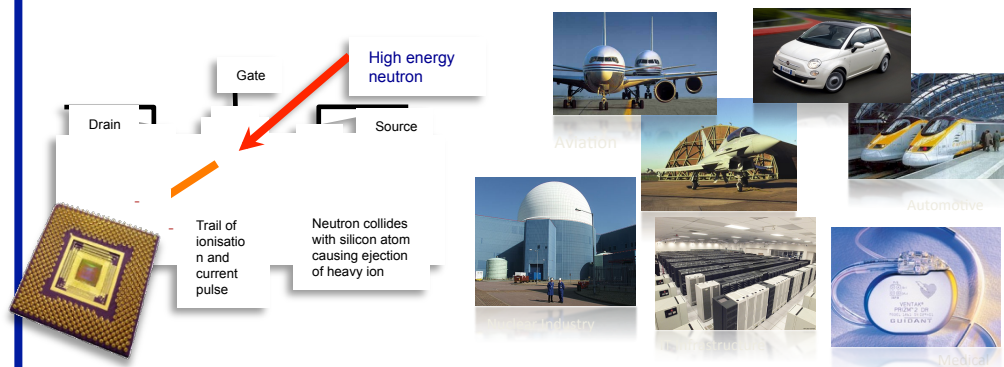


# Chipir Beamline: A Fast (MeV) Neutron Testing Facility for the Semiconductor Industry



## Meeting the Needs of the Semiconductor Industry

### An Industry Wide Problem



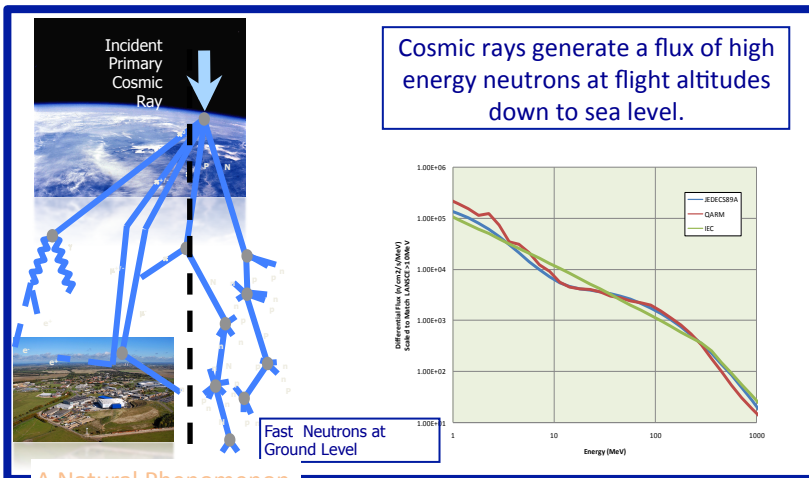
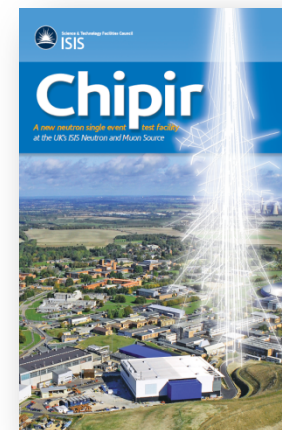
Fast neutrons present in the atmosphere are severely disrupting the operation of many electronic devices and systems.

### A European Strategic Solution

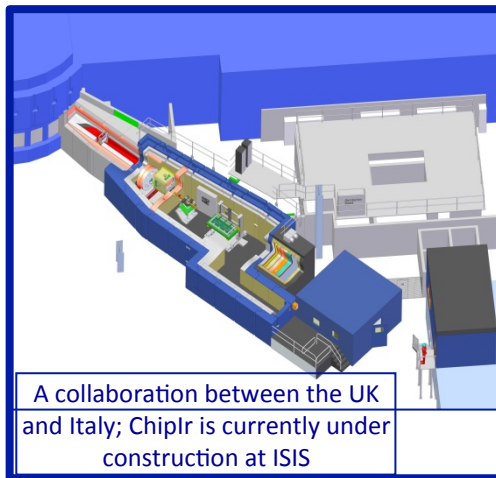
The Target Station 2 at ISIS will site an accelerated testing facility specifically designed for the electronic industry. This will provide Europe with a world leading facility.

Atmospheric neutron spectrum to 800MeV with large area beam

Bespoke design to ensure accurate and efficient test measurements



A Natural Phenomenon

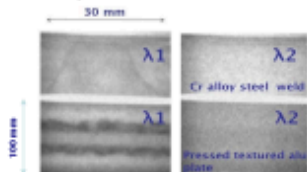




# Neutron radiography and tomography

Neutron radiography and tomography is an emerging field of applied science. The Imat instrument at the ISIS Second Target Station will offer both imaging and diffraction techniques for materials science, engineering, geology and archaeological sciences.

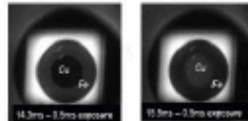
Imat will be the first beamline on a pulsed neutron source where **energy-resolved imaging** will be available. This will allow contributions from different materials and their different phases to be separated. This type of separation is not possible using conventional neutron radiography.



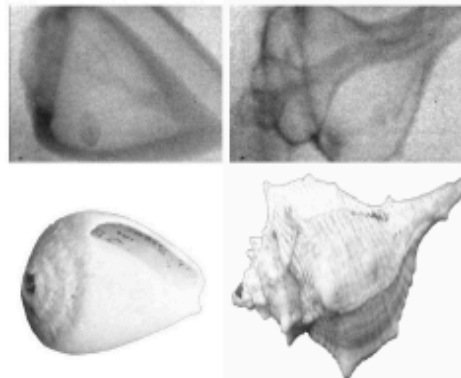
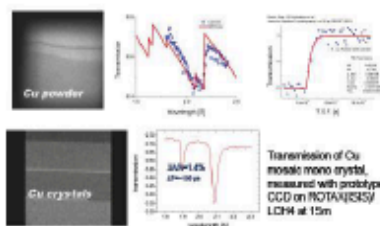
Making microstructures visible with energy-selective imaging.

Left: Texture variations are visualized by taking images with narrow wavelength bands. Right: The microstructure features disappear above the wavelength of the 1<sup>st</sup> Bragg edge of a material. Data from ROTAX, ISIS.

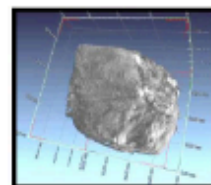
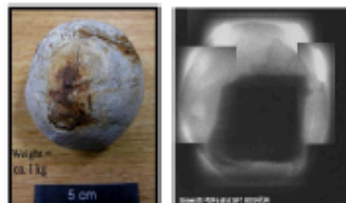
Time Of Flight Neutron Imaging will allow to enhance image contrast between materials with similar integrated cross sections.



Transmitted intensities will allow to obtain spatially resolved Bragg-edges or Bragg-peaks information.



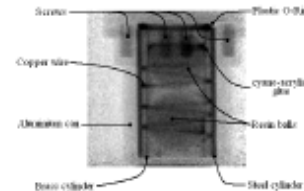
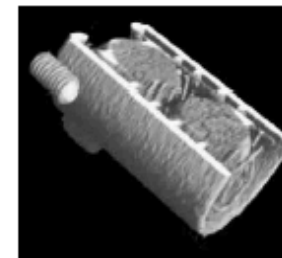
White beam tomography of Pb shot from Bosworth Field (1485) (War of the Roses). Data collected on ROTAX. E. Godfrey (Open University), D. Tresoldi, G. Salvato (CNR Messina).



A wrought iron cube – missing a corner – was cast off-centre inside a cannonball.



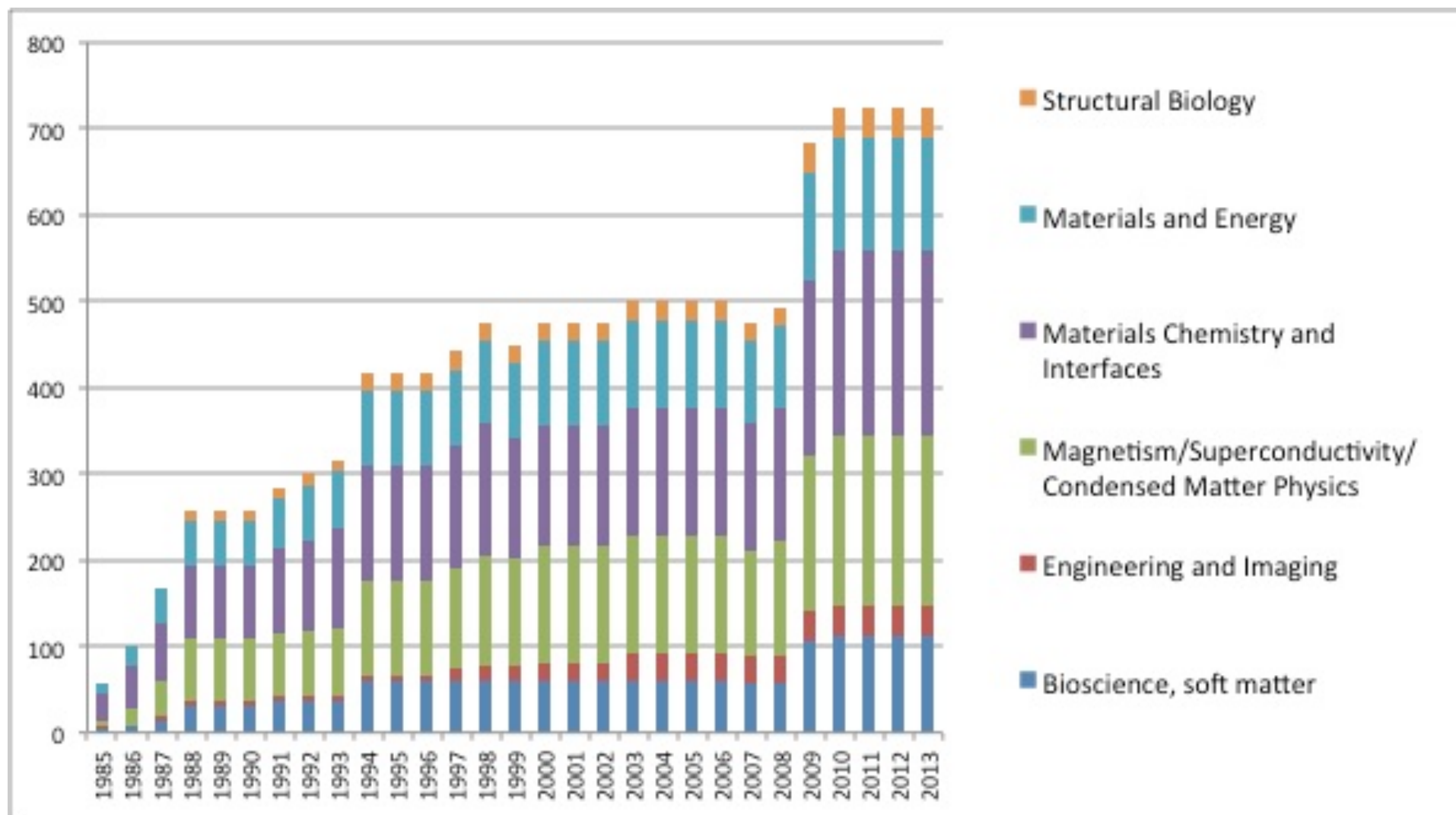
Preliminary imaging tests have been carried out successfully with two prototype cameras at ISIS. The second (portable) tomography chamber has been assembled and used successfully for energy selective neutron imaging experiments.



**Ricerca interdisciplinare  
presso ILL & ISIS**



**Ruolo peculiare del CNR  
grazie alle competenze trasversali  
al suo interno (Dipartimenti)**



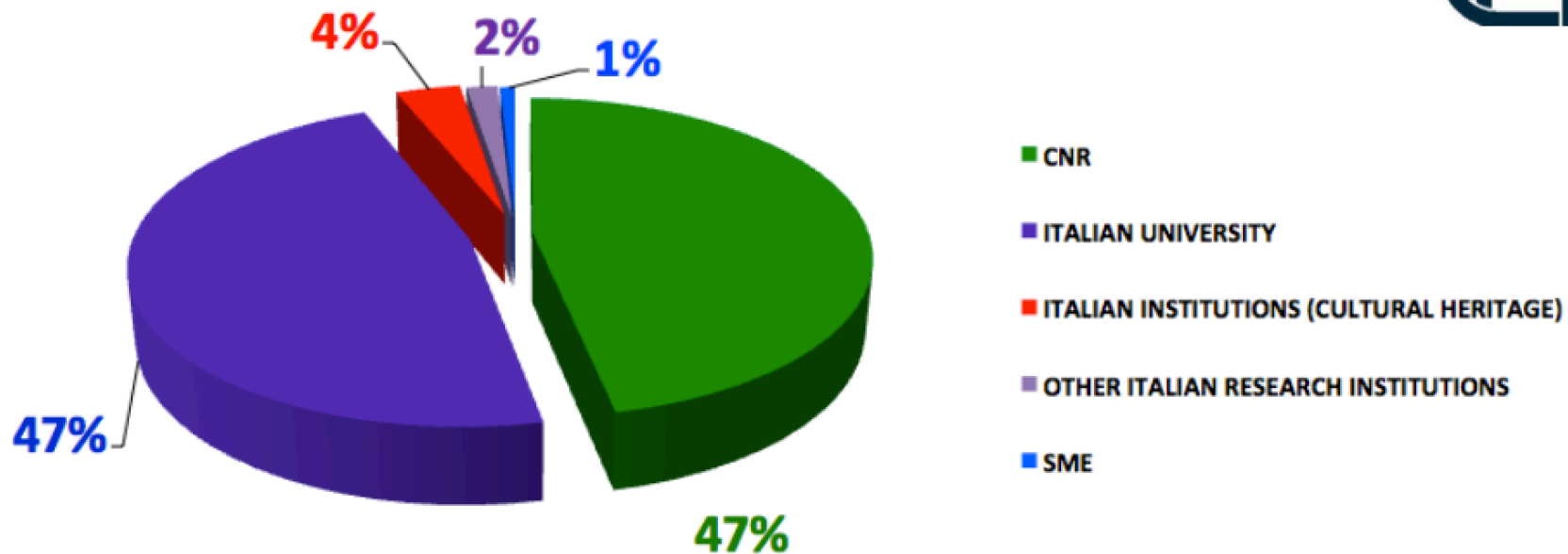
[\(Italian\) Science @ ISIS](#)

Courtesy of R. McGreevy ISIS Director

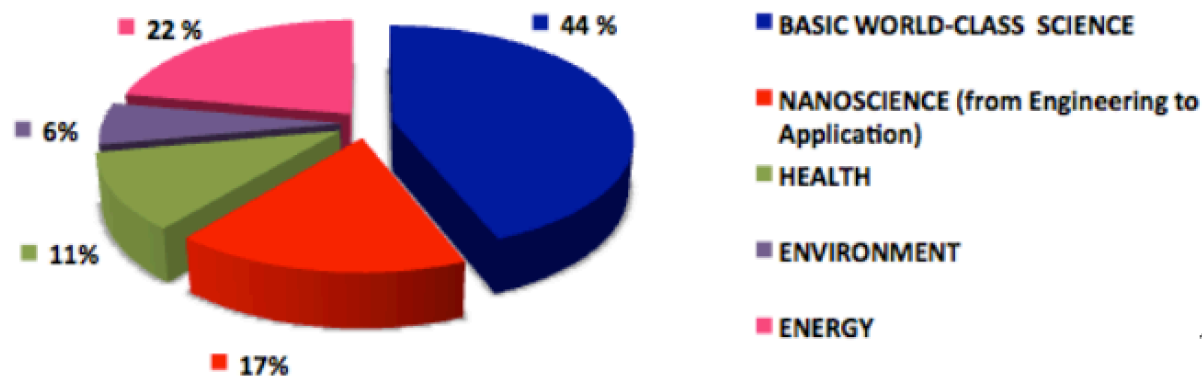
**Iniziative trasversali, in particolare  
roadshow, per aprire ad altri user  
l'utilizzo dei neutroni**



## ITALIAN 'USE' OF ISIS BEAM TIME 2007-2012



## Overall distribution of Italy science programme at ISIS

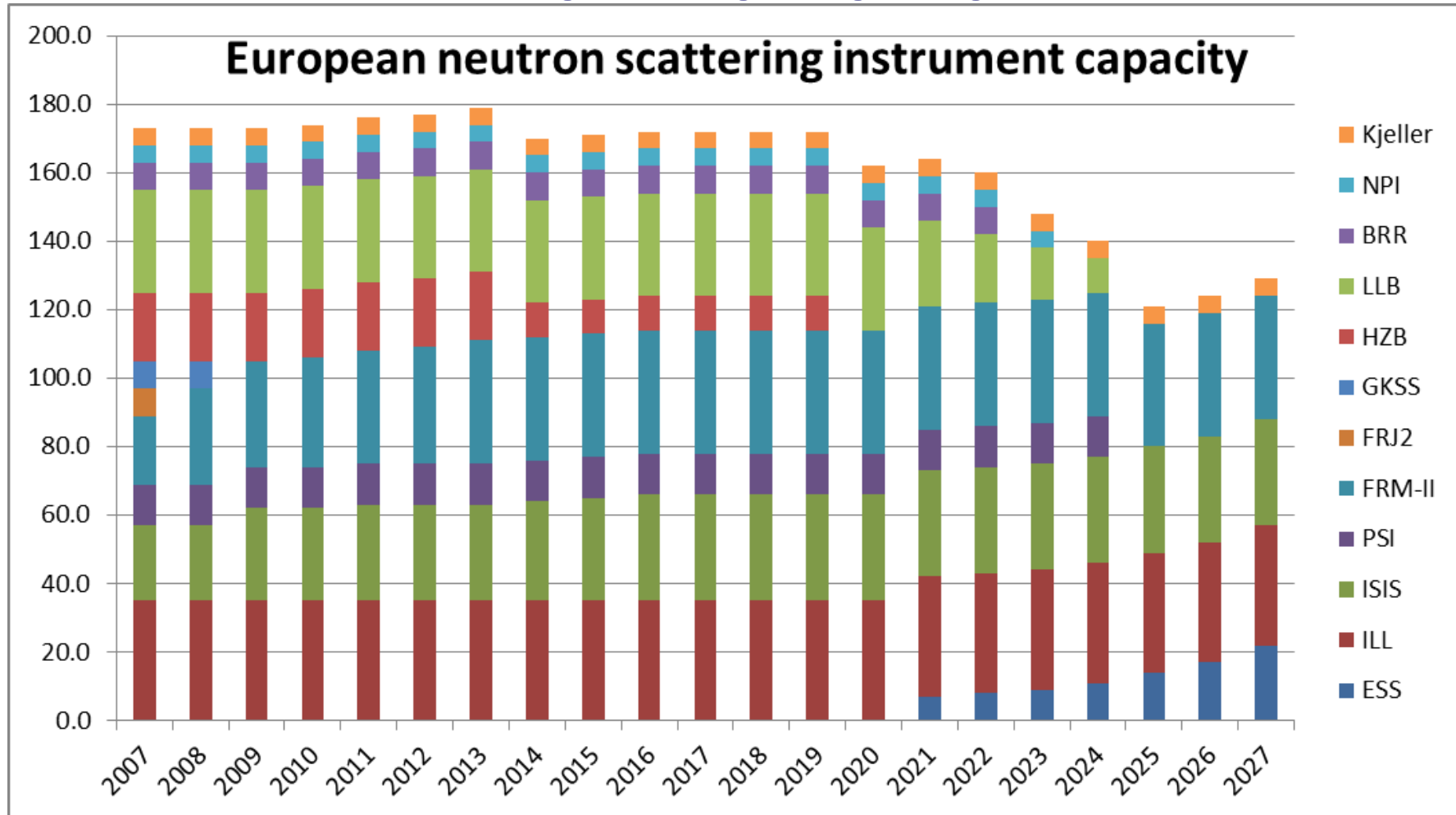




# **Stato dell'arte nello sviluppo delle sorgenti attuali, in confronto alle necessità**



## Neutron scattering is *neutron capacity* limited – and things are going to get worse



## **Impegno del CNR per preservare la *Neutron Capacity* in Italia e in EU:**

- Rinnovo accordo ILL e ISIS 2014-2020**
- Partecipazione a Neutron Science per ESS**

**ESS**



## ***ESS Neutron Science***

***12 Strumenti già approvati***

***2 strumenti proposti da gruppi italiani:***

***VESPA (proposta italiana)***

***T-REX (proposta tedesca, partecipazione italiana)***

# CNR in-kind contribution to ESS

The Italian National Research Council (CNR) aims at further expanding Italian Research & Technology capability in Neutron Science, through its commitment in the construction of the ESS neutron beamlines.

Such an approach is strategic for Italy to train young generation of Italian researchers in Neutron Science and to guarantee a long term perspective and further expansion into new generation neutron facilities.

## CNR-ESS project

- CNR will contribute 20M in kind to ESS Neutron Science
- Funding flows from MIUR to CNR
- Collaboration with University
- Collaboration with ESS
- Collaboration with other ESS partners (Julich; ISIS?)

***Neutroni per l'Italia:  
opportunità per nuovi sviluppi della scienza con i neutroni***

2<sup>a</sup> edizione

**Il Consiglio Nazionale delle Ricerche e la European Spallation Source:  
ricadute scientifiche e industriali**

Sede CNR di Roma, via dei Taurini, Aula PT  
Mercoledì 7 - Giovedì 8 Ottobre 2015  
ore 10:00 – 17:30







## Conclusioni

**Impegno del CNR per preservare la *neutron capacity* in Italia e in EU, attraverso:**

**☐ Rinnovo accordo ILL e ISIS 2014-2020**

**☐ Partecipazione a Neutron Science per ESS**