Attivita' del gruppo di Pavia

Calo Cube Meeting
Firenze 22 January 2014

- Digitizzatore
- SiPM
- Irraggiamento
- Test beam
- Simulazione

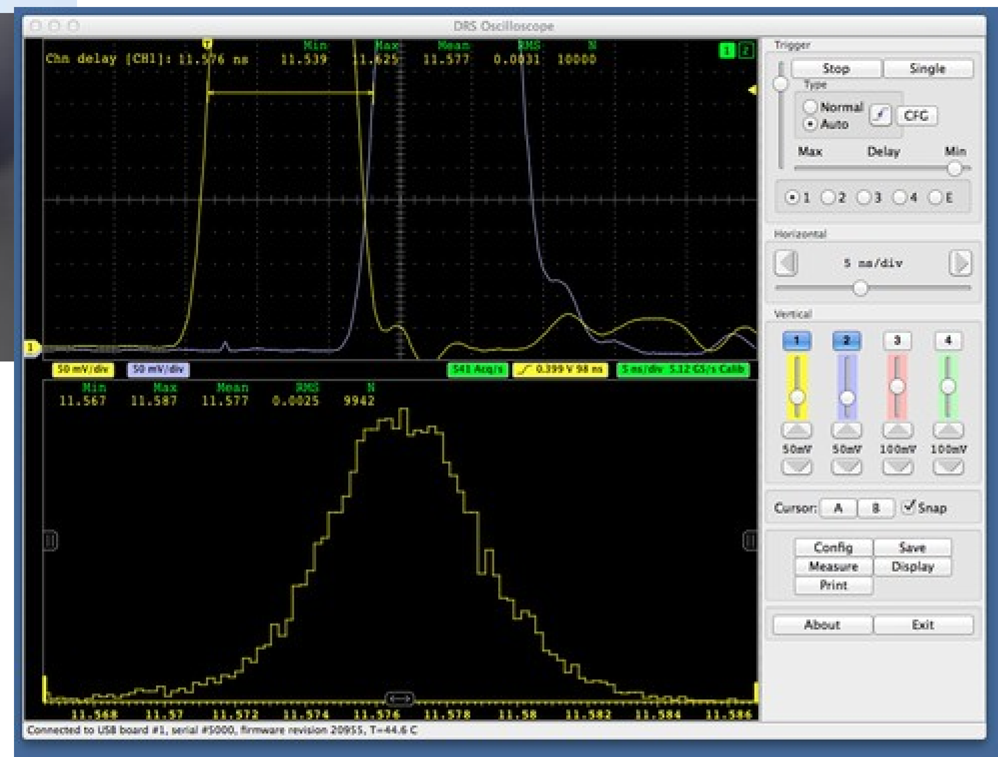
Digitizzatori DRS4

Il gruppo di Pavia collabora dall'inizio con l'esperimento MEG al PSI (Zurigo) dove i digitizzatori DRS sono stati sviluppati da Stefan Ritt

2 schede di test con 4 canali di DRS4 sono a Pavia
Campionamento fino 5 Gs/s (scheda VME dalla CAEN in vendita)

Software installato e funzionante sia per l'acquisizione via USB che come oscilloscopio digitale

Esempio di uso della scheda DRS
come oscilloscopio digitale



Applicazioni DRS4

L'applicazione del DRS4 per CaloCube consiste nel campionamento ad alta frequenza del segnale del fotorivelatore per discriminare il segnale Cerenkov da quello di scintillazione

Tecnica gia' studiata da DREAM

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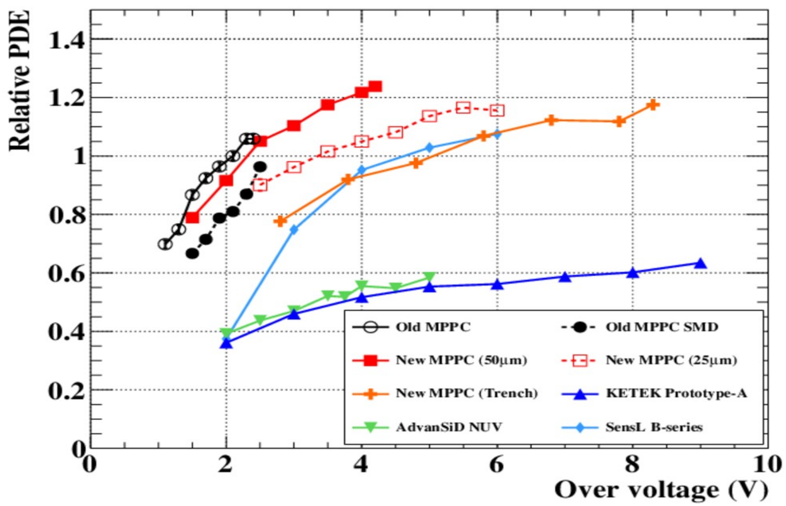
SiPM

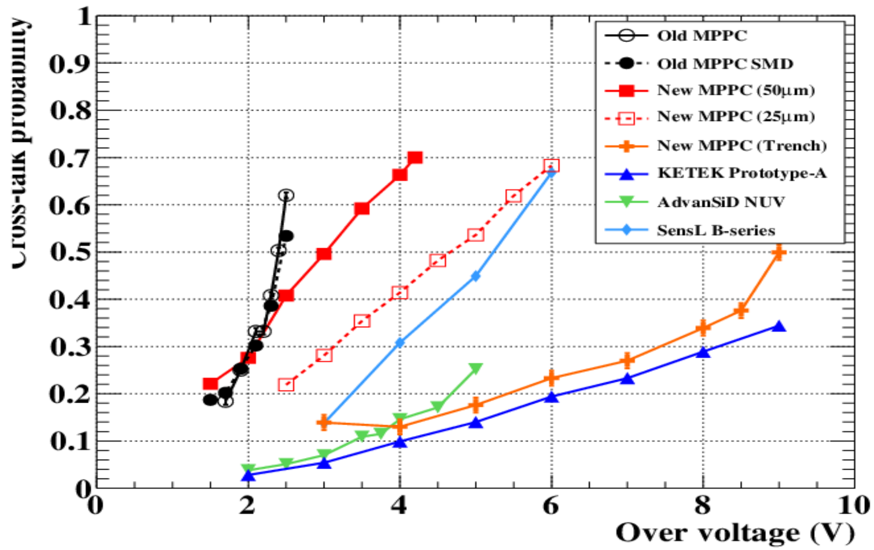
Nel contesto di MEG a Pavia siamo coinvolti (con PSI e INFN Genova) nello studio di SiPM per elevate prestazioni di misura temporale: Advansid (FBK), Hamamatsu, Sensl,
Excelitas, Ketek sono stati studiati

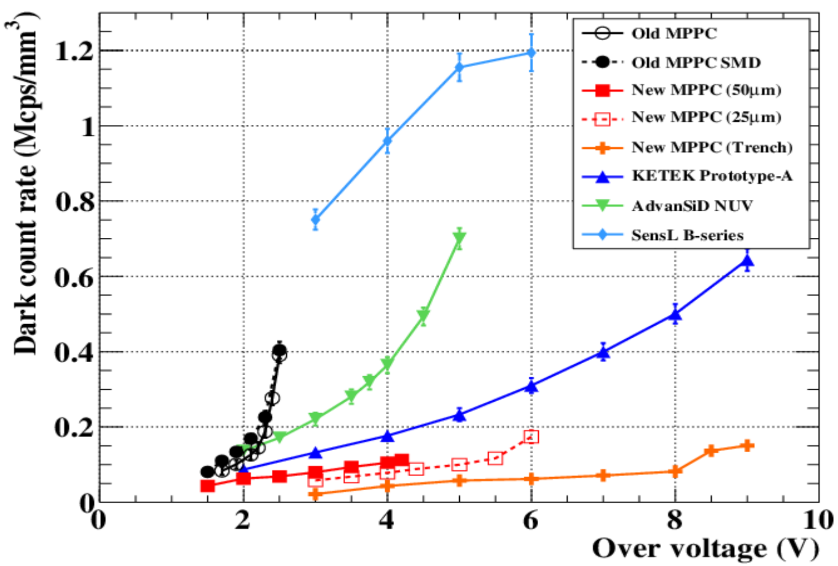
Stretti contatti con Advansid che e' stata scelta come fornitore (6500 pezzi)

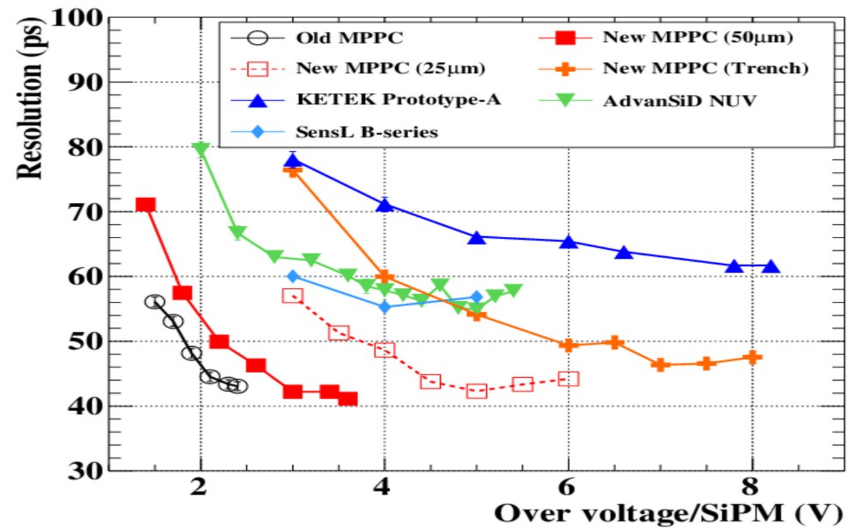
Gruppo del servizio elettronico (tecnologo + tecnici + assegnista) a disposizione

Risultati test SiPM









Simulazione

In AGILE ci siamo dedicati alla simulazione del tracciatore sia per l'esperimento sia (in grande dettaglio) per il test beam.
Sia del rivelatore che del sistema di test

Test beam

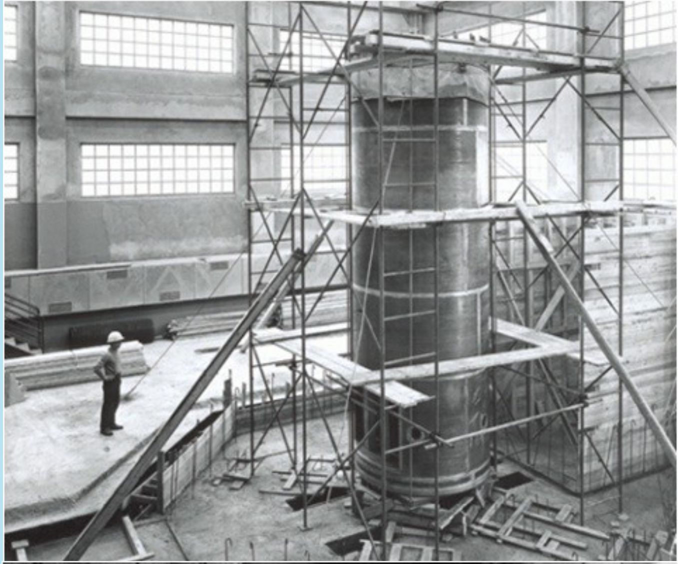
Nel corso del commissioning del tracciatore per il satellite AGILE abbiamo contribuito in modi sostanziale alla progettazione del test beam e all'analisi dei dati.
In particolare abbiamo acquisito particolare esperienza alla BTF con il fascio di test di fotoni.

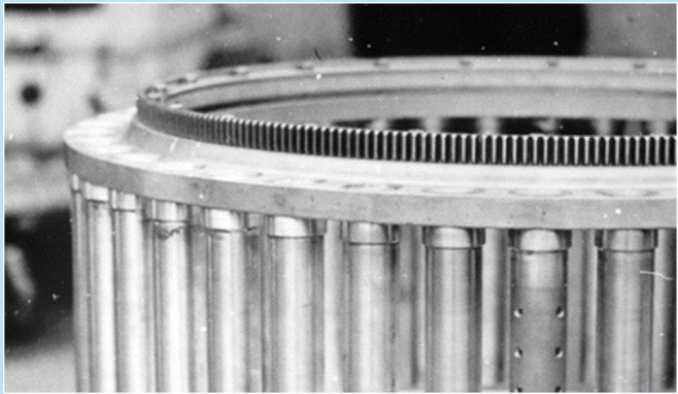
LENA *from the beginning …*

The reactor reached its first criticality on November,15th 1965 and was officially inaugurated on December 16th 1966.

After the first 40 years of operation, an official report of 2005 reported a list of **600 publications** related to research conducted with the reactor in different areas:

- ✓Nuclear Chemistry and Radiochemistry,
- ✓Activation Analysis
- ✓Basic Chemistry





Main Facilities

- 250 kW TRIGA Mk II Research Reactor
  - X ray industrial generator
    - 250 kV, 12 mA dose rate 15.6 Gy/min
    - 350 kV, 6 mA dose rate 17.5 Gy/min

- Gamma source of 60Co (0.26 kGy/h)

- Radiochemistry Laboratory (Class 2)

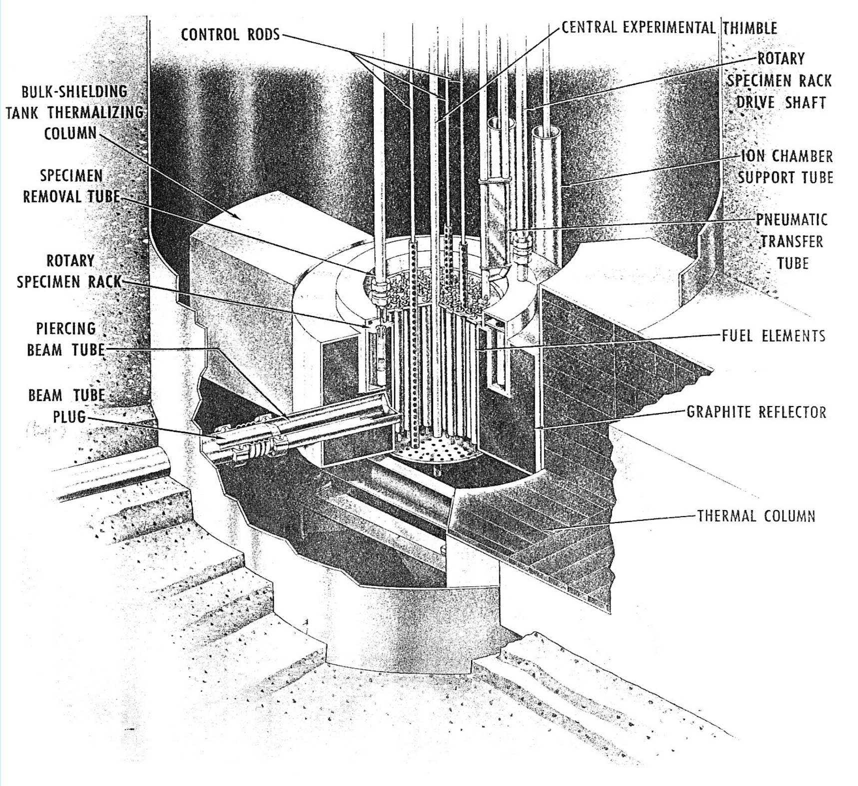
- Cyclotron IBA Cyclone 18/9
  - 18 MeV protons   (Imax = 80 μA)
  - 9 MeV deuterons (Imax = 40 μA)

TRIGA Mark II Nuclear Research Reactor

TRIGA (**T**raining, **R**esearch, **I**sotopes production, **G**eneral **A**tomics)

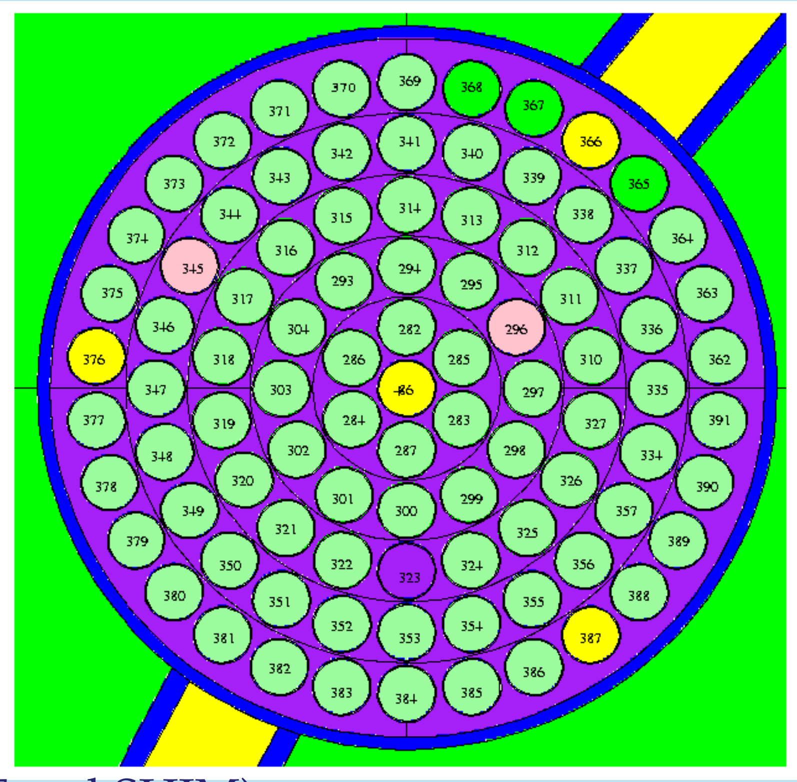
- **250-kW** light-water **Thermal Reactor,** with an annular graphite reflector, cooled by natural convection
- offers many positions of irradiation (facilities) with **"in-core"** neutrons flux **from 10^{12} to 10^{13} n cm^{-2} s^{-1}**
- **6 “out-core” irradiation facilities** with typical neutron flux **from 106 to 10^{10} n cm^{-2} s^{-1}**
- **Fuel:** 20% enriched Uranium
- **Moderator/Cooling:** light water
- **Reflector:** graphite
- **3 control rods**
- **Irradiation:** 400 hours/year

TRIGA Mark II Nuclear Research Reactor



REACTOR CORE

The core is placed at the bottom of the 6.25-m-high open tank with 2-m diameter.

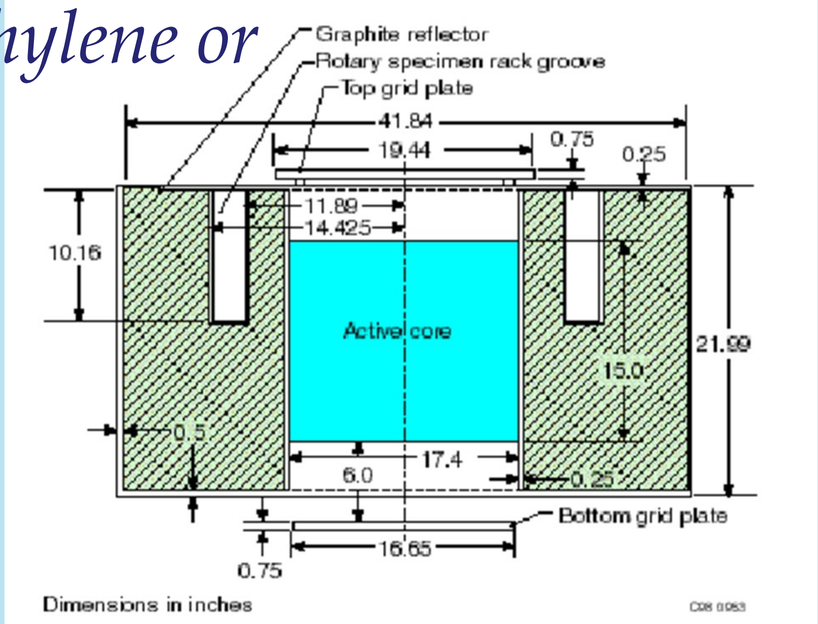


- **Cylindrical configuration**
- **Lattice of 90 cylindrical elements (September 2013):**
  - **80 moderator-fuel elements**
  - **3 control rods** (REGULATING, TRANSIENT and SHIM)
  - **1 Radium-Beryllium source**
  - **2 vertical irradiation facilities** (Central Thimble, Pneumatic Transfer System Thimble *(Rabbit)*)

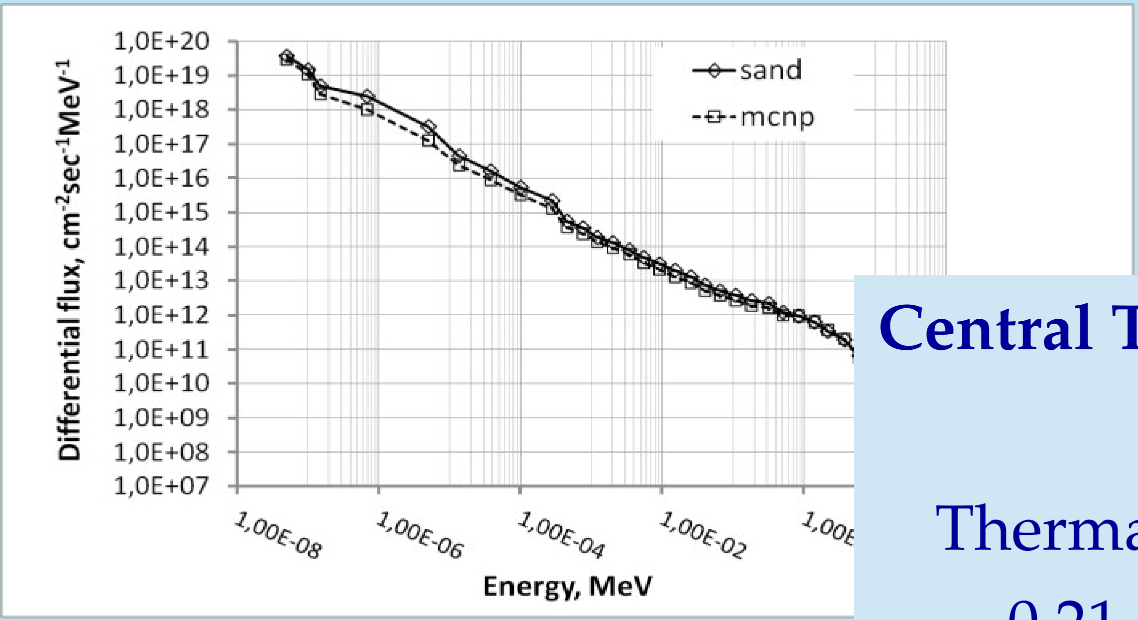
"In-core" irradiation facilities – Central Thimble

Central Thimble

- It is positioned along the <u>vertical axis</u> of the "core" cylinder, where the <u>neutron flux is maximum</u>
- It can host up to **3** samples in cylindrical containers *(130 mm-height; 30 mm-diameter made by Polyethylene or Aluminum)*



“In-core” irradiation facilities



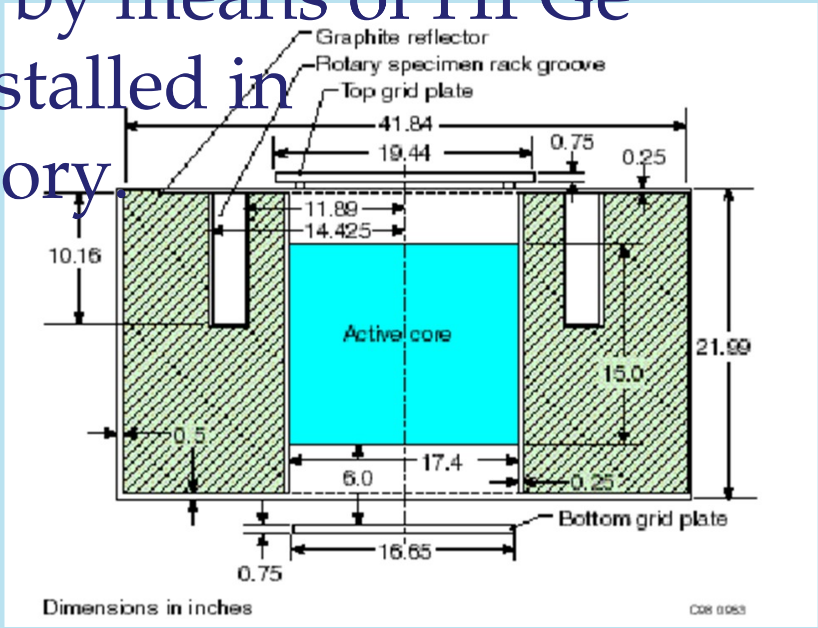
Central Thimble	Measured Flux (n cm-2 s-1)
Thermal (E < 0.21 eV)	(3.00 ± 0.15) 1012
Epithermal (0.21 eV < E < 9.2 keV)	(4.64 ± 0.21) 1012
Fast (E > 9.2 keV)	(5.89 ± 0.18) 1012
Total Flux	**(1.39 ± 0.31) 1013**

D. Alloni, M. Prata, A. Salvini, A. Ottolenghi
“Neutron flux characterization of the Pavia TRIGA Mark II Reactor for radiobiological and microdimetric applications”
submitted to Radiation Protection Dosimetry (2013)

“In-core” irradiation facilities – Rabbit Thimble

Pneumatic Transfer System Thimble

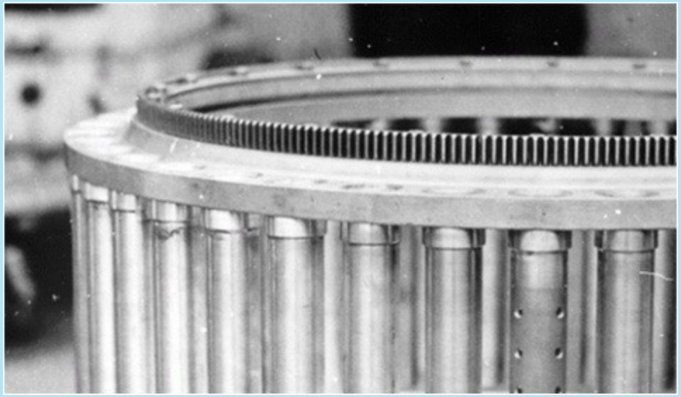
- It is positioned along the vertical axis of the “core” cylinder, in the external ring (F-ring)
- A pneumatic transfer system offers the possibility to make short irradiation time in order to detect immediately the short half-life activated radionuclides, by means of HPGe gamma spectrometry installed in Radiochemistry Laboratory.

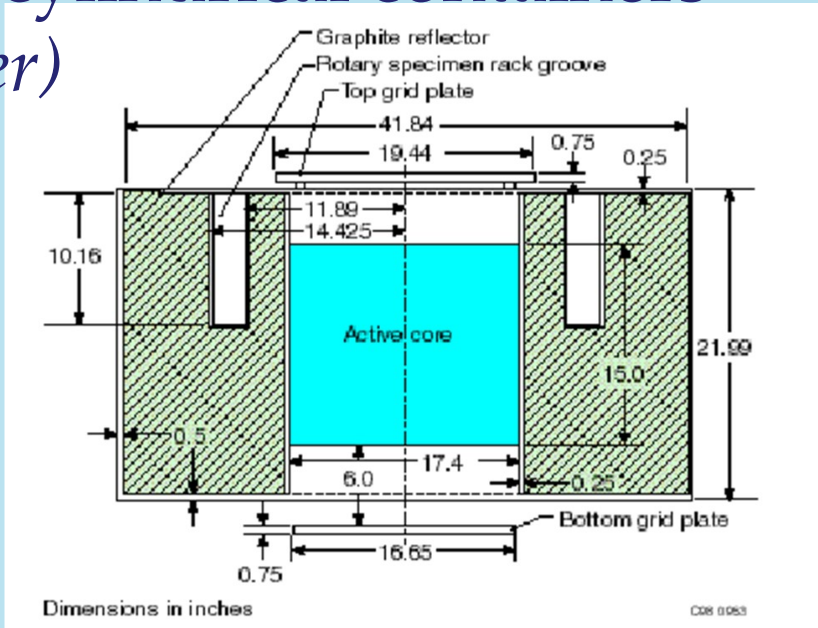


"In-core" irradiation facilities – Lazy Susan

Rotary specimen rack

- An annular groove in the upper part of the reflector body is provided to contain a special irradiation facility (**rotary specimen rack**).
- The rotary specimen rack is made of aluminum and consists of **40 holes** with inner diameter of 38 mm.
- It can host up to **80 samples** cylindrical containers *(130mm-height; 30mm-diameter)*



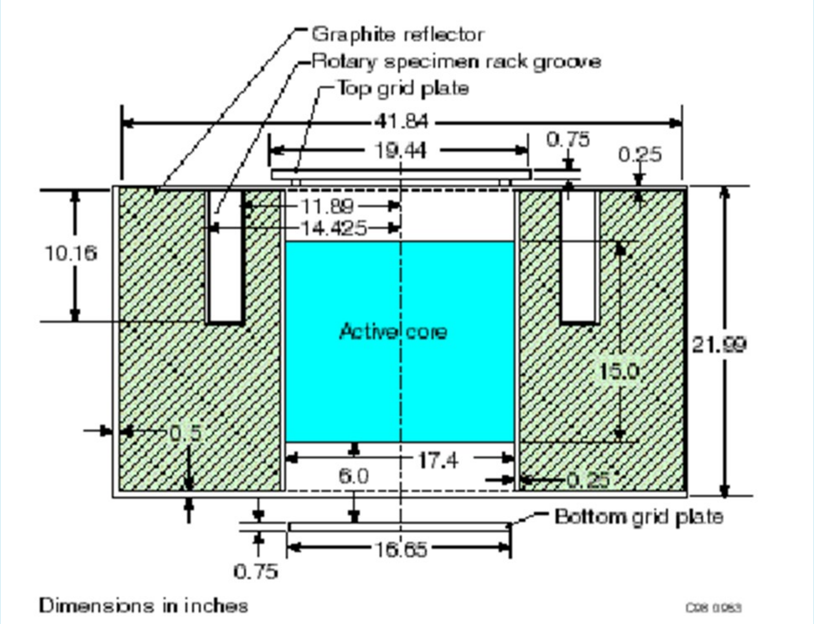


“In-core” irradiation facilities – Thermal Channel

Thermal channel

It has been recently installed, out from the reflector body, an aluminum cylinder (38cm-height; 7cm-diameter)

- (**Thermal channel**).



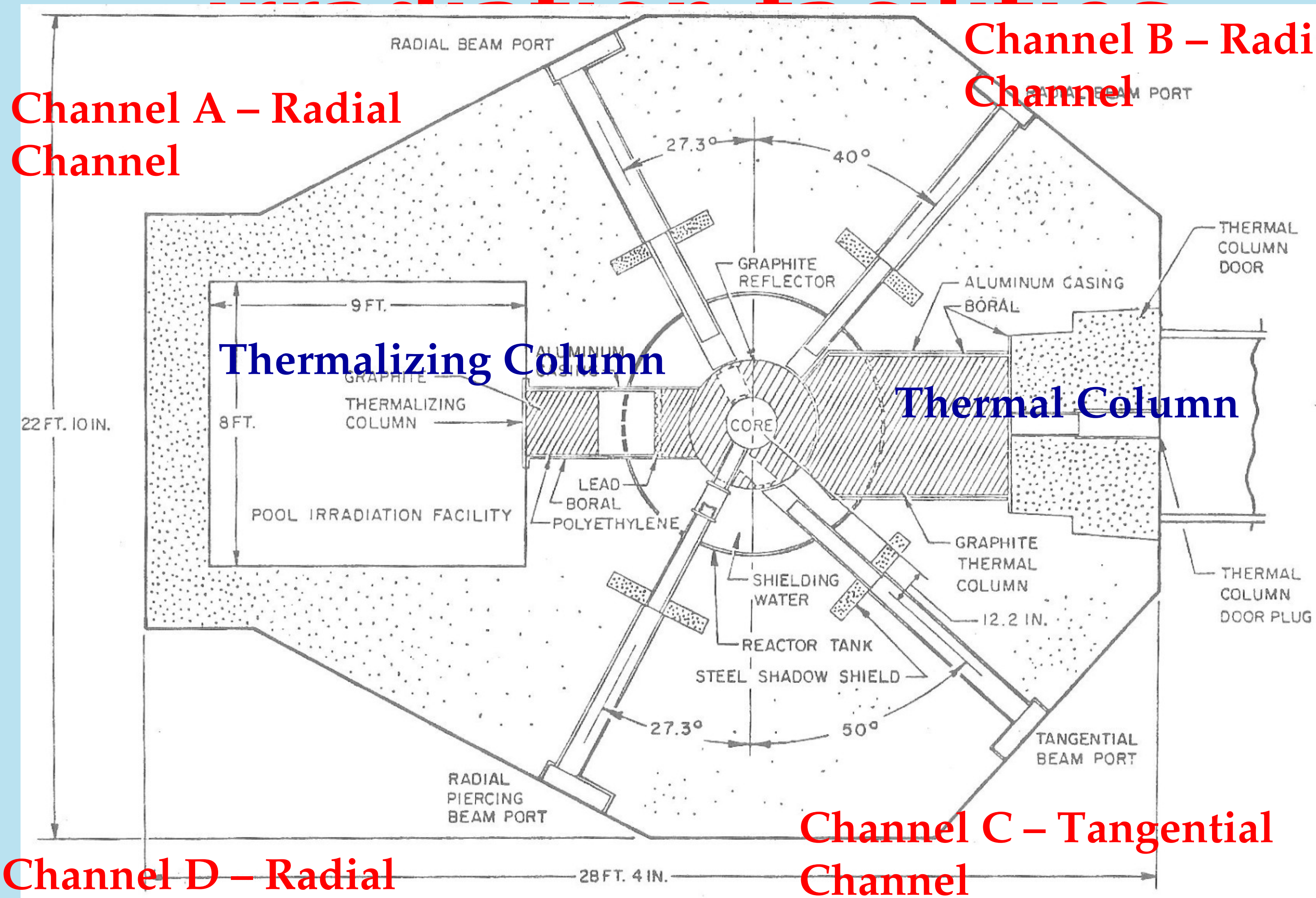
“In-core” irradiation facilities – Neutron Fluxes

- In order to characterize the irradiation facilities, experimental data on neutron fluxes have been collected analyzing and measuring the induced gamma activity in thin target foils of different materials irradiated in different TRIGA experimental channels.
- The data on the induced gamma activities have been elaborated and finally compared with the s

A. Borio di Tigliole, A. Cammi, D. Chiesa, M. Clemenza, S. Manera, M. Nastasi

Irradiation	Measured Flux (n	MCNP Flux (n

“Out-core” irradiation facilities



Channel A – Radial Channel

Channel B – Radial Channel

Thermalizing Column

Thermal Column

Channel C – Tangential Channel

Channel D – Radial Piercing Channel

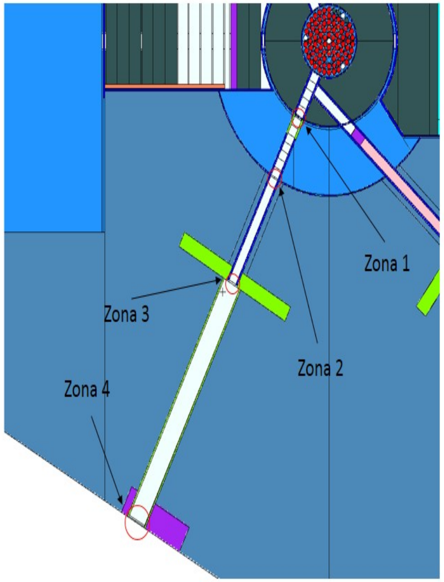
"Out-core" irradiation facilities – Channel D

Neutron Fluxes n/cm^{2}s

- MCNP5 SOURCE

	Zona 1	Zona 2
Thermal	$6.34 \bullet 10^{11}$	$7.03 \bullet 10^{10}$
Epithermal	$4.43 \bullet 10^{11}$	$3.39 \bullet 10^{10}$
Fast	$7.14 \bullet 10^{10}$	$7.66 \bullet 10^{9}$
Total	**$1.14 \cdot 10^{12}$**	**$1.12 \cdot 10^{11}$**

	Zona 3	Zona 4
Thermal	$3.16 \bullet 10^{9}$	$2.99 \bullet 10^{8}$
Epithermal	$4.53 \bullet 10^{9}$	$5.65 \bullet 10^{8}$
Fast	$1.38 \bullet 10^{9}$	$2.36 \bullet 10^{8}$
Total	**$9.07 \cdot 10^{9}$**	**$1.10 \cdot 10^{9}$**



“Out-core” irradiation facilities – Thermal Column

Thermal Column modified for BNCT research & activities

Radial Piercing Channel (Ch. D)

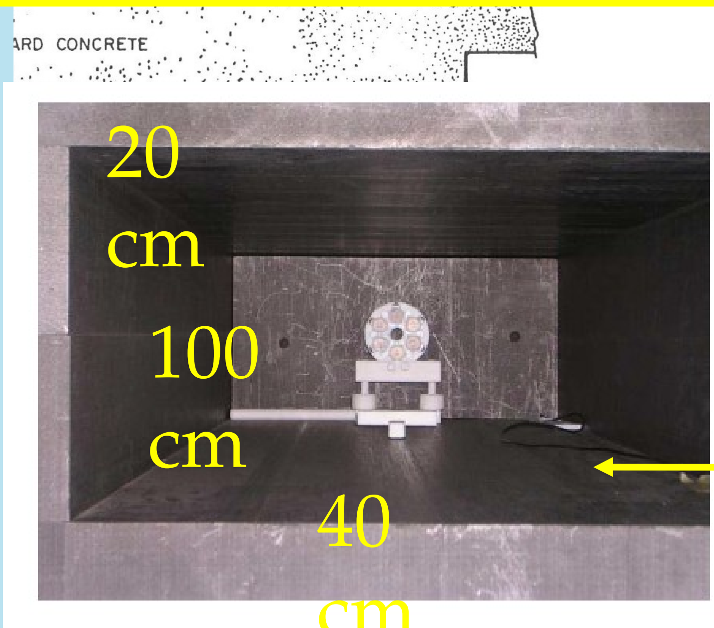
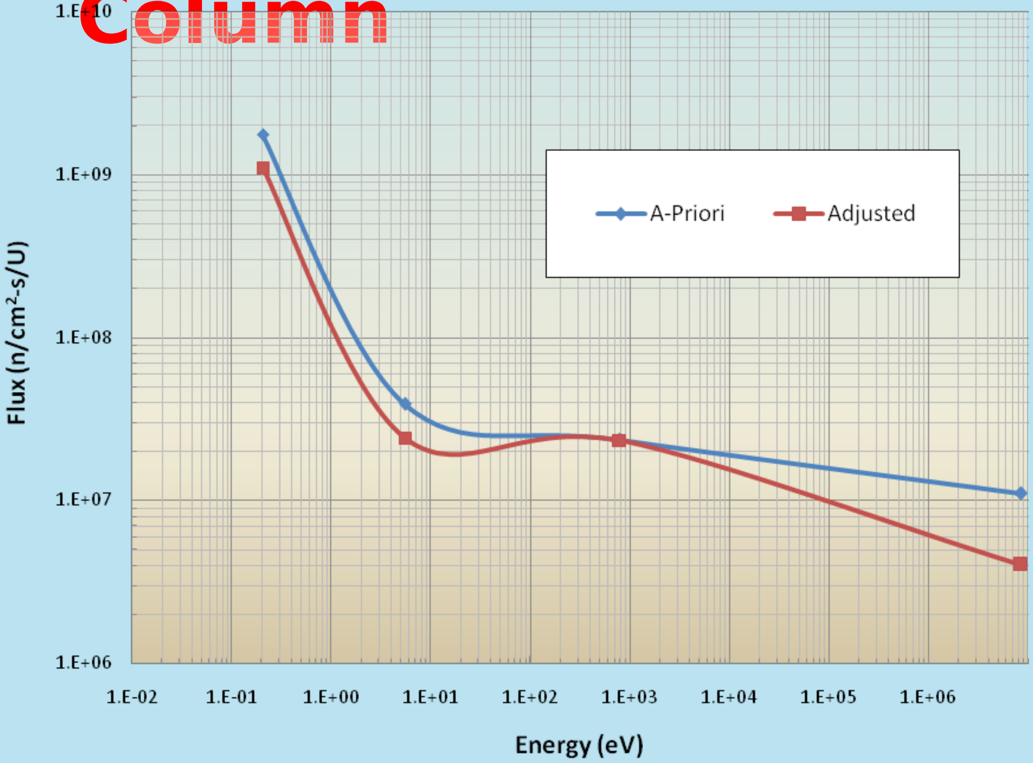


Fig. 2. View upstream into the graphite thermal column, showing positioning of the neutron activation dosimeter foil packages.

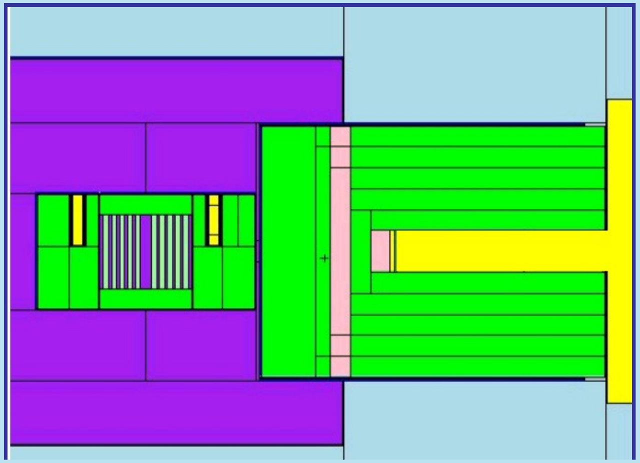
“Out-core” irradiation facilities – Thermal Column



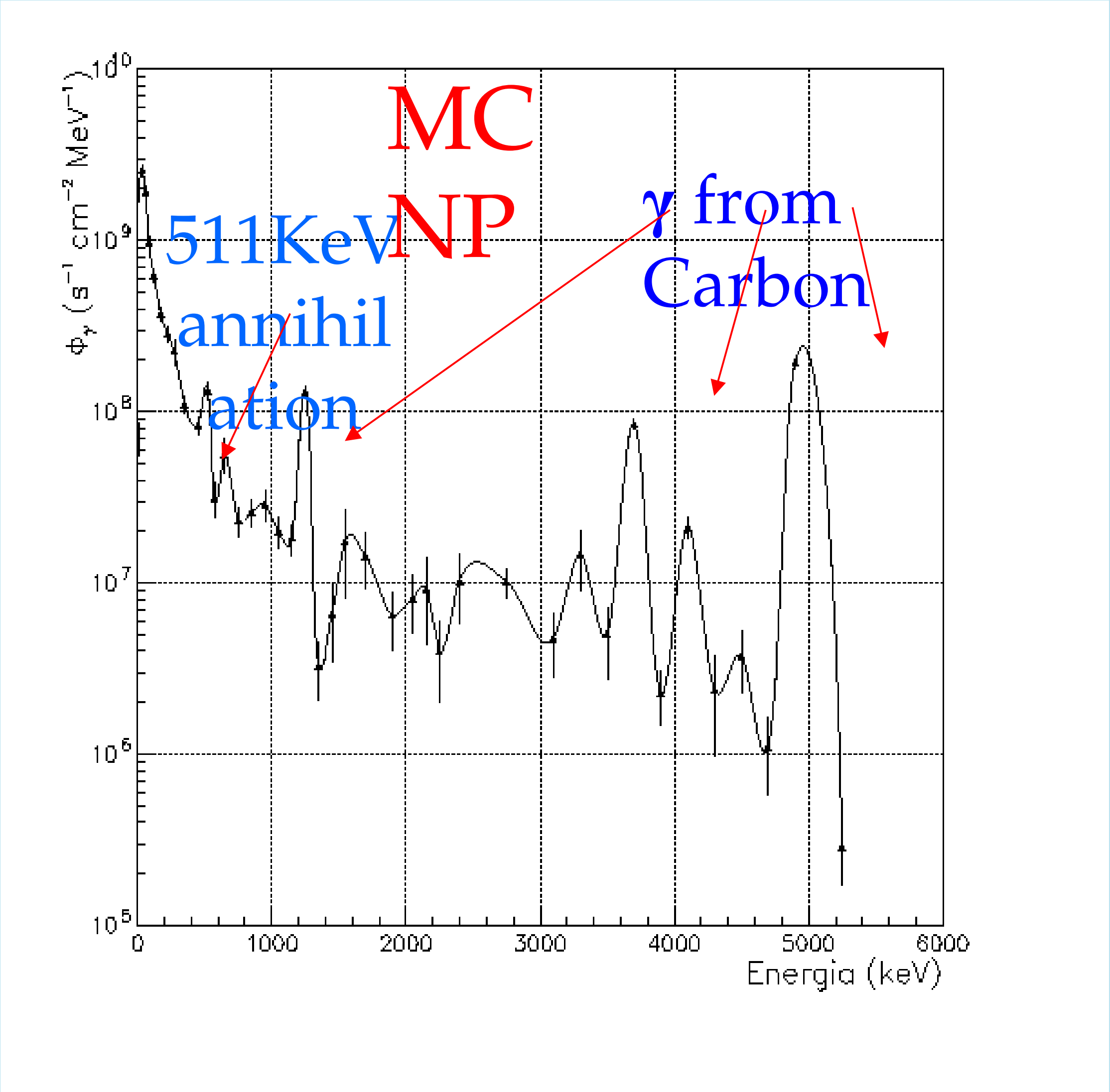
Energy Group (eV)	Measured Flux ($n\ cm^{-2}\ s^{-1}$)
$1.58\ 10^{3} < E < 1.73\ 10^{7}$	$4.39\ 10^{7} \pm 9.0\%\ (1\sigma)$
$1.07\ 10^{1} < E < 1.58\ 10^{3}$	$1.20\ 10^{8} \pm 5.4\%\ (1\sigma)$
$4.14\ 10^{-1} < E <$ 1.07 101	$7.51\ 10^{7} \pm 3.1\%\ (1\sigma)$
$1.00\ 10^{-5} < E < 4.14\ 10^{-1}$	$1.17\ 10^{10} \pm 2.5\%\ (1\sigma)$

Thermal Column – The γ spectrum in air

Calculated by MCNP
Measured by TLD



Bismuth shields to cut gamma coming from the core



LENA Research Center

- The research facilities are at the disposal of:
  - Public Research Institutions (National and International)
  - Private Companies
  - Schools and Universities students
  - Individual workers

- The reactor is used for many different purposes:
  - Fundamental Research
  - Applied Research and Technologic Transfer
  - Education and Training
  - Public Information