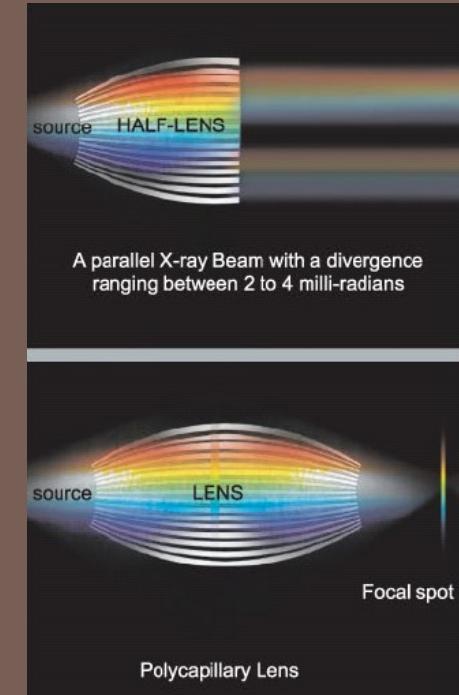
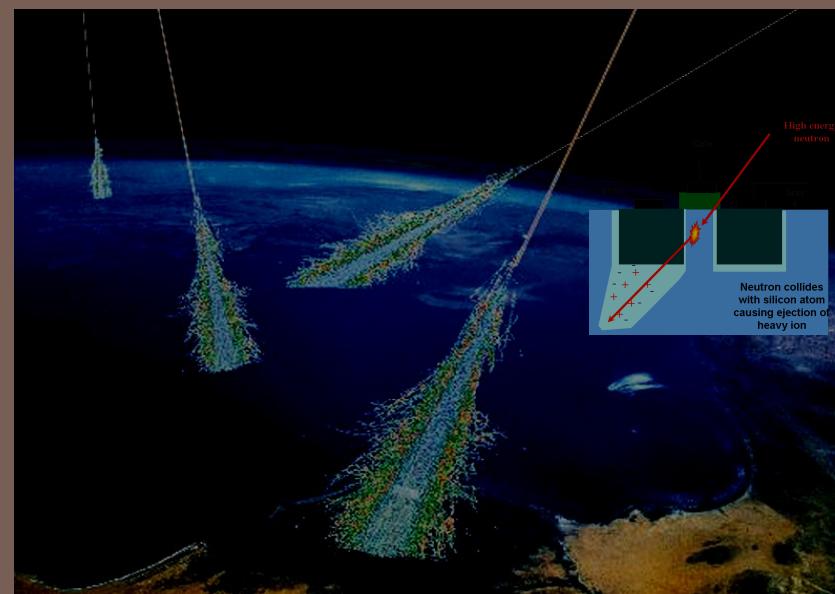
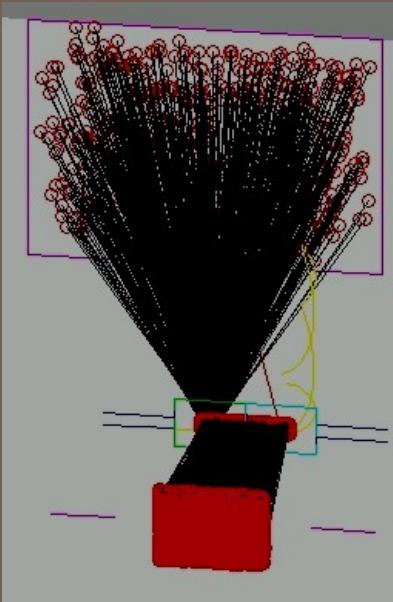


# The NAST Instrumentation Project: design and construction of multipurpose instruments at the ISIS pulsed neutron source



# NAST Instrumentation Project

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- *To provide innovative instrumentation for applications in Aerospace, ICT, Biomedical and Cultural Heritage*
- Coordinator P. Picozza

# Team

3

C. Andreani <sup>1</sup>, M. Alessandroni <sup>3</sup>, F. Aliotta <sup>7</sup>, R. Bedogni <sup>4</sup>, L. C. Chapon <sup>6</sup>,  
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- 1) Università degli Studi di Roma Tor Vergata, Dipartimento di Fisica and Centro NAST
- 2) Università degli Studi di Roma Tor Vergata, Dipartimento di Ingegneria Elettronica and Centro NAST
- 3) Università degli Studi di Milano Bicocca, Dipartimento di Fisica G. Occhialini and Centro NAST
- 4) Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati -Frascati
- 5) Consiglio Nazionale delle Ricerche- Istituto sistemi Complessi, Firenze
- 6) STFC Rutherford Appleton Laboratory, ISIS Facility, Harwell Science and Innovation Campus, Didcot, Oxon OX11 0QX, UK

# Background

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- 1- non destructive imaging in bulk materials- neutron imaging: roadmap to energy resolved neutron imaging
- 2- Reliability of nanoscale electronic devices: Accelerated tests of neutron-induced soft errors

# Background

5

- 1- non destructive imaging in bulk materials-  
neutron imaging: roadmap to energy resolved  
neutron imaging
- 2- Reliability of nanoscale electronic devices:  
Accelerated tests of neutron-induced soft  
errors



PANAREA

*Progetto per l' Applicazione dei Neutroni Alla Ricerca in Elettronica e Archeometria*

*Project funded by CNR within the CNR-STFC Agreement concerning collaboration  
in scientific research at the spallation neutron source ISIS (2008-2014)*

# Two instruments to be built at ISIS second target station (2008-2014)

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**IMAT**- An imaging and materials  
ence & engineering facility

**ChipIr**- Accelerated neutron testing  
single event effects in  
miconductor microelectronic chips

4 Research Units:

- 1) Università degli Studi di Milano - Bicocca *PANAREA Coordinator* Prof. Giuseppe Gorini
- 2) CNR, Istituto Sistemi Complessi, Firenze (resp. Dott. Marco Zoppi)
- 3) CNR, Istituto per i Processi Chimico-Fisici, Sede di Messina (resp. Dott. Francesco Aliotta)
- 4) Università degli Studi di Roma Tor Vergata- CENTRO NAST (resp. Prof Carla Andreani)

+ contributions from:

CNR-IBAM

CNR-ISMN

Università degli Studi di Padova

Università degli Studi di Roma Tre

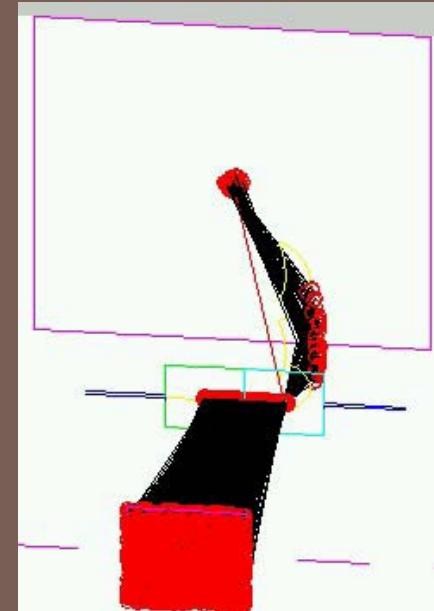
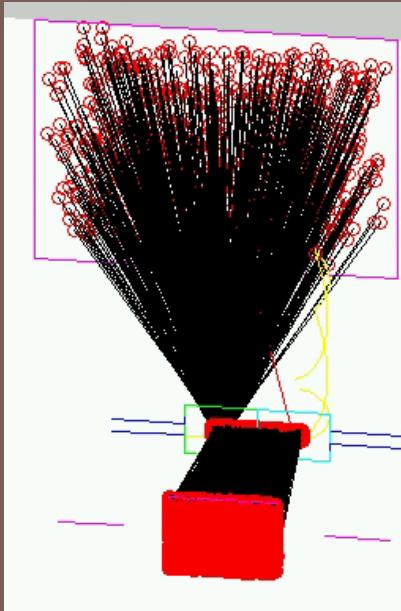
FINMECCANICA

S.T. Microelectronics

# IMAT- An imaging and materials science & engineering facility

7

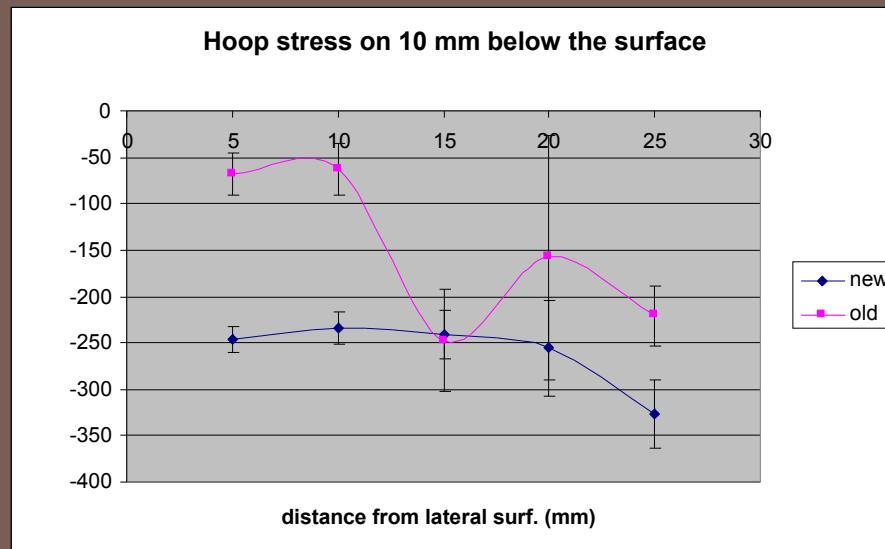
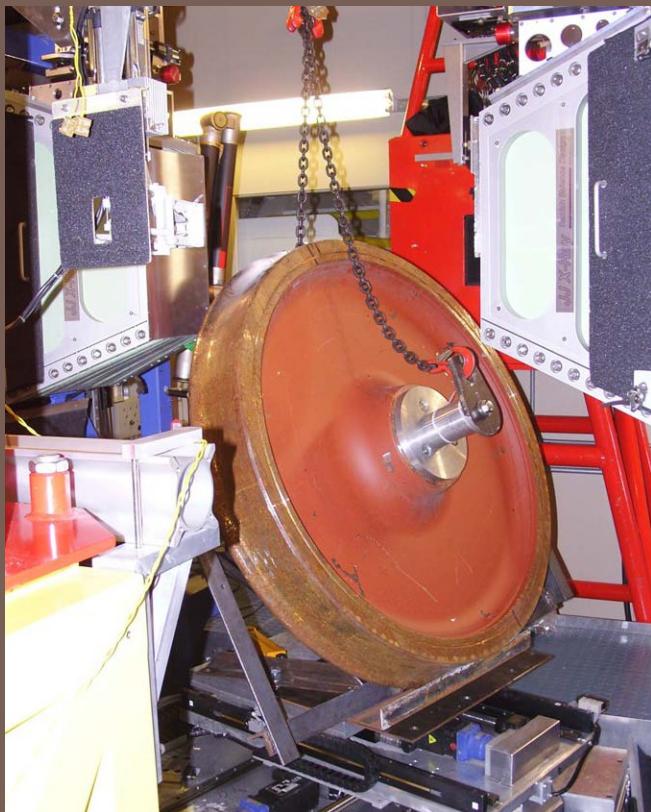
- Energy resolved Imaging+spatially resolved Diffraction in:
- Structural materials, Cultural heritage artefacts, water/lithium distributions in fuel cells/batteries, fuel and lubricants in combustion engine technology



# IMAT- An imaging and materials science & engineering facility

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## □ High speed train wheel- ETR 500



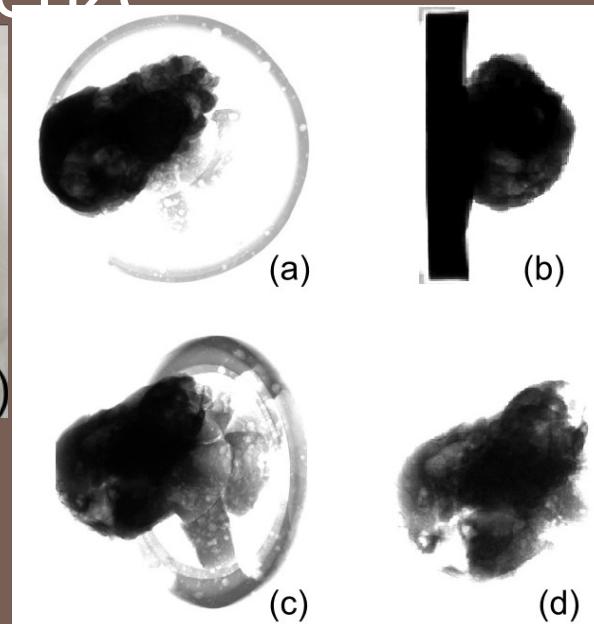
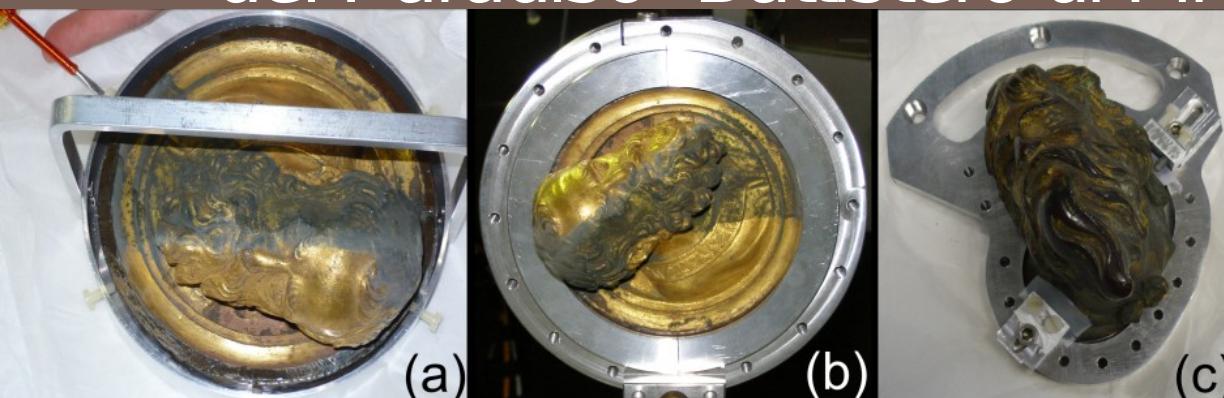
M. Ferrogalini, F. Chiti, M. Alessandroni\*,  
E. Perelli Cippo, A. Paradowska, R. Senesi\*,  
G. Gorini\*, C. Andreani\*

\*NAST members

# IMAT- An imaging and materials science & engineering facility

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- Renaissance bronzes from L. Ghiberti ‘Porta del Paradiso’ Battistero di Firenze



G. Festa, C. Andreani\*, M. P. De Pascale\*,

R. Senesi\*, G. Vitali, S. Porcinai, et al,

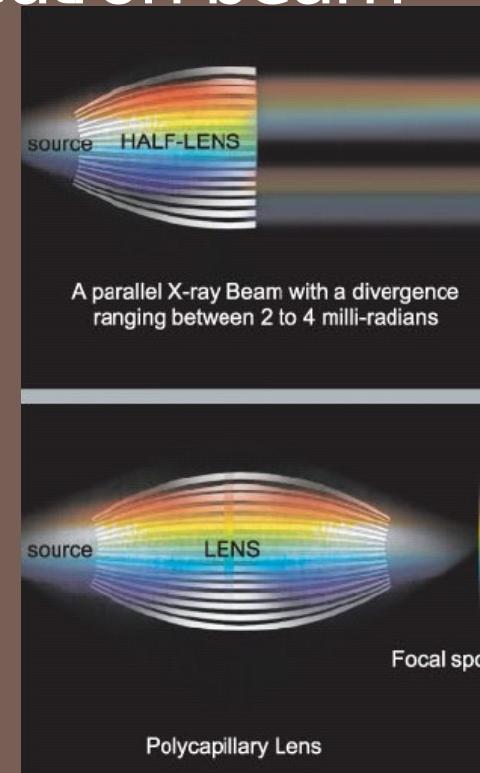
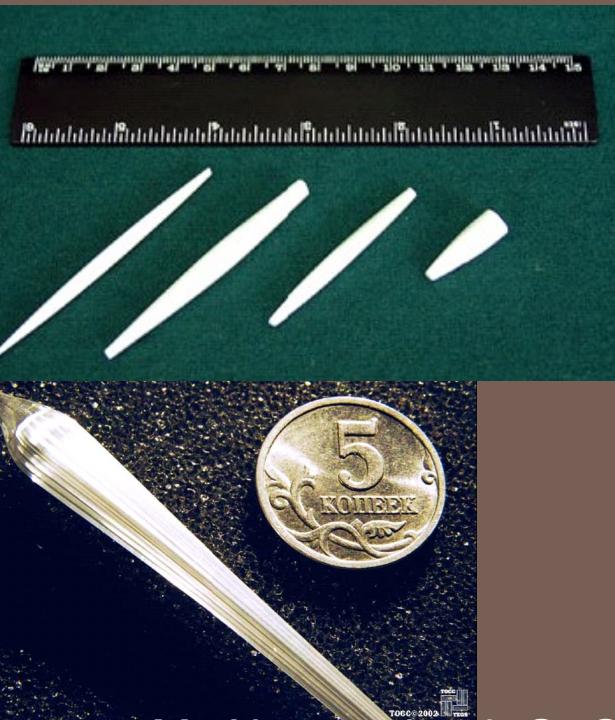
Submitted to J. Appl. Phys.

\*NAST members

# IMAT- An imaging and materials science & engineering facility

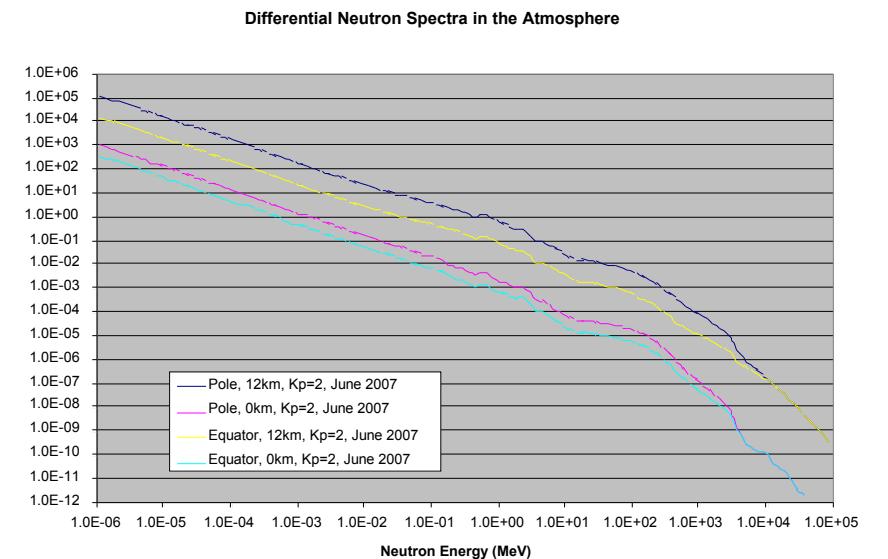
10

- NAST involvement:
- Polycapillary lenses for neutron beam microfocussing

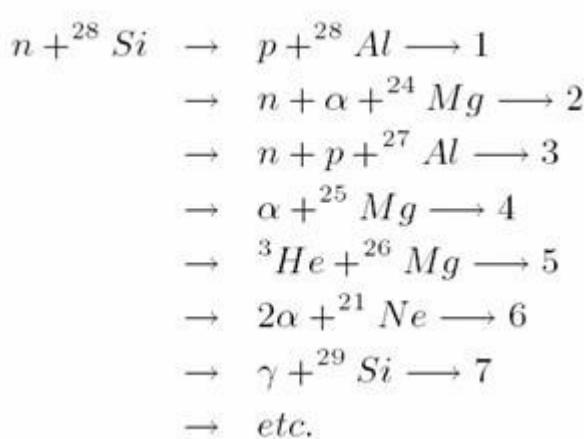


# Chip Irradiation Instrument

11



- **Single Event Effect (SEE):**
- perturbation of the behavior
- of electronic (optoelectronic) devices,
- circuits and/or systems produced
- by a single ionizing particle



"Cosmic rays damage automotive electronics", Martin Mason, Actel Corporation, 31/5/2006

# Chip Irradiation Instrument

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Reliability in advanced ICs is improving down to some **10-100 FIT**

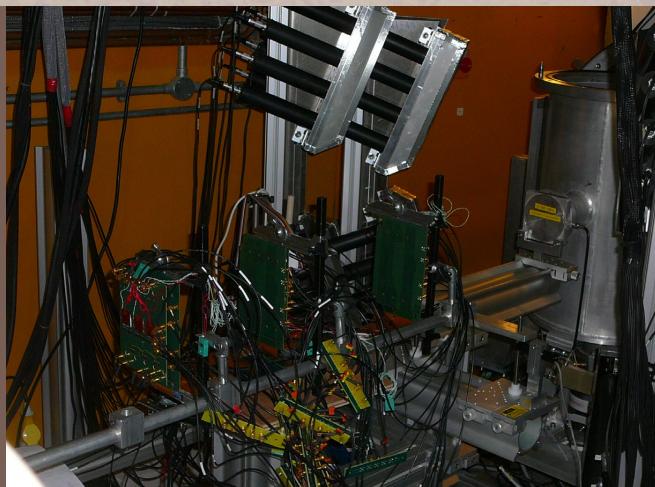
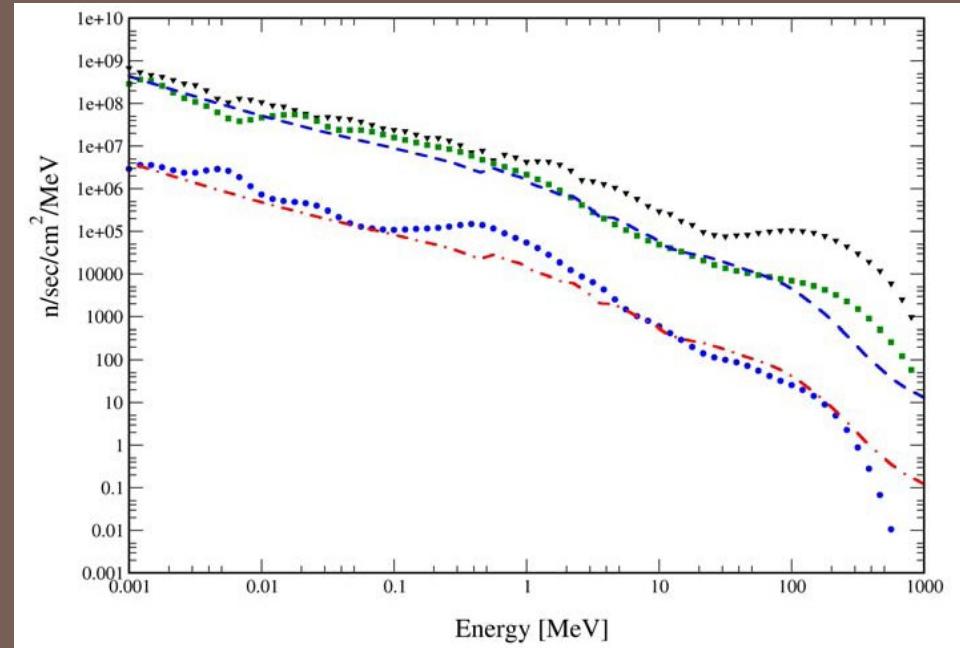
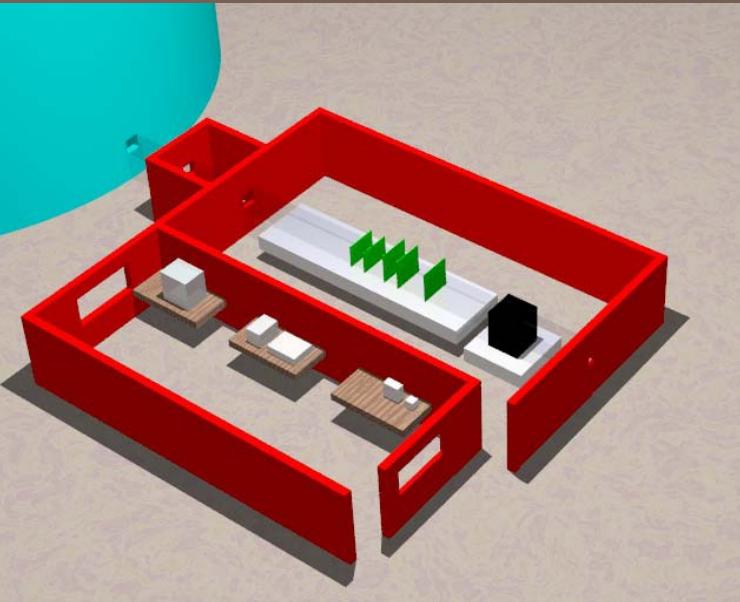
One Failure in time (FIT) equals one failure per billion hours

- SEE at sea level is dominated by **Soft Errors (SE)** leading to the
- **Soft Error Rate (SER)** figure of merit;
- if not properly mitigated, SER may reach **10<sup>5</sup> FIT**

Critical charge of the order of 10 fC/ $\mu$ m

# Chip Irradiation Instrument

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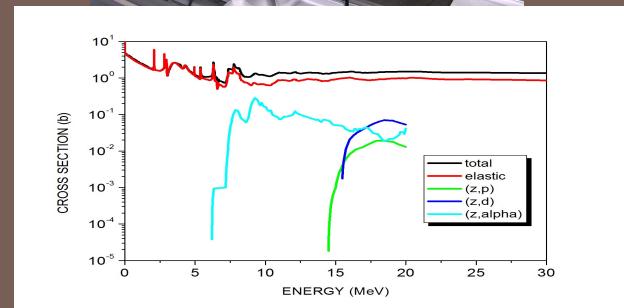
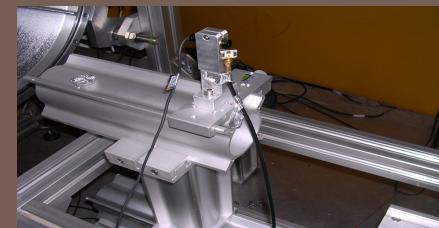
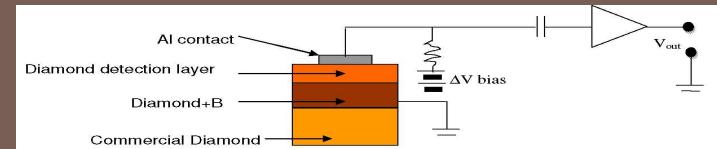
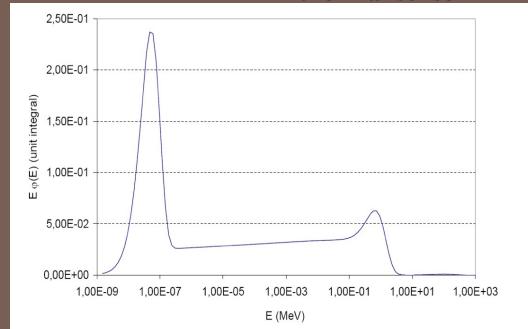
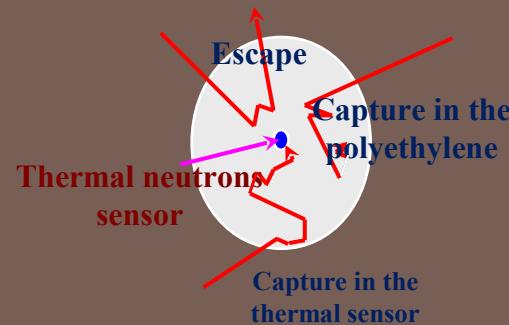
Accelerate ( $\times 10^6\text{-}10^7$ ) the atmospheric spectrum!

Accurate dosimetry required..

# NAST involvement on ChipIR

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## Neutron dosimetry instrumentation from 1 meV to 600 MeV

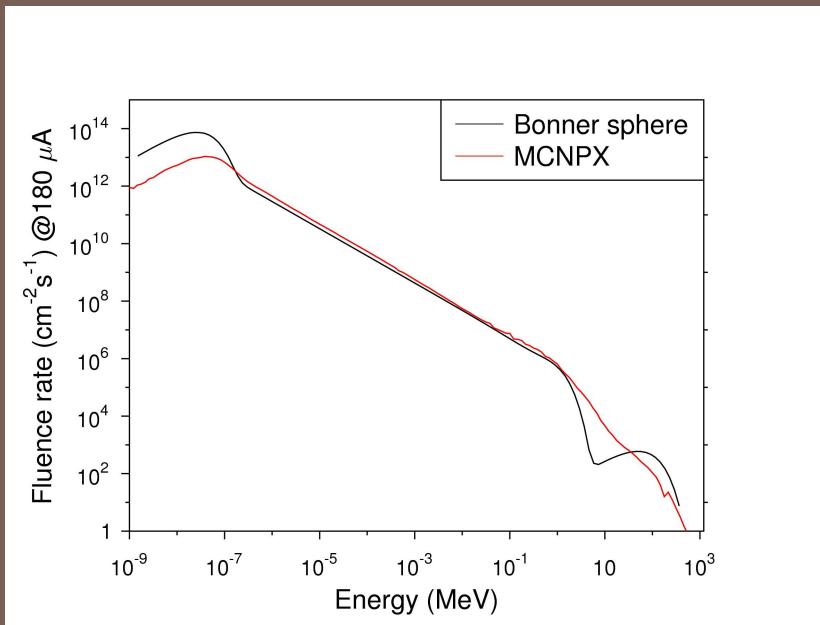


NAST: C. Andreani, M. P. De Pascale, G. Gorini, P. Picozza, A. Pietropaolo, A. Salsano, R. Senesi  
INFN: A. Esposito, R. Bedogni  
UNITOV: E. Milani, E. Verona Rinati

# NAST involvement on ChipIR

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## Results



A. Bedogni et al. NIM A submitted



Future: miniaturized detectors..

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