RADNEXT introduction

Rubén García Alía, Daniel Soderstrom (CERN)
GB-RADNEXT Workshop
12-13 June 2024
https://indico.cern.ch/e/radnext-2024

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What is RADNEXT?

About RADNEXT

RADNEXT is an H2020 INFRAIA-02-2020 infrastructure project with the objective of creating a network of facilities and related irradiation methodology for responding to the emerging needs of electronics component and system irradiation; as well as combining different irradiation and simulation techniques for optimizing the radiation hardness assurance for systems, focusing on the related risk assessment.

Transnational Access

Transnational Access to irradiation facilities is the cornerstone of the RADNEXT project. More than 6000 beam time hours are awarded during the four years of the project, in more than 20 different facilities in Europe and beyond.

Both academic and industrial groups are eligible for beam time as potential RADNEXT users, and in particular small and medium-sized enterprises (SMEs) are strongly encouraged to submit their proposals. Beam time awarded for RADNEXT users is free of charge, funded by EU European Union's Horizon 2020 research and innovation programme under grant agreement No 101008126.

The next Call For Proposals will be opened in September 2024.

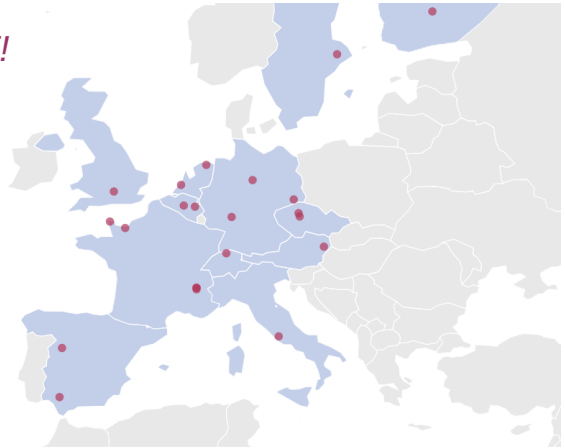
EU funded beam time for radiation effects research is granted through proposal evaluated by a panel of experts, with calls opening every 4 months (next call is in September)

What is RADNEXT?

What is RADNEXT?

Coordinator
Facilities
Academia
Agencies & Institutes
Industry

+ TRIUMF!



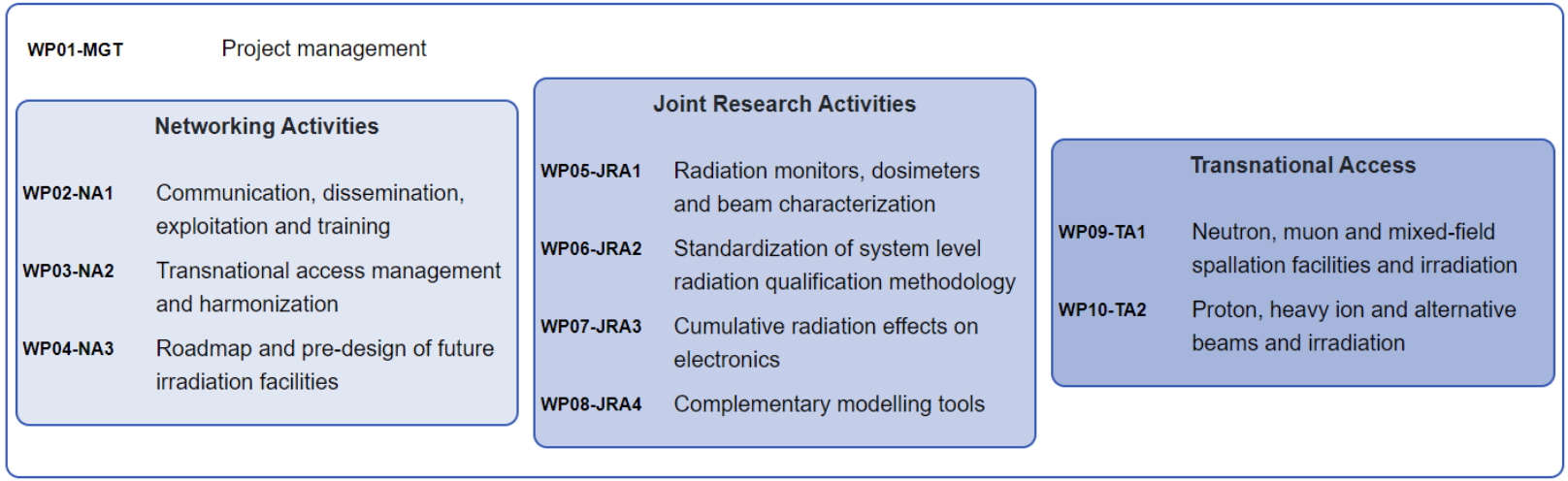
Coordinator: CERN (Int.)

Facilities:

- GSI (DE)
- UMCG PARTREC (NL)
- GANIL (FR)
- RADEF (FI)
- UCLouvain (BE)
- PSI (CH)
- CNA (ES)
- NPI CAS (CZ)
- TRIUMF (CA)
- STFC-ISIS (GB)
- ENEA-FSN (IT)
- CNRS LPSC (FR)
- UU NESSA (SE)
- ILL (Int.)
- Centre Spatial Liege (BE)
- HZDR (DE)
- ESRF (Int.)
- ELI ERIC (CZ)
- CLPU (ES)
- PTB (DE)
- Seibersdorf Laboratories (AT)
- ATRON (FR)
- HollandPTC (NL)

What is RADNEXT?

Work Packages

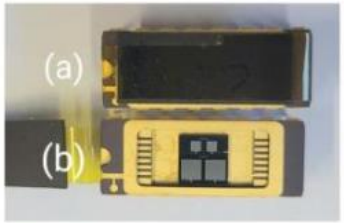


Example of RADNEXT research (and dissemination!)

New publication in *IEEE Transactions on Nuclear Science*: OPEN ACCESS

Comparison of High Energy X-ray and Cobalt 60 irradiations on MOS capacitors

by Vincent Girones and coauthors



Can TID effects be studied in MOS capacitors using a commercial X-Ray irradiator?

YES!

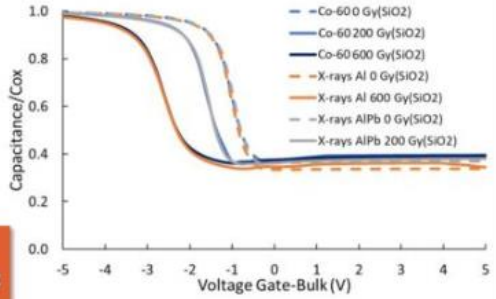
High-energy X-rays irradiation with a lead filter led to the same degradation as observed in Co-60 irradiation

Highlights:

I. No gap is observed between degradations by X-ray and Co-60 irradiations due to a thin layer of Aluminum (low Z) as BEOL reducing dose enhancement effect.

II. Large shift of the flatband voltage and weak reduction of the slope of the C/V curve indicate a dominance of oxide trapped charges.

III. Post-irradiation annealing and the presence of package lids have shown no significant effect on the studied MOS capacitors.



Check out full details at:
http://dx.doi.org/10.1109/TNS.2024.3366432

PROJET COFINANCÉ PAR LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL

Some examples of RADNEXT experiments

https://indico.cern.ch/event/1095485/
https://indico.cern.ch/e/gradnext-2023
https://indico.cern.ch/event/1353707/

Some examples of RADNEXT experiments

Session 1: Industry-relevant results gained from RADNEXT Transnational Access — *Salvatore Fiore*
40/S2-C01 - Salle Curie, CERN — 13:30 - 13:35

Session 1: Calibration of the deposited energy in CMOS imagers for particle detection on nanosatellites
Josua Florczak

Session 1: High energy ion beam benchmarks for dosimetry and radiation effects — *Natalia Emriskova*
40/S2-C01 - Salle Curie, CERN — 13:55 - 14:15

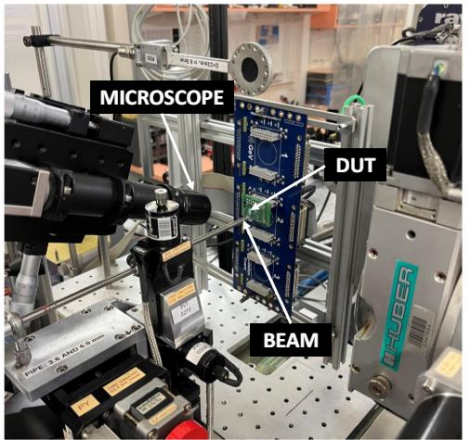
Session 1: Pulsed X-Rays for SEE pre-qualification of COTS — *Samuel Dubos*
40/S2-C01 - Salle Curie, CERN — 14:15 - 14:35

Session 1: Characterizing Neutron Induced Errors on RISC-V Processors for Safety-critical Applications
Fernando Fernandes dos Santos

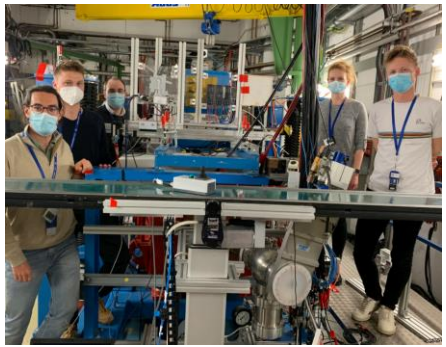
Session 1: SEE testing of GaN power transistors with high energy hadrons — *Mario Sacristan Barbero*
40/S2-C01 - Salle Curie, CERN — 14:55 - 15:15

Session 1: Ground SEE testing of LEON5/NOEL-V demonstrator chip in European deep-submicron technology
Adria Barros de Oliveira

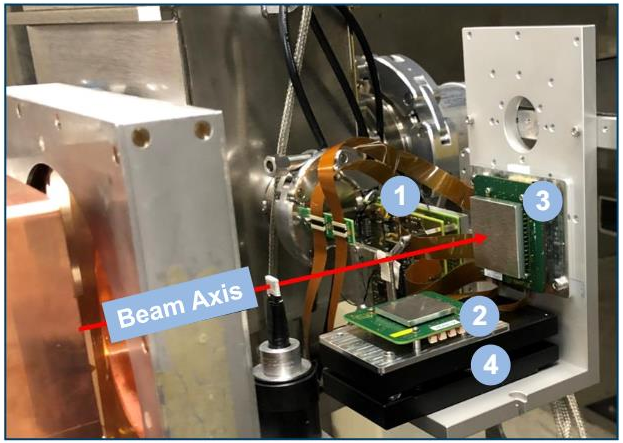
Some examples of RADNEXT experiments



ESRF
The European Synchrotron



GSI



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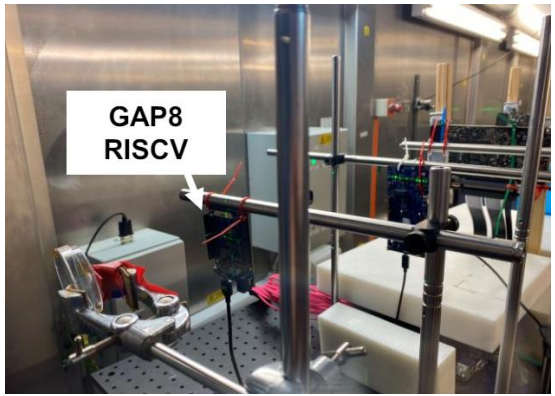
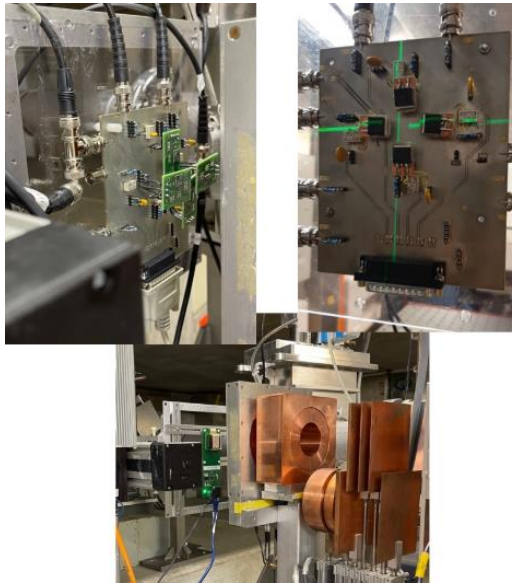
Some examples of RADNEXT experiments



Science & Technology Facilities Council
ISIS Neutron and Muon Source



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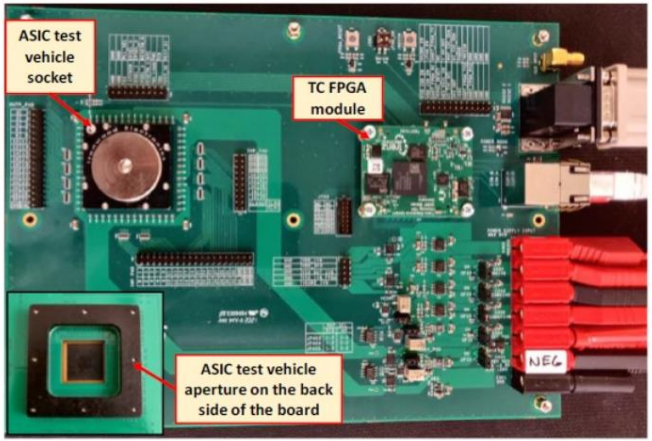

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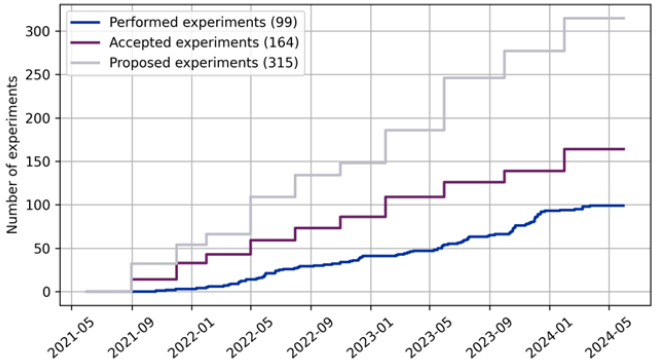
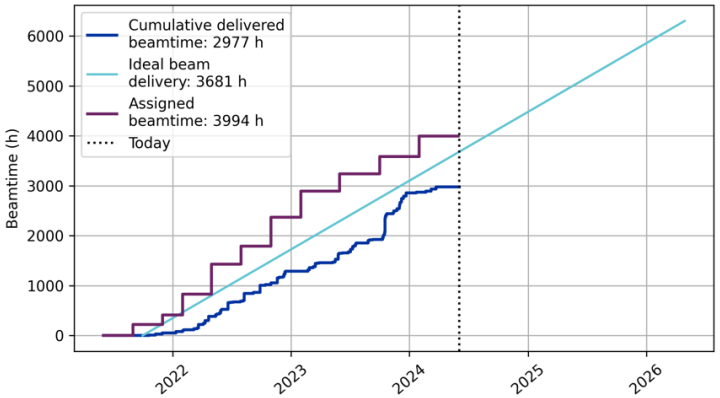
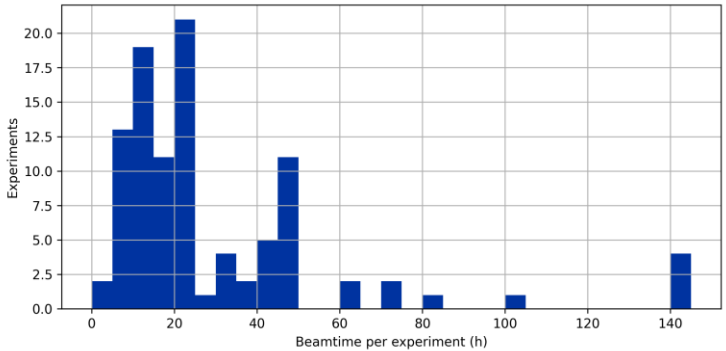
UCLouvain

Some RADNEXT beam provision statistics

- We have delivered 3000h out of the 6300h of RADNEXT TA
- On average, we assign 400 hours of beam every new call
- Around 1400 h of beamtime is delivered yearly (2022-01 – 2024-01)
- 12, 24, or 48h beamtime per experiment are common
- **Project end has been extended by one year, up to May 2026!**

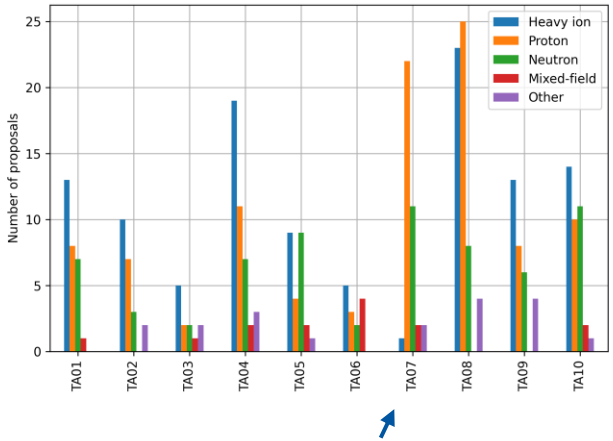




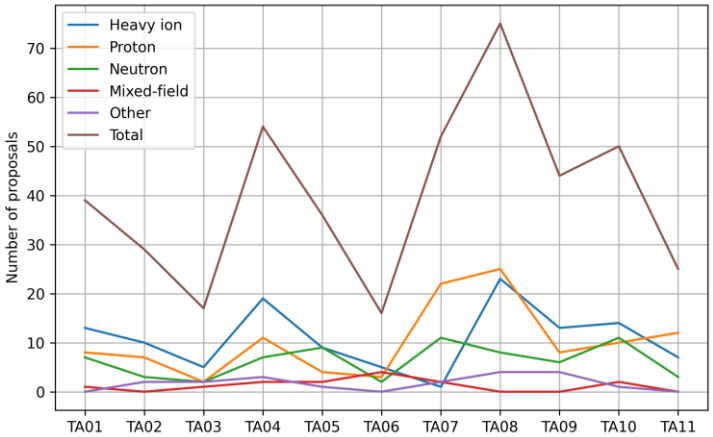


Some RADNEXT beam provision statistics

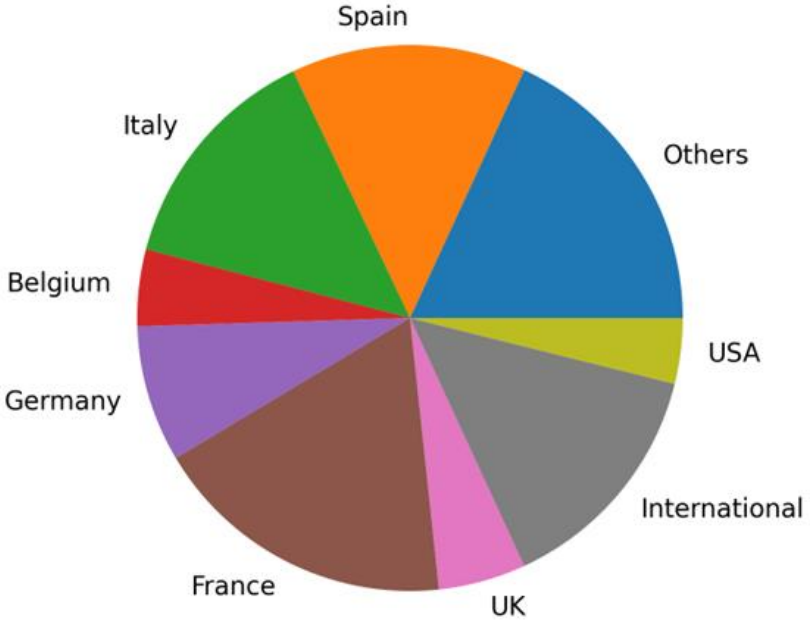
- Main interest is on heavy ions and protons, though neutrons are in high demand as well
- Strong fluctuations in number of proposals per call, without specific trends



No ions
available in call
TA07

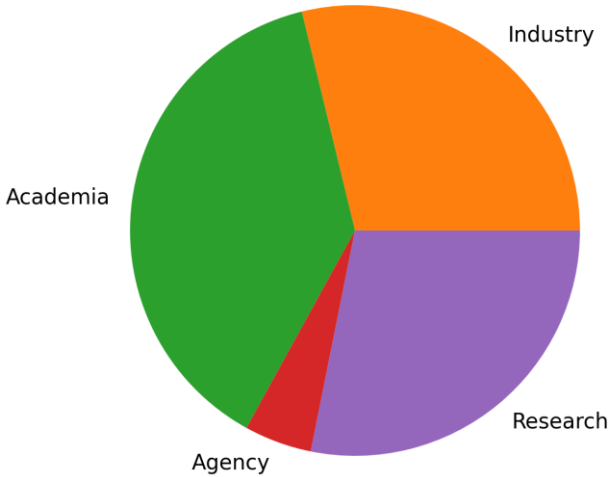


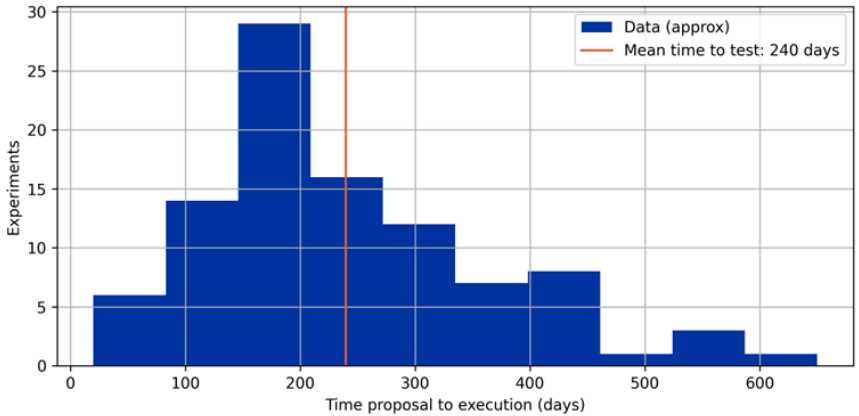
Some RADNEXT beam provision statistics



Countries	Total
France	56
International	44
Italy	43
Spain	43
Germany	25
UK	16
Belgium	14
USA	12
Slovenia	10
Brazil	7
Sweden	6
Switzerland	6
Finland	6
South Korea	4
Poland	4
Greece	3
Netherlands	3
Luxembourg	2
Austria	1
Australia	1
Hungary	1
Canada	1
Ireland	1

Some RADNEXT beam provision statistics





Some overview thoughts of RADNEXT facilities and related availability and demand

- “Standard” facilities (i.e. those covering test needs described in SEE test standards) are (as expected) in highest demand
  - Note that this holds true even for the case of RADNEXT, which targets radiation effects research (as opposed to pure “qualification”) activities, anyhow mainly done with standard beams
- This demand is complemented by a moderate interest in “alternative” facilities (e.g. related to their characterization, usage for SEE tests not directly covered in “standard” facilities, etc.)

Some overview thoughts of RADNEXT facilities and related availability and demand

- **Heavy ions**
  - RADEF and UCL remain the baseline for “conventional” SEE testing, and are in very high demand
    - RADEF extensively using their higher energy cocktails (especially 16 MeV/n), compatible with testing in air
    - Upgrade of UCL to 15 MeV/n expected in upcoming years
  - Higher energy facilities (GANIL, SIS-18@GSI) are also of interest, especially for tests requiring larger penetration
    - Albeit with the constraint of (a) being available only a few weeks per year and (b) offering a single ion species per run (still, LET can be varied in a certain range through the energy)
  - Another “specialized” facility: micro-beam at UNILAC@GSI
  - Some efforts related to use of pulsed x-rays as heavy ion proxies in ESRF

Some overview thoughts of RADNEXT facilities and related availability and demand

- **Protons**
  - High demand for high-energy (>200 MeV) proton testing at PSI, TRIUMF and PARTREC
    - PARTREC has not been able to deliver significant beam time yet due to accelerator unavailability, but is expected to back to nominal operation over the summer
    - HPTC recently incorporated in RADNEXT network as additional high-energy proton facility – interest manifested also by Orsay proton therapy center as well
  - Lower proton energies (few tens of MeV) available with high fluxes at UCL and NPI-CAS, and are especially useful for displacement damage
  - CNA tandem proton can be used for direct ionization SEE testing and detector calibration (RADEF also offers proton energies between 0.4-55 MeV, though its RADNEXT beam time is mainly devoted to heavy ions)
  - Laser Plasma Accelerated protons used at CLPU for characterization/dosimetry of related radiation field

Some overview thoughts of RADNEXT facilities and related availability and demand

- **Neutrons**
  - High demand for atmospheric neutrons at ChipIr and TRIUMF
  - Lower energy, high intensity neutrons available in NPI-CAS, GANIL and UCL (again, useful mainly for displacement damage testing)
  - 14 MeV neutrons (FNG, LPSC, PTB) also largely used, for displacement damage as well as SEE (mainly soft error) characterization/screening
    - PTB provides multiple neutron energies, which can be used to derive neutron SEE cross sections as function of energy in threshold region
  - Thermal neutrons available at ILL and STFC, and occasionally used for ground-level, accelerator and fusion soft error tests

Some overview thoughts of RADNEXT facilities and related availability and demand

- **Other beams/fields**
  - Electrons and photons at HZDR
  - Mixed-field system level testing in CHARM
  - Muons at STFC (not used yet, due to low demand and/or lack of availability)
    - Could be provided by TRIUMF as well, though they are not currently part of the RADNEXT “beam menu”

Thanks for your attention!