WP09/TA1 - Introduction, Status Overview & Outlook

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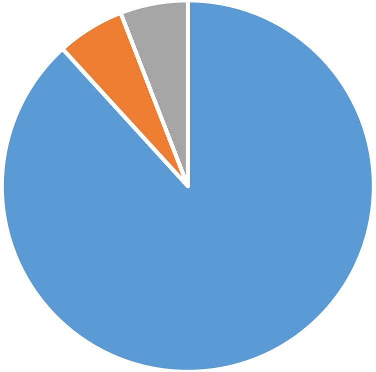
RADNEXT 1st Annual Meeting – 8-9 June 2022
https://indico.cern.ch/e/radnext-2022

WP9: variety of facilities



Neutron Facilities

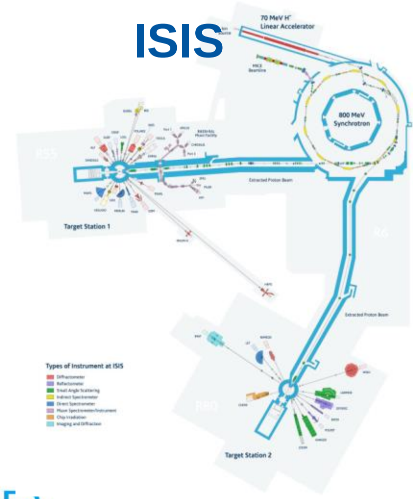
Neutron Facilities	Energy range	Flux ($s^{-1}cm^{-2}$)	Neutron production	Country
ChipIr (UKRI)	Atmospheric	$6 \cdot 10^6$	Spallation (up to 800 MeV)	UK
TRIUMF	Atmospheric	$5 \cdot 10^5 - 3 \cdot 10^6$	Spallation (up to 500 MeV)	CA
FNG (ENEA)	14 MeV (or 2.5 MeV)	Up to $5 \cdot 10^9$	DT (or DD)	IT
~~**Fraunhofer INT (INT)**~~	~~14 MeV (or 2.5 MeV)~~	~~Up to $3 \cdot 10^8$~~	~~DT (or DD)~~	~~DE~~
NESSA (UU)	14 MeV (or 2.5 MeV)	Up to 10^9	DT (or DD)	SE
CNRS-LPSC	14 MeV (or 2.5 MeV)	Up to $5 \cdot 10^7$	DT (or DD)	FR
PTB	monoenergetic up to 20 MeV	$10^3 - 10^8$	Nuclear reactions	DE
NPI-CAS	quasi-monoenergetic up to 30 MeV	$10^3 - 5 \cdot 10^8$	$^7Li(p,n)$	CZ
GANIL-SPIRAL2 (GANIL)	quasi-monoenergetic up to 30 MeV		$^7Li(p,n)$	FR
ILL	Thermal	$3 \cdot 10^9$	Nuclear Reactor	FR
EMMA (UKRI)	Thermal	$2 \cdot 10^6$	Pulsed, spallation moderated	UK
NPI-CAS	Low and intermediate energy white beam	$10^{11} - 10^{12}$	Be converter	CZ
GANIL-SPIRAL2 (GANIL)	Low and intermediate energy white beam	10^{11}	Be converter	FR
PTB	Low and intermediate energy white beam	10^8	Be converter	DE
nELBE	Low and intermediate energy white beam	$5 \cdot 10^7$	Photoproduction: ~1 MeV (100 keV - 10 MeV)	DE

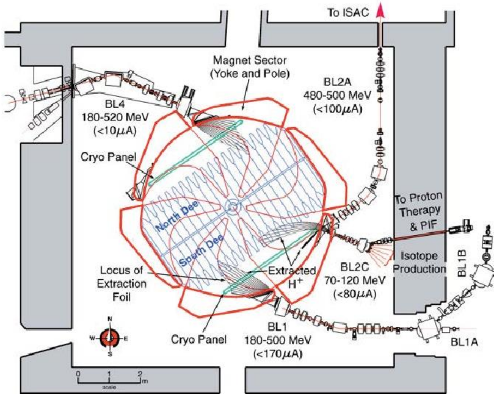
Atmospheric neutrons – High energy

Neutron Facilities	Energy range	Flux ($s^{-1}cm^{-2}$)	Neutron production	Country
ChipIr (UKRI)	Atmospheric	$6 \cdot 10^6$	Spallation (up to 800 MeV)	UK
TRIUMF BL1B - TNF (TRIUMF)	Atmospheric	$5 \cdot 10^5$ - $3 \cdot 10^6$	Spallation (up to 500 MeV)	CA

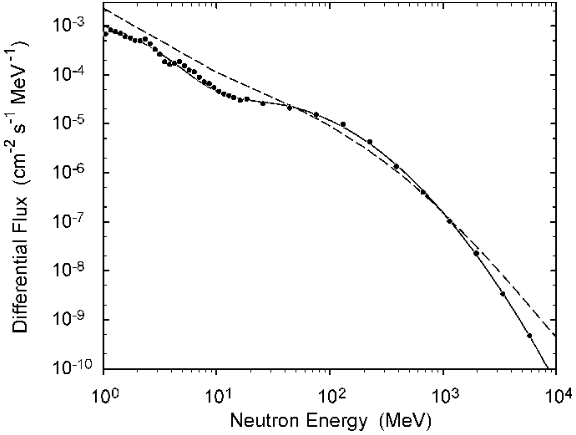
Need big accelerators

ISIS





TRIUMF



Atmospheric neutron spectrum

Monoenergetic sources

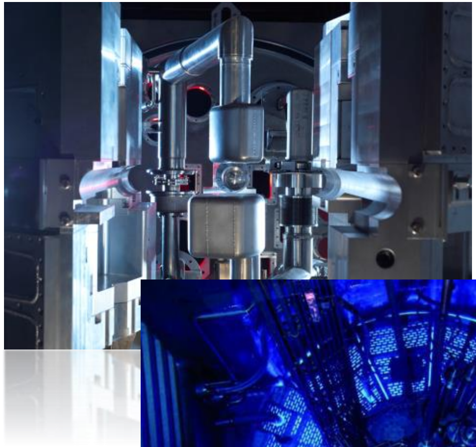
Neutron Facilities	Energy range	Flux ($s^{-1}cm^{-2}$)	Yield (s^{-1})	Neutron production	Country
FNG (ENEA)	14 MeV (or 2.5 MeV)	-	10^{11}	DT (or DD)	IT
NESSA (UU)	14 MeV (or 2.5 MeV)	-	$4 \cdot 10^{10}$	DT (or DD)	SE
CNRS-LPSC	14 MeV (or 2.5 MeV)	-	$8 \cdot 10^{9}$	DT (or DD)	FR
PTB	monoenergetic up to 20 MeV	10^{3} - 10^{8}	-	Nuclear reactions	DE
NPI-CAS	quasi-monoenergetic up to 30 MeV	10^{3} - $5 \cdot 10^{8}$	-	$^{7}Li(p,n)$	CZ
GANIL-SPIRAL2 (GANIL)	quasi-monoenergetic up to 30 MeV		-	$^{7}Li(p,n)$	FR

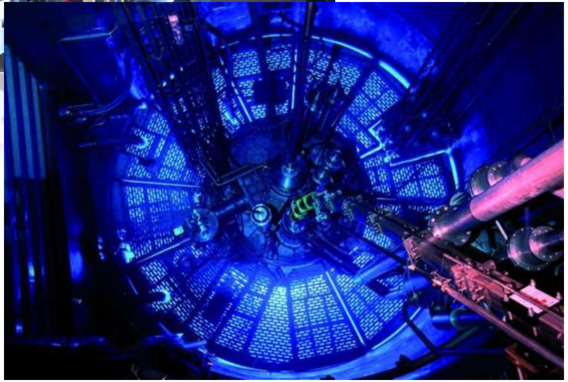
Based on nuclear reactions.

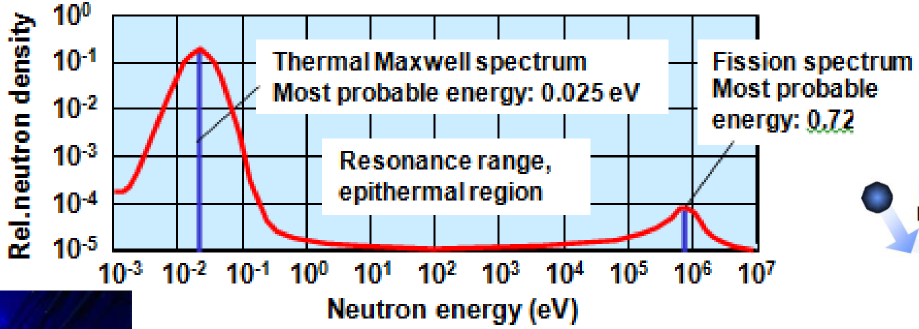
- **Measurement of cross sections as a function of energy**
- **Comparative studies**
- Preparation and **test of setups and methods** (more availability than spallation sources).
- Characterisation of dosimeters as a function of energy.
- They are NOT fully representative of the atmospheric spectrum, but they can be used in a complementary way.

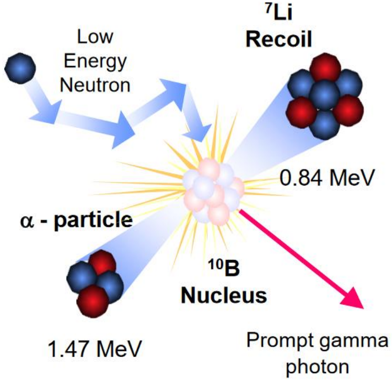
Thermals

Neutron Facilities	Energy range	Flux ($s^{-1}cm^{-2}$)	Neutron production	Country
ILL	Thermal	$3 \cdot 10^9$	Nuclear Reactor	FR
EMMA (UKRI)	Thermal	$2 \cdot 10^6$	Pulsed, spallation moderated	UK







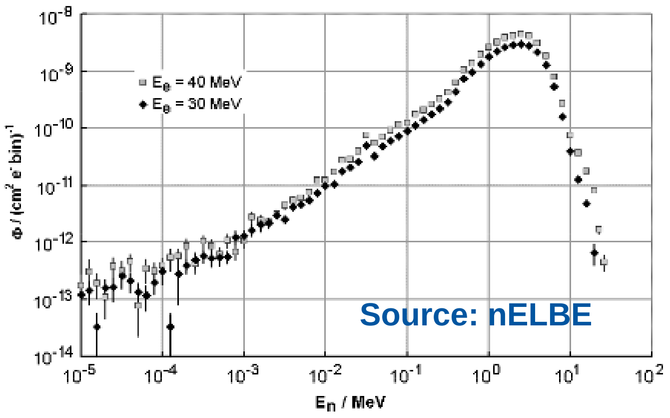


- Thermal neutrons are known to induce **<u>SEE in the electronics when Boron is present</u>**.

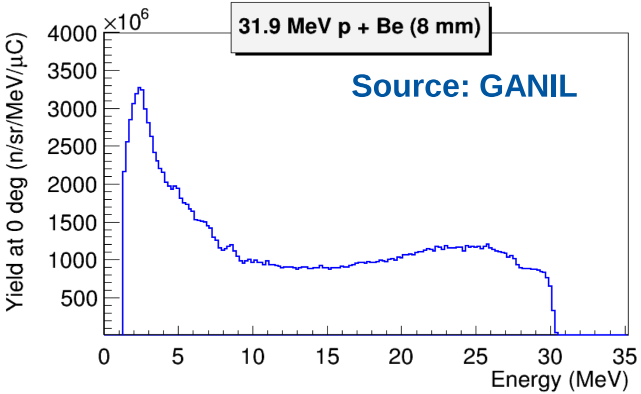
White beams (low and intermediate energy)

Neutron Facilities	Energy range	Flux ($s^{-1}cm^{-2}$)	Neutron production	Country
NPI-CAS	Low and intermediate energy white beam	10^{11} - 10^{12}	Be converter	CZ
GANIL-SPIRAL2 (GANIL)	Low and intermediate energy white beam	10^{11}	Be converter	FR
PTB	Low and intermediate energy white beam	10^{8}	Be converter	DE
nELBE	Low and intermediate energy white beam	$5 \cdot 10^{7}$	Photoproduction: ~1 MeV (100 keV - 10 MeV)	DE

High Fluxes!

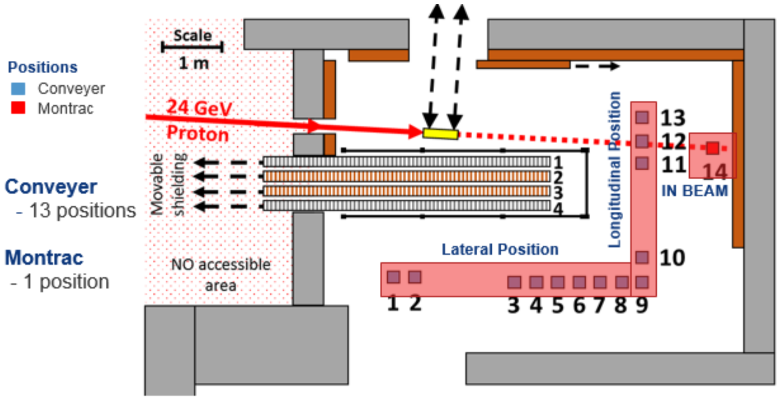


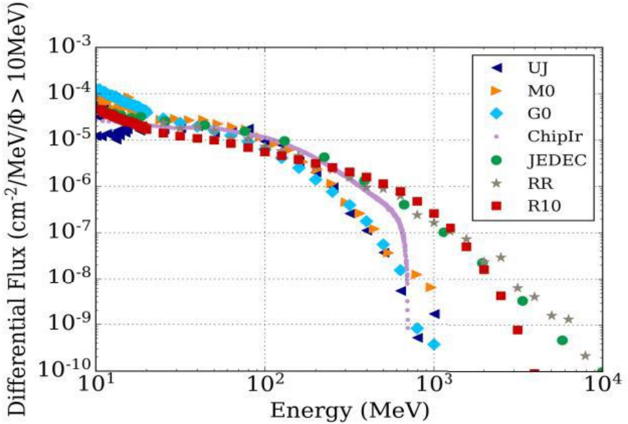
Electron beam on Target: ^{nat}Ta 3.52 cm



Measured continuous energetic spectra with thick Be converter and proton and deuteron beam

Mixed Field (CHARM)





CHARM comparison with the atmospheric neutron spectrum

- CHARM's spallation mixed field (mainly **neutrons, protons and pions**)
- Main interest from radiation effects community: representative radiation environment at **system level**, thanks to very large radiation field available (homogeneous, highly penetrating)
- **Strong interest from space community:** lifetime effects – TID, displacement damage – and SEEs
- Testing electronics for **accelerator environment**.

Muons

- Muons are the **largest component** of the atmospheric flux on the ground
- Muons **cross sections are much smaller** than neutrons. At the moment they are not a problem for industry, but more an academic interest.
- Facilities need to be ready if the problem increases with **scaling down of microelectronics**.

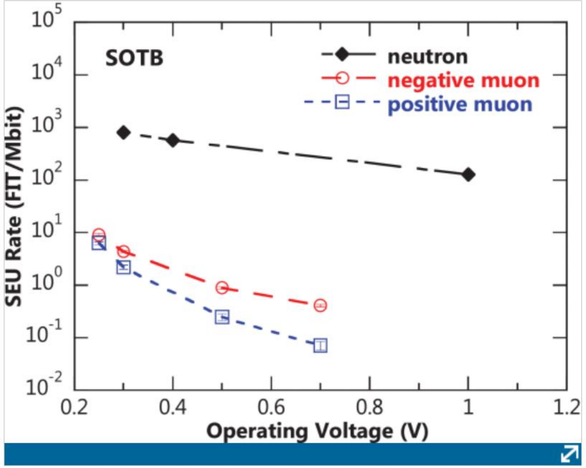
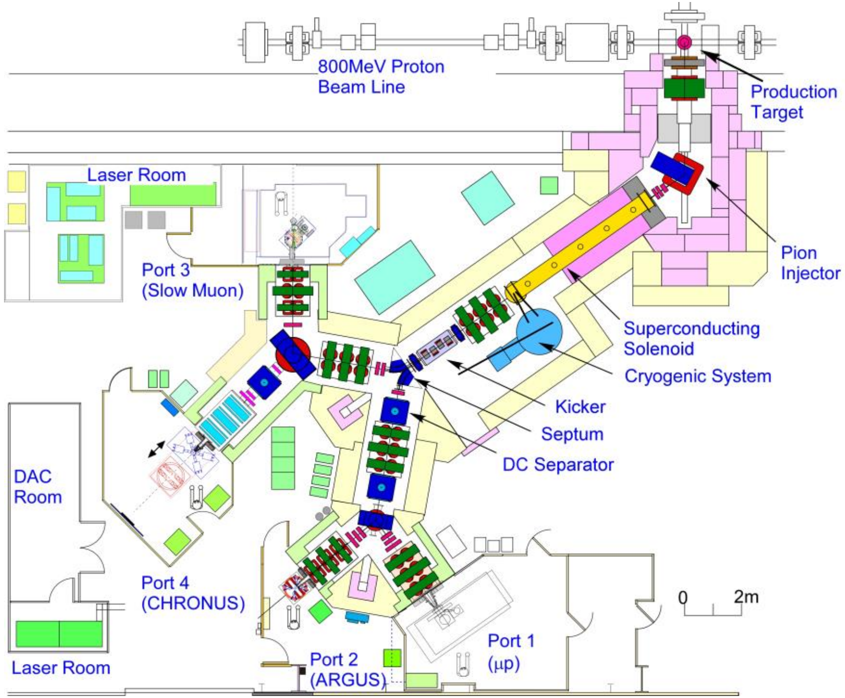


Fig. 5.
Ground-level SEU rate induced by cosmic-ray neutron, negative muon, and positive muon on the 65-nm SOTB SRAM.

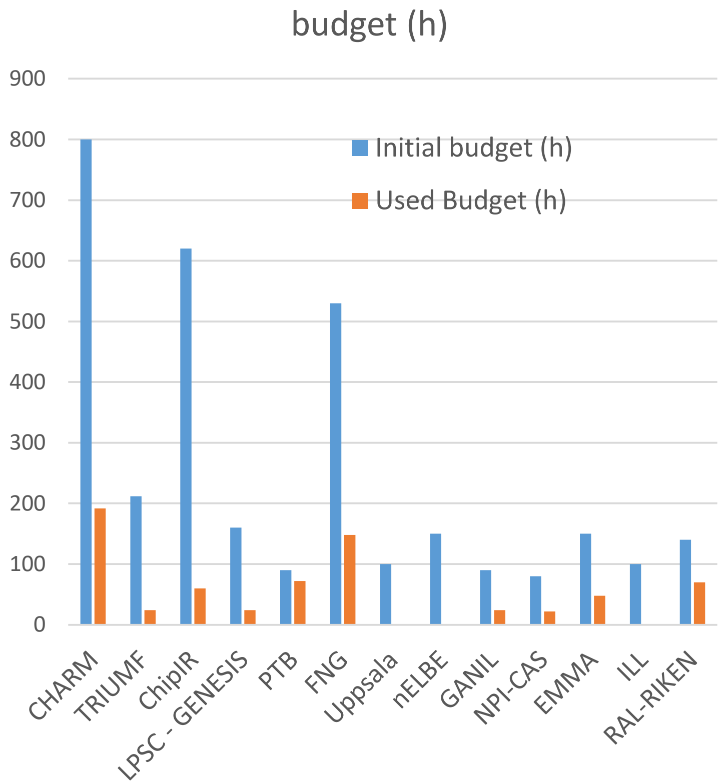
Source: Manabe et al. 2019

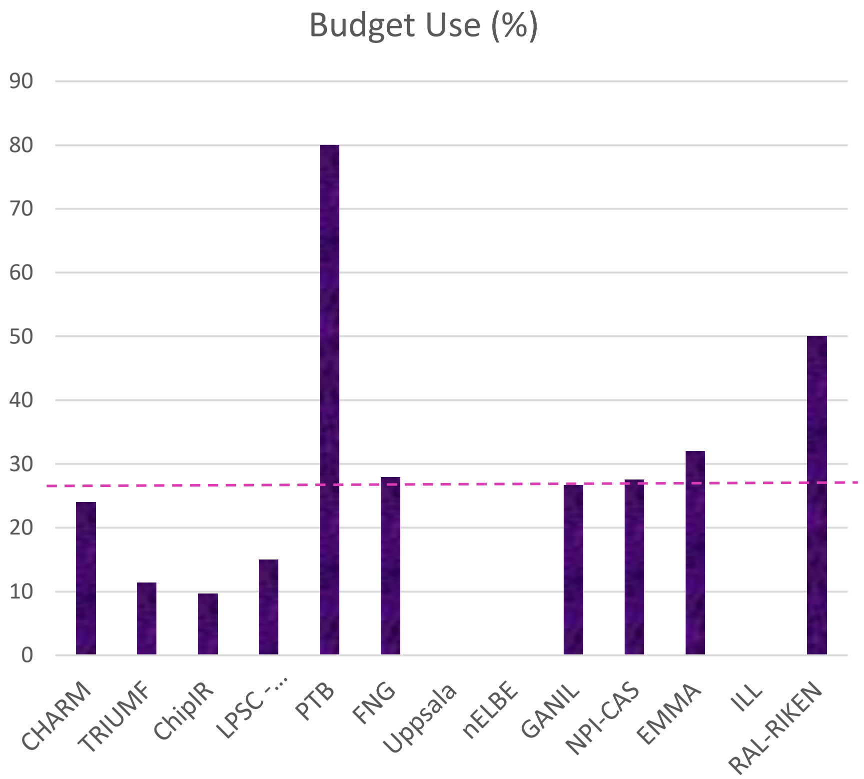


RAL-RIKEN Muons up to 60 MeV/c

Facility budget use

Completed and approved





Availability Criticalities of first year

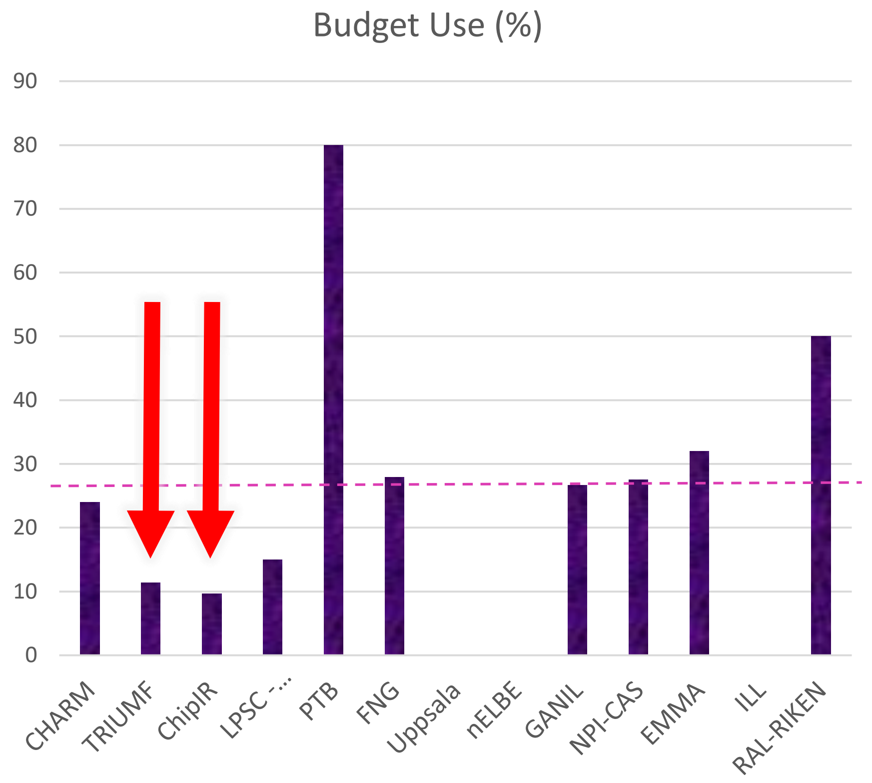
Atmospheric:

ChipIR

- Limited availability due to long ISIS shutdown this year. It ran two experiment starting in May 2022.

TRIUMF

- Limited availability, (longer shutdown) but will do first experiment in 2022.
- Some reluctance of users to travel to Canada has been observed (due to covid in particular). First experiment will be September 2022.



Availability Criticalities of first year

Thermals:

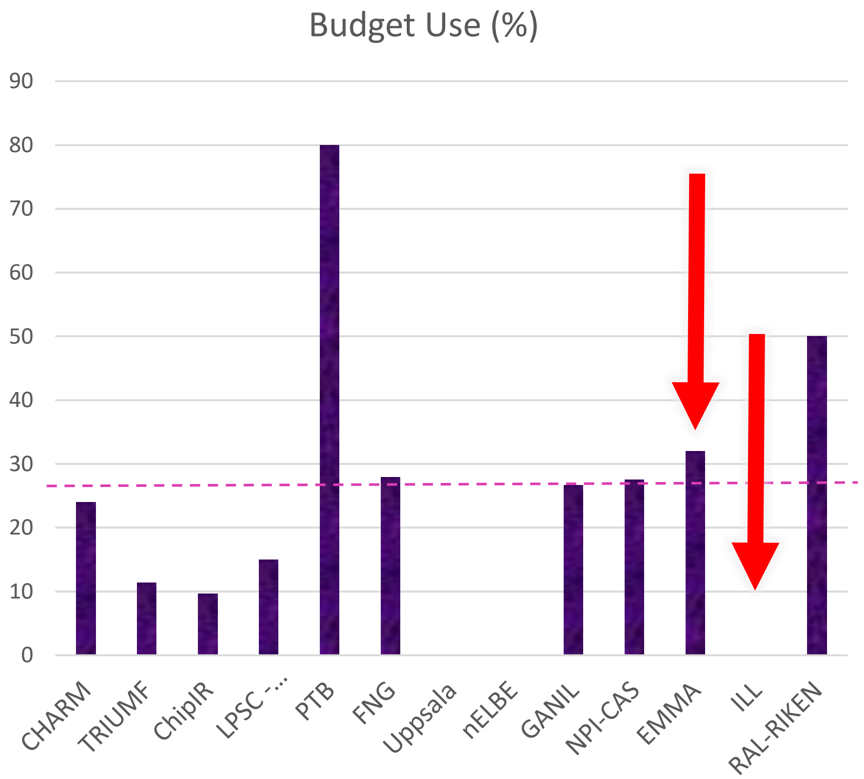
EMMA

- Has not been available due to long shutdown of ISIS Target Station 1. It will be available from September 2022.

ILL

- No proposals so far for ILL.

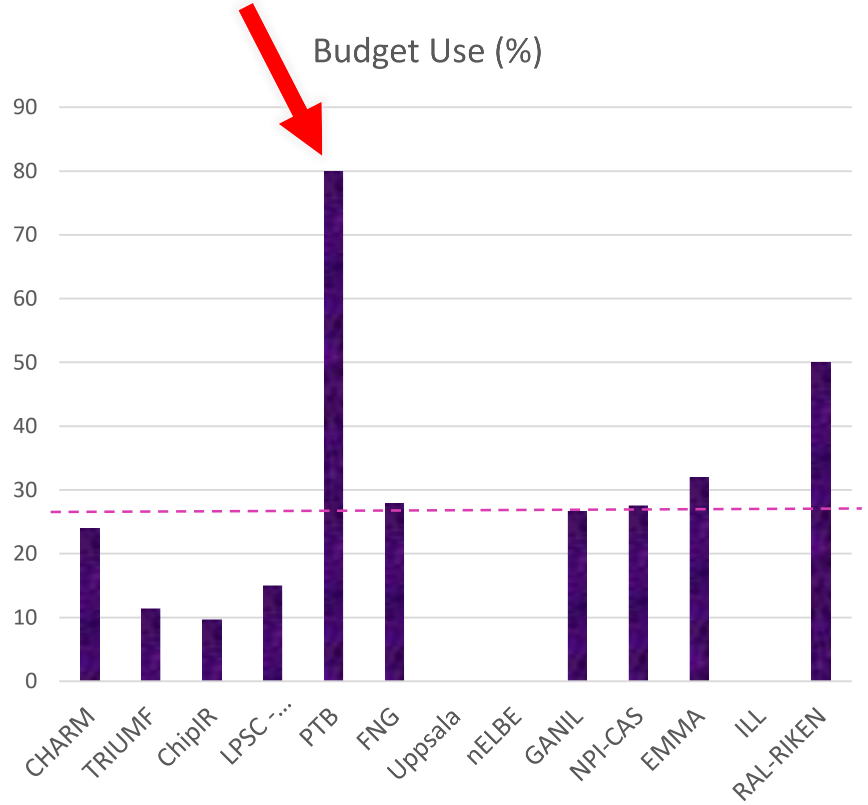
- Few proposals for thermals in general so far. (Also one of the only two proposals was from a French team)



Availability Criticalities of first year

PTB

- Budget has been almost saturated.
- The facility has very good availability and is responsive.
- The initial budget was low.
- Fluxes are not high, that means that experiments are not very quick (typical experiments is in the order of 24h).



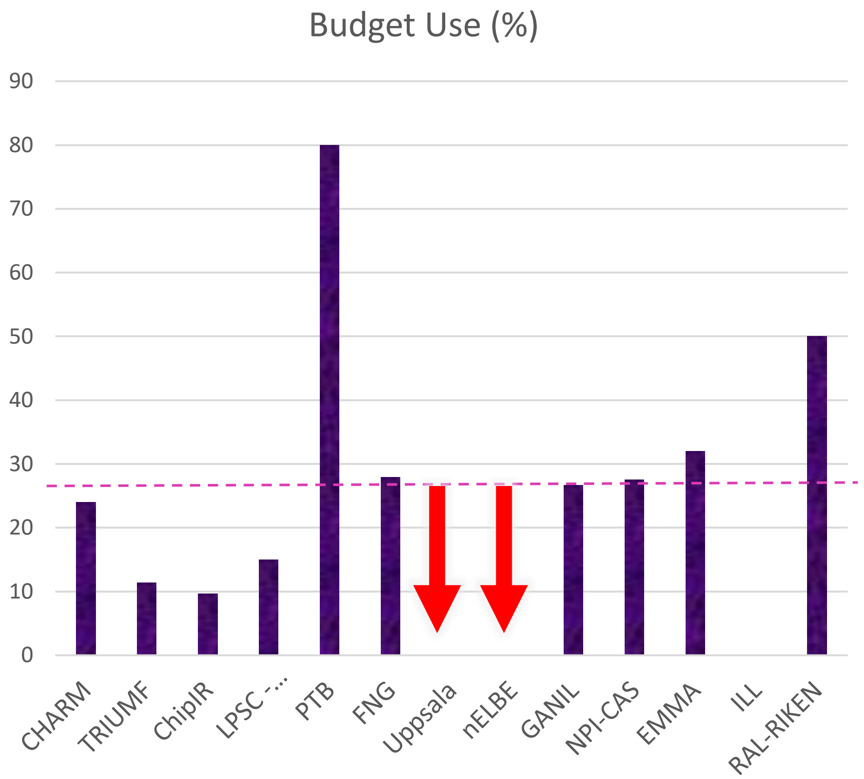
Availability Criticalities of first year

NESSA - Uppsala

- Facility not completed until 2023.
- Change of reference person.
- It could still be in time for radnext (low h budget anyway)

nELBE

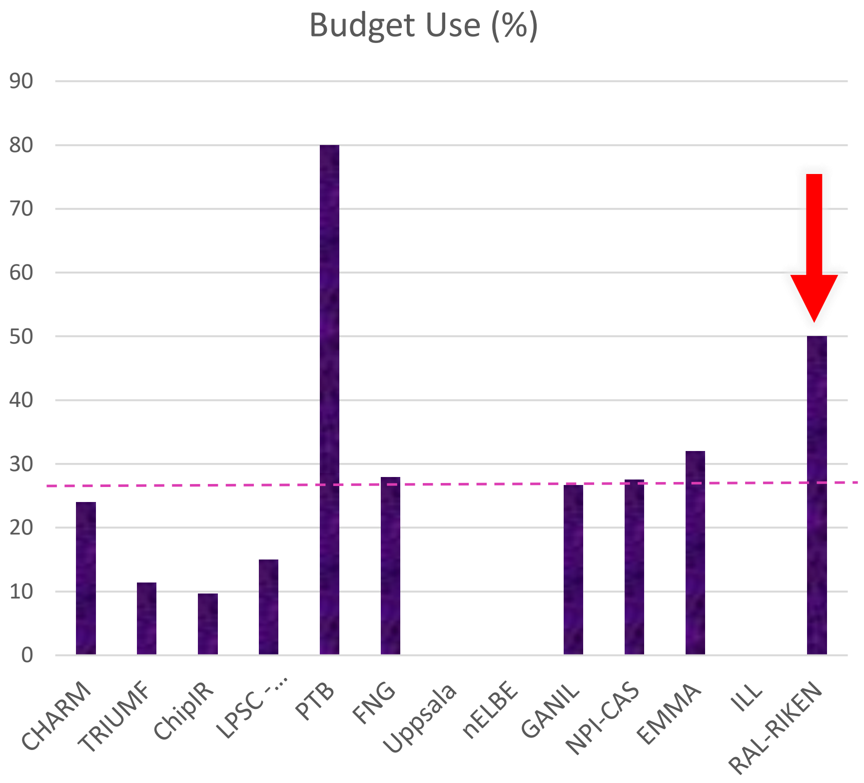
- No proposals so far, but it is a quite unique beam (only photoproduction beam ≈ 1MeV)



Availability Criticalities of first year

Muons

- Only one experiment accepted so far.
- This experiment alone will use about 50% of current total budget.
- The issue is that muon experiments are long because low cross sections and need to find the optimal energy for charge deposition (just energy scan can takes about 24 h)

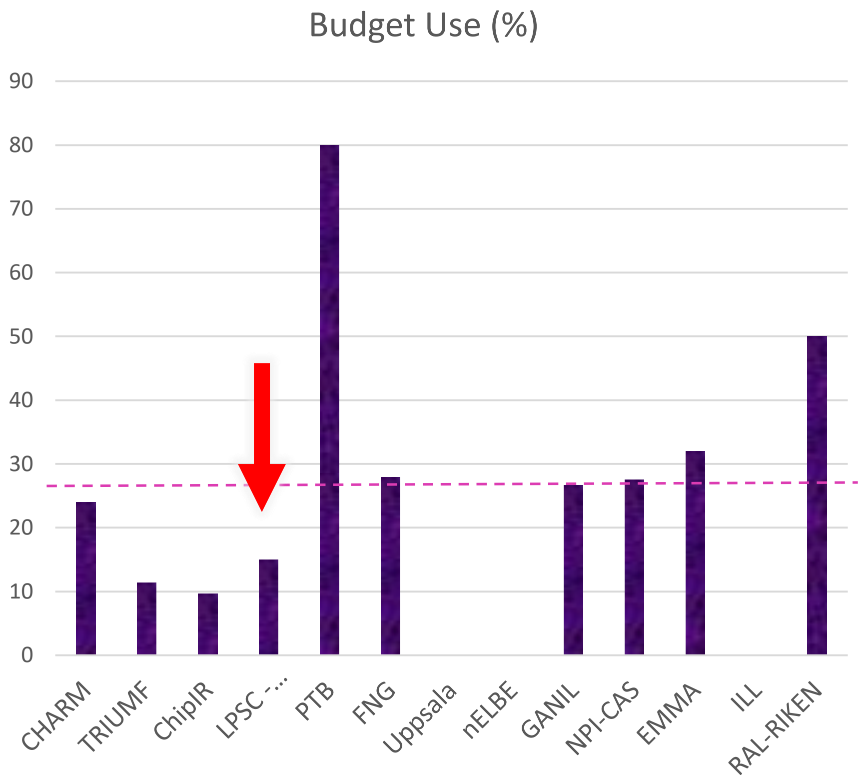


Availability Criticalities of first year

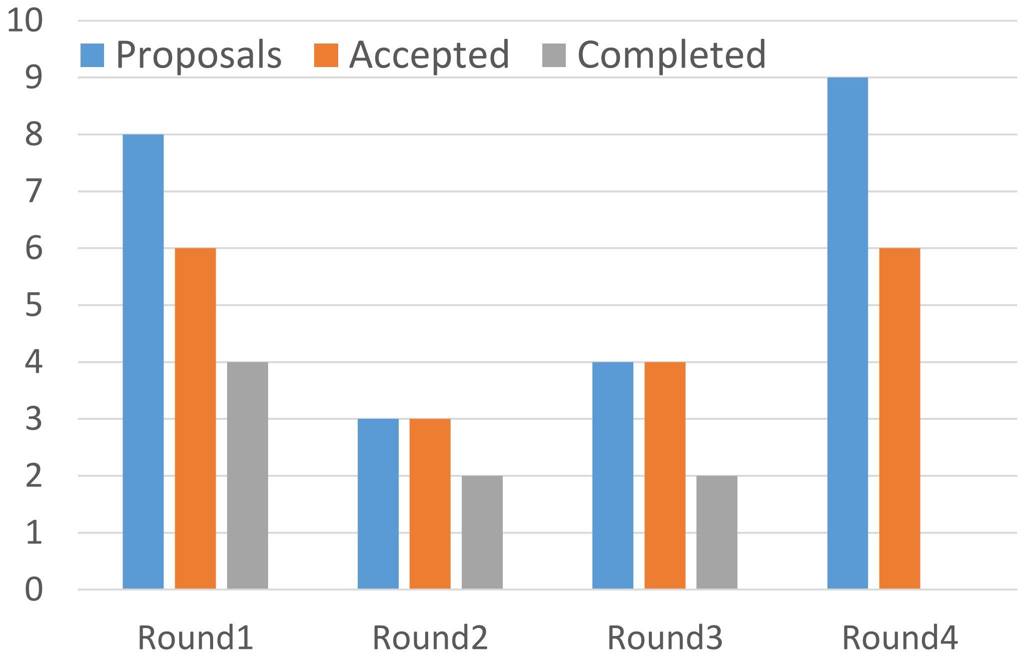
LPSC

- Only one experiment accepted so far.

- Other suitable experiments needed to be diverted to other facilities because of impossible access for some nationalities, and no TA for French teams to a French facilities.

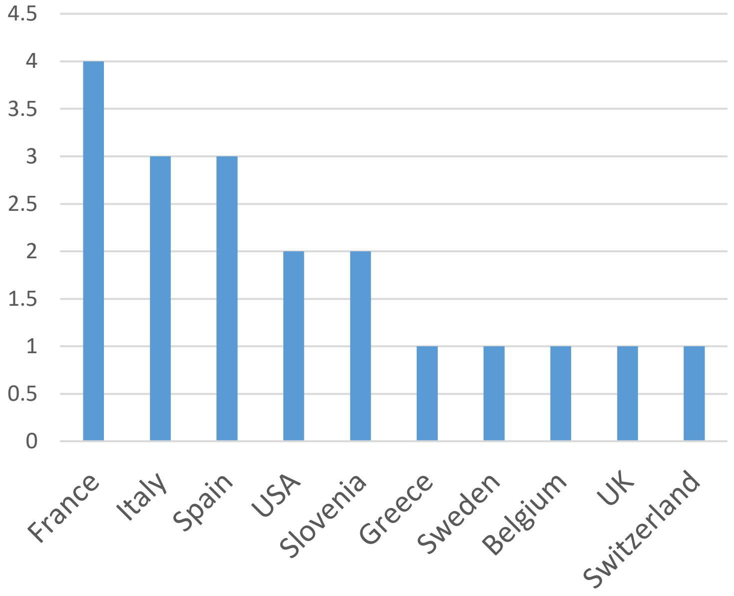


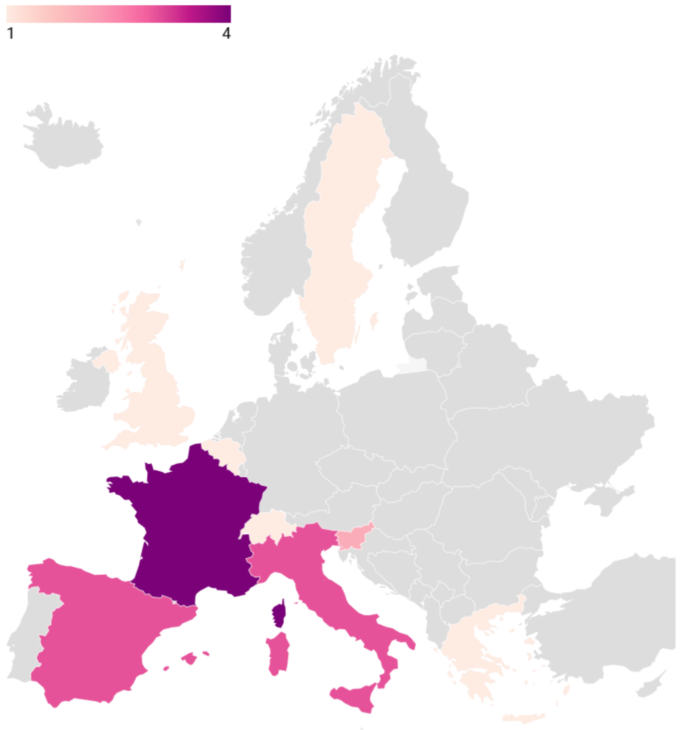
Proposals lifecycle



- Normal fluctuation in number of proposals?
- Round 2 deadline was around Christmas holidays, or many users were trying to get heavy-ions and protons.
- Shortest times from submission to delivery is in the order of 3-4 months (typically at mono-energetic neutron facilities)
- Typical time for other users/facilities is 6 months or even >1 year.
- How about reducing to 3 rounds per year?

Origin of accepted proposals (institution)

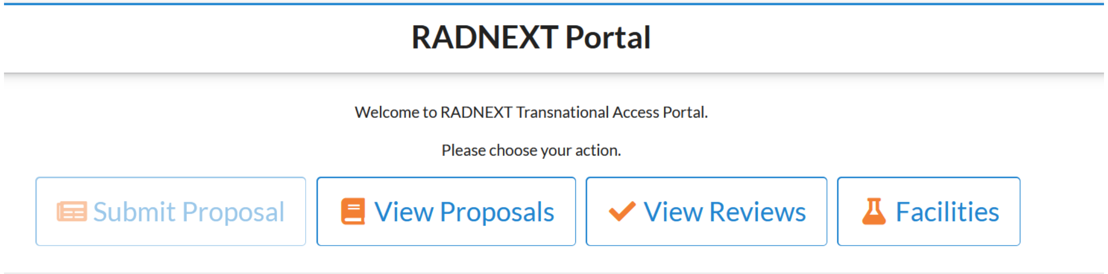




Difficulties for WP leaders

- The main issue (we know that WP3 is working on it) is **the interface with the proposal system that is very difficult to navigate**.
  - When RADOCS was used it was much easier to navigate (also because we were used to that system), but it couldn't generate automatic messages as needed.
  - The new system can do this, but we do not have filters to navigate the proposals.

- Procedure for assigning number of hours to successful proposals is not very clear (see WP10 presentation for more details).



Potential criticality: access for industry and users with little experience

- Difficulty in some cases for industrial users to compete with experienced academics that are used to write good proposals.
- How to make sure potentially good users are not demotivated after first failure.

Feedbacks from user reports

- “***For another proposal we experienced some delay in the evaluation process and we did not get any specific feedback, it would have been very useful to better tune future application.”***

In particular for rejected proposals more detailed feedback is asked. This may be difficult if reviewers have large number of proposals. Consider recruiting more reviewers to reduce number of proposals/reviewer.

- **Most users are just happy**

Thanks for your attention!

Image Source: CERN