HZDR TA Report

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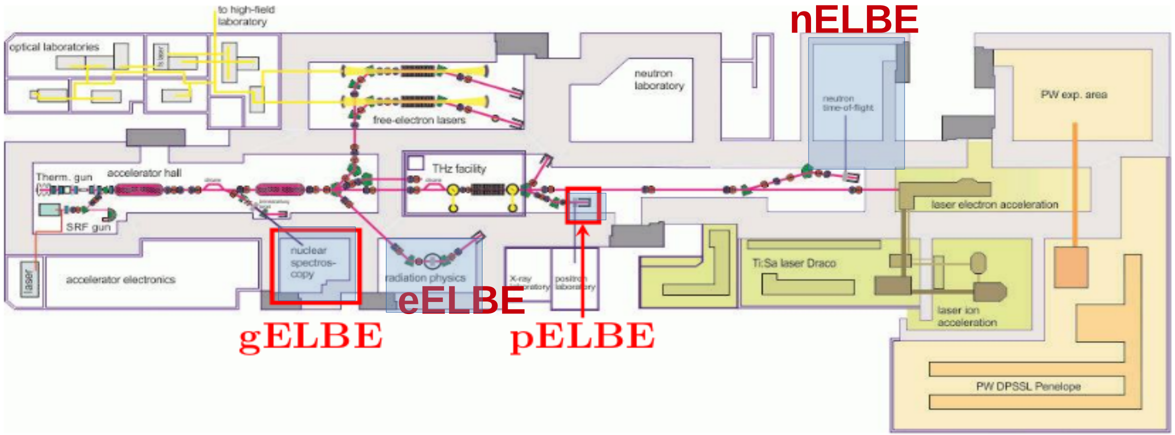
RADNEXT 1st Annual Meeting – 8-9 June 2022

https://indico.cern.ch/e/radnext-2022

The ELBE radiation source facility at HZDR

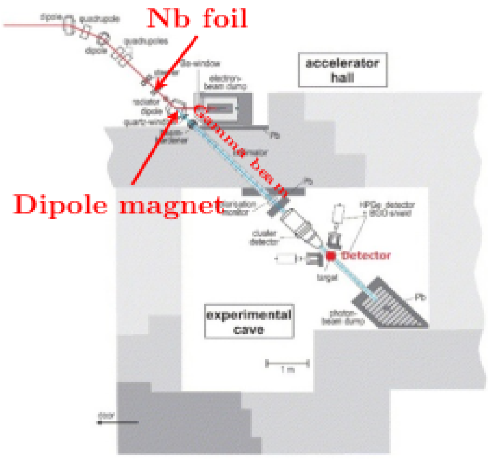


DRACO
Laser-accelerated proton/ion beams

- ELBE ("*Electron Linac for high Brilliance and low Emittance*") is based on a superconducting linear accelerator which accelerates electrons to energies in the interval **[5, 40] MeV** at a beam current of up to **1 mA**
- Guiding the electron beam on suitable targets allows the production of secondary radiation: intense **photon, positron and neutron beams** are available to the users in dedicated caves
- A unique feature: **pulsed beams**, with a pulse width between 10 ps and 1 µs, a repetition rate of 26 MHz/2^n (n=1,...,7) and a charge load up to ~77 pC/pulse.
The time structure of the electron beam is directly transferred to the secondary radiation.

- *Beam time for the ELBE facility is allocated following a selection process of submitted proposals by the ELBE SAC*
Calls for proposals are issued twice per year, in spring and fall - - > But GOOD Interactions with the RADNEXT Approval process

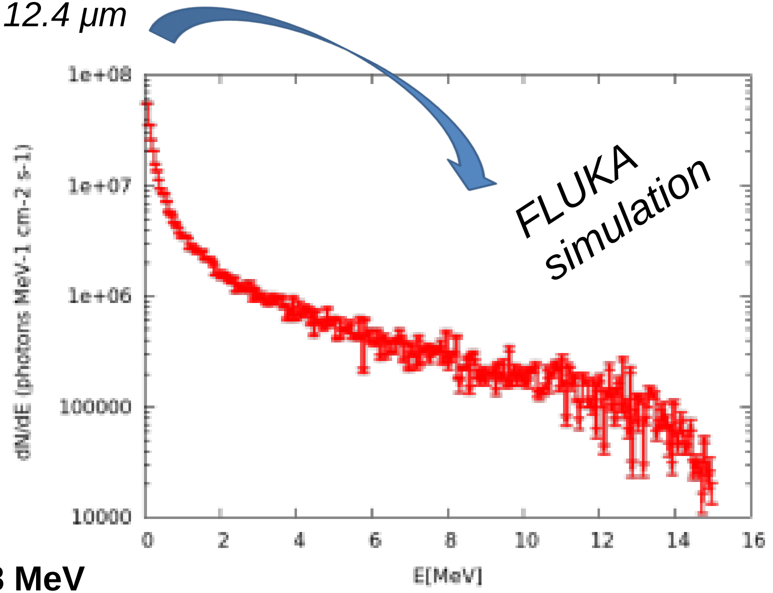
gELBE



Photon spectrum for a 15 MeV e- beam, using the thickest Nb target of 12.4 μm

Corresponding photon flux:

~ 2.5 × 10^7 γ cm^{-2} s^{-1}
per 1 μA of e^- beam current



- Highest end-point of the delivered Bremsstrahlung spectrum: **~ 18 MeV**
  Energy spectrum can be "hardened" by adding suitable absorber material. An extended set of FLUKA simulations has been developed, allowing to define the optimal conditions for experiments with respect to the choice of radiator foil thickness and absorbers

- As in the other secondary radiation sources of ELBE, the pulse structure of the electron beam is transferred to the photon beam This allows not only **radiation hardness studies**, but also detector studies with special temporal structure of the signal and/or signal/background configuration, **in harsh radiation environments**

nELBE

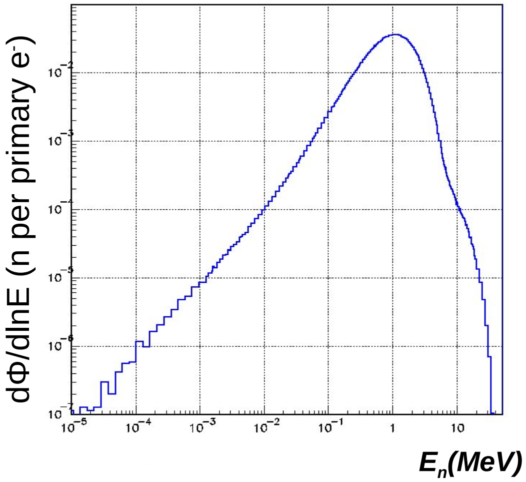
nELBE neutron beam
produced via (gamma,n) reaction
on liquid lead target

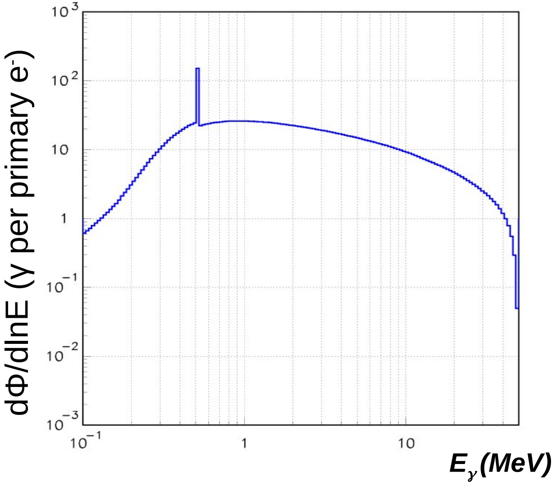
Neutron flux: ~ 5×10^{7} n cm^{-2} s^{-1}

Liquid lead Target

Time-of-flight hall
6 m x 6 m x 9 m

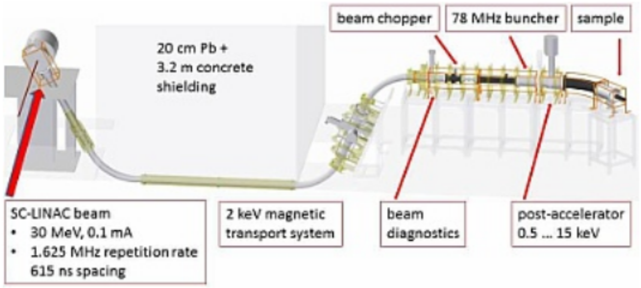
Neutron and photon spectra

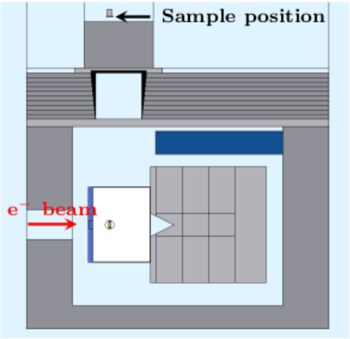




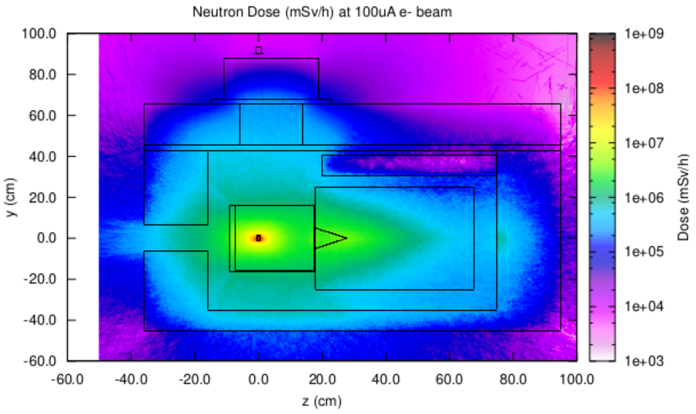
EPOS along the nELBE beamline: a second neutron irradiation area

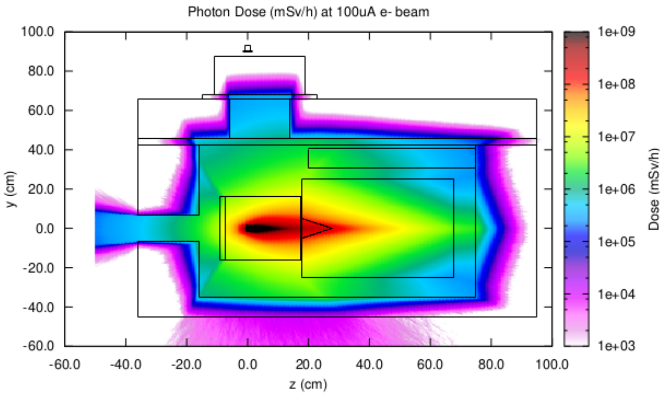
➢ e⁻





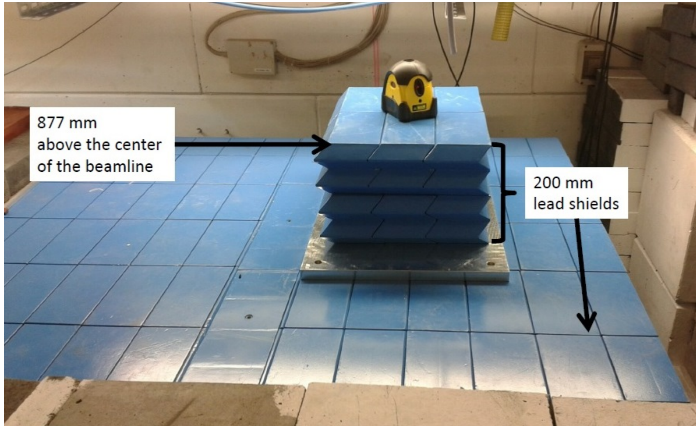
- ELBE electron beam hits a 1 cm thick water-cooled W target and produces positrons through Bremsstrahlung and following pair production
- In the tungsten target, the electron beam induces **neutron photo-production**
- At the measurement position **neutron dose** is completely dominant respect to any other contribution

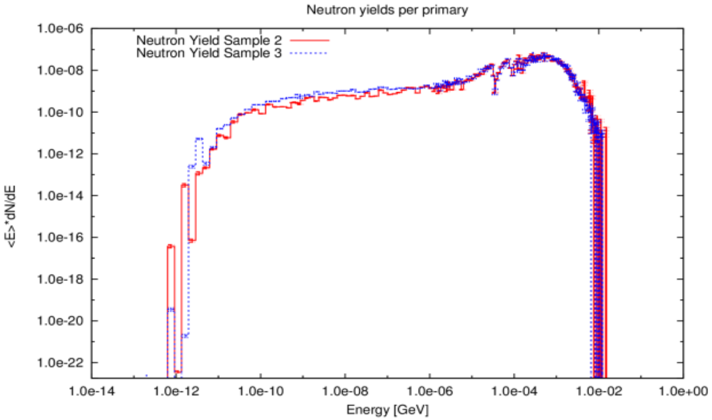




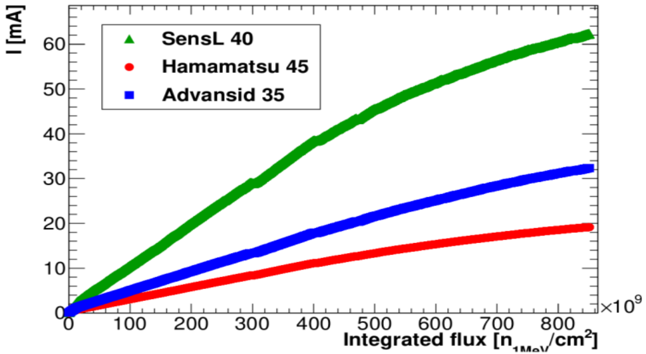
FLUKA simulations

EPOS along the nELBE beamline: experience with SiPM irradiation





Neutron spectrum at the measurement position



Dark current of the SiPM cells from three vendors as a function of the integrated neutron flux

- Parasitic irradiations in conjunction with positron physics beamtimes have been carried out routinely

Total delivered fluence: $> 10^{12}$ n_{1MeV} $/cm^2$

(irradiation time: 2 days)

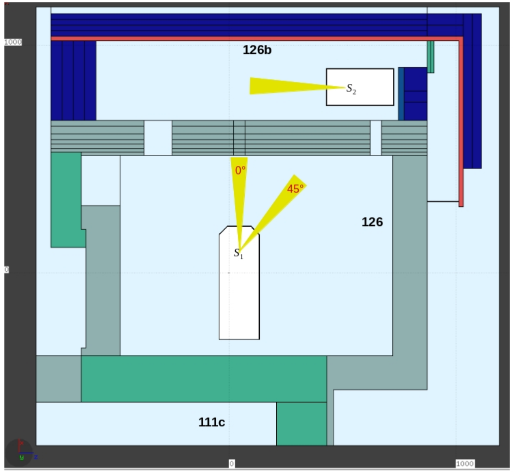
HI Laser-generated protons: DRACO

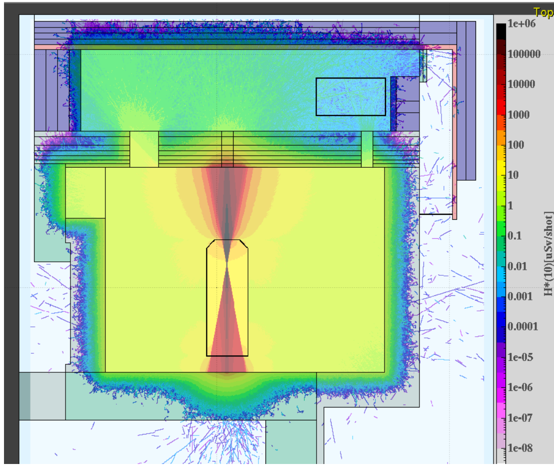
High Intensity, high power laser (up to 1 PW) able to deliver protons up to (routinely) ~ 100 MeV
Goal. 200-250 MeV for medical applications

Typical currents: up to 50-60 nC/laser shot   Goal ~ 1Hz

Need of **Dosimetry experiments** to fully characterize the radiation environment: <u>protons and associated intense bremsstrahlung</u>

The new Athena area, for biological sample irradiation



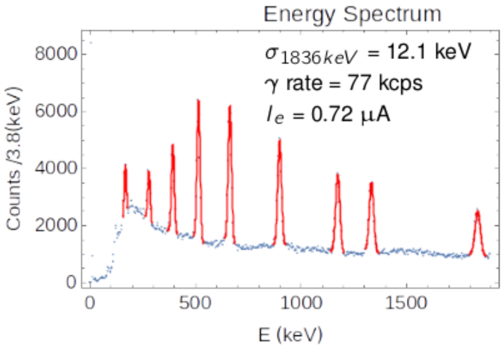


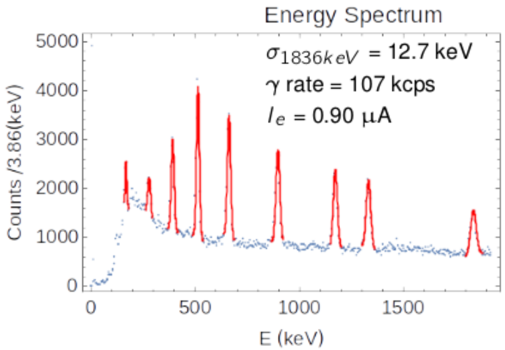
1. Completed TA campaigns

One campaign completed at **gELBE** on April 22-25 - 72 hours delivered

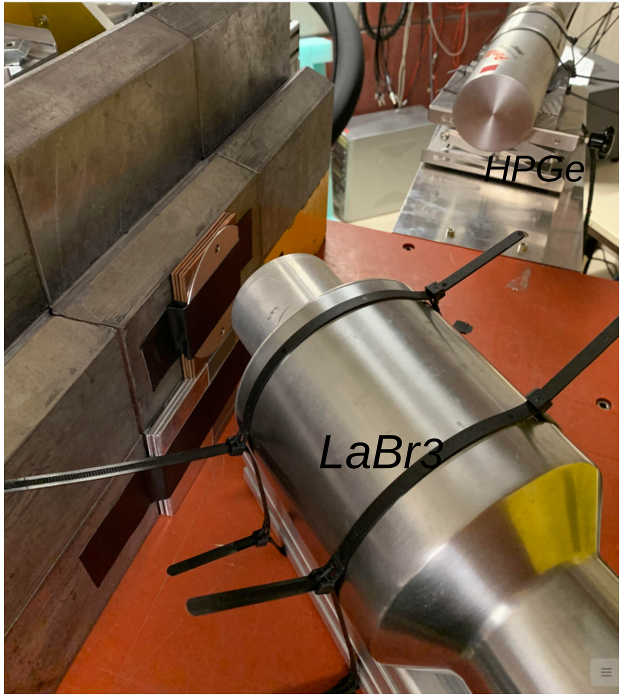
The detector system for the Stopping target monitor of Mu2e (LaBr3 + HPGe detectors) was tested with background conditions similar to Mu2e
Users from Liverpool/Manchester/UCL

- ✓ 72 hours of gELBE beam
- ✓ 3 people will have partial reimboursement with the user support funding from RADNEXT





Photon spectra show an optimal signal/background ratio



2. Scheduled TA campaigns

- “Characterization of the neutron radiation at the EPOS (nELBE second irradiation point) area”

  Foreseen for second half of 2022

  A group from INFN-LNF very interested to apply

  Application to be submitted to RADNEXT

  - - > *no need of the SAC approval!*

3. Accepted and assigned TA campaigns, to be scheduled

- none

4. TA time already awarded VS Total facility TA quota

Summary		
Beamline	TA facility quota (h)	TA time awarded (h)
gELBE	**80**	72
eELBE	**80**	0
nELBE	**150**	0
DRACO	**120**	0

5. Approach for user (financial) support

- Given the limited amount of funding, we try to strictly follow the rule:
  45 Euro/TA per beam hour

- The user support can be in any case modulated case-by-case

  We consider also that a support, even if considerably moderated, can have a positive Impact on the will of the users to participate in the beamtime

Thanks for your attention!

Image Source: HZDR
(Anna Ferrari)