

ELSA: Status, Recent Projects and Plans

Dennis Proft

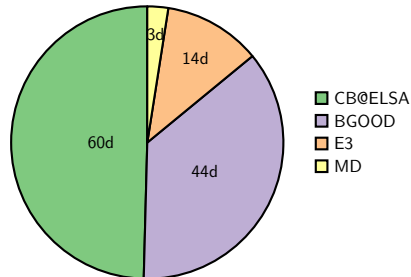
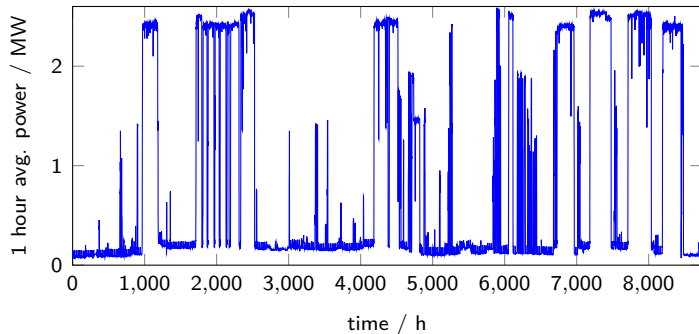
Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

19.06.2025

BGOOD Collaboration Meeting



Beamtime Overview 2025

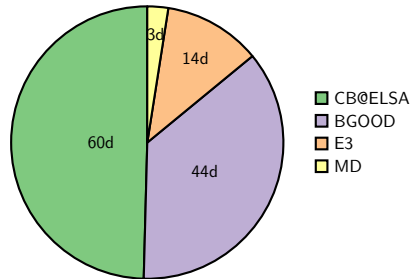
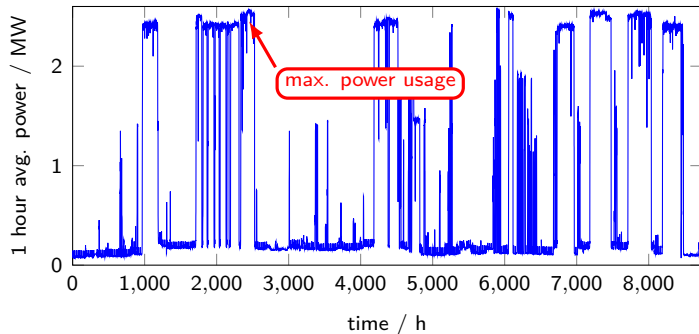


“Beam On” 2025: 111 d (2 660 h)

“Machine On” 2025: 125 d (3 007 h)

- Very successful year $\Rightarrow$ more than 3 000 h beam time!
- ELSA joined *Beamline for Schools* competition
 - ▶ Invited 5 high-school students from US
 - ▶ Studies on transition radiation yield of low cost materials

Beamtime Overview 2025

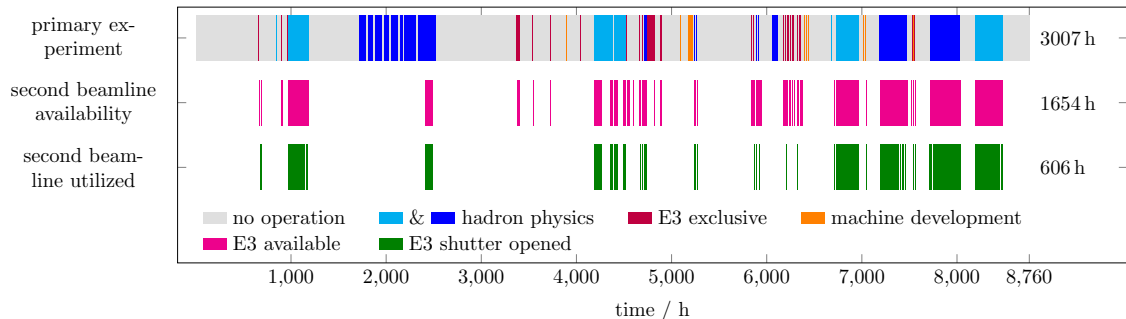


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Beamtime Overview 2025 (Details)



Total beamtime 2025: 3 007 h

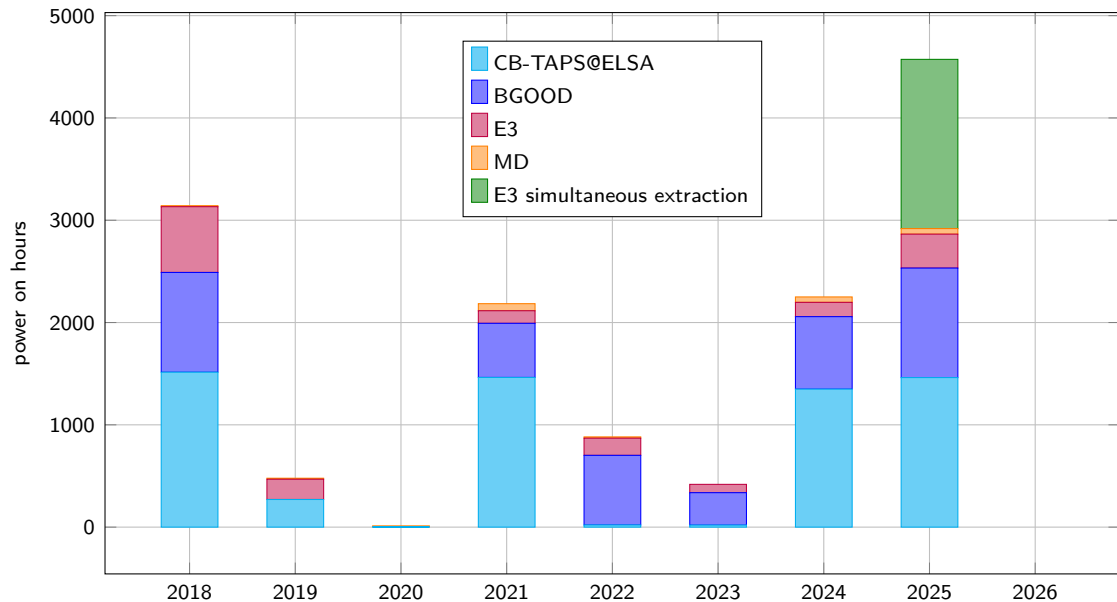
- Hadron physics experiments: **2532 hours** ⇒
- Exclusive E3 experiments: 331 hours
- Machine development: 55 hours

Gained 1654 hours more beam time availability by establishing the simultaneous extraction mode!

→ With 606 hours beam on!

- Remaining 1048h preparation / setup time for experiments

Beamtime 2018-2026



Selection of Current/Ongoing Projects at ELSA

1) Injector Upgrade

- Redesign of therm. Gun
- RF Feed-forward

2) Spin-polarized electrons

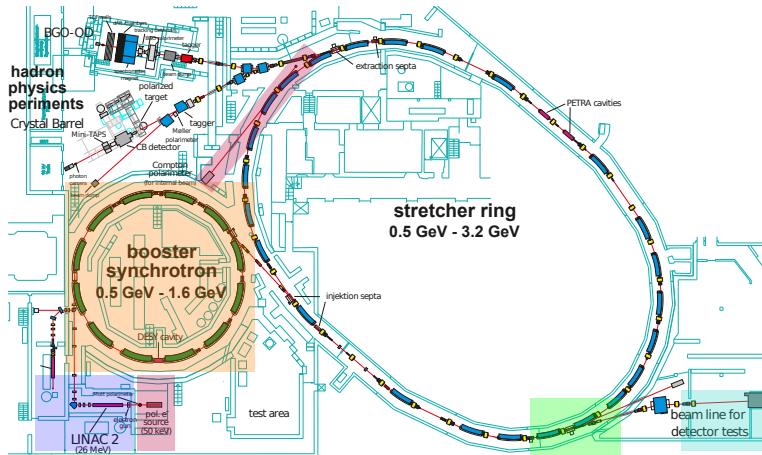
- Recommissioning of pol. Source
- Polarimetry

3) Extraction

- Permanent magnet septum

4) FLASH@ELSA

- High dose rate dosimetry



5) Infrastructure

- Upgrade/Replacement of Synchrotron AC capacitors

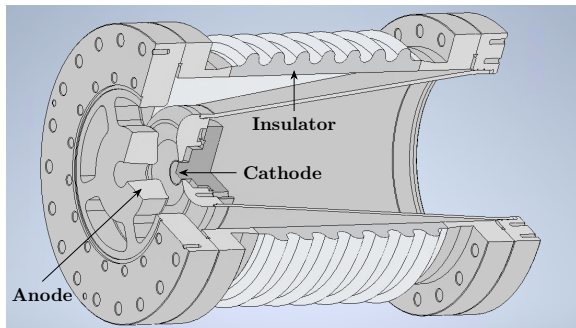
New Injector Beamline at LINAC2 (1)

Goal:

- Improve Reliability of electron source
- Realize single bunch operation mode
- Enhance beam diagnostics in front of LINAC2 → PoIQ operation would also benefit

Current status:

- Manufacturing of gun assembly ongoing (insulators delivered)
- 2 Bachelor theses finished regarding characterizing TAPE effect
- 1 PhD student currently working on teststand design



New Injector Beamline at LINAC2 (2)

Limitations:

- limited laser power $\rightarrow$ small emission currents
- vacuum quality and vacuum diagnostic (residual gas)

Findings:

- Tested measurement of photo- and darkcurrent and analysis
- Handling of dispenser cathode in TAPE operation
- Identification of TAPE operational parameters
- Experience with cathode pyrometry

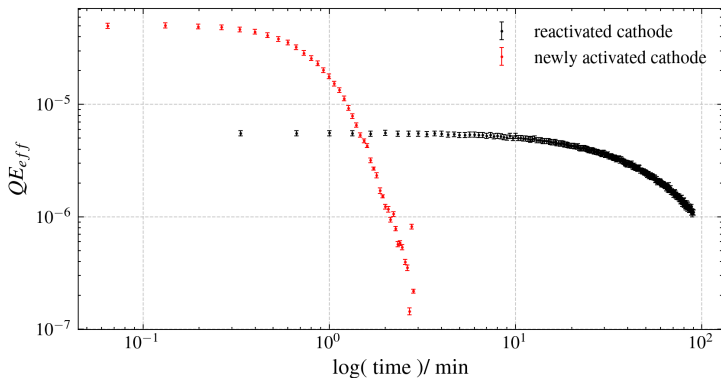
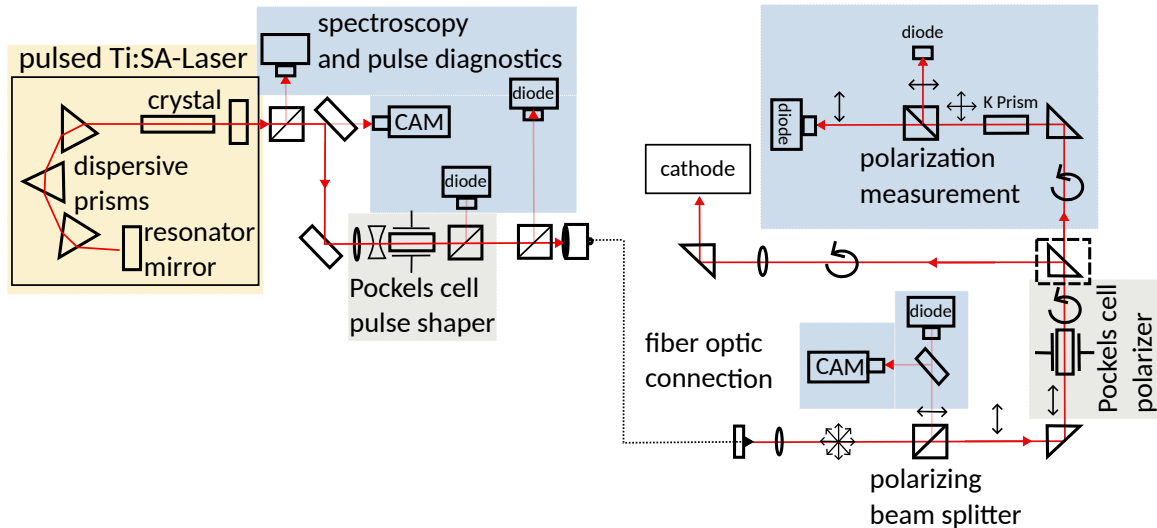


Figure: Comparison of QE and lifetime of a reactivated and a newly activated cathode

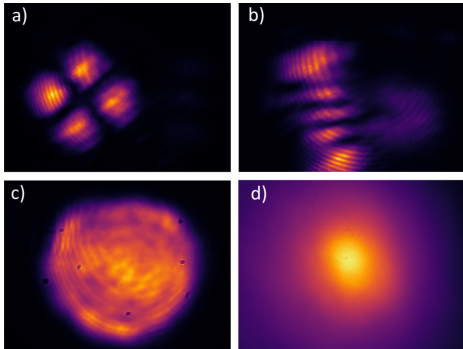
Source for Polarized Electrons (1)

General Setup

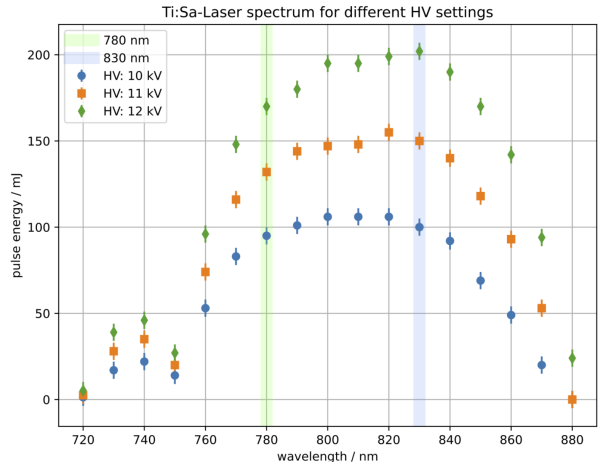


Source for Polarized Electrons (2)

Ti:Sa Laser Source



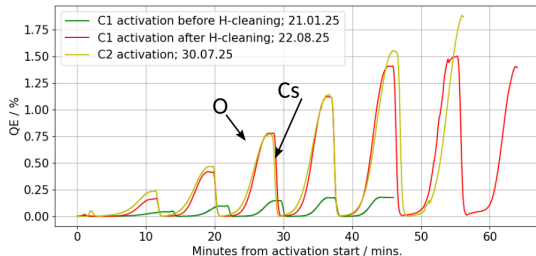
- Online spectrometer control
- Laser beam monitoring via in-house developed imaging suite FGrabbit



- Provides 200 mJ (10 μ s) @ 830 nm
- Flash light pumped up to 12 kV at 50 Hz

Source for Polarized Electrons (3)

Activation



- Crystal #1

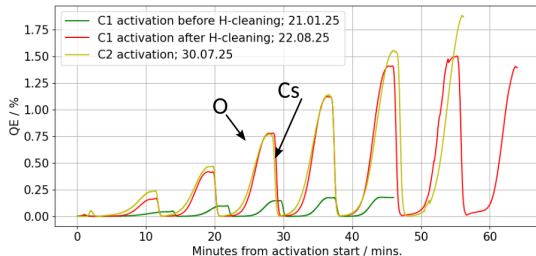
- ▶ Initial QE 1.2 % (in 2023, last productive use in 2017)
- ▶ Repeated heat-cleaning → QE dropped to 0.13 % max

- Crystal #2

- ▶ Stable activation, QE increased with each cleaning cycle
- ▶ Achieved up to 2.02 % QE @ 633 nm
- ▶ Typical lifetime $\tau \approx (280 \pm 60)$ h, sufficient for regular accelerator operation

Source for Polarized Electrons (3)

Activation



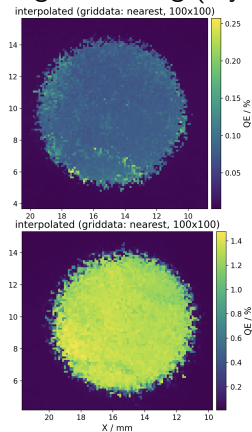
- Crystal #1

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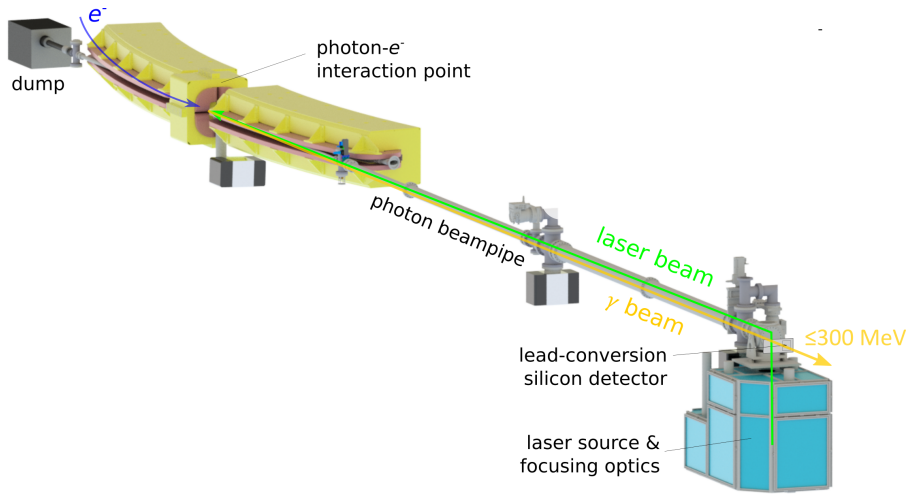
- ▶ Stable activation, QE increased with each cleaning cycle
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hydrogen cleaning (crystal #1):

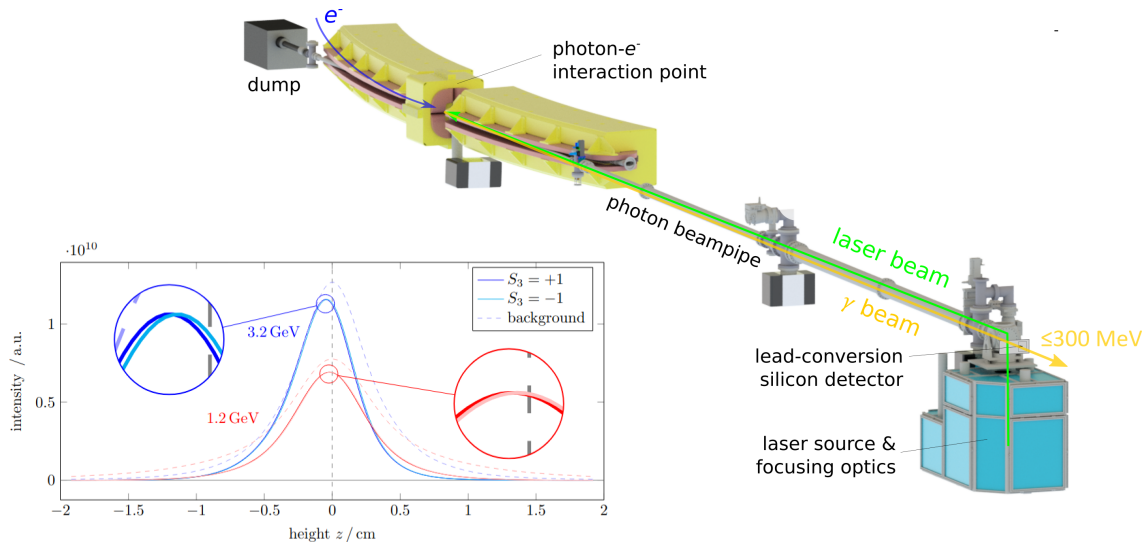


- Overall QE increased to 1.56 %

Compton Polarimeter Upgrade (1)



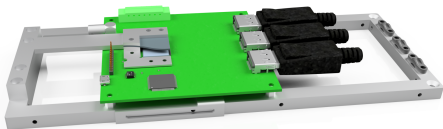
Compton Polarimeter Upgrade (1)



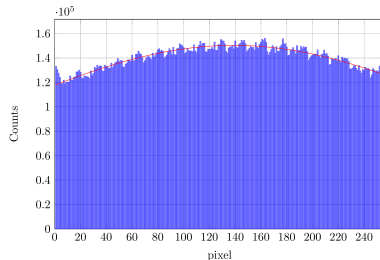
Compton Polarimeter Upgrade (2)

New Timepix3 Detector

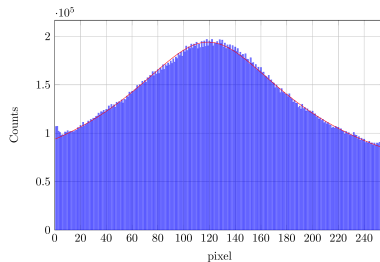
- Pixelized readout ASIC, $14\text{ mm} \times 14\text{ mm} \times 500\text{ }\mu\text{m}$
- 256×256 pixels, $55\text{ }\mu\text{m}$ pitch
- Time resolution: 1.56 ns
- Data Rate: $40\text{ MHits/cm}^2\text{s}$
- $2X_0$ Pb conversion target



horizontal profile:

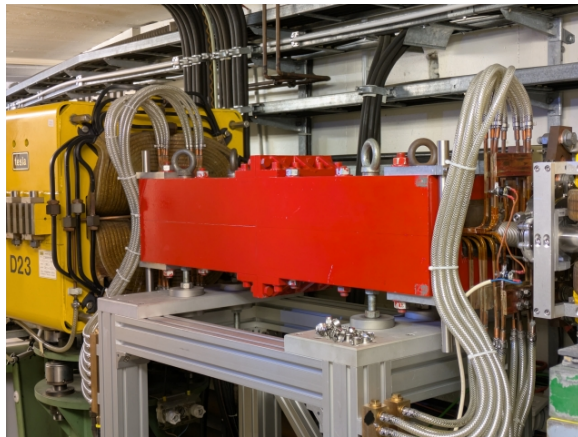


vertical profile:

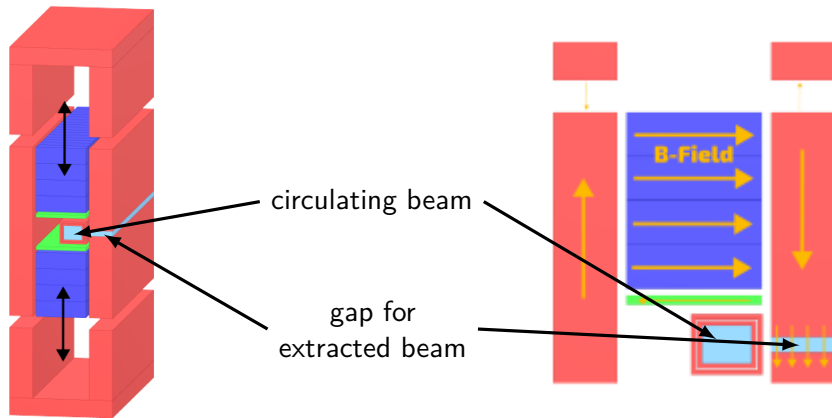


Development: Permanent Magnet Septum (1)

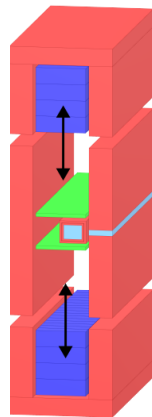
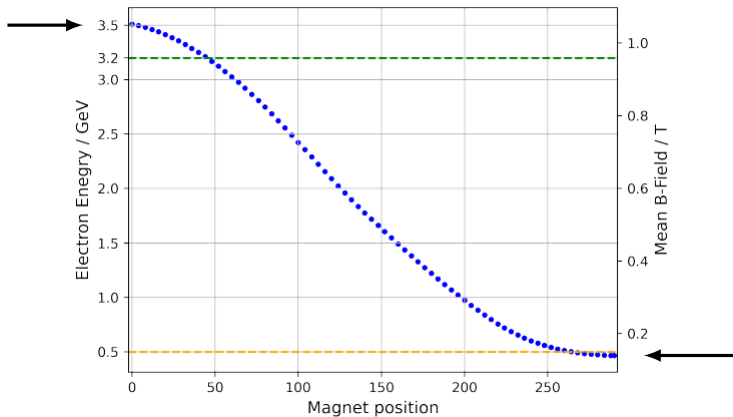
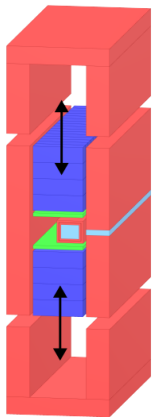
- Replacement of main extraction septum magnet by permanent magnet
 - Research on sustainable accelerator components:
 - ▶ power consumption reduction:
 $70\text{ kW} \rightarrow 0\text{ kW}$
 - Challenge:
 - ▶ radiation damage
 - ▶ ELSA energy range: 0.5 GeV to 3.2 GeV
 - Field variability: 150 mT to 970 mT
- ⇒ SmCo magnets & variable magnetic short circuit



Development: Permanent Magnet Septum (2)

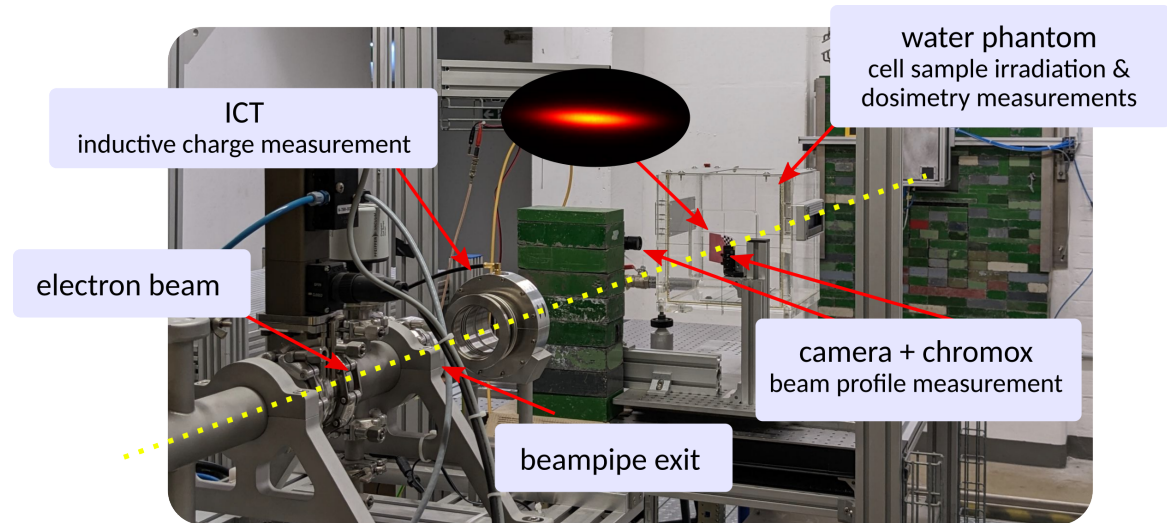


Development: Permanent Magnet Septum (2)



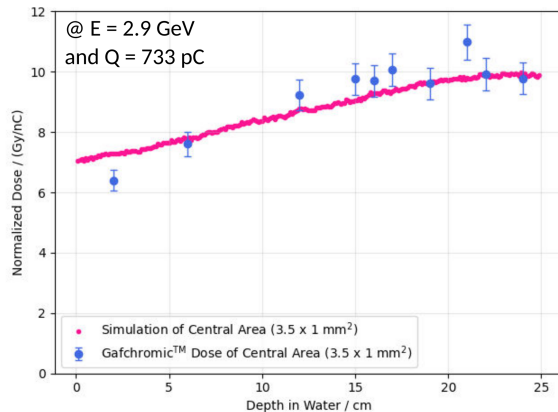
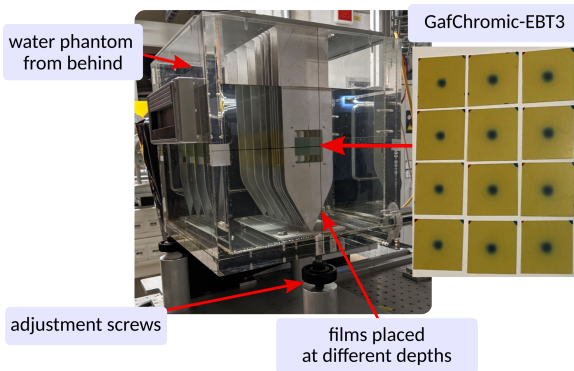
FLASH@ELSA

Setup for Cancer Cell Irradiation



FLASH@ELSA

Dosimetry: Radiochromic Films (gafchromic™)

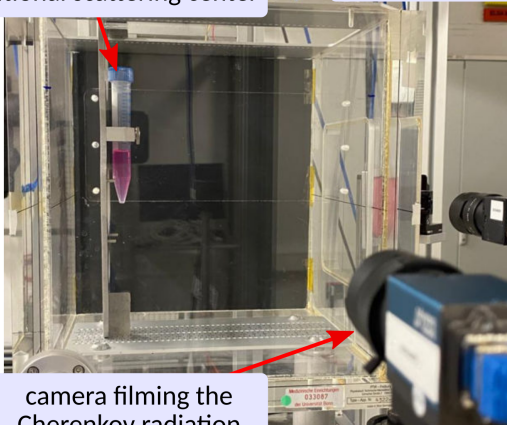


FLASH@ELSA

Dosimetry: Cherenkov Radiation

dummy sample as
additional scattering center

water phantom
from the side



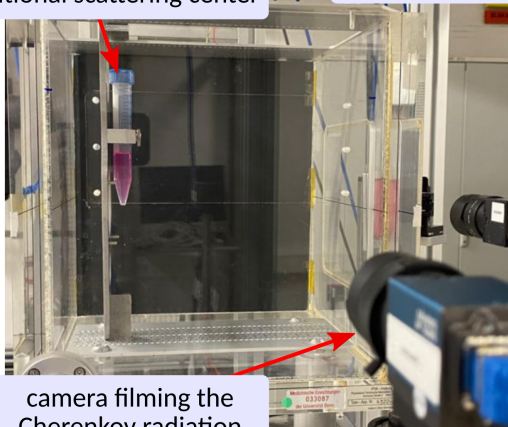
camera filming the
Cherenkov radiation

FLASH@ELSA

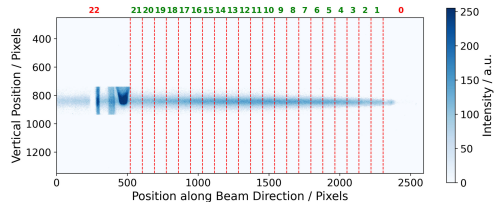
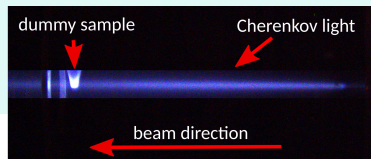
Dosimetry: Cherenkov Radiation

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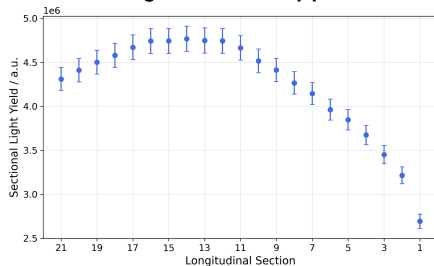
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camera filming the
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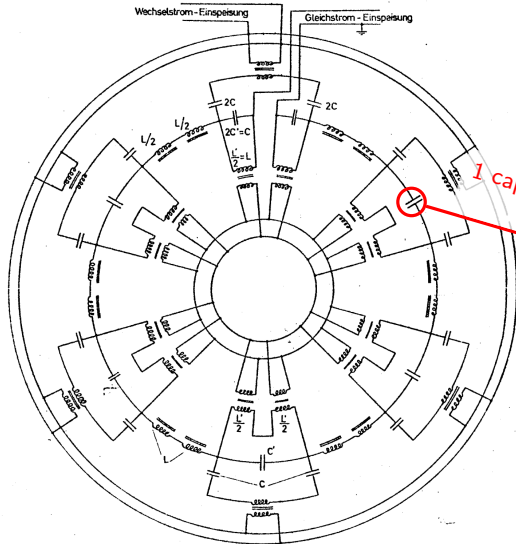
Longitudinal intensity profile



New Capacitors for Booster Synchrotron (AC filter, 2024 finished)



New Capacitors for Booster Synchrotron (resonance circuit, ongoing)



1 capacitor (schematics)
 $\cong$ 1 bank



Abb. 26: Schematisches Schaltbild der Magnetstromversorgung
(White-Schaltung).

New Capacitors for Booster Synchrotron (resonance circuit, ongoing)

replacement of 655 capacitors

- permit for usage expired 31.12.2025
 - $\approx 35 \text{ m}^3 / 42\,000 \text{ kg}$ of contaminated components
- disposal delayed

≈ 80 new capacitors

- long tendering process
 - ▶ no bidders in first round
 - ▶ technical requirements not met in offers
 - ▶ tender limits lowered in 2026
- ⇒ production process of new capacitors (≈ 80) almost finished (last update: delivery in week 28)

in parallel development and realization of

- new monitoring / diagnostics
- safety measures, PLC, electronics



Thank you for your attention



ELSA Team

Current / Recent Bachelor & Master-Students

Ben, Oliver, Paul, Yannick, Axel, Daniel, Anne, Tim,
Max, Matti, Arthur, Florian, Jerome, Nicholas

PhD & Scientific Staff

- Frank Frommberger
 - ▶ Radiation Safety
 - ▶ Control System
- Michael Switka
 - ▶ Polarized Source
 - ▶ Compton Polarimeter
- Samuel Kronenberg
 - ▶ LINAC2-Beamline
 - ▶ TAPE Hybrid Gun
- Thomas Perlitius
 - ▶ Synchrotron Capacitors
- Leonardo Thome
 - ▶ FLASH@ELSA
 - ▶ Single Turn Extraction
- Tobias Schiffer
 - ▶ Compton Polarimeter

Technical Staff:

Andreas Merzbach, Andreas Offermann, Aytekin Yildiz, Christian Pötzsch, Dennis Dick,
Gerd Engelmann, Jörg Schelske, Martin Holzhäuser, Michael Brock, Michael Humpert,
Norbert Rick, Philipp Hänisch, Thomas Becker