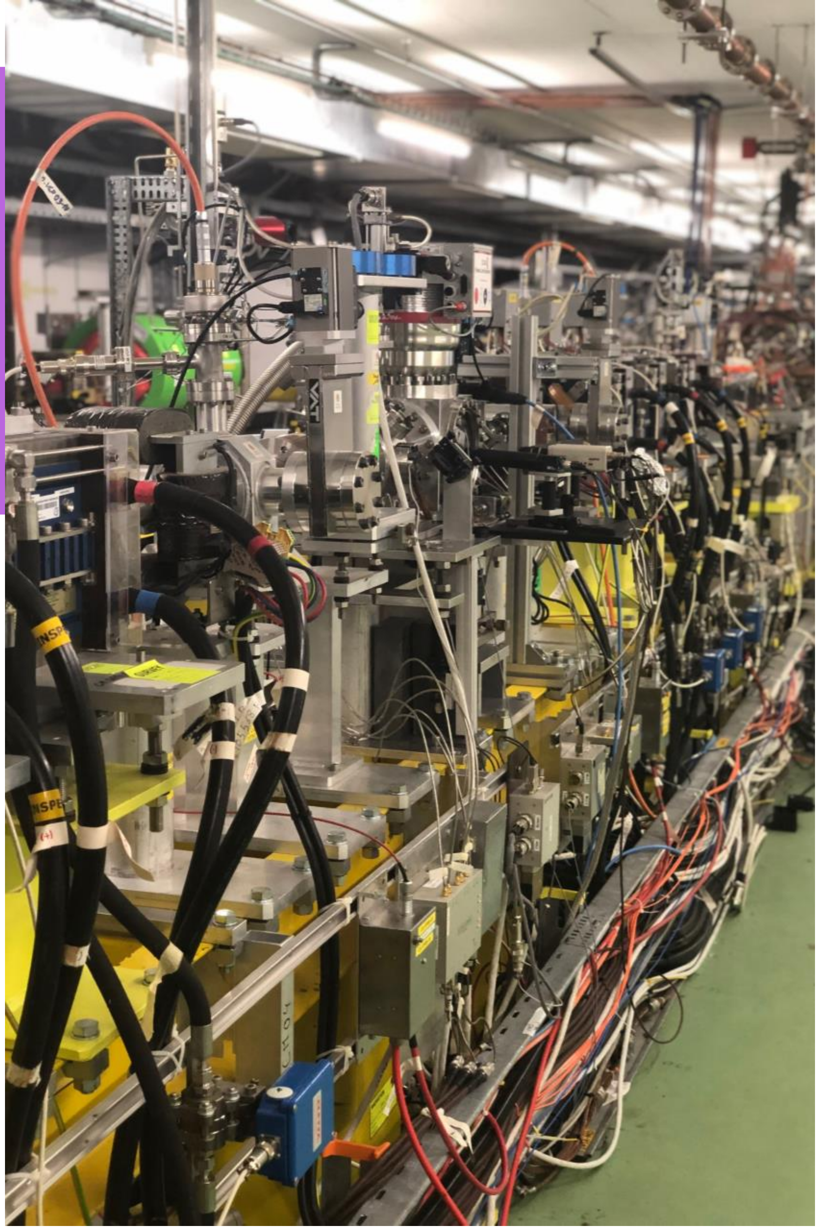
Status and Overview of the CLEAR Facility at CERN

33rd Linear Accelerator Conference (LINAC 2026)

Antonio Gilardi

21/08/2026



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Everything I am reporting here is the result of a tremendous team effort.
None of this would have been possible without the hard work, dedication, and collaboration of our team.

Facility Introduction

FLEXIBLE

WHAT

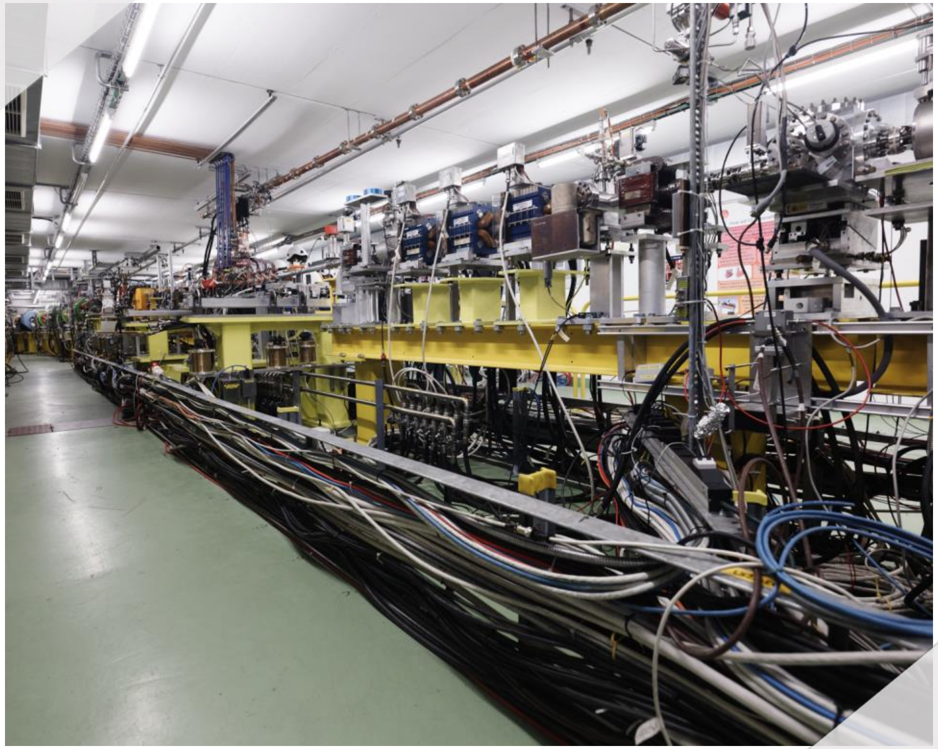
- CLEAR operates as an independent accelerator, which allows it to run even when the broader CERN accelerator complex is shut down (e.g., LS3) .
- Each year, CLEAR typically operates for about **30–40 weeks**, usually from **March through December**.
- The operation is generally structured in **two shifts during daytime**, running **five days per week**, with **no night or weekend shifts** (apart from occasional exceptions).
- In some cases, **remote supervision has been used for overnight or weekend operation**, mainly for **low-charge studies**.

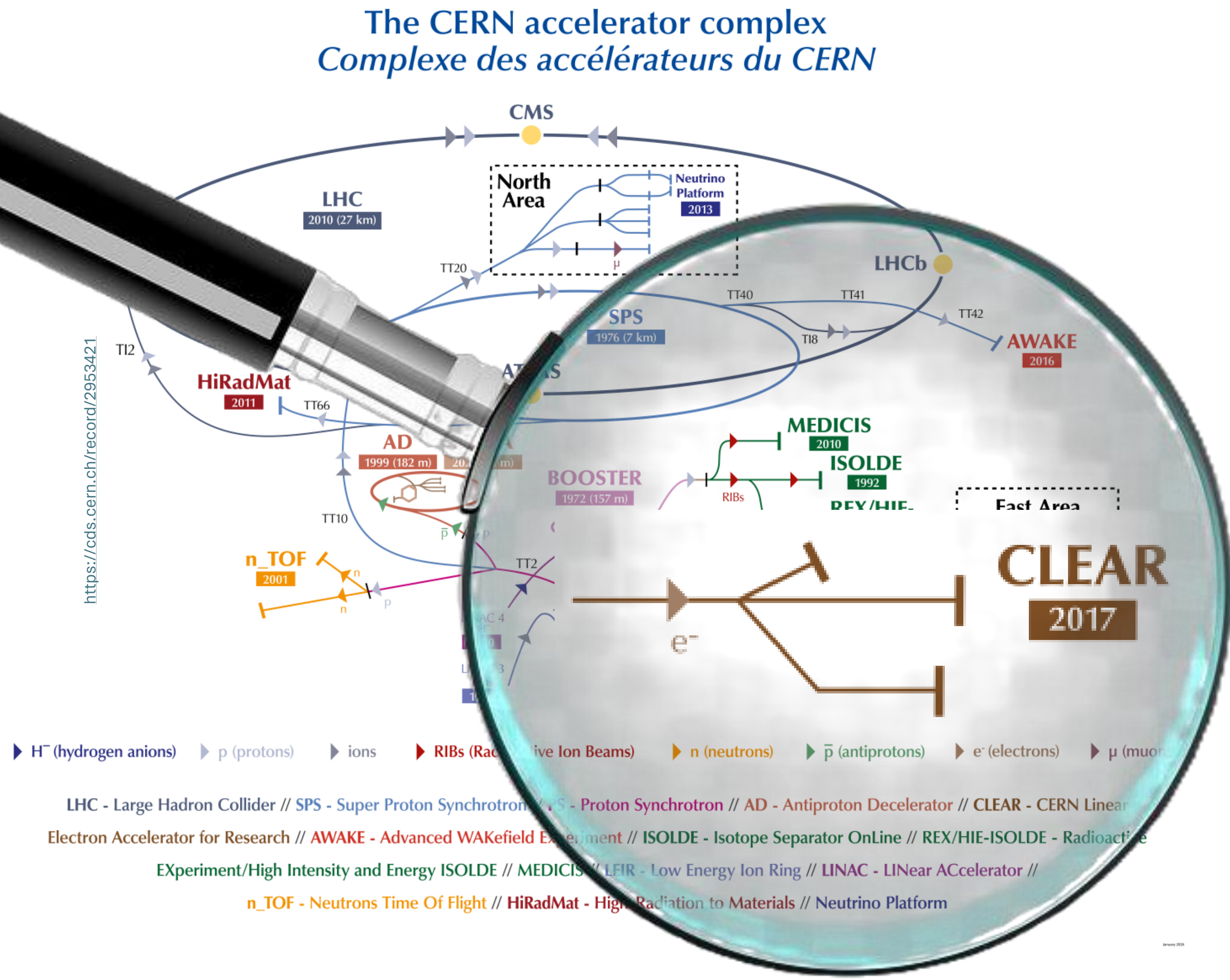
CLEAR operates as a user facility, but in most cases it goes beyond simply delivering a beam according to user specifications.
When needed (often), we actively support users in refining their experimental setup, optimizing methodologies, adapting measurement strategies, and analyzing and interpreting the results.

As a result, many CLEAR experiments develop into fully collaborative efforts

Facility Introduction

WHERE





Facility Introduction

WHEN

2017-2030

Start with beam August 2017

- 19 weeks of operation in 2017
- 36 weeks in 2018
- 38 weeks in 2019
- 34 weeks in 2020
- 35 weeks in 2021
- 37 weeks in 2022
- 38 weeks in 2023
- 39 weeks in 2024
- 32 weeks in 2025
- ...

WHO

Roberto


Wilfrid


Davide



Antonio


Camilla


Alex


Giacomo


Sabrina


Johan

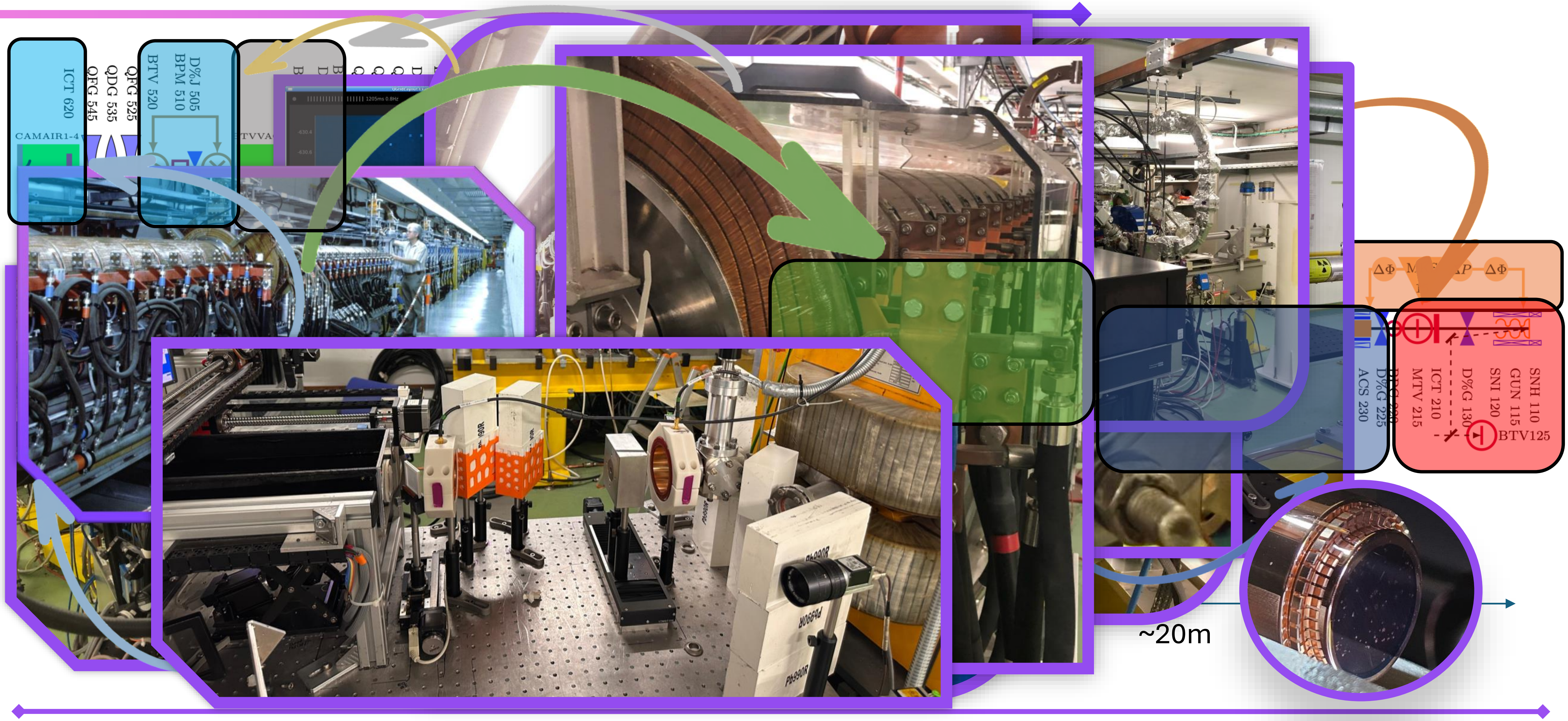

Francisco


Sara


Ciara

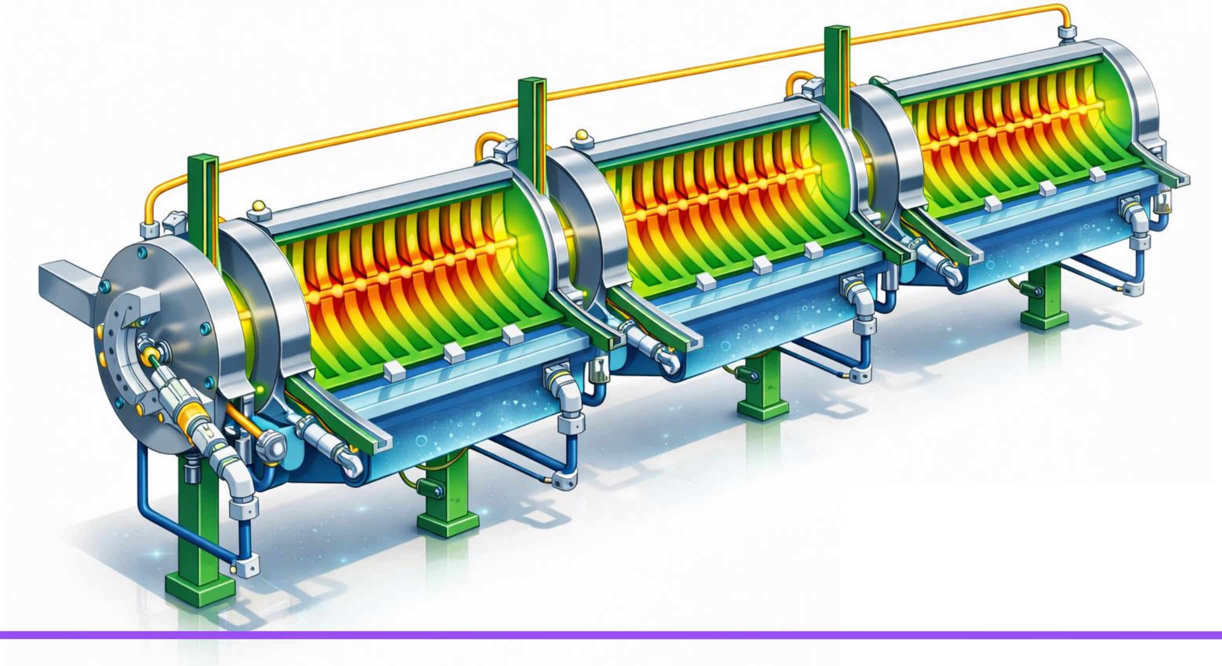
2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | ...

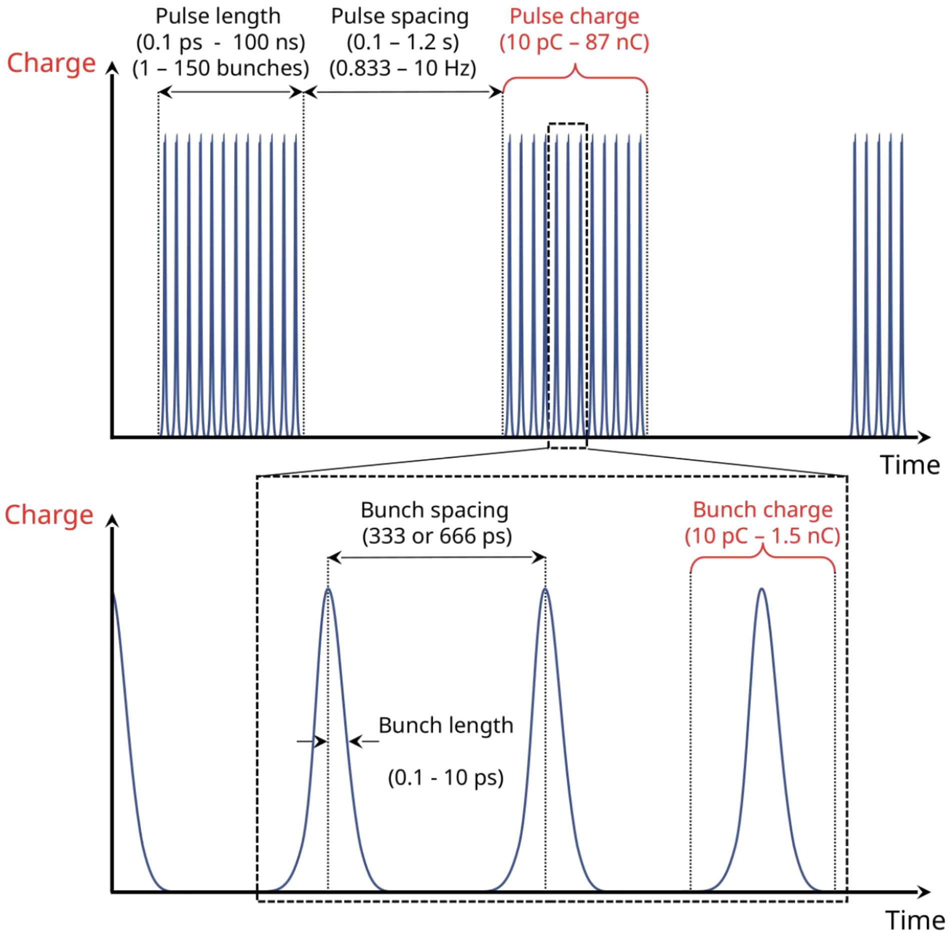
Main Features & Parameters



Main Features & Parameters

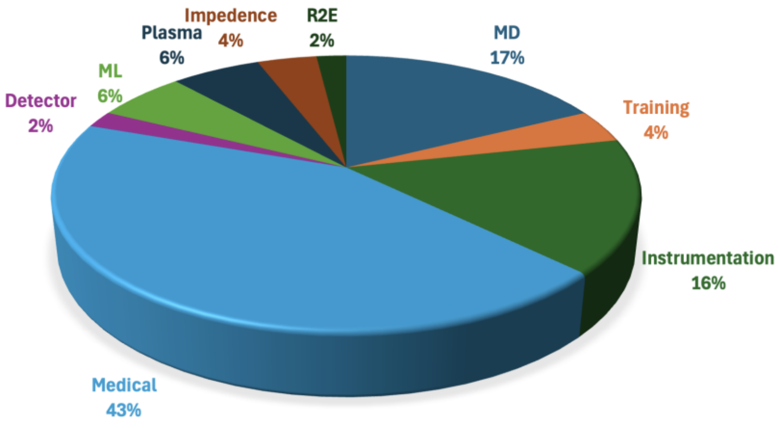
Beam parameter	Value range
Energy	20 MeV to 220 MeV
Bunch charge	0.01 nC to 1.5 nC
Normalised emittances	3 µm for 0.05 nC per bunch; 20 µm for 0.4 nC per bunch (both planes)
Bunch length	~100 µm to 1200 µm
Relative energy spread	< 0.2 % rms (< 1 MeV FWHM)
Repetition rate	0.833 Hz to 10 Hz
Number of micro-bunches in train	1–150
Micro-bunch spacing	1.5 GHz or 3.0 GHz



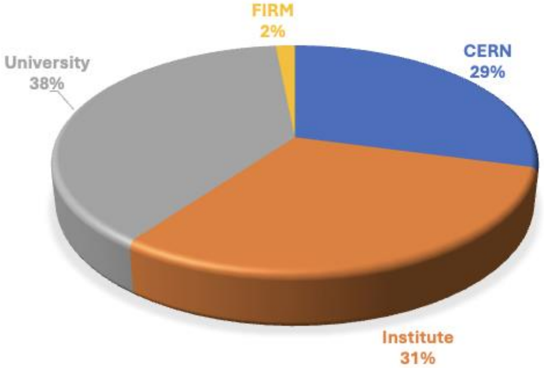


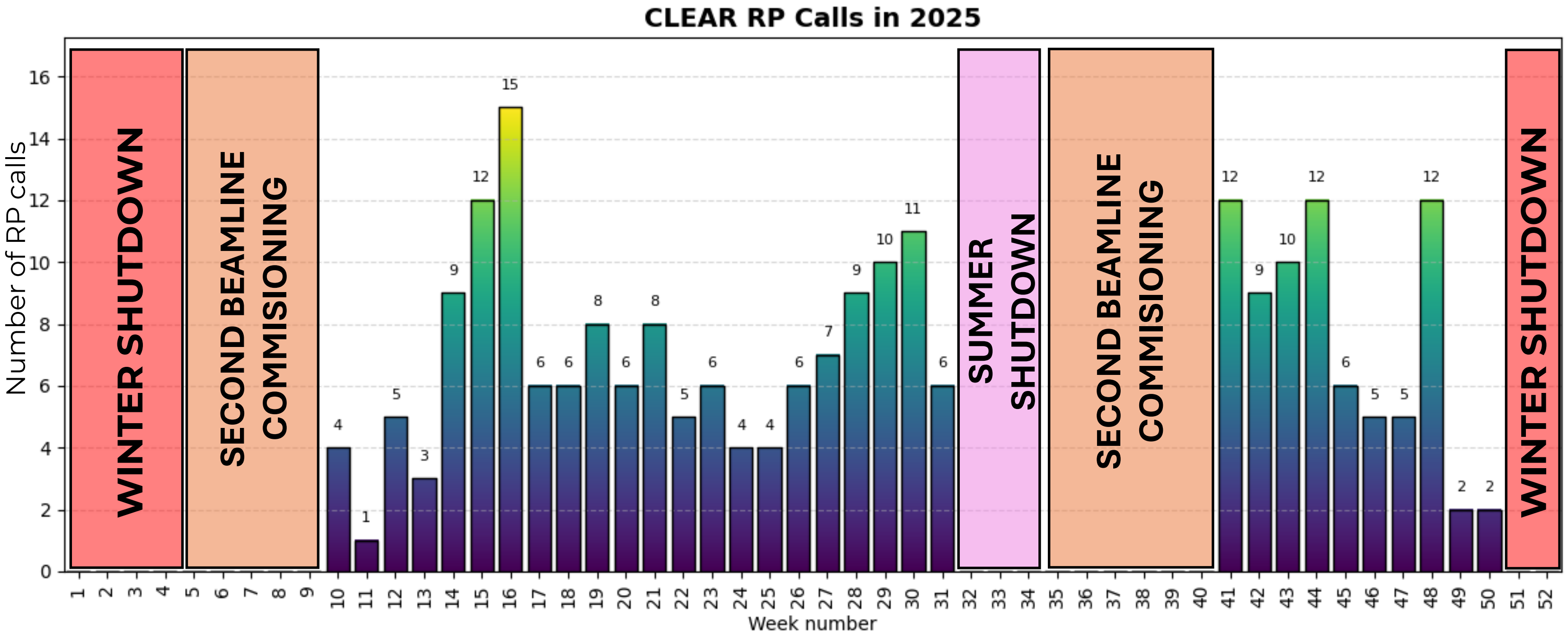
Experimental Program

EXPERIMENT TYPE DISTRIBUTION



EXPERIMENT ORIGIN DISTRIBUTION





Selected Results

THz GENERATION

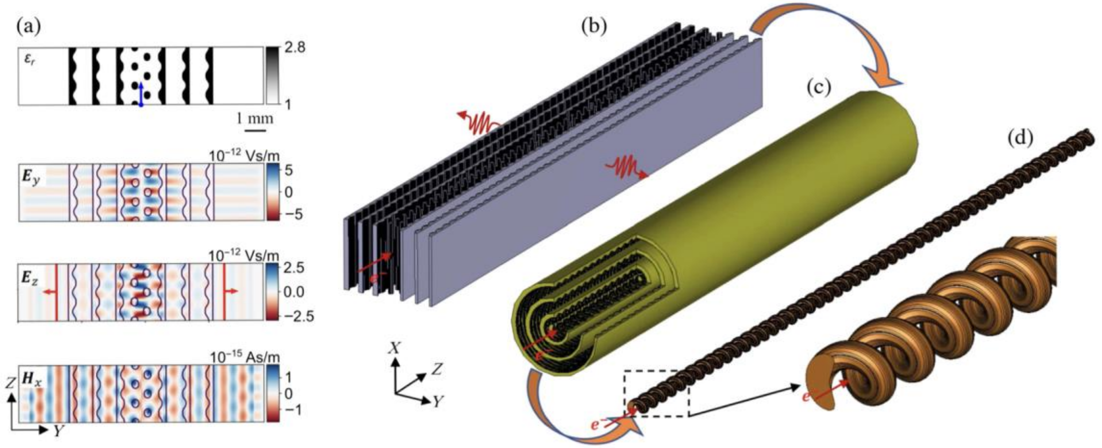


FIG. 1. Evolution of the THz radiator design. (a) 2D optimized structural morphology developed through inverse design. (b) Extruded structure. (c) Multilayer helically rotated structure. (d) Single-layer helically rotated structure.

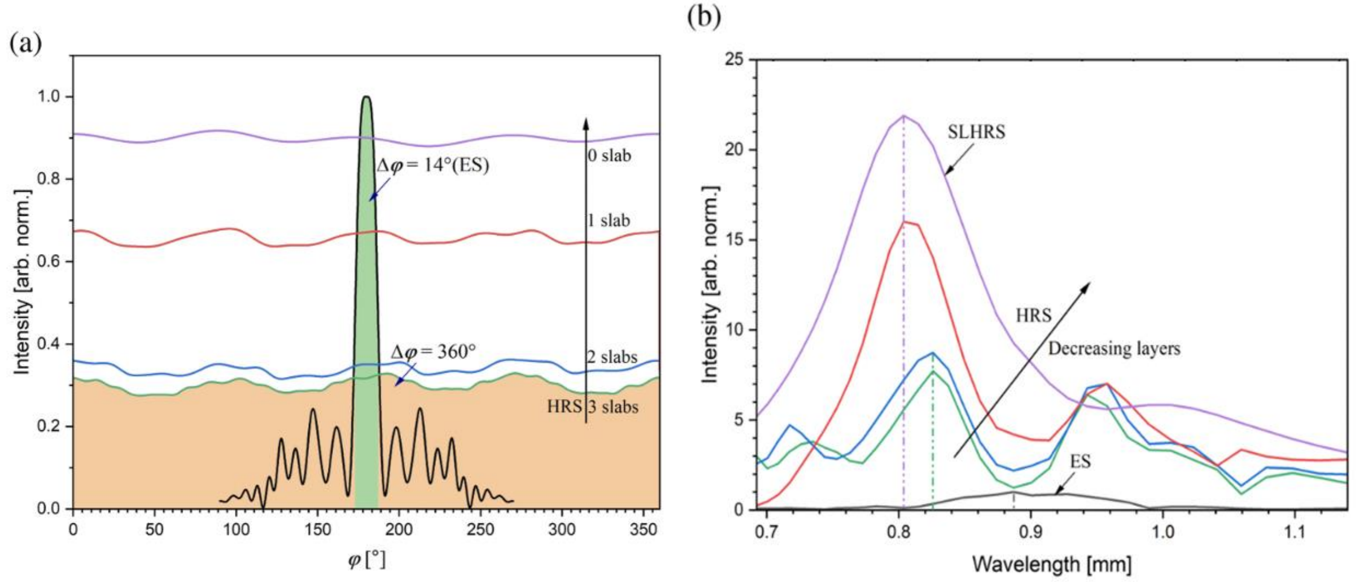
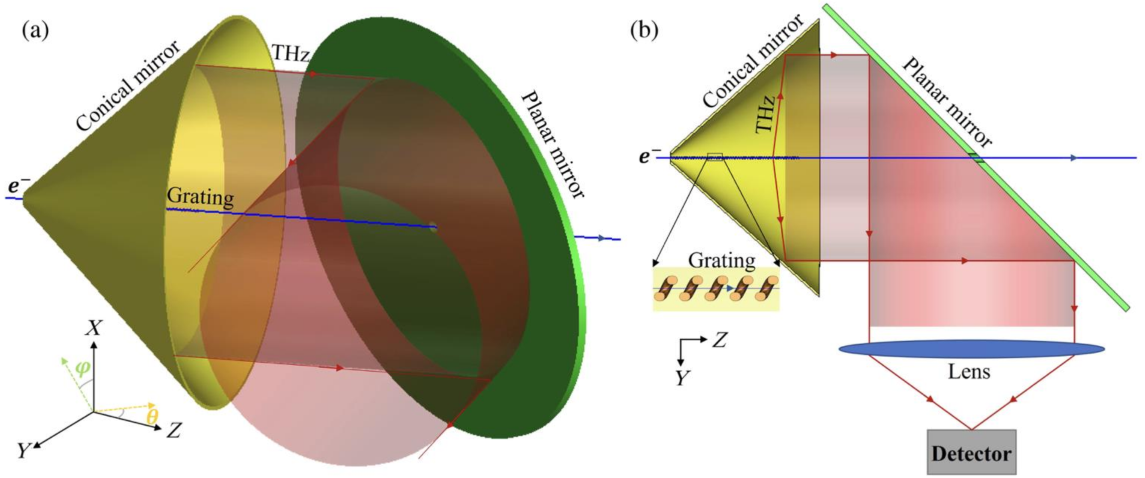


FIG. 4. Comparisons of SPR between the extruded and helically rotated structures. (a) Distributions of peak emission intensity along the azimuthal direction. (b) Emission spectrum.

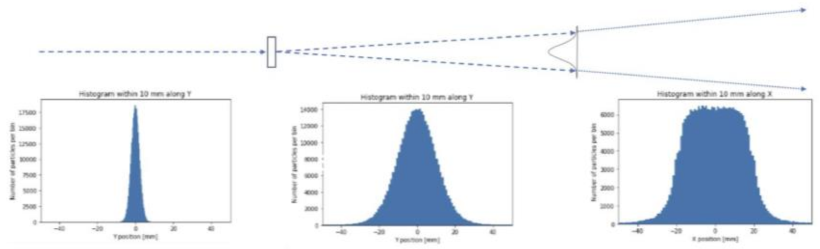


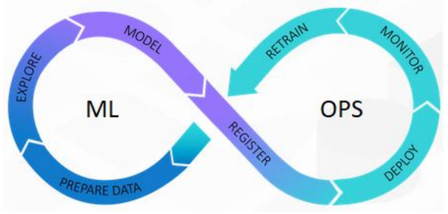
doi:10.1103/PhysRevAccelBeams.28.054501

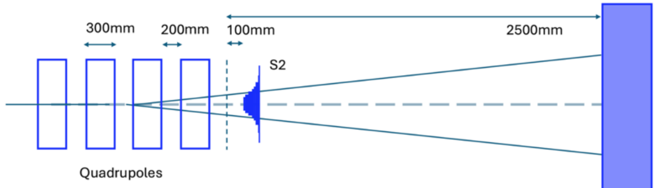
Selected Results

MEDICAL APPLICATION

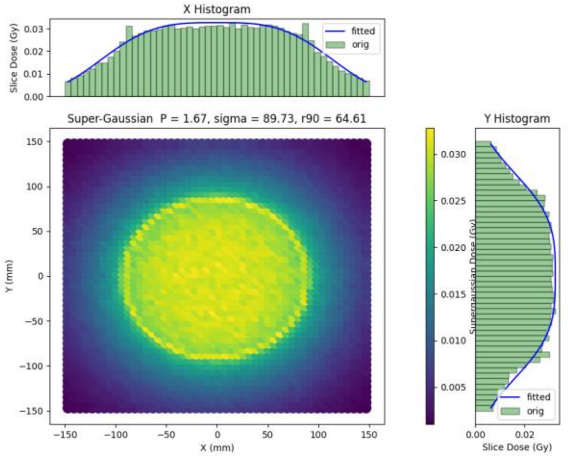
BEAM MANIPULATION



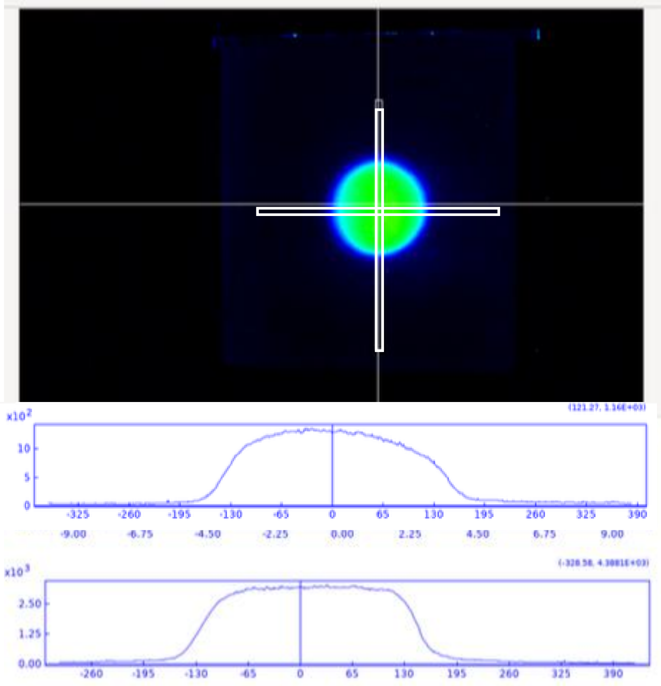


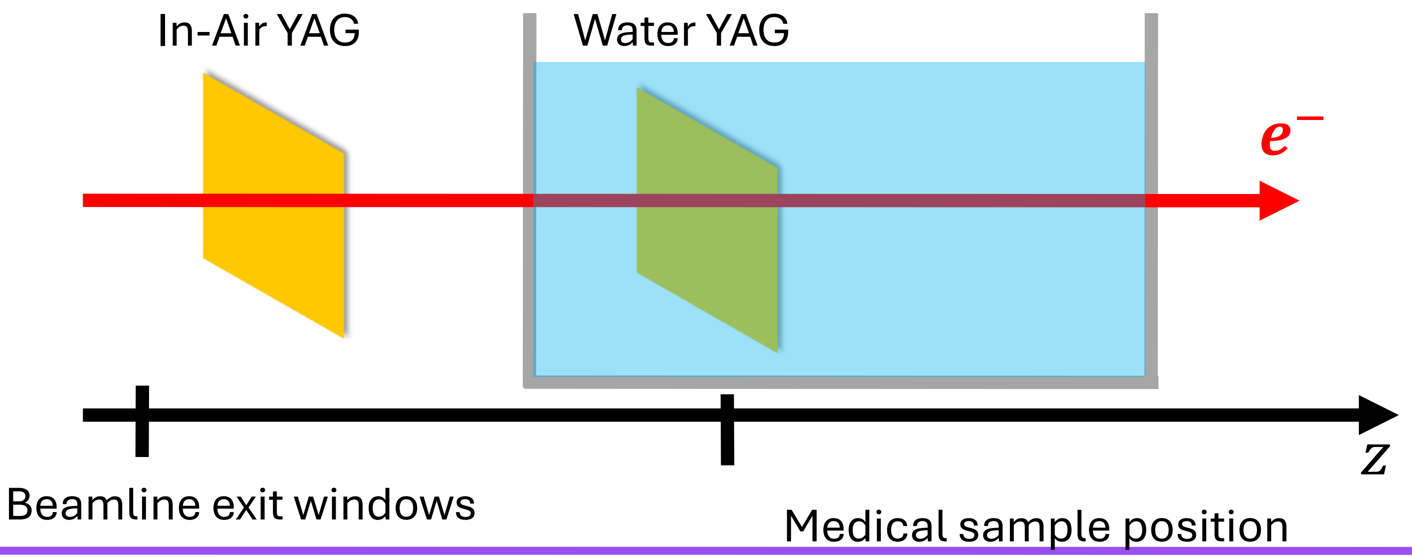


Quadrupole-scatterer System



UNIFORM



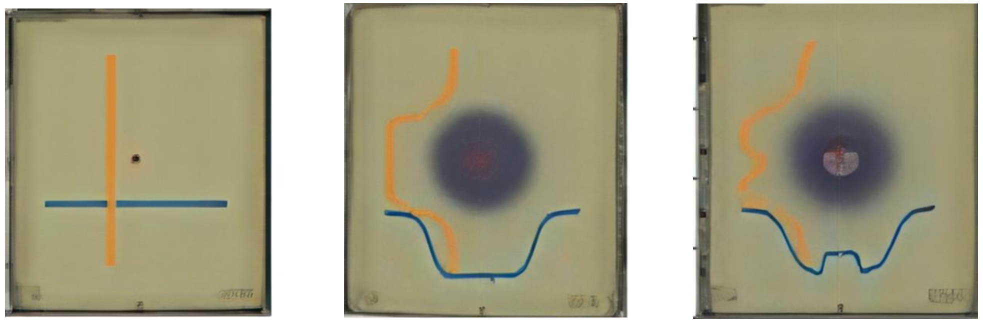


Selected Results

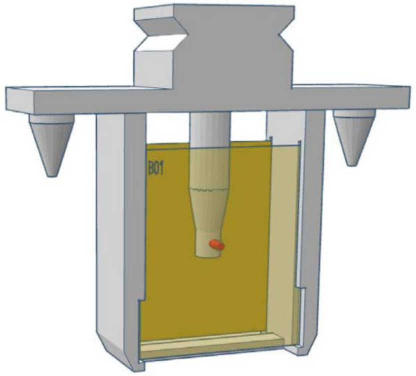
MEDICAL APPLICATION

DOSIMETRY

RADIO-CHROMIC FILMS

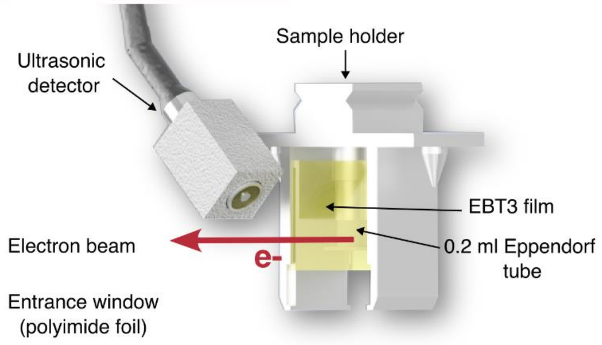


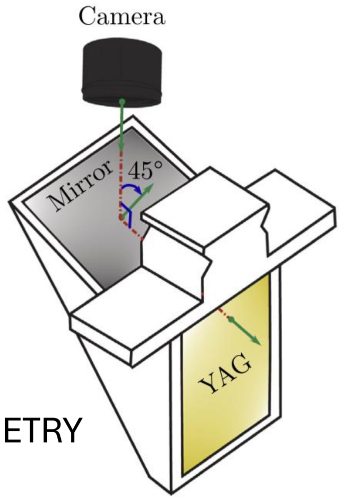
MICRO DIAMOND



RADIO-PHOTO-LUMINESCENCE
(silver-doped phosphate glass)

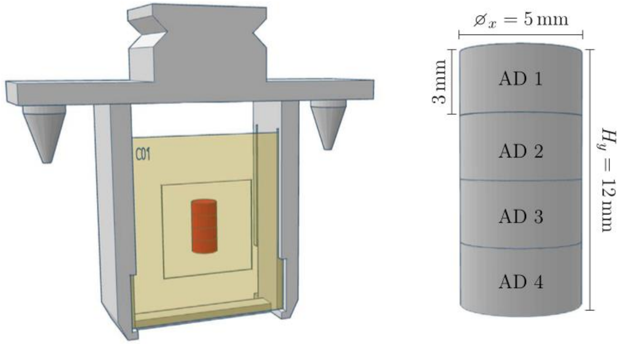
THERMO ACUSTIC





OPTICAL DENSITY DOSIMETRY

ALANINE



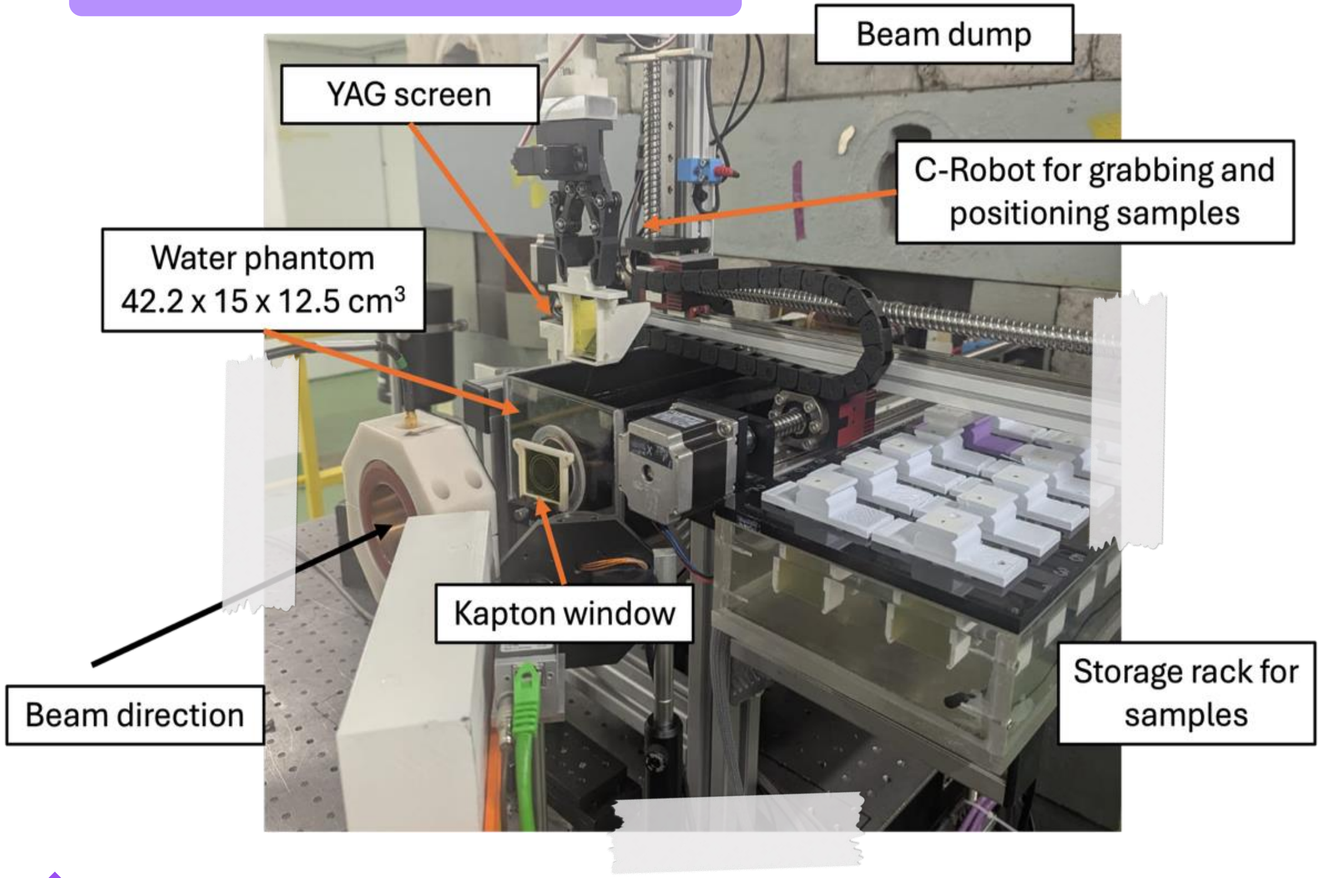
doi: 10.1016/j.nima.2024.169845
doi: 10.3389/fphy.2025.1597079

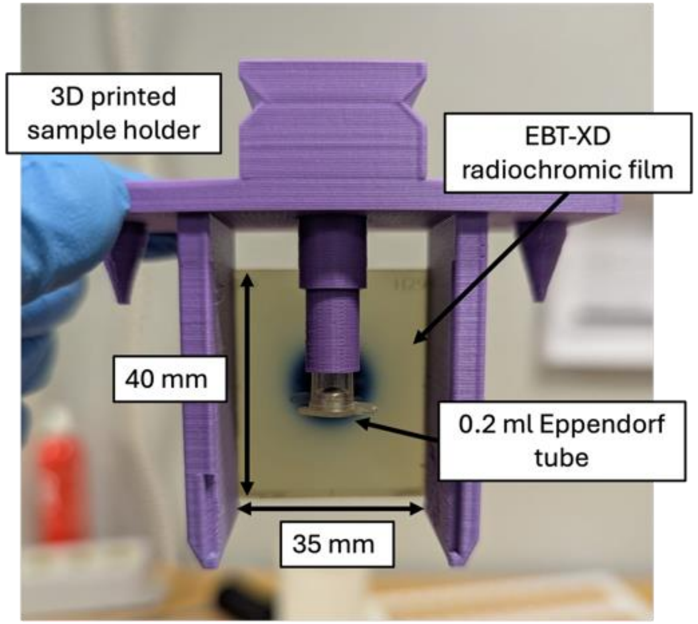
Selected Results

MEDICAL APPLICATION

DOSIMETRY

All the medical experiment have used the CLEAR Robot to perform their irradiation.

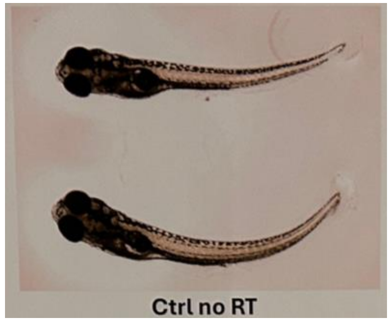


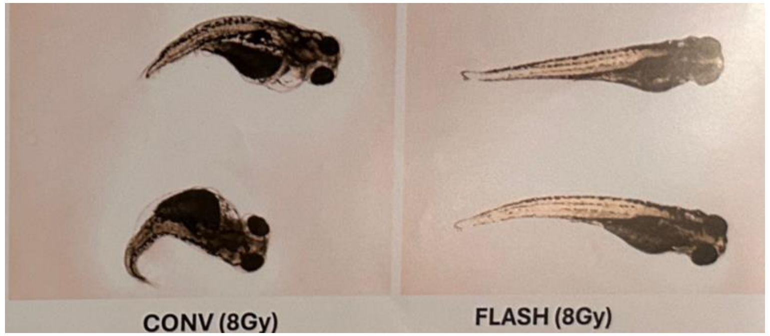


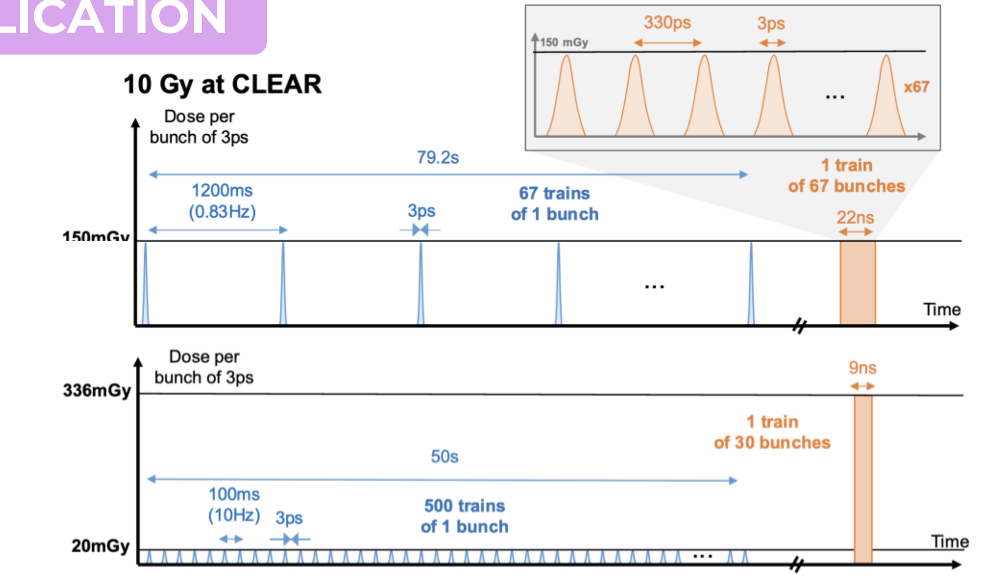
Selected Results

MEDICAL APPLICATION

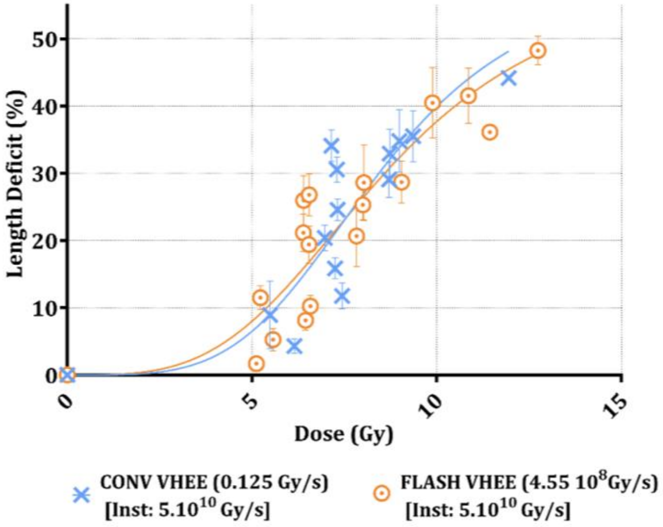
EXAMPLE #1



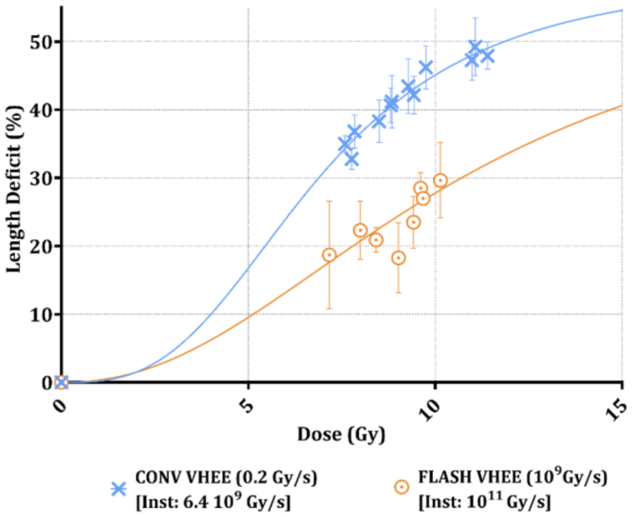




Same "instantaneous" dose rate



Factor ~ 15 in "instantaneous" dose rate



doi.org/10.1016/j.radonc.2025.110942

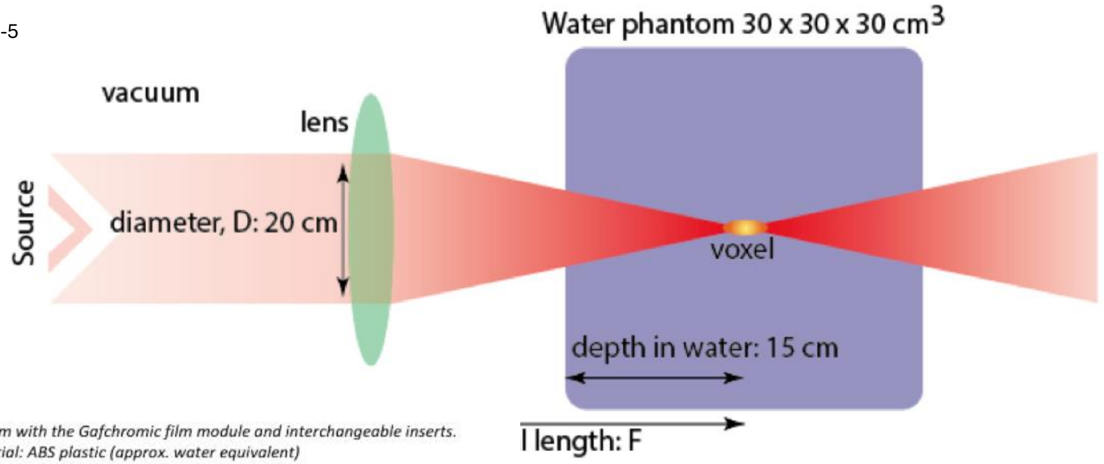
Forst observation of FLASH sparing effect with a VHEE beam!

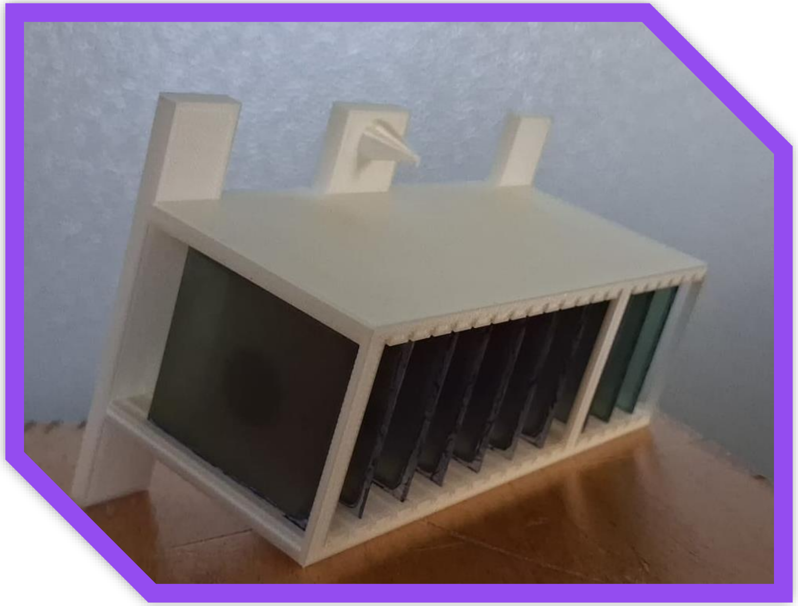
Selected Results

MEDICAL APPLICATION

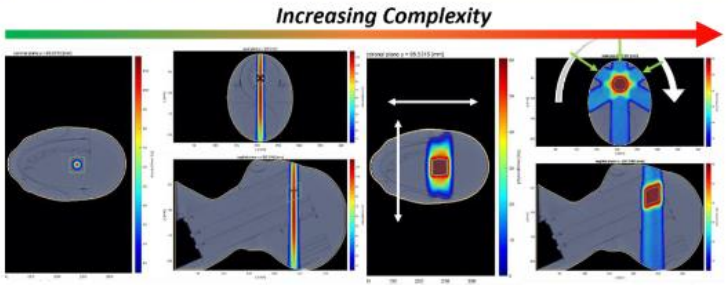
EXAMPLE #2

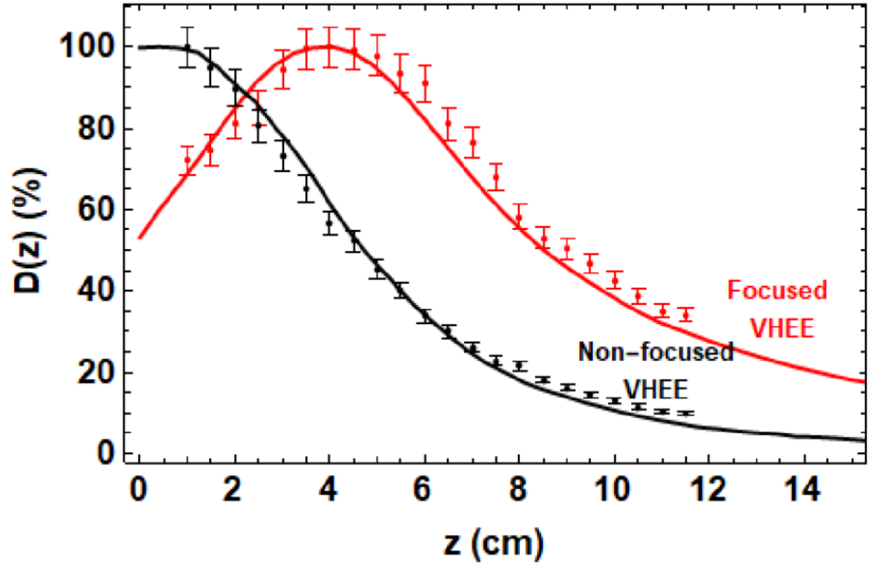
doi: 10.1038/s41598-024-60997-5





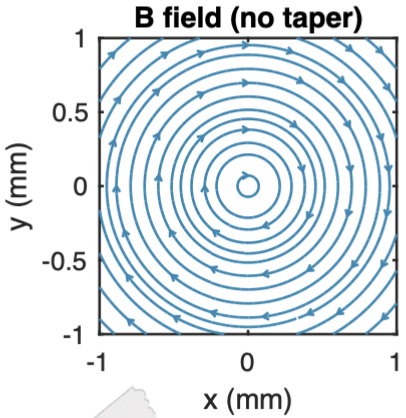
Marvin (head and neck) phantom with the Gafchromic film module and interchangeable inserts.
- *Material: ABS plastic (approx. water equivalent)*
- *Dimensions: 41 × 21 × 33 cm³ - Weight: 9 kg.*

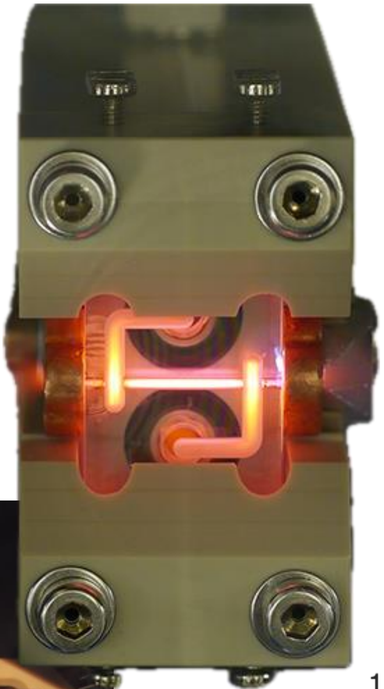


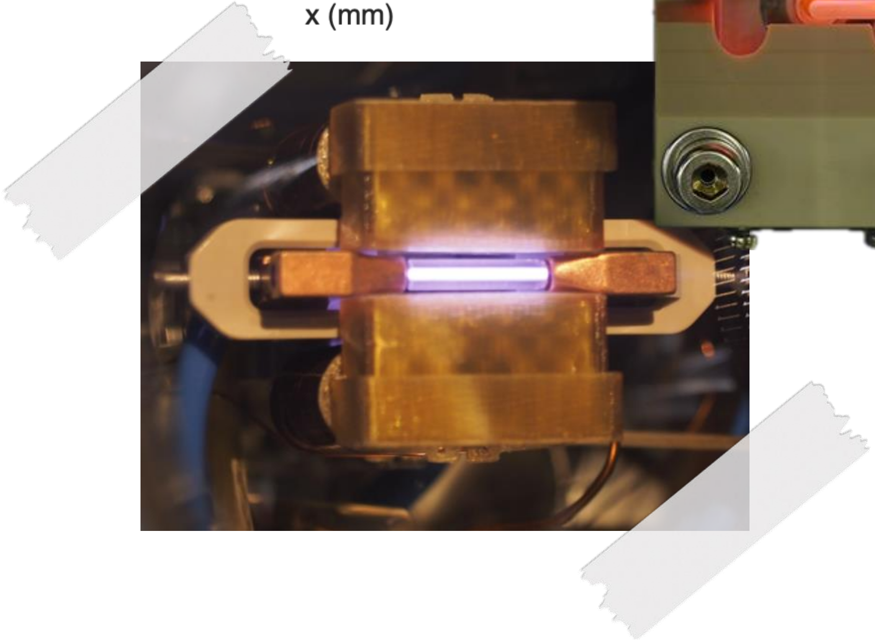


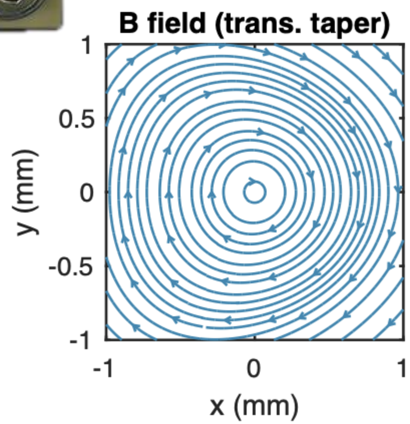
Selected Results

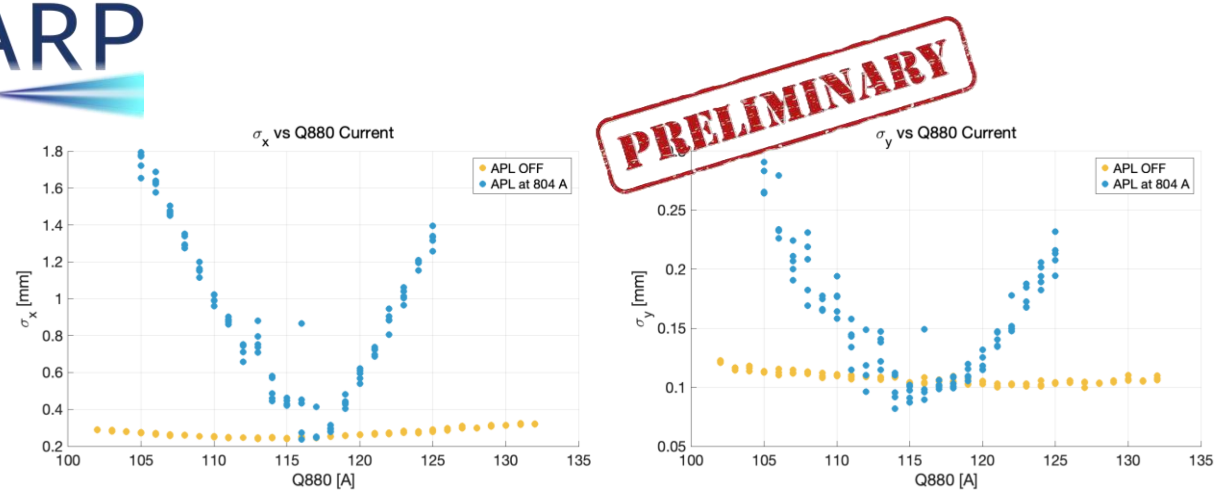
SHARP









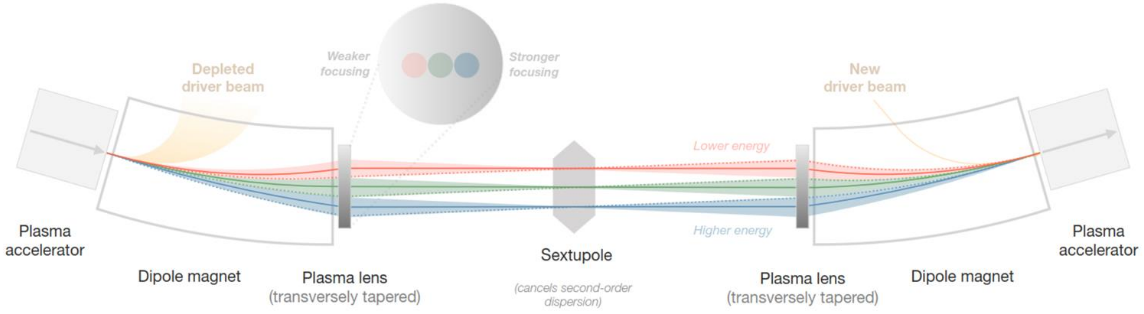


Quadrupole scans with & without APL

doi: 10.1088/1742-6596/3266/1/012014

SPARTA

doi:10.1016/j.nima.2025.170223



Conclusion & Outlook

- ❑ CLEAR provides a unique and highly flexible testbed for a wide range of accelerator studies. Furthermore, the team and the facility enable rapid iteration from idea to beam test.

- ❑ CLEAR will operate at least through 2030 (with no long shutdown currently foreseen), providing a stable platform for future studies. The facility welcomes new experimental proposals from anyone with a strong idea to test.

- ❑ Last year was an outstanding year — by far the most impactful for our infrastructure.

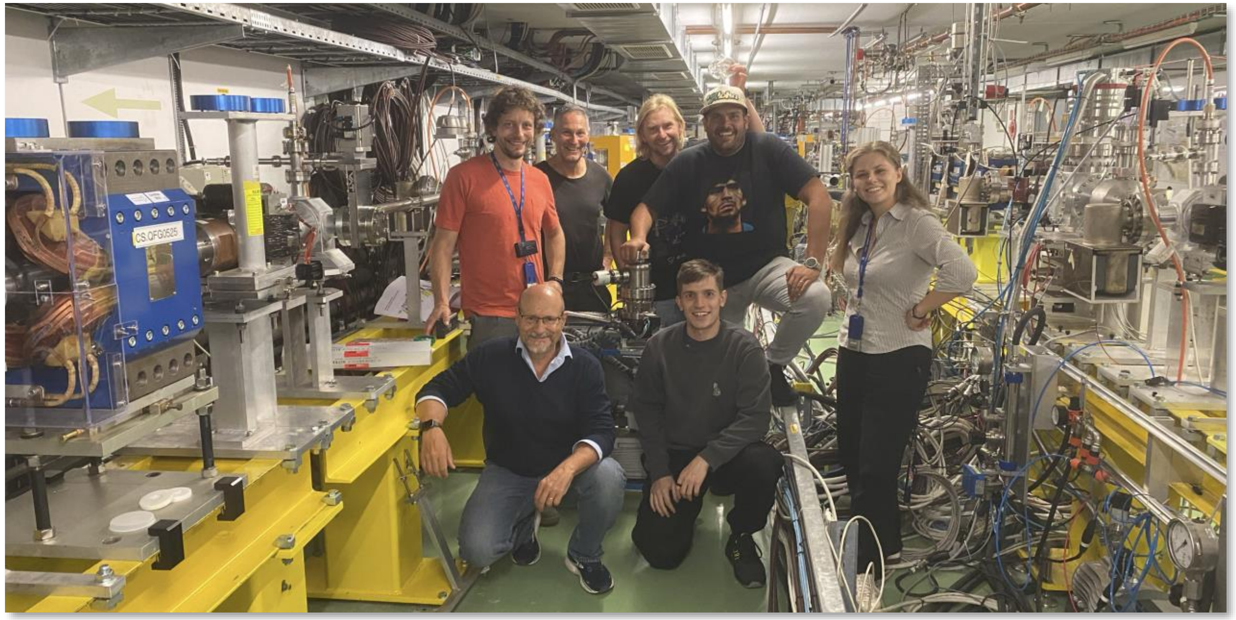
- ❑ Expect a general growth of user/request driven by facility schedule over the next year

- ❑ The scientific portfolio is broad, and all the results are impressive, each having a significant impact in its respective field. Let's keep the gradient.

Thanks for the attention!

ADDITIONAL SLIDES

TEAM



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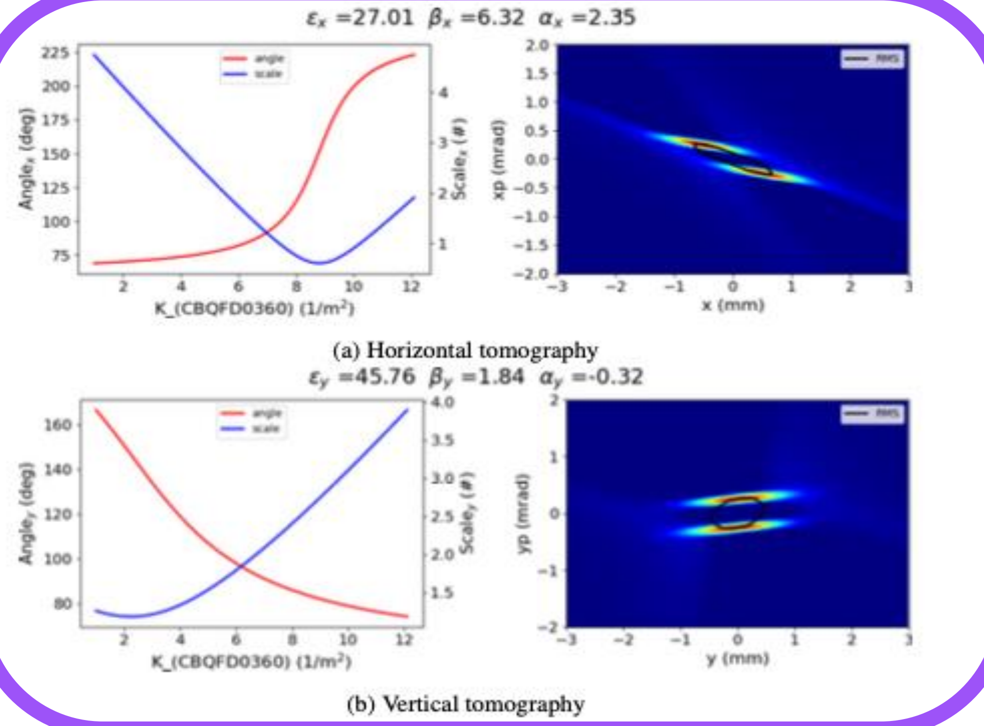
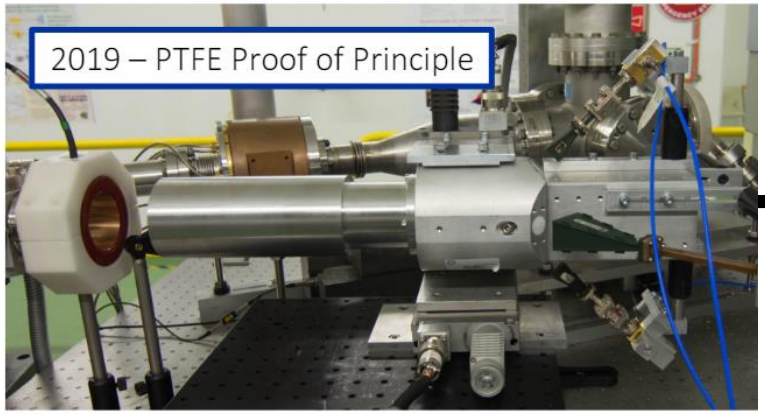
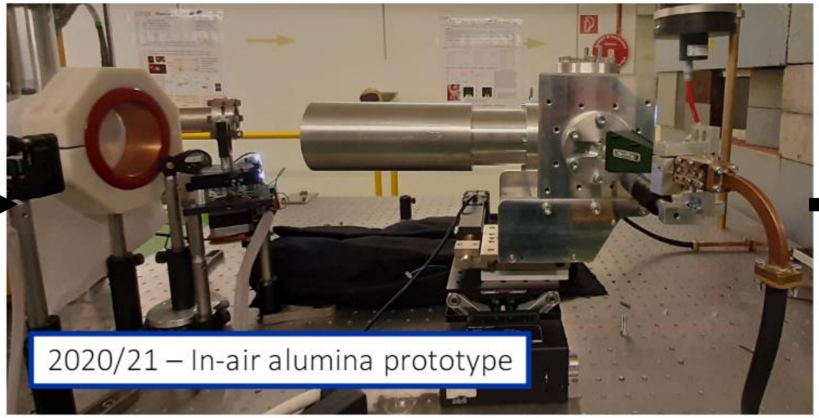
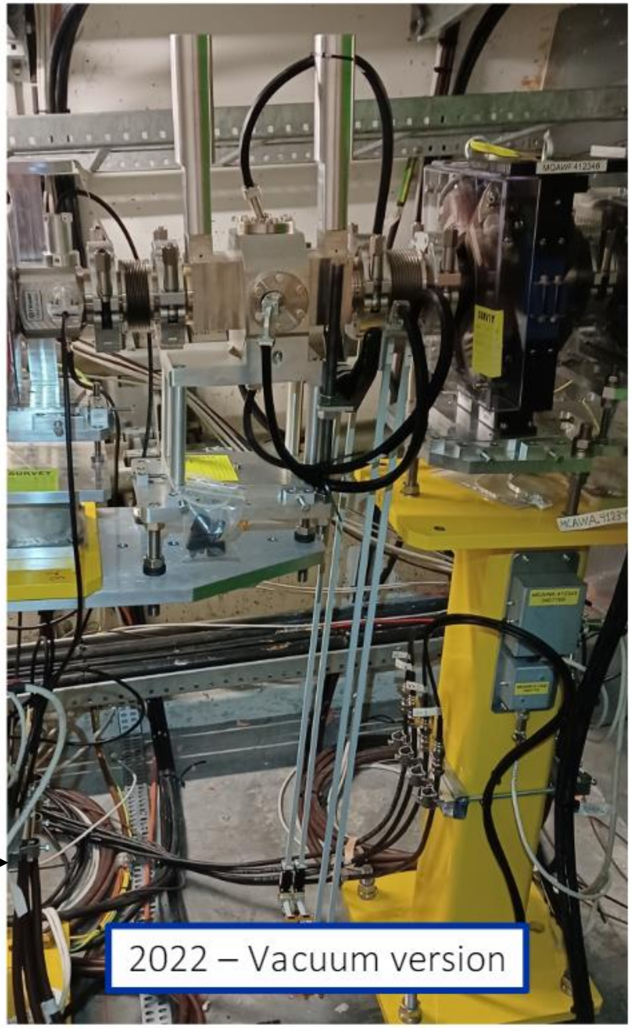


(a) Horizontal tomography

(b) Vertical tomography







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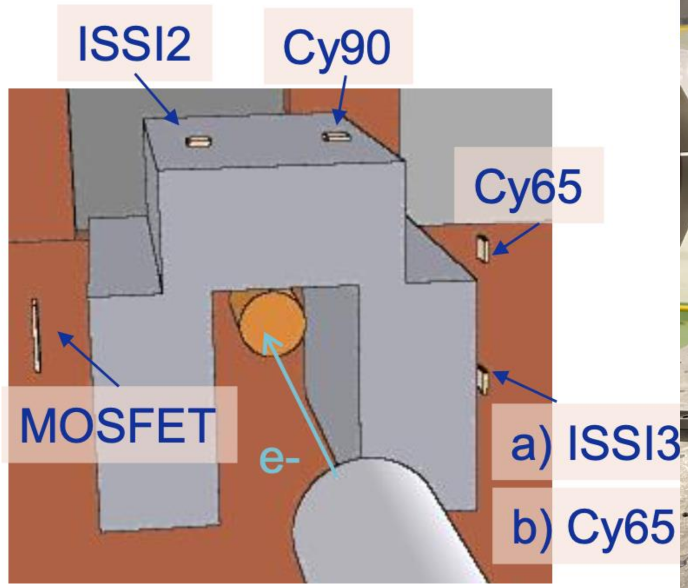
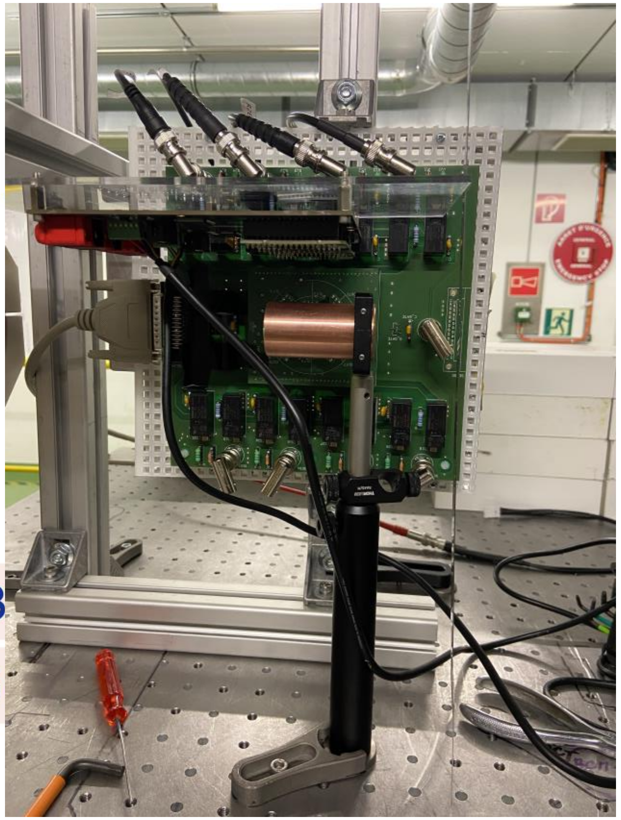
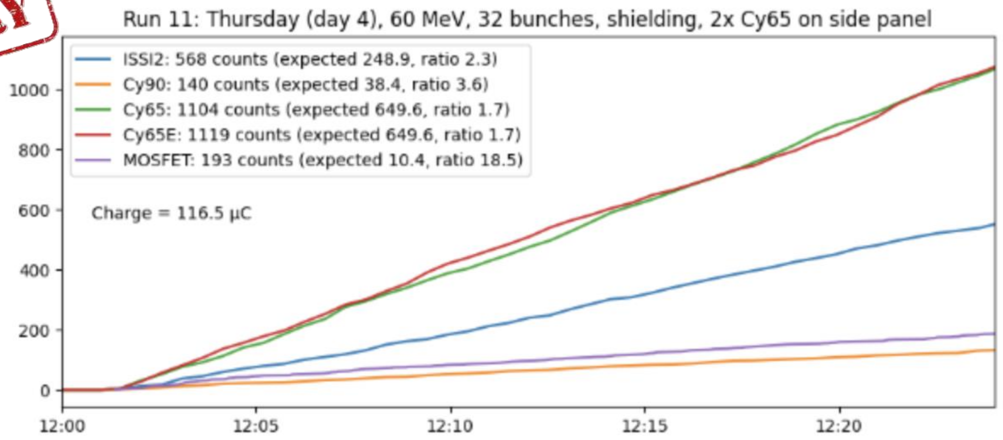


Curtesy G. Lerner & M. Cecchetto

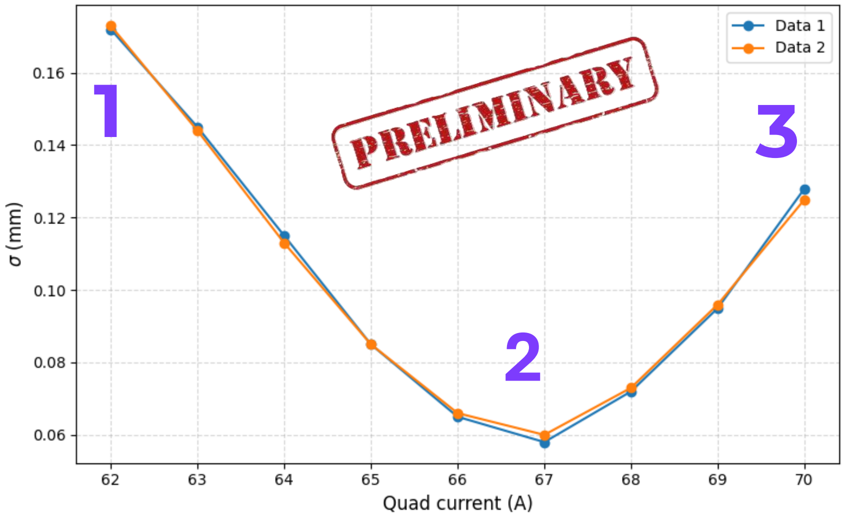


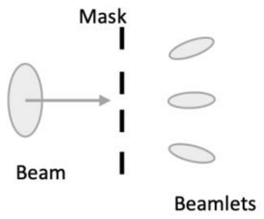
PRELIMINARY

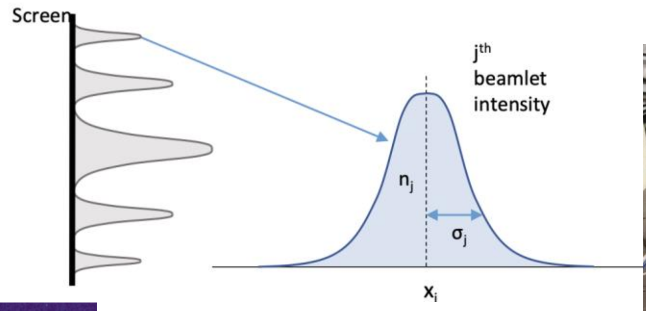


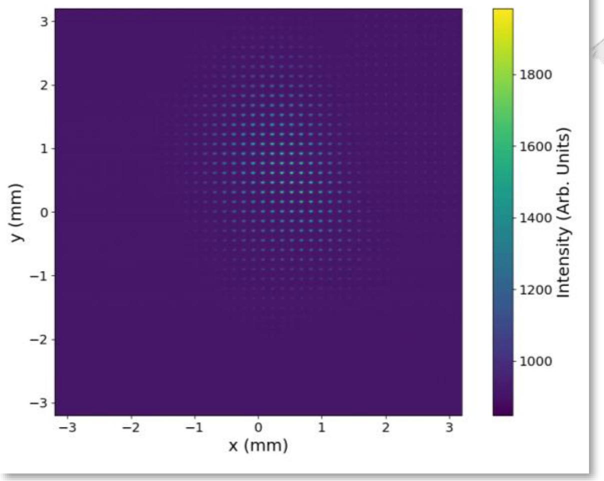
- 3 different setups
- 5 different energies (28MeV, 32MeV, 40MeV, 60MeV, 80MeV)

ADDITIONAL SLIDES

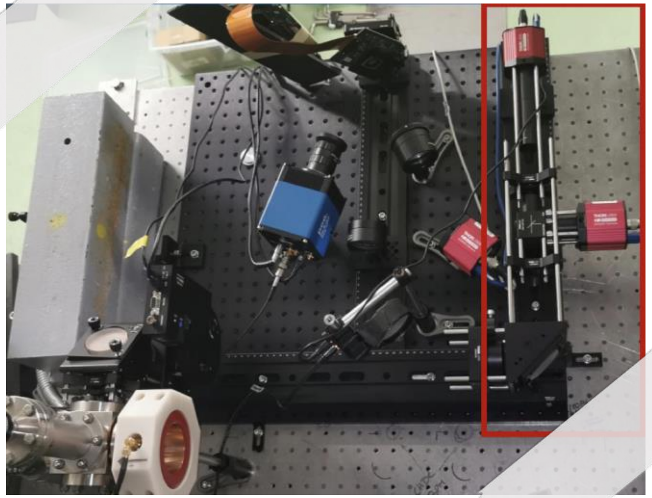


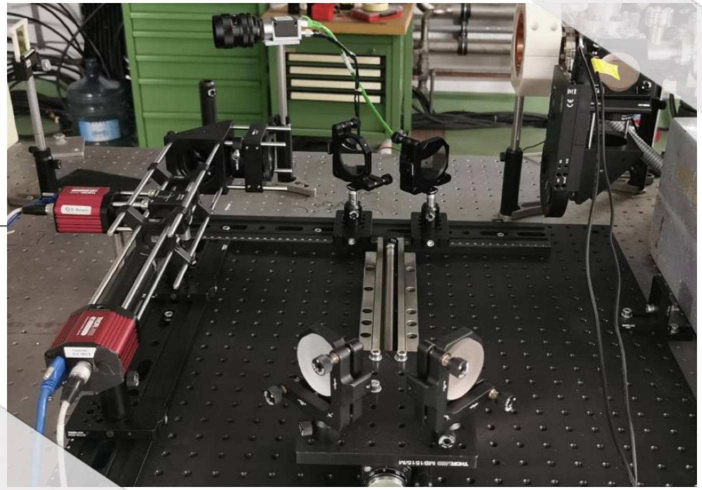




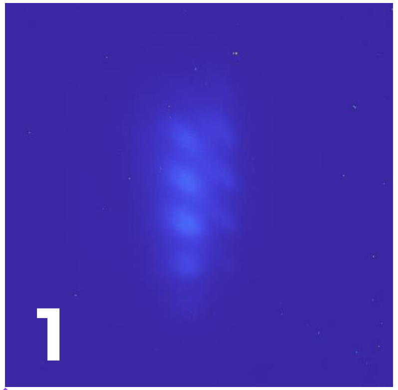


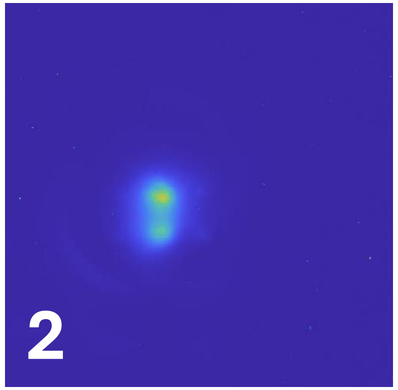
OTR

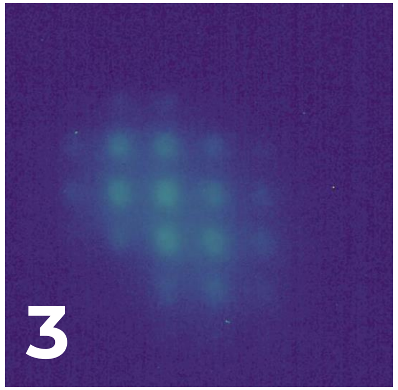




OSR

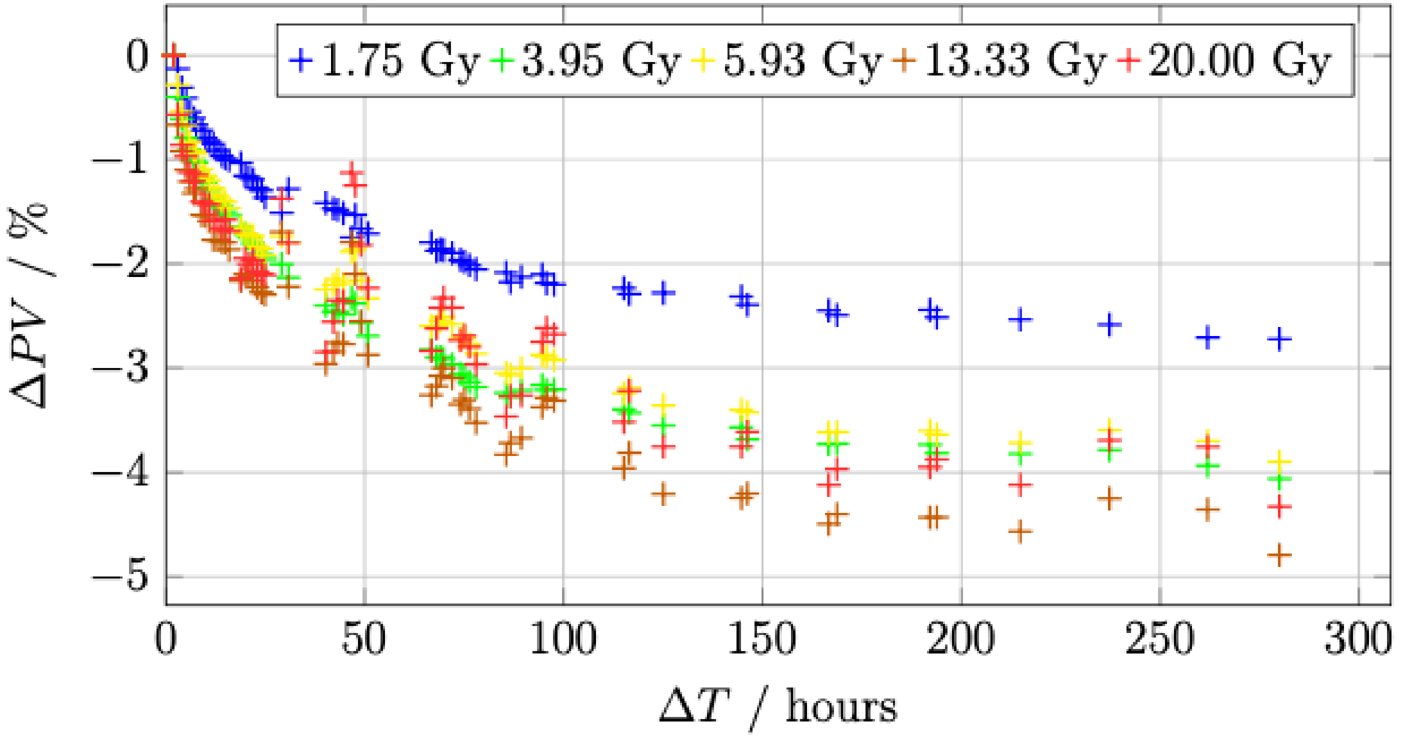


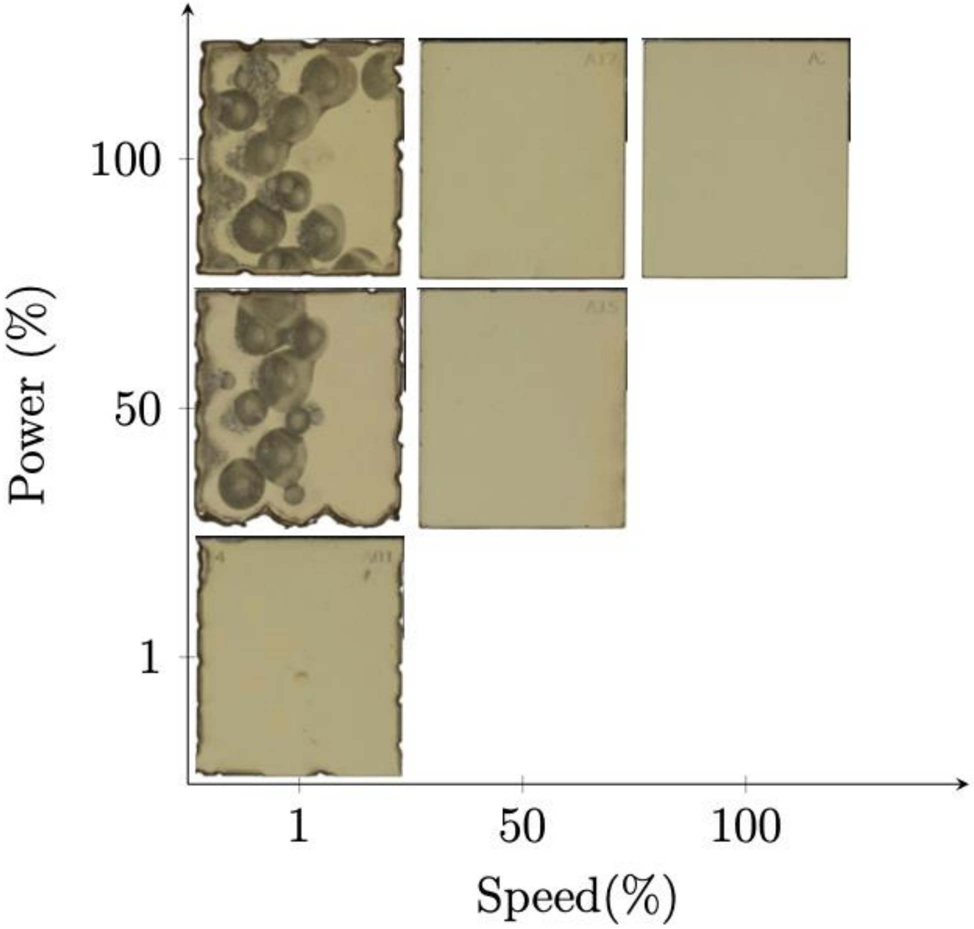




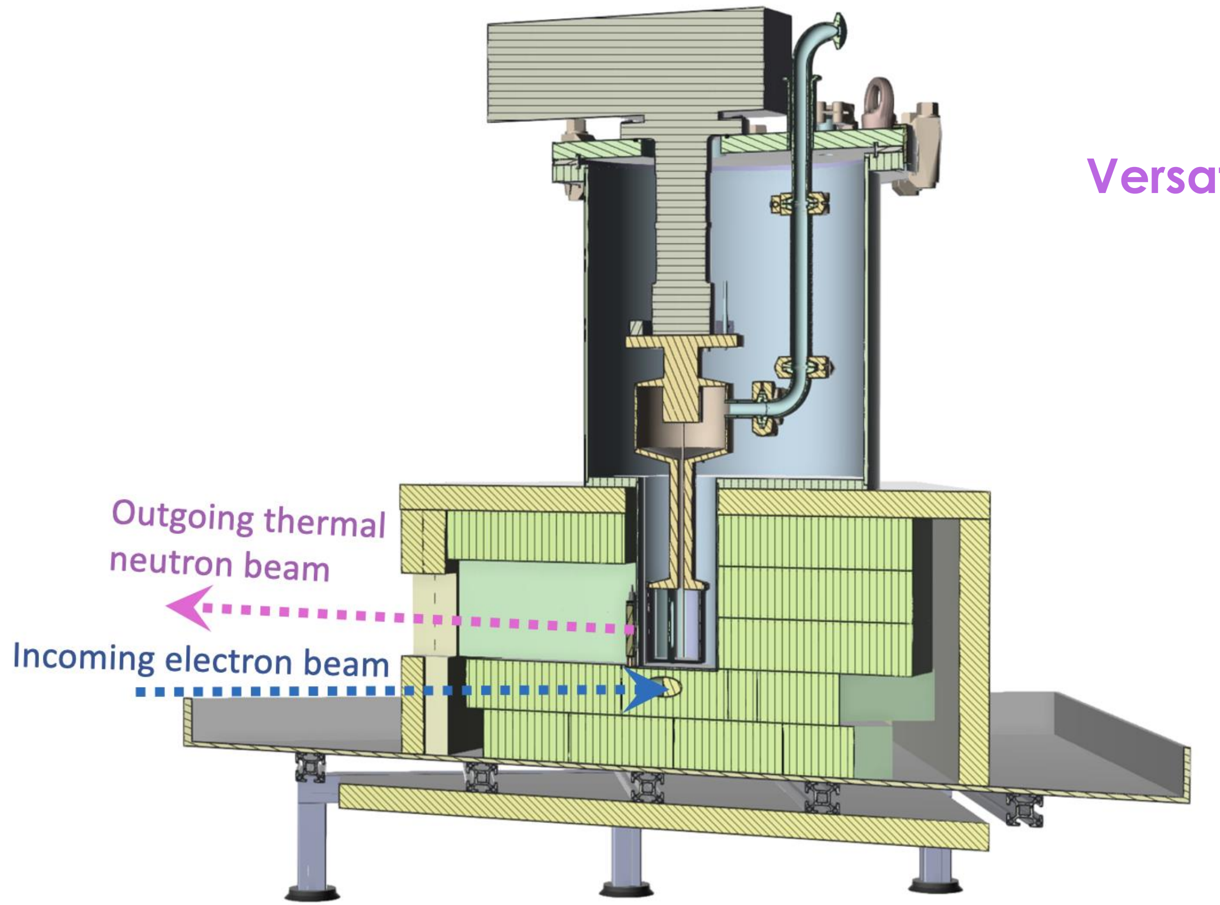
Curtesy of J. Wolfenden

ADDITIONAL SLIDES

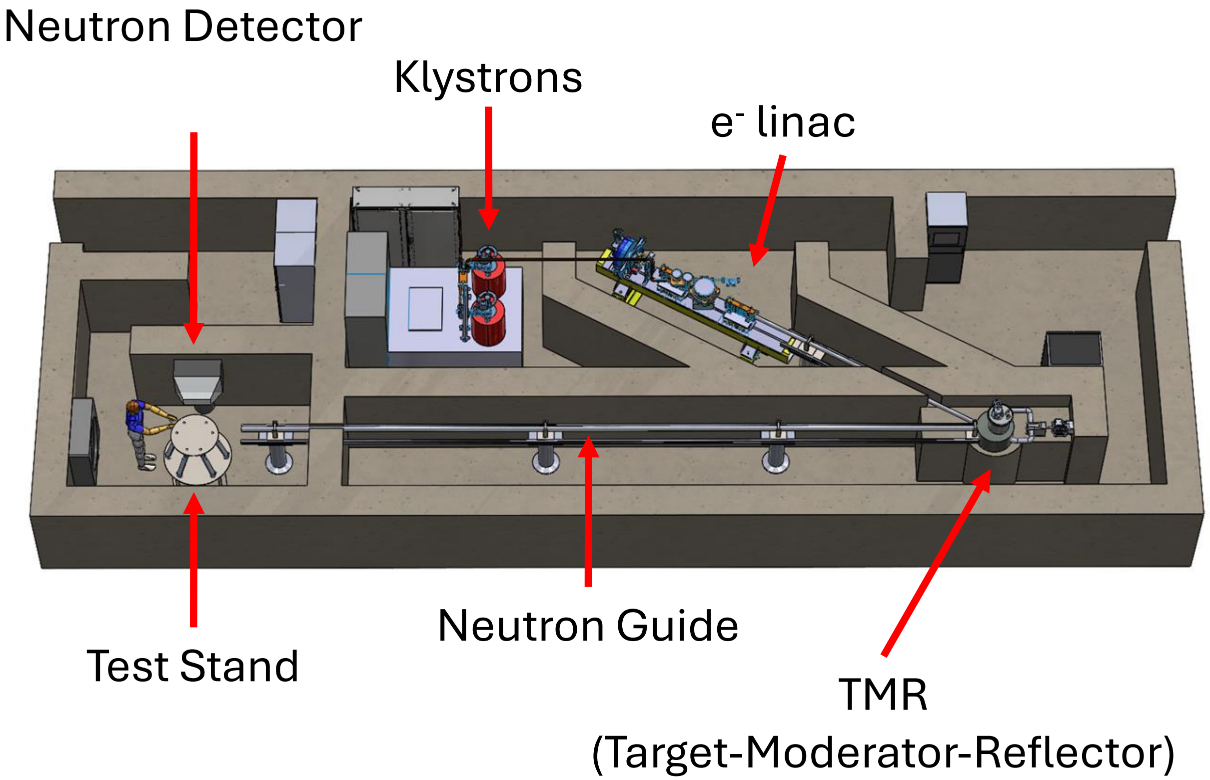




doi: 10.3389/fphy.2025.1597079



Versatile Ultra-Compact Advanced Neutron generator



ADDITIONAL SLIDES

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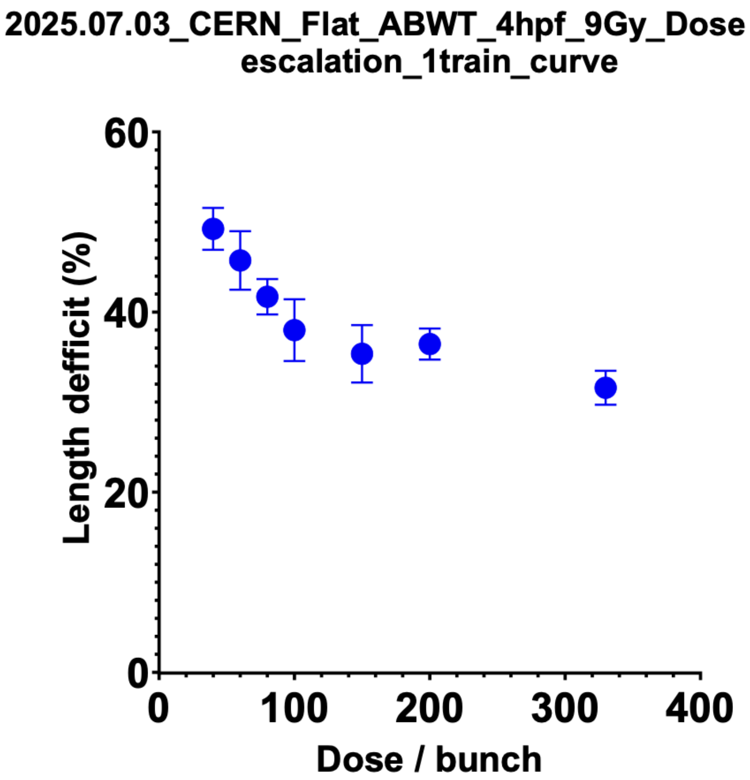
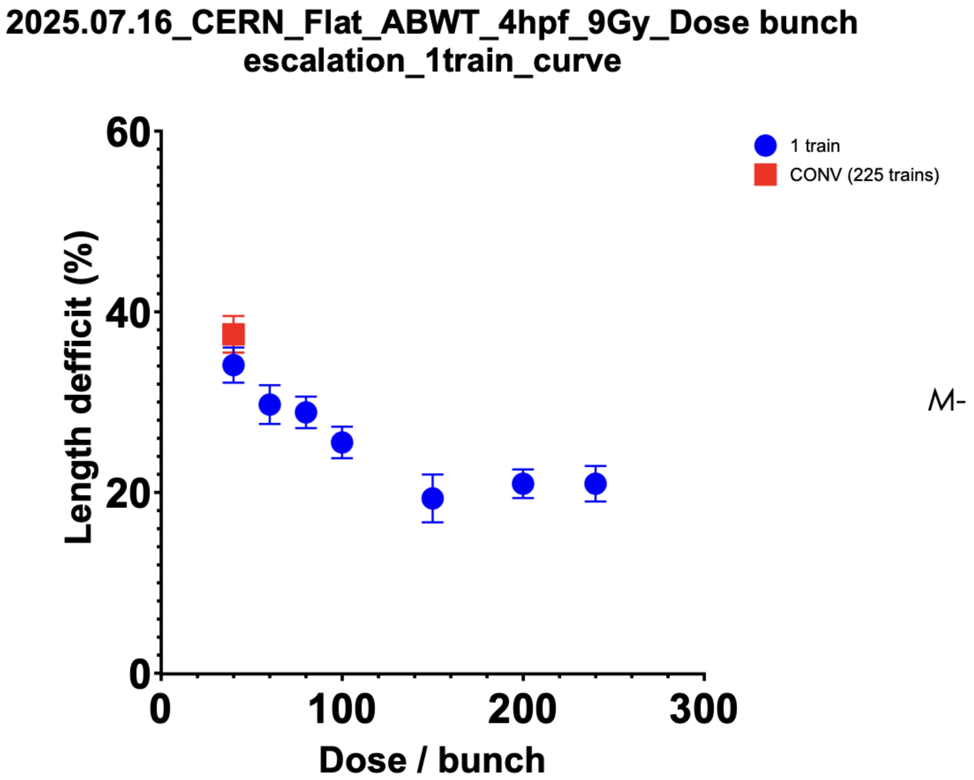
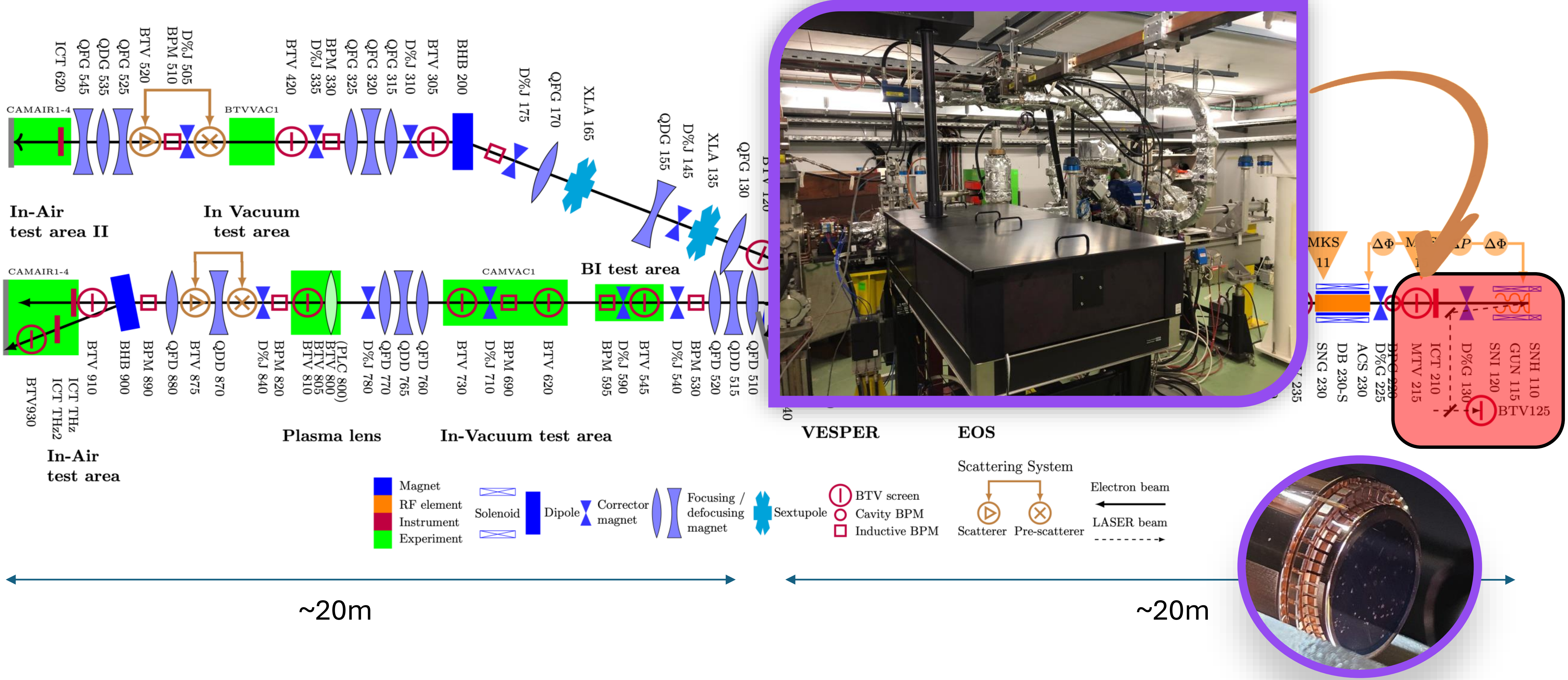
doi: 10.1016/j.radonc.2025.110942



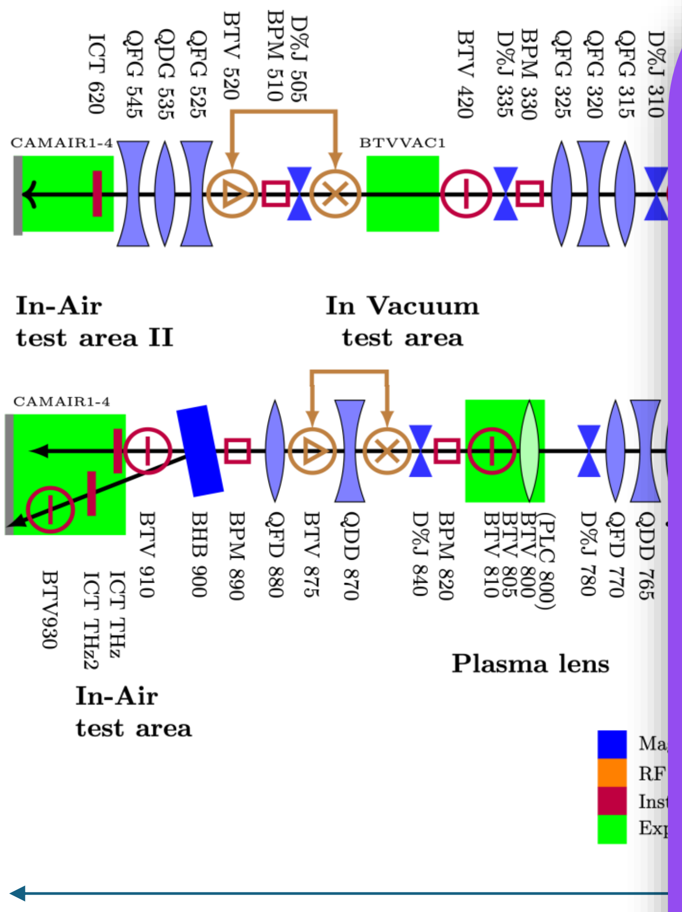


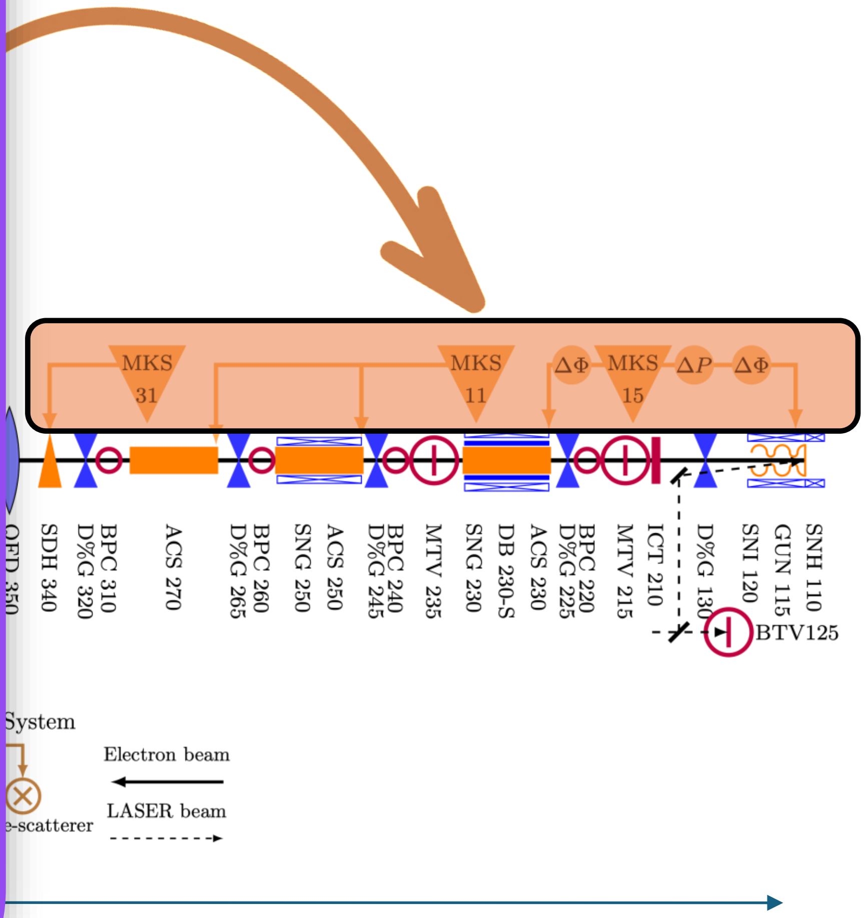
ZFE

Main Features & Parameters

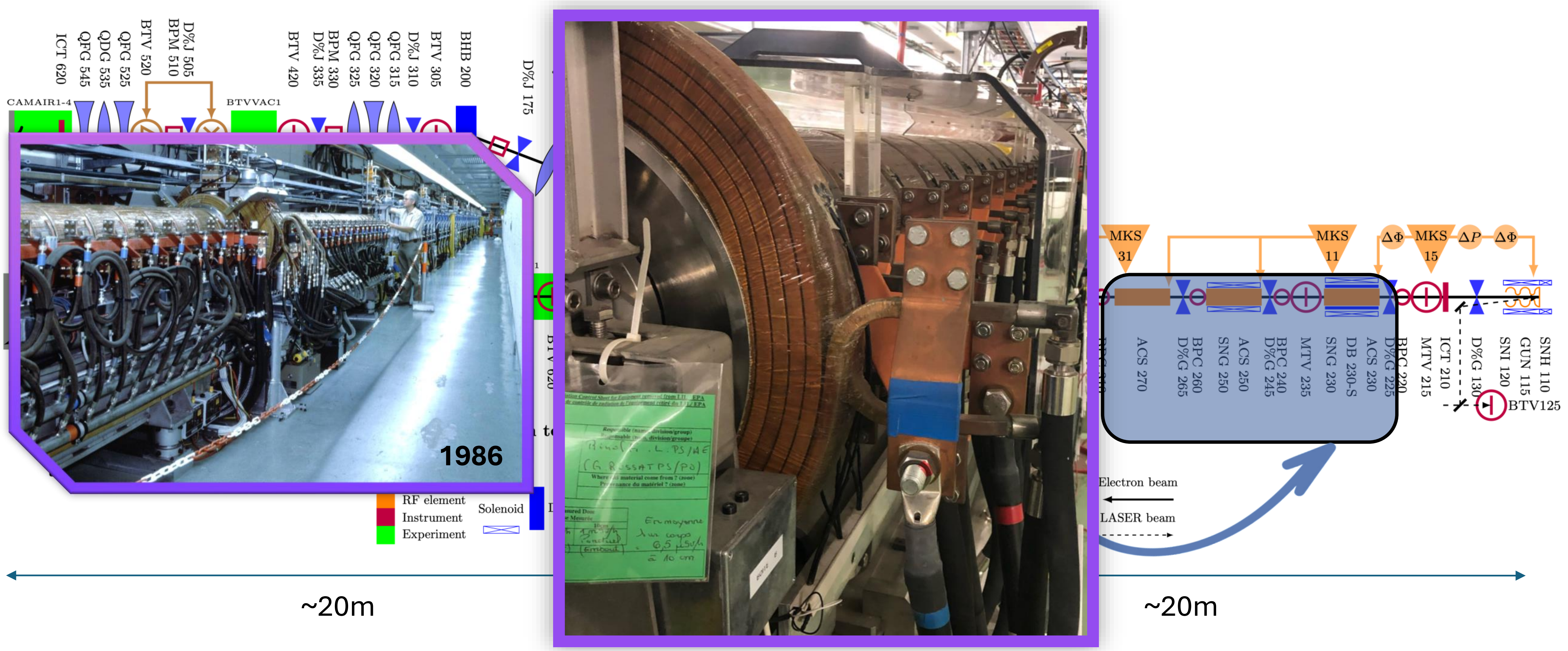


Main Features & Parameters

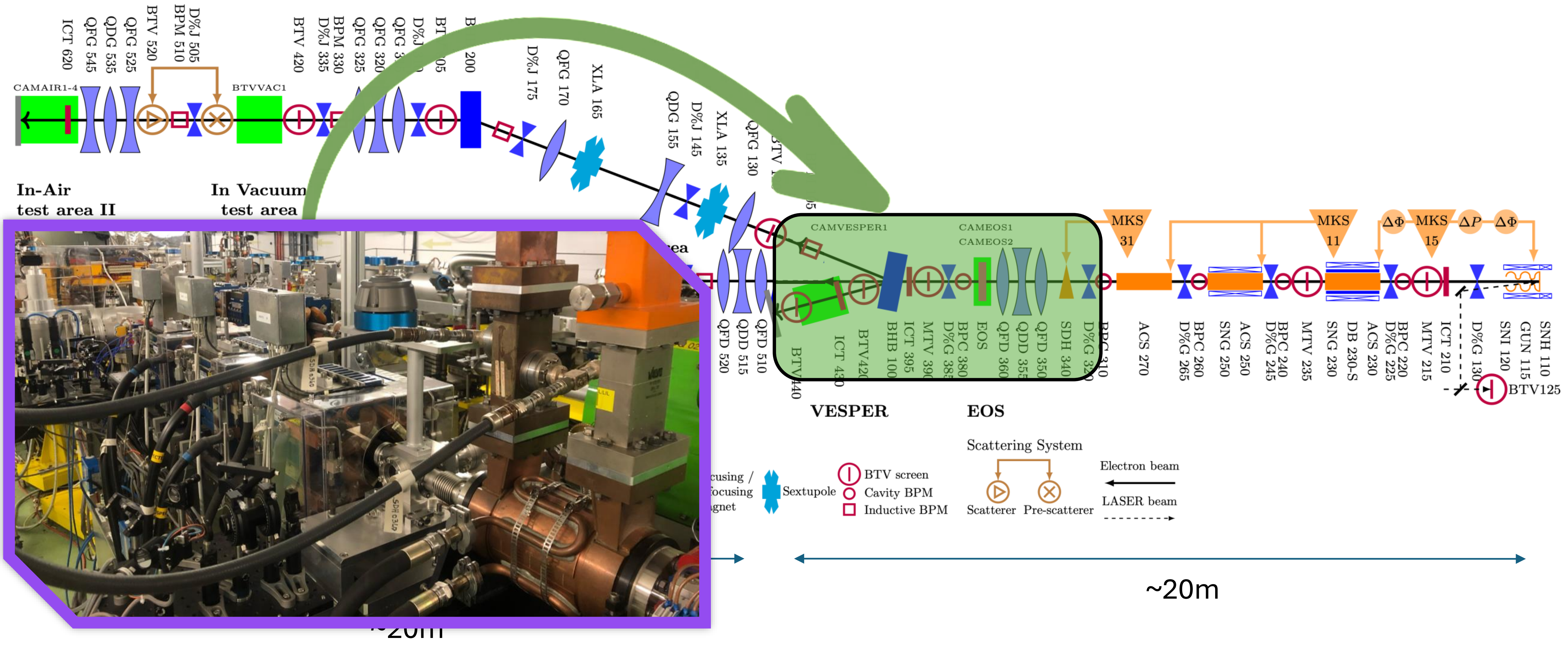




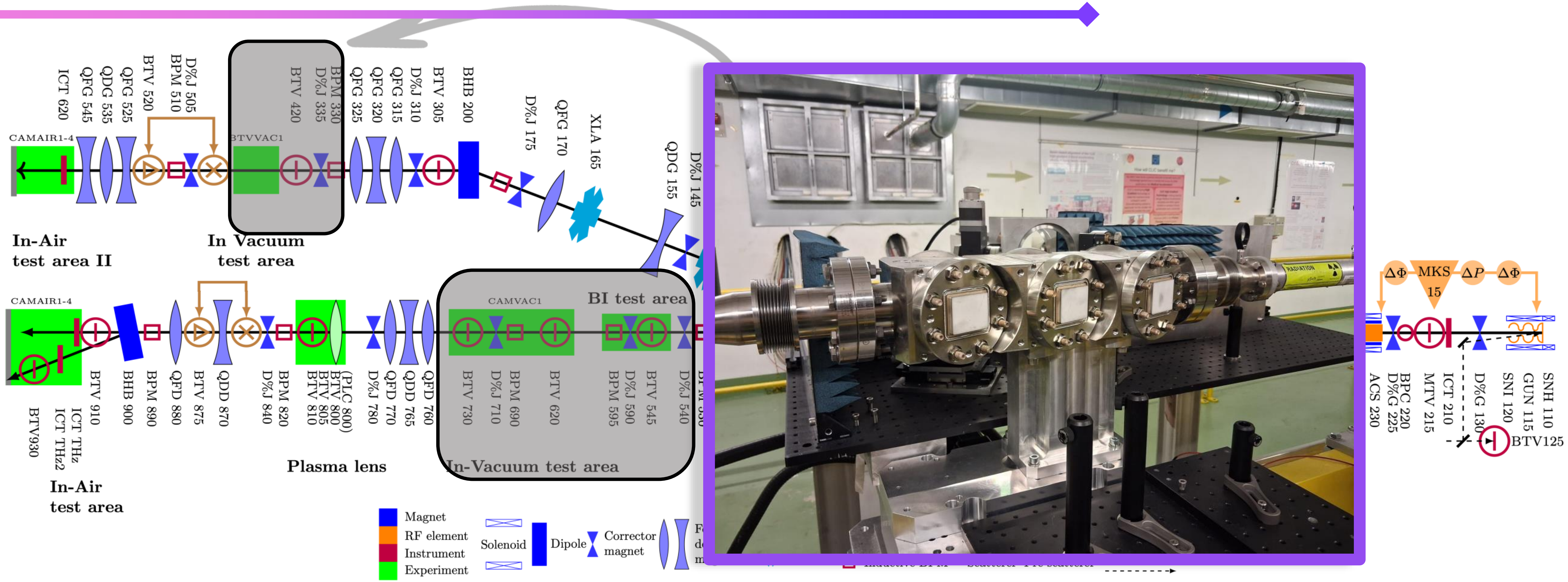
Main Features & Parameters



Main Features & Parameters



Main Features & Parameters



~20m

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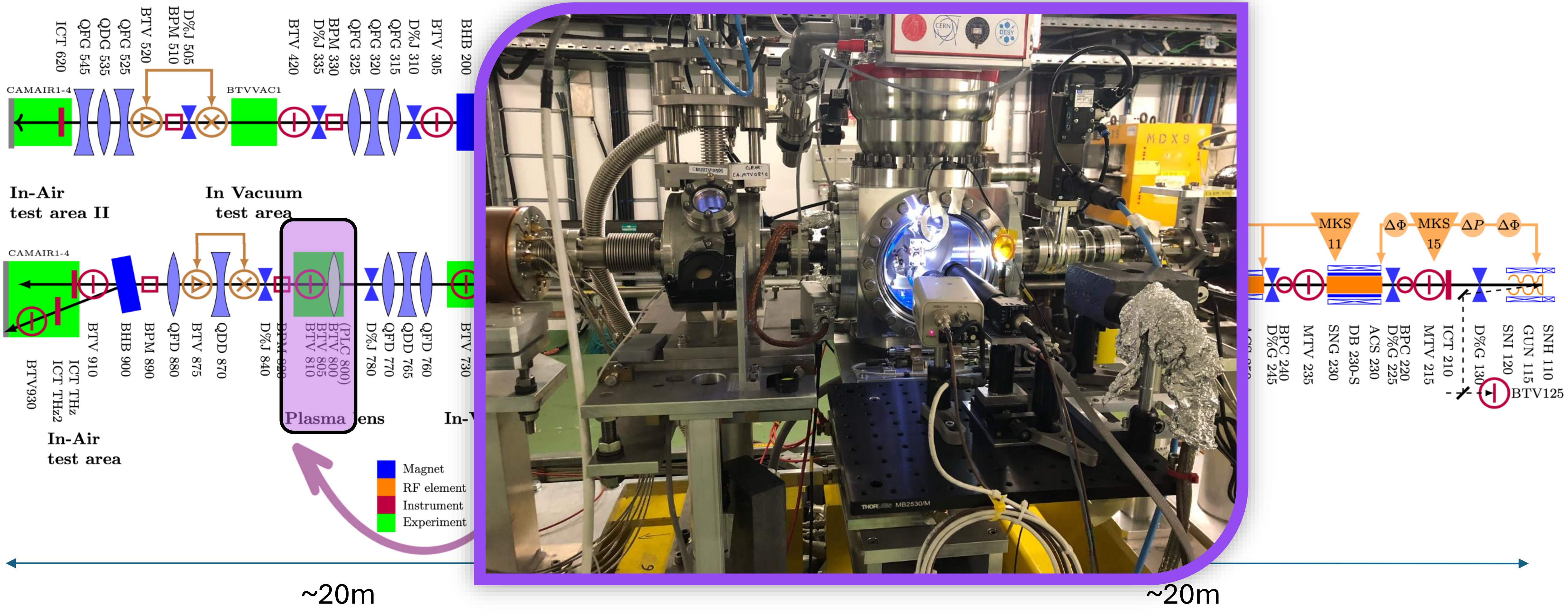
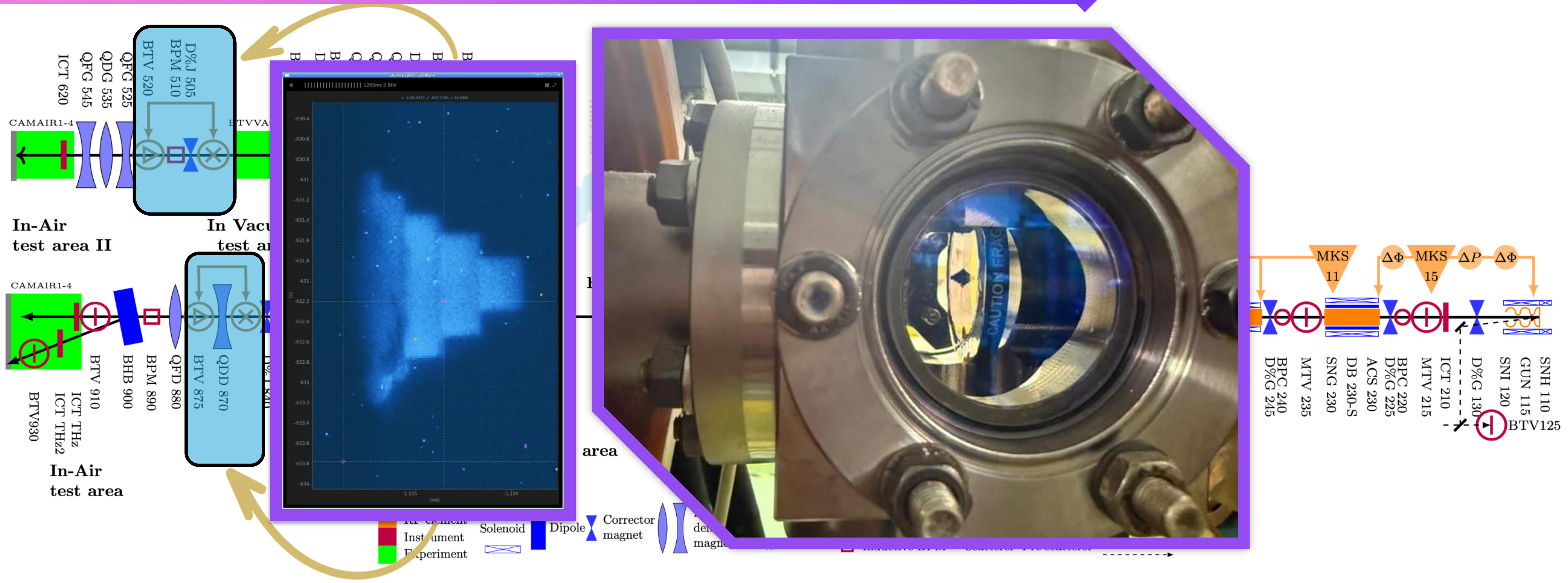
Main Features & Parameters



Main Features & Parameters



~20m

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Main Features & Parameters