



Status of the MAGIX Experiment.

Update on behalf of the **MAGIX** collaboration

Sebastian Stengel (sestenge@uni-mainz.de)

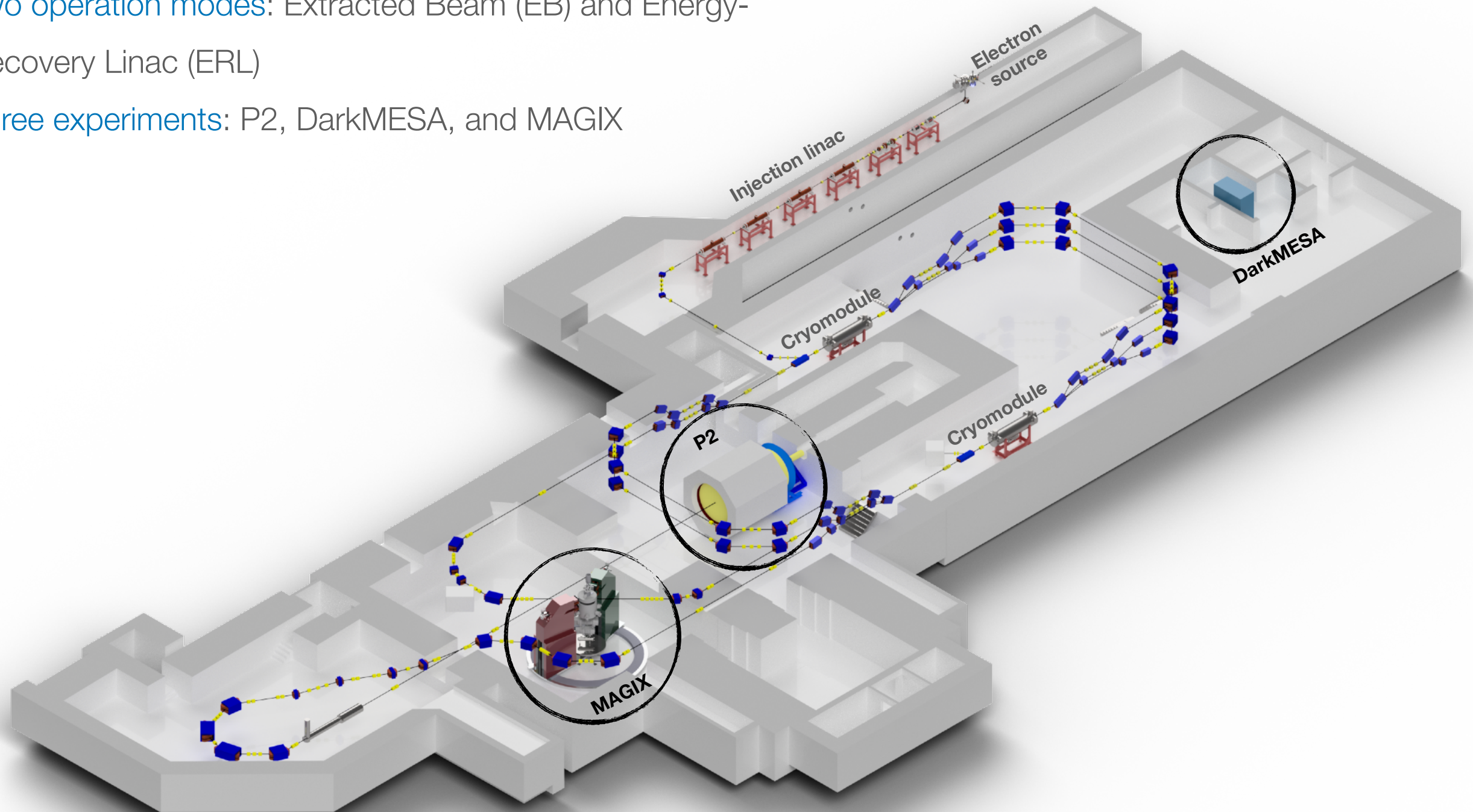
Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

CRC 1660 Graduate School, Schwäbisch Gmünd, Germany, September 23rd, 2025

<https://indico.zdv.uni-mainz.de/event/36/>

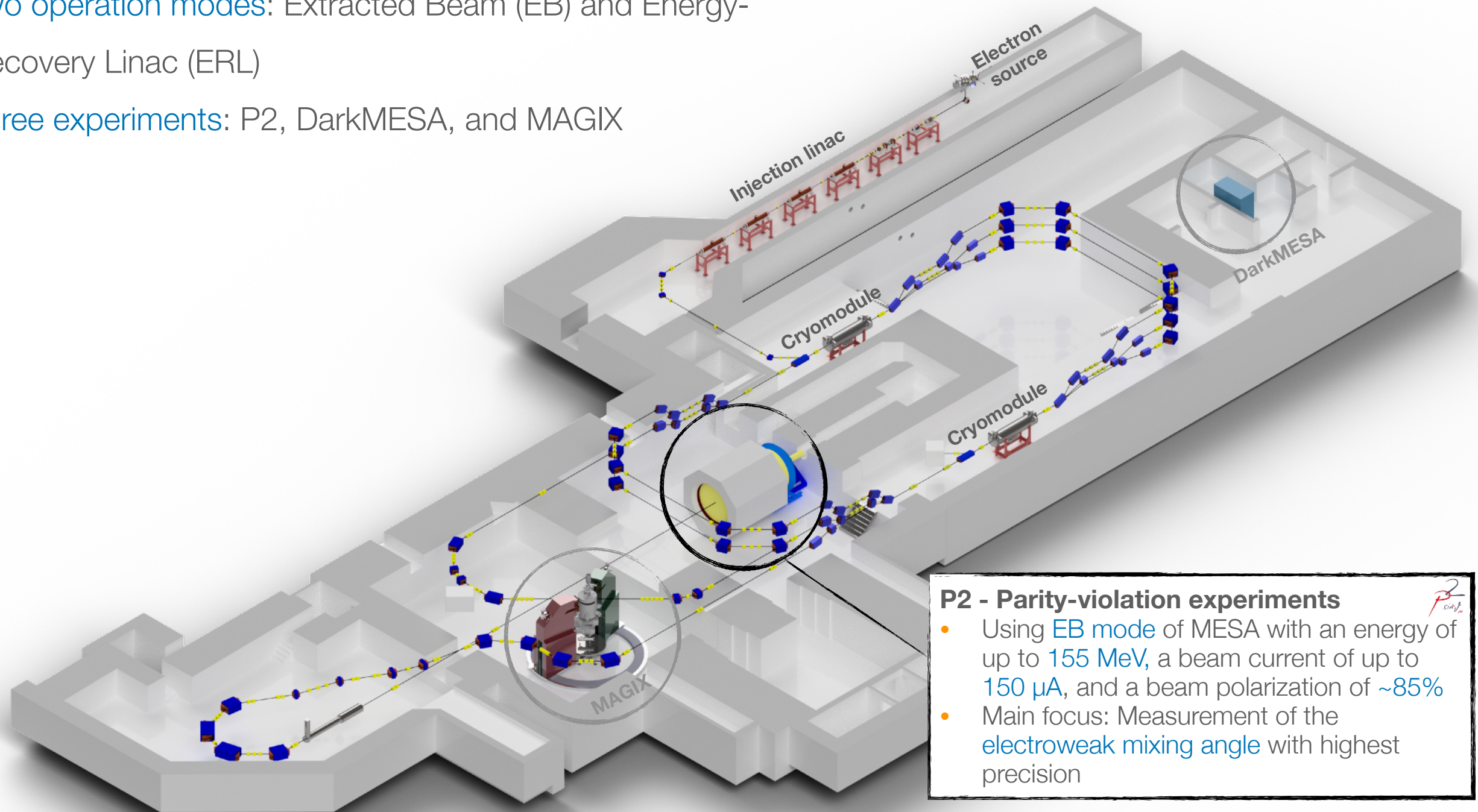
MESA and its experiments.

- High-intensity electron accelerator in the low-energy regime
- Two operation modes: Extracted Beam (EB) and Energy-Recovery Linac (ERL)
- Three experiments: P2, DarkMESA, and MAGIX



MESA and its experiments - P2.

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- Three experiments: P2, DarkMESA, and MAGIX

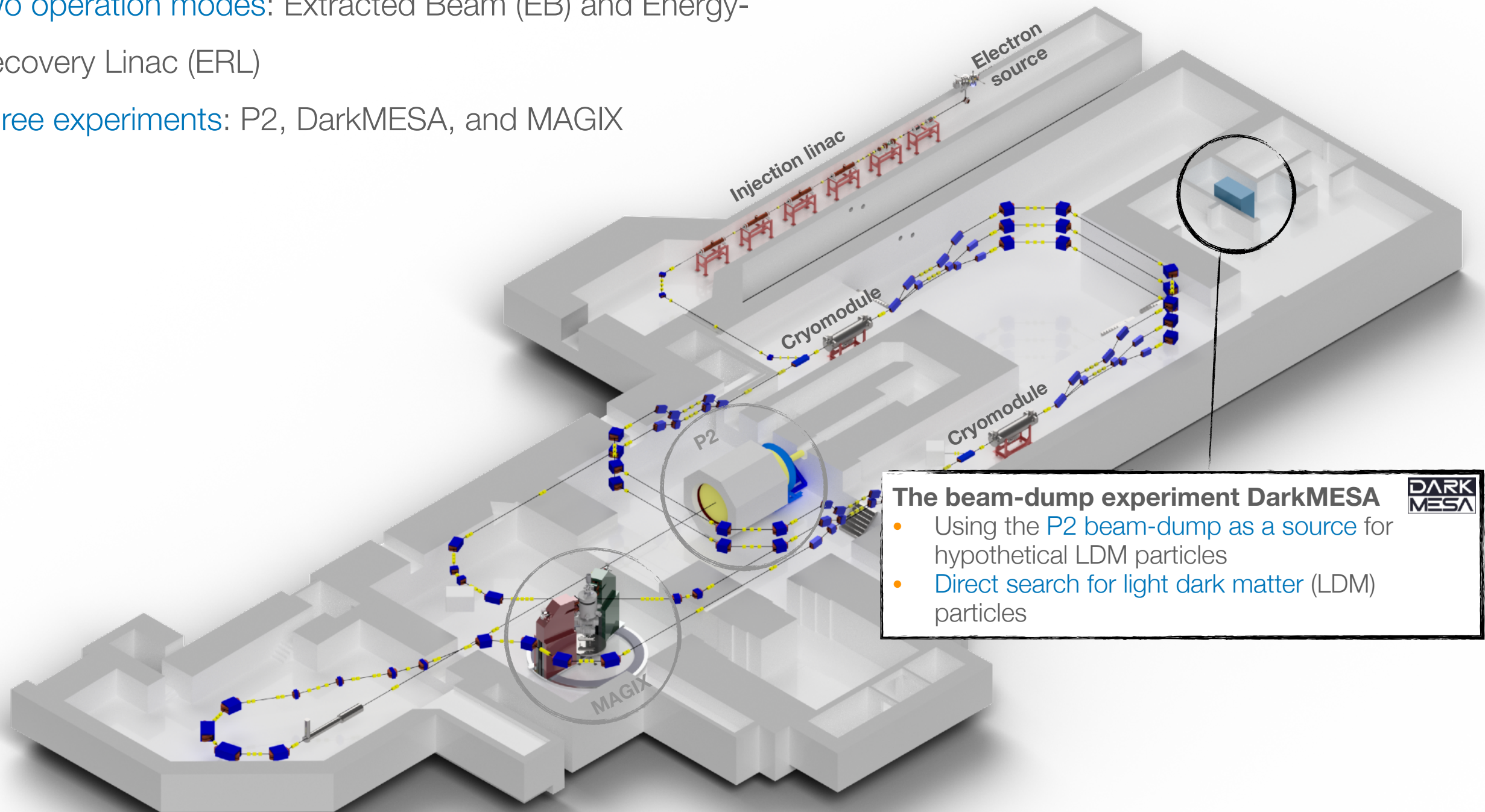


P2 - Parity-violation experiments

- Using **EB mode** of MESA with an energy of up to **155 MeV**, a beam current of up to **150 μA** , and a beam polarization of **$\sim 85\%$**
- Main focus: Measurement of the **electroweak mixing angle** with highest precision

MESA and its experiments - DarkMESA.

- High-intensity electron accelerator in the low-energy regime
- Two operation modes: Extracted Beam (EB) and Energy-Recovery Linac (ERL)
- Three experiments: P2, DarkMESA, and MAGIX



The beam-dump experiment DarkMESA

- Using the P2 beam-dump as a source for hypothetical LDM particles
- Direct search for light dark matter (LDM) particles



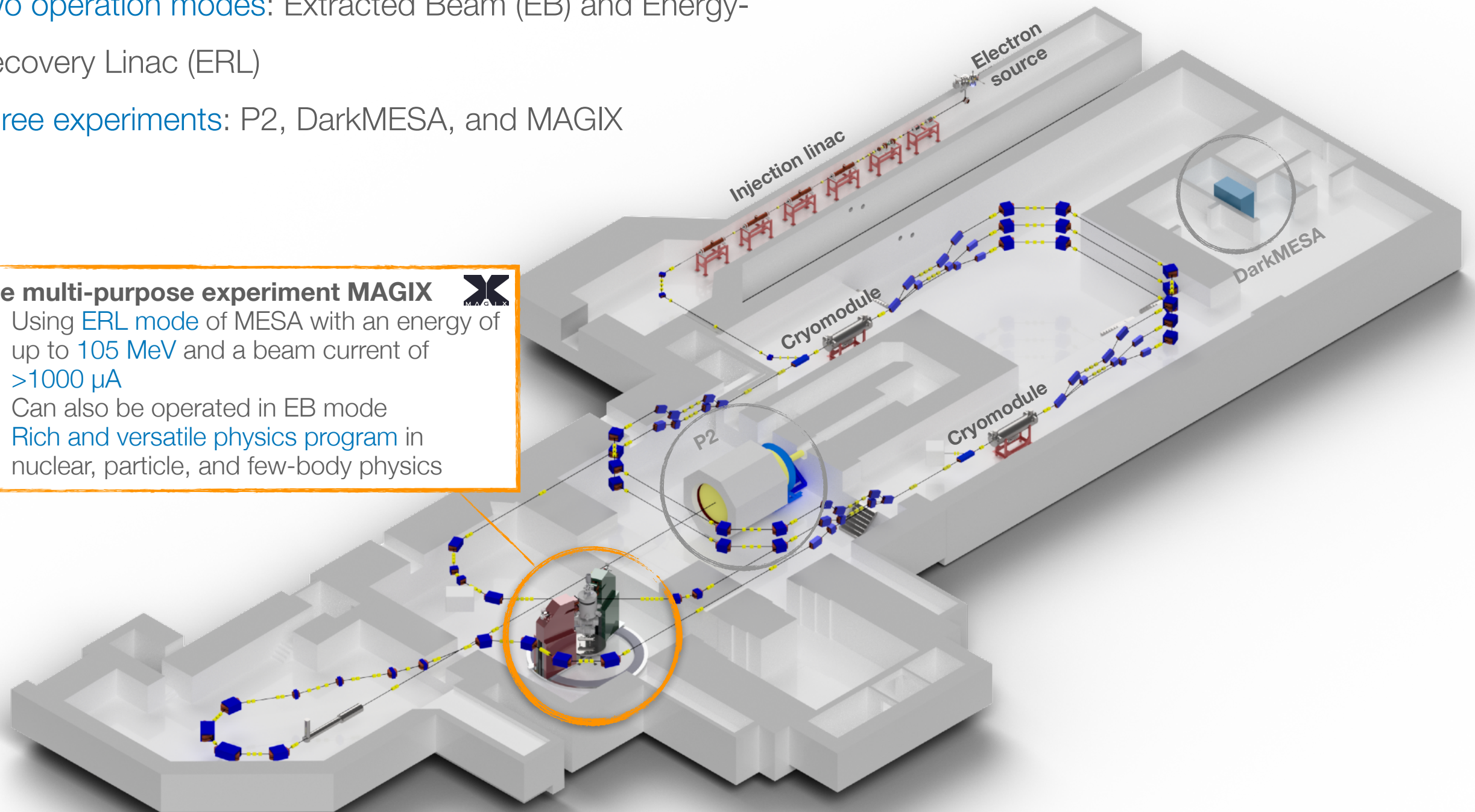
MESA and its experiments - MAGIX.

- High-intensity electron accelerator in the low-energy regime
- Two operation modes: Extracted Beam (EB) and Energy-Recovery Linac (ERL)
- Three experiments: P2, DarkMESA, and MAGIX

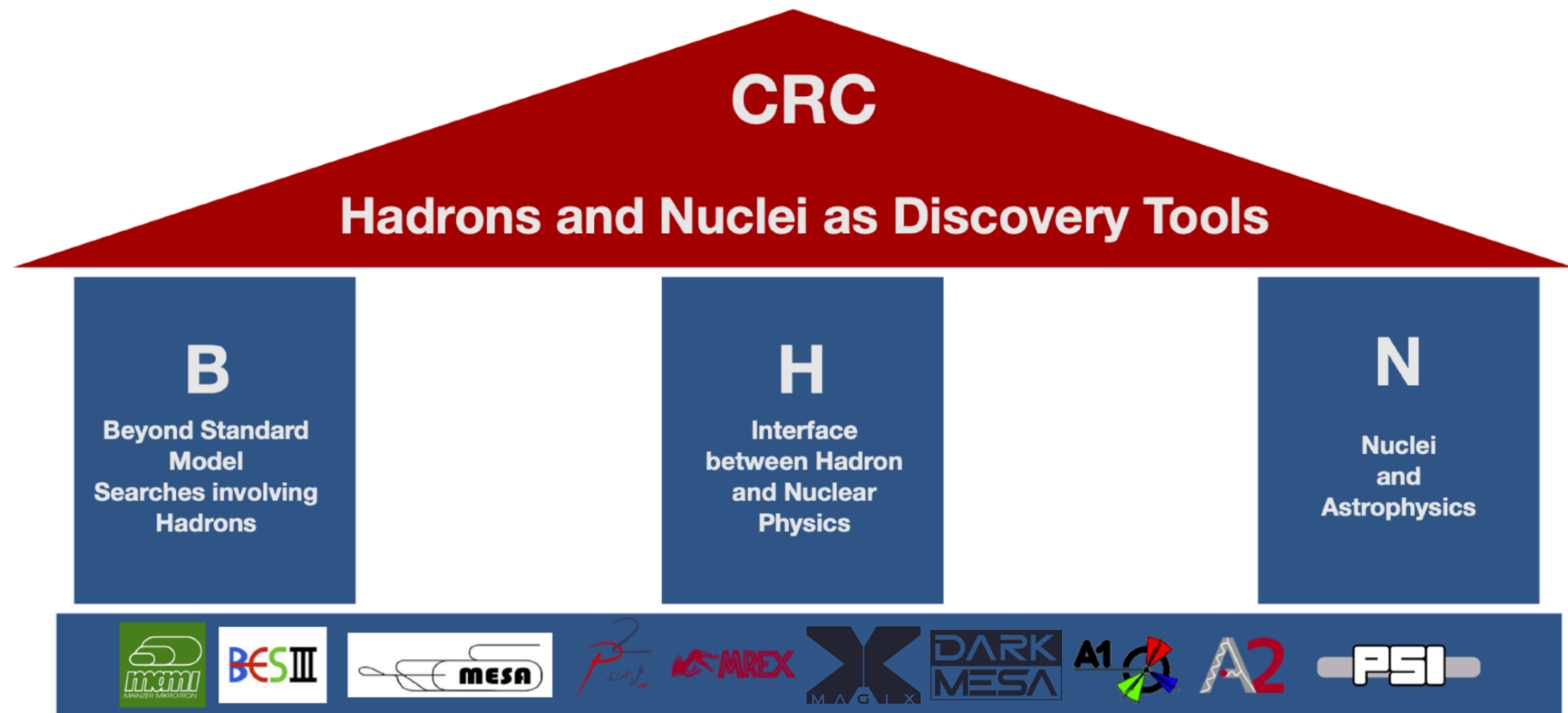
The multi-purpose experiment MAGIX



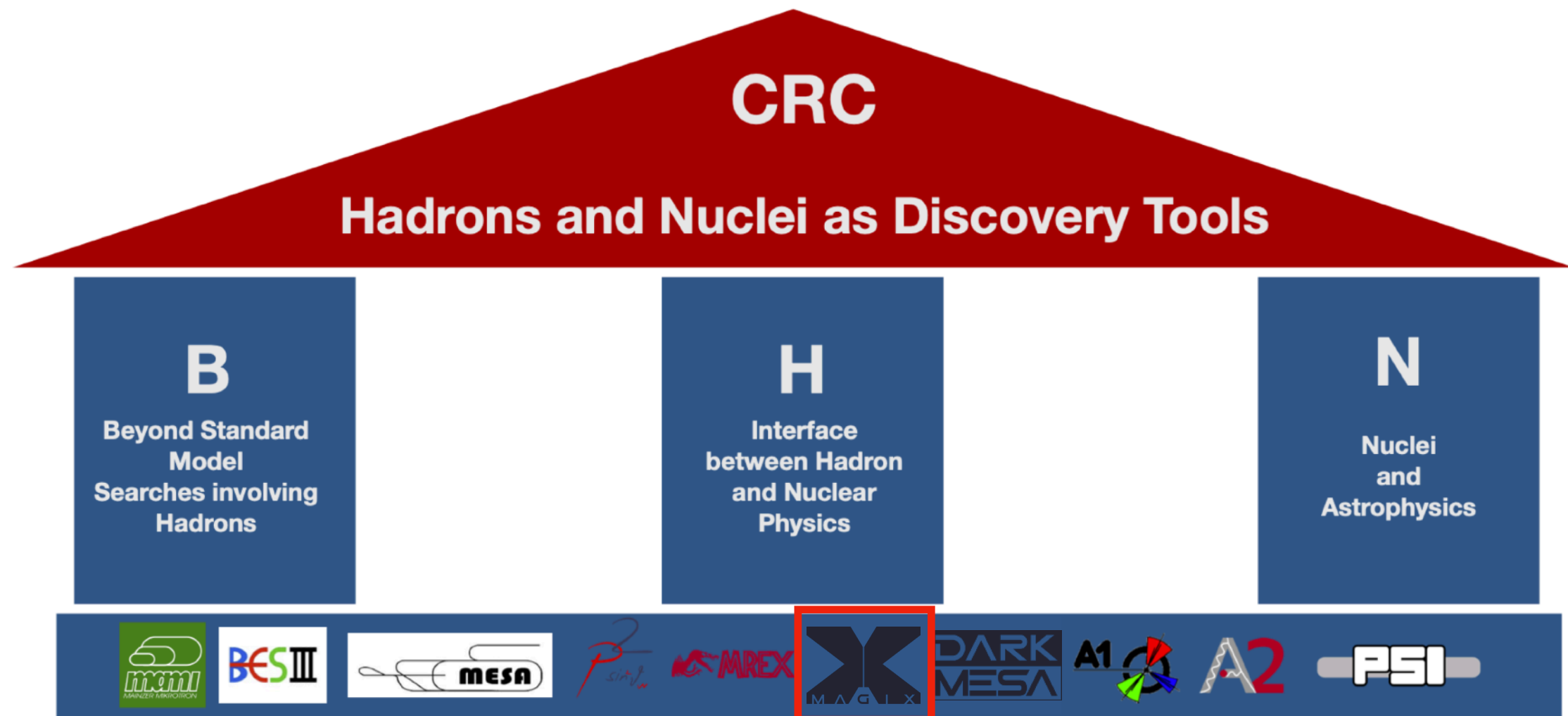
- Using ERL mode of MESA with an energy of up to 105 MeV and a beam current of $>1000 \mu\text{A}$
- Can also be operated in EB mode
- Rich and versatile physics program in nuclear, particle, and few-body physics



MAGIX in the CRC 1660.



MAGIX in the CRC 1660.



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H05: „Electron and photon scattering“

N02: „Study of reaction cross-sections of astrophysical interest“

B05: „Dark sector searches at MESA“

N03: „Few-body systems“

CRC

Hadrons and Nuclei as Discovery Tools

B

Beyond Standard
Model
Searches involving
Hadrons

H

Interface
between Hadron
and Nuclear
Physics

N

Nuclei
and
Astrophysics



MAGIX in the CRC 1660.



In preparation

N04: „Study of the nuclear pygmy and dipole resonance region“

H05: „Electron and photon scattering“

N02: „Study of reaction cross-sections of astrophysical interest“

B05: „Dark sector searches at MESA“

N03: „Few-body systems“

CRC

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The acronym MAGIX.



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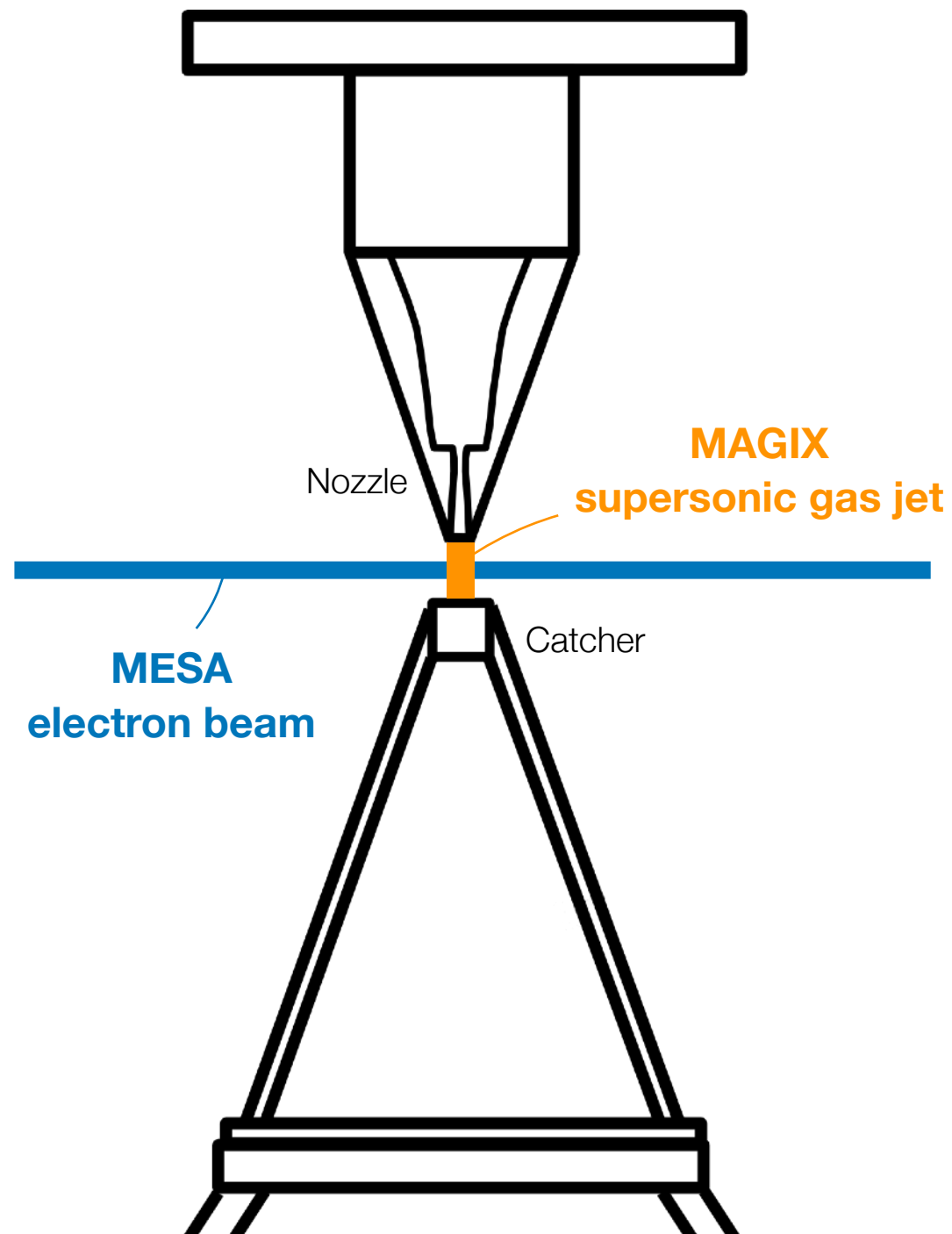
MAinz

The acronym MAGIX.



MAinz **G**as **I**njection Target

The basic idea of MAGIX.

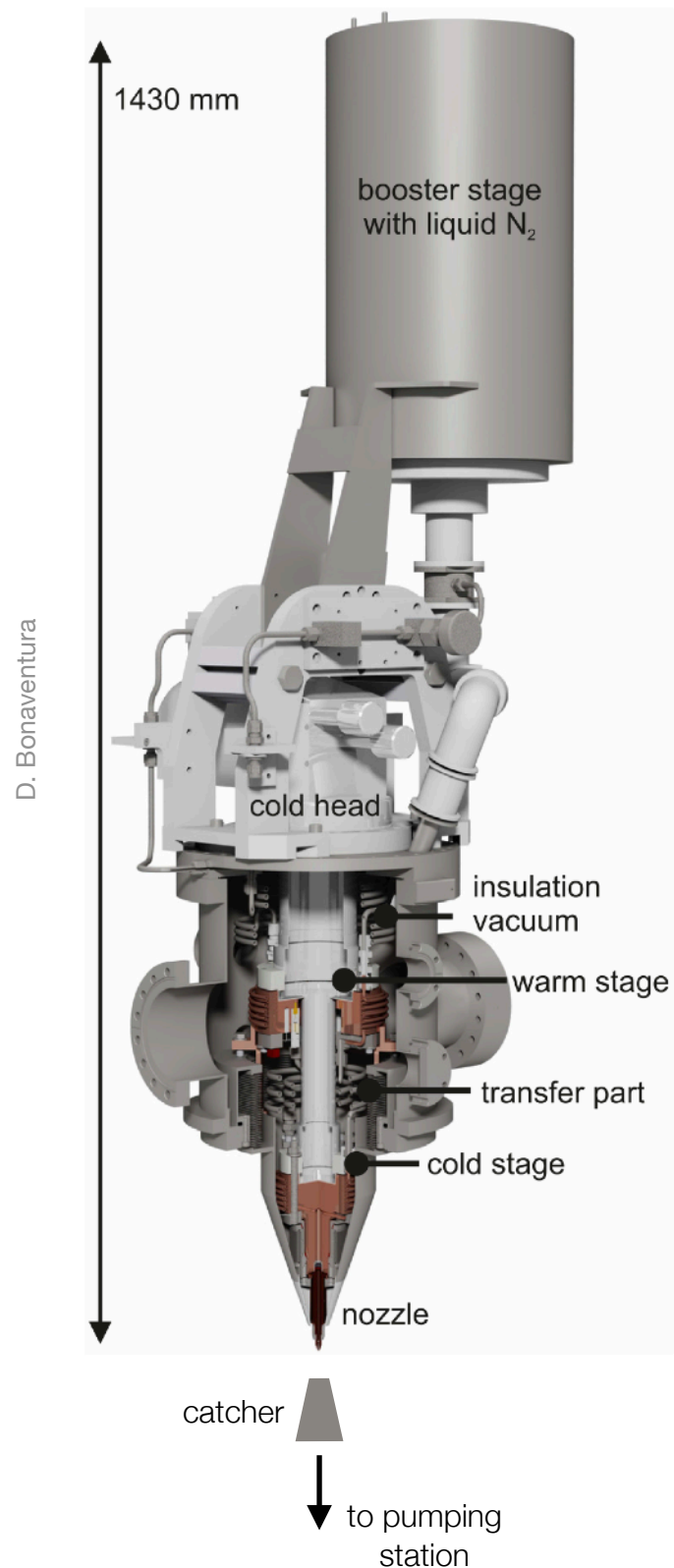


**Windowless
gas jet target**
and minimal material budget

**High-intensity
electron beam**
in the low-energy regime

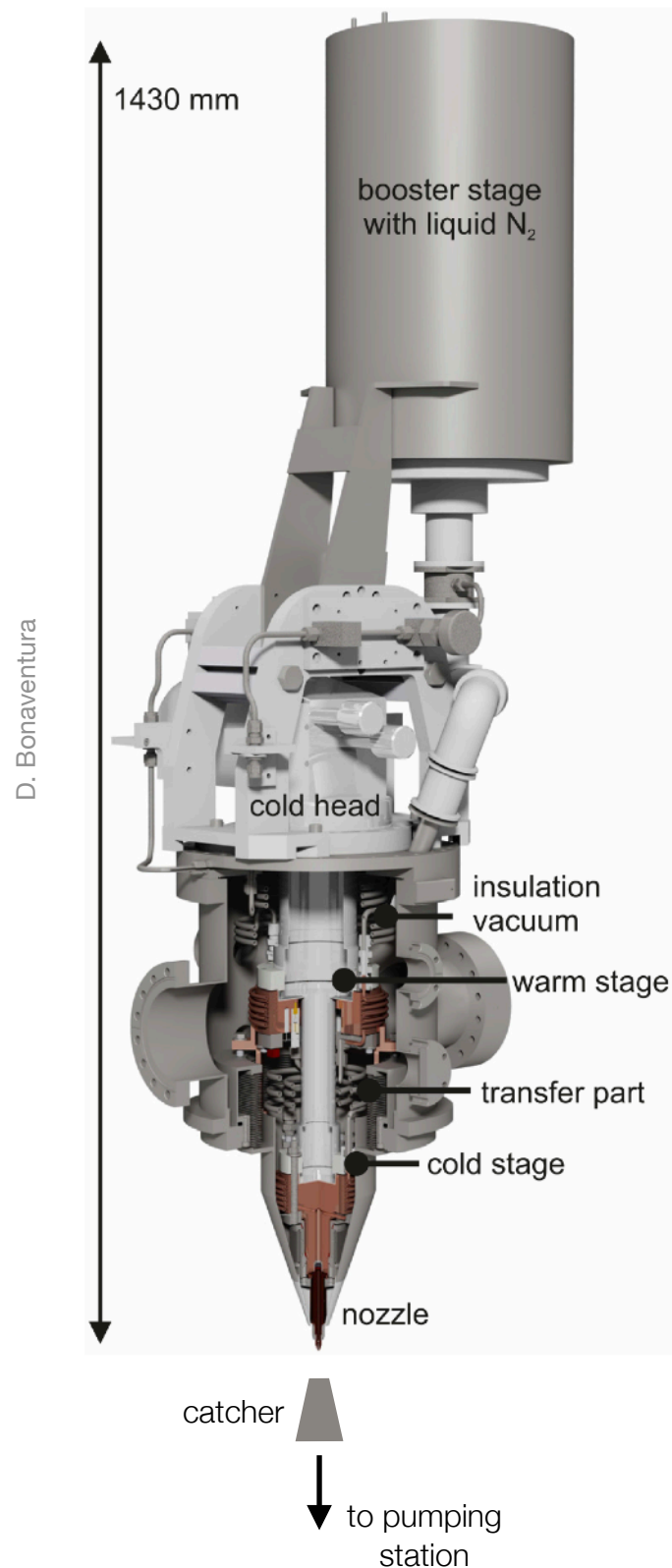
**Clean
experimental
environment**
with drastically reduced particle
interactions prior to detection

The MAGIX gas jet target.

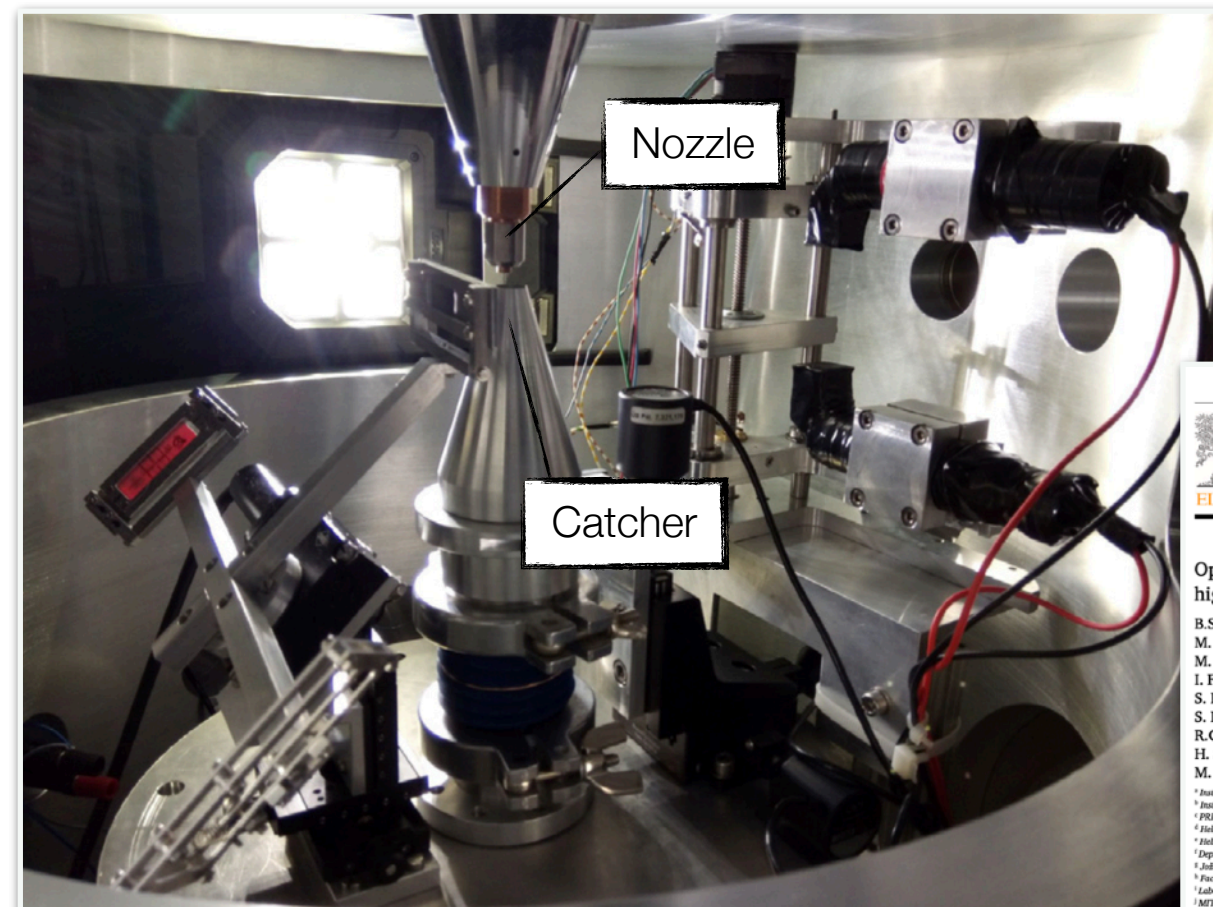


- Developed and constructed by AG Khoukaz from WWU
- Works with almost all gases, e.g. hydrogen or argon
- Windowless, thin, point-like jet target

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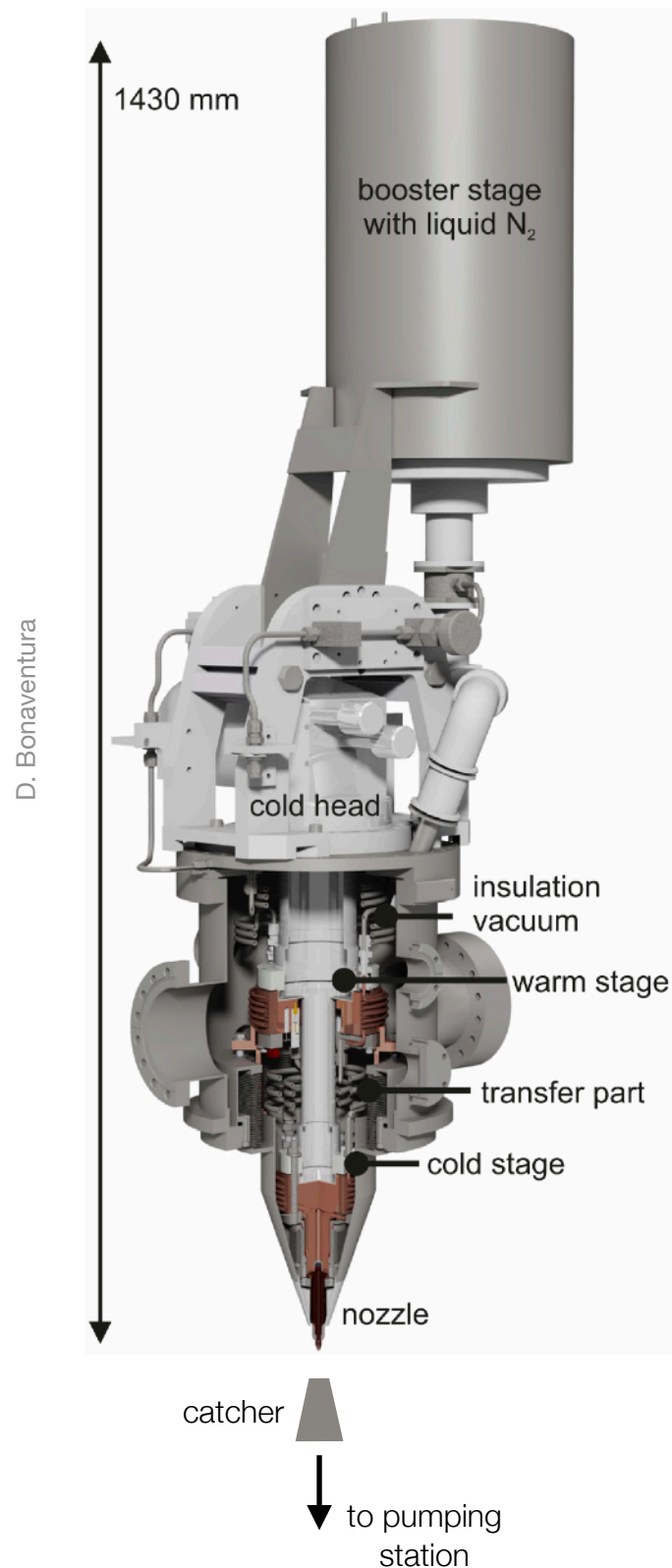


S. Schlimme *et al.*, 10.1016/j.nima.2021.165668

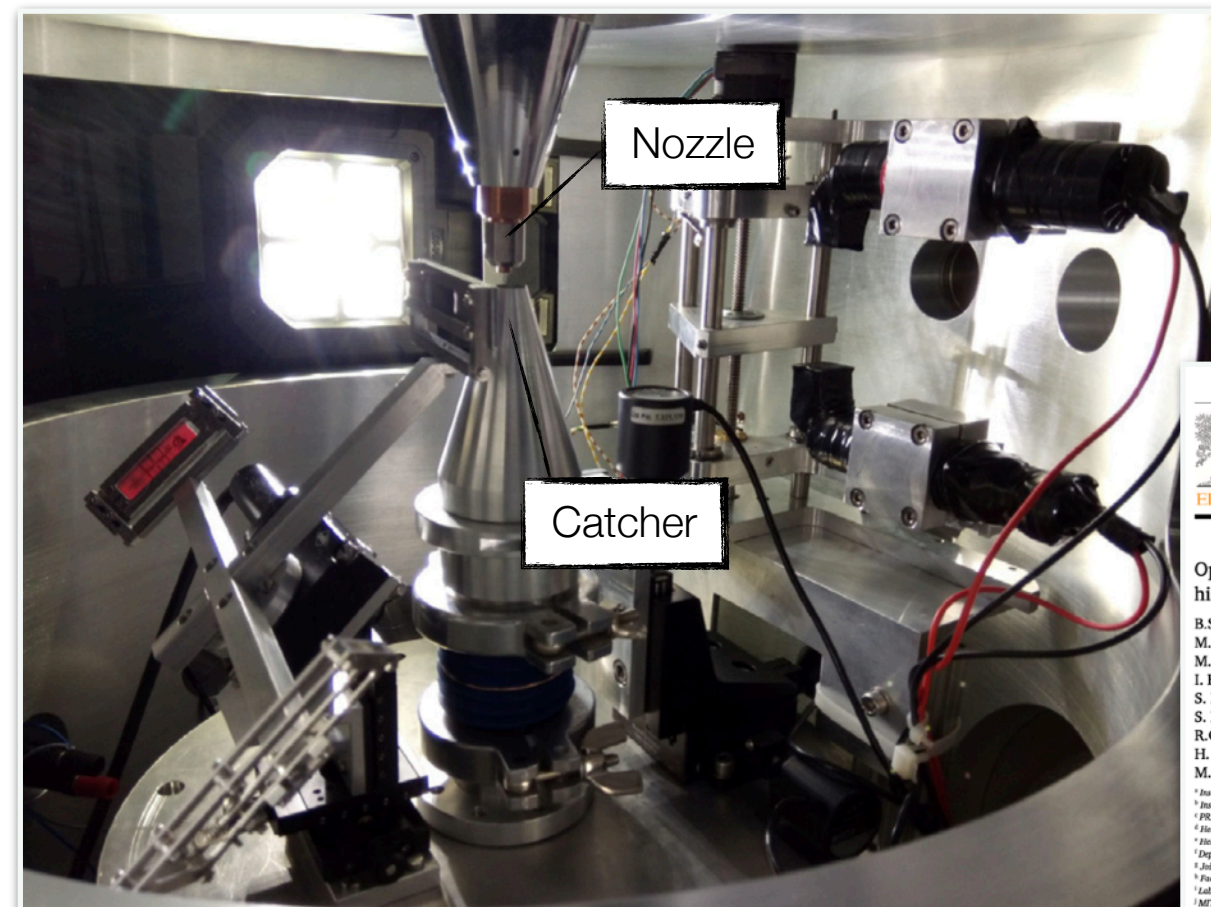


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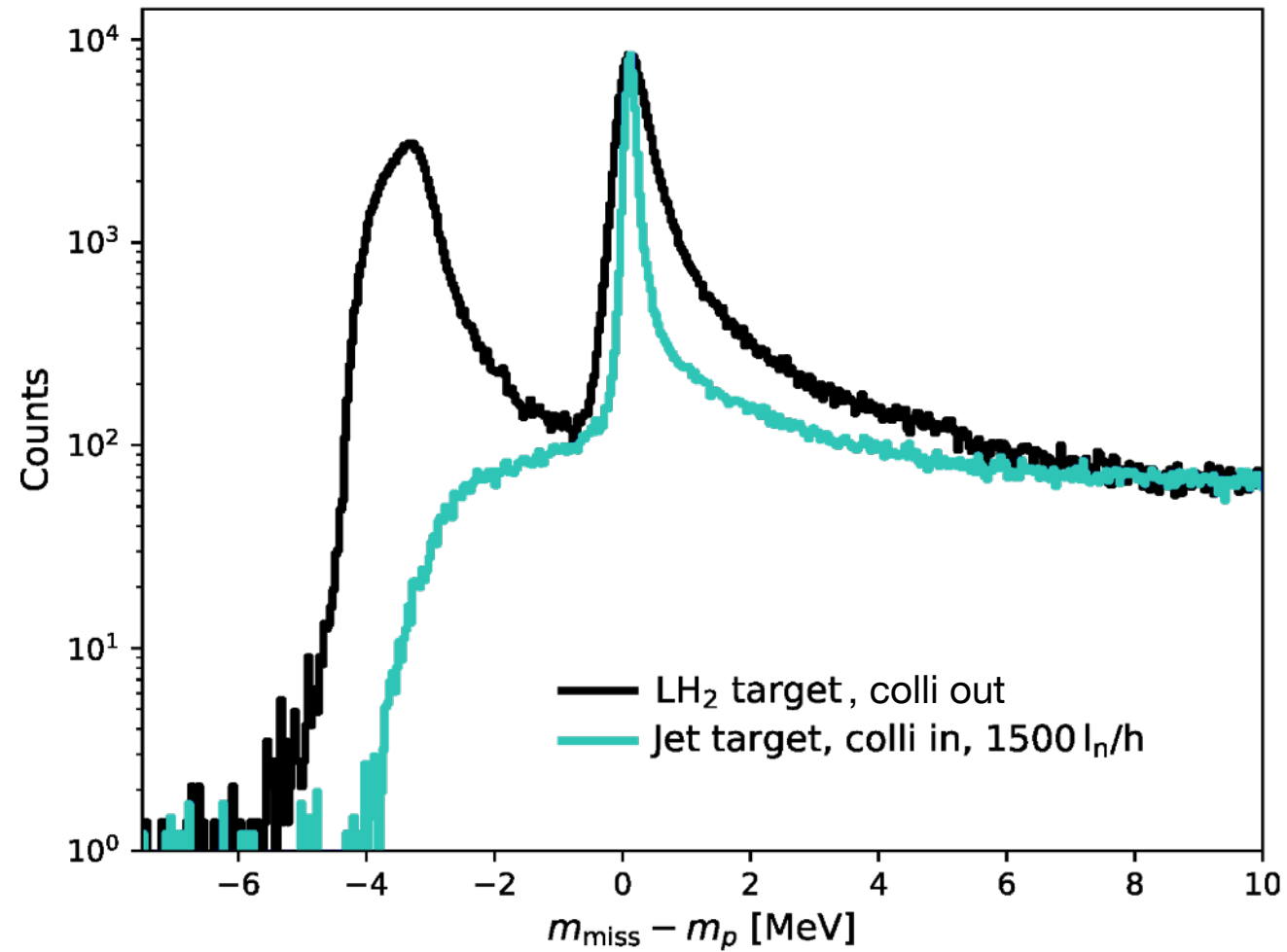


P. Brand



S. Schlimme et al., 10.1016/j.nima.2021.165668

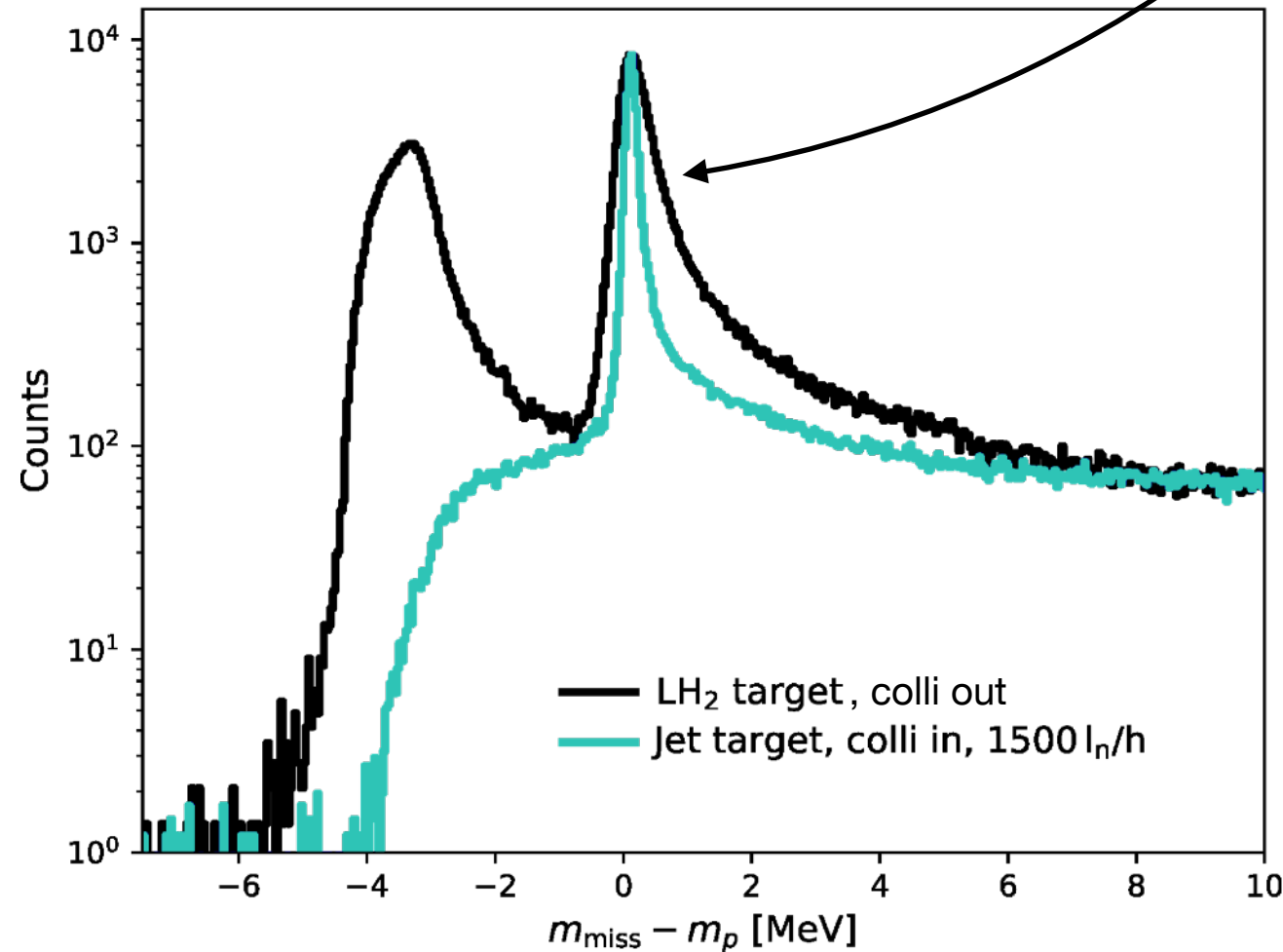
Benefits of a gas jet target.



Benefits of a gas jet target.



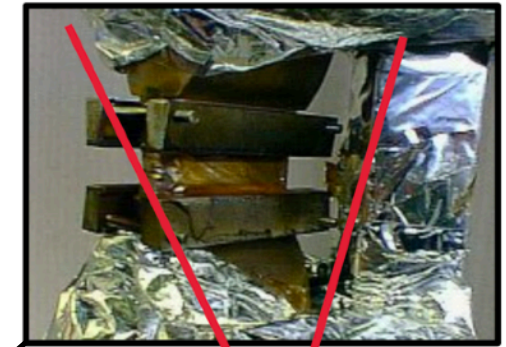
Typical
LH₂
target



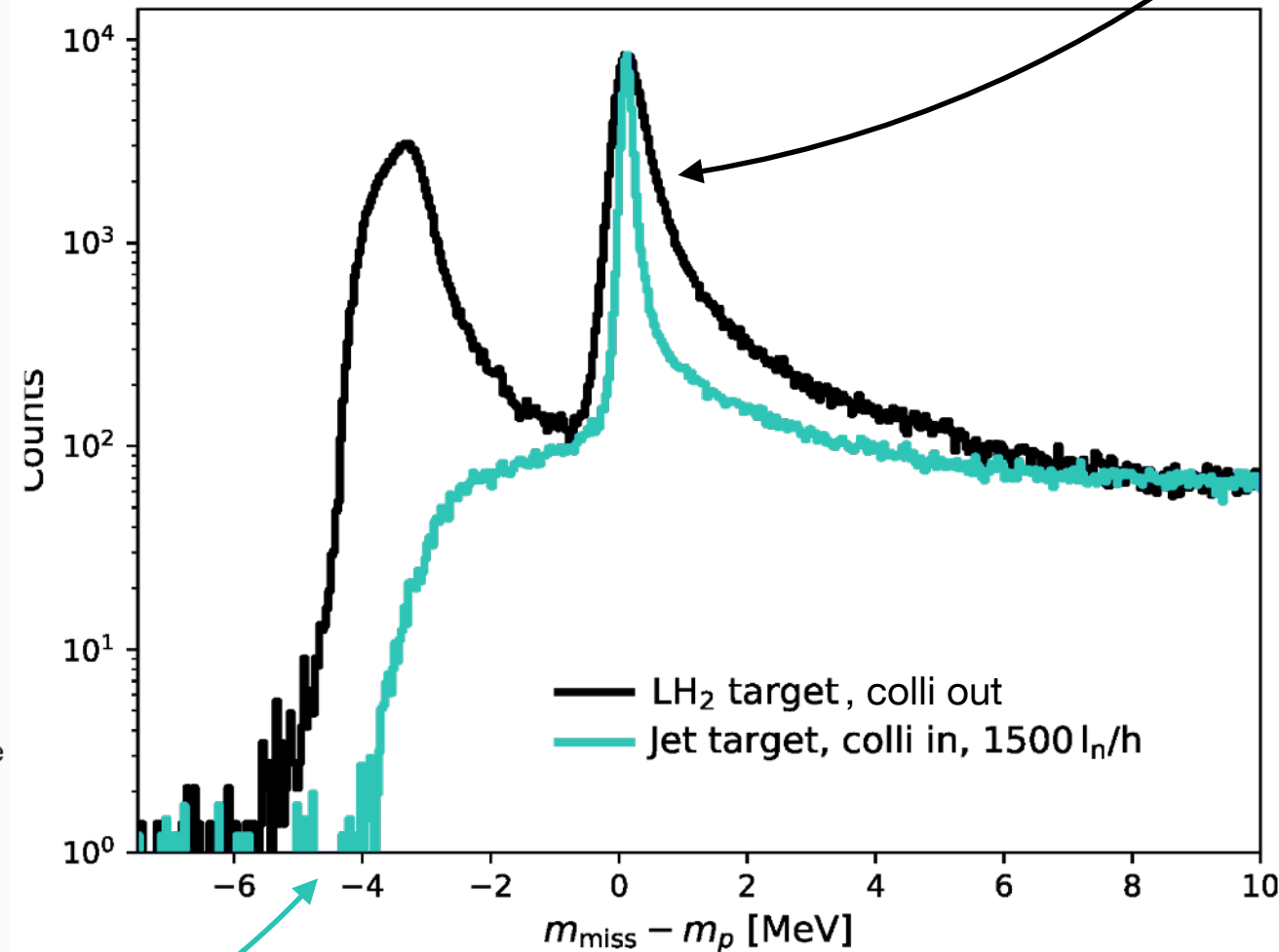
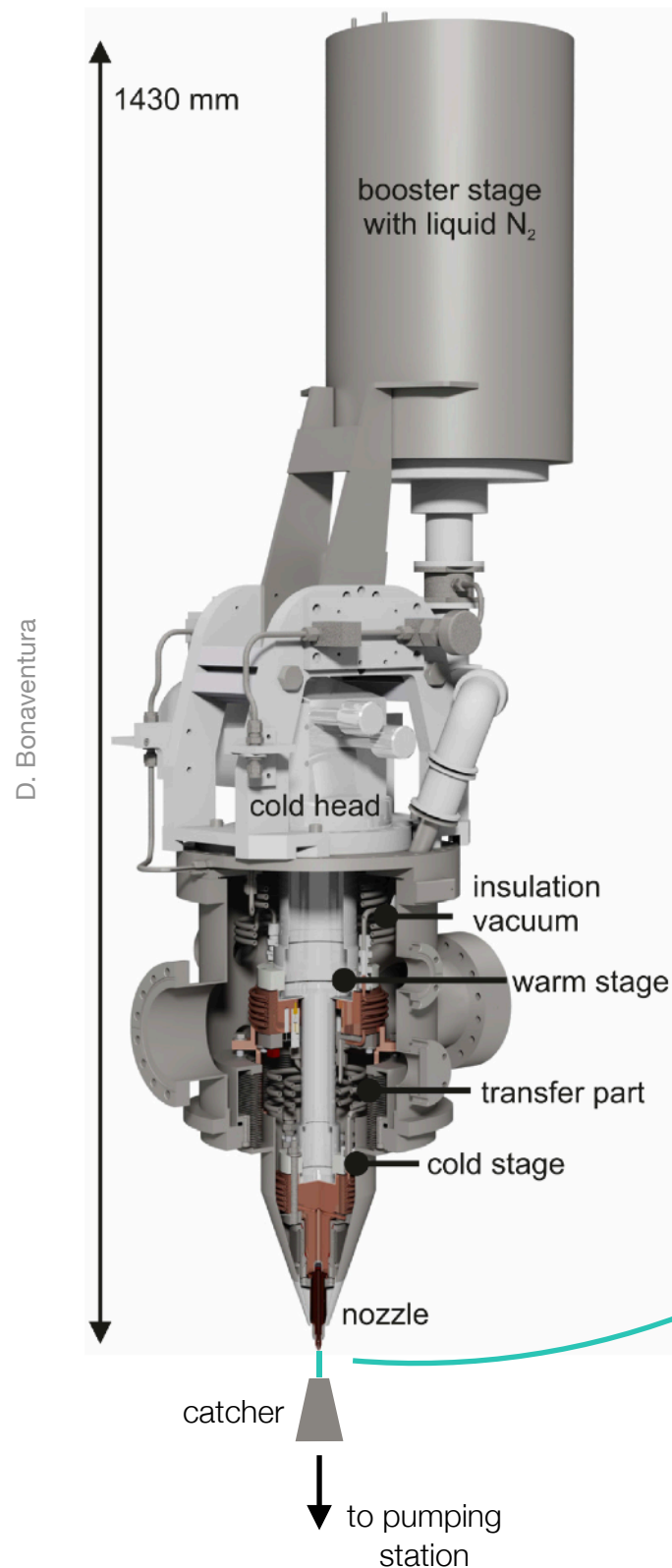
- large energy loss straggling and multiple small angle scattering
- background from target foils
- target length acceptance issues

S. Schlimme

Benefits of a gas jet target.



Typical
LH₂
target



- large energy loss straggling and multiple small angle scattering
- background from target foils
- target length acceptance issues

- Sharper elastic peak in electron-proton scattering
- Background effects drastically reduced

S. Schlimme

The acronym MAGIX.

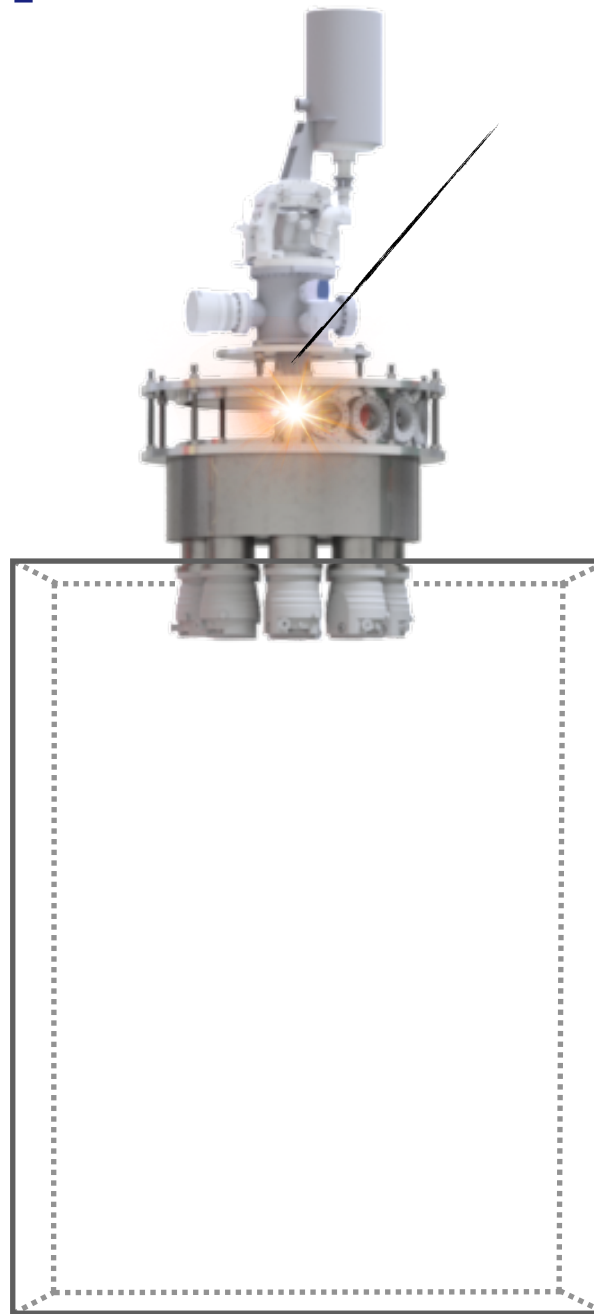


MAinz

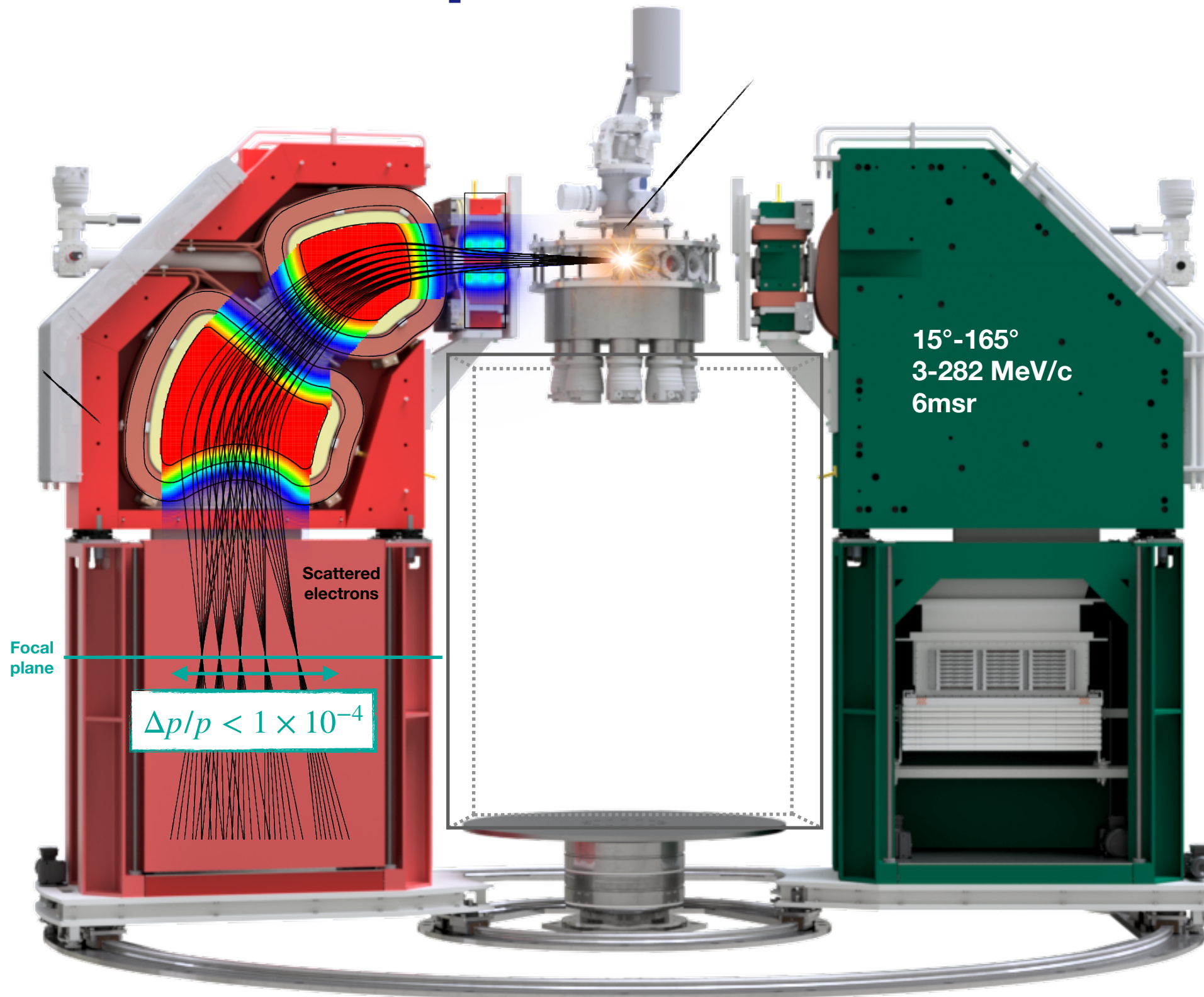
Gas **I**njection Target

EXperiment

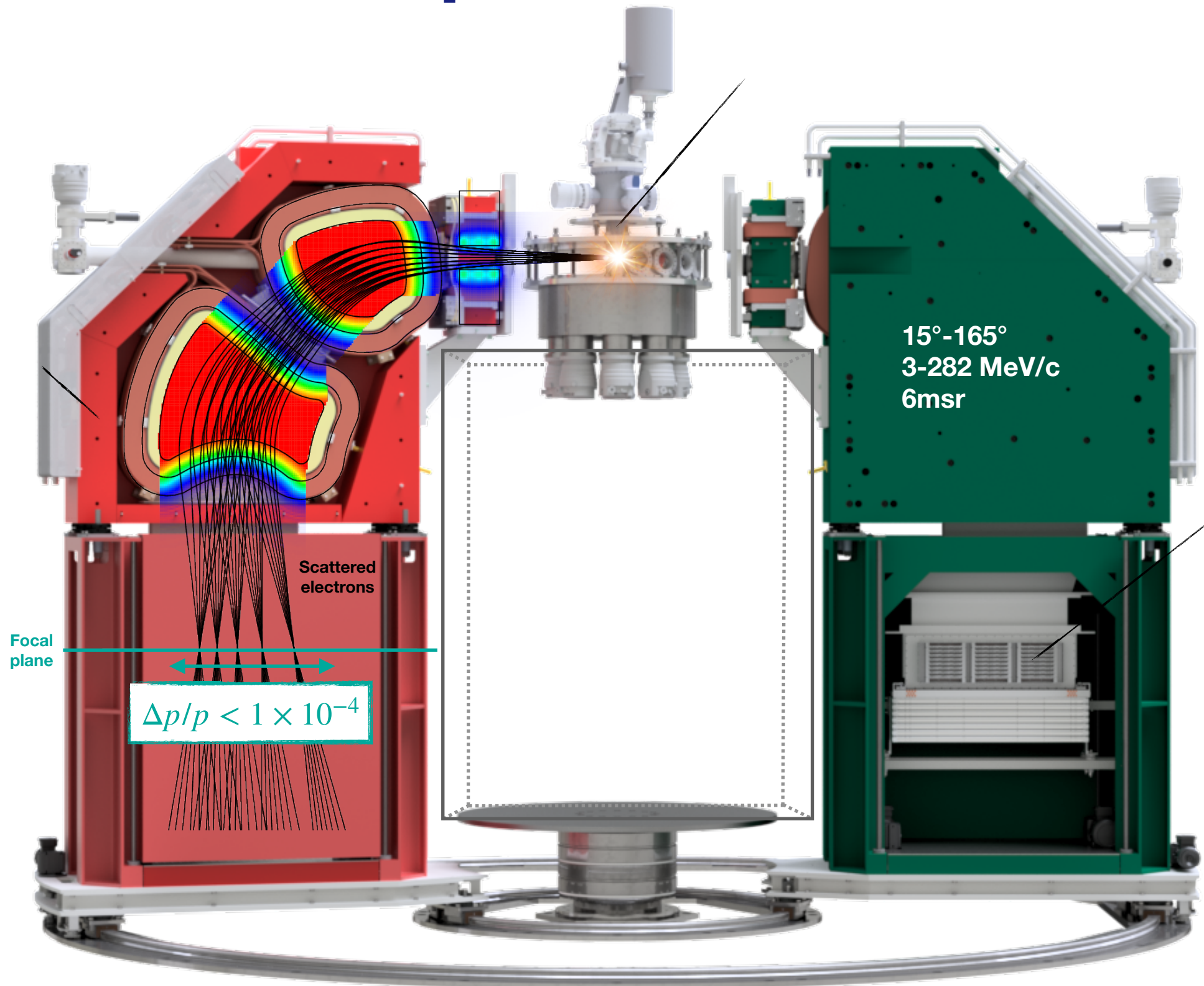
The MAGIX setup.



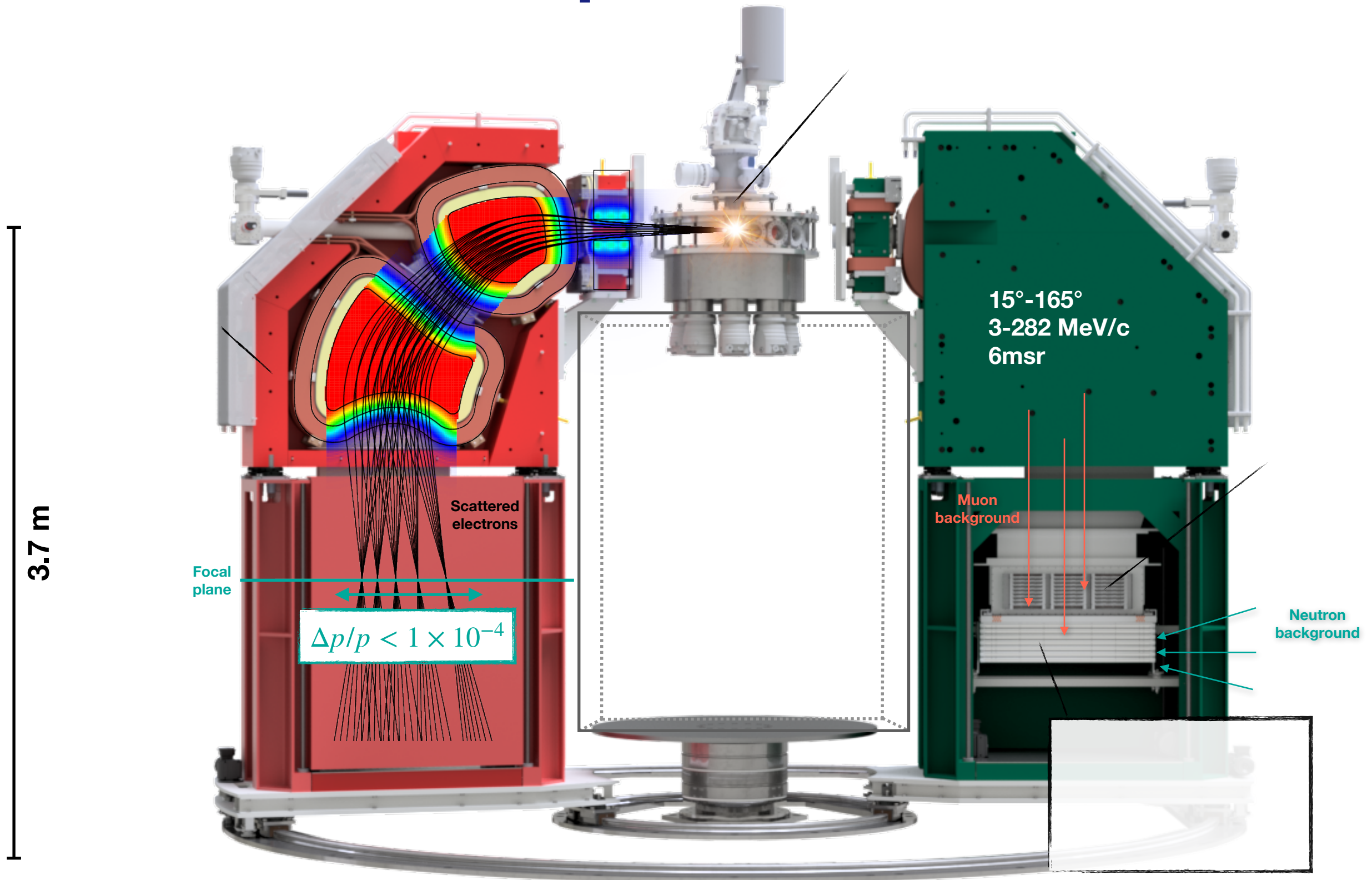
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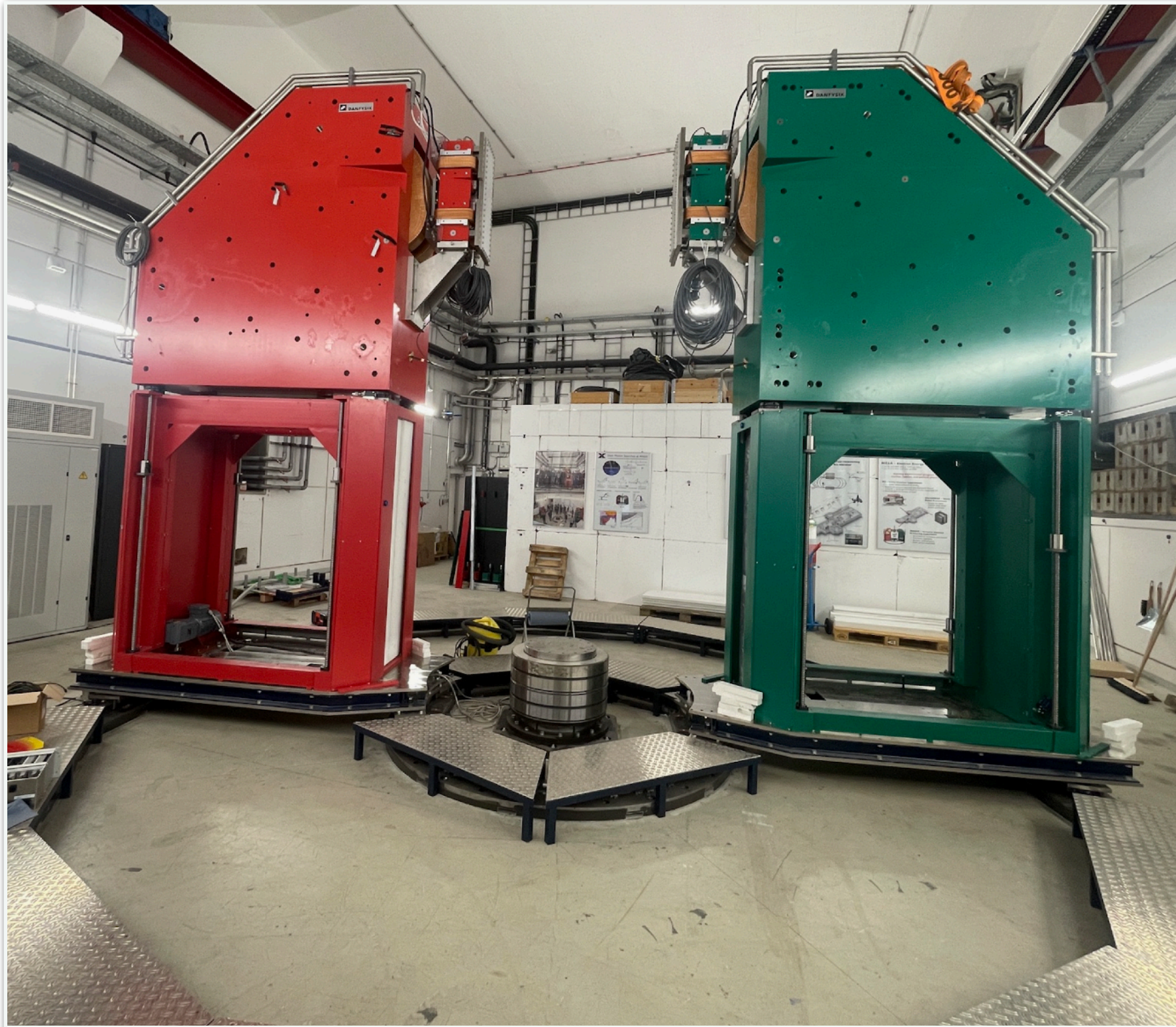
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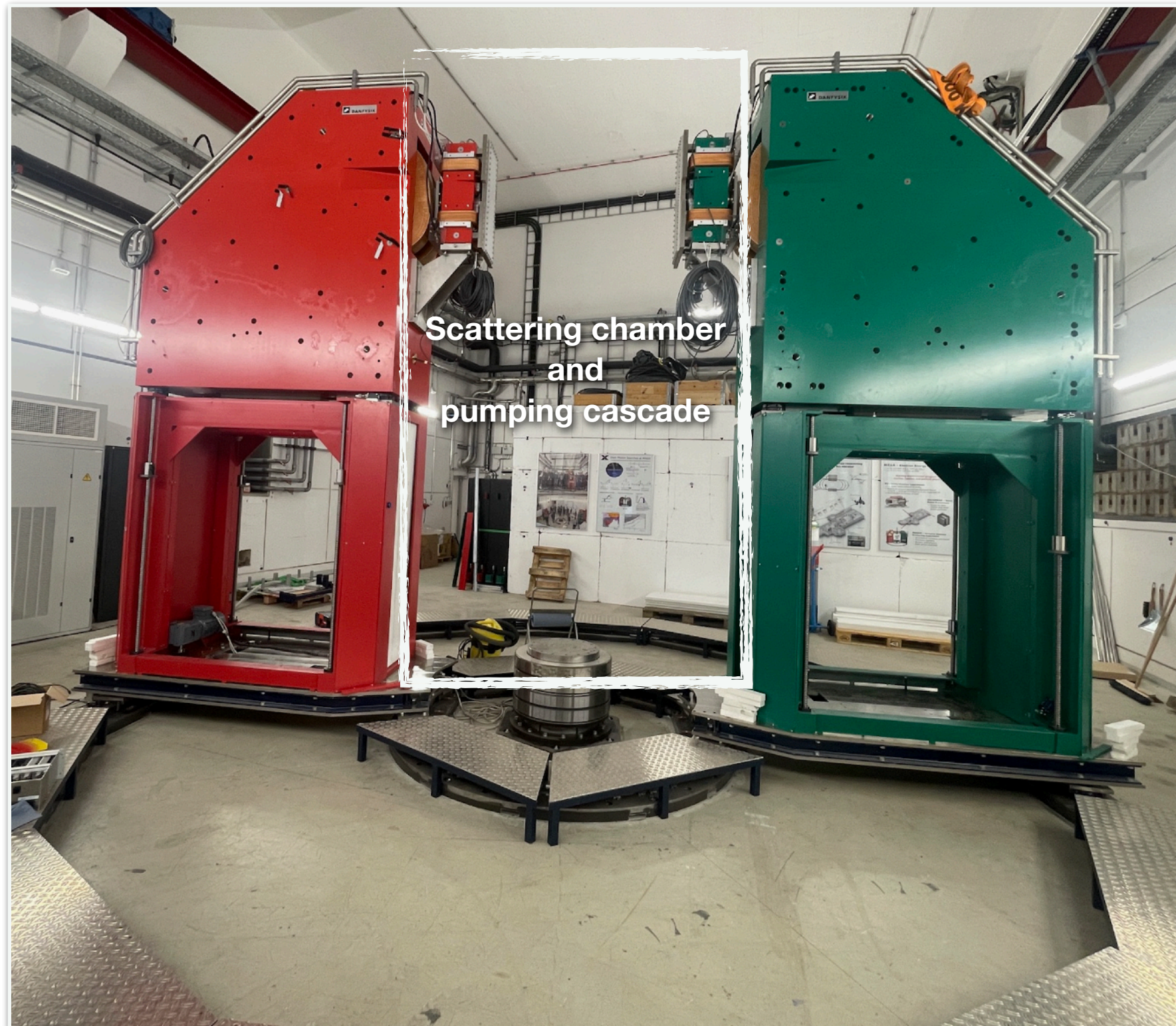
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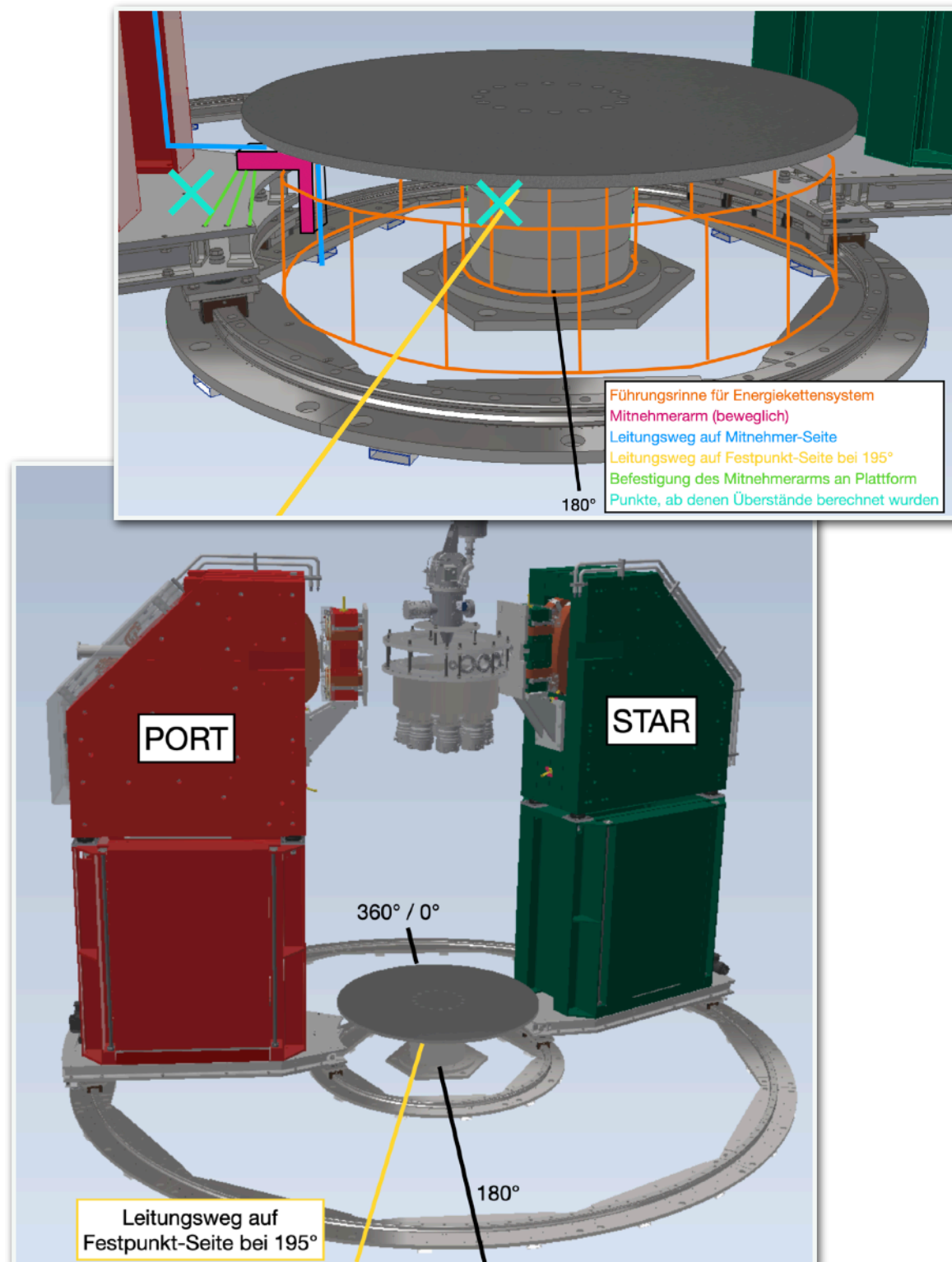
Inside the MAGIX hall.



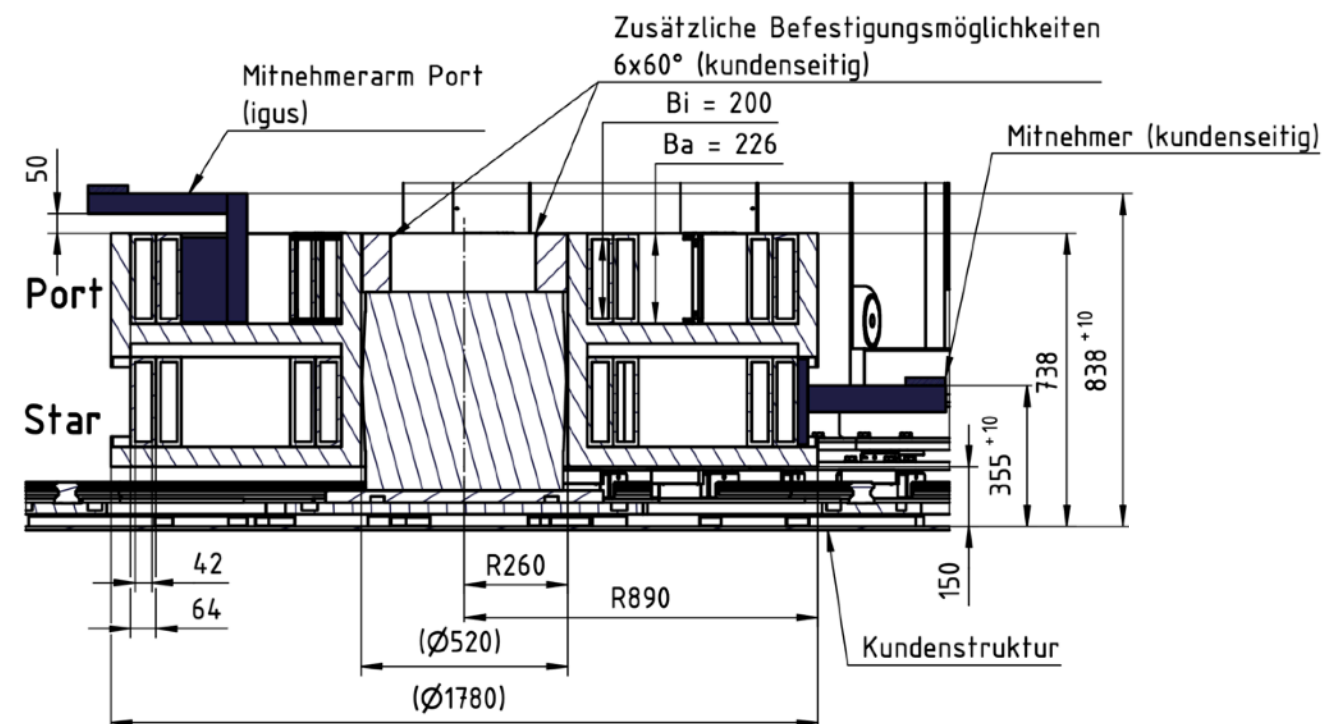
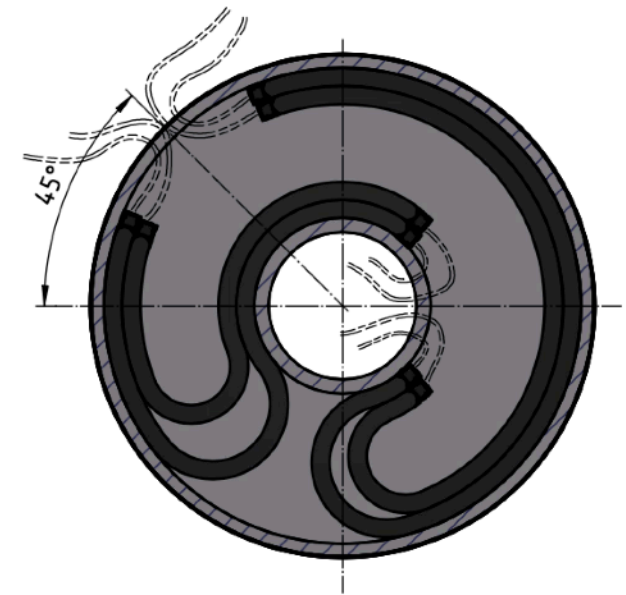
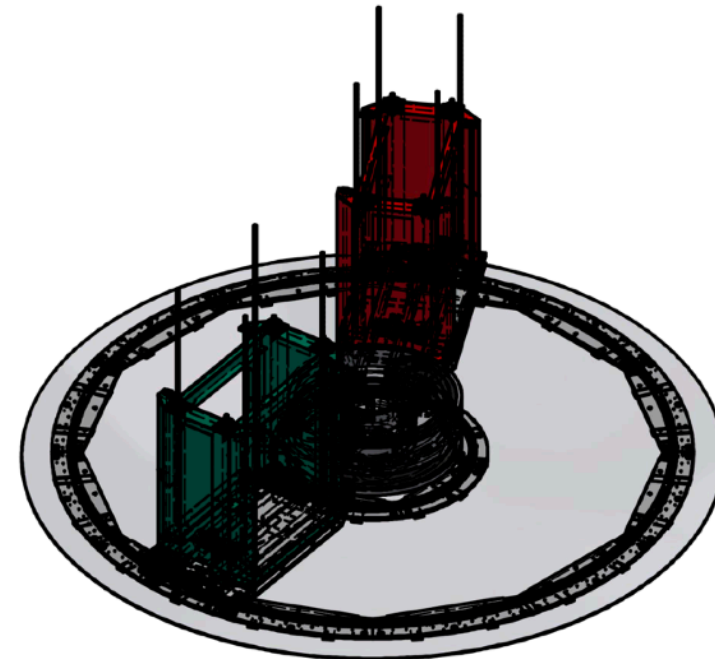
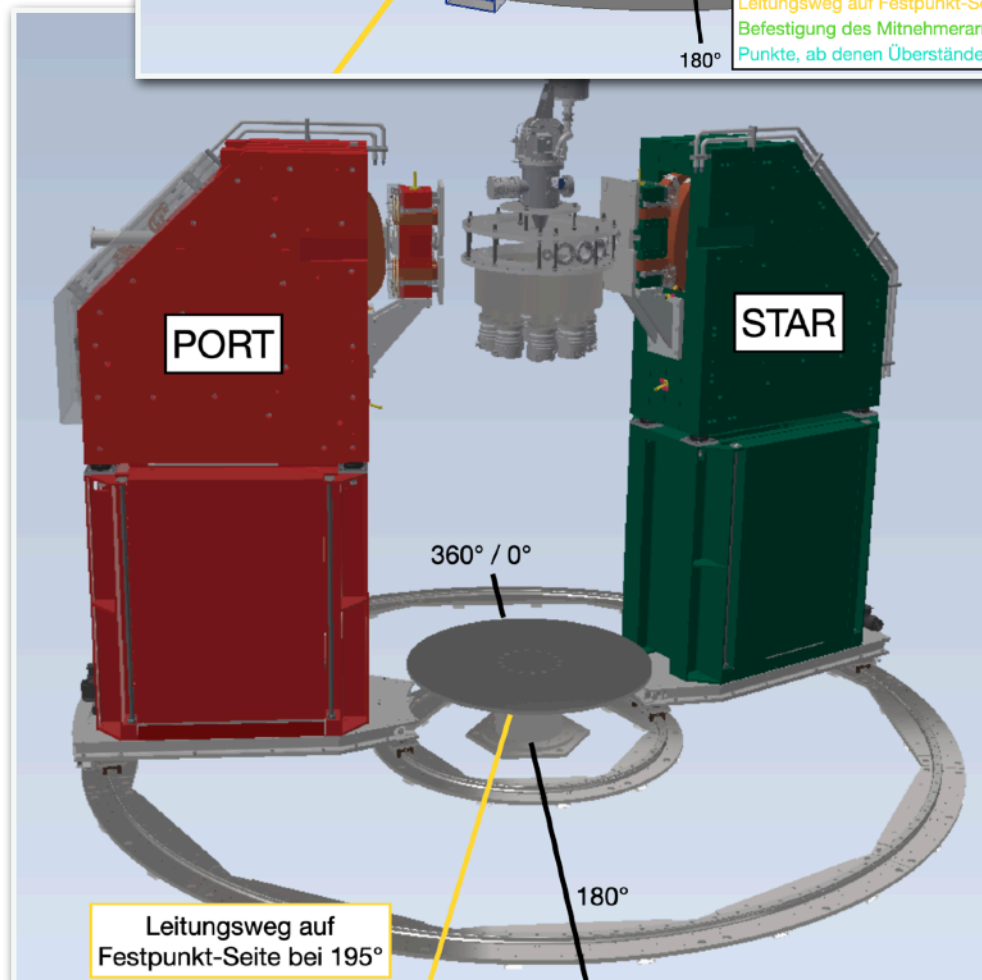
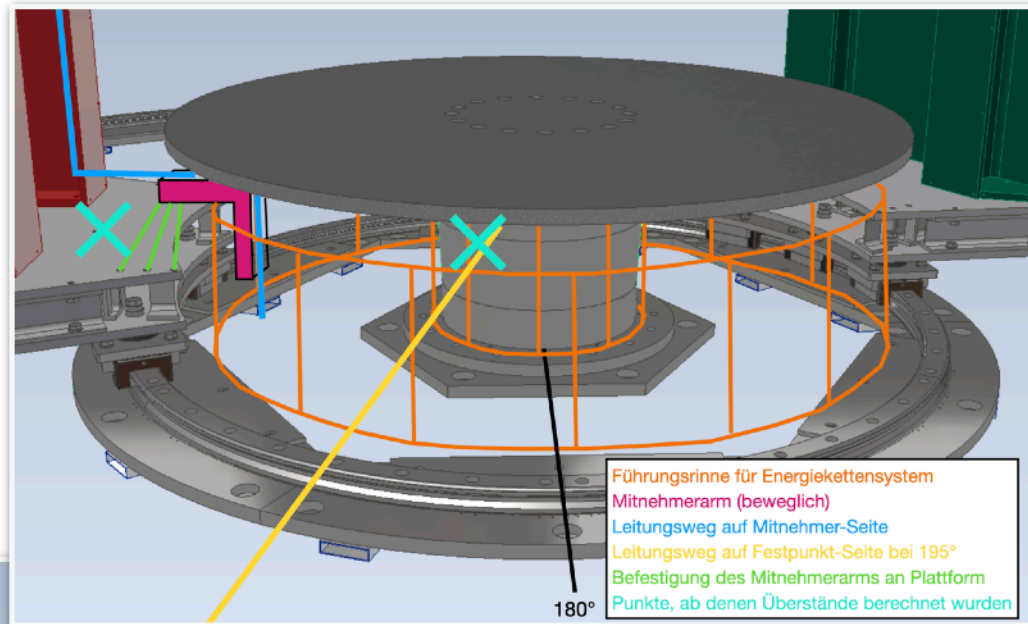
Inside the MAGIX hall.



Energy chain system.

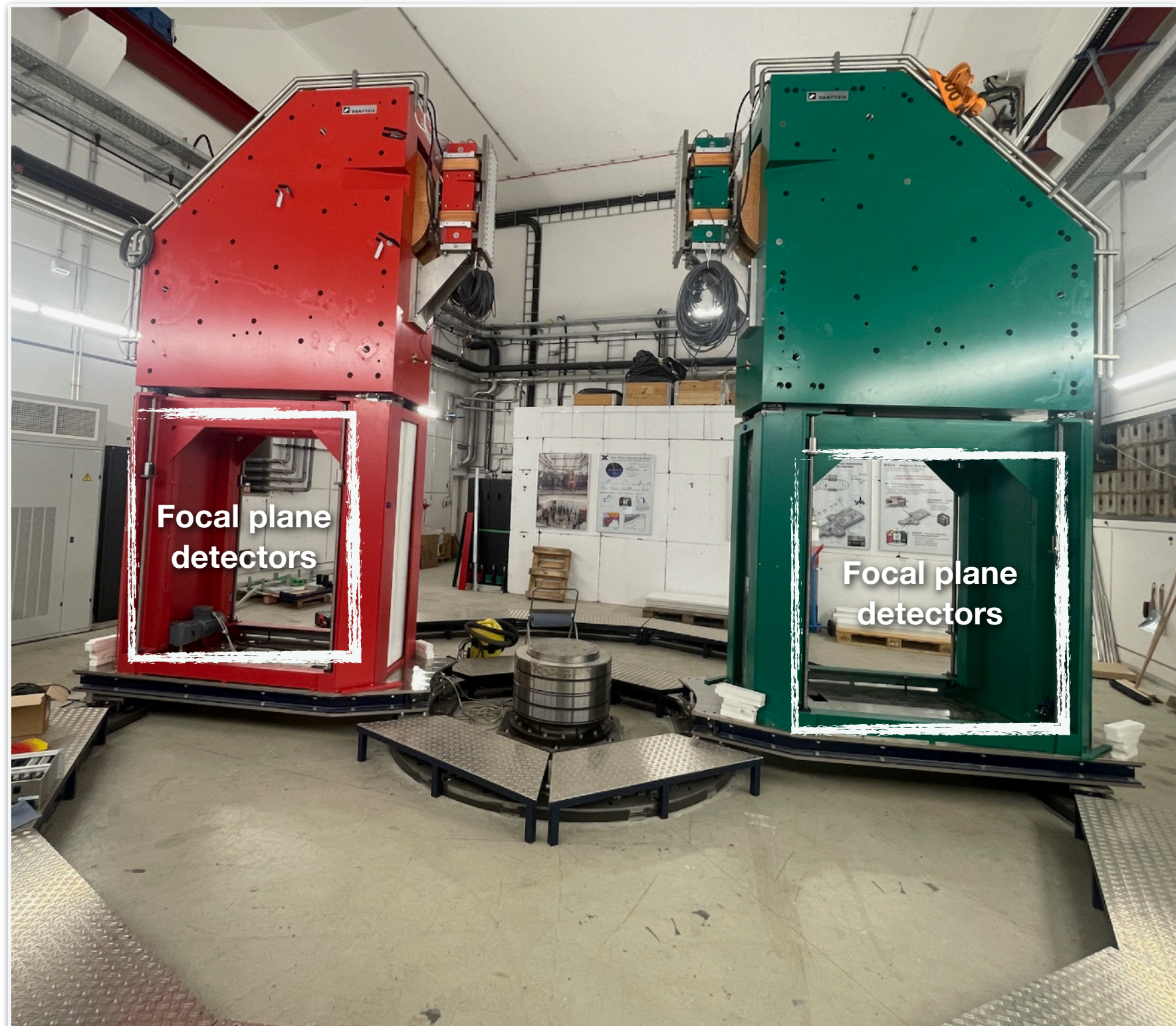


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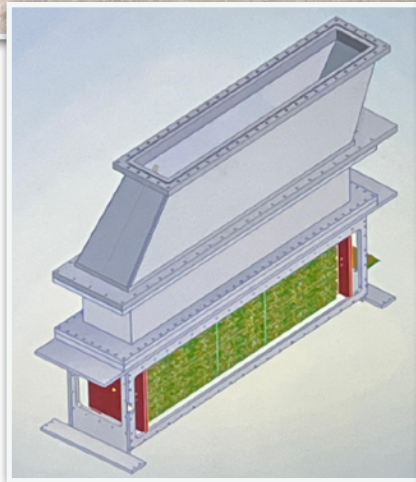
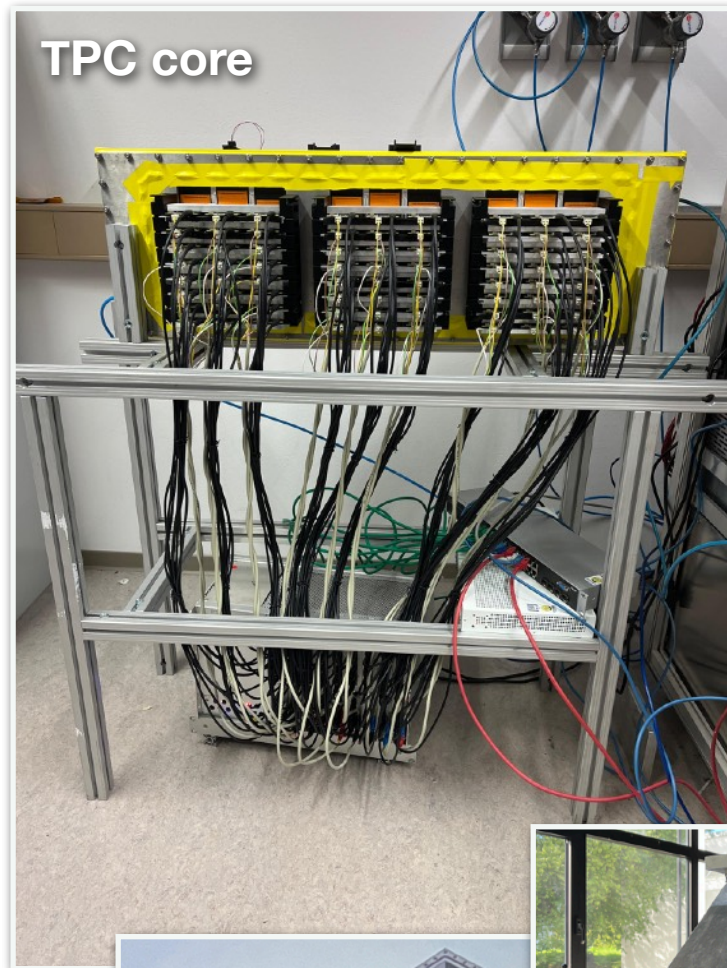


- Delivery and installation until Jan/Feb 2026

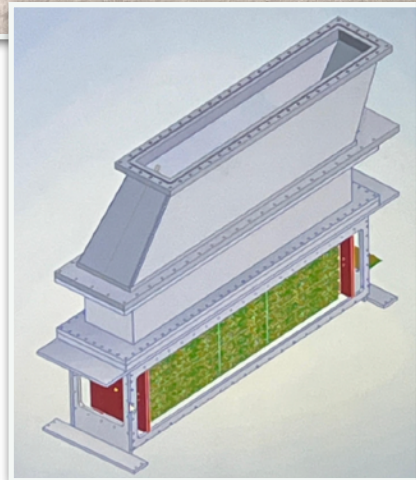
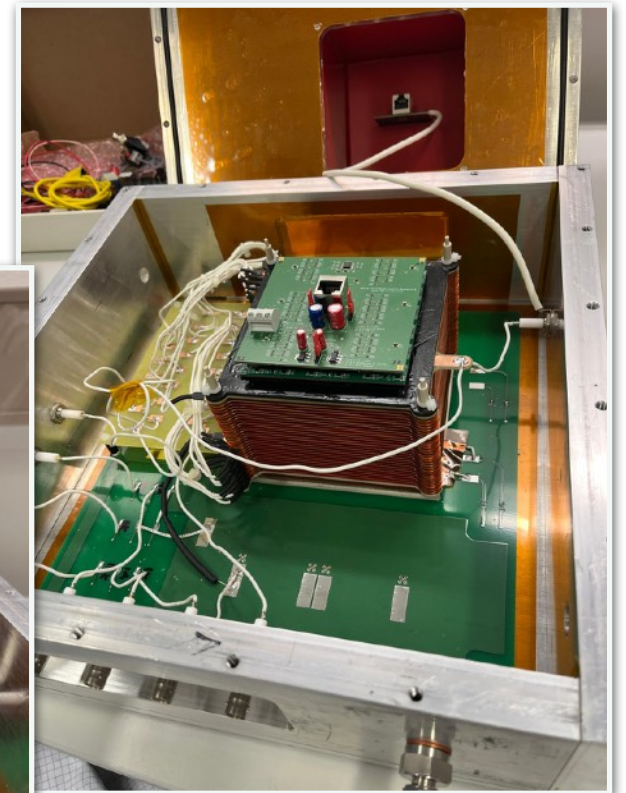
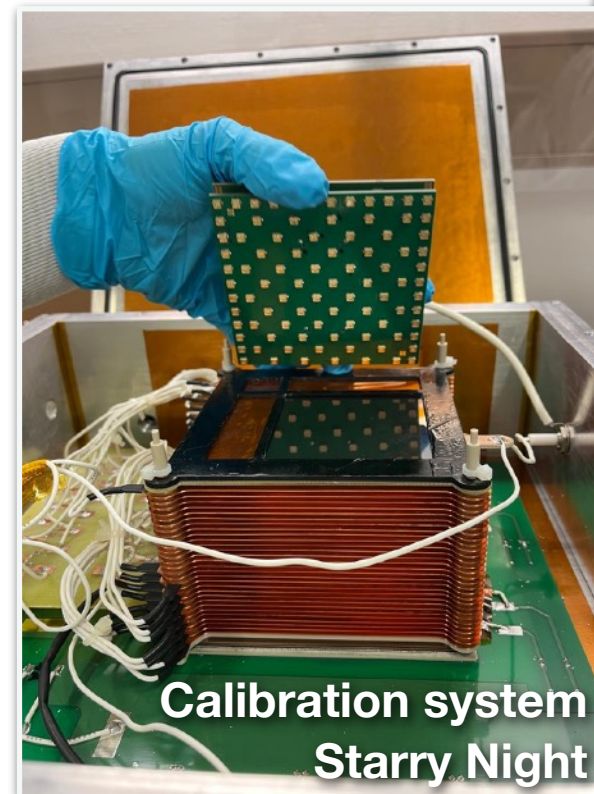
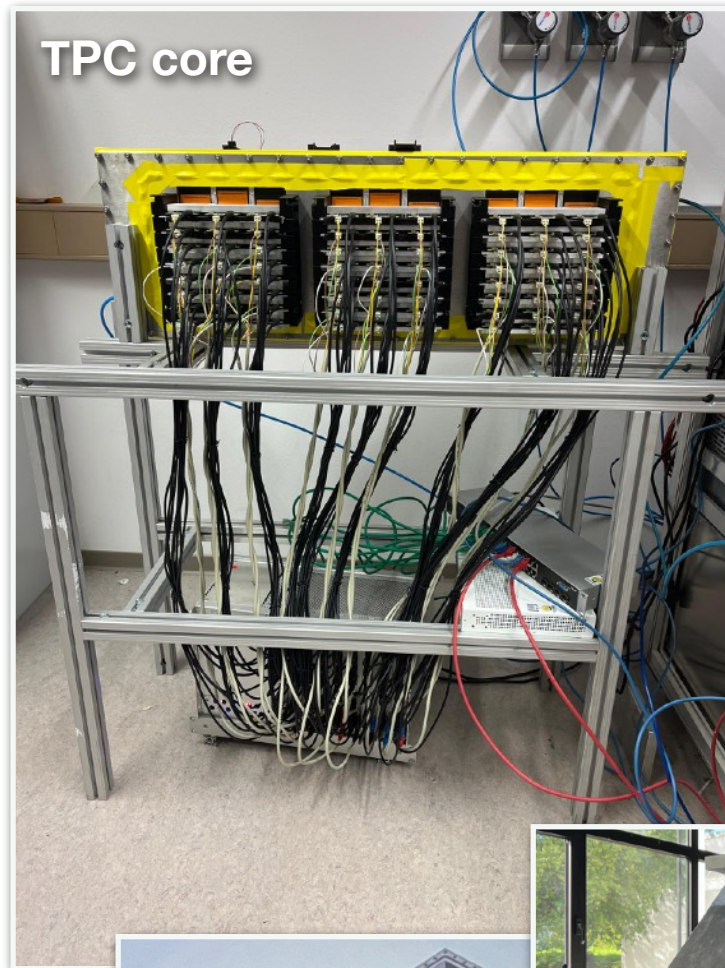
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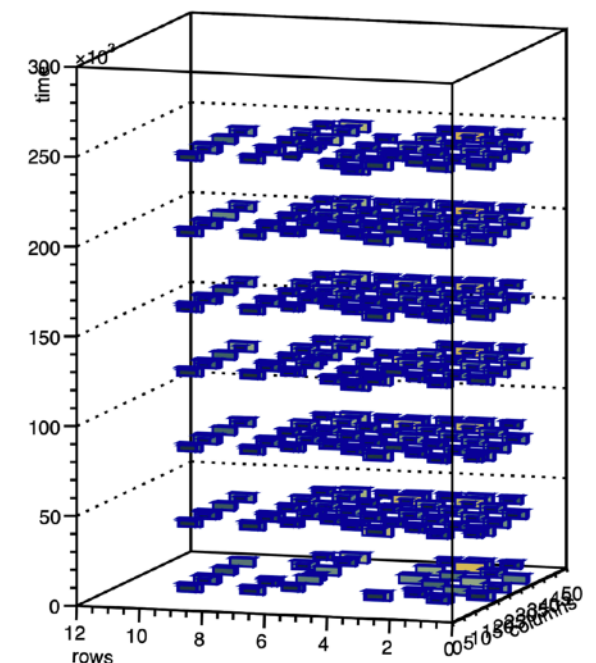
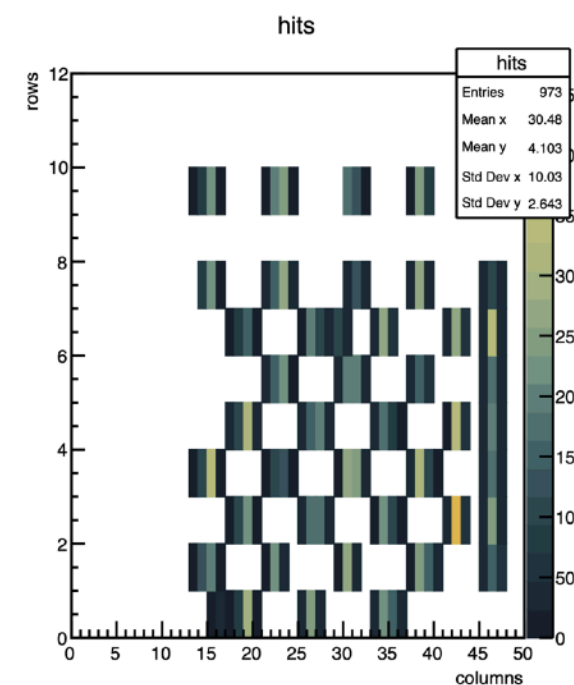
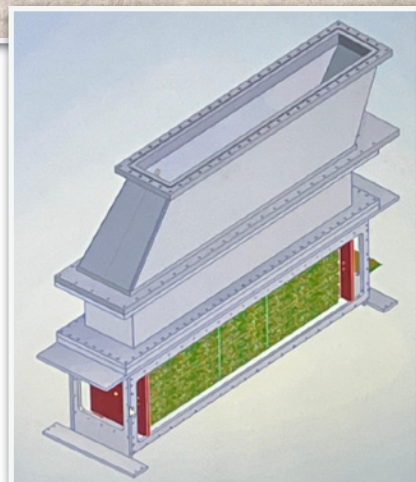
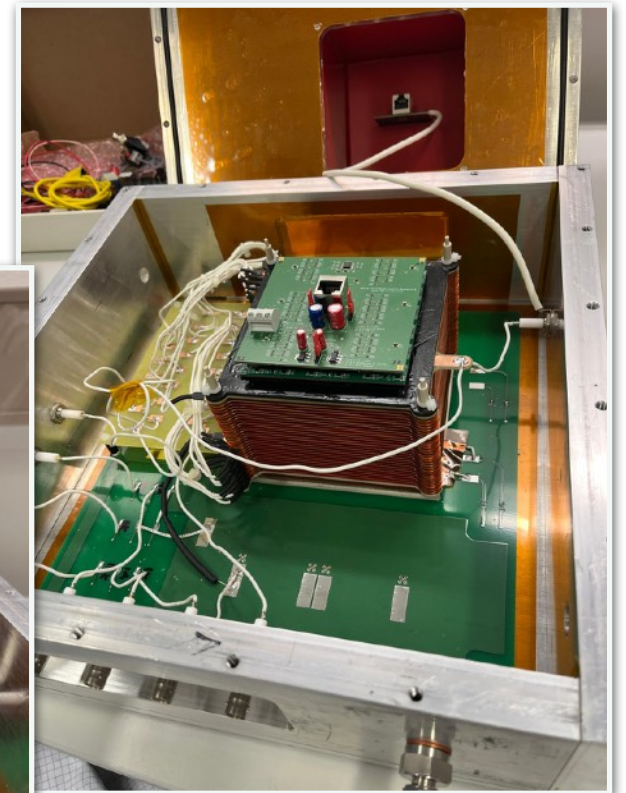
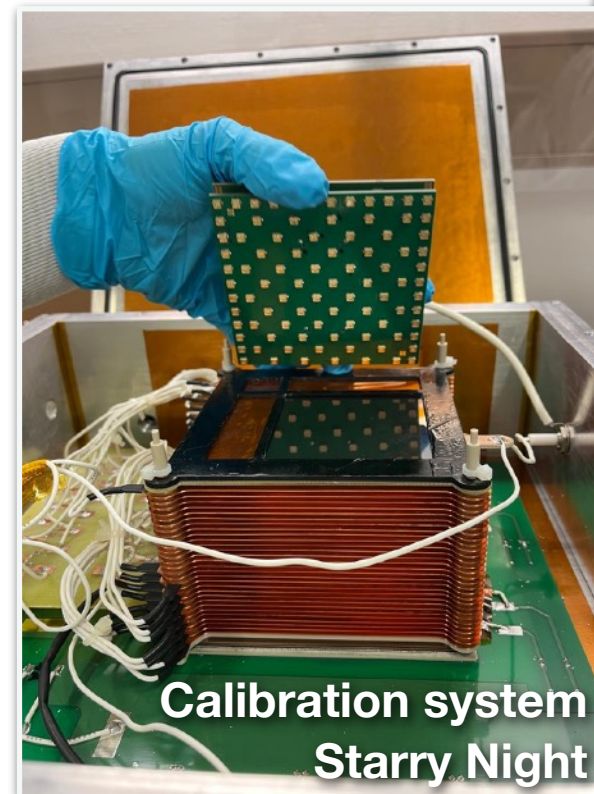
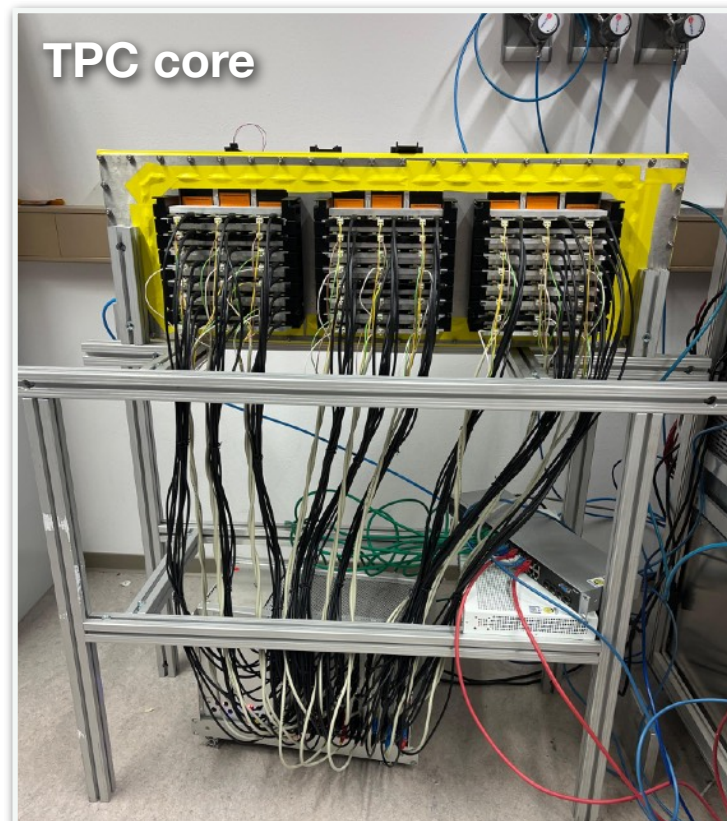
Focal plane detectors - TPC.



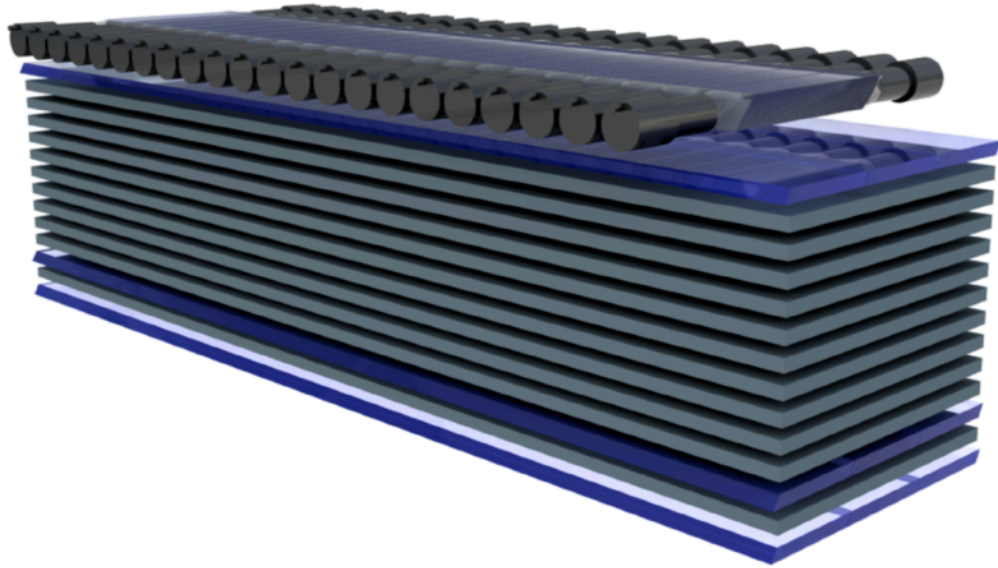
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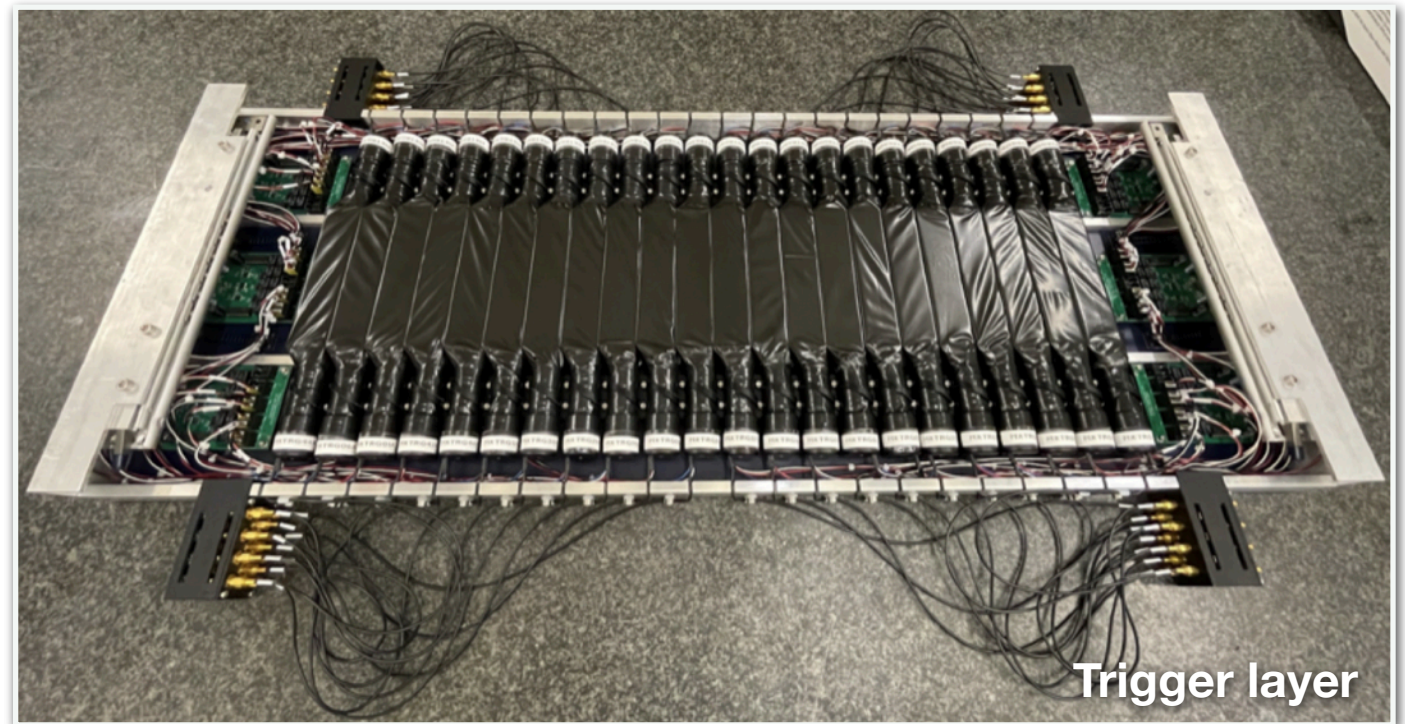
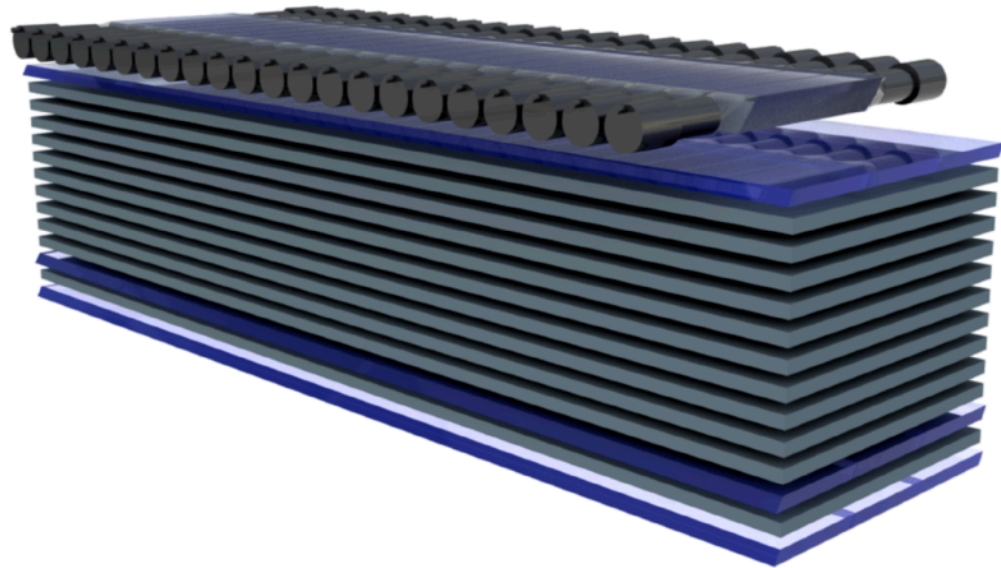
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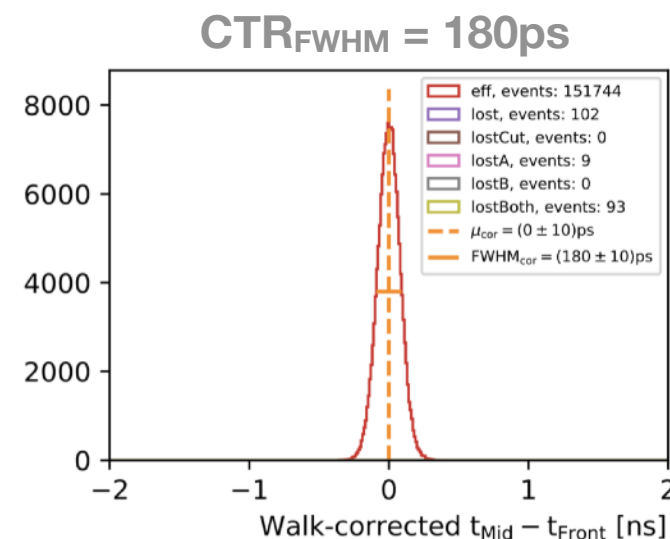
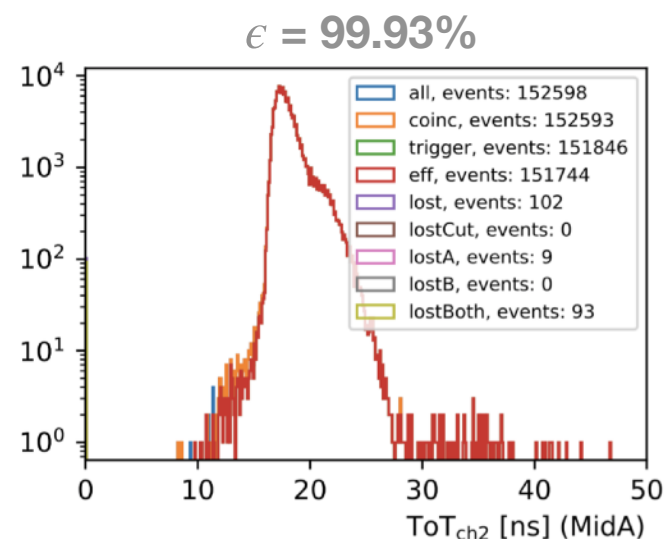
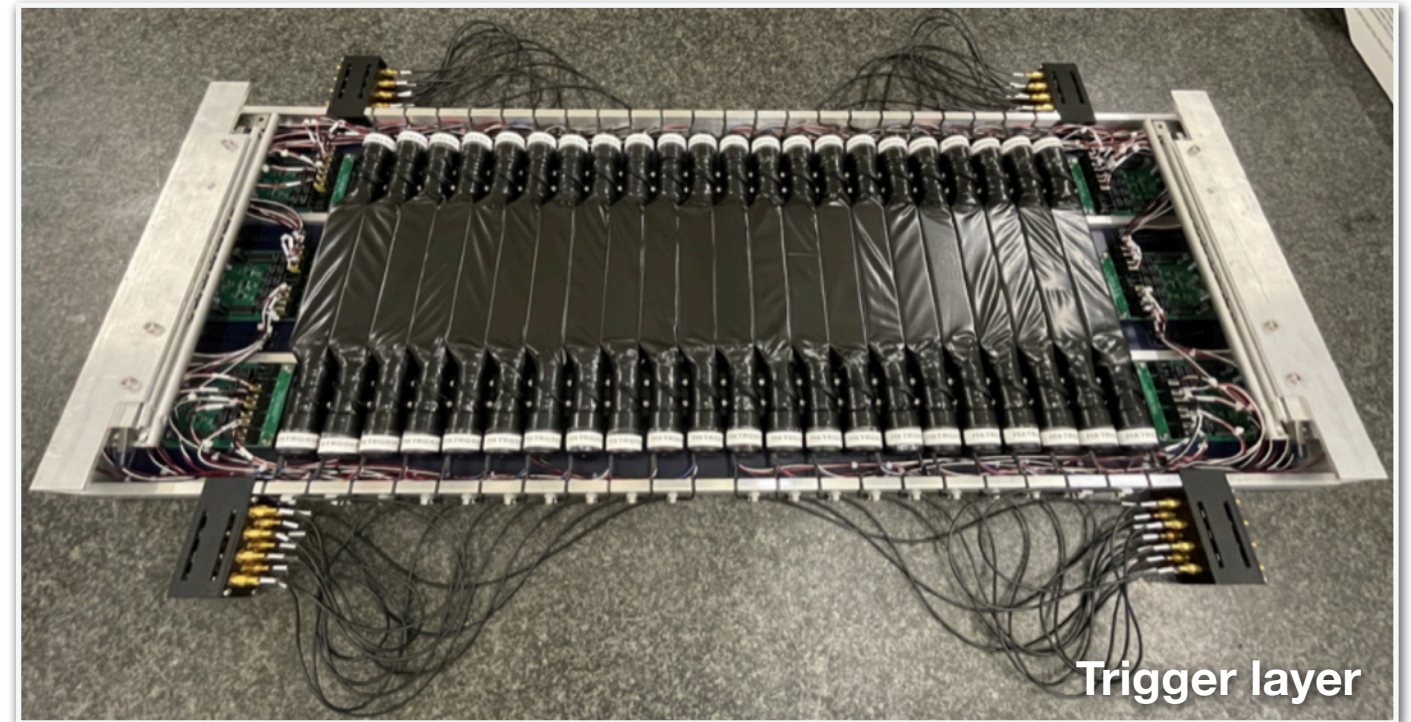
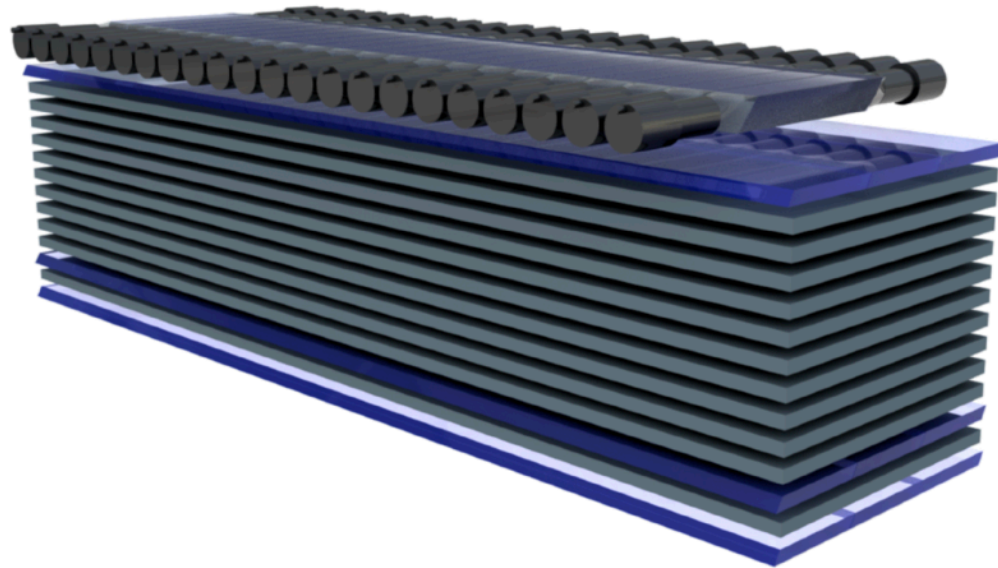
Focal plane detectors - Trigger veto system.



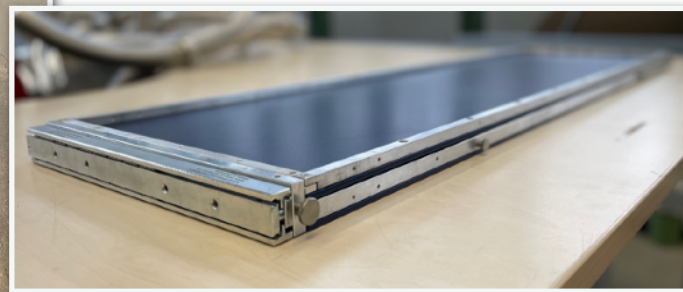
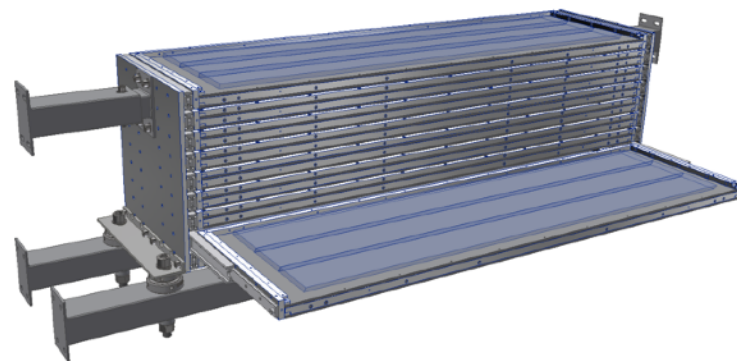
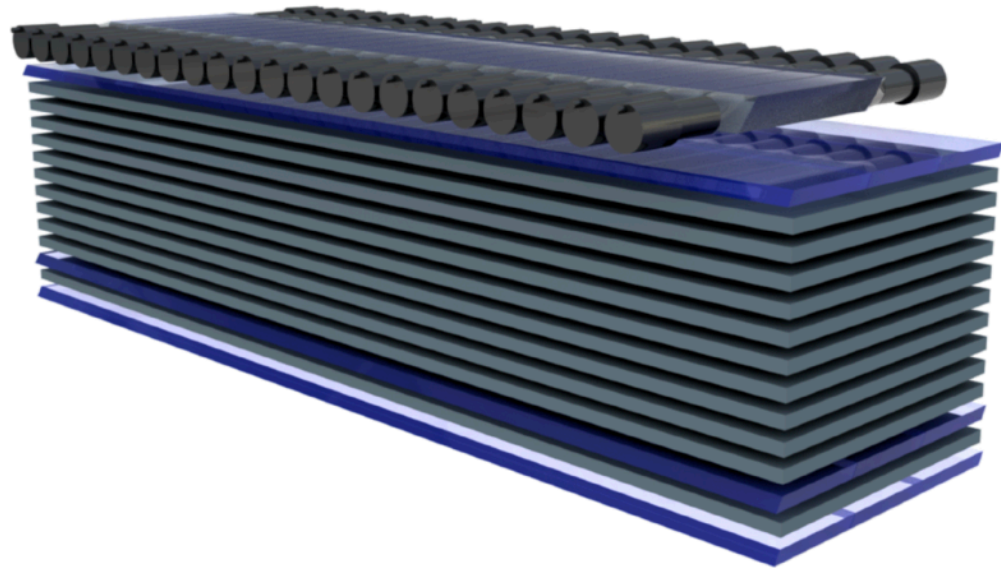
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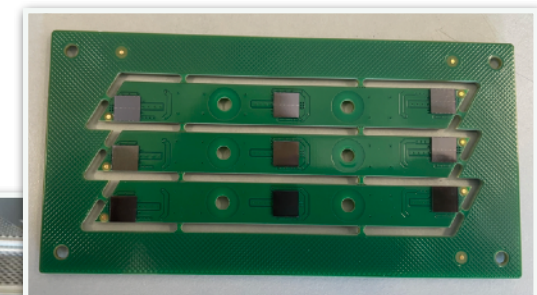
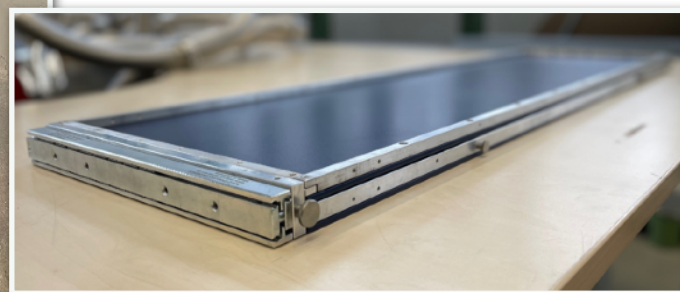
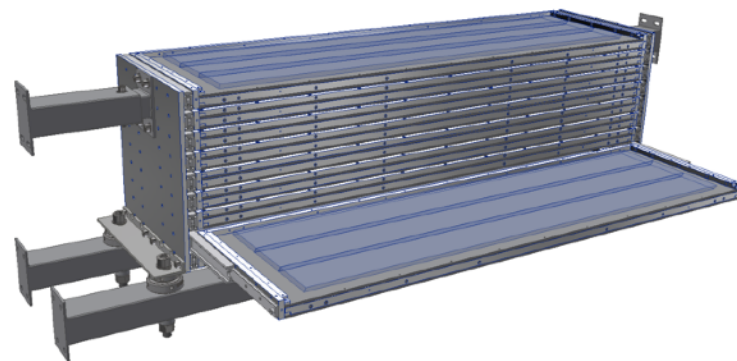
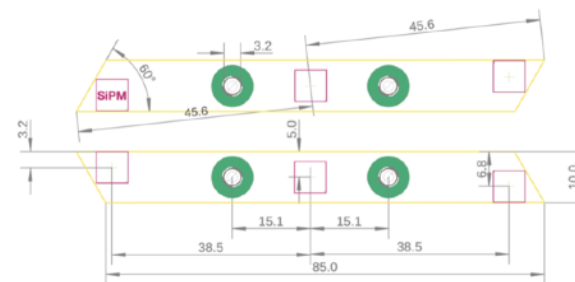
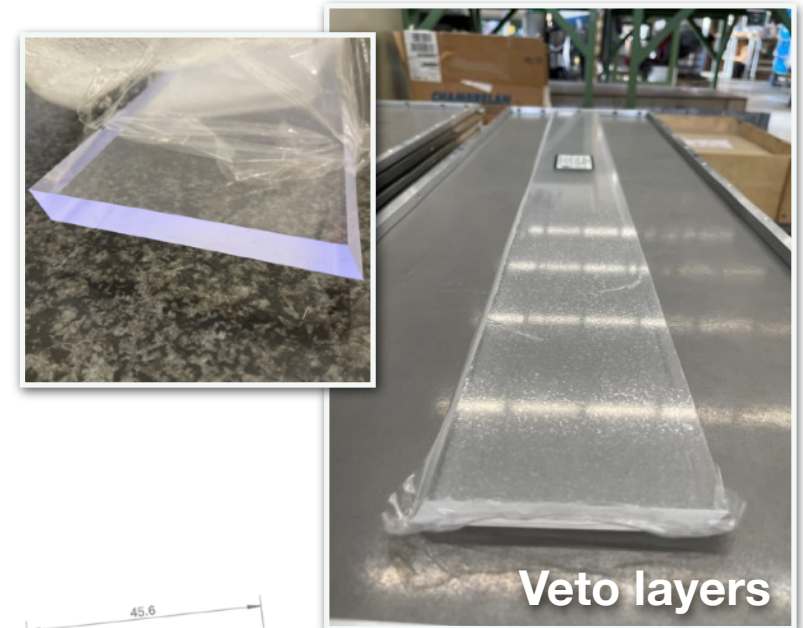
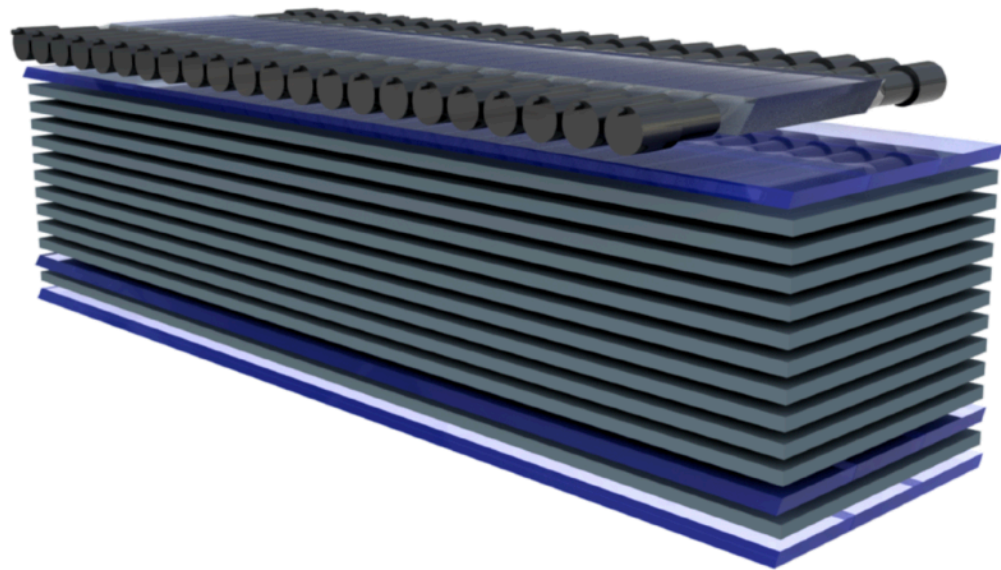
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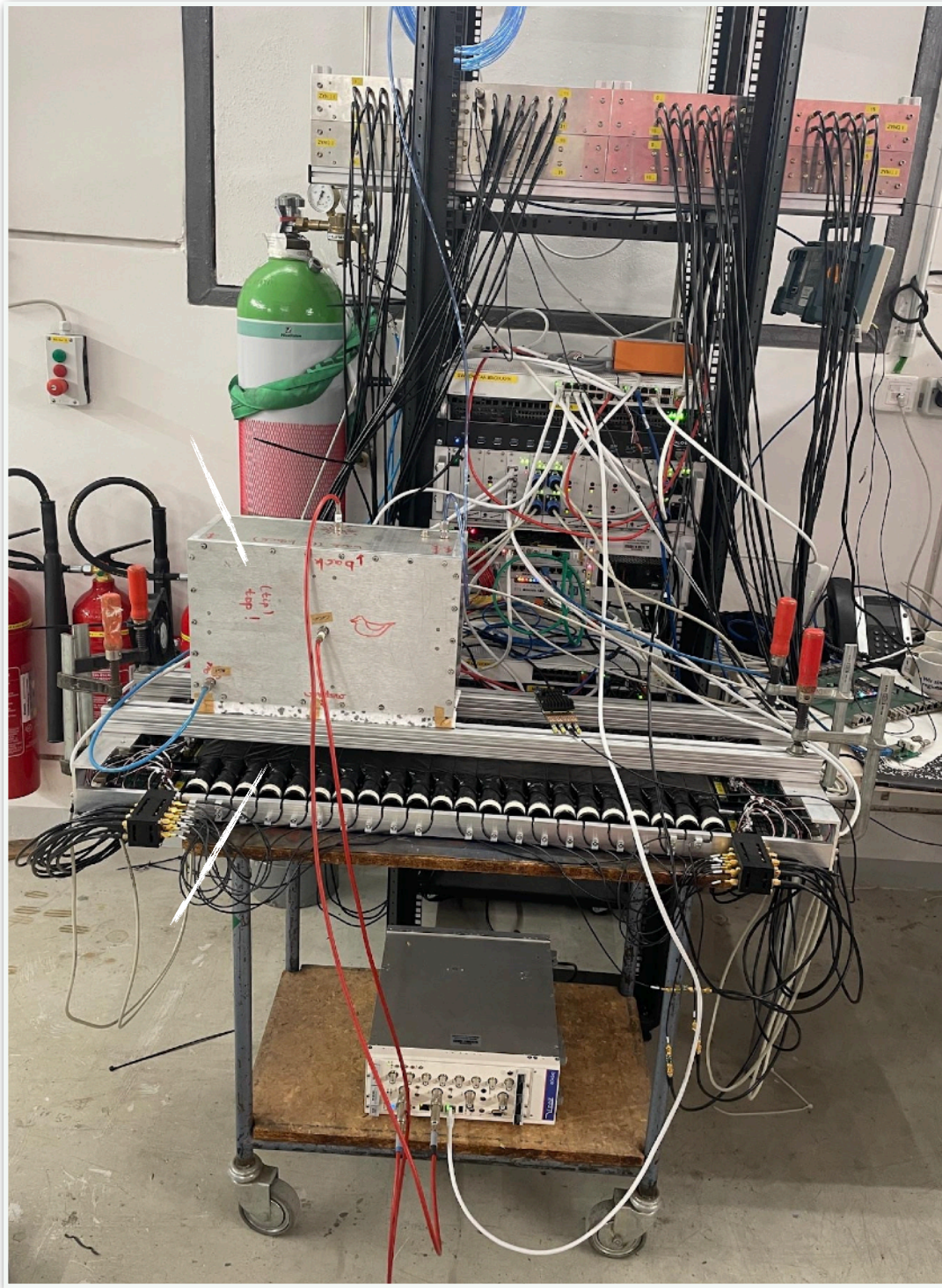
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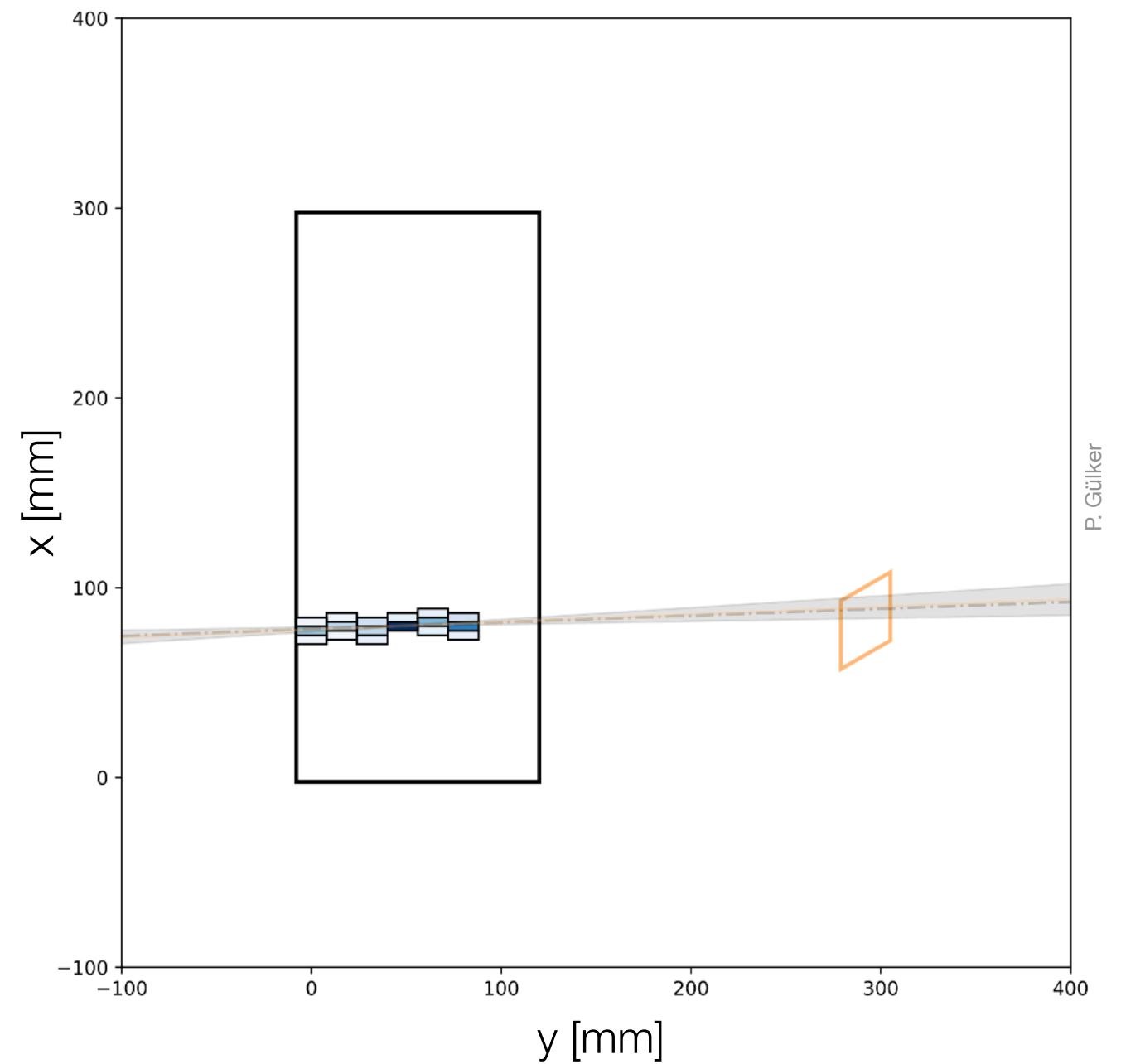
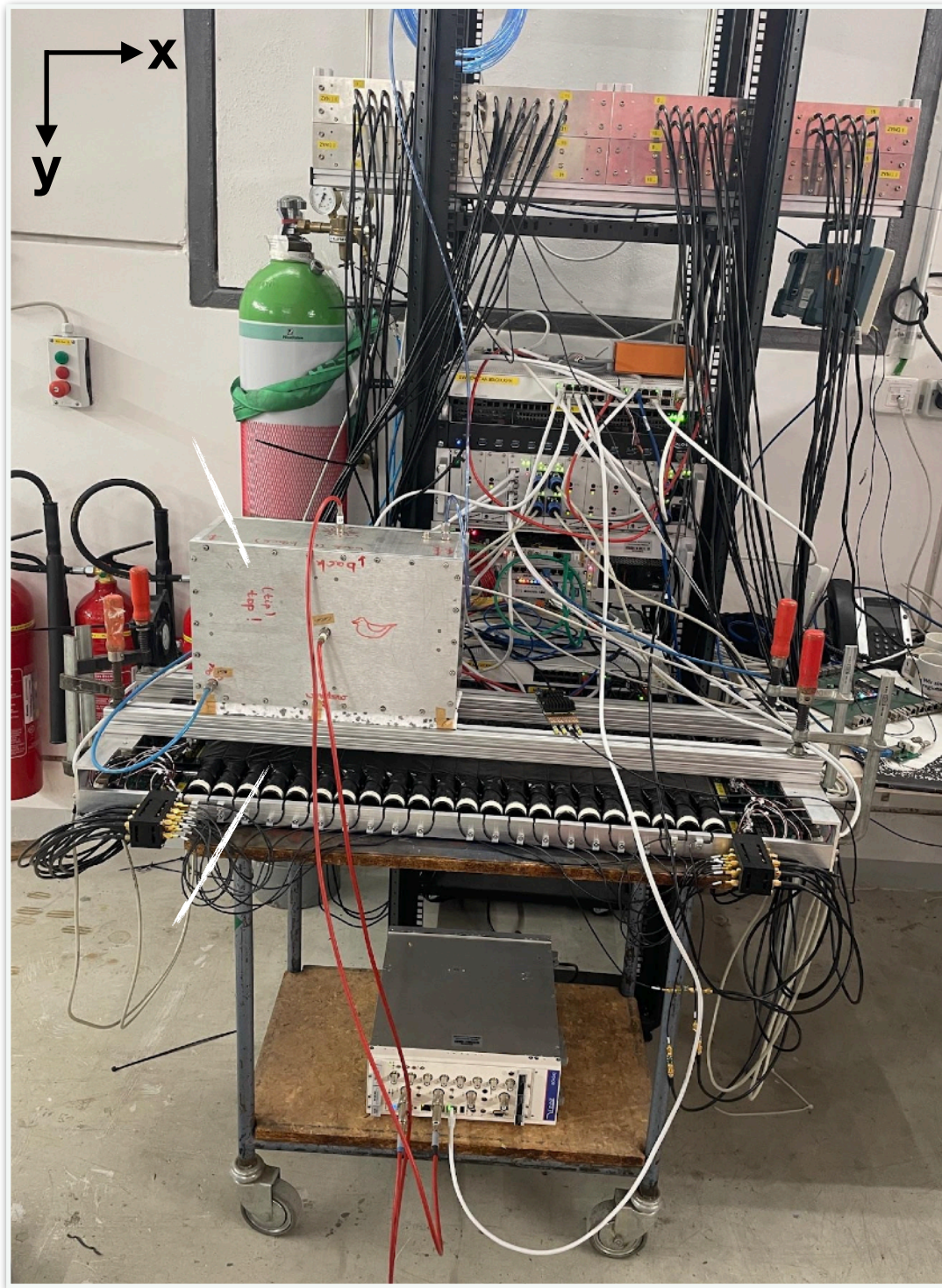
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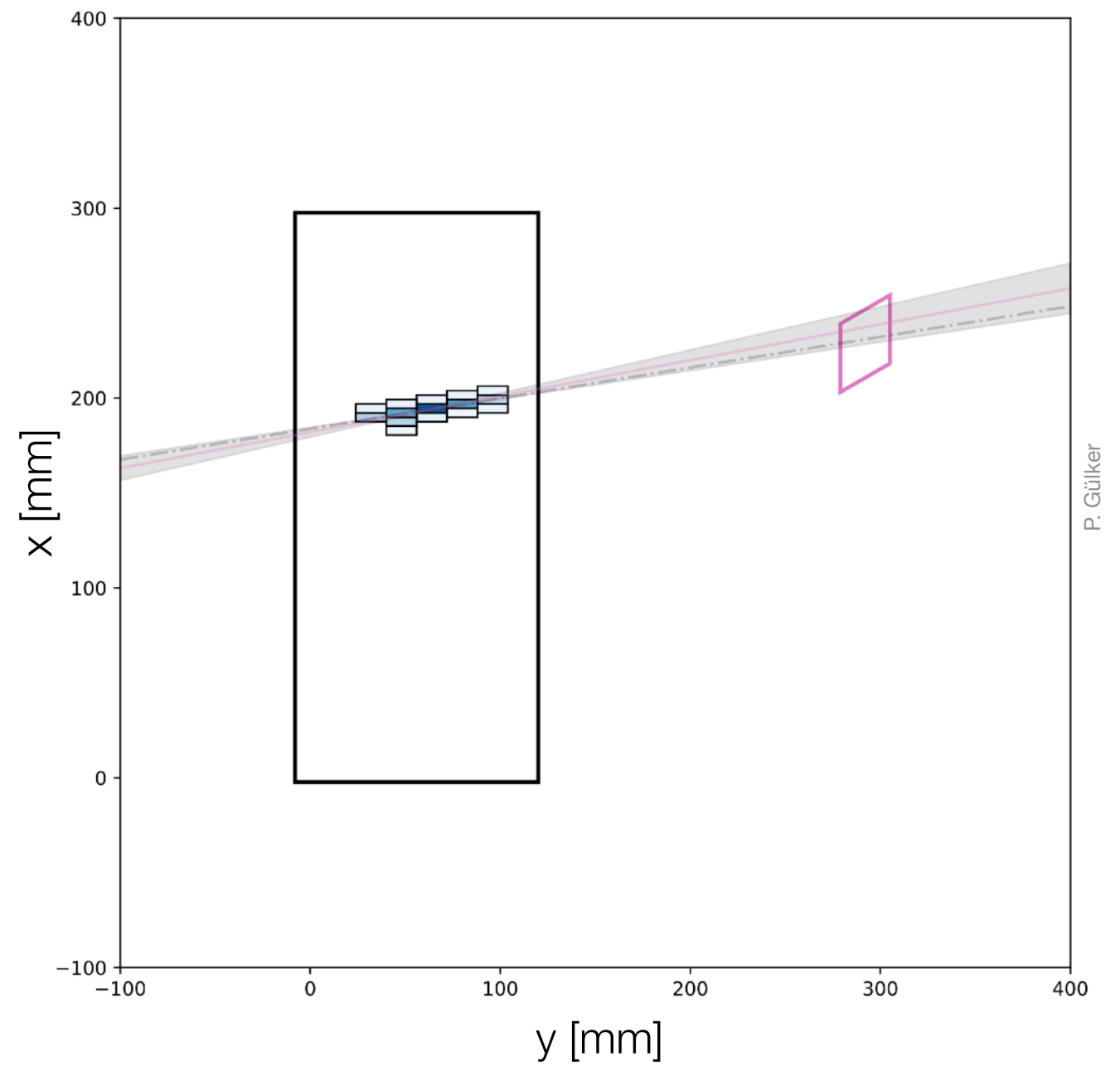
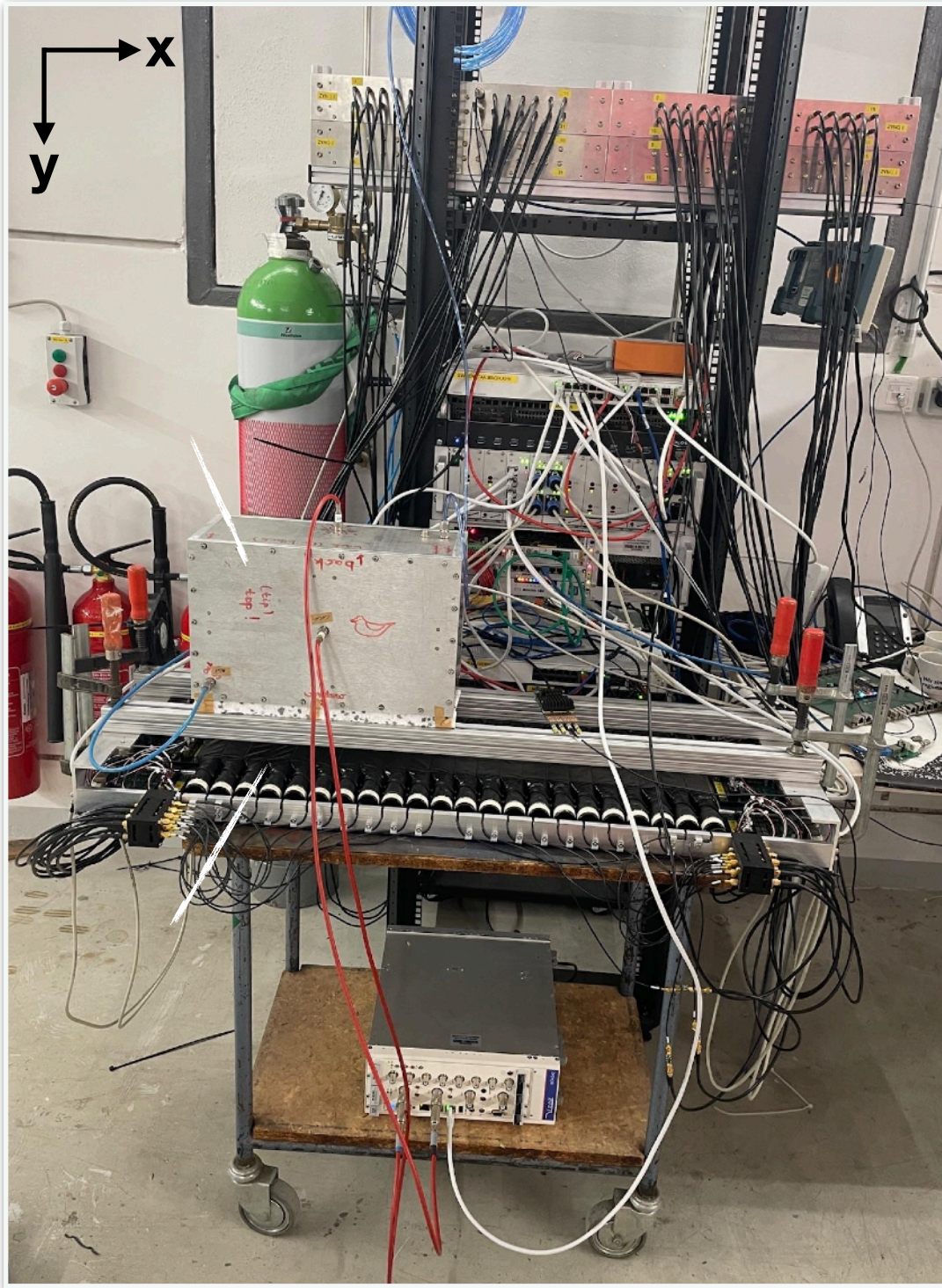
Combining both DAQs.



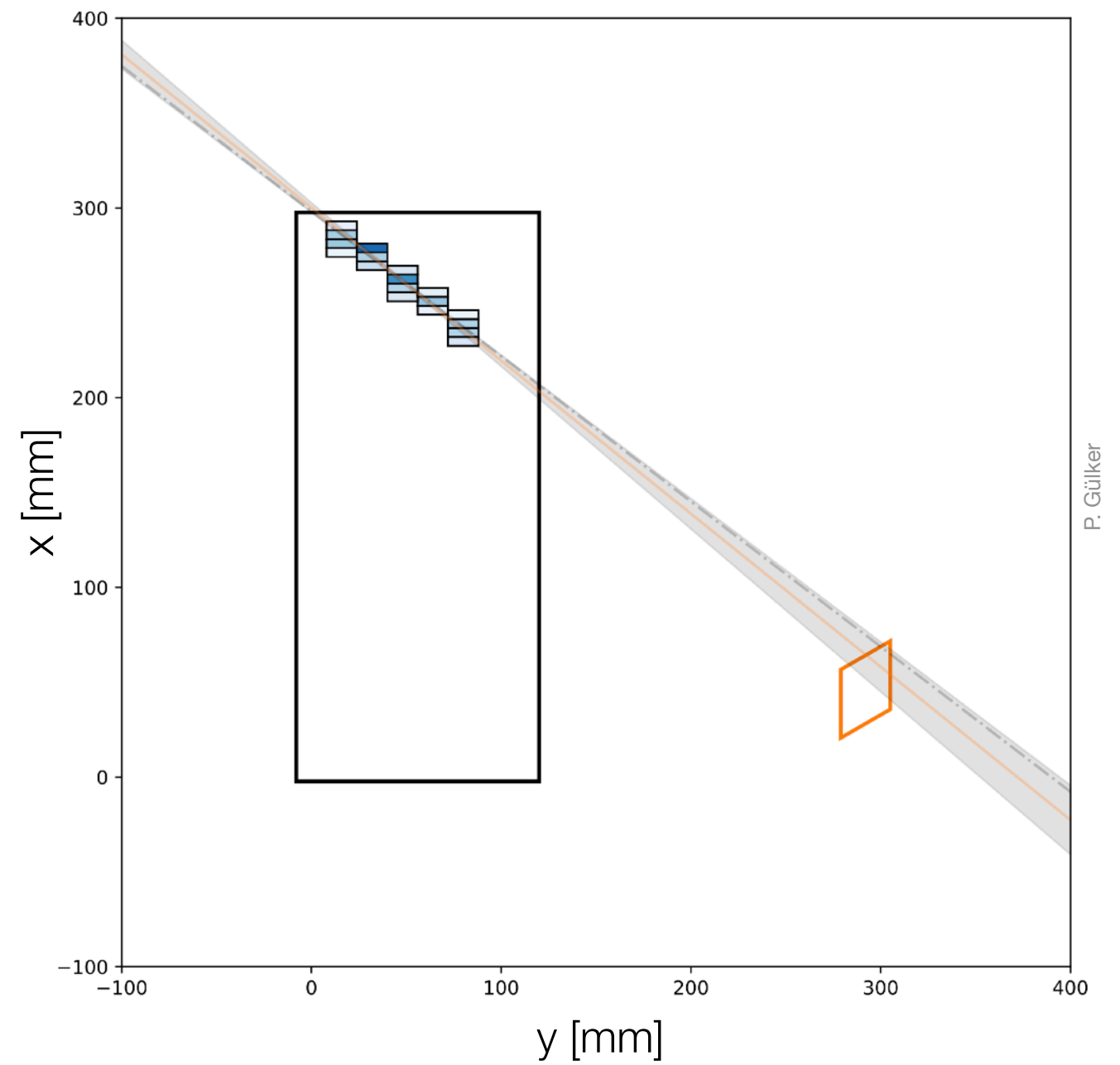
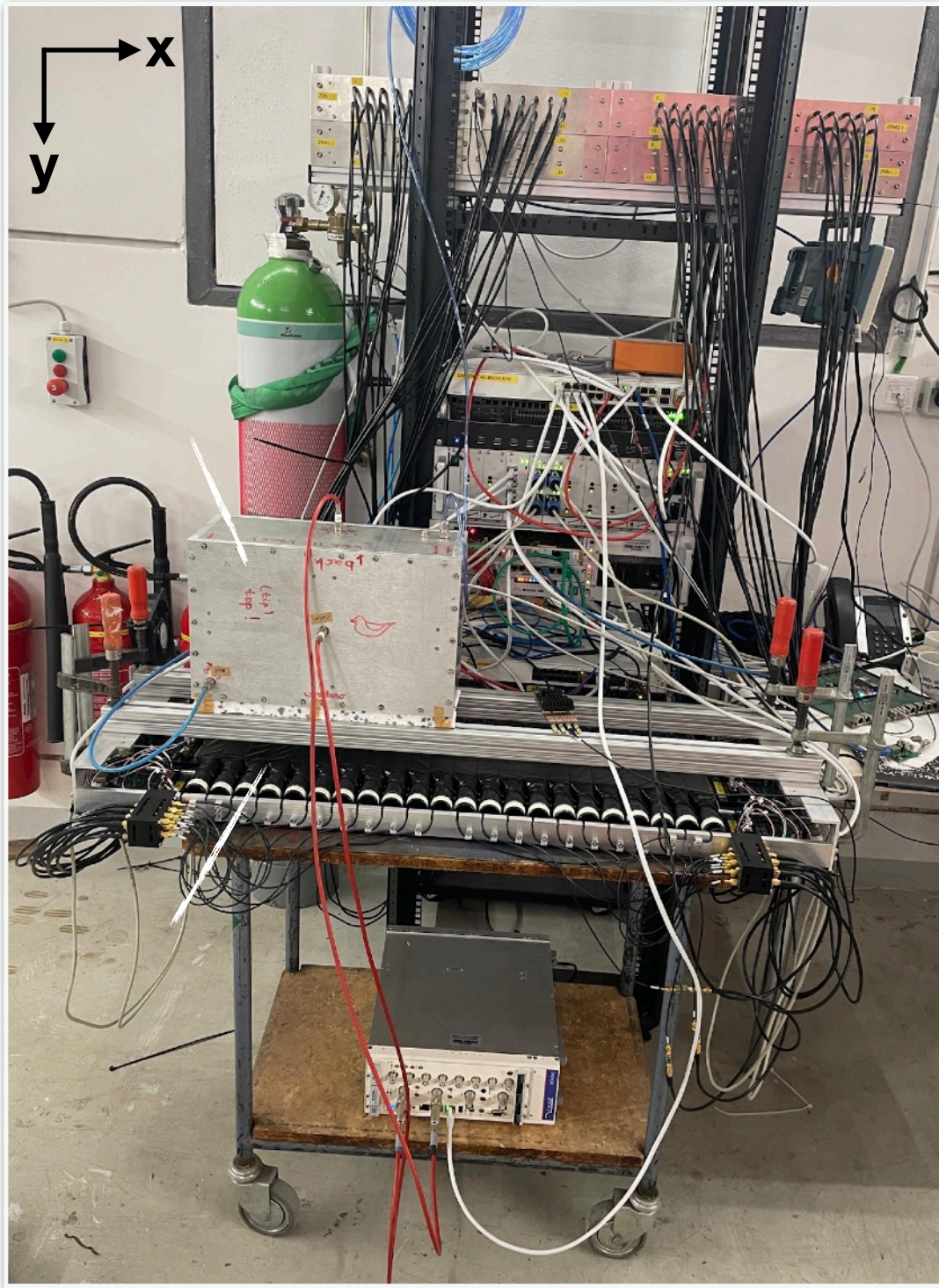
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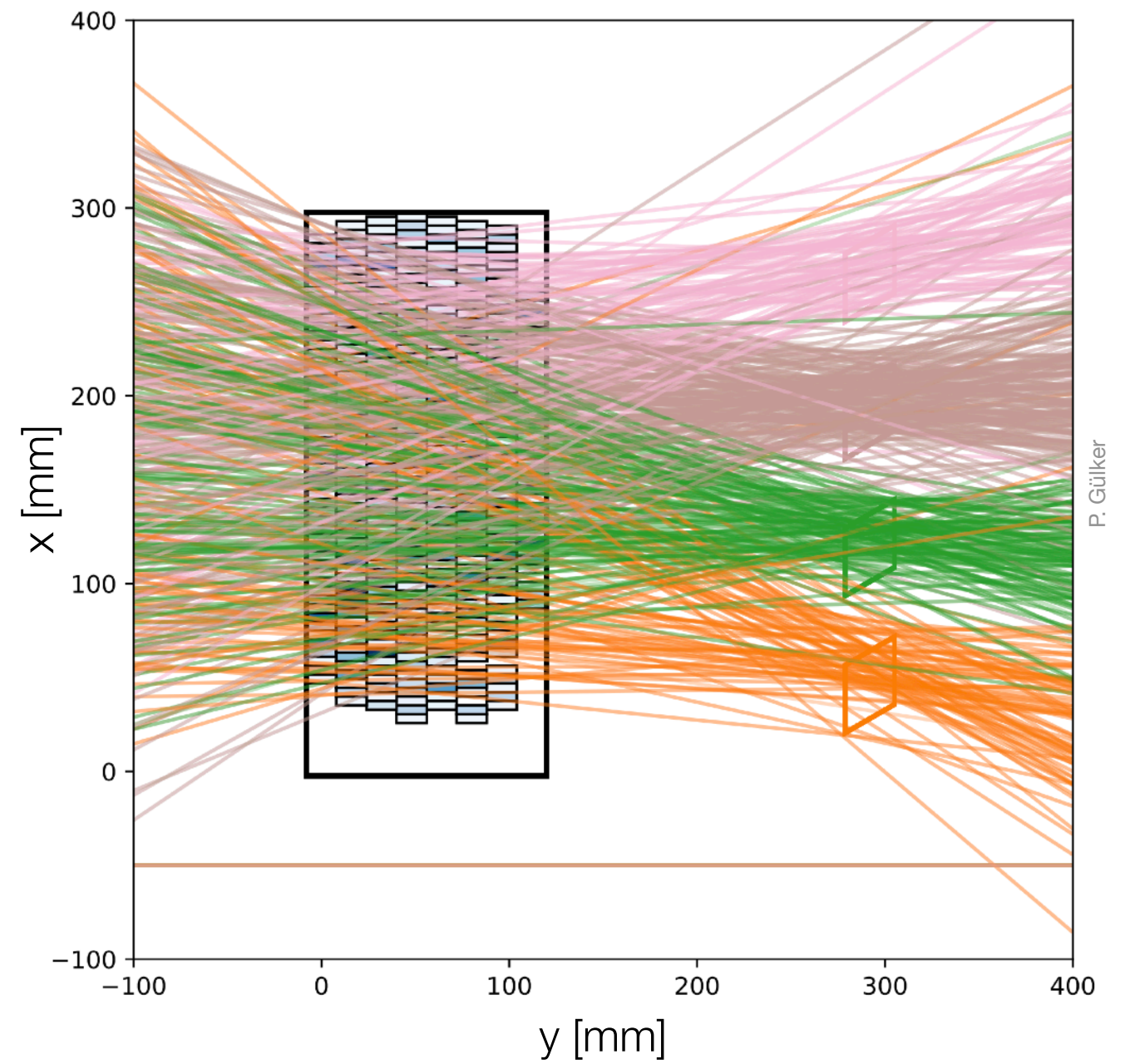
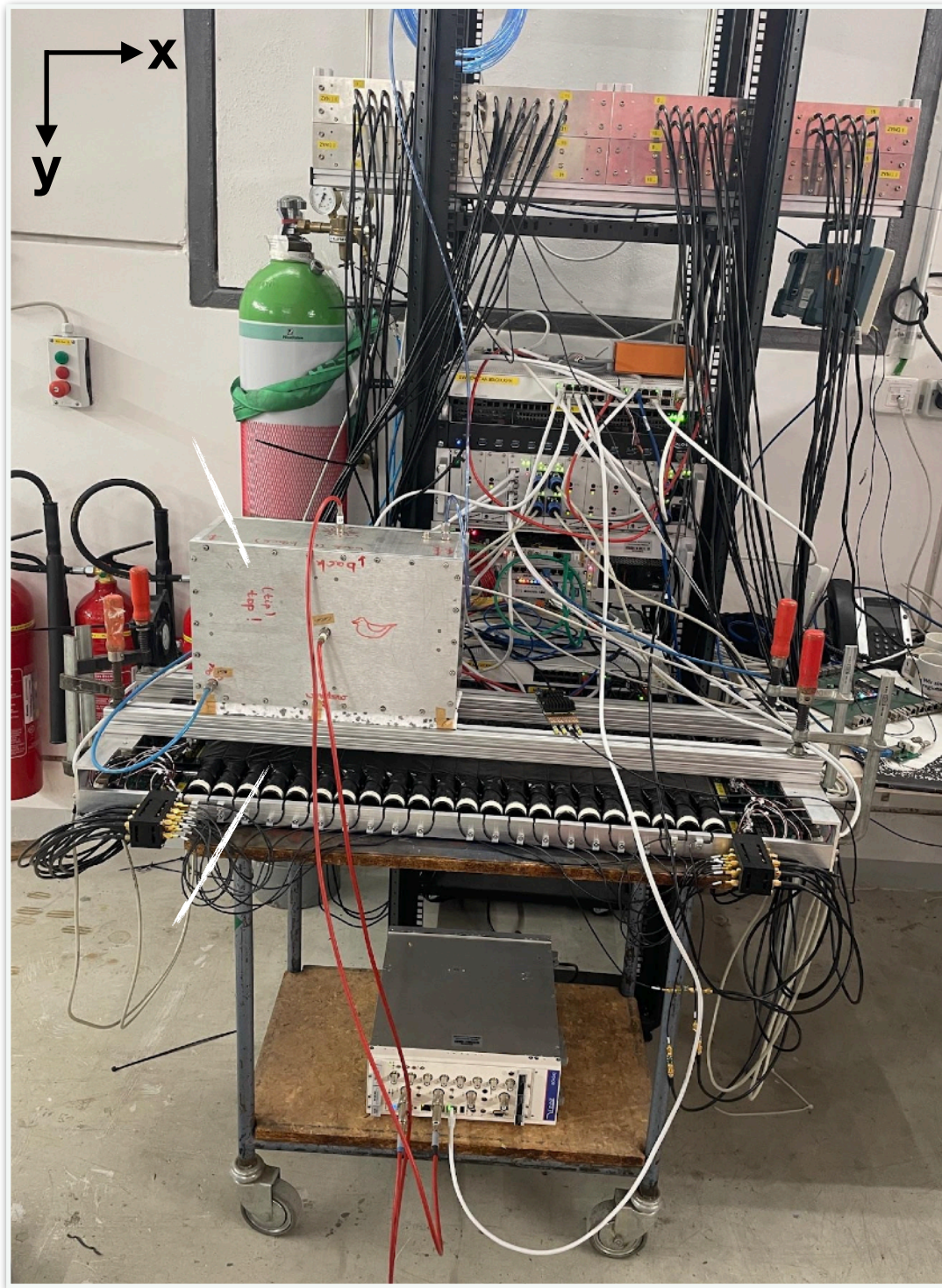
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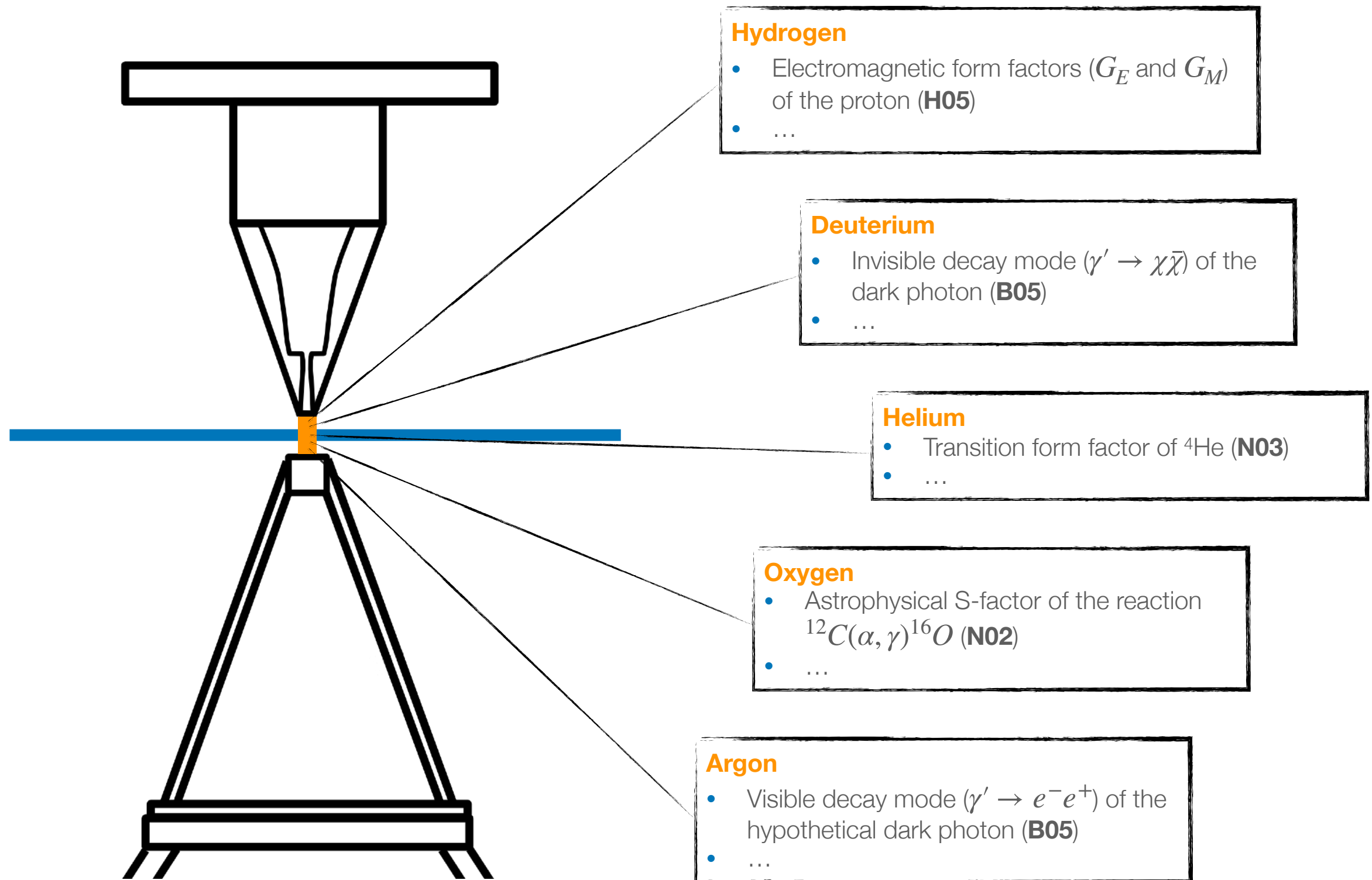
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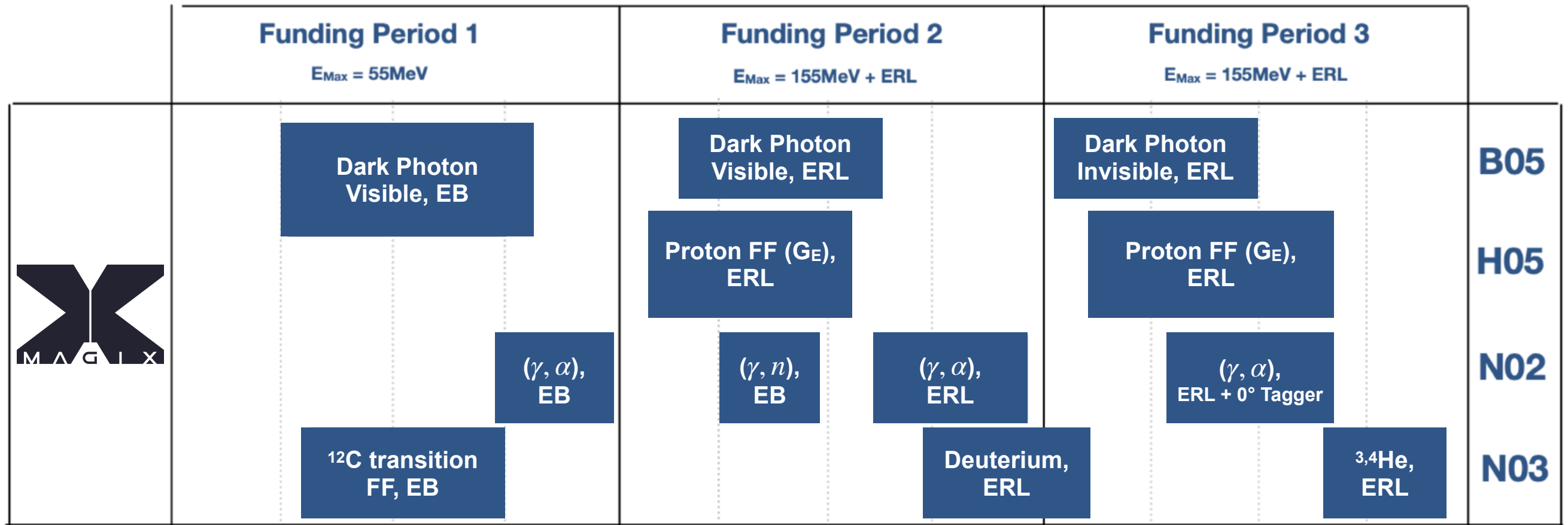
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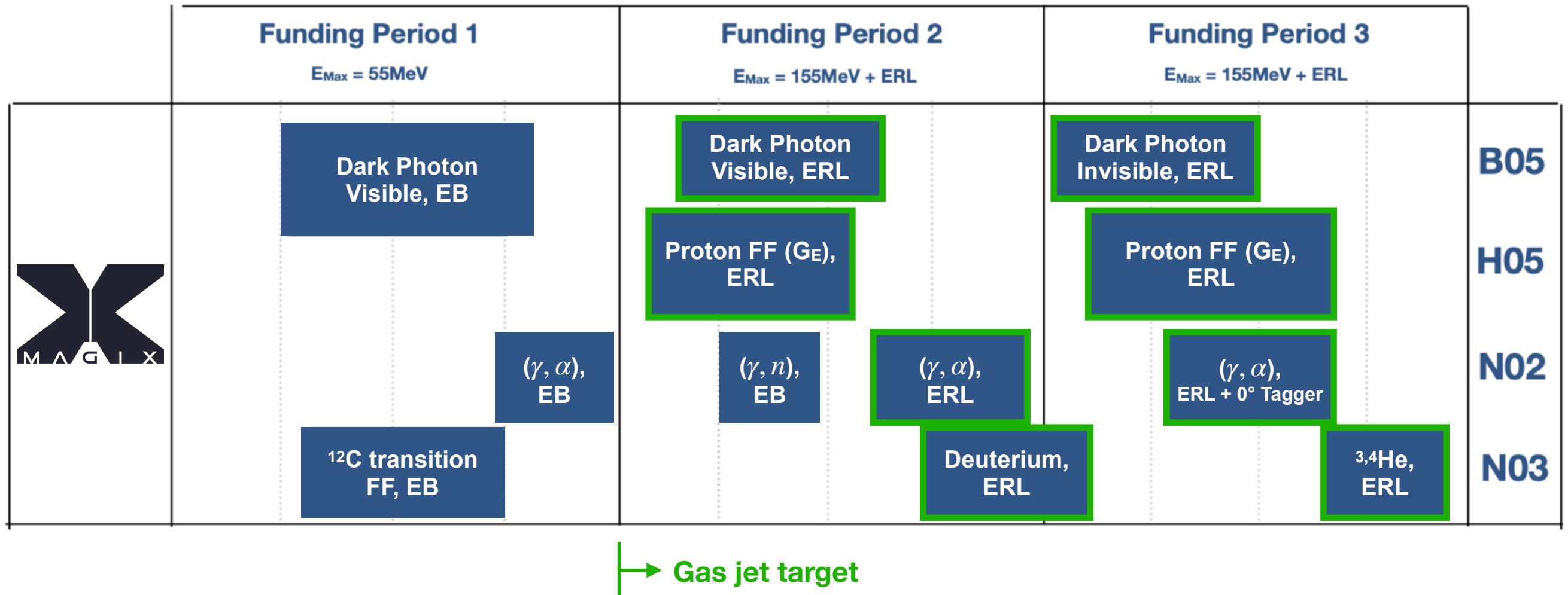
A versatile physics program.



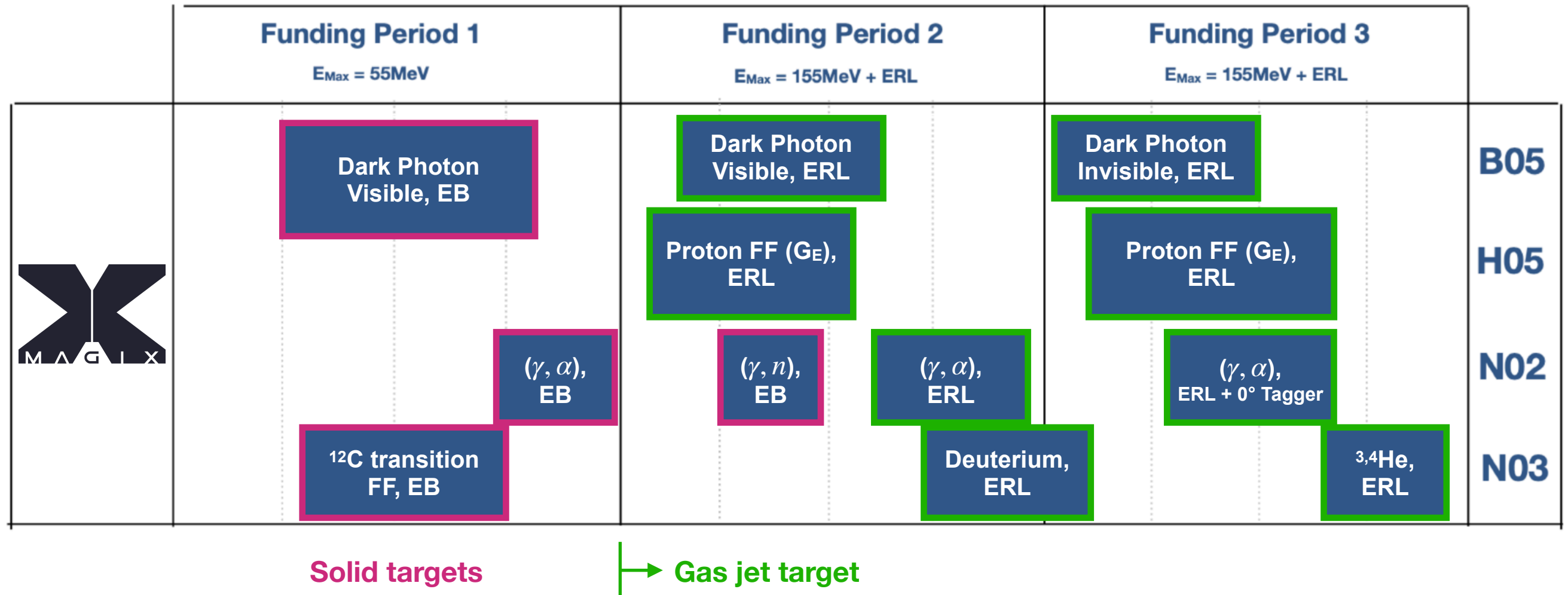
MAGIX' timeline in the CRC 1660.



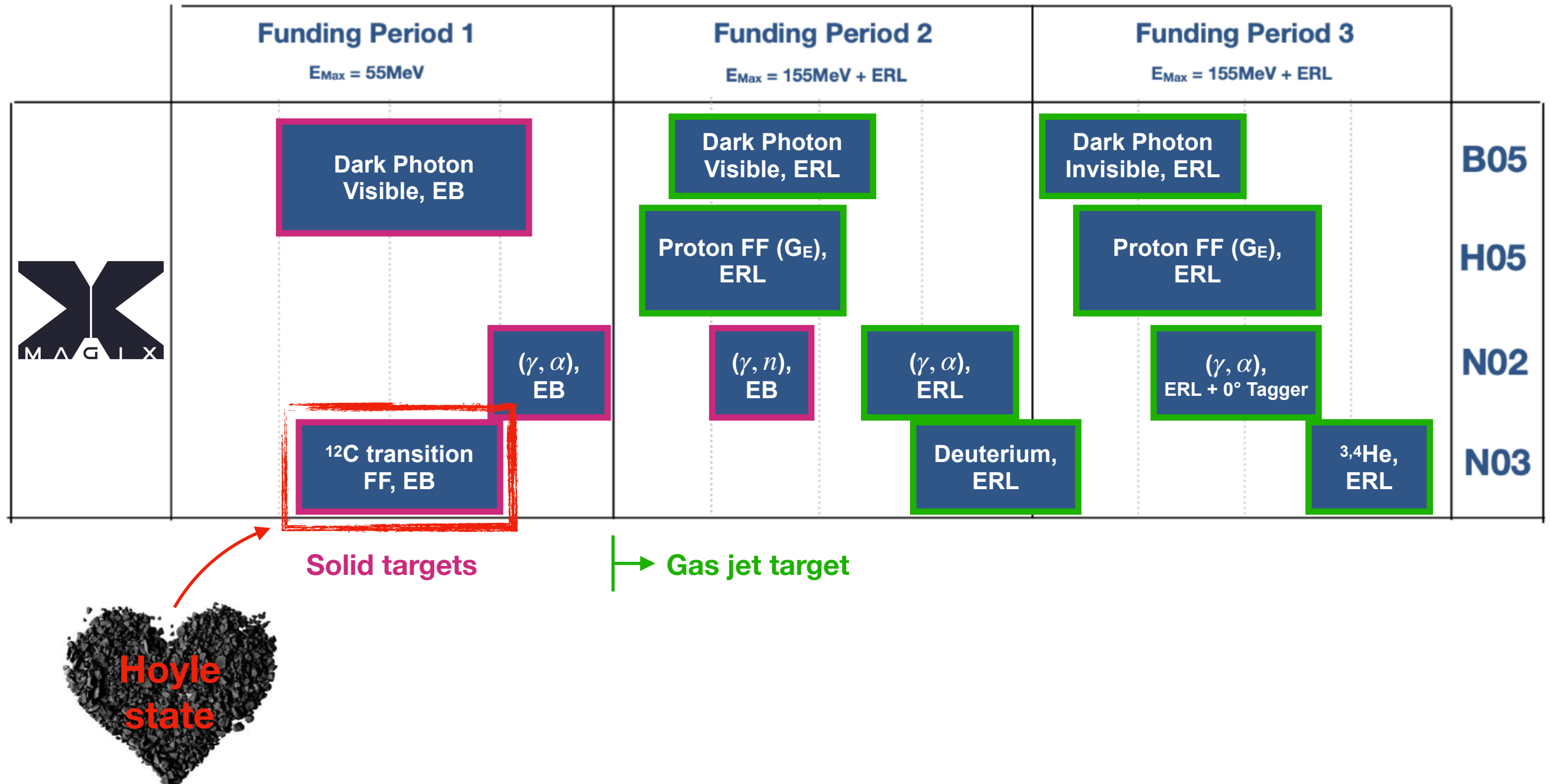
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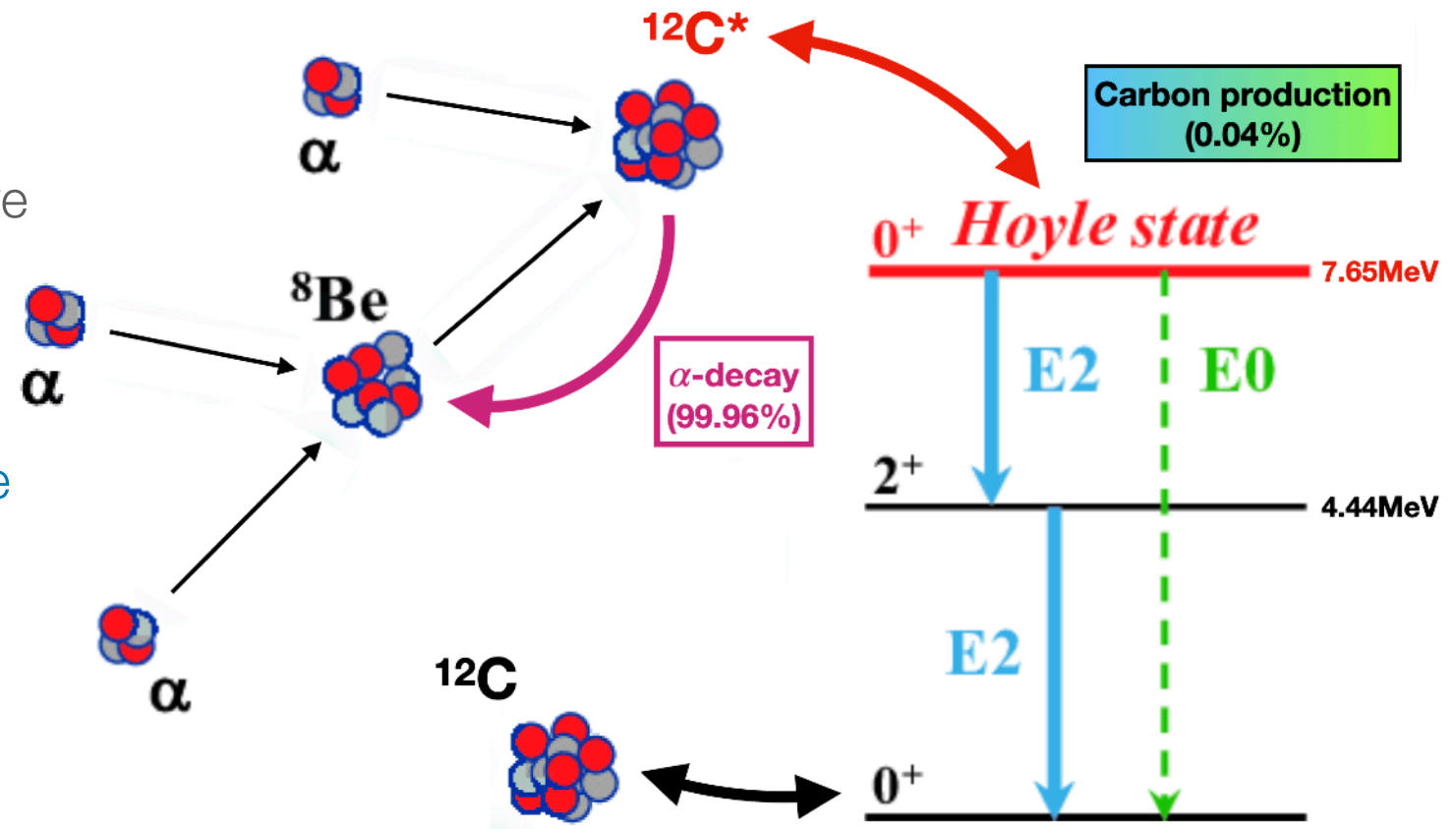


What is the Hoyle state?

- Specific excited state of ^{12}C
- Resonant spin-0⁺ state roughly 7.65MeV above the ground state

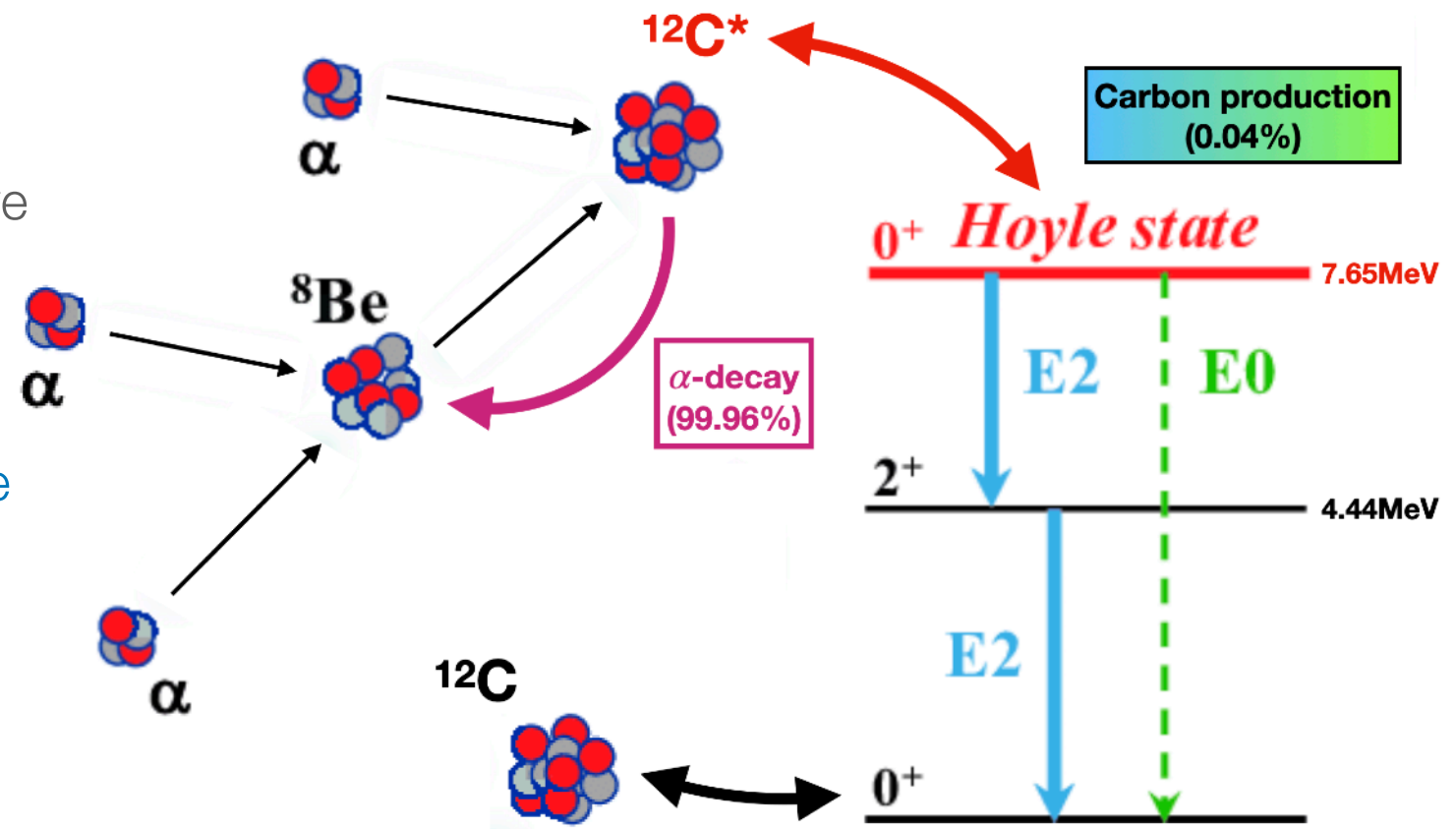
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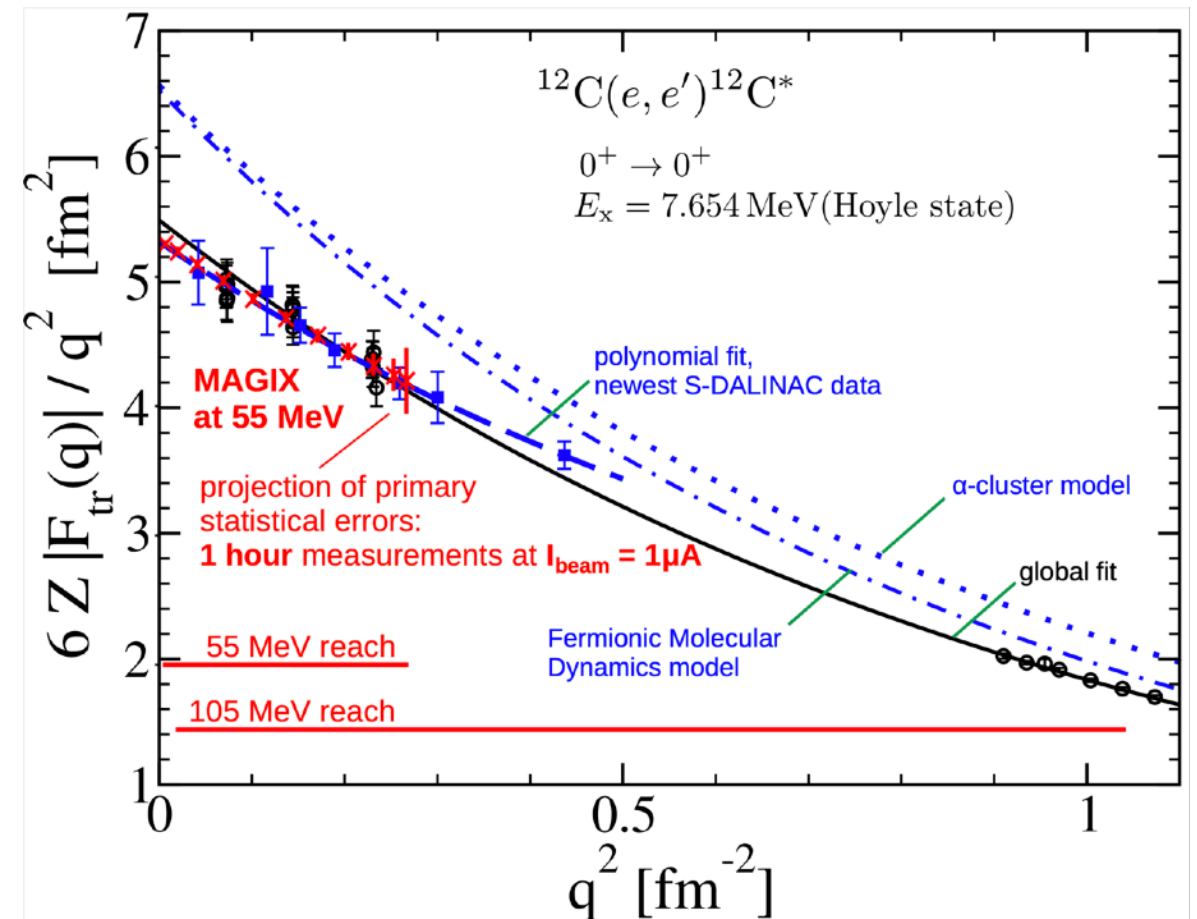


Everybody loves the Hoyle state!

- **Nuclear astrophysicists:** Hoyle state is an important step in the formation of heavy elements
- **Philosophers:** anthropic principle; no life without the Hoyle state
- **Few-body physicists:** Hoyle state is a prime example of an α -cluster state
- **Experimentalists:** relatively simple measurement(s); integrable with setup commissioning and calibration

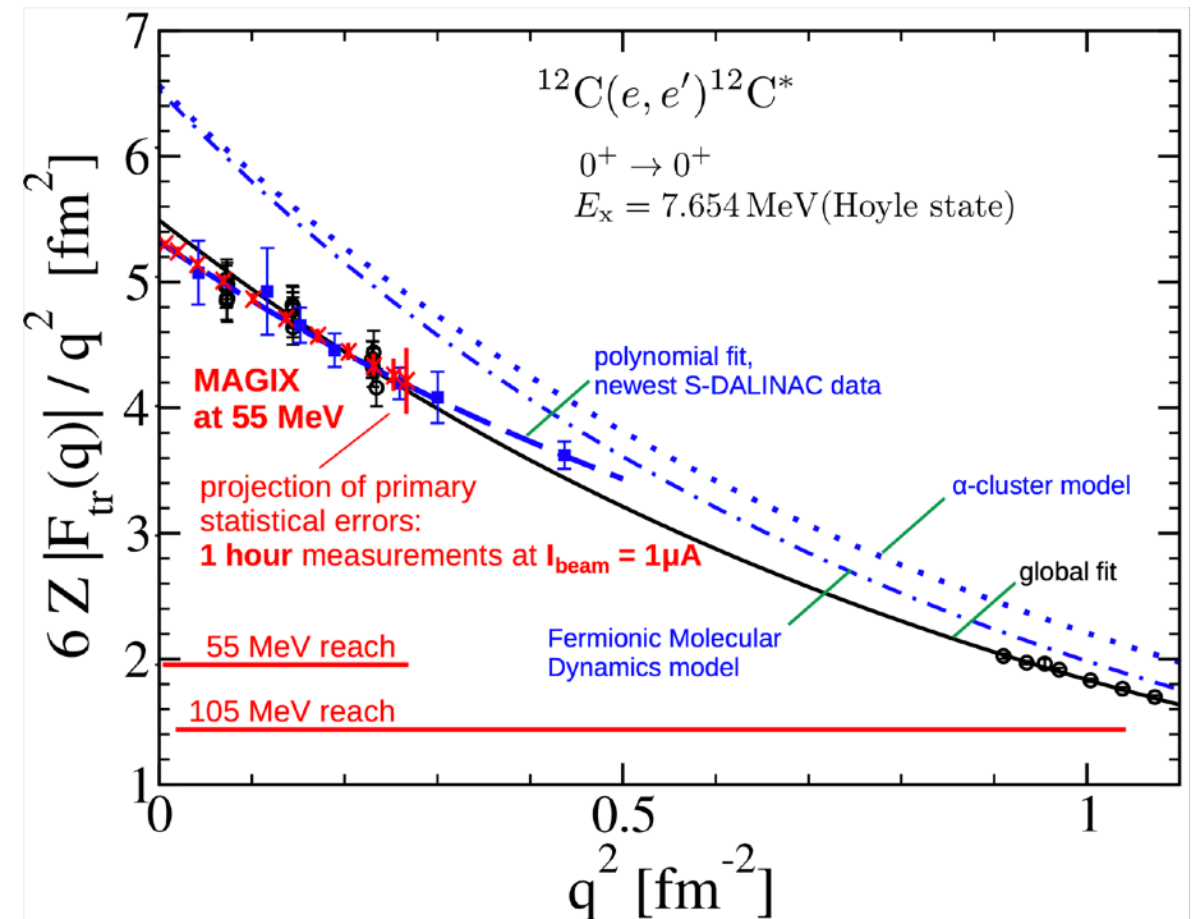
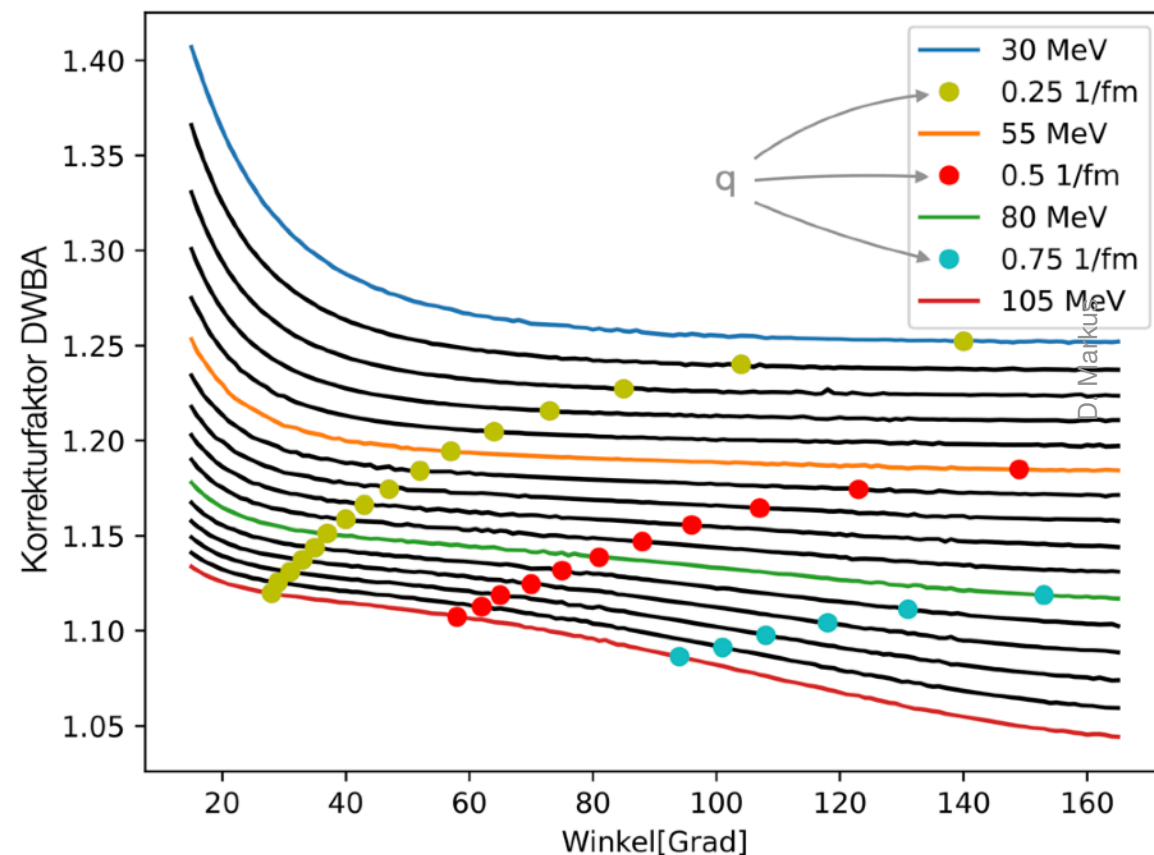
Measuring the Hoyle state at MAGIX.

- MAGIX can study the E0 monopole transition via inelastic electron scattering on a ^{12}C target



Measuring the Hoyle state at MAGIX.

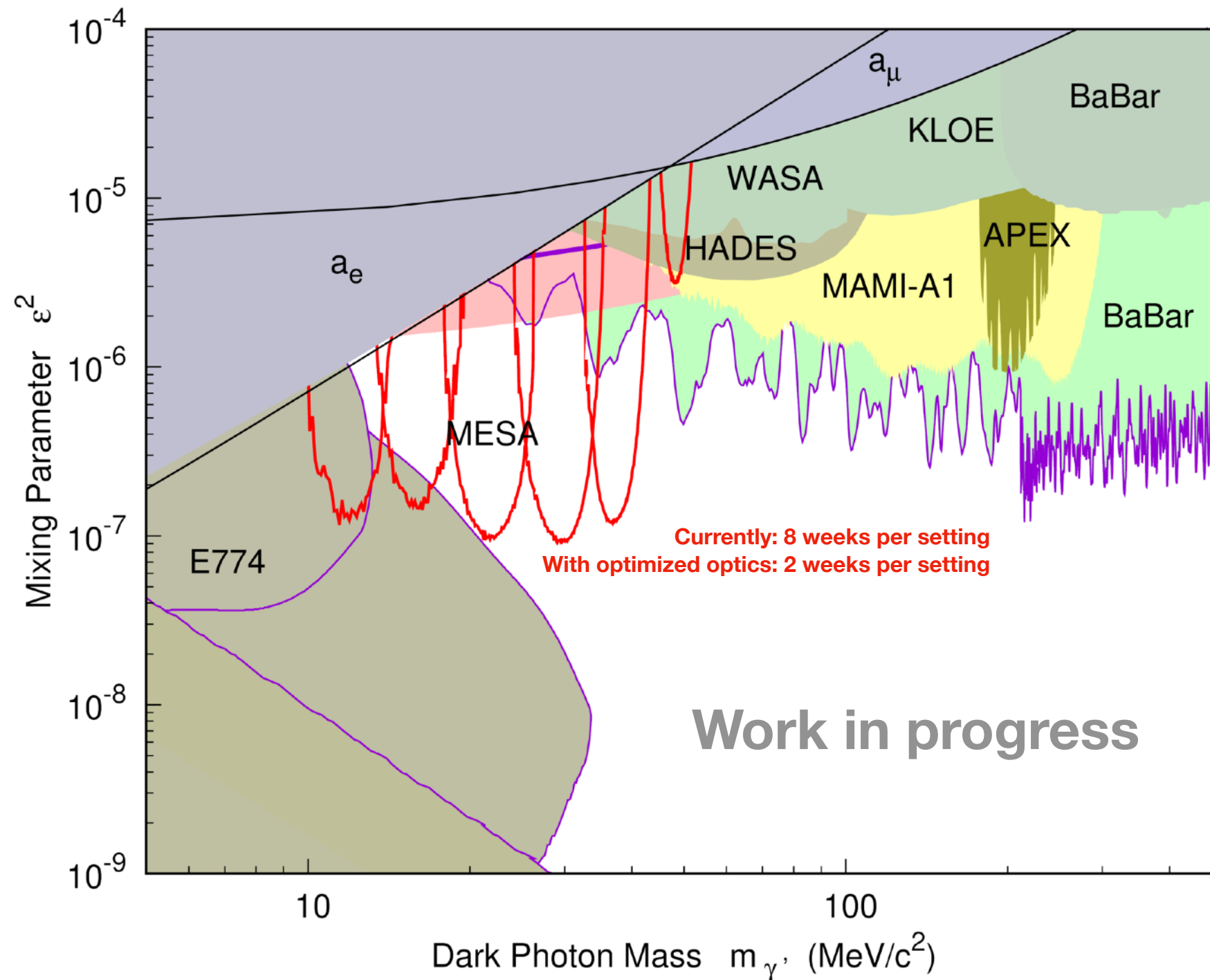
- MAGIX can study the E0 monopole transition via [inelastic electron scattering](#) on a ^{12}C target



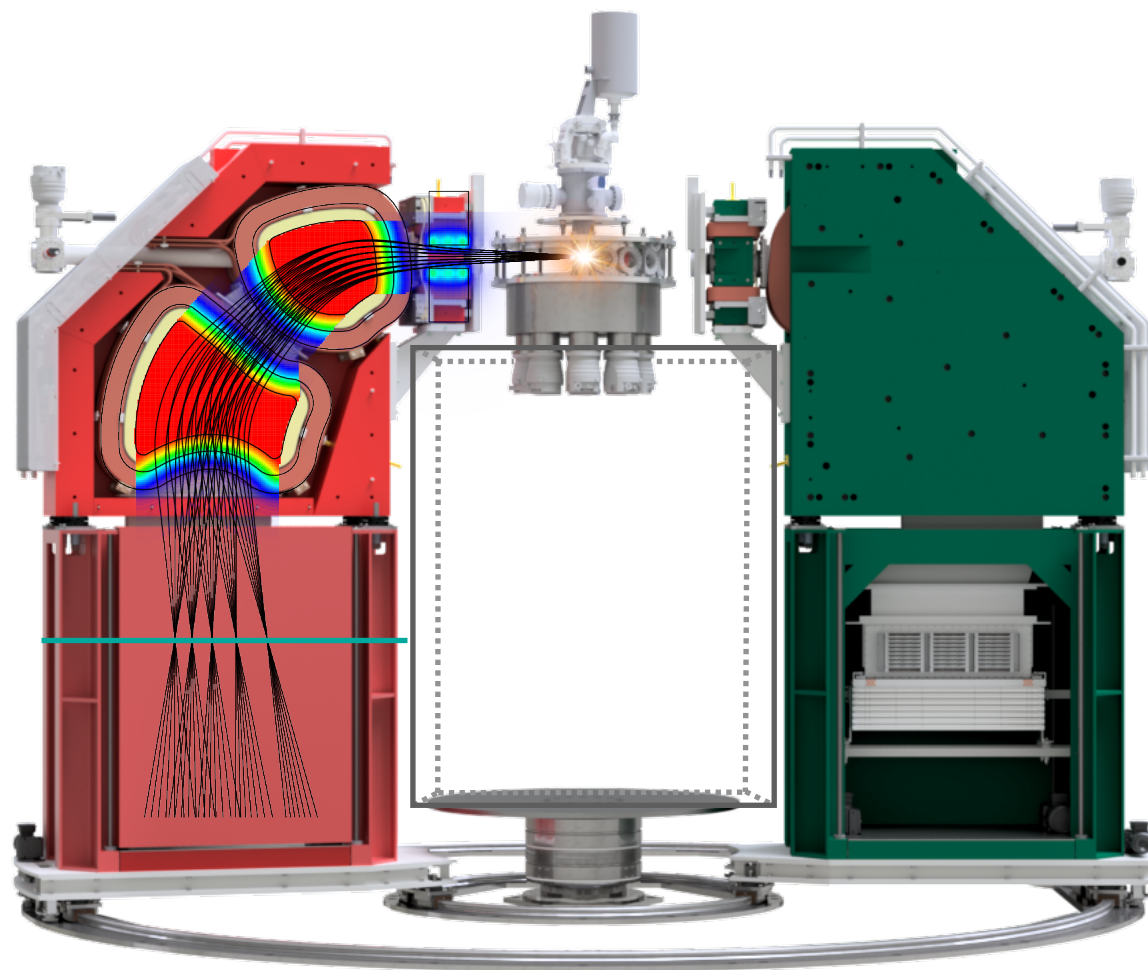
Preparation in progress:

- Now: [Simulation studies and analysis preparation](#) by D. Markus
- Soon: U. Bajpai will start his [PhD position on the Hoyle state](#) (funded by CRC 1660)

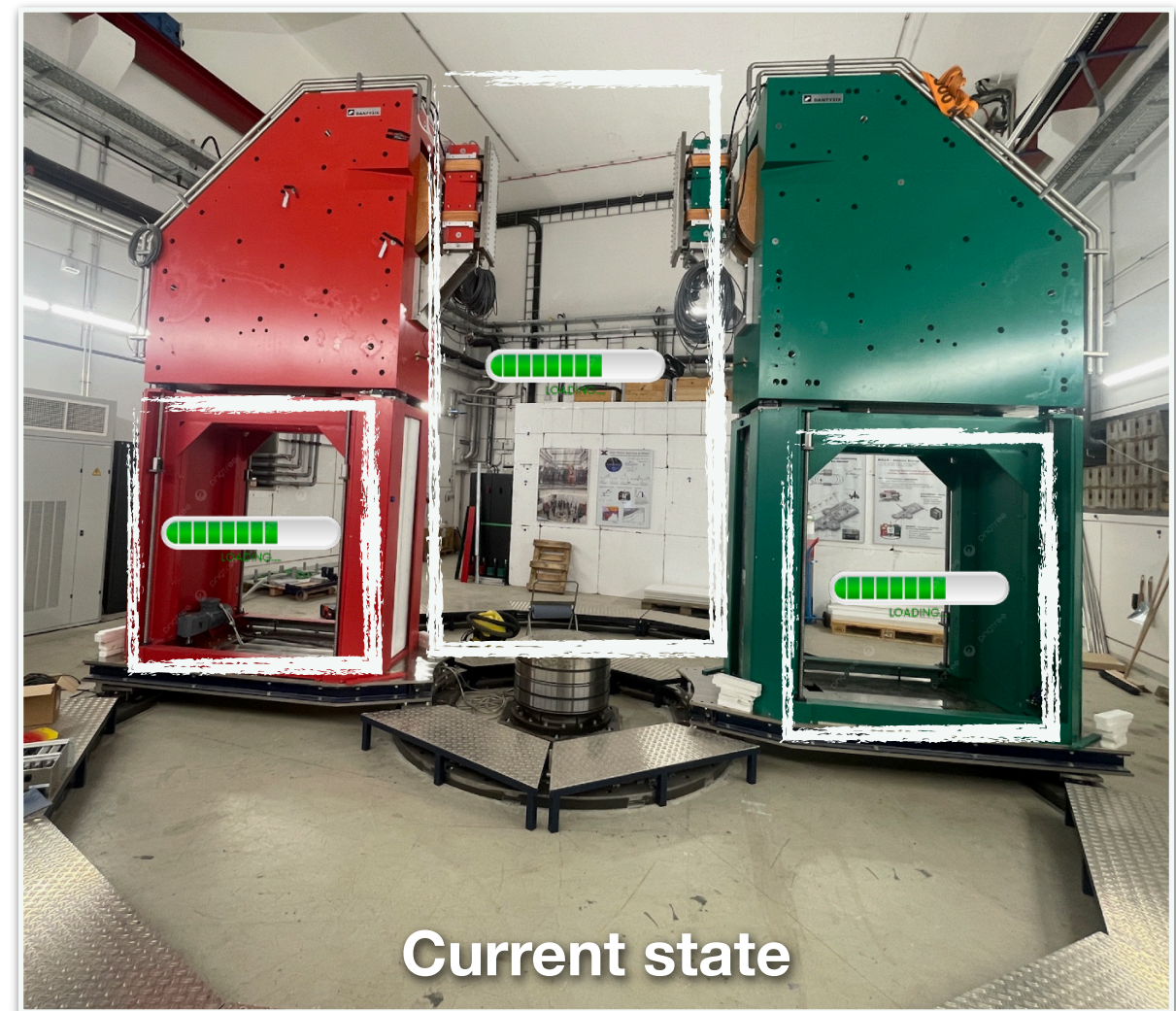
Visible dark photon decay at MAGIX.



Almost there.

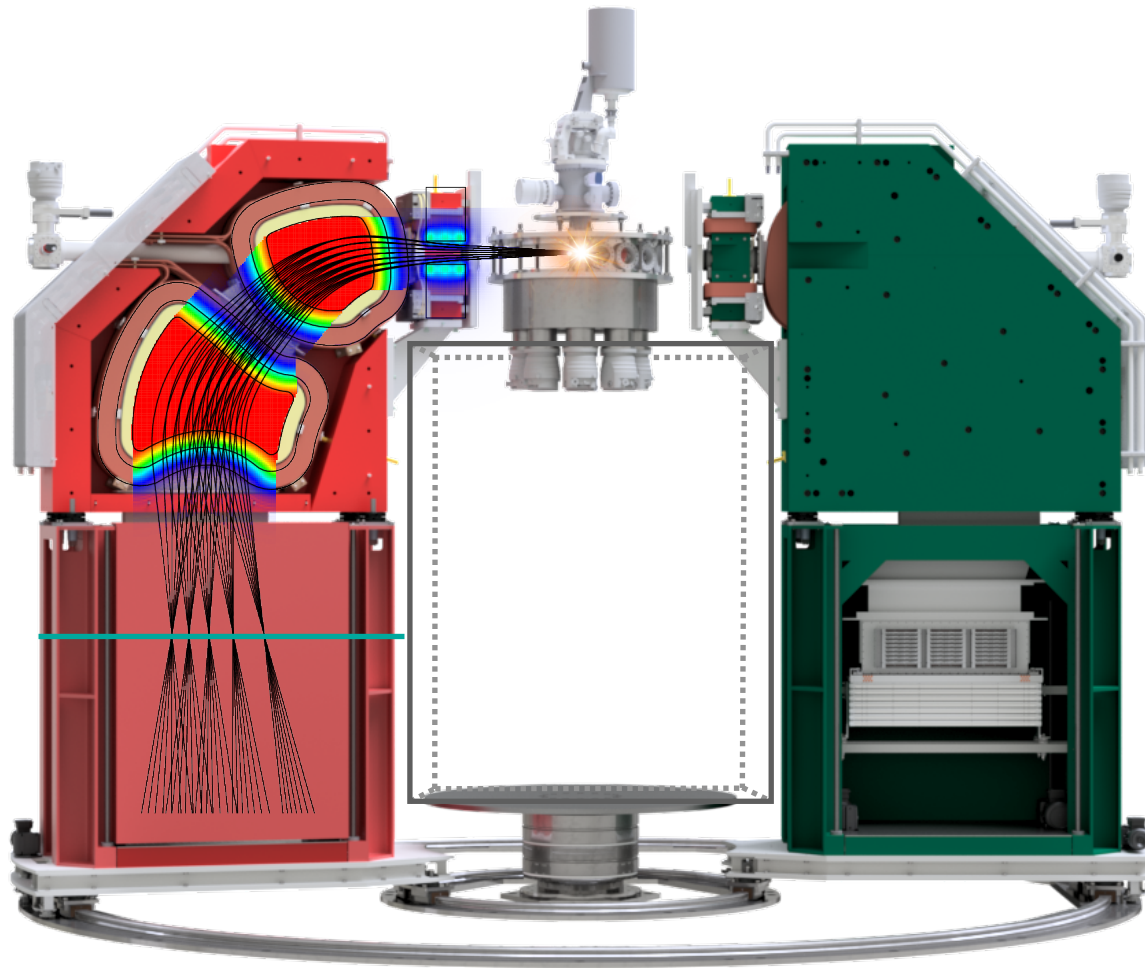


Intended state

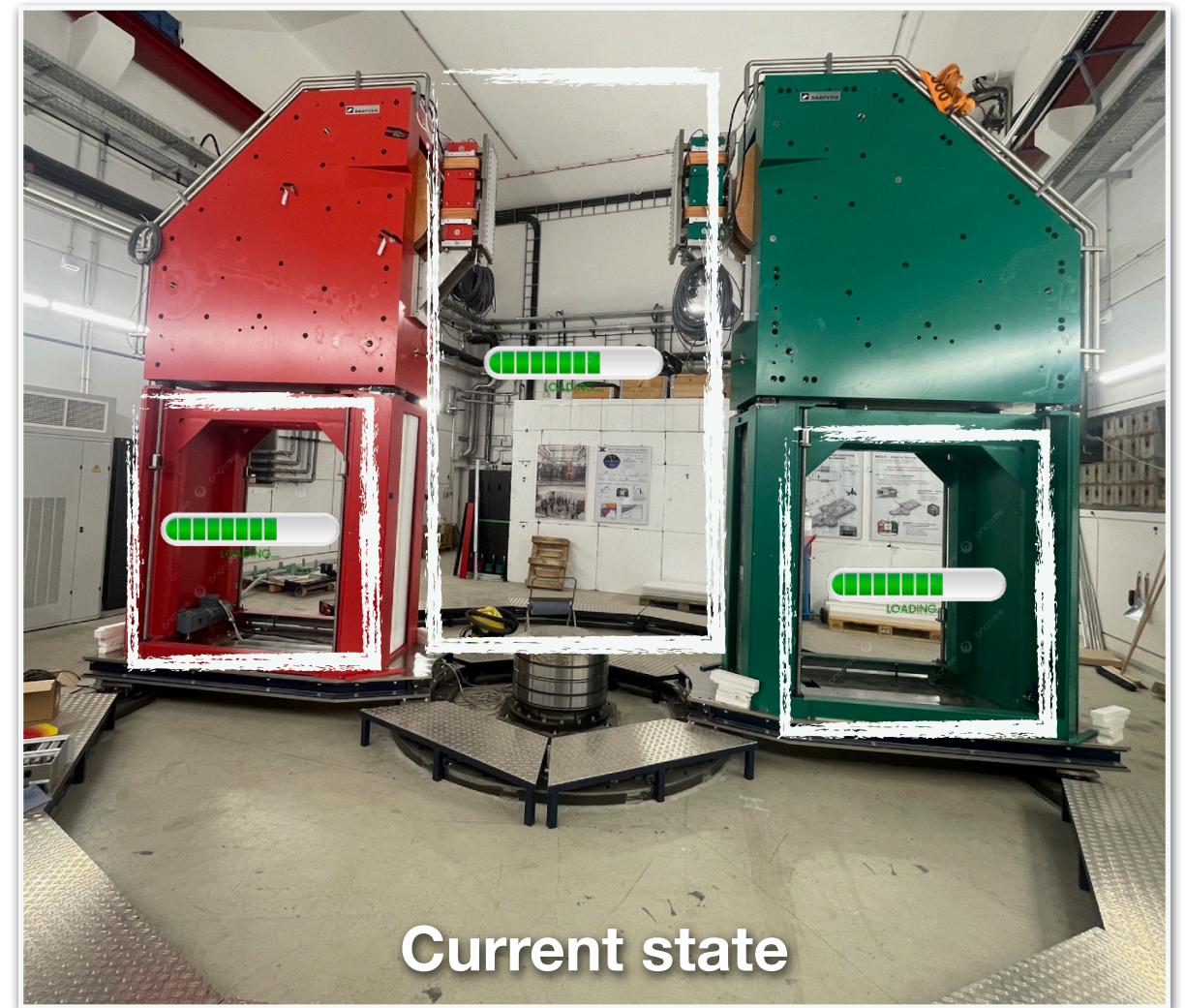


Current state

Almost there.



Intended state



Current state

Thanks for your attention!

Contact

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