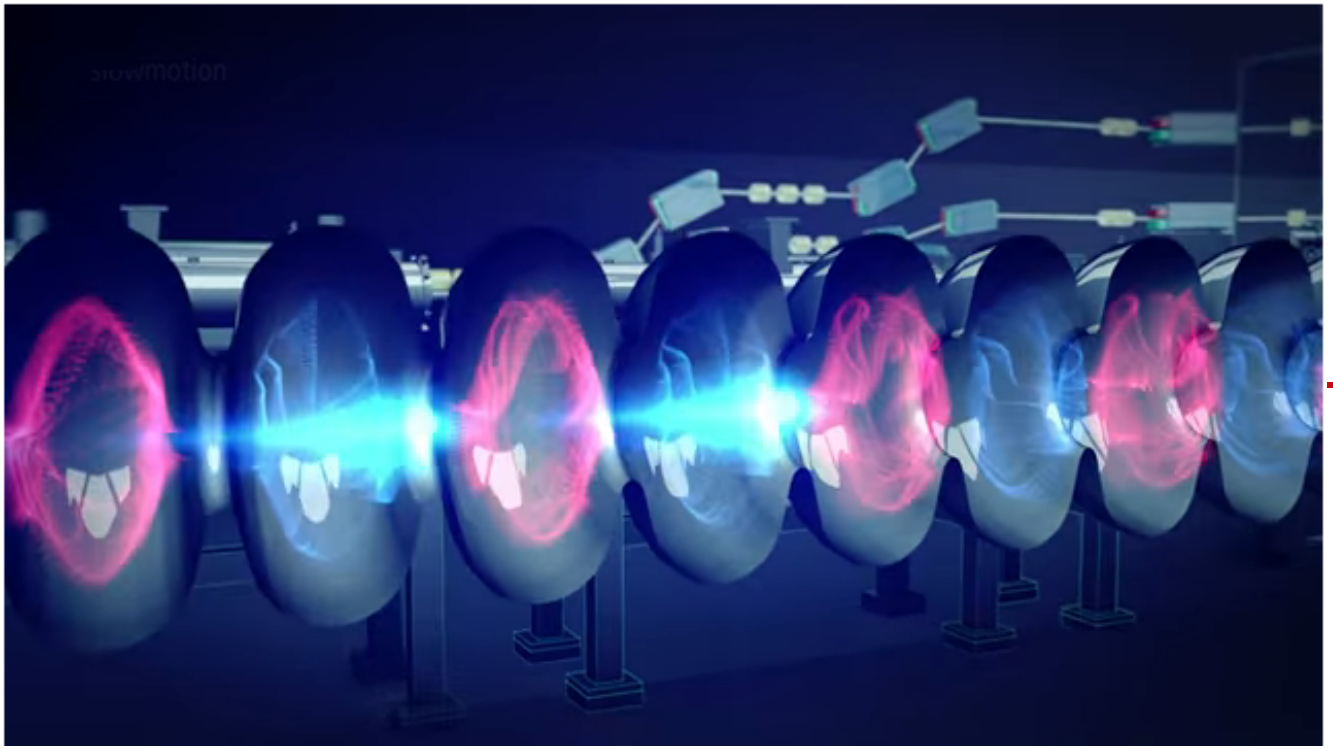
STATUS OF THE MESA PROJECT



Cluster of Excellence
PRISMA+
Precision Physics,
Fundamental Interactions
and Structure of Matter

ACCELENCE

ARIES

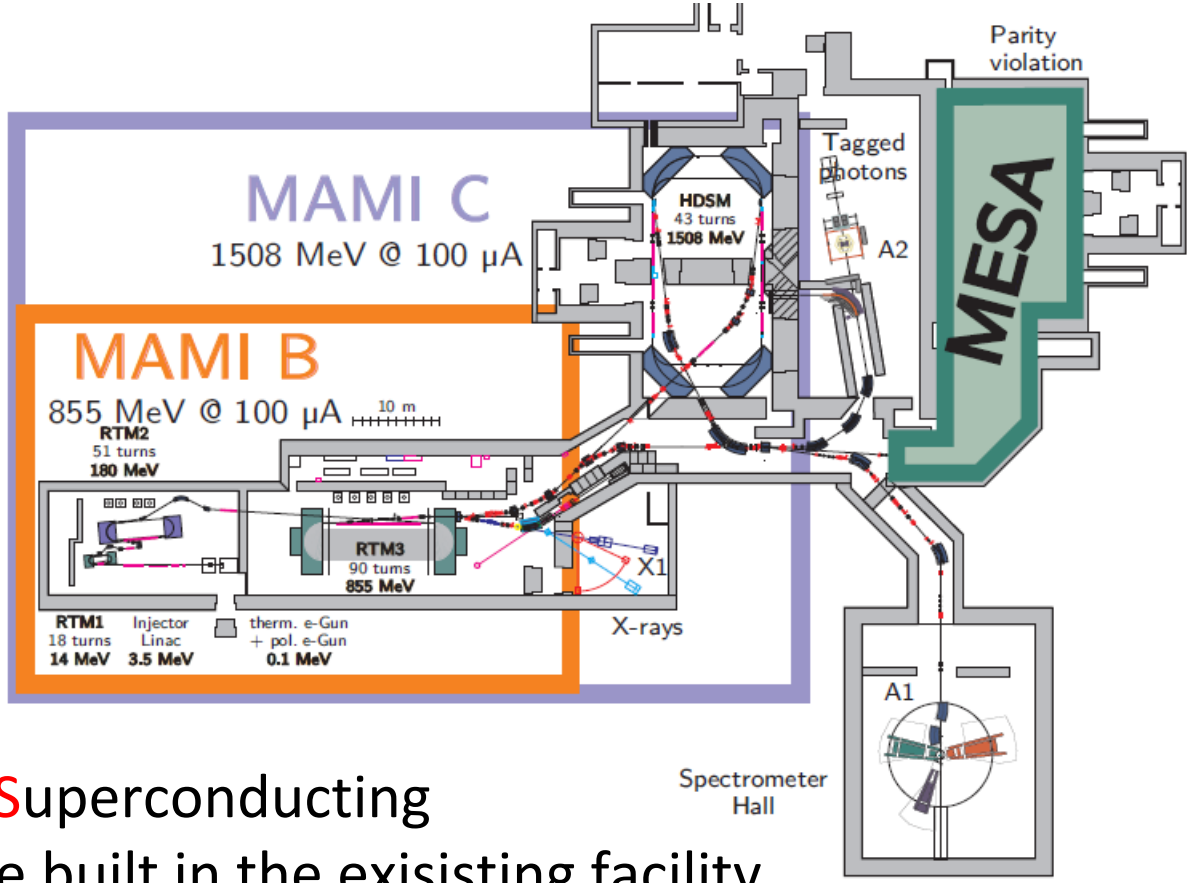
Florian Hug
for the MESA group

ERL Workshop 2019
HZB Berlin

MAMI and MESA at KPH Mainz

- MAMI is operating since >25 years at KPH

- In 2012 funding of PRISMA cluster of excellence has been granted including a new accelerator project:

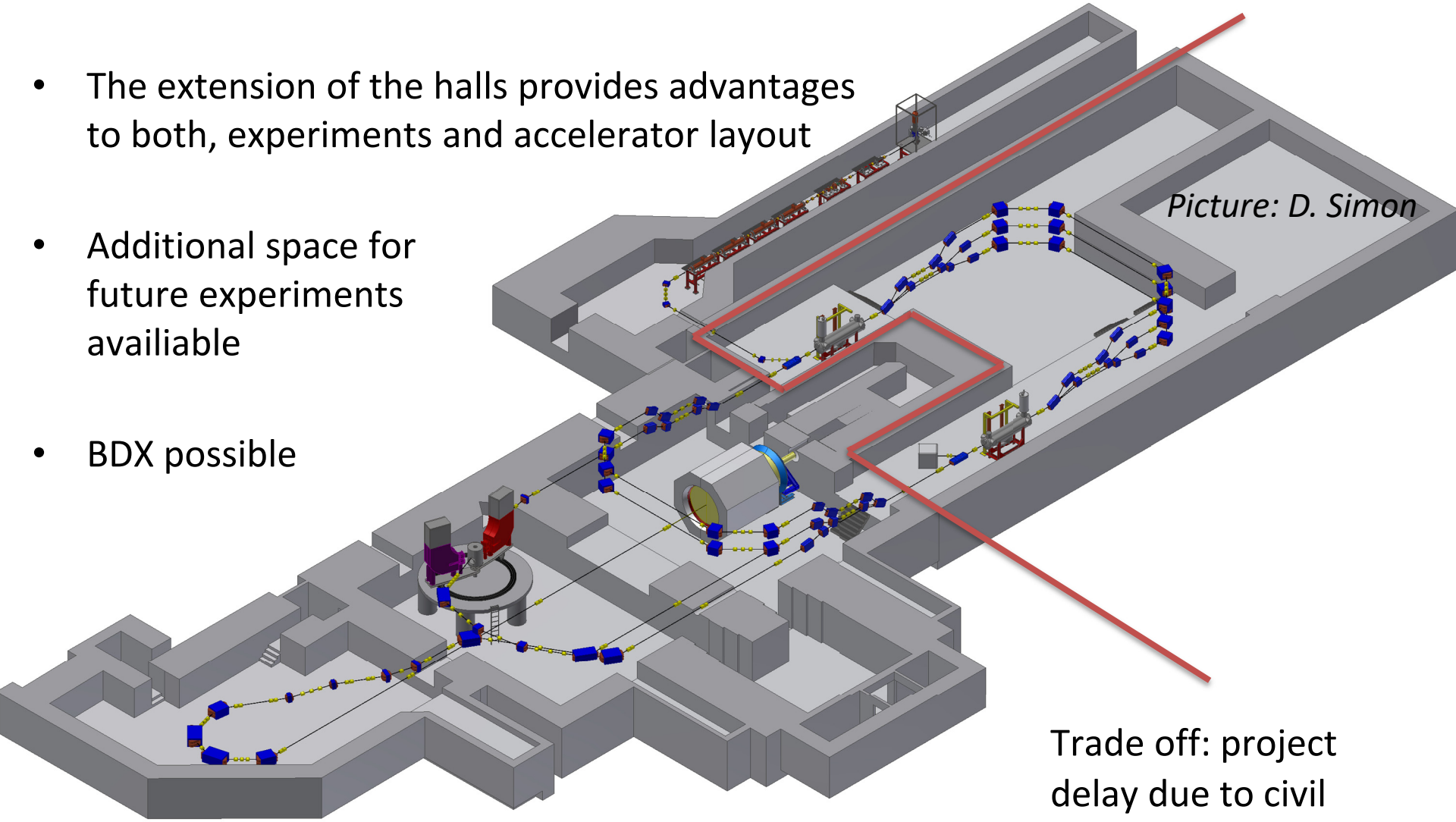


Mainz Energy Recovery Superconducting Accelerator (MESA) to be built in the exisisting facility

- In June 2015 DFG granted a research building to JGU „Center for Fundamental Physics (CFP)“ including an extension for MESA halls

MESA Accelerator Layout

- The extension of the halls provides advantages to both, experiments and accelerator layout
- Additional space for future experiments availiable
- BDX possible



Picture: D. Simon

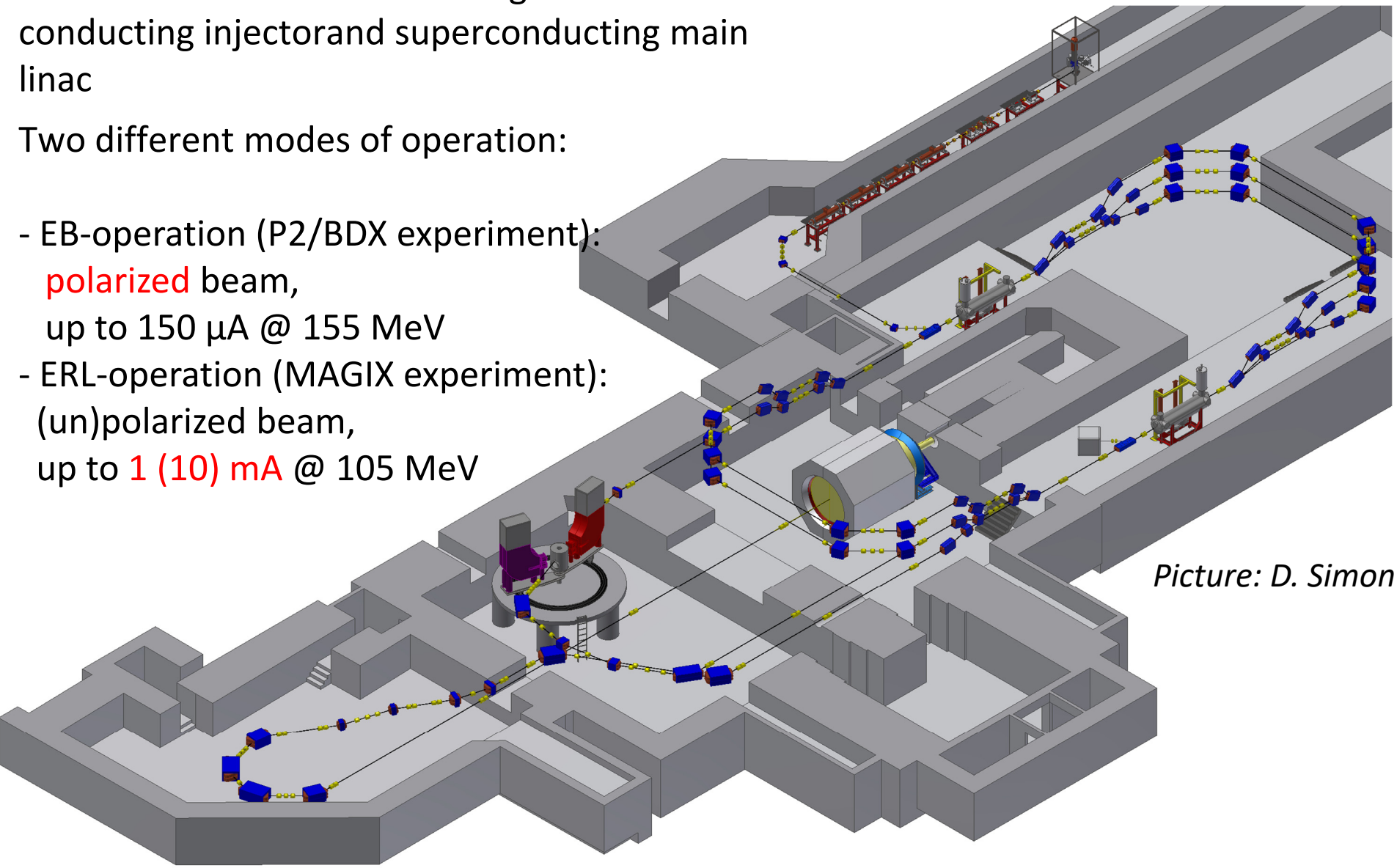
Trade off: project delay due to civil construction time

MESA Accelerator Layout

Double sided recirculation design with normal-conducting injectorand superconducting main linac

Two different modes of operation:

- EB-operation (P2/BDX experiment):
  polarized beam,
  up to 150 µA @ 155 MeV
- ERL-operation (MAGIX experiment):
  (un)polarized beam,
  up to 1 (10) mA @ 105 MeV



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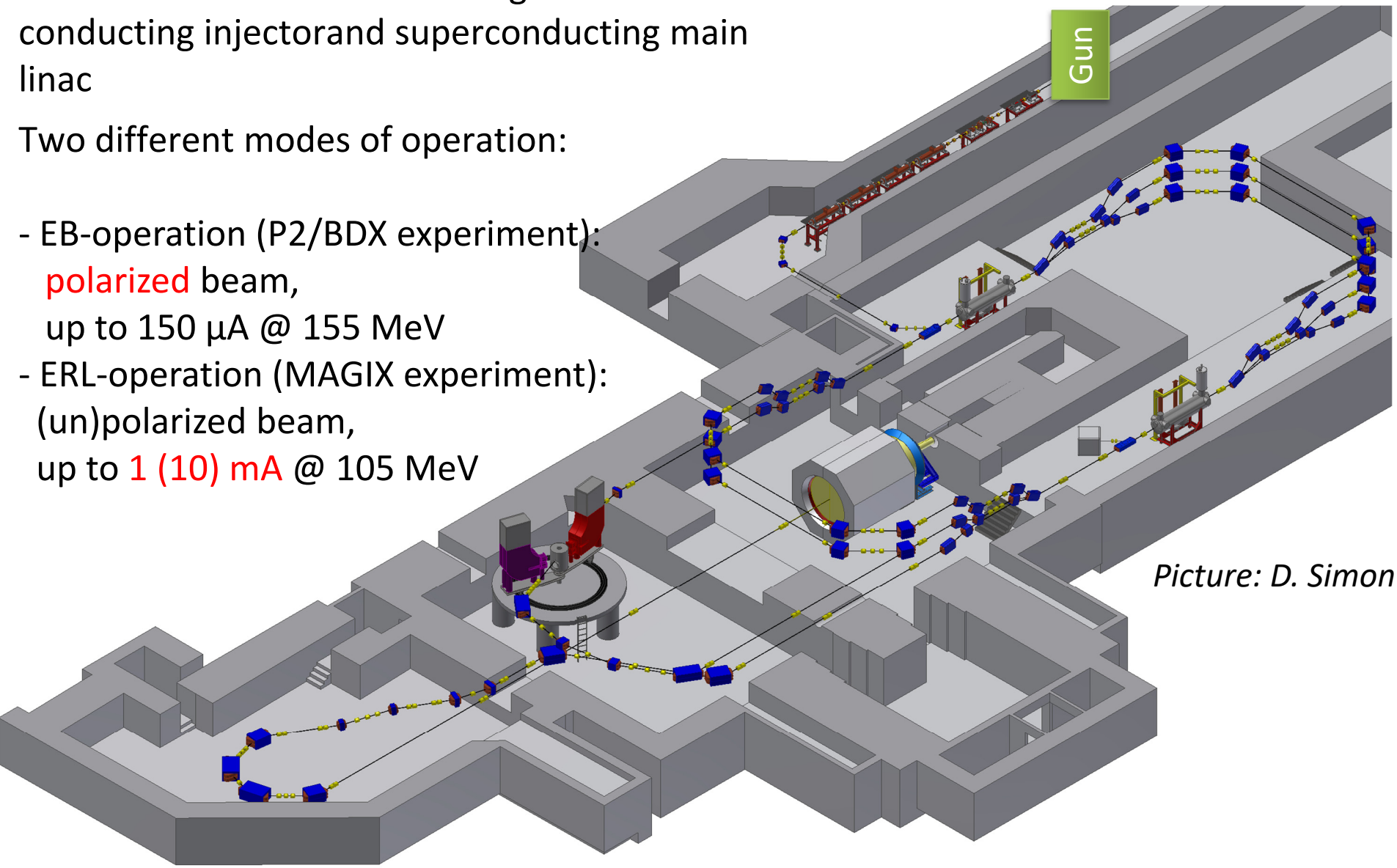

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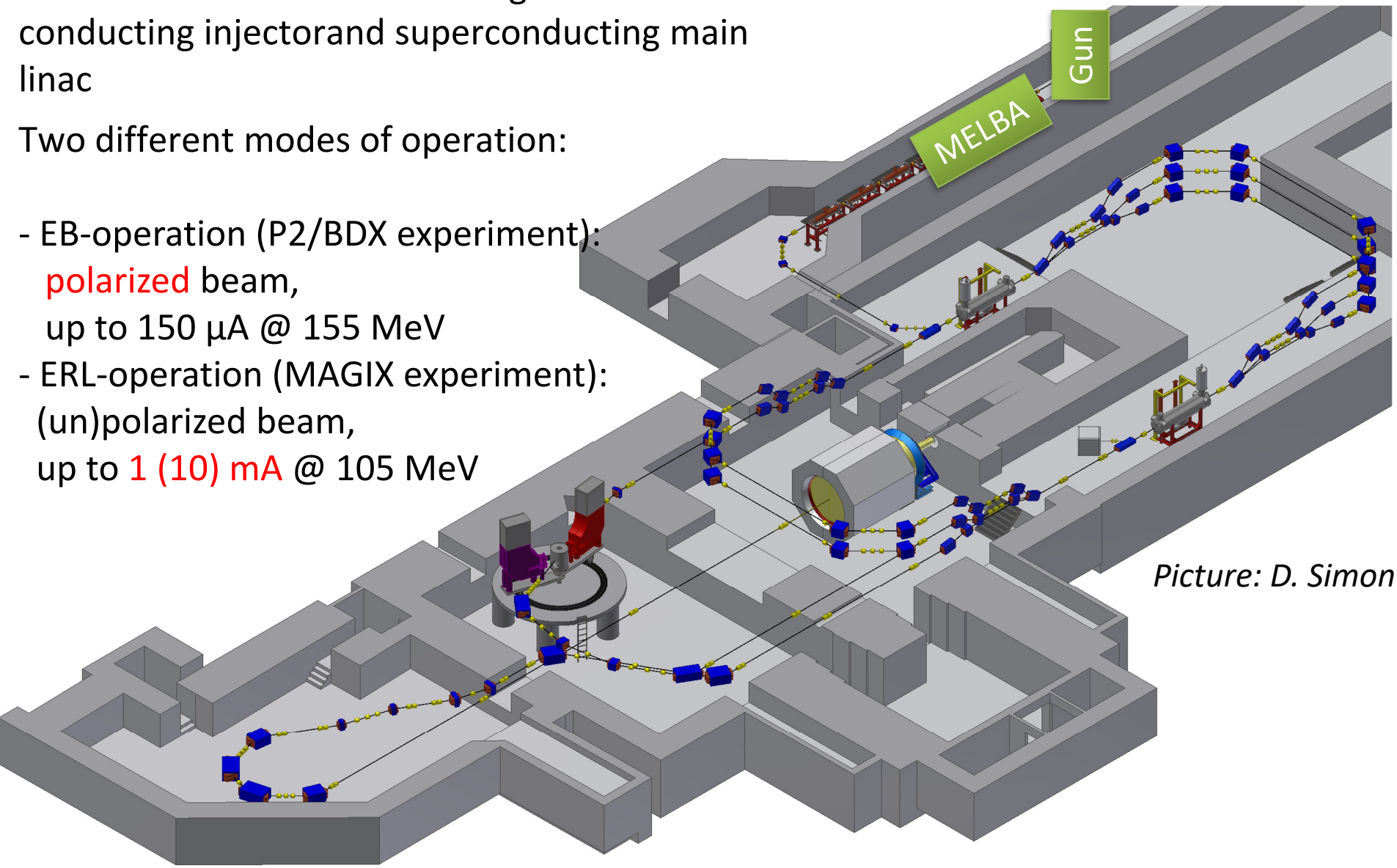

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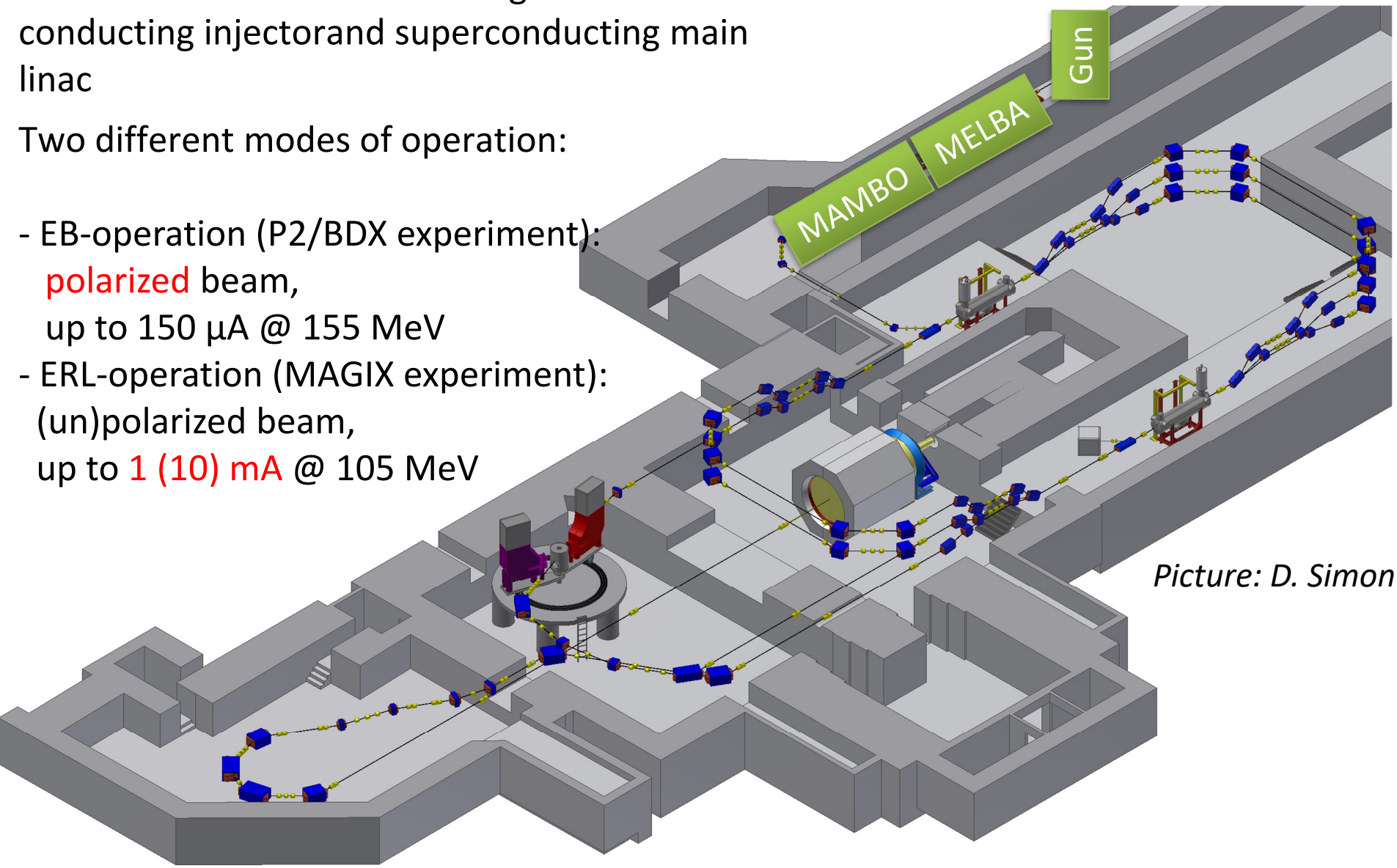

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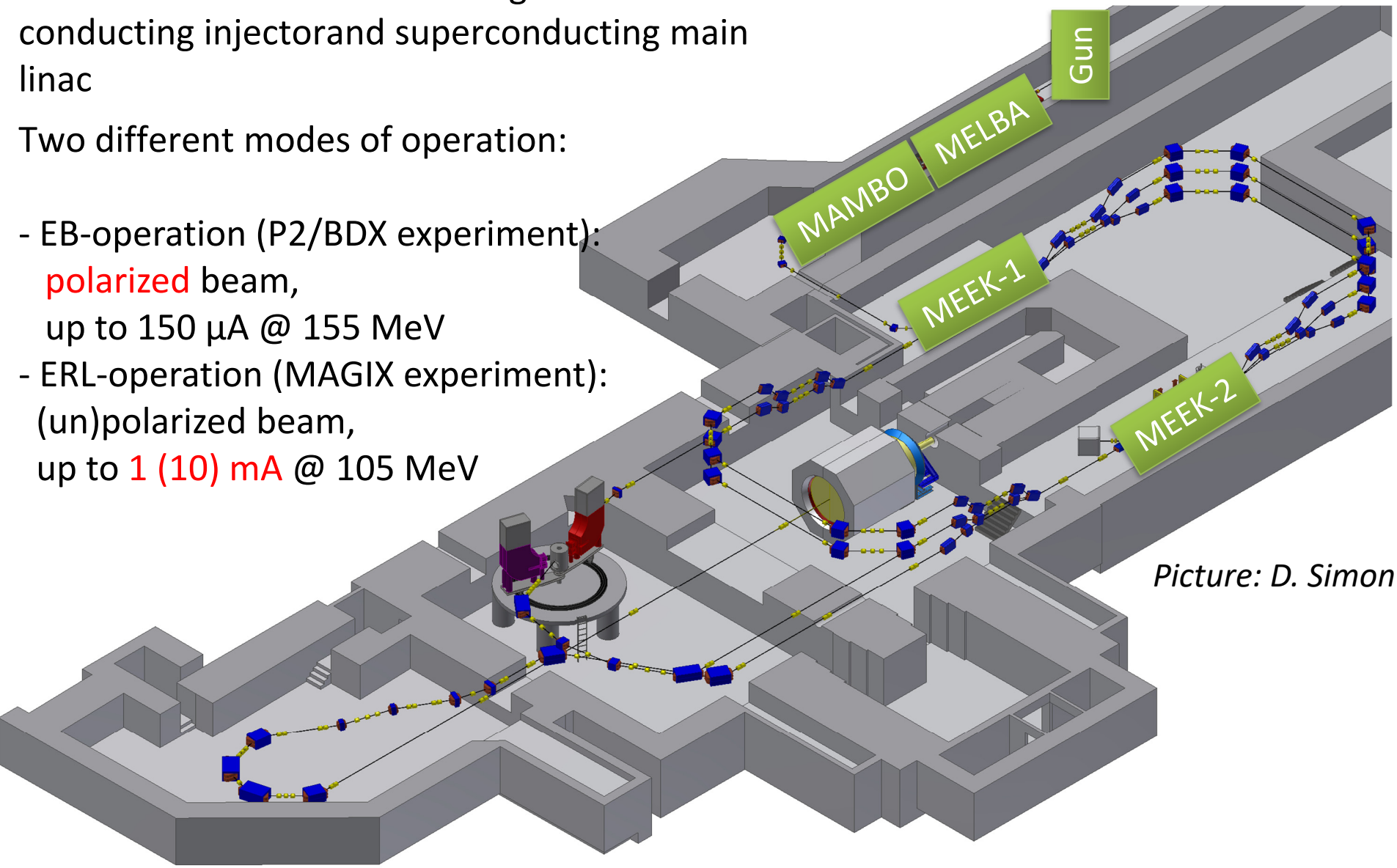

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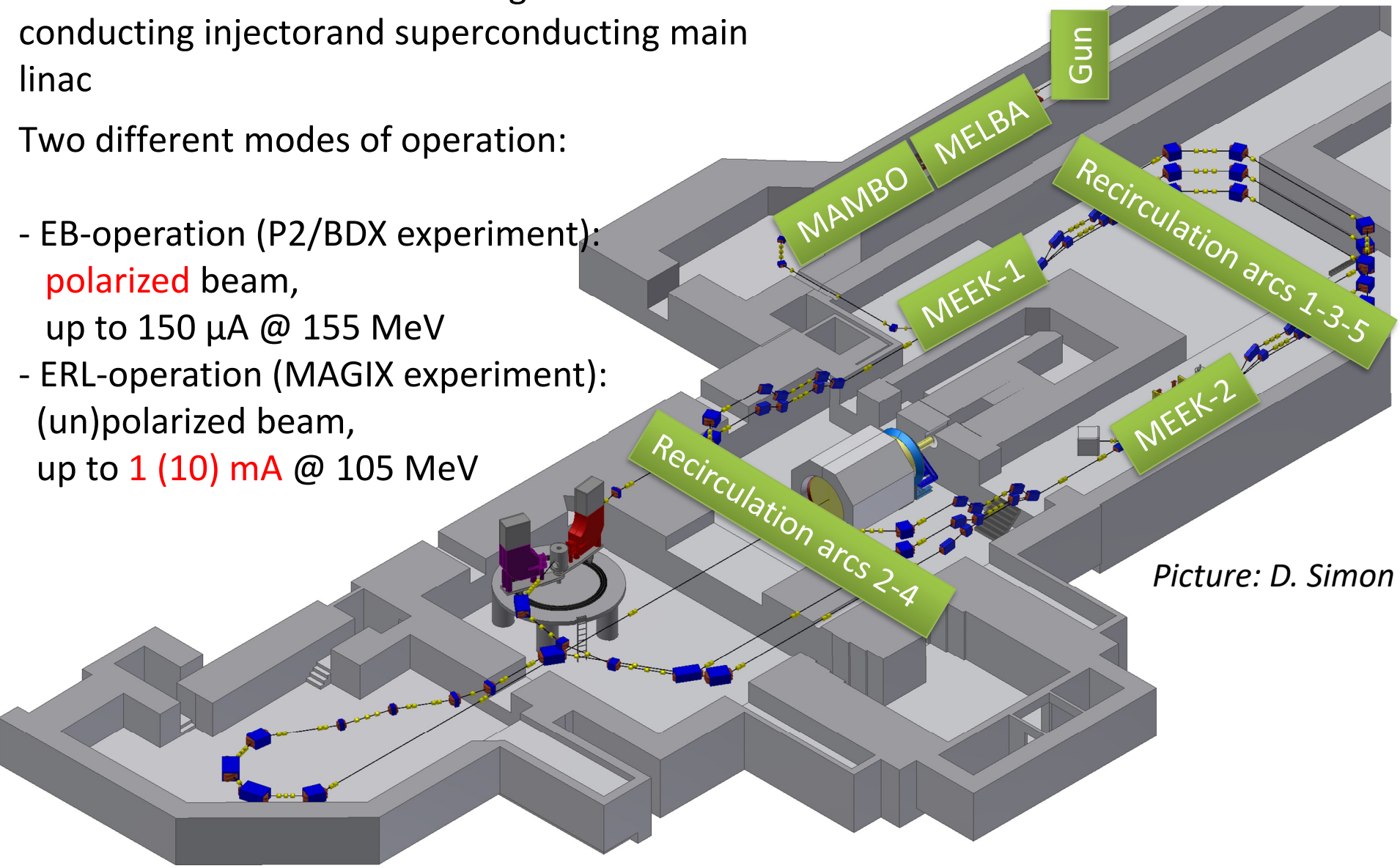

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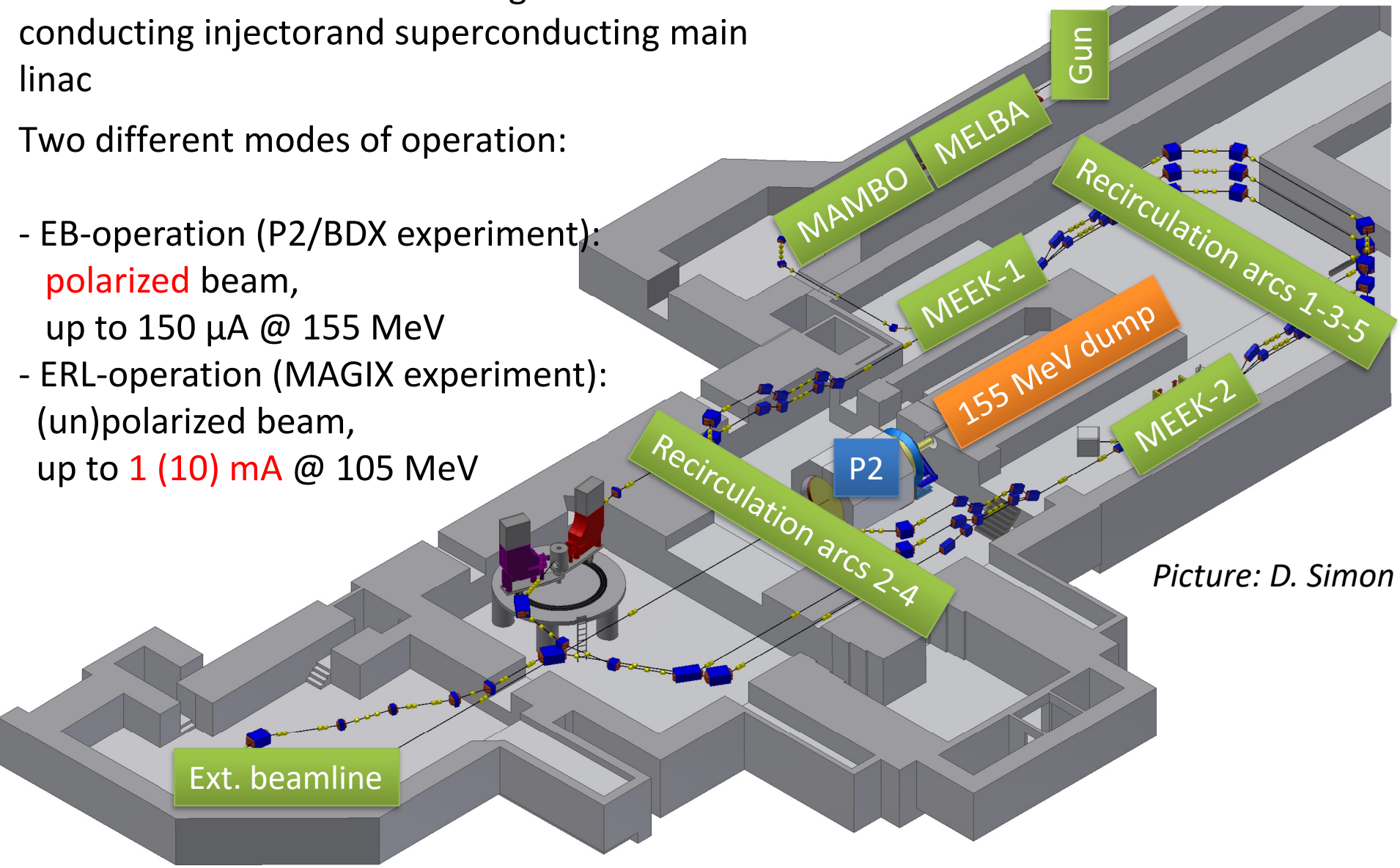

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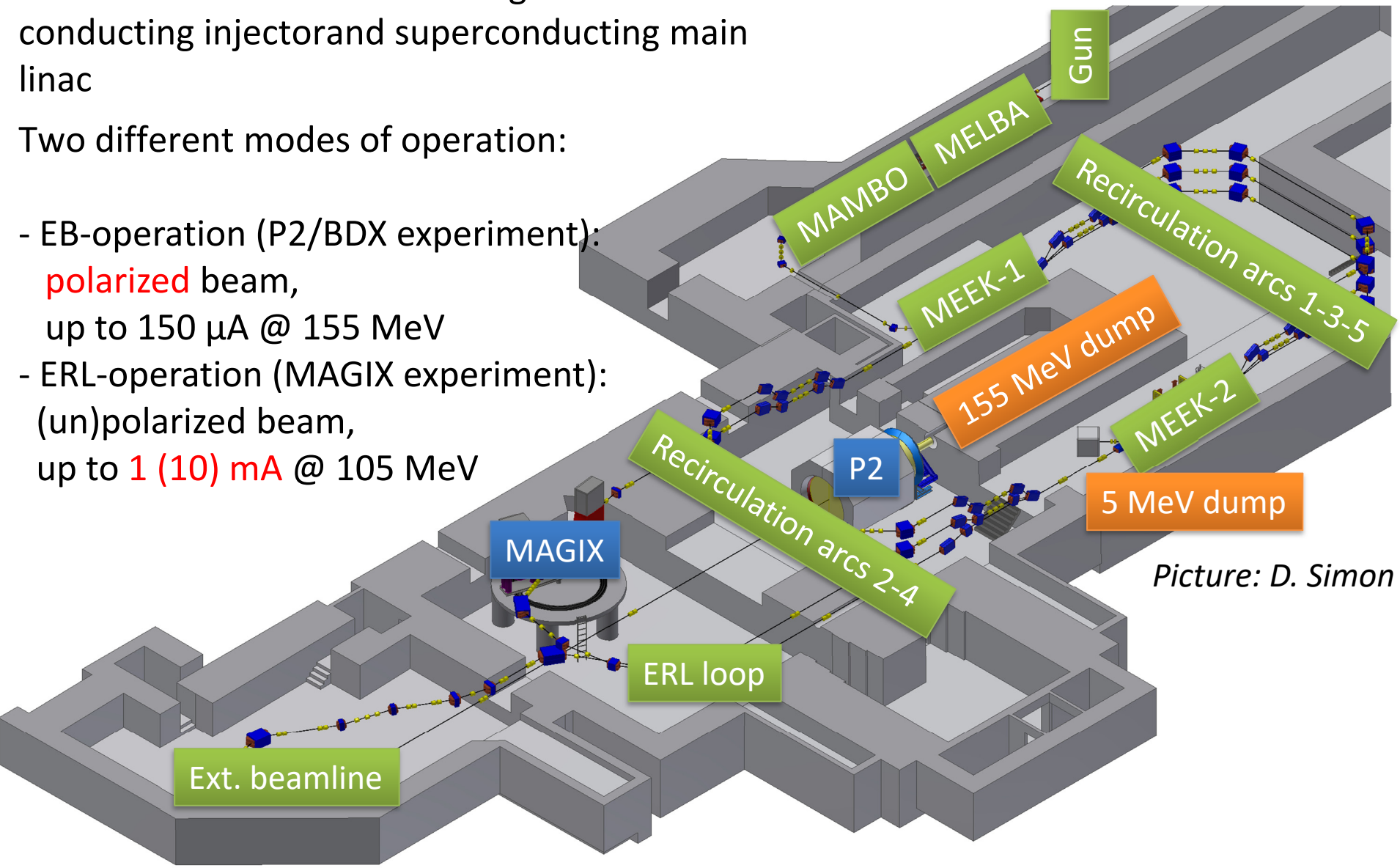
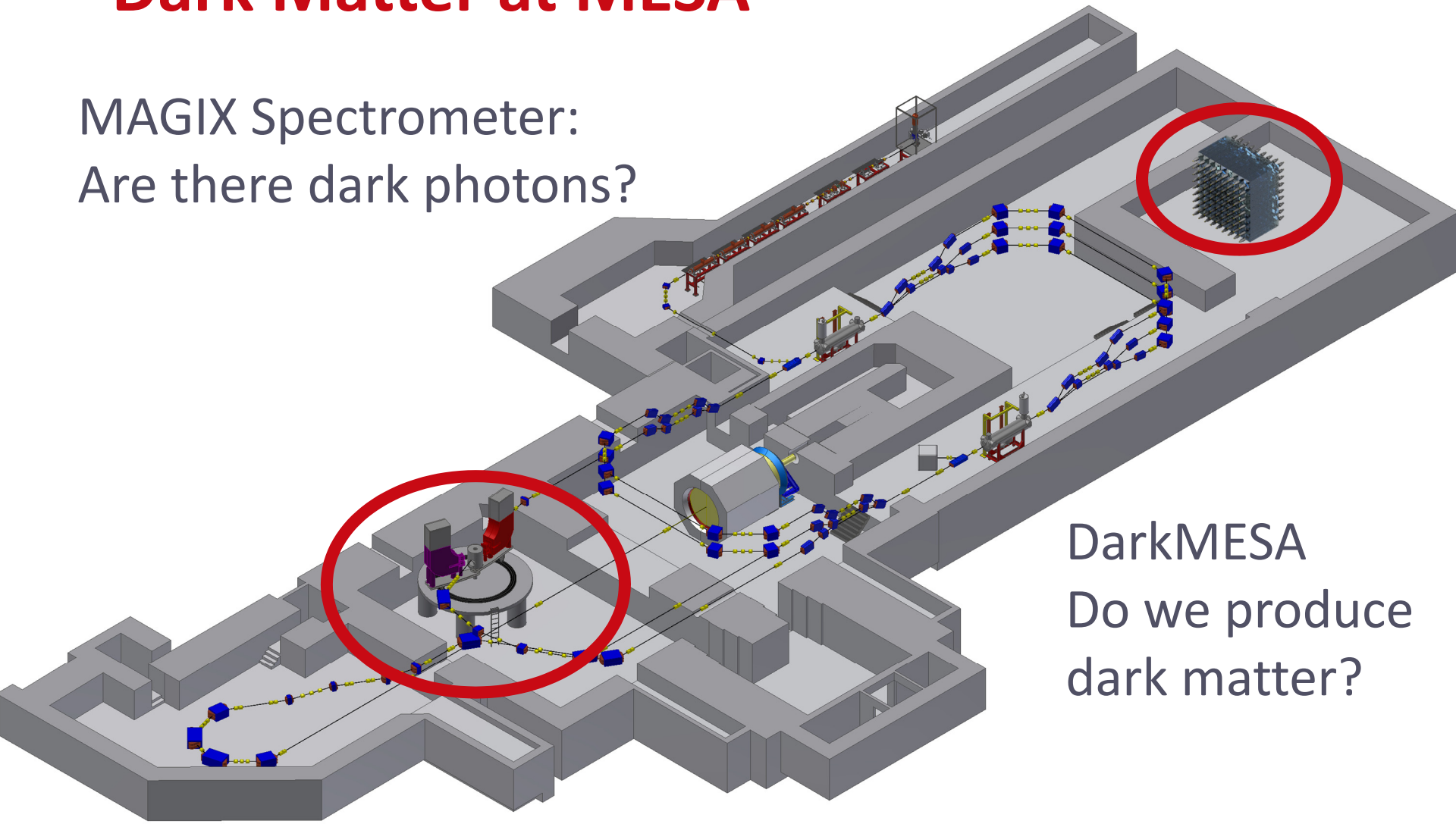


Picture: D. Simon

Dark Matter at MESA

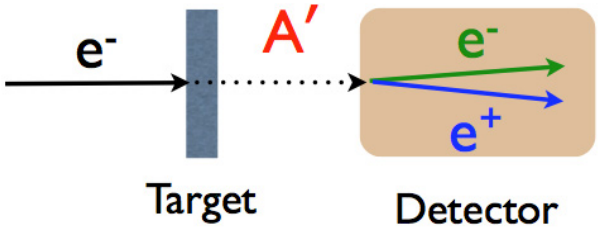
MAGIX Spectrometer:
Are there dark photons?

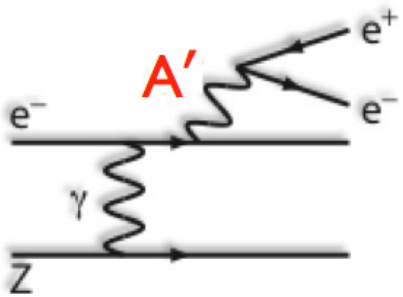


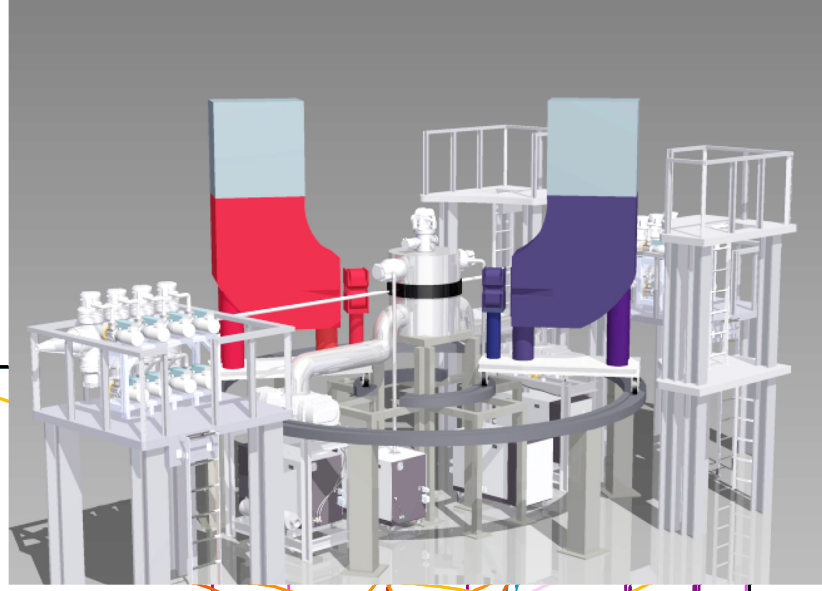
DarkMESA
Do we produce
dark matter?

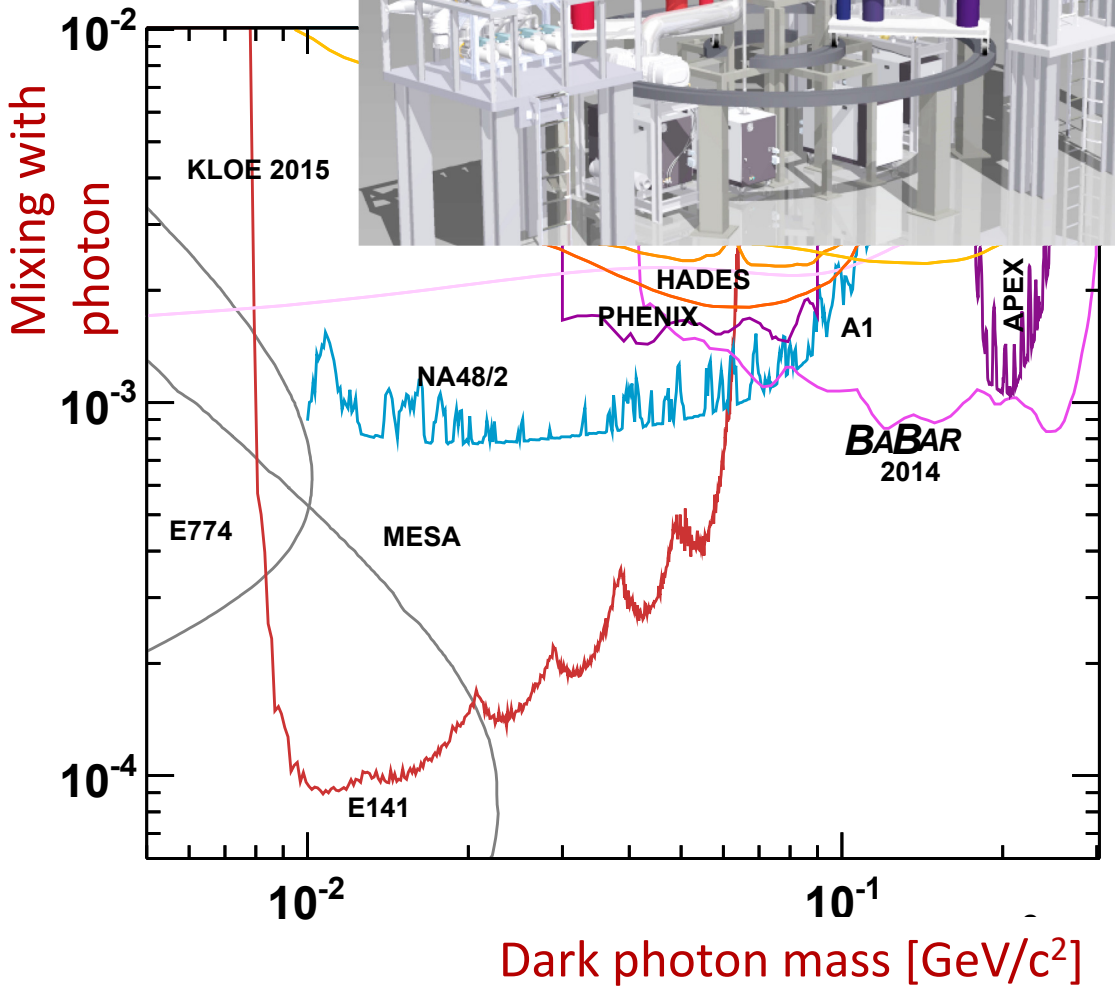
Dark Photons at MAGIX

Low-energy, high-intensity accelerators on the MeV to GeV scale are ideally suited for Dark Photon (A') searches

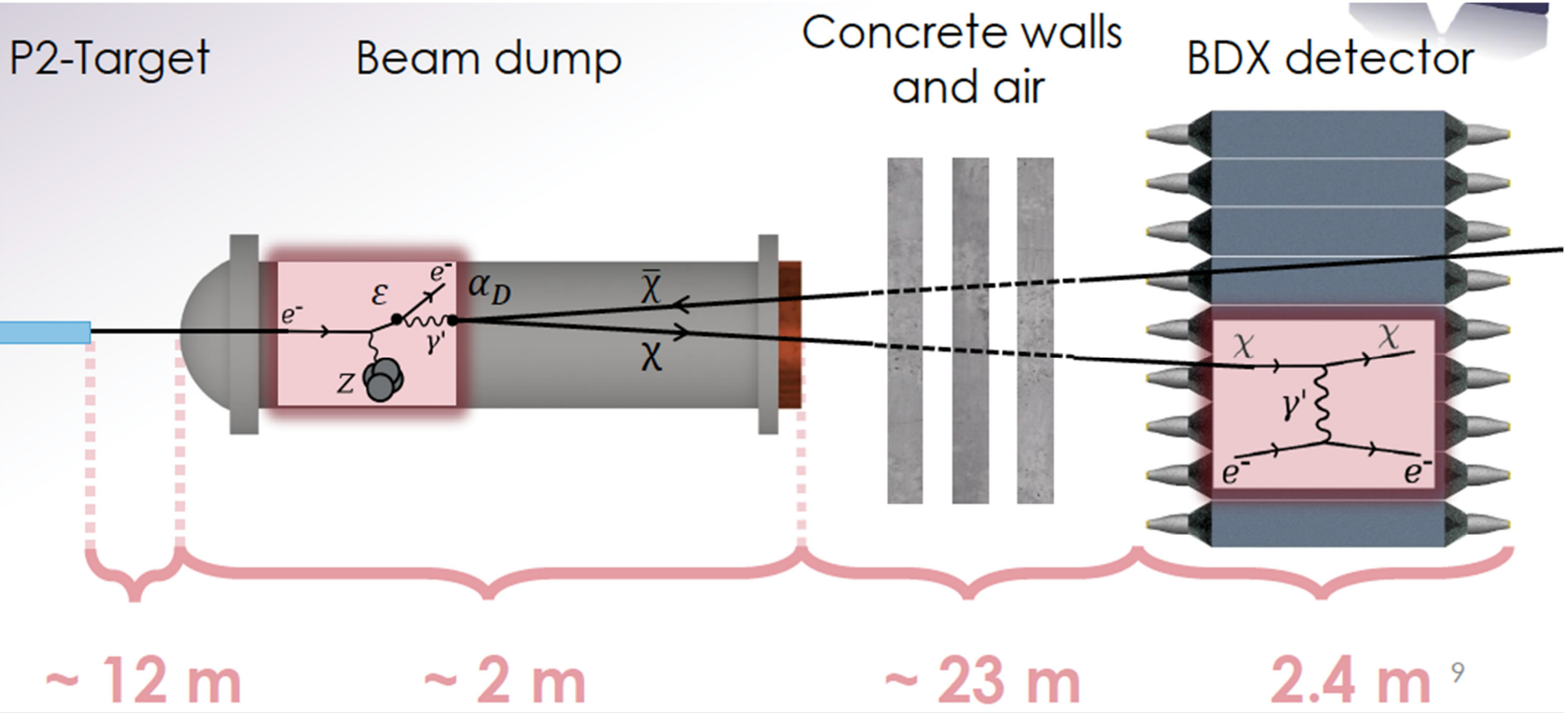






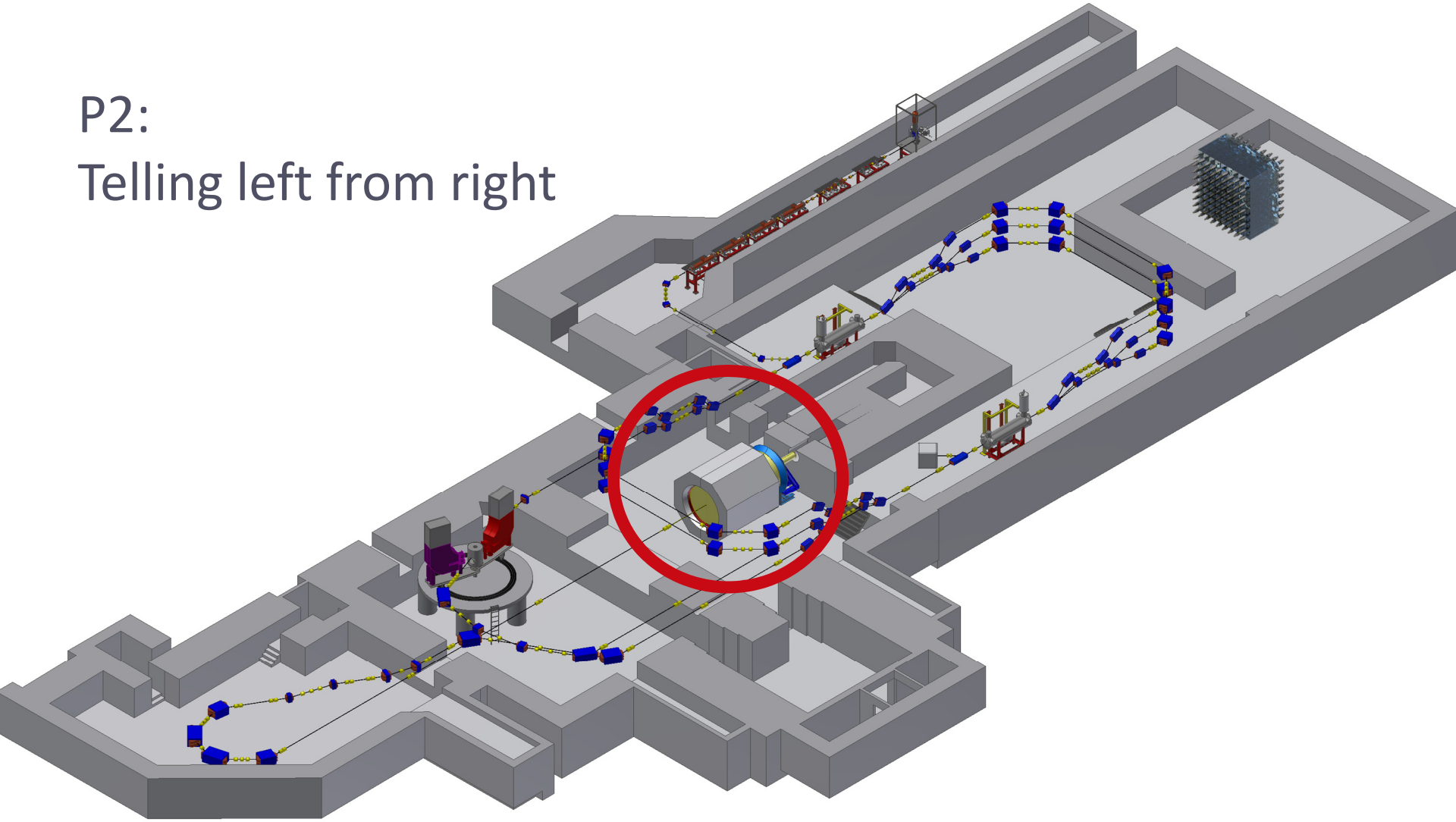


Dark Matter in the Beam Dump: DarkMESA



The weak mixing angle at MESA

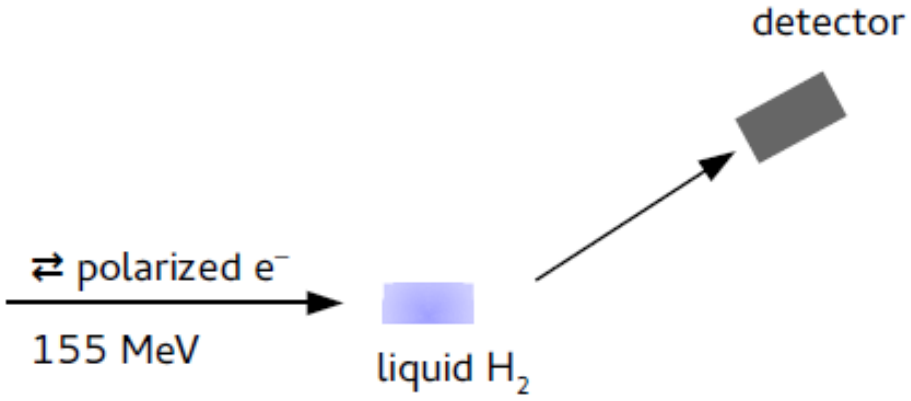
P2:
Telling left from right



The weak mixing angle at MESA

P2 experiment @ MESA:

- Main Goal: precision measurement of electroweak mixing angle θ_W
  → measure $\sin^2\theta_W$ to a precision of 0.13%
- Experimental Method: Measurement of parity violation assymetry in elastic electron proton scattering at low momentum transfer Q^2



$$\frac{N_- - N_+}{N_- + N_+} = \frac{G_F Q^2}{4\sqrt{2}\pi\alpha}\left(Q_W - F(Q^2)\right)$$

$$Q_W = 1 - 4\cdot\sin^2(\theta_W)$$

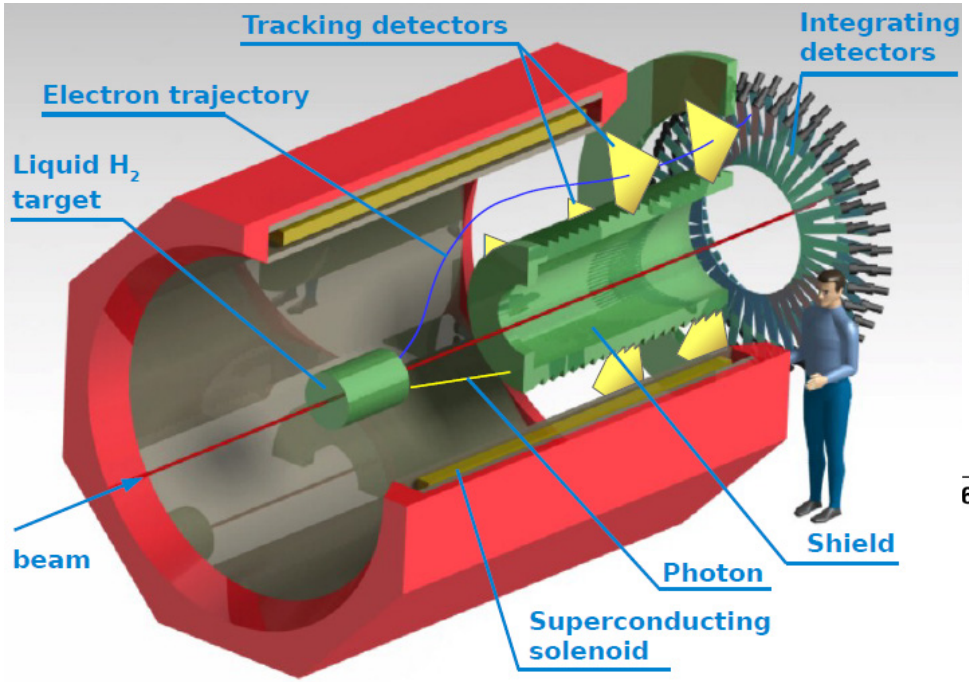
- The expected assymmetry is very small ~30 ppb

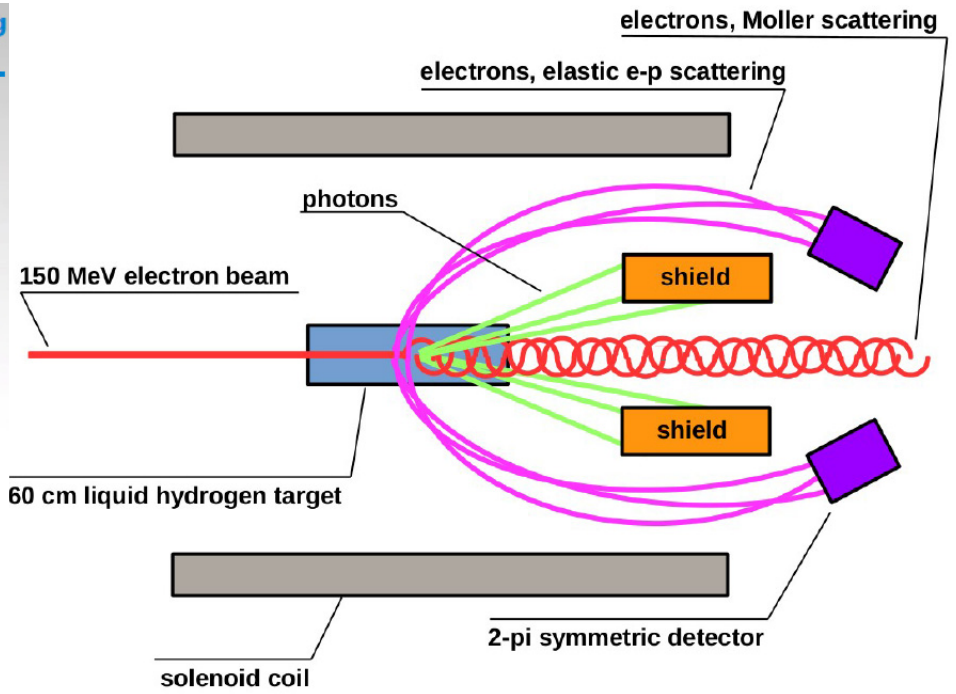
→ High demands on beam quality: We need a polarized beam of 150 µA @ 155 MeV with high polarization and high stability in energy, energy spread, position and angle for a very long time (~10.000 h)

The weak mixing angle at MESA

Experimental setup of P2:

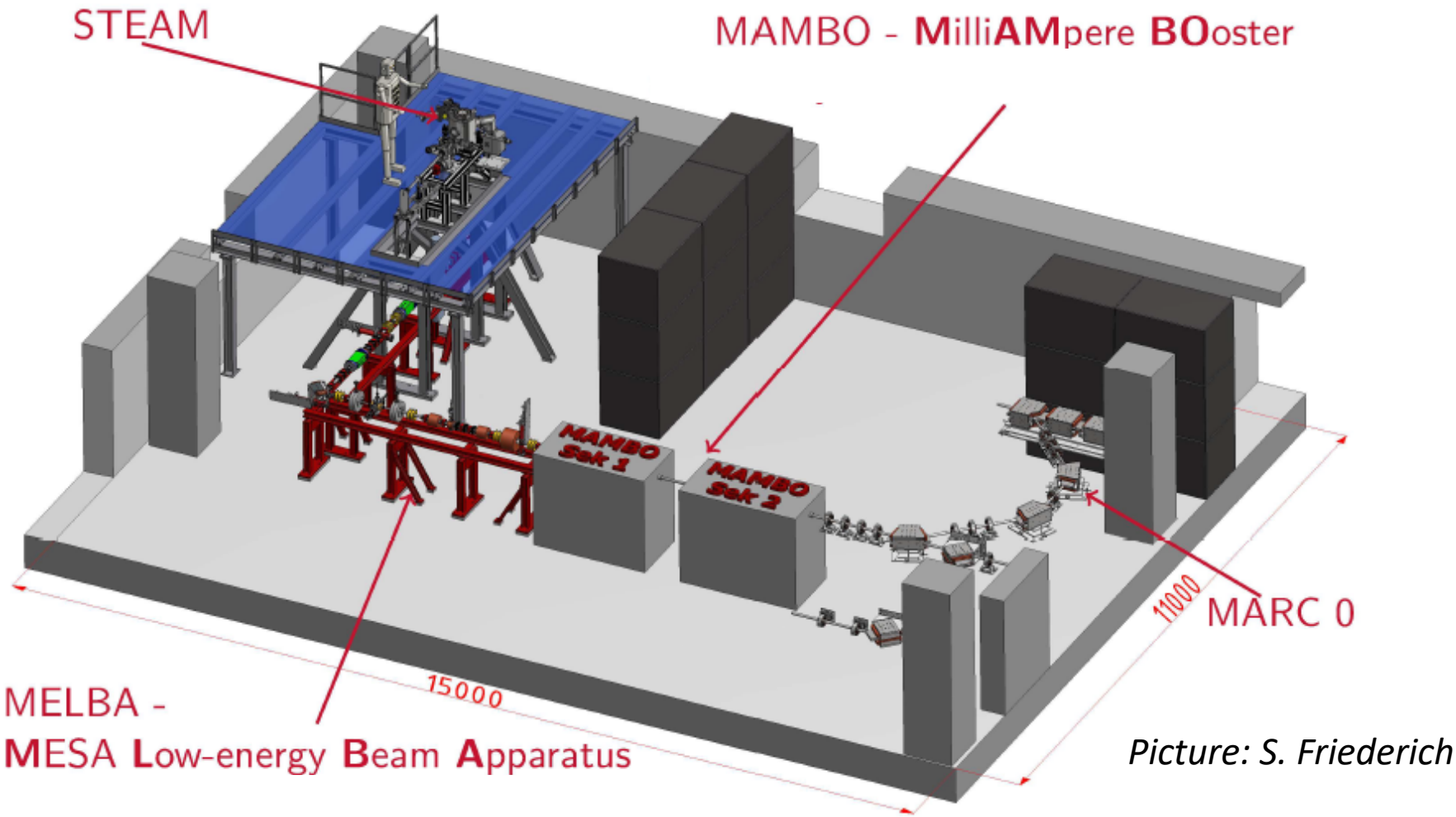
- 60 cm Liquid Hydrogen target, beam deposition 2.8 kW @ 15 K
- 0.6 T superconducting FOPI Solenoid, outer coil diameter 3.8 m
- 2 π symmetric detector plane with Cherenkov detectors, additional tracking detectors





I. Sorokin

Injector Test Setup until July 2019



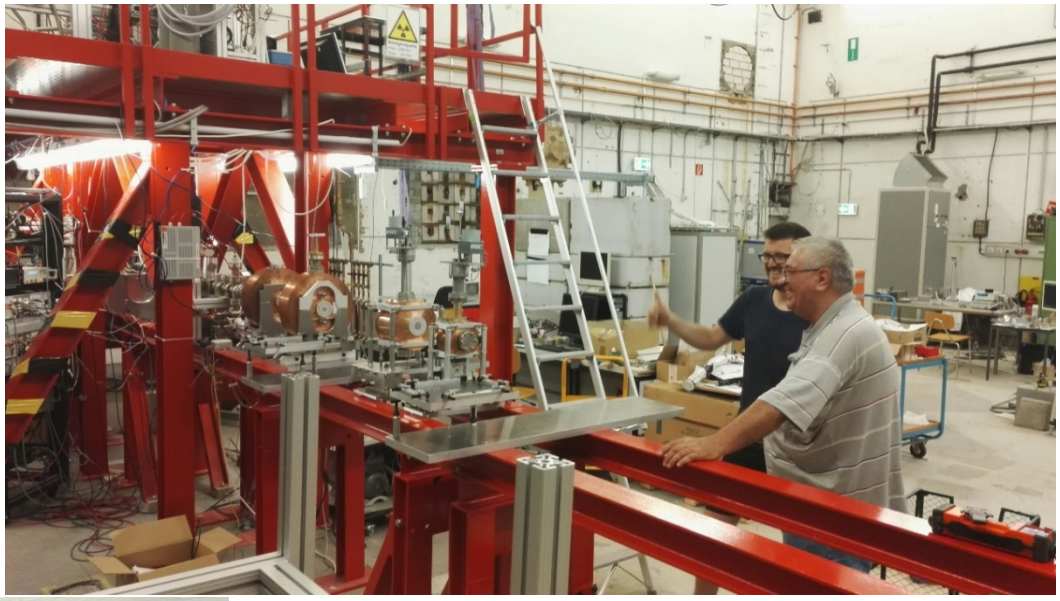
Picture: S. Friederich

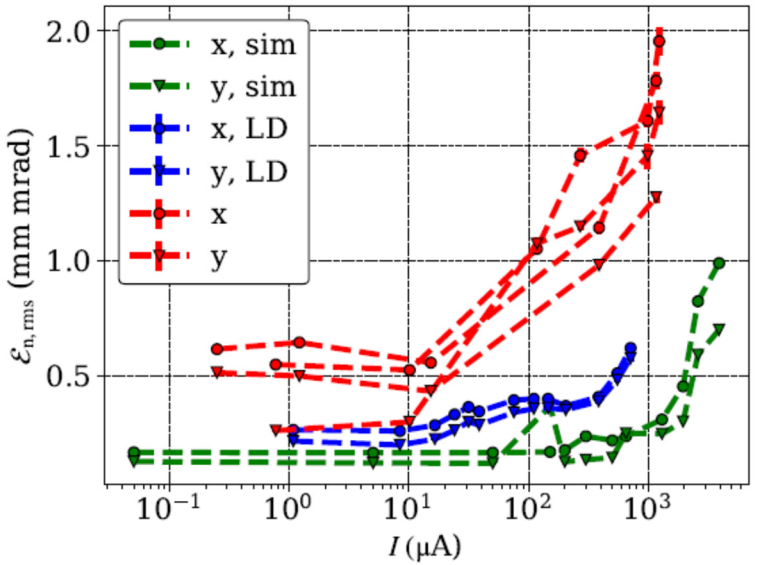
Injector Test Setup until 2019

- electron source and first parts of low energy beam transfer system are tested currently

→ **First MESA beam was existing already (up to ~150 keV)!!!**

→ **Beam current up to 10 mA achieved**





C. Matejcek, K. Aulenbacher & S. Friederich, IPAC 2019

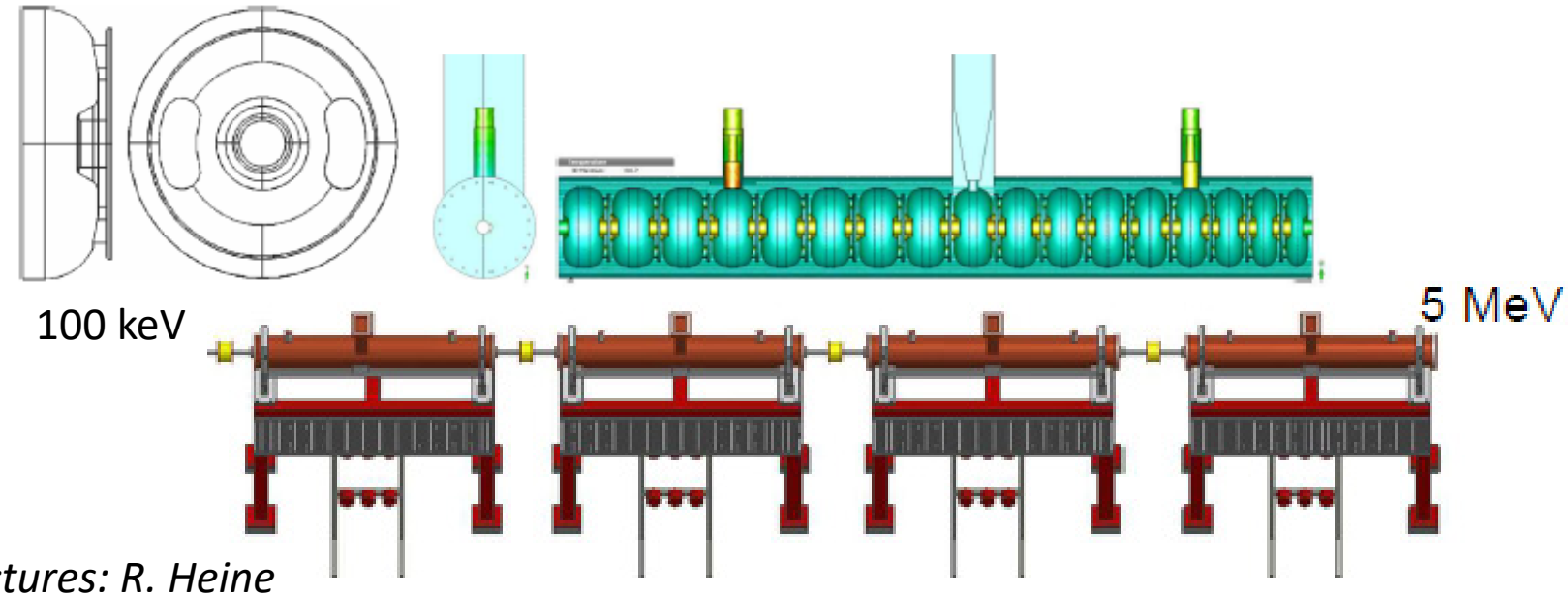
Injector Test Setup until 2019

Picture by MELBA group

MAMBO Booster Linac

- Design inspired by the MAMI injector LINAC
- 4 room temperature RF bi-periodic pi/2 standing wave structures @ 1.3 GHz
- 1 graded-β , 3 const. β sections; Energy gain ΔE=1.25 MeV/section
- RF-Amplifiers: SSA with ~90 kW (graded β) and 3 x ~60 kW (fixed β)

→ Status: FGG granted, parts ordered. Delivery expected **in September 2020**

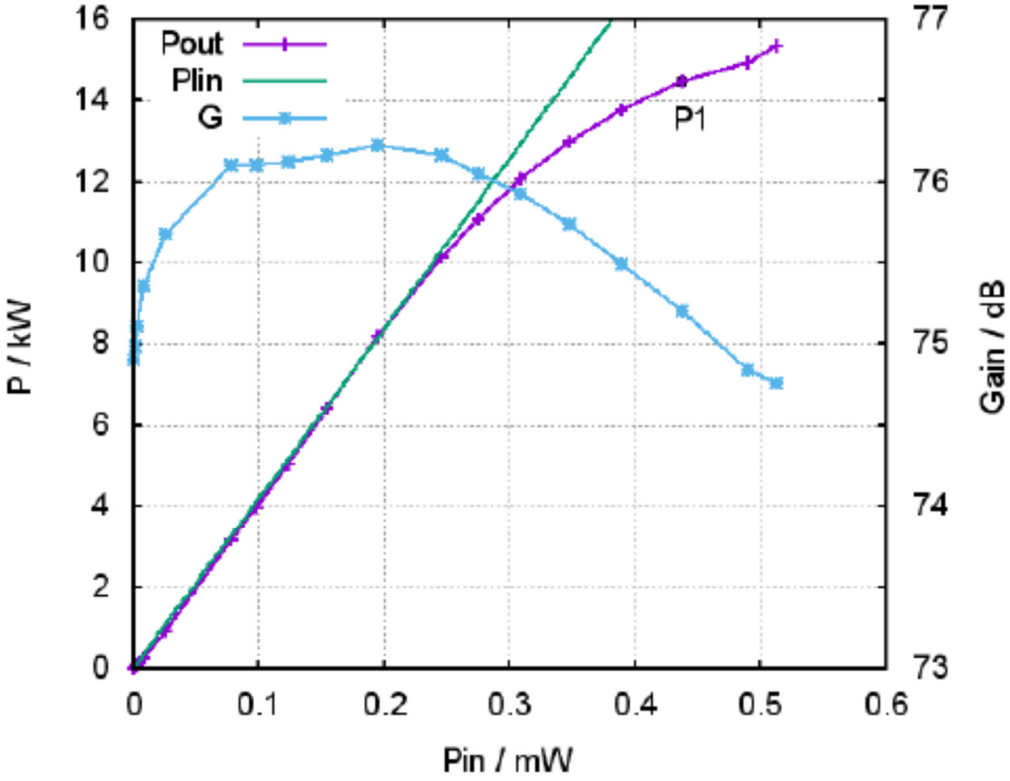


Pictures: R. Heine

MAMBO Booster Linac

15 kW SSA-prototype

Test results

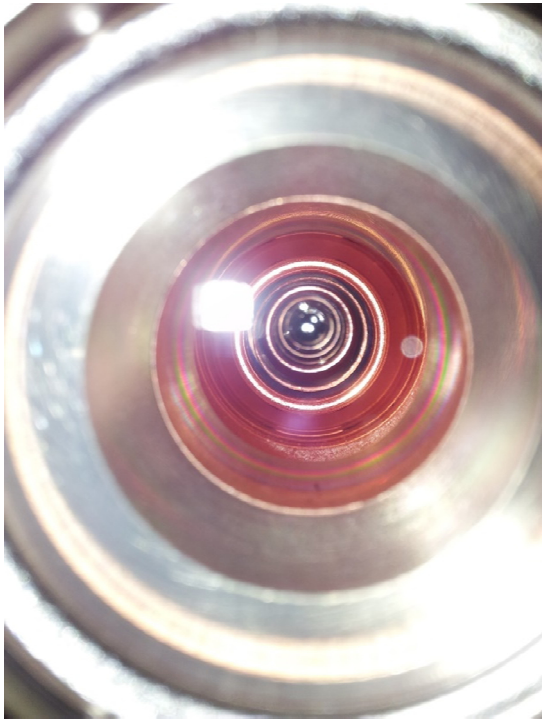


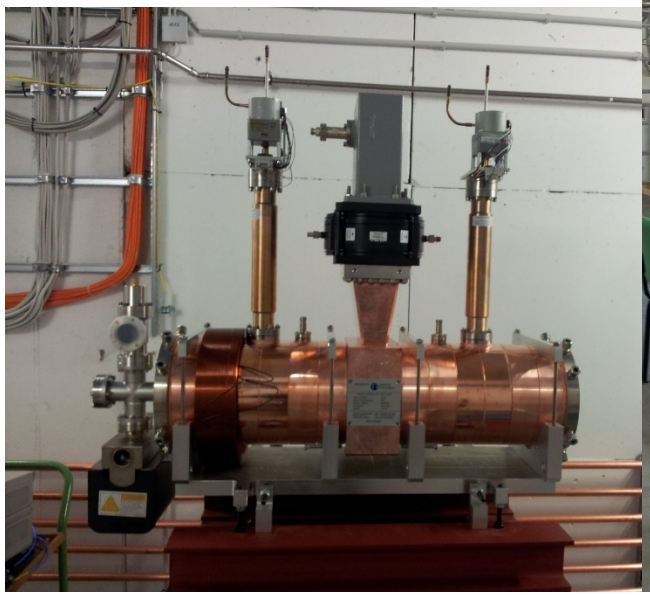
R. Heine, F. Fichtner , IPAC 2018

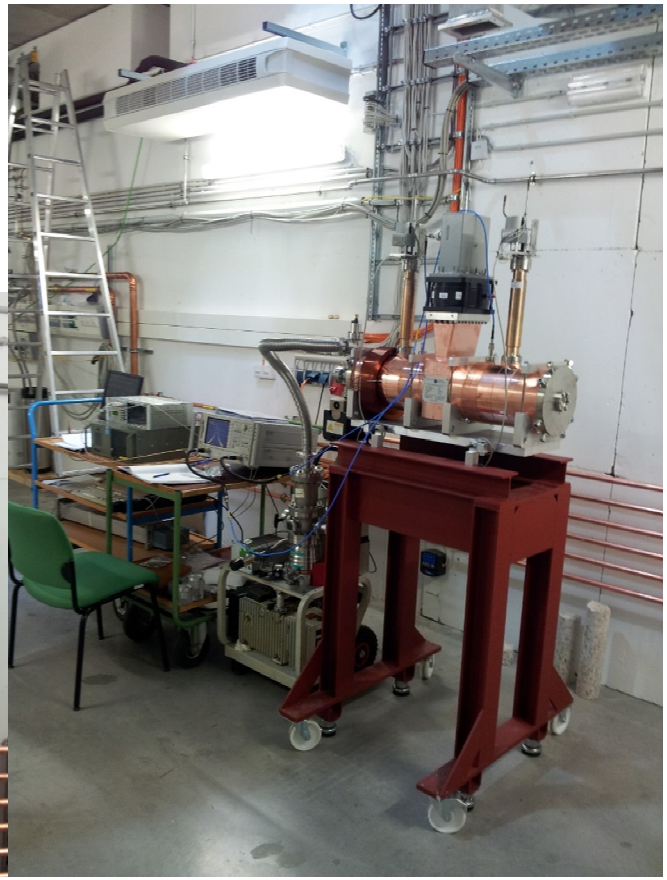
→ SSA is used for cavity tests at HIM

MAMBO Booster Linac: Prototype Cavity

- Successful testing rf-properties of couplers and tuners
- multipacting studies
- First test of PLL for SRF cavity tests
  (MSc thesis S. Thomas)







Pictures: R. Heine

Outlook/Timeline

- Construction of the extended MESA hall will delay the construction start of the accelerator and experiments to at least **2021.** Commissioning of the accelerator is planned to start in **2022**

- But many accelerator parts have been ordered or even built already

- We tested the injector in a test setup in Hall 3 (old part of the building) until civil construction progress required to stop and to empty the underground halls (end **June 2019**)

- The MAMBO linac parts are ordered and will be at Mainz **in fall 2020**. Afterwards setup and commissioning can start.

- Cryomodule tests started at HIM **in June 2018.** One module is accepted (**April 2019**). The second module is under retreatetment and will be tested again **end 2019.** One module will be tested at HZB with beam **from 2021** on

- First beam to experiments can be expected **in 2023**

More about MESA at ERL 2019

- **Design/Status MESA Cryomodules:** Tuesday 16:00 (F. Hug)
- **BBU Calculations for MESA:** Thursday 10:10 (C. Stoll)
- **MESA cryomodules @ bERLinPro:** Tuesday 14:50 (S. Thomas)
- **MESA injection arc:** Postersession Wednesday (A. Khan)
- **MESA optics:** Tuesday 12:00 (F. Hug)

Thank You for Your attention!

MESA new underground hall construction site on September 13th 2019