MESA: THE MAINZ ENERGY-RECOVERING SUPERCONDUCTING ACCELERATOR

A quick overview about the experiences with turn-key cryomodules for CW operation at Johannes Gutenberg-Universität Mainz

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On behalf of the MESA team

SRF Conference, Dresden, 2019

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

EXC 2118/2019

in cooperation with

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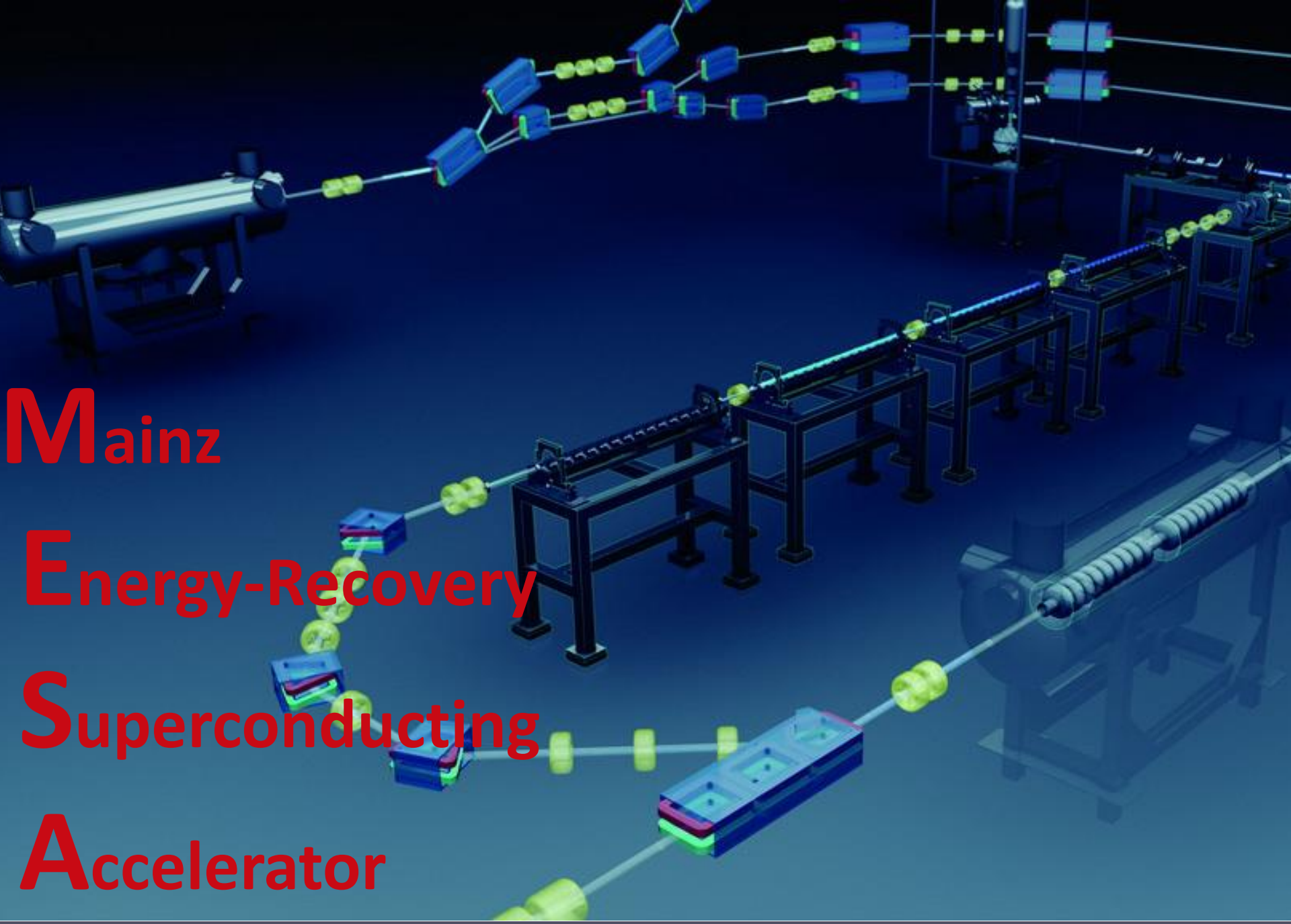
Accelerator Physics

Over 50 years experience:
MAMI: CW, e^-, 1.5 GeV, RTM normal conducting

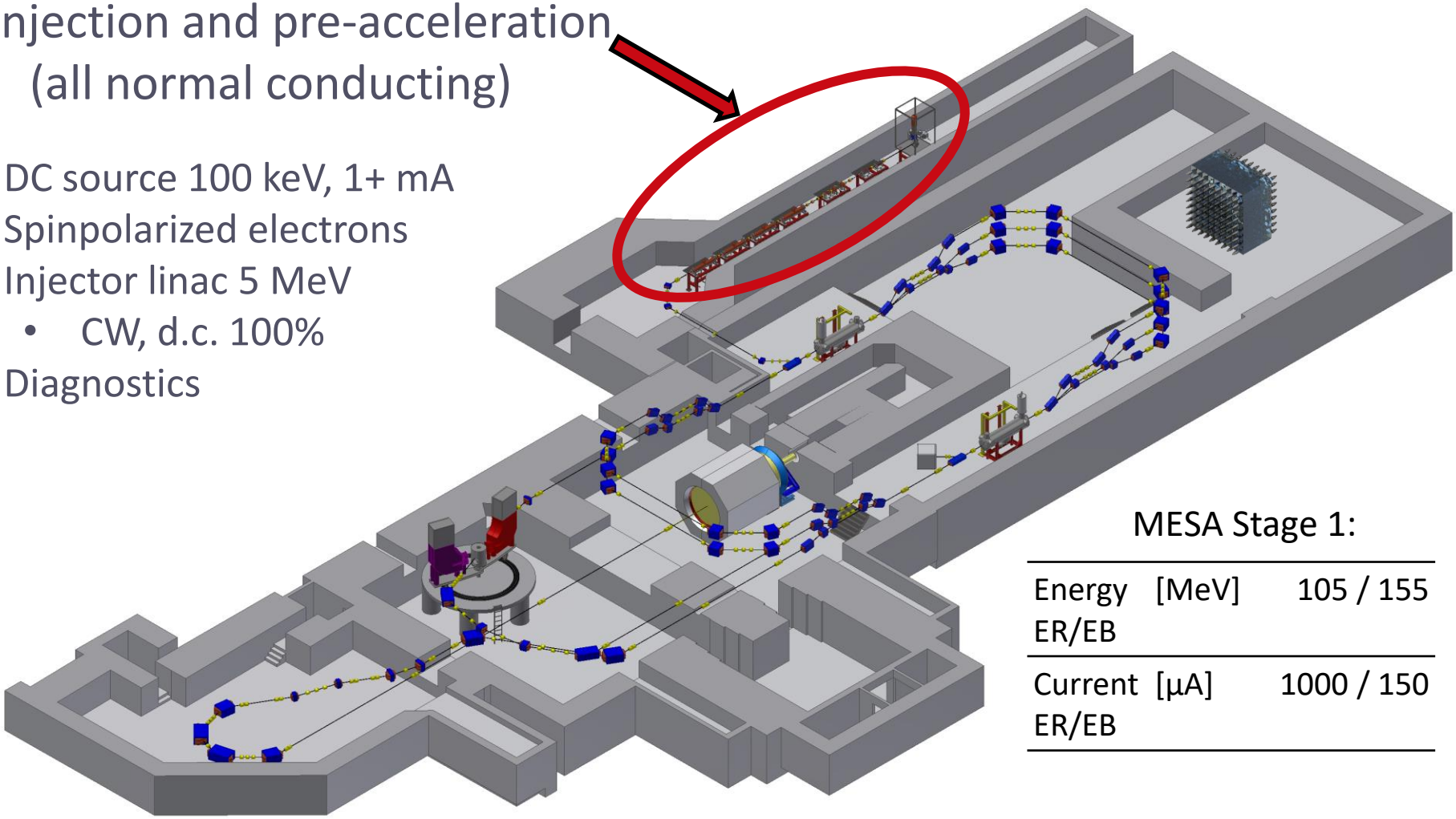
Since 2012: Second accelerator funded:
MESA (CW , e^-, **superconducting**, **ERL**)


Mainz
Energy-Recovery
Superconducting
Accelerator

Mainz Energy-Recovery Superconducting Accelerator

1. Injection and pre-acceleration
   (all normal conducting)

- DC source 100 keV, 1+ mA
- Spinpolarized electrons
- Injector linac 5 MeV
  - CW, d.c. 100%
- Diagnostics



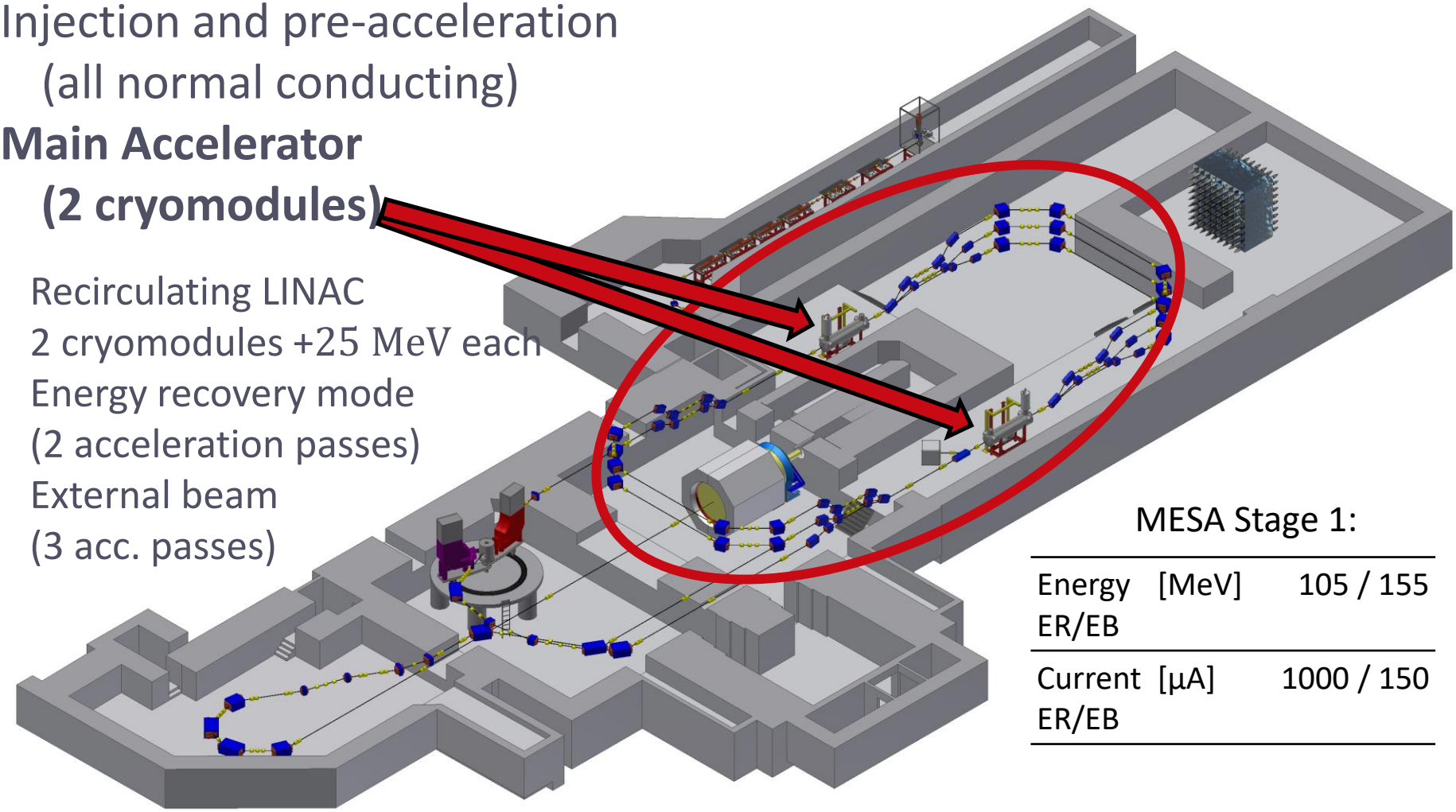
MESA Stage 1:

Energy [MeV] ER/EB	105 / 155
Current [µA] ER/EB	1000 / 150

Mainz Energy-Recovery Superconducting Accelerator

1. Injection and pre-acceleration
   (all normal conducting)
2. **Main Accelerator**
   (2 cryomodules)

- Recirculating LINAC
- 2 cryomodules +25 MeV each
- Energy recovery mode
  (2 acceleration passes)
- External beam
  (3 acc. passes)



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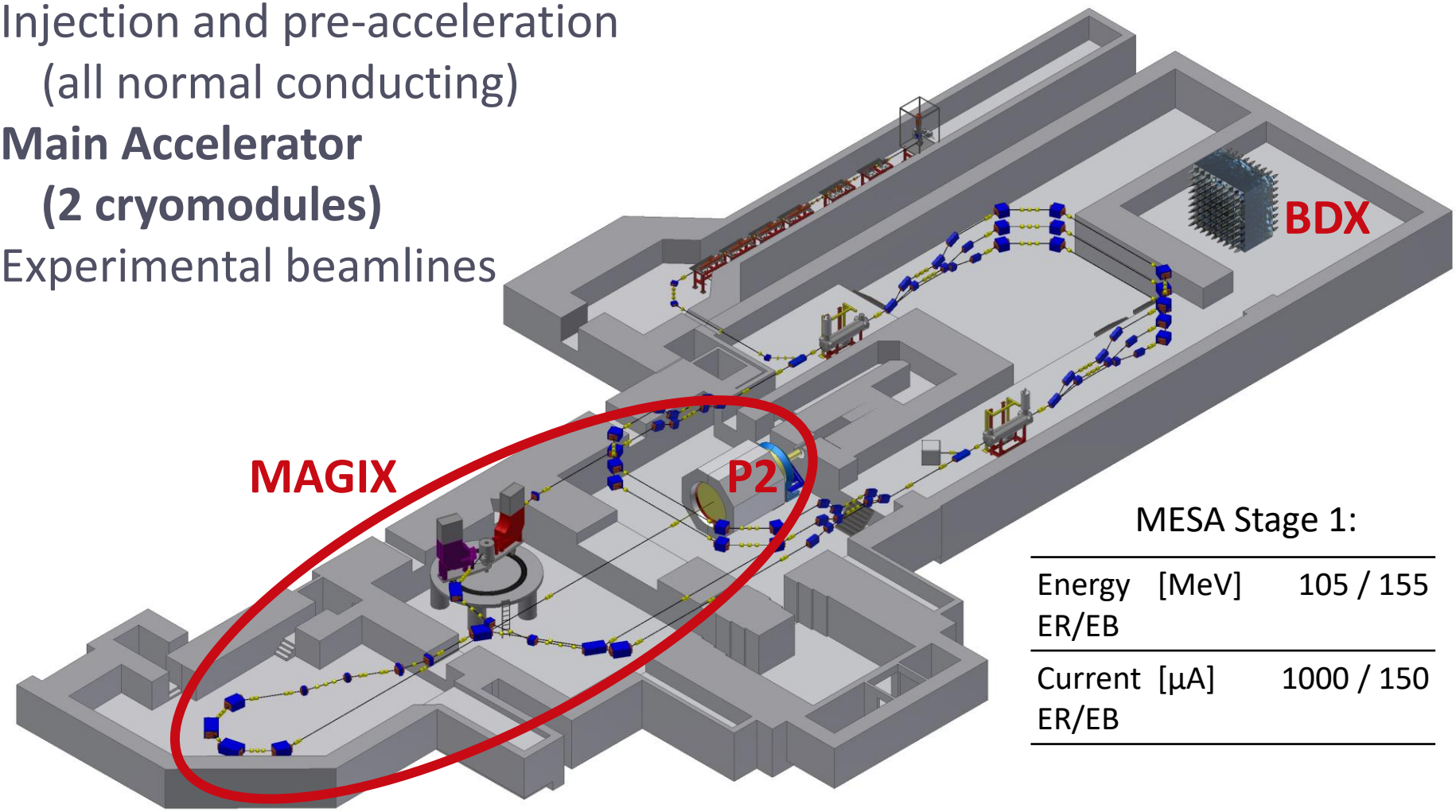
Mainz Energy-Recovery Superconducting Accelerator

1. Injection and pre-acceleration
   (all normal conducting)
2. **Main Accelerator**
   (2 cryomodules)
3. Experimental beamlines



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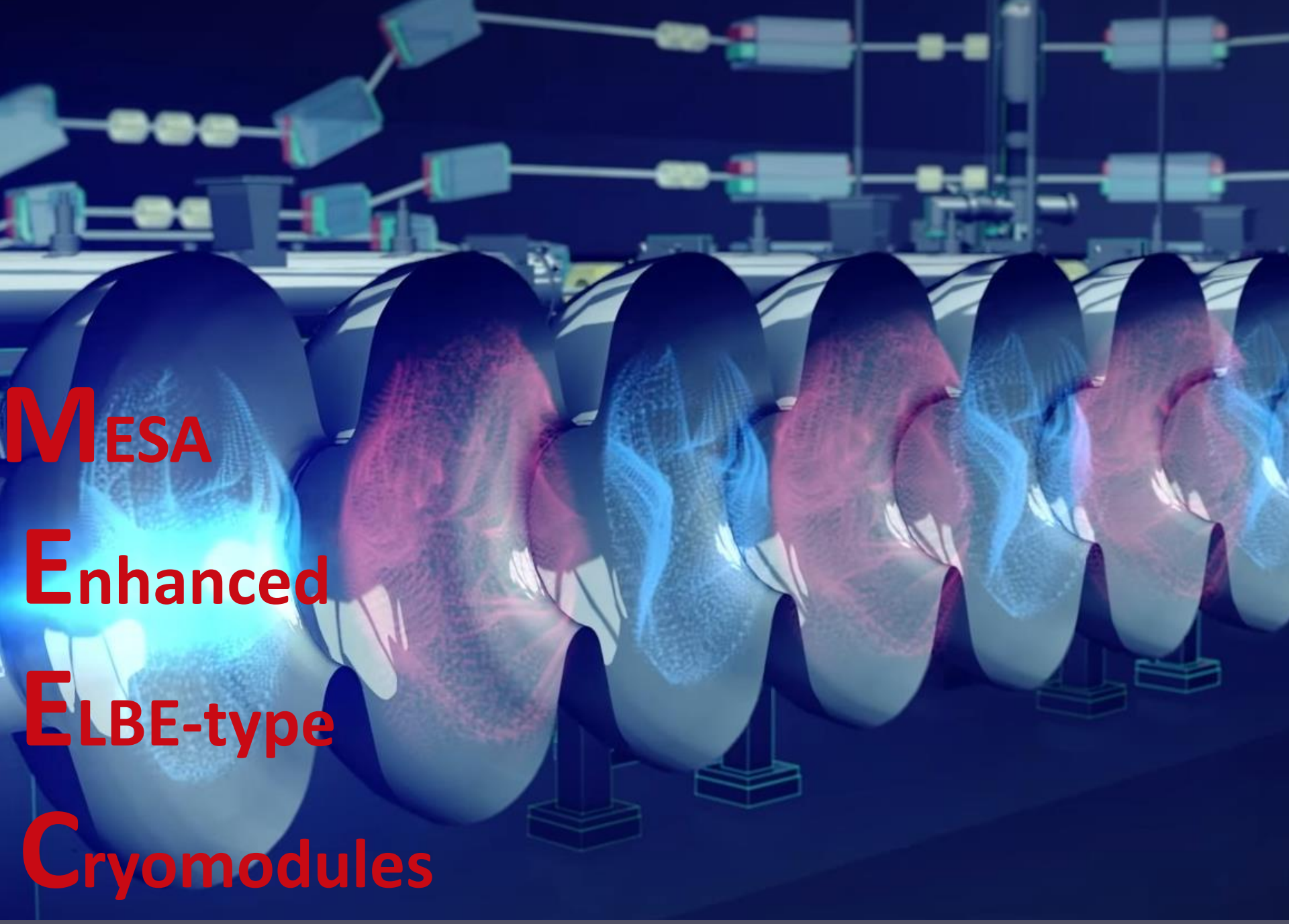
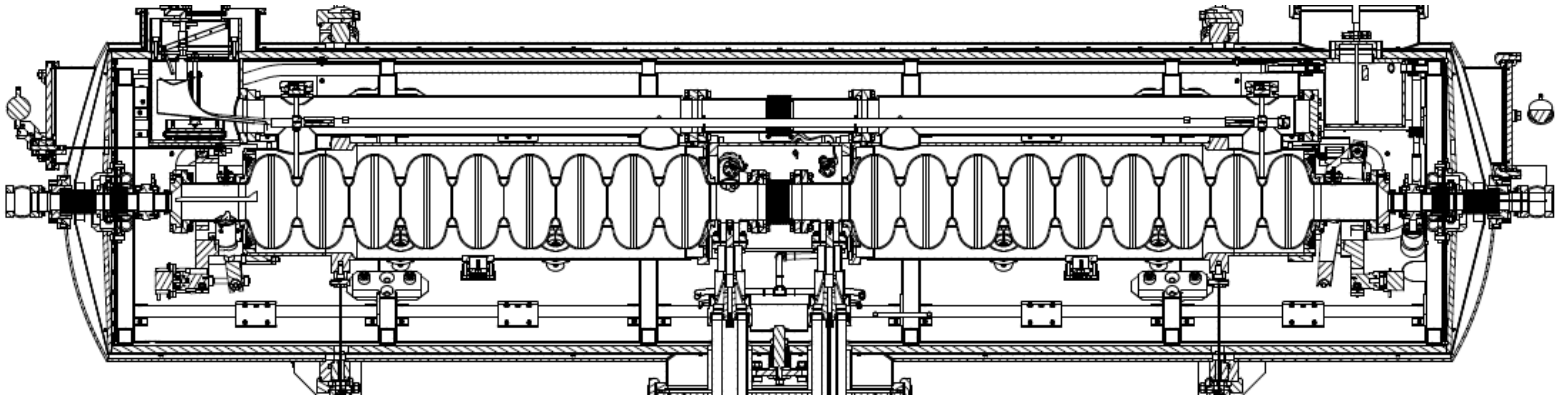

MESA
Enhanced
ELBE-type
Cryomodules

MESA Enhanced ELBE-type Cryomodules



Variable	Specification
energy gain per CM	> 25 MV
static losses	<15 W
dynamic losses @25 MV (CW)	<25 W
$\propto Q_0$ @12.5 MV m^{-1}	>1.25 × 10^{10}

- XFEL/Saclay tuner
- BBU simulations ongoing ($I_{\mathrm{th}} \leq 12$ mA)
- Tests with beam at bERLinPro

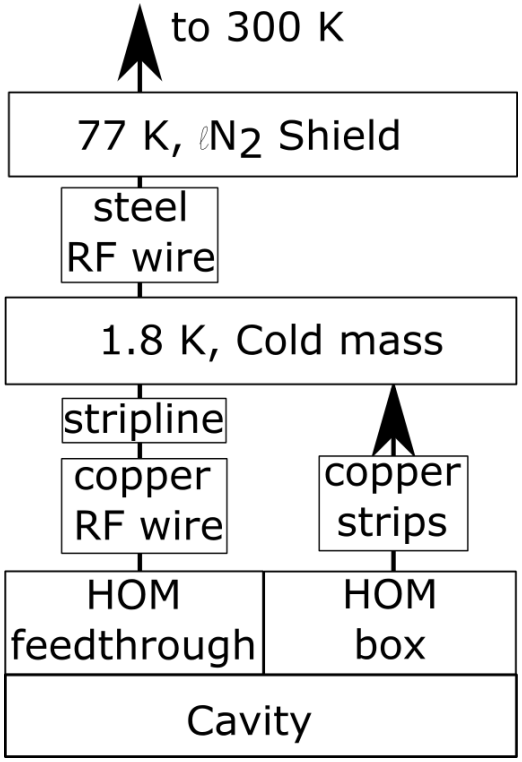
B.C. Kuske *et al.*, "Incorporation of a MESA Linac Modules into BERLinPro", in *Proc. IPAC'19*

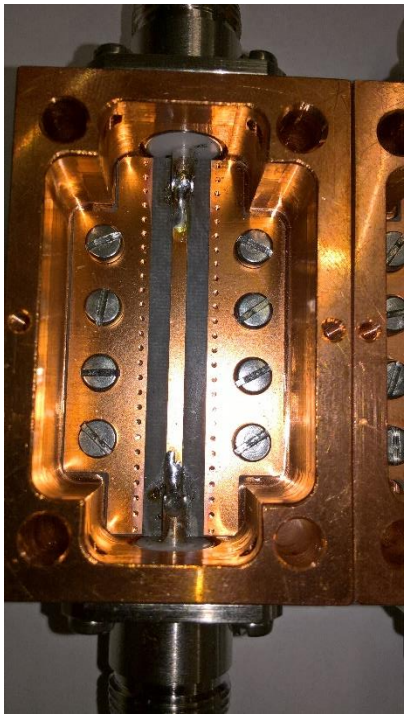
MESA Enhanced ELBE-type Cryomodules

Concern: Heating of the HOM-Antenna

Changes:

- Sapphire windows at HOM feedthrough
- Strip line in HOM cable for cooling





Cryomodule (2 XFEL Cavities @ 12.5 MV/m)

Production of 2 Cryomodules

- 2015: Ordered at RI Research Instruments GmbH
- Contract contains
  - Changes (XFEL/Saclay tuner, Sapphire feedthrough)
  - Specs (12.5 MV/m, $Q_0 \geq 1.25 \cdot 10^{10}$)
  - **Cryogenic Components** (valve box, 2K heat exchanger and JT valve, transfer line)
  - Stand alone **control system** (and connectable to EPICS)
  - With expertise of DESY, HZDR and industry partners
- Milestones
  - VT at DESY
  - FAT at Mainz
  - SAT at Mainz

Production of 2 Cryomodules

- Close cooperation between RI and Mainz University
  - Weekly **conference calls**
  - **Personal meetings** if necessary approx. **3 per year**
  - **Approval** of all changes
  - Quality control: All RF **measurements** verified by JGU

  - ➢ Effective cooperation between RI and JGU
  - ➢ Close cooperation needed for project coordination

2 Cryomodules, including modifications, VB, JT valve and control system built by RI

Site Acceptance Test at HIM

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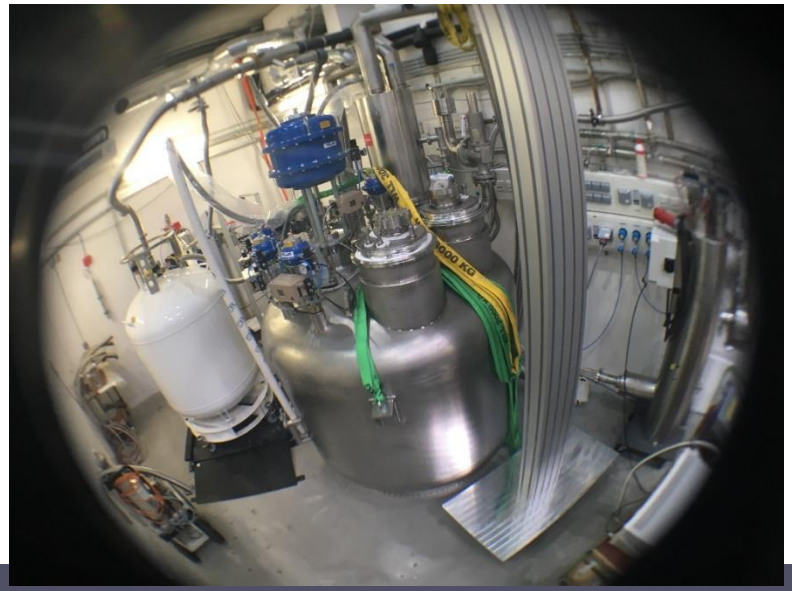
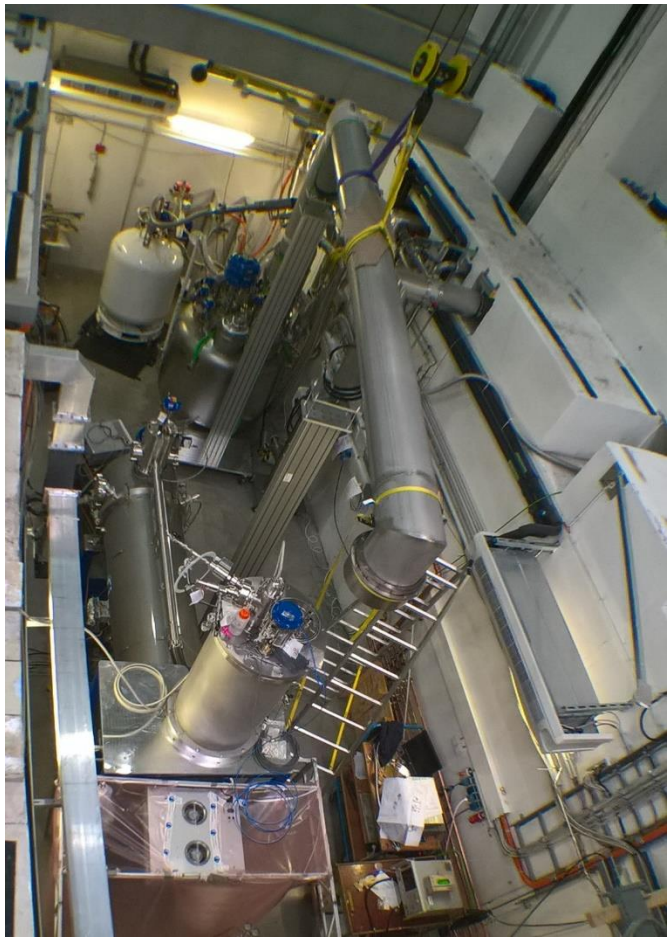
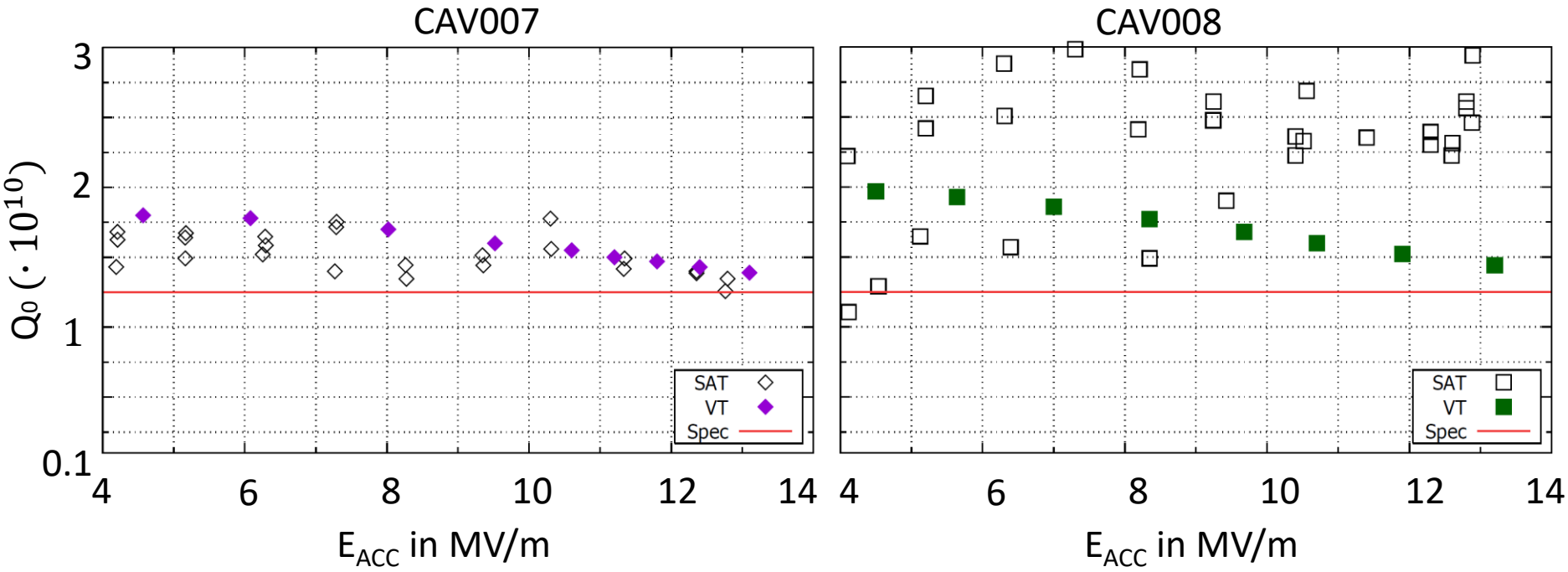
- Several successful cooldown cycles to 1.8 K at the HIM RF bunker with both cryomodules
- CW measurements up to 12.5 MV/m
- Static heat load more than 30% better than design value for both modules
- **SAT for first module approved recently (30.4.2019)**





Site Acceptance – Cryomodule 1

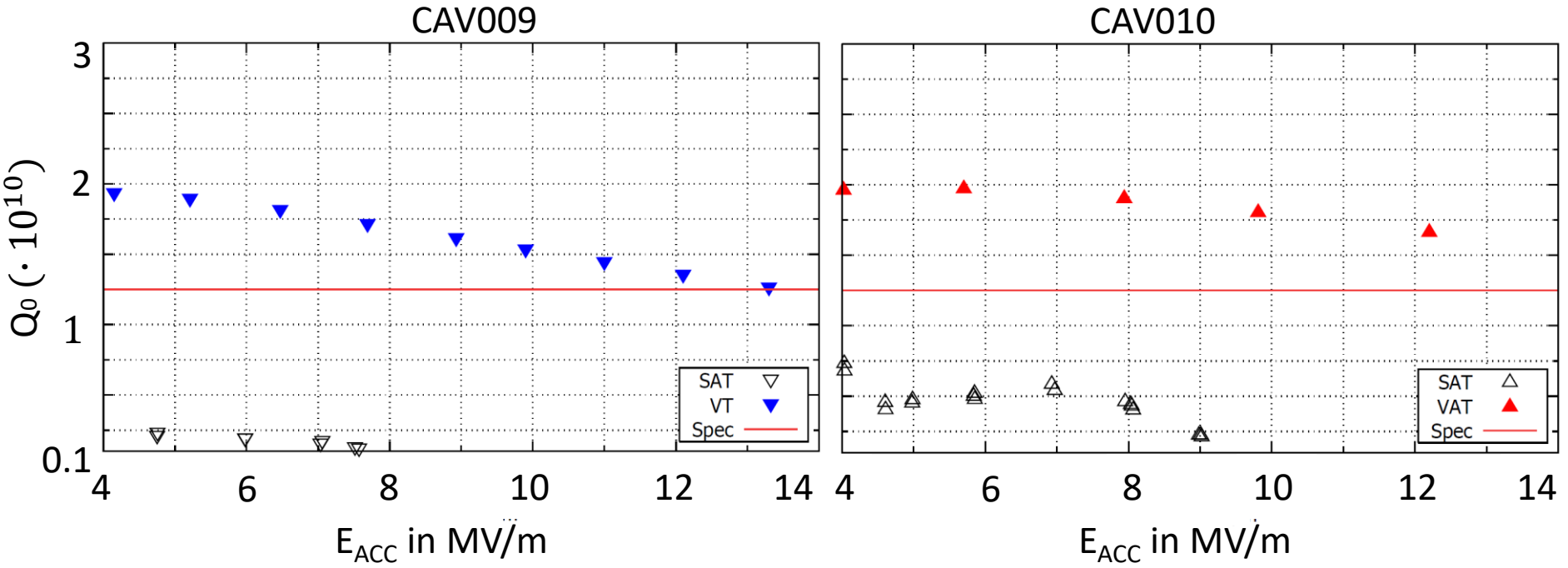


CAV008:

- **Systematic error** with **LLRF test system** occurred
- Helium flow indicates $Q_0 > 1.25 \cdot 10^{10}$ at 12.5 MV/m

To be measured again…

Site Acceptance – Cryomodule 2

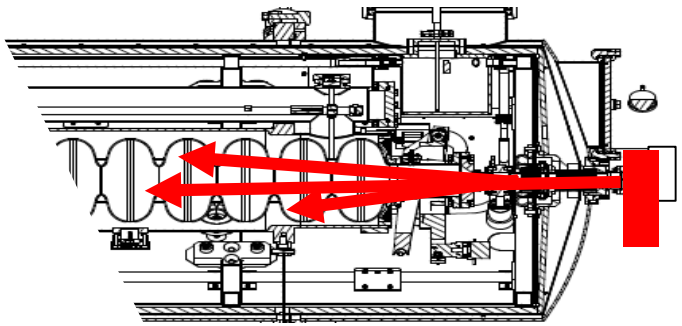


Field emission because of a valve in a undefined state at the beam pipe

Particles could float in N_2

CM for **refurbishment**

Test within **2019**



Valve movement caused particles

Outlook

More information:

TUP041 – SRF Testing for MESA

THP054 – Cryogenic Installations

MESA

- Userfacility ERL
- At Johannes Gutenberg Universität Mainz
- Under construction (start 2022)

Cryomodule production:

- Succesfull turn key CM production by industry
- CM1 with 2x 12.5 MV/m @ $Q_0 \geq 1.2 \cdot 10^{10}$
- CM2 at refurbishment
- CM transport under vacuum
- Tests with beam at bERLinPro

Outlook

More ... n:

TUP0... sting for MESA

T... yogenic Installations

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Thank you for your attention