X-box-B RF test stand possibilities at CERN

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CERN

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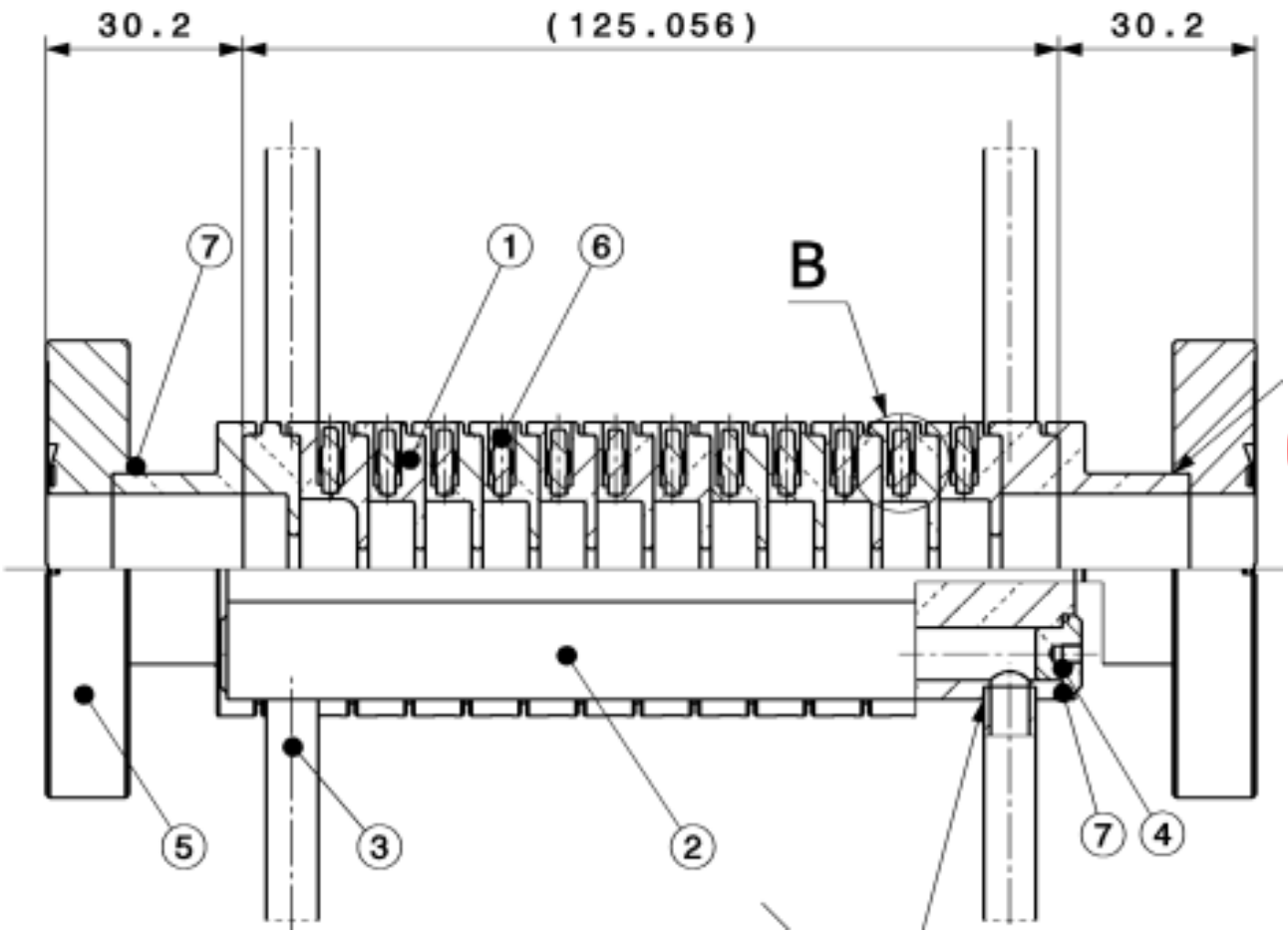
Outline

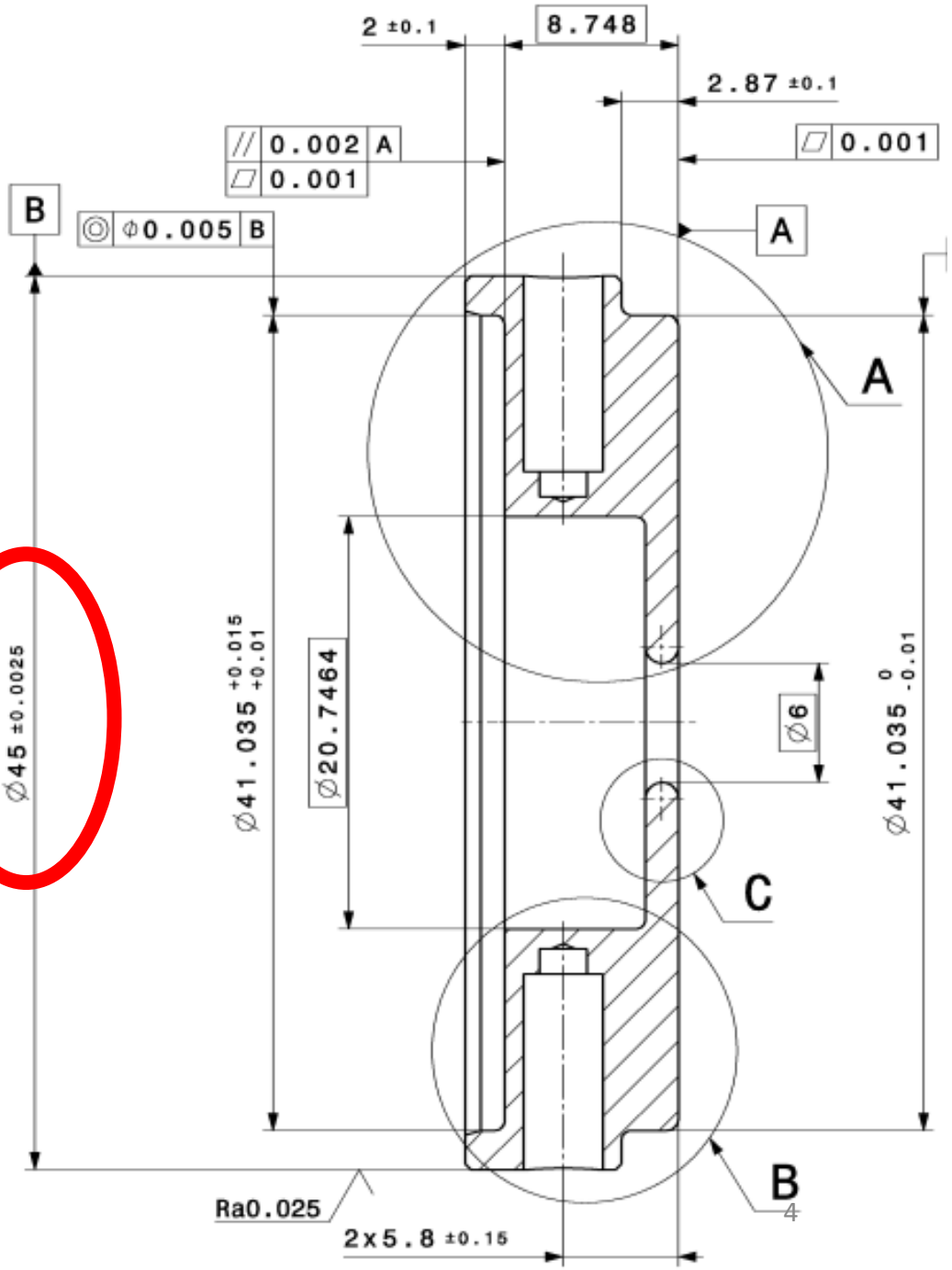
- Motivation
- X-band high power test stands at CERN
- What is needed
- What are the options
- Summary

Motivation

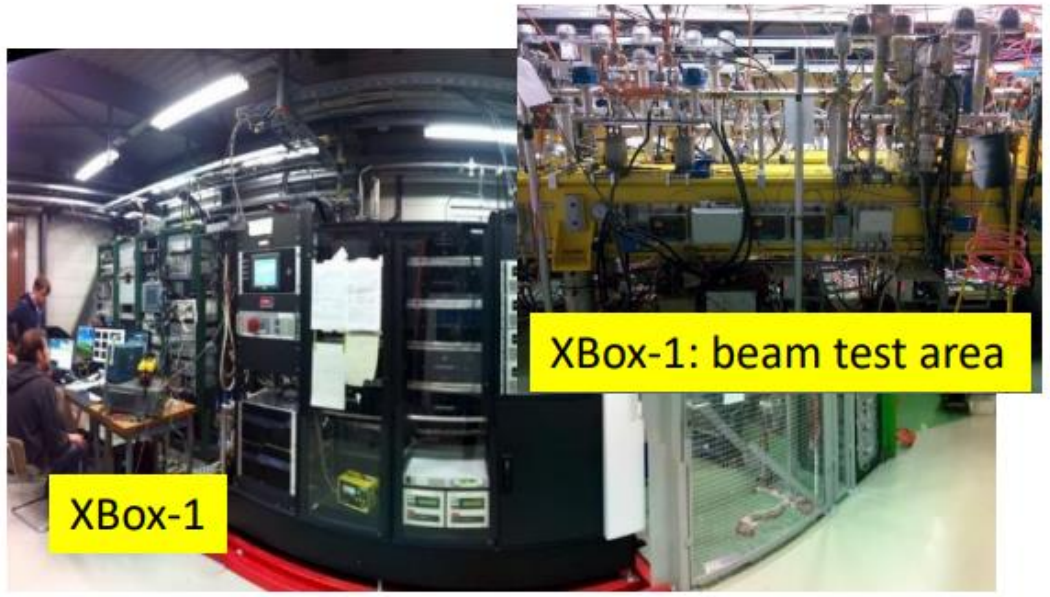
- Muon cooling RF system at 350 MHz – 700 MHz require high field(up to 13T) solenoids with big worm bore diameter (1 m – 0.5 m)
- This is very challenging solenoids which are difficult to get on the short (few years) time scale
- X-band frequency (12 GHz at CERN) is very far from the frequency range of interest for the muon cooling RF system: 350 – 700 MHz
- On the hand, it has an advantage of very small cavities which require warm bore diameter only ~50mm
- This offers much chipper (and faster) way to build a test stand to study high gradient performance at strong magnetic field up to 13 T

X-band cavity example

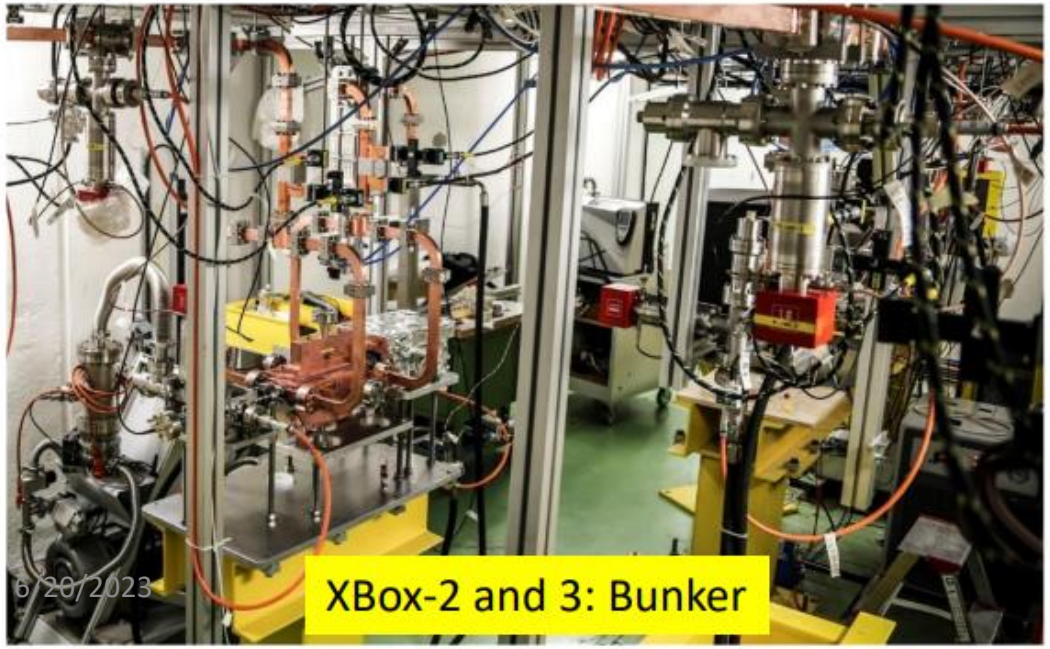


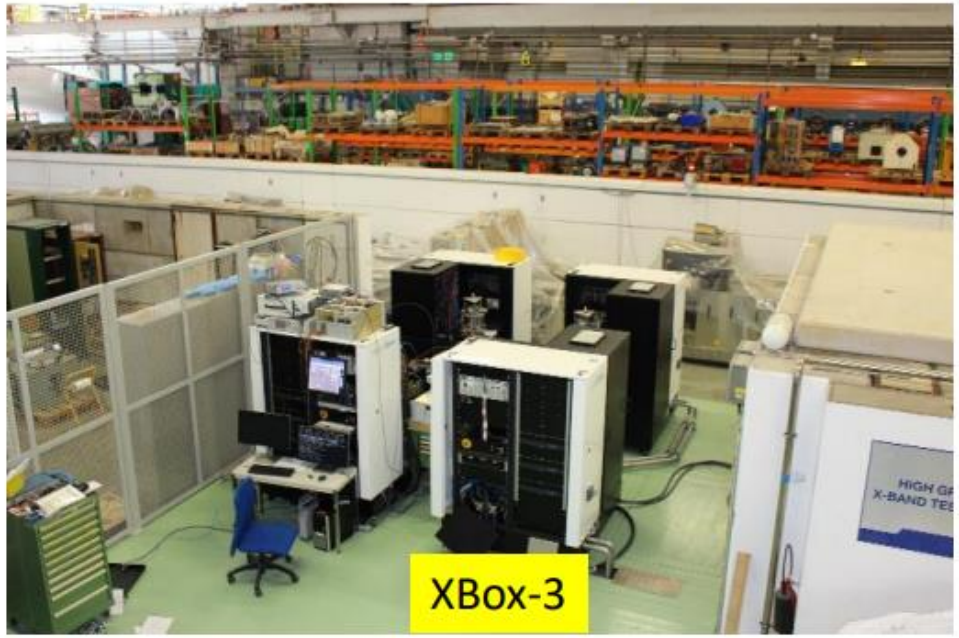


X-band test stands at CERN

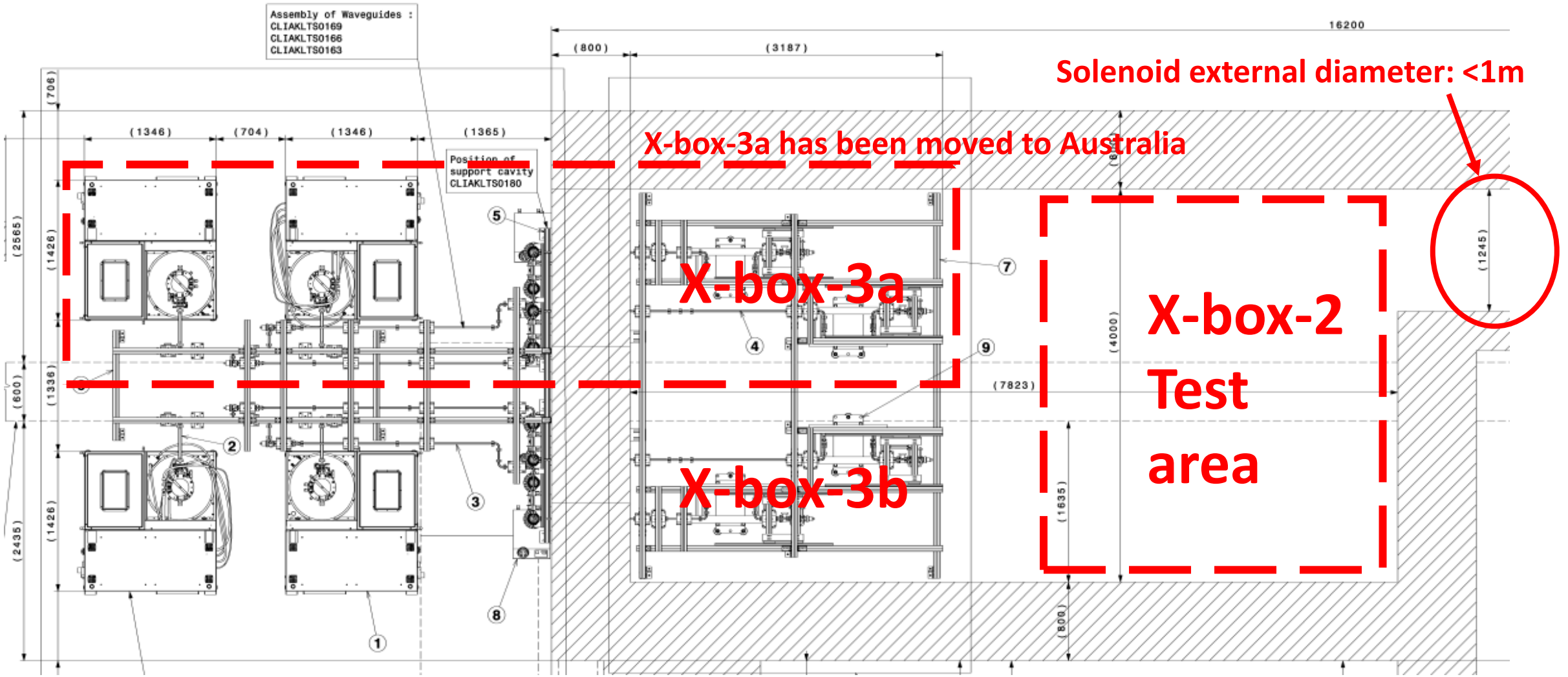


Nuria made a great summary at the: [IMCC Annual Meeting 2022]

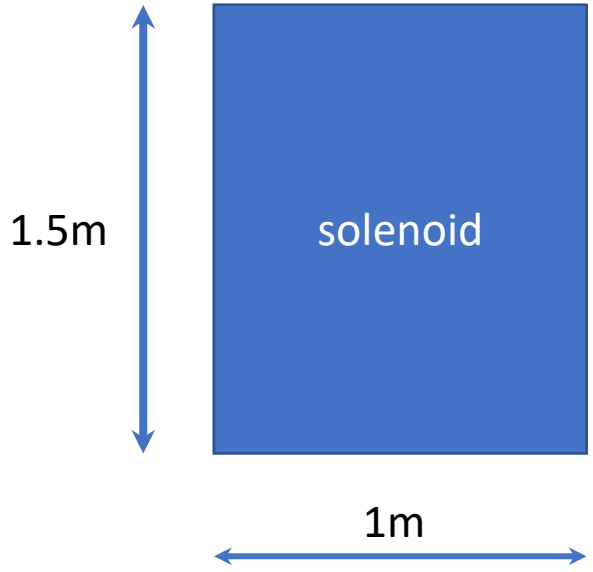


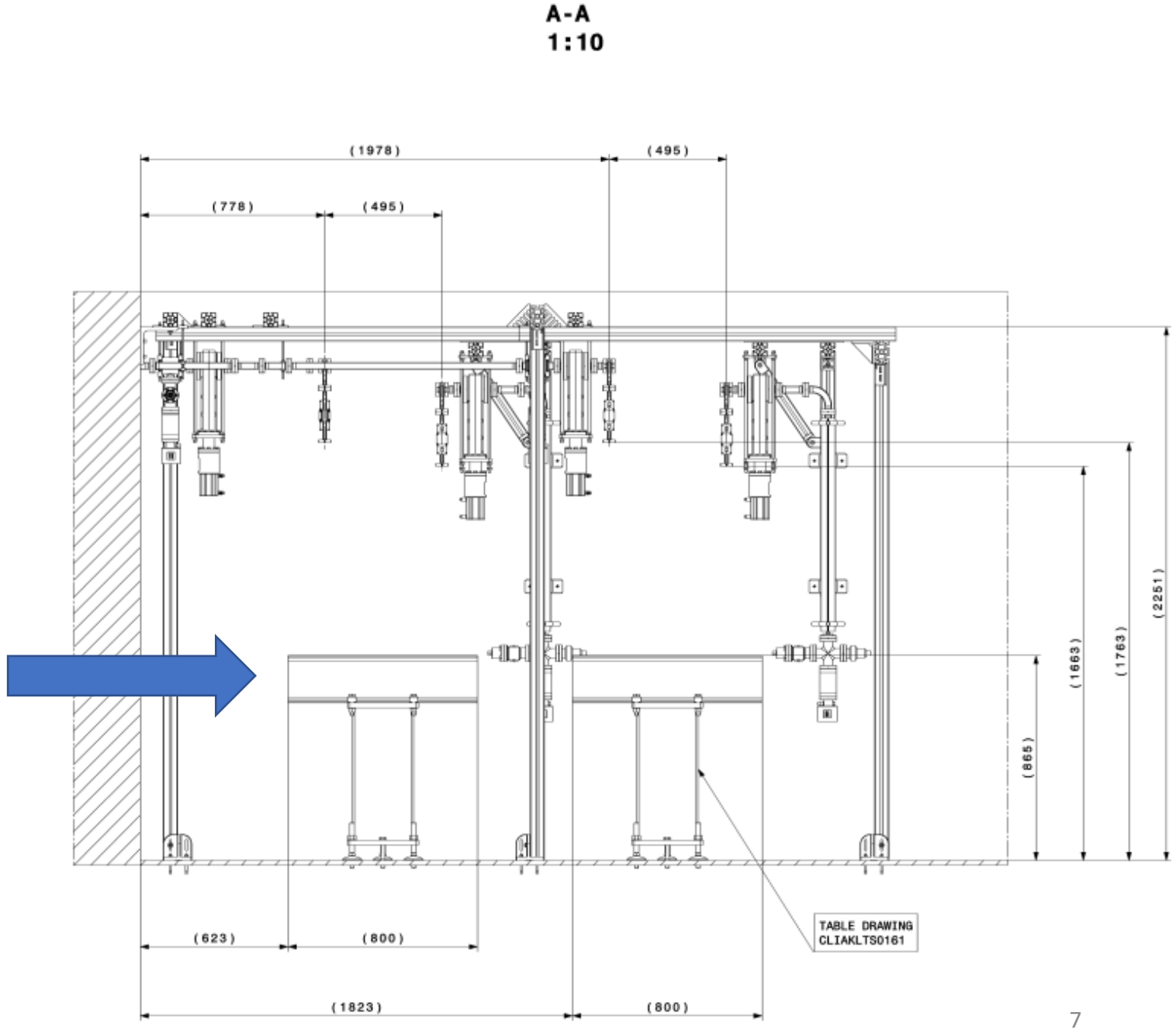


X-box-3 layout and dimensions

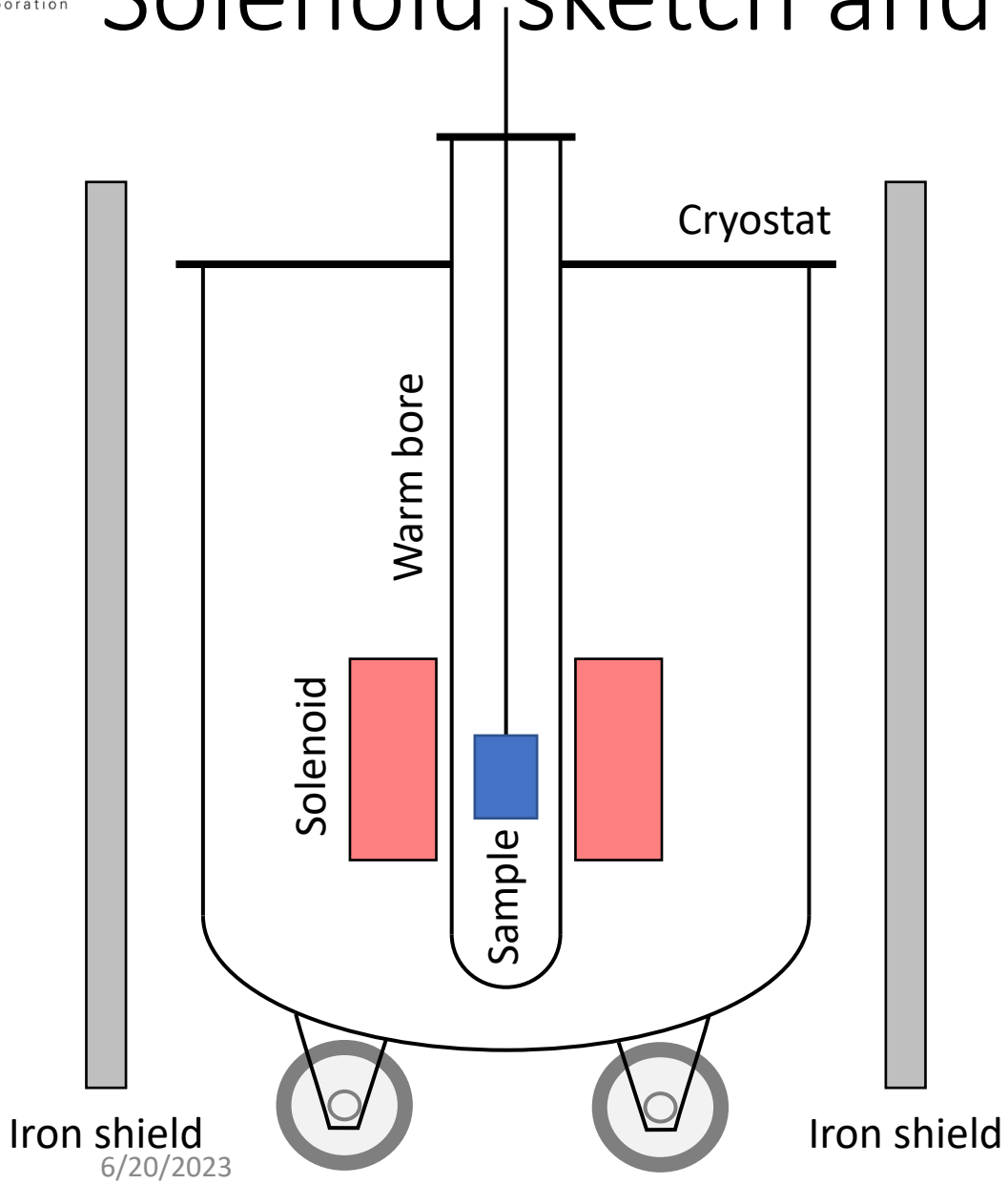


X-box3 test area and solenoid integration





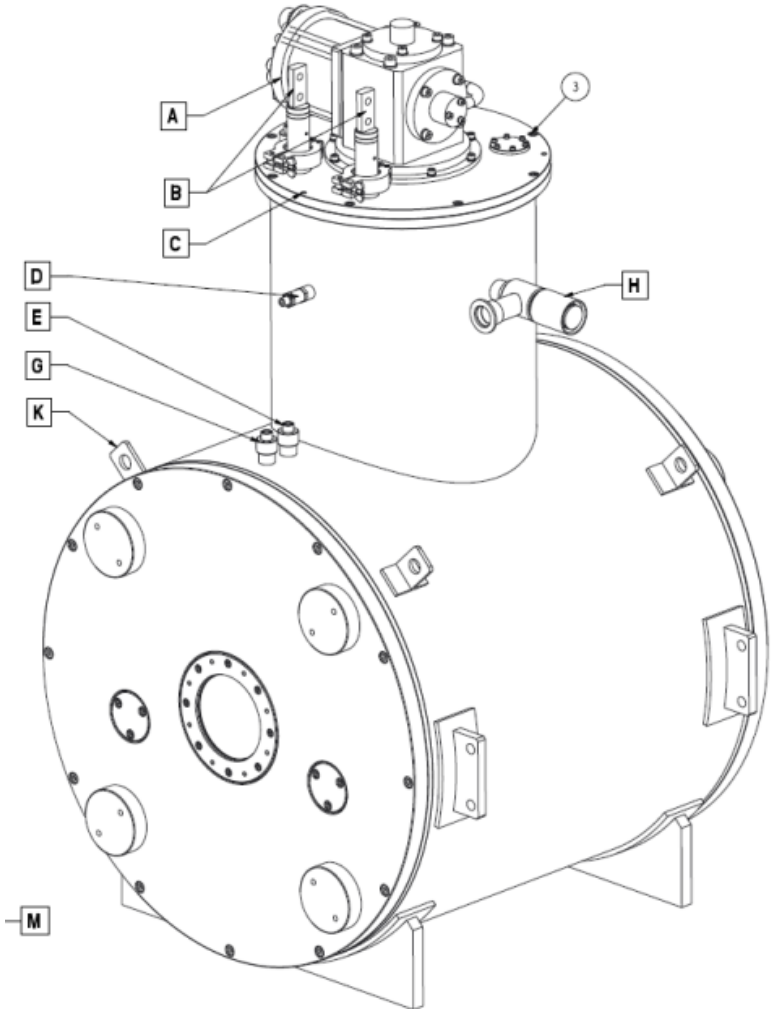
Solenoid sketch and specifications

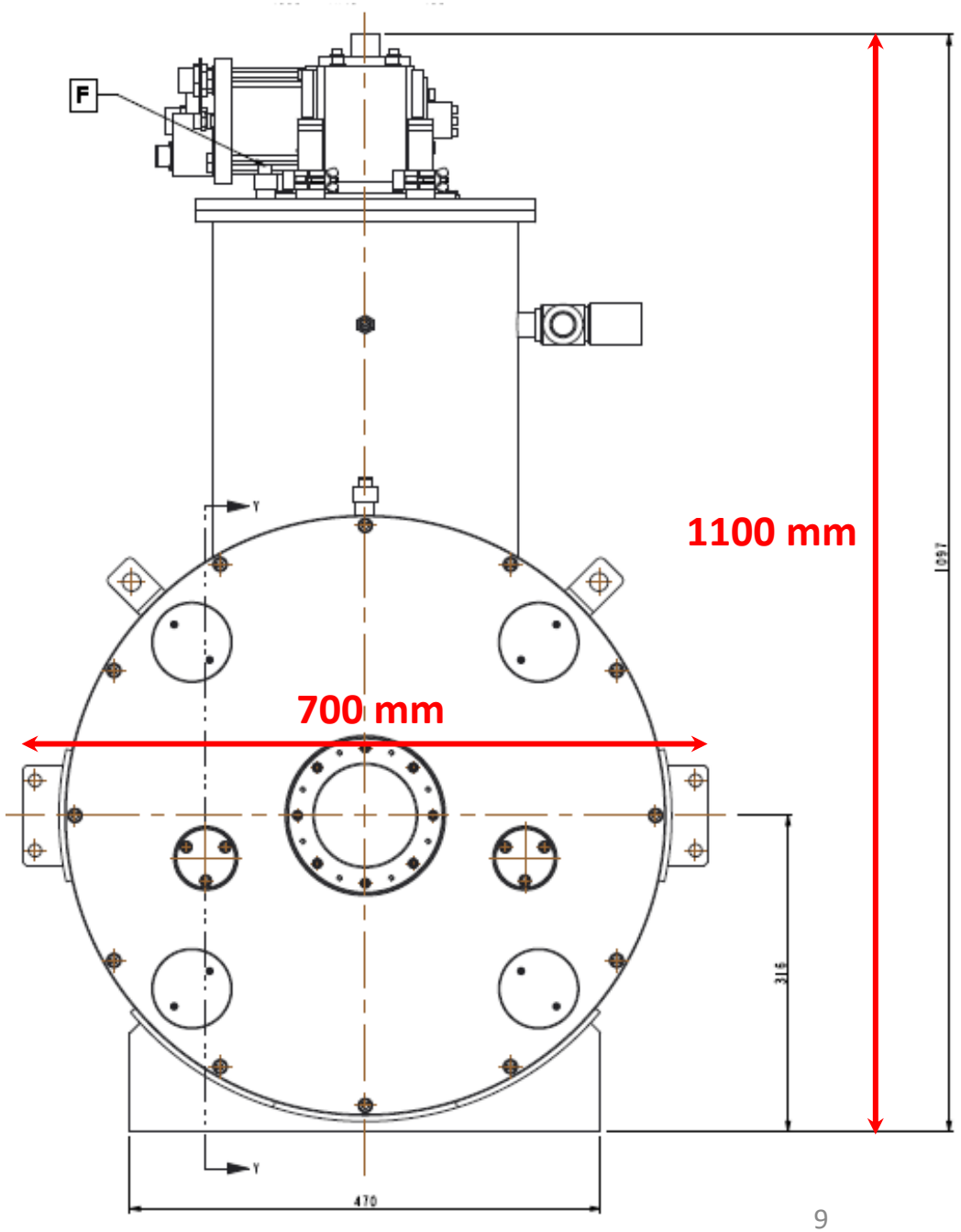


- Minimum bore field: 12T
- Minimum warm bore diameter: 50mm
- Test volume: 50mm (diameter) x 50mm (height)
- Field homogeneity in test volume: 3 %
- Option for VTI, from 50 K to RT conditions
- Mobile system (cryostat/magnet/sample)
- Maximum outside diameter of cryostat: 800mm
- Maximum height of the cryostat: 1m
- Magnetic shielding in test location, either de/mountable or integrated in cryostat (mobile)
- NOTES:
  - Preferred solution would be cryo-cooled
  - Helium delivery possible with mobile dewar, helium recovery line available in the vicinity

Oxford Instruments solution

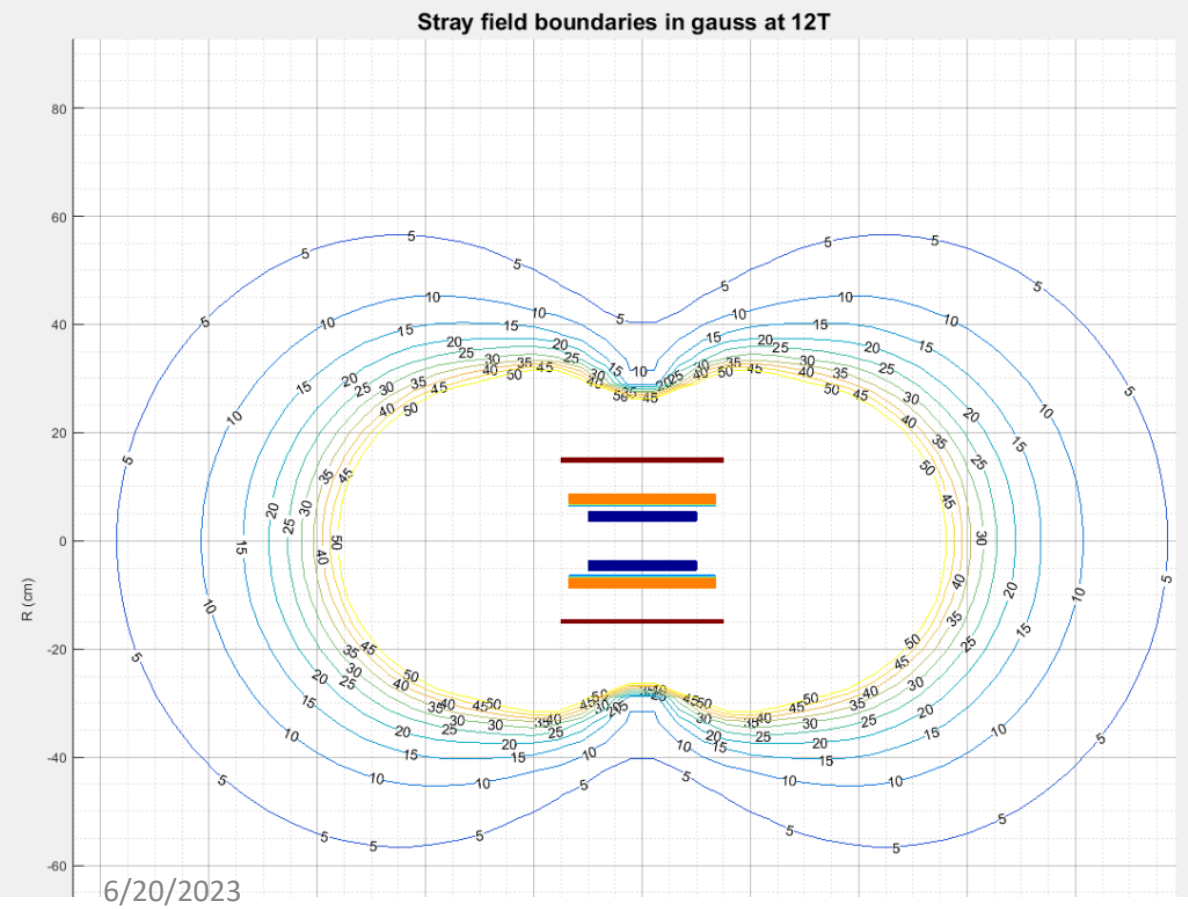
- Cryofree (dry) magnet system with RT bore,
- in a 12 T, 50 or 100 mm warm bore
- standard 0.1% on 10 mm dsv homogeneity
- also looks good for 3% on the D50 x H50 mm cylinder
- Upgrade to Variable Temperature Insert (VTI) option is possible at later stage

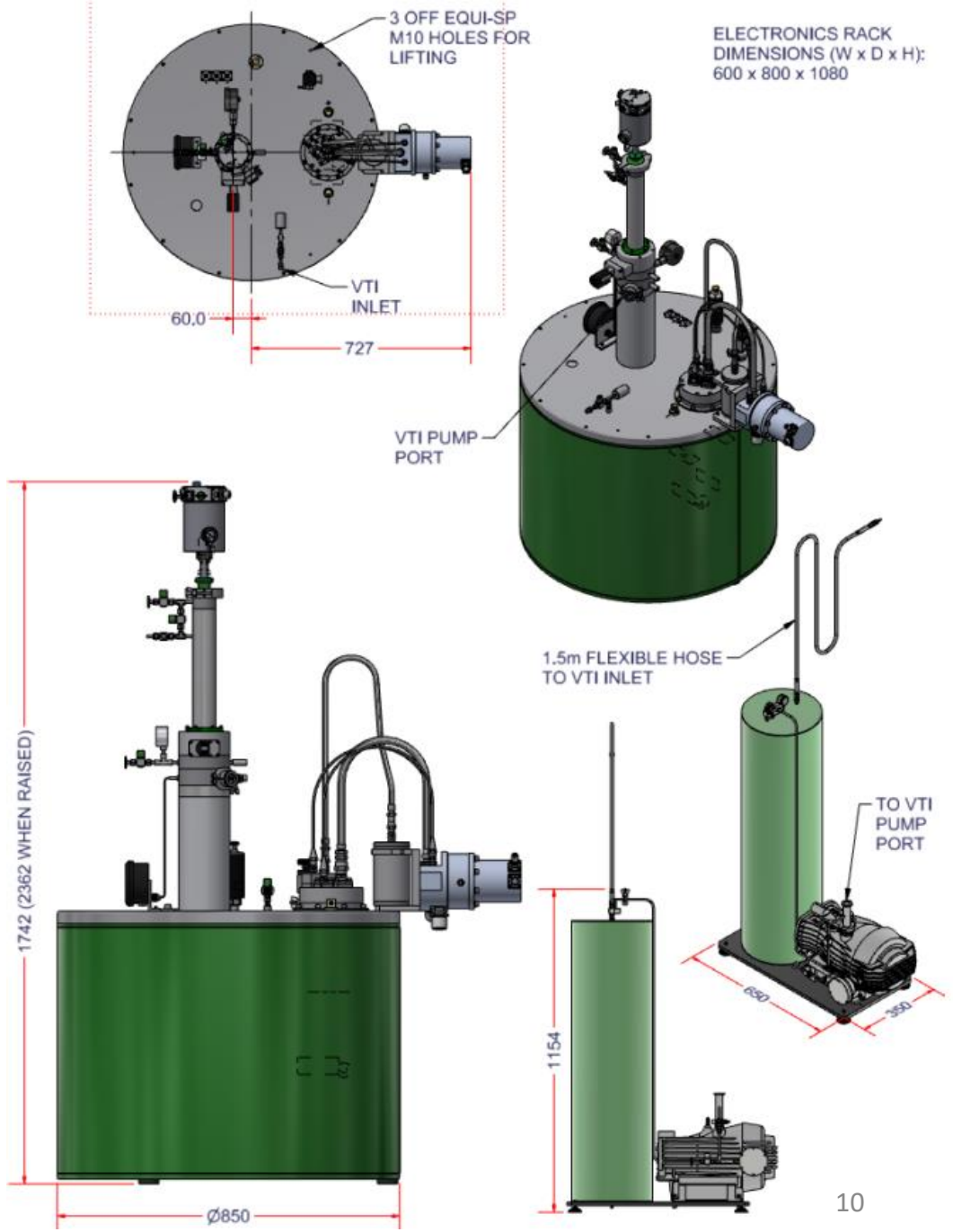




Cryogenic Ltd solution

- Integrated VTI solution with a 50 mm access.
- Can run at room temperature or down to 1.6 K





OR to use solenoid build for another experiment, for example, PSI positron production experiment

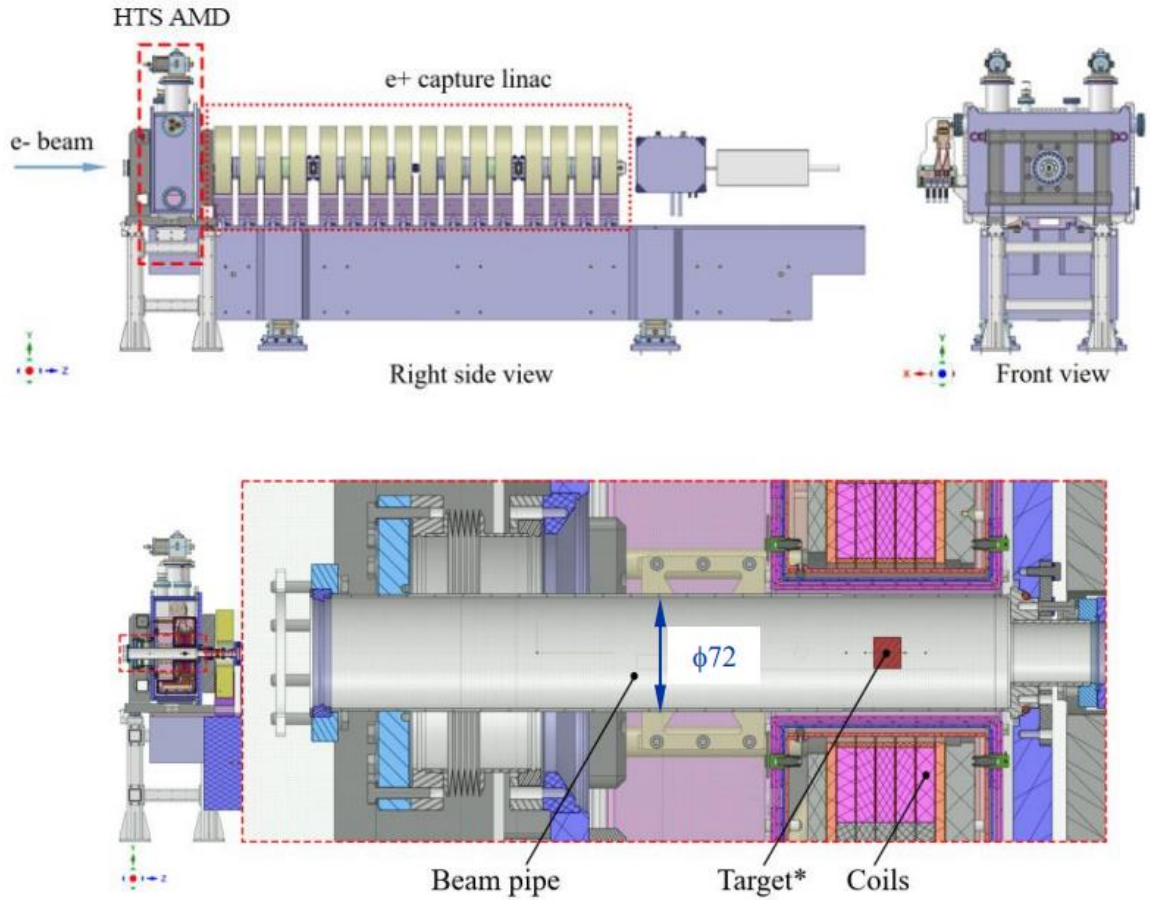
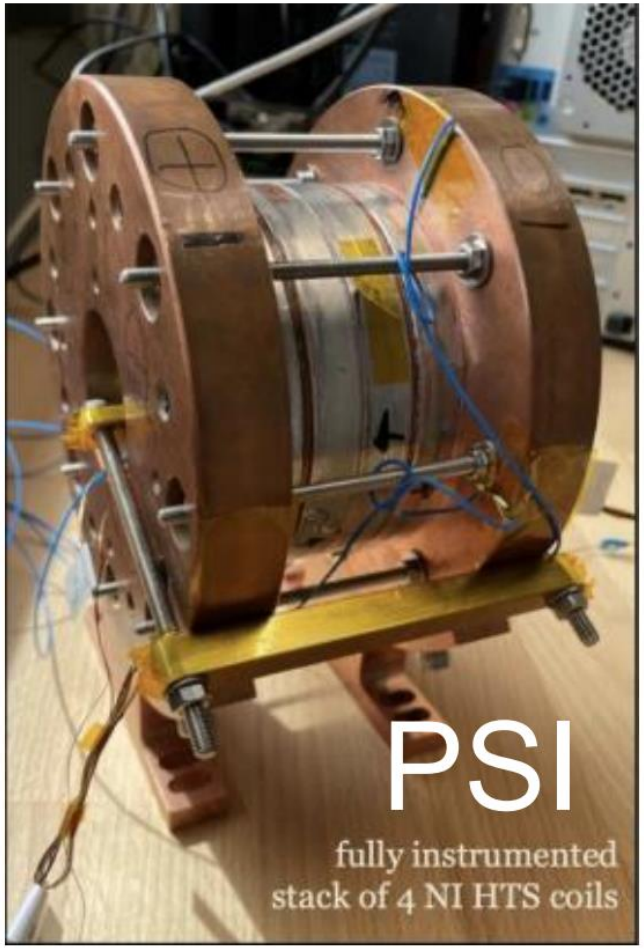


Fig. P3 experiment CAD model (top) general view and (bottom) cross section. [Courtesy of PSI]



- **High field HTS solenoid**
- **15 K**
- **15 T**
- **Warm bore D72mm**
- **Experiment in 2015/16**
- **So far, no plans to use it after the experiment**

Presented at the FCC week 2923, P. Craievich (PSI)

Summary

- What is there
  - High gradient X-band RF infrastructure:
    - Bunker
    - High power RF
    - RF controls and High gradient diagnostic
    - High gradient testing ‘Know-How’
- What is needed for upgrade to **X-box-B**
  - CERN management as well as IMCC and CLIC support
  - High field solenoid
  - Design and fabrication of RF cavities for tests
  - Personnel resources to do the integration and the high gradient testing

International MUON Collider Collaboration

HG2023

15TH WORKSHOP ON BREAKDOWN SCIENCE AND HIGH GRADIENT TECHNOLOGY

16-20 October 2023

https://agenda.infn.it/e/HG2023

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