Vertical cavity testing at Daresbury

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Cavity Processing and Testing
PIP-II Technical Workshop
2-Dec-20

SuRF Lab Team

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CEA Saclay

DESY

ESS

Jlab

+Many others

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‘Horizontal’ VTF approach

Cavity Support Insert (CSI)

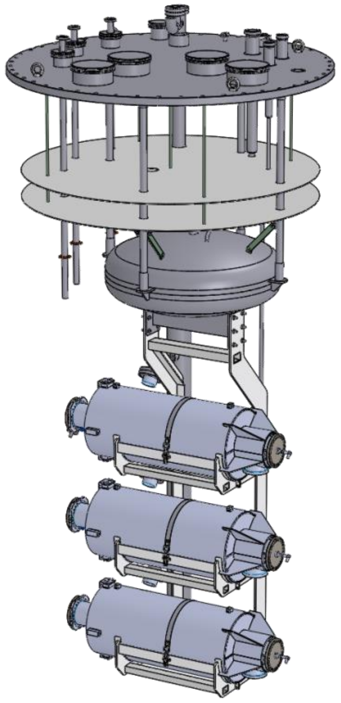
Individual LHe jackets, each ~50 L
Ends of the cavities are not covered by LHe Tank

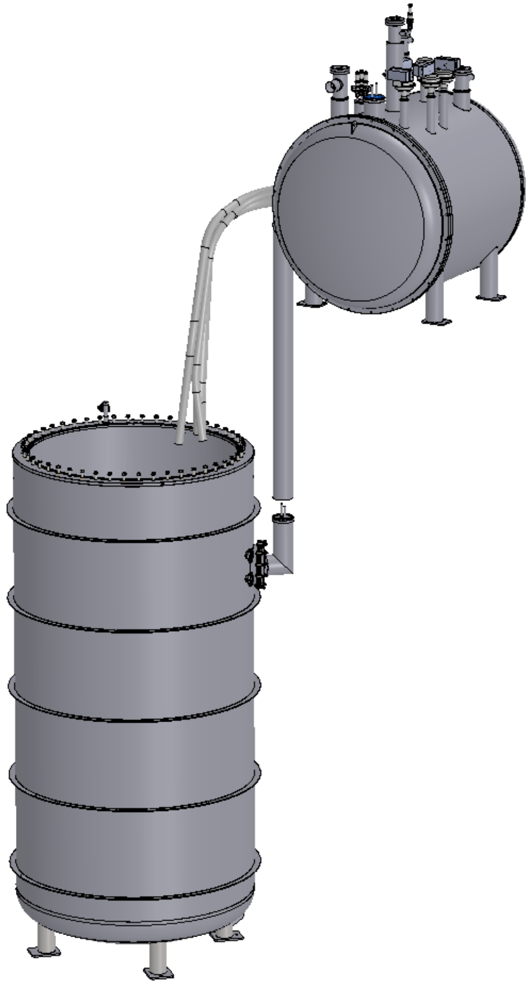
Cryostat sized to accommodate horizontal cavity mounting (closer to configuration in linac)

3 cavities tested per cooldown

~1500 L required per test.

Huge saving in LHe~70% over standard VTF





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RF testing

- Before measurements cable cal performed to calc Pinc, Pref & Ptrans
- Low power cal performed to get Qext on transmit
  - Low power so Q decay measurement is valid
- Square pulse can be used to determine over/under coupling
- A solid state amplifier can supply up to 200W at the cavity at 704 MHz.
- The cavity is “filled with RF” over about 4 tau
- So CW for typically a minimum of 6-10s

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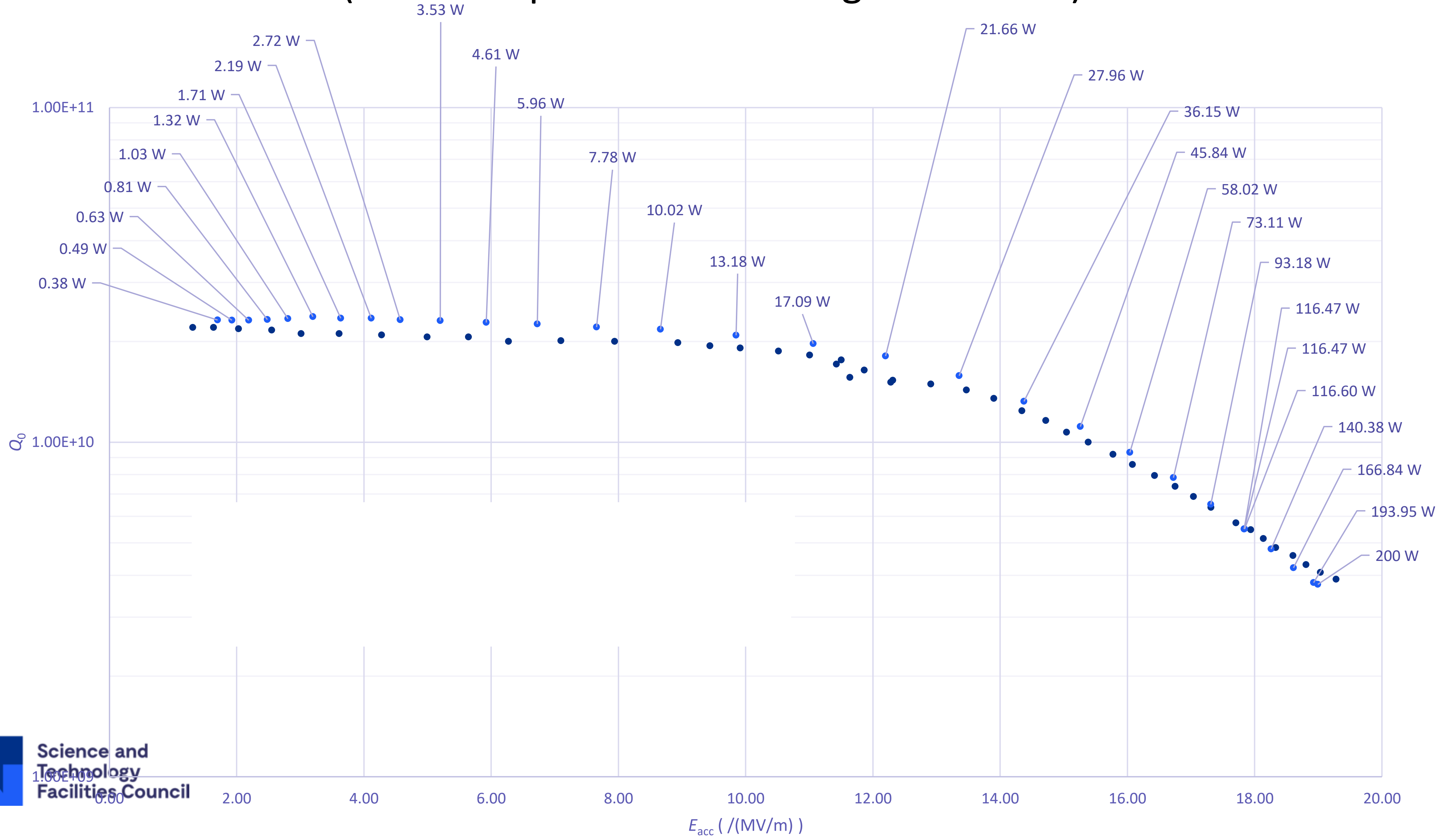
Validation of STFC results versus European collaborator (before Improvement of Magnetic Shield)



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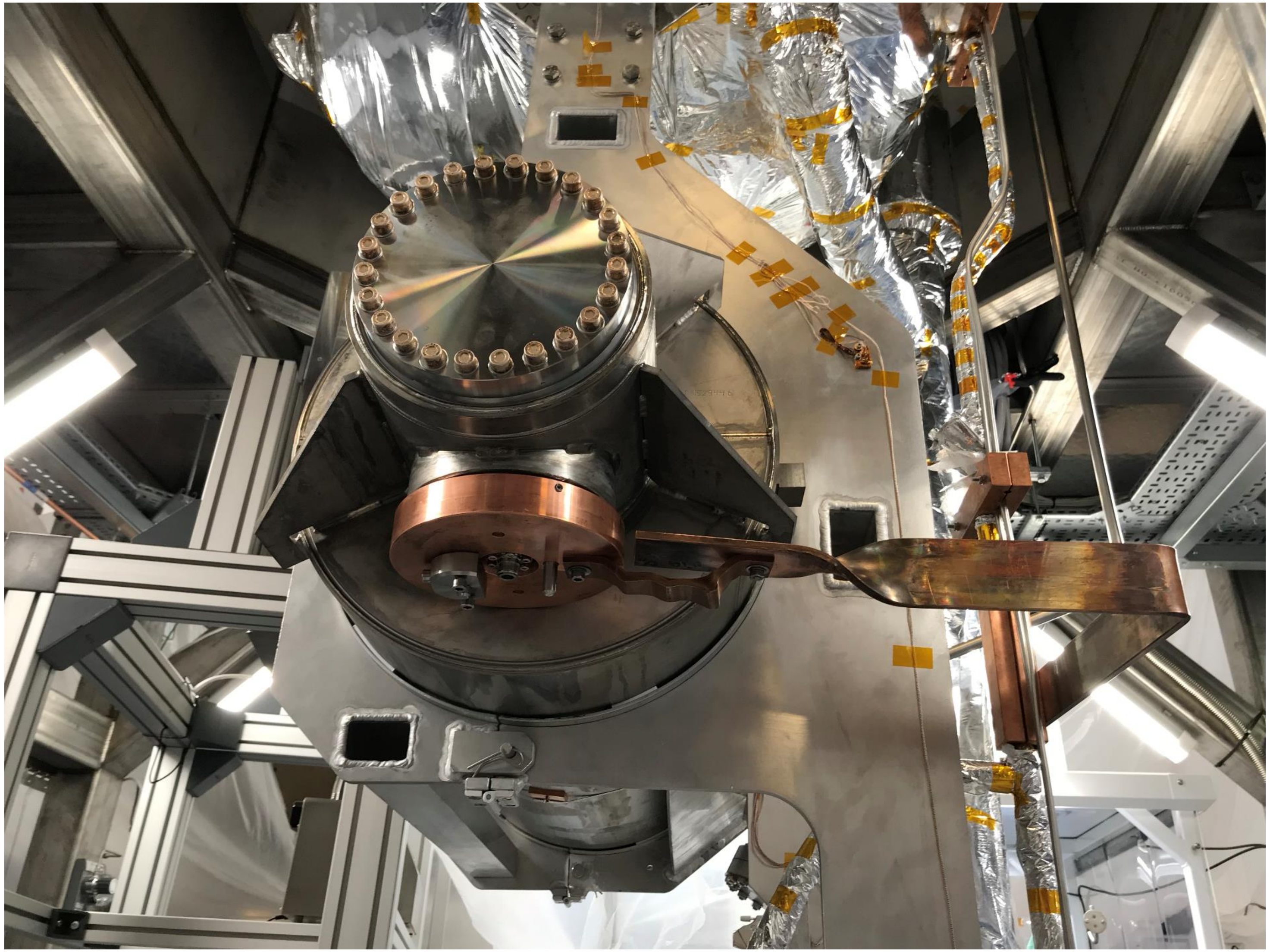
Thermal Issues with High power Input flange

- Main Power coupler in the accelerator is cooled.
- Not the case in our cryostat
- LHe jacket covers the middle section of the cavity
- Thermal anchoring of the input flange is required
- This reduces the time needed for the flange to cool



Challenges to achieve Q and E for PIP II

- Magnetic shield
- Microphony due to higher Q
- Building new LLRF for 650 MHz
    - Use coaxial resonator-want to complete one for 650 MHz
    - Easily fits in cryostat
    - Want to purchase a new HPA for 650 MHz
- **Questions**
    - What frequency range does the LLRF need to operate over
    - What BW does our new high power amplifier need to operate over? 10 MHz?

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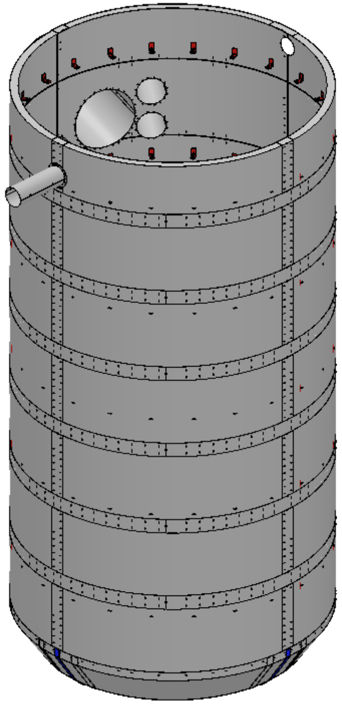
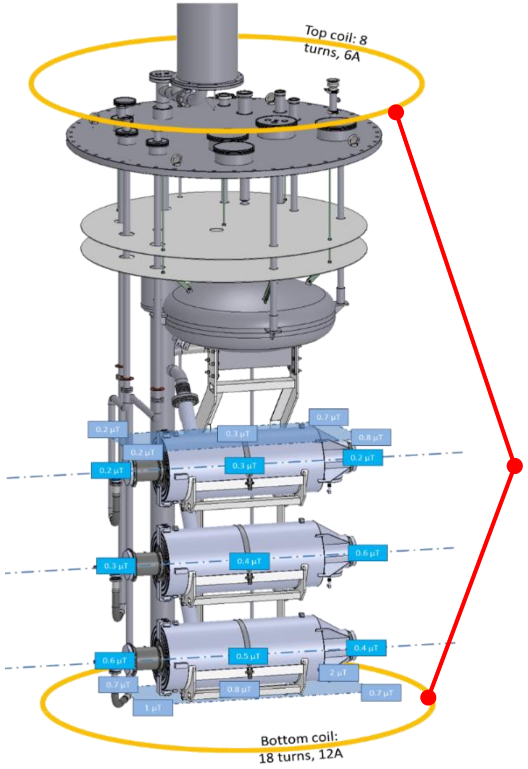
Magnetic shielding for PIP II





Stray field attenuation to <1.4 μT by static Mu-metal shield

Further attenuation <1.0 μT by two active coils

Current values after coil optimisation

Top	0.23μT
Middle	0.76μT
Bottom	0.35μT

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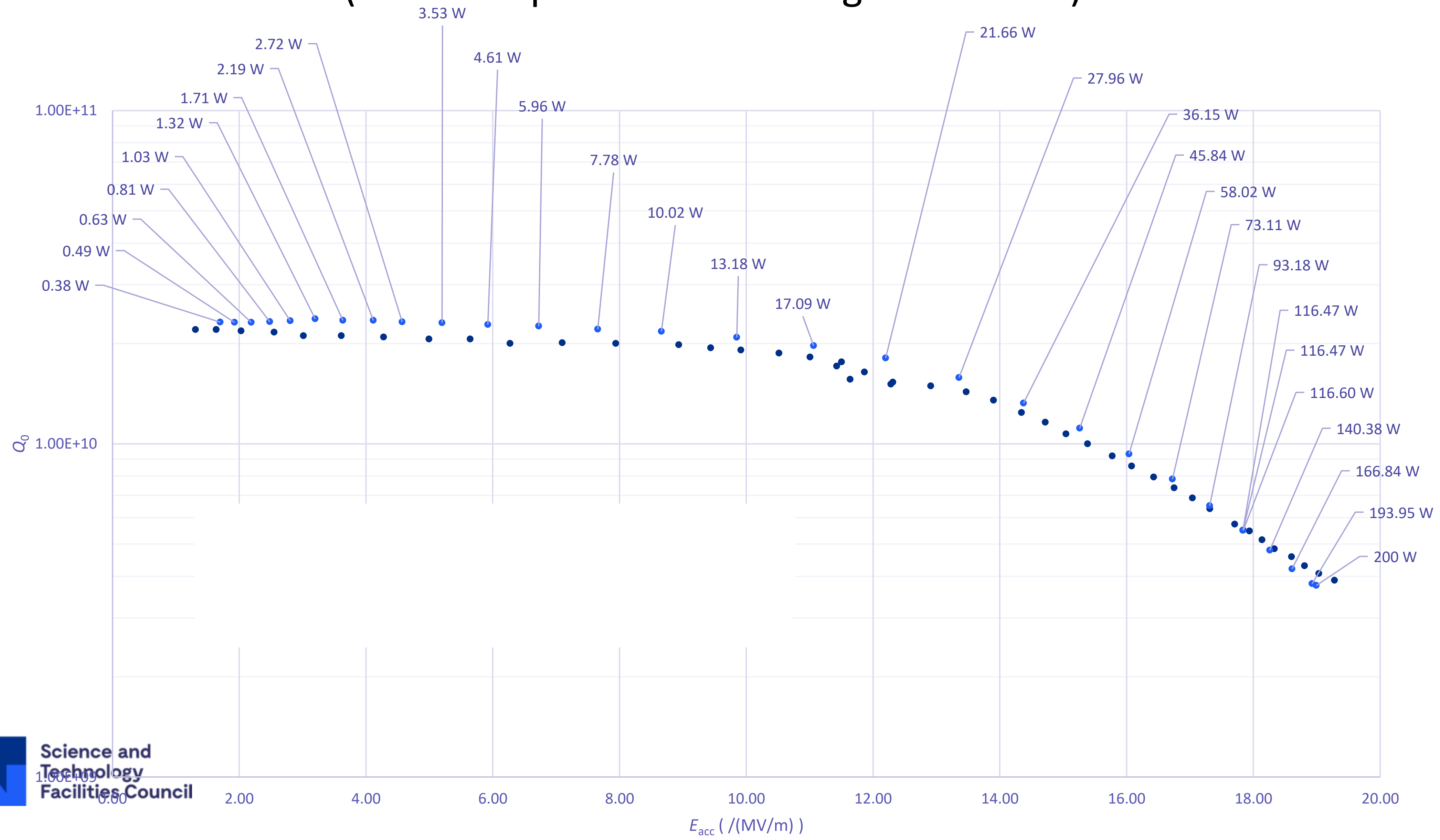
Apply a middle coil to optimise middle cradle value for PIP II?

Validation of STFC results versus European collaborator (before Improvement of Magnetic Shield)



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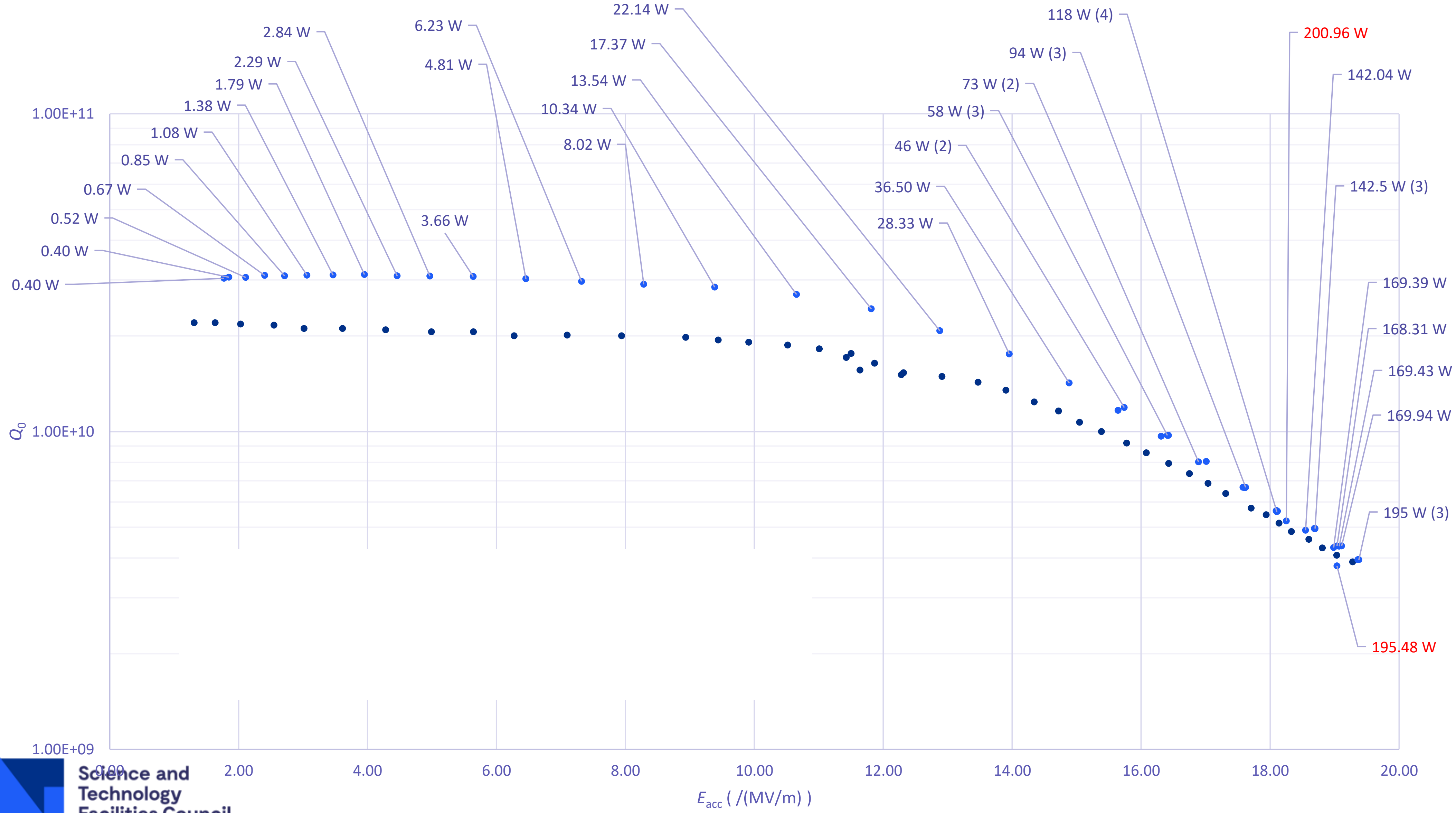
Results after Improvement of Magnetic Shield



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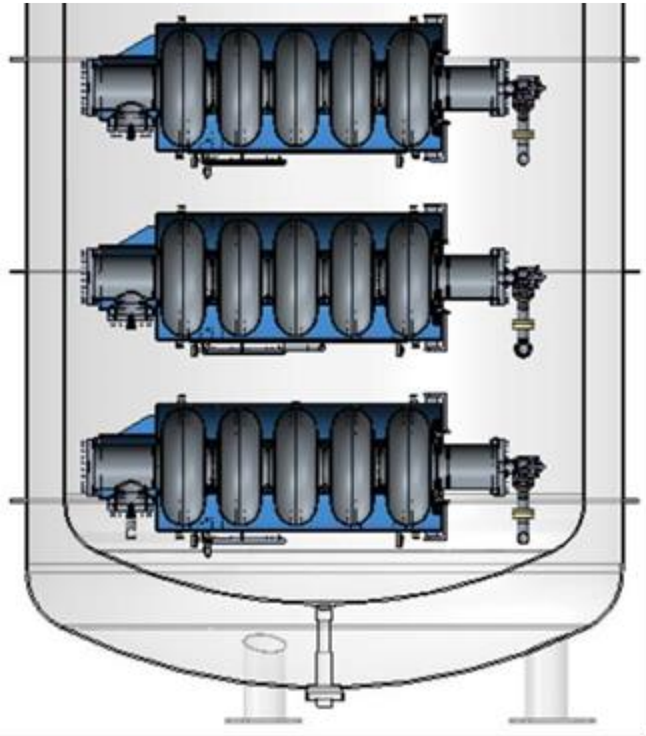
Schematic Arrangement of Radiation detectors

Dose Rate Detectors

Dose Rate Detectors

Dose Rate Detectors



Energy Spectrum Detectors

Energy Spectrum Detectors

Energy Spectrum Detectors

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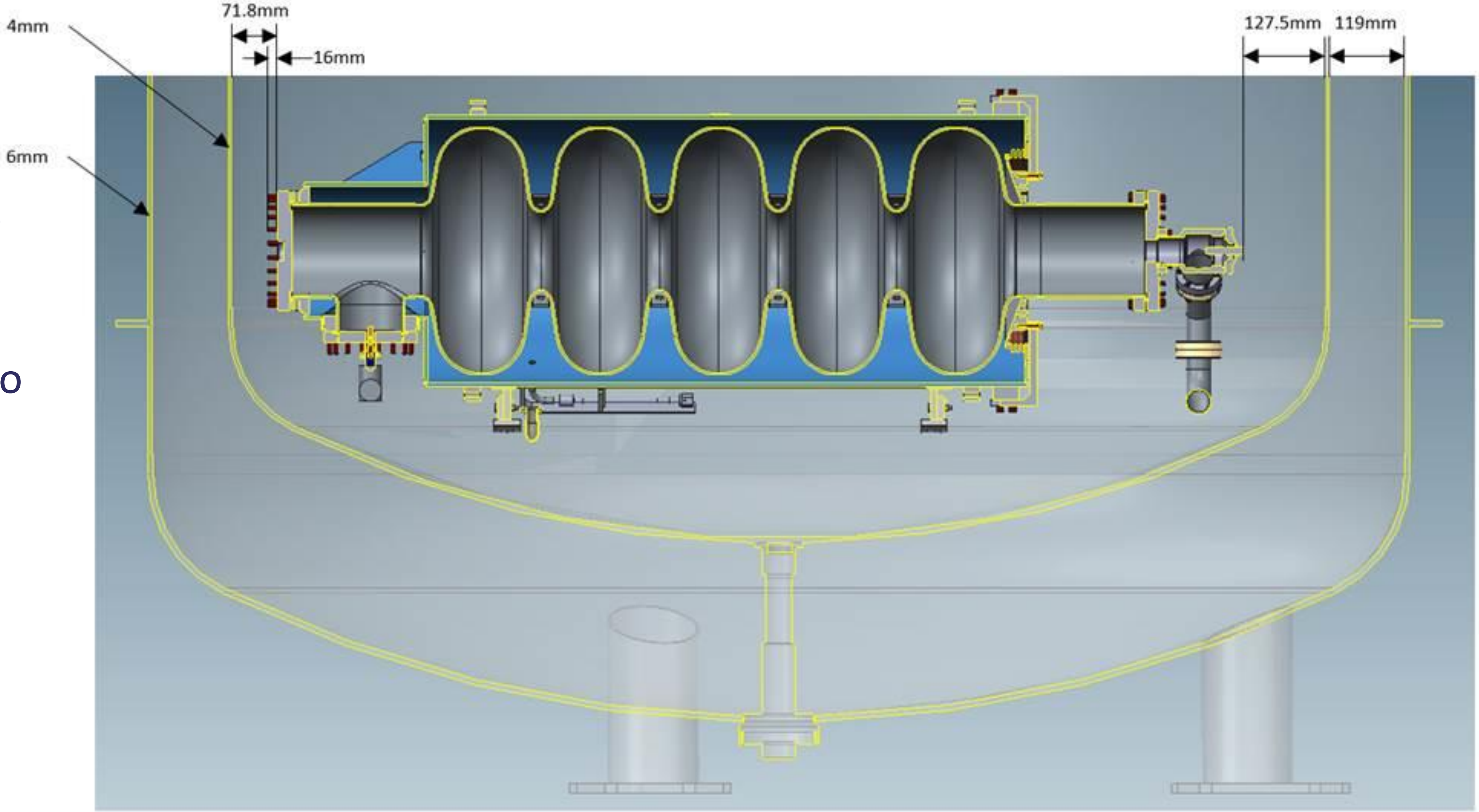
Schematic showing wall thickness and distance from outer wall to the end of the ESS cavity

- Wall thickness 10-25mm
- (0.5-1 inch)
- End of cavity to outer wall
- Left 19.1cm
- <8 inches
- Right 24.7cm
- <10 inches



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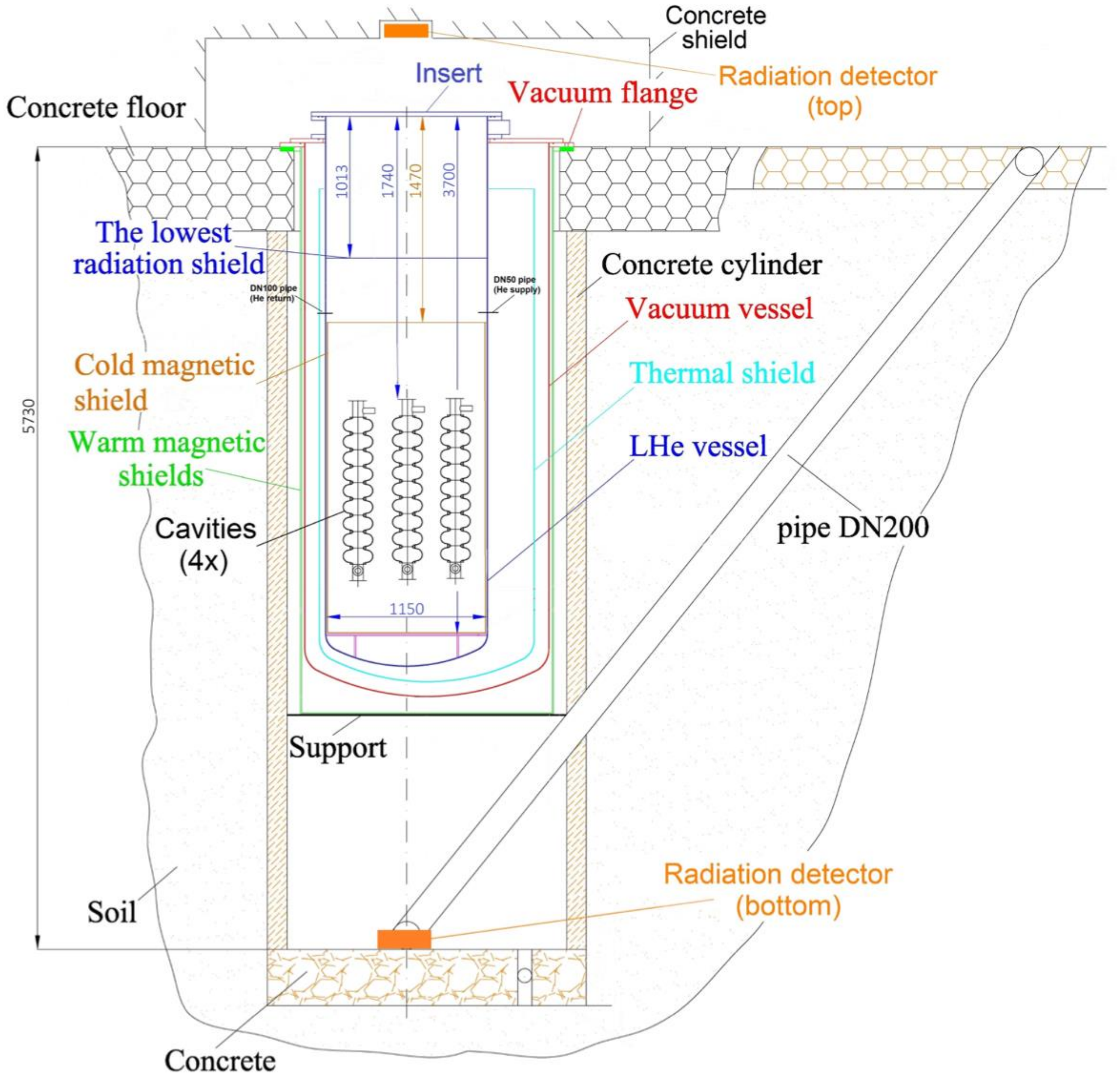
DESY VTF setup

- Kind thanks to DESY for permission to show their VTF schematic
- Distance from end of cavity to Lid about 1740mm (68.5 inches)
- Distance from end of cavity to radiation detector guess at 2m?
- Probably several cm (maybe 2-3 inches) of metal for lid, radiation baffles etc
- Would expect to record orders of magnitude more radiation in our configuration



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Questions?

Thank you

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@STFC_matters

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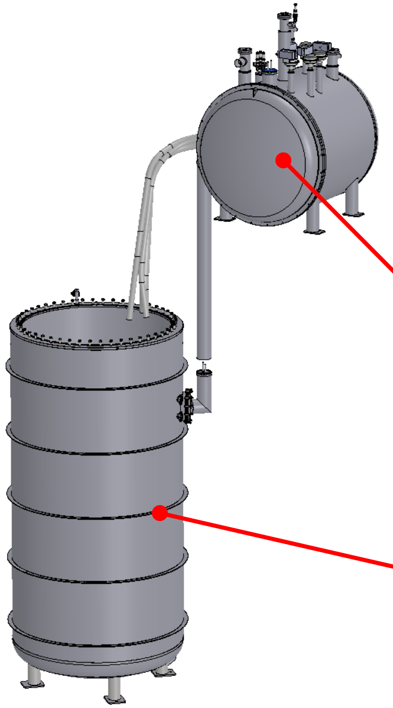

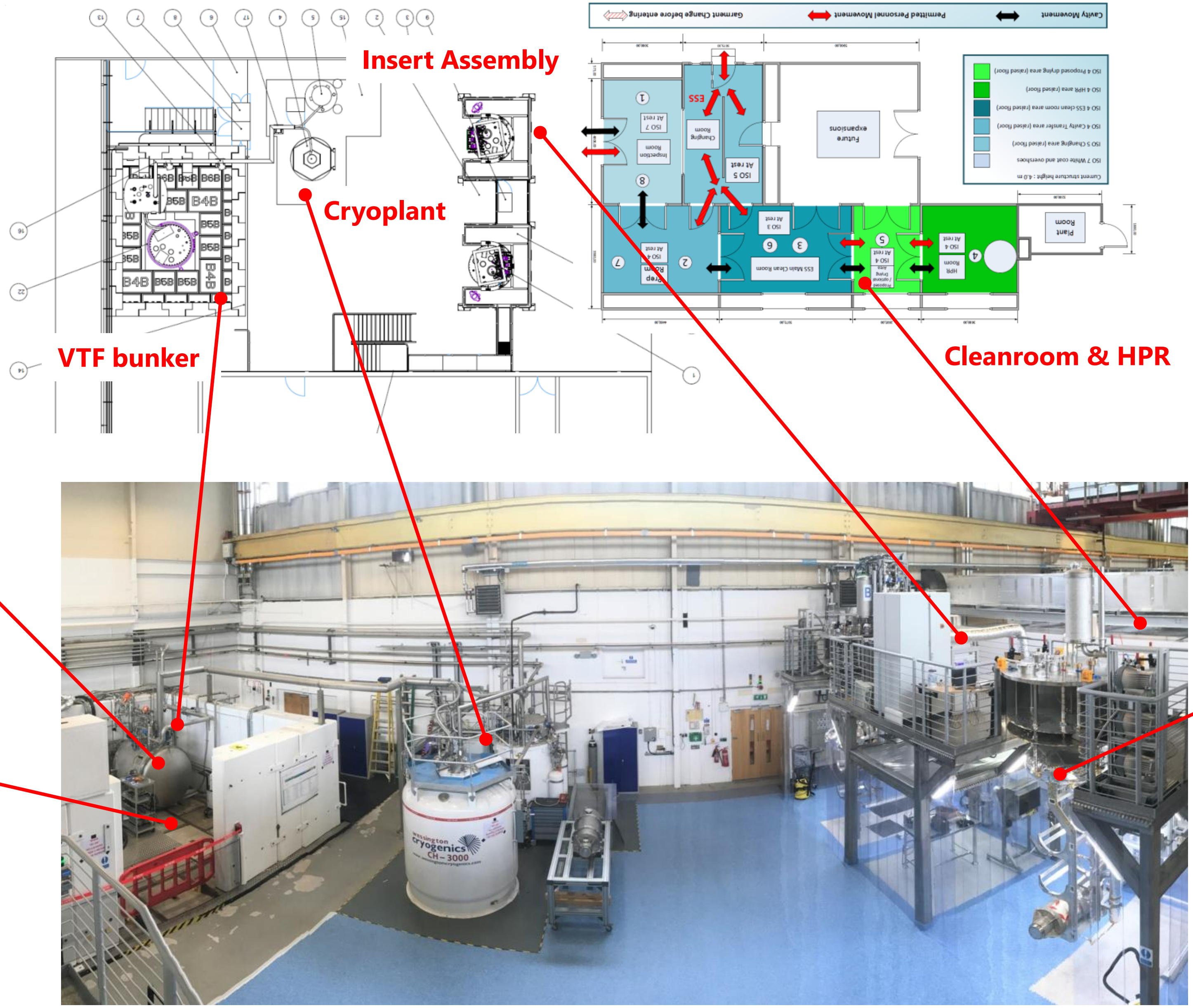

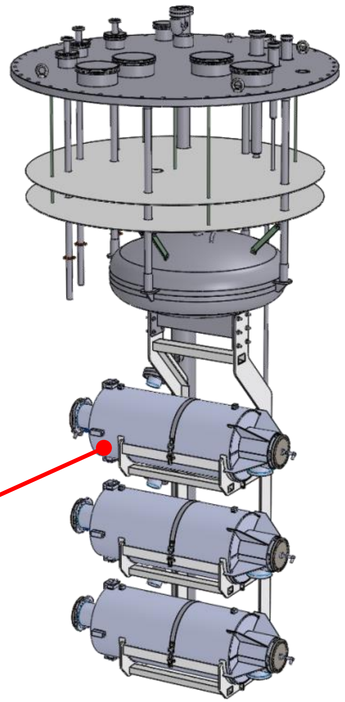

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How to avoid 4Pi/5 Excitation

1. ESS spec 4Pi/5 mode must be a minimum of 1.2 MHz from Pi mode
2. HOM's must be at least 5MHz away from Beam Line Harmonics (BLH)
3. We do get excitation, even when amplifier input signal is turned OFF, (must be sufficient noise O/P from amplifier to cause LLRF to lock to it.
4. Slowly ramp power up in steps-lock to Pi mode
5. Can control which mode LLRF locks to by altering phase of LLRF
6. **Question**
    1. For PIP 2 what is the frequency separation between the 4pi/5 and Pi mode

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Questions for Fermi Lab

1. What BW does our HPA need to operate over 10 or 15 MHz
2. What BW does the LLRF need to operate over
3. What are the frequencies of the passband modes
4. For PIP II what is the frequency separation between the pi mode and the pi/5 mode

- Proposal
- We build a coaxial 650 MHz resonator to test our new 650 MHz LLRF

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