CLS Improvements and Future Goals

About Me

- 22 years at CLS
- High power DC power supplies for magnets
- Electronics Design
- Motion control and HW support for beamlines

- And since 2018 RF&HV

CLS Improvements and Future Goals

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CLS Booster Amplifier

- In 2015 CLS saw the need to upgrade our 70kW Klystron.
- We had a klystron failure
- Spares were hard to find.
- The idea of a solid state amplifier was started

CLS Booster Amplifier

- My colleagues Jon Stampe and Jignya Patel produced the technical specification.
- In late 2018 Cryoelectra installed the SSA.
- The SSA has been working well.

CLS Booster Amplifier

- We have taken a pragmatic approach and decided to retain the ability to run the klystron if the unexpected should happen.
- This means we run with a circulator on the output of the SSA, although it is not specifically required.
  - Multiple layers of defence.

Booster LLRF

- 2019 brought with it the realization that we needed to replace our aging LLRF.
- After 20 successful years, time had taken its toll on dwindling spare parts and our confidence in maintaining system reliability.

Booster DLLRF

- ALBA and CLS entered an agreement to supply CLS with the designs and support that would see a digital LLRF system for the BR.
- Currently have built one system and it is scheduled to begin operation this fall.

Booster DLLRF

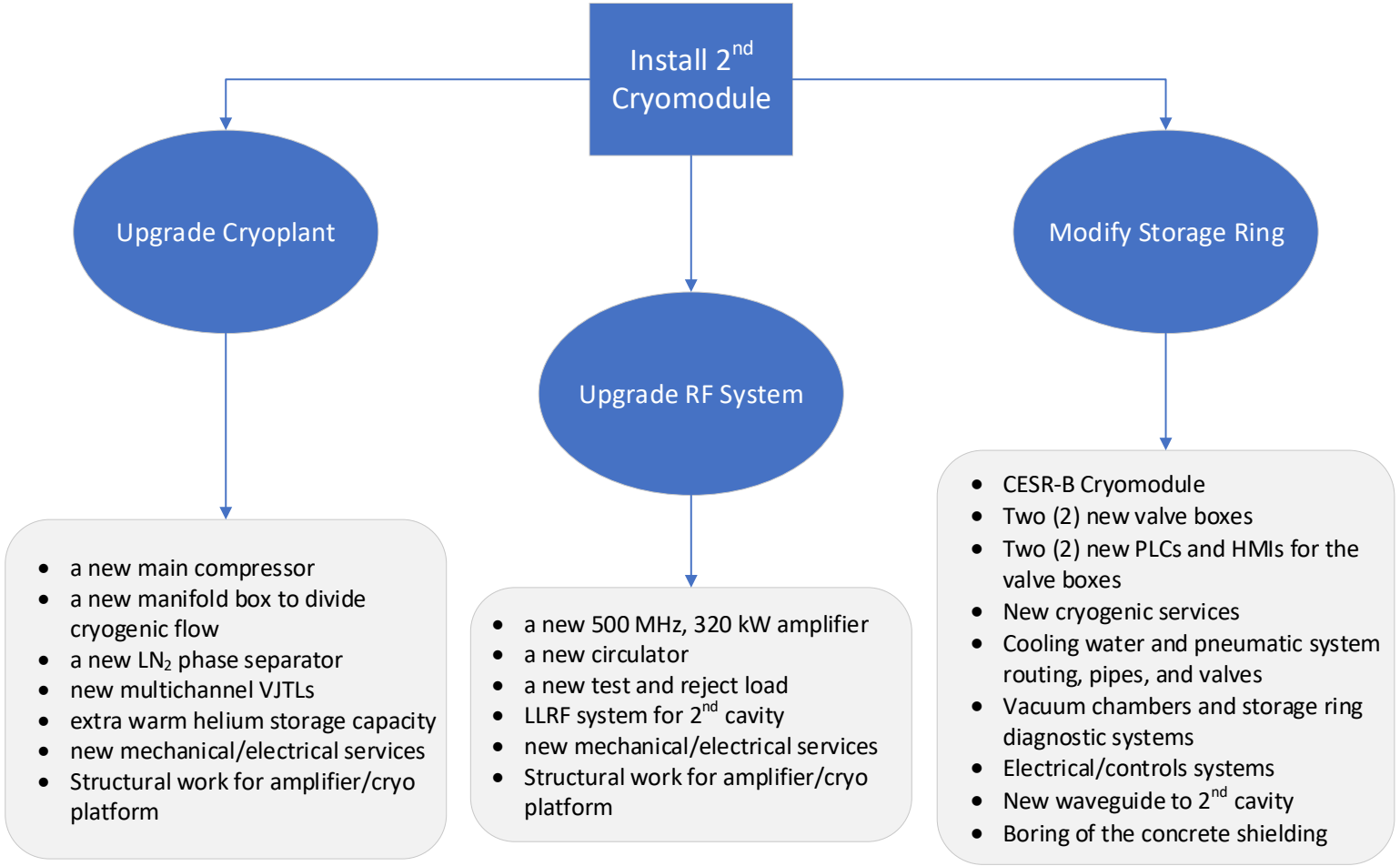
- CLS gains knowledge in FPGA development towards future DLLRF development.
- CLS gains the ability to upgrade or modify the system hardware and software to accommodate our specific needs.
- Provides the ability to tune two five cell Petra cavity for phase angle and field flatness.
- This provides an easier to use interface that is less error prone interface for our facility operators.
  - Automatic vs manual
- We have taken the opportunity to develop some enhancements that maybe useful for other locations at CLS.
  - We have created a Level Translator. The LT provides CLS the ability to interface different signals levels while providing input to output isolation, channel to channel isolation and power supply isolation.

Storage Ring

- In 2019 CLS contracted Research Instruments to provide our 3rd Cryomodule.
- This provides the opportunity for CLS to run 2 cavities in the SR.
- We installed a Neg pump just upstream of the cavity.
  - Big help reducing partial warmups and less chance of a quench.

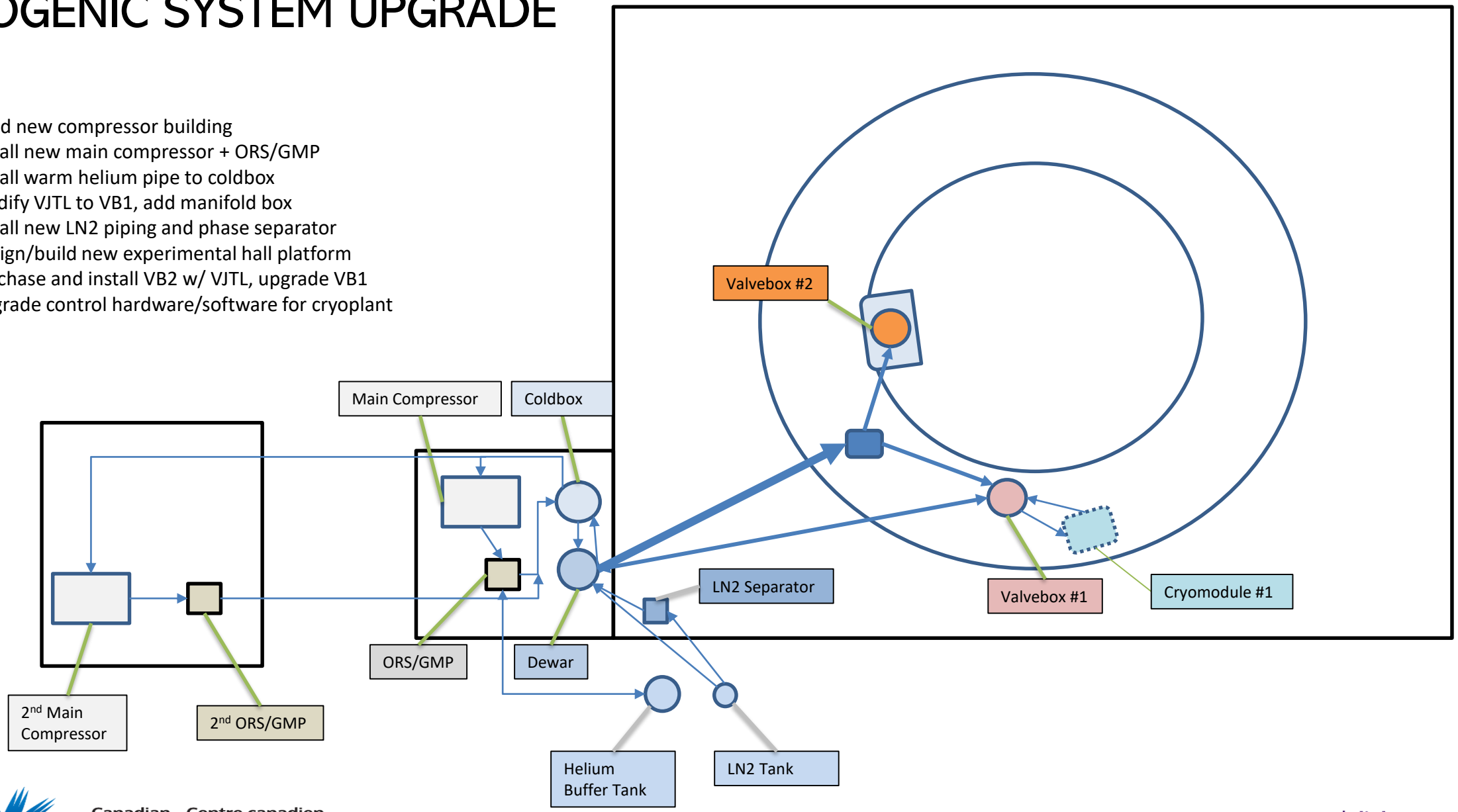
So what is next?

Second RF Cavity Install



CRYOGENIC SYSTEM UPGRADE

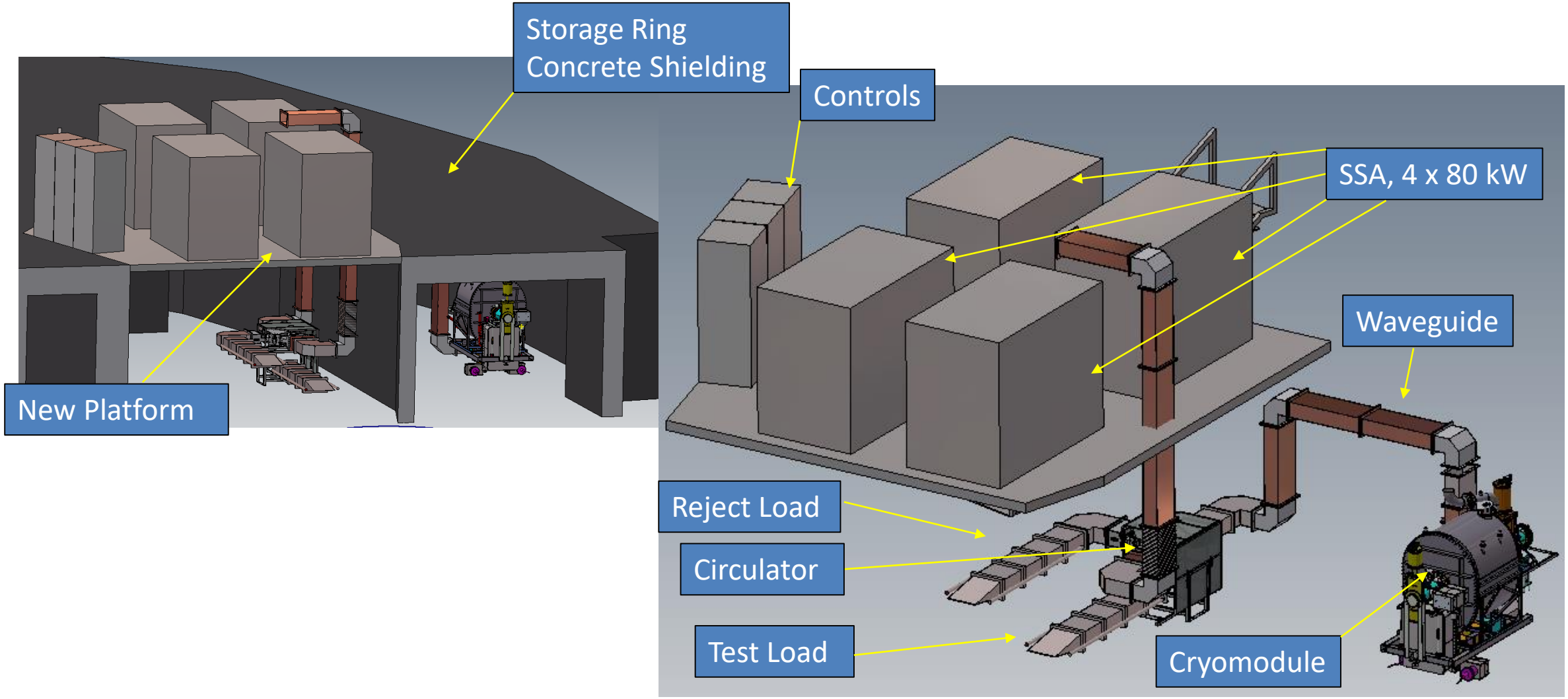
- Build new compressor building
- Install new main compressor + ORS/GMP
- Install warm helium pipe to coldbox
- Modify VJTL to VB1, add manifold box
- Install new LN2 piping and phase separator
- Design/build new experimental hall platform
- Purchase and install VB2 w/ VJTL, upgrade VB1
- Upgrade control hardware/software for cryoplant



RF Amplifier Upgrade Considerations

- Preference to solid state amplifiers over vacuum tubes due to their many advantages and easy availability
- CLS goal to be able to run the storage ring current at 250 mA with existing and expected ID load in near future
  - To match the current ID load with existing klystron amplifier capacity, the storage ring current is limited to 220 mA.
- Capability to run each cavity at a voltage (~1.2 MV) that reduces number of thermal cycles required
- Give enough RF redundancy to deliver beam at reasonable current (220mA) if one of the two RF amplifiers/cavities is down.
  - With current system, partial warm-ups are required every few weeks to maintain reliable operation at 2.04 MV and avoid cavity quench.
- We want a solution that avoids complexity due to moving mechanical components (waveguide phase shifters and variable power splitter) and control of two cavities in a single closed loop.

RF Amplifier Upgrade

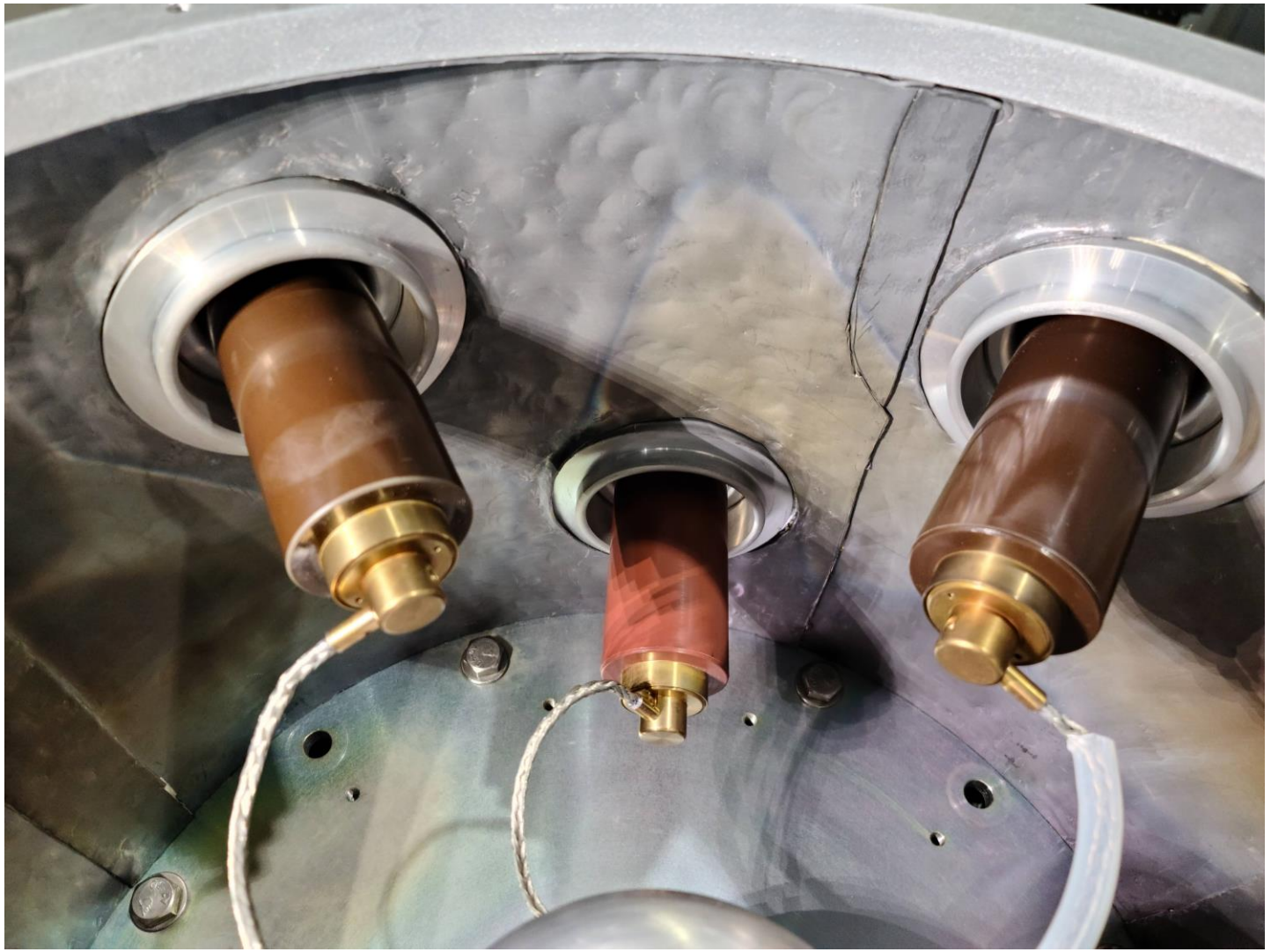


Recent faults on the SR RF System

- Lead ionization onto ceramic?

Klystron problems

- Evidence of heating on gun tank lead shielding may suggest that lead has been ionized, and could have been deposited on the ceramics.
- This caused a trip typically on restart after a cool down of the tube.
- Was getting worse with time.
- HVPS V high. It results from a fast reduction in tube current which the HVPS can't track due to the slow regulation time constant. We assume that it is due to an arc between cathode and mod anode (zero biases tube.) It is difficult to get a fast reading on this due to the slew rate on the Mod anode PS telemetry. Not easy to get fast telemetry on HV PVs. We were able to make a "safe" HVPS I metering point on the return side of the HVPS shunt R. Not possible with Mod A as both reference and returns are at HV.



Inconclusion

- CLS is attempting to improve reliability
  - Booster Ring RF replacement systems
  - Storage ring redundancy is getting nearer with 3rd cavity

Thank you for your attention

Questions?