

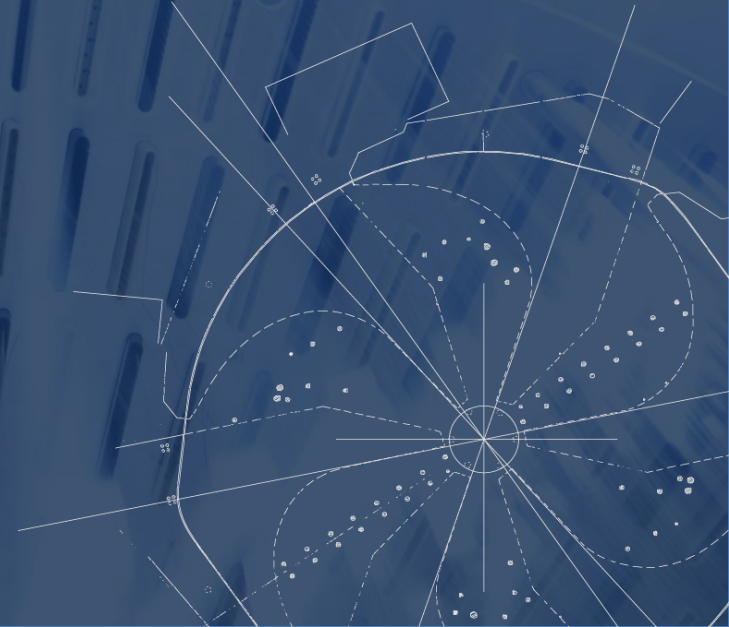


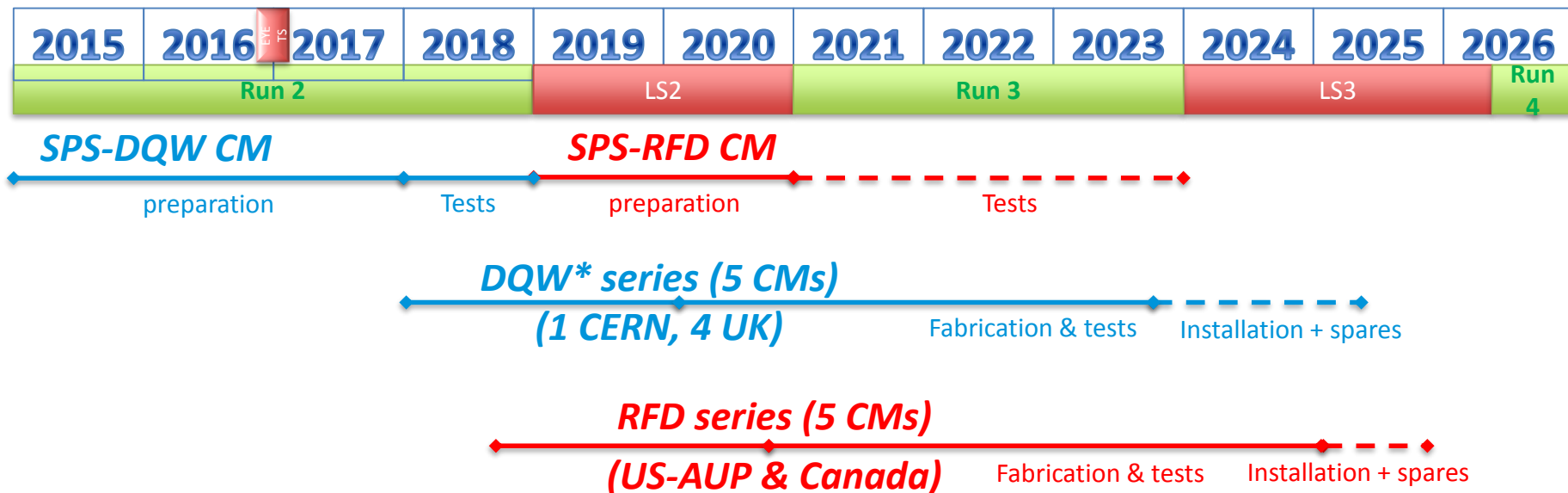
Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

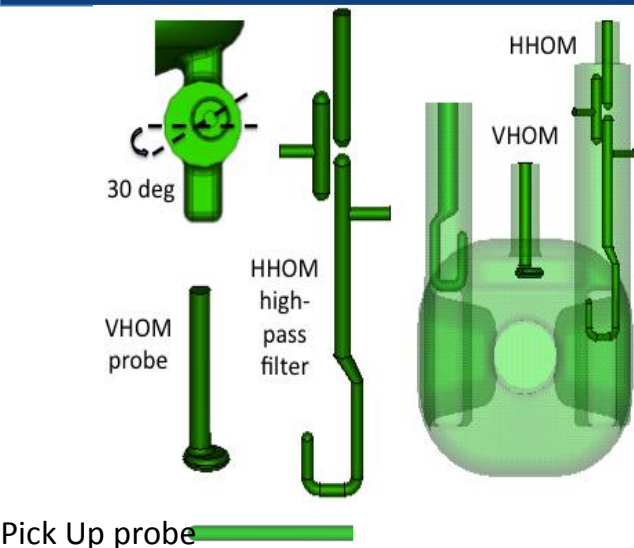
TRIUMF plans for RFD cryomodule assembly

Bob Laxdal, TRIUMF

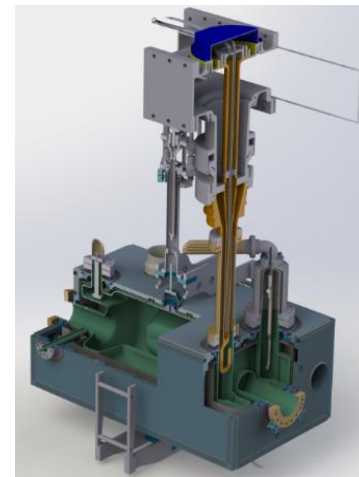
Oct. 18, 2018



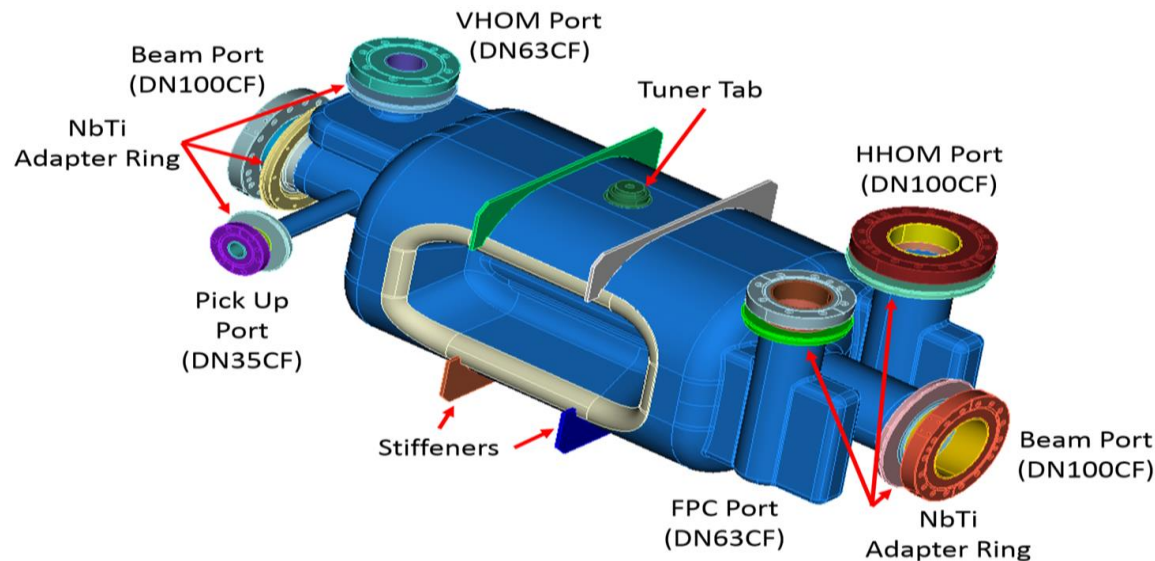




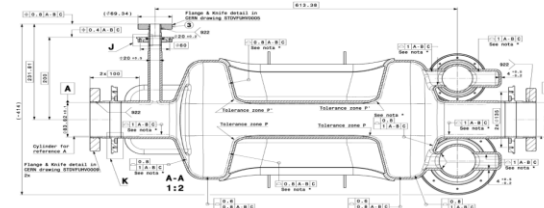
$R/Q=430$ $G= 107 \text{ Ohm}$



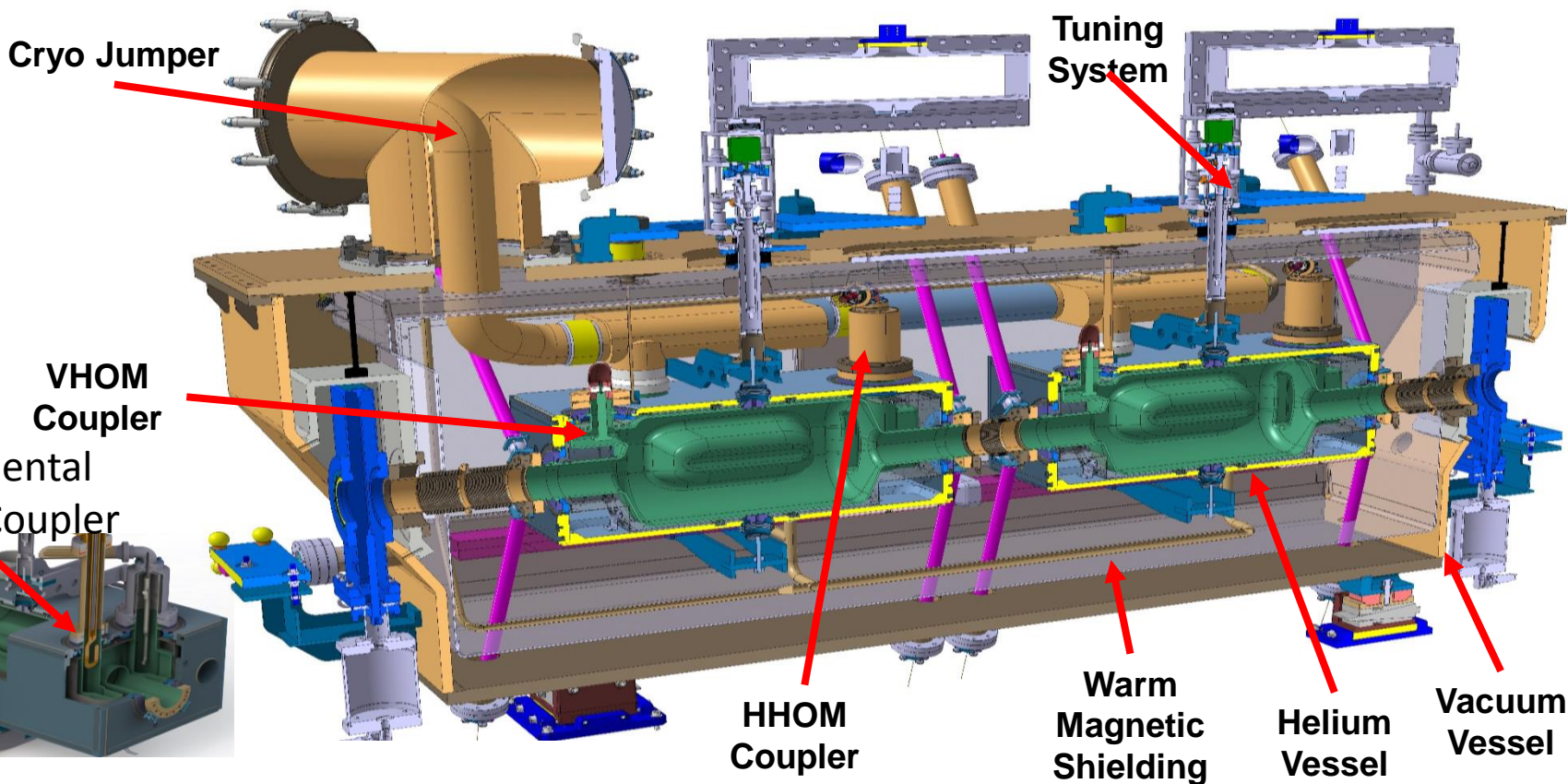
- Main Mechanical interfaces:
He-vessel: Bolted-welded concept, Tuner: Symmetric tuning – warm motor, Three point support + alignment system
- Main RF interfaces
1 FPC: Single ceramic coaxial line ($Q_{\text{ext}}=5e5$), 2 HOM couplers (V and H), 1 PU

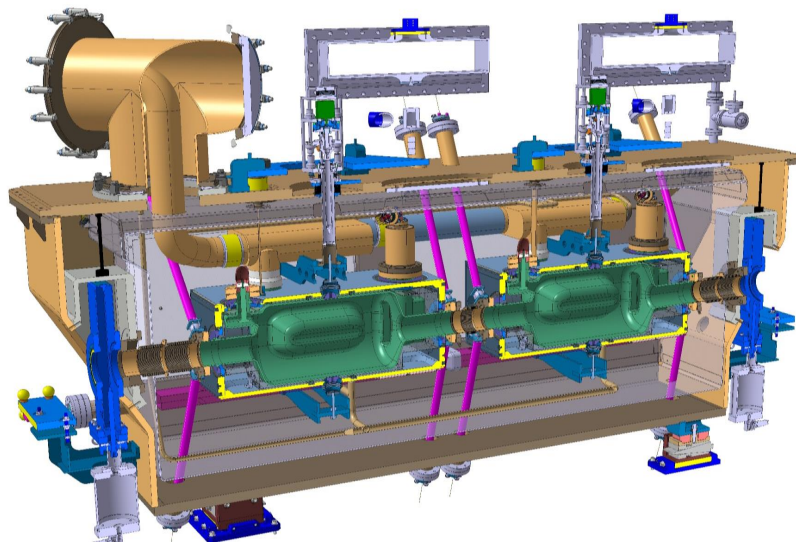


SPS-RFD Specifications Drawing - CERN

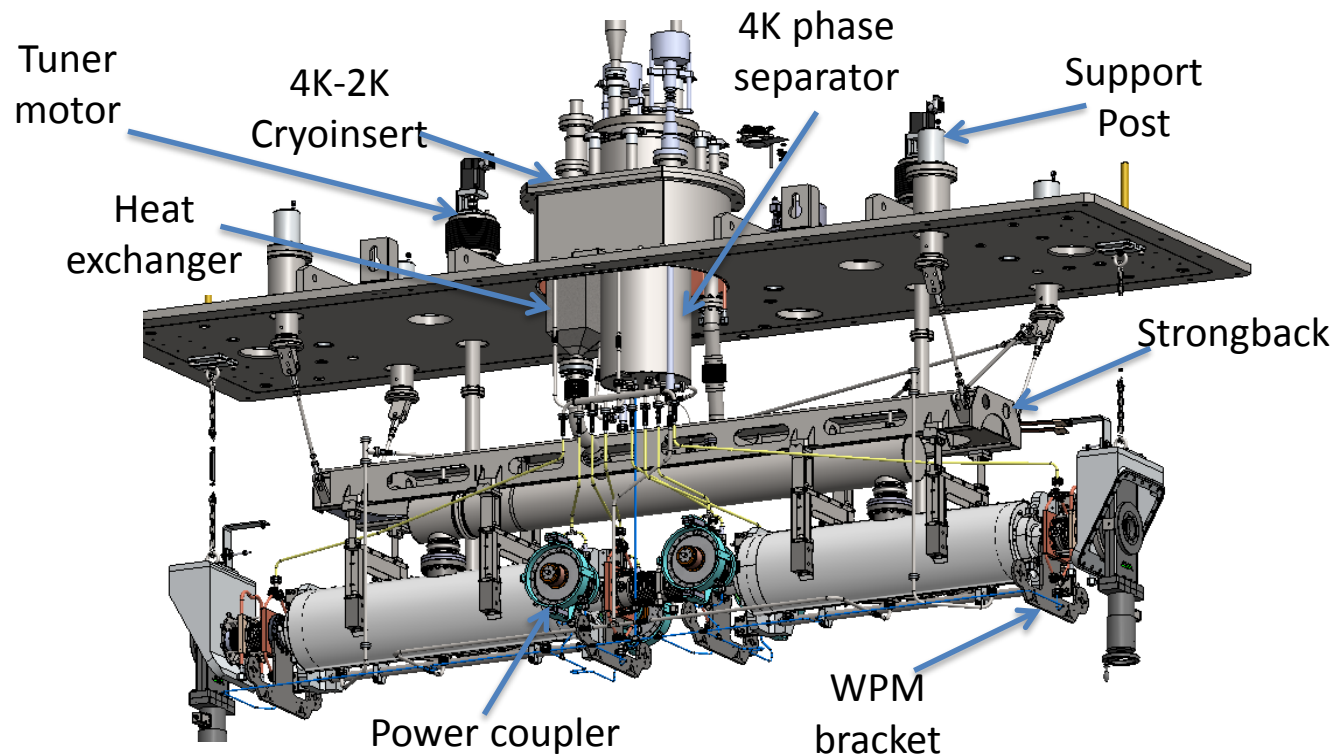


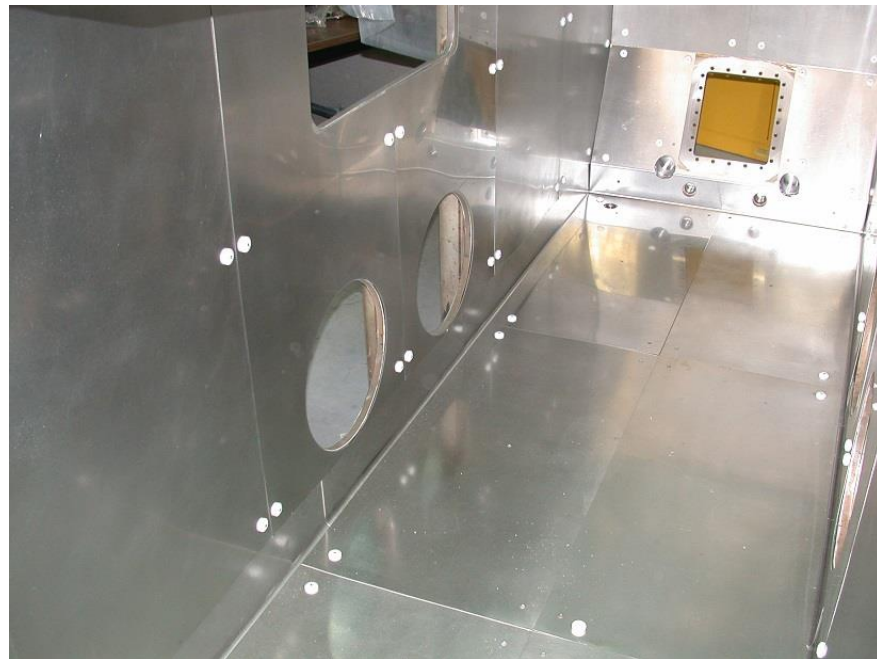
- Electromagnetic and mechanical design completed by ODU/SLAC team – HOM validation in progress
- Interfaces to Helium vessel completed by CERN – **finalized?**
- Fully integrated design:
 - Includes FPC and HOM couplers, Tuner interfaces – **finalized?**



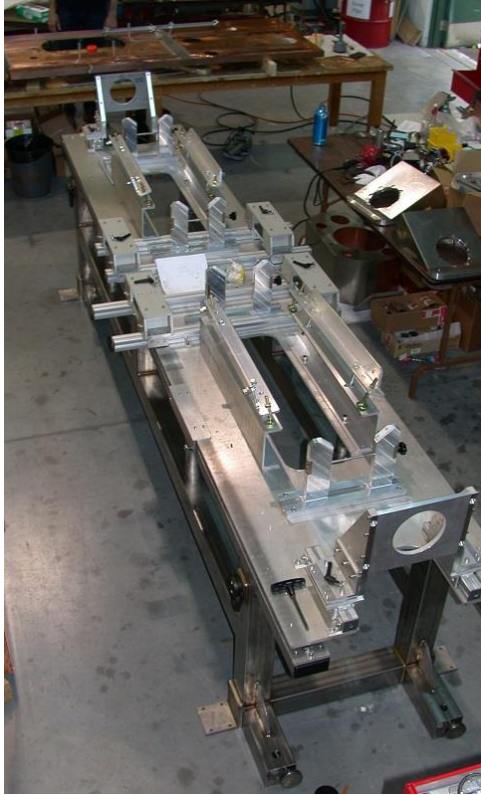


RFD cryomodule overlaps in size and complexity with e-Linac accelerating cryomodules developed and fabricated at TRIUMF



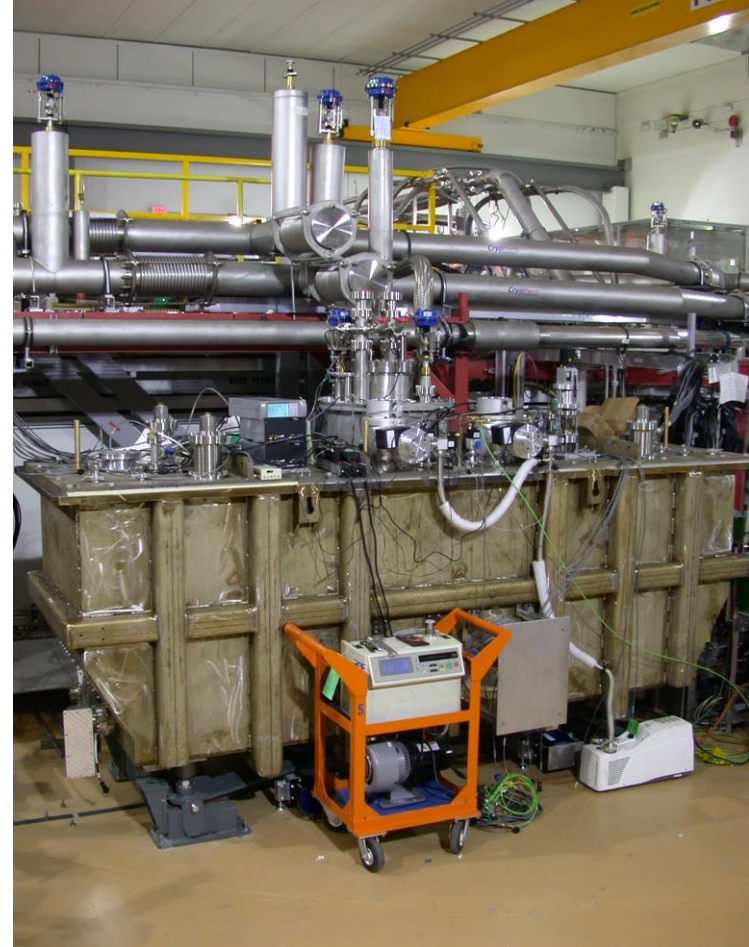




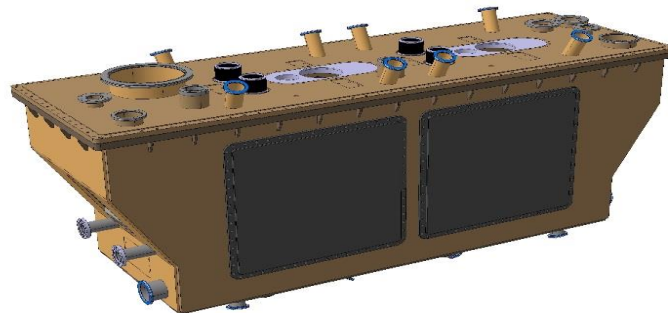
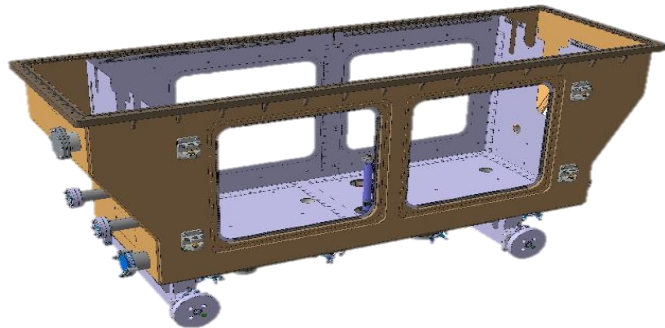
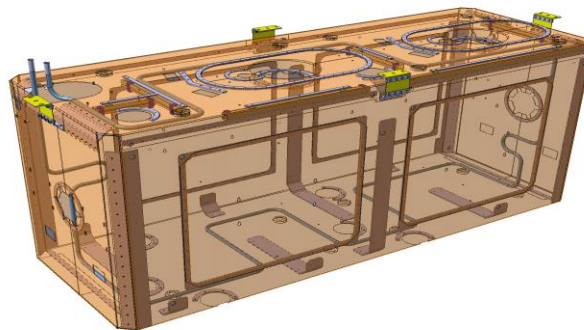
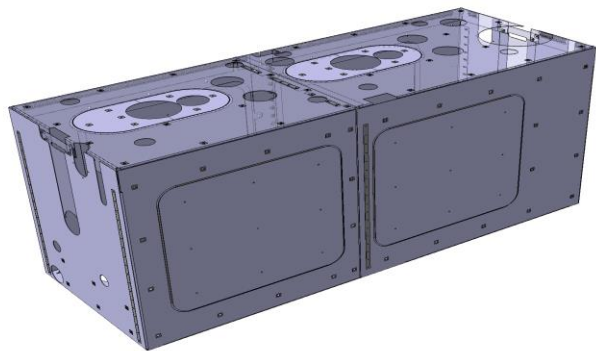




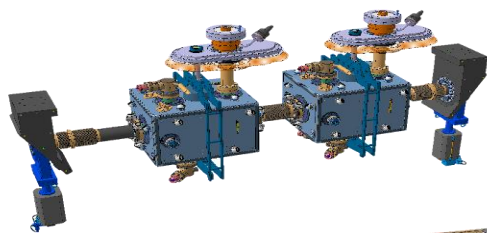




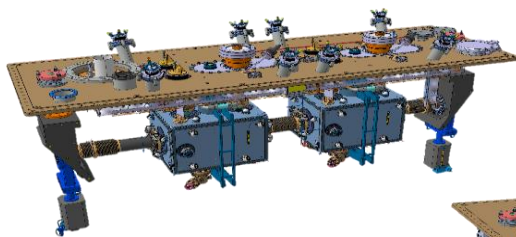
Basic building blocks looks like e-Linac cryomodule



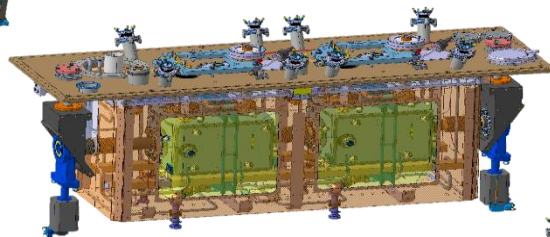
Assembly infrastructure exists from e-Linac assembly



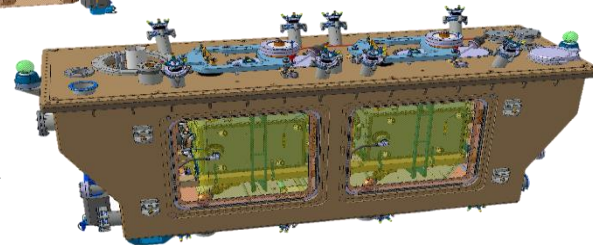
String assembly



Top assembly



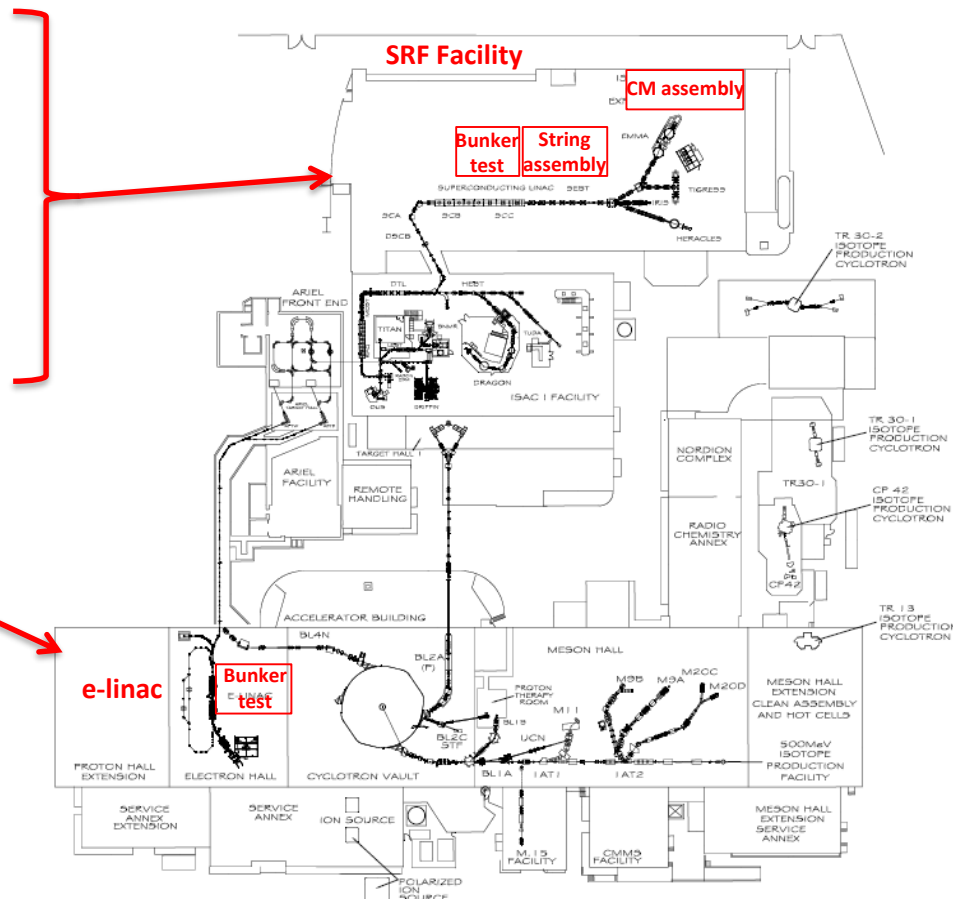
With thermal shield



Install in tank

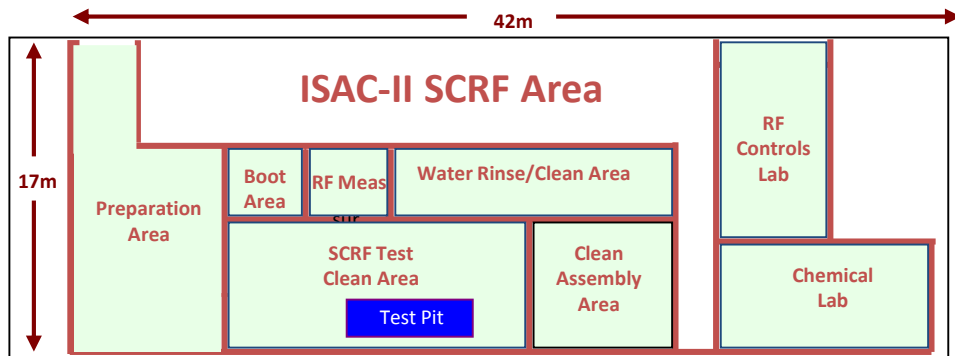
Would be good to get an advance
look at the assembly fixtures/tools

- RFD string to be assembled in the SRF clean room
- Top assembly in the CM assembly area
- Cryogenic test and rf test in the SRF test area – first choice
- Testing could also be done in the e-Linac hall depending on schedule



•The ISAC-II building houses the SCRF test and assembly areas

- SRF area - 500m² of floor space, overhead crane
- US cleaning tanks, HPWR area, rf test area, cryogenics on tap, cryomodule assembly area (clean room for hermetic string assembly and larger CM assembly space in adjacent hall), chemical etching lab (BCP)
- Cryomodule test capability in ISAC-II
 - LHe – 100ltr/h in falling level, 200W at 4K, 20W at 2K
 - LN2 at 1.5 Barg
 - Shielded pit, LLRF, controls

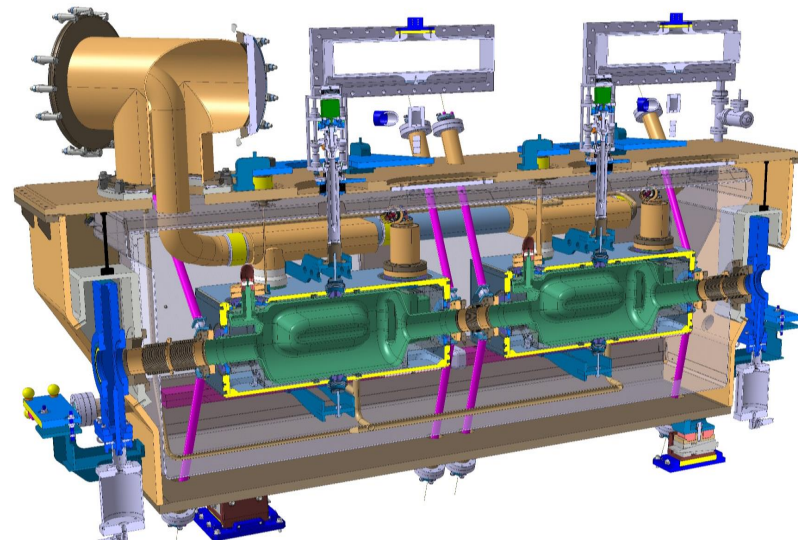


- RFD-SPS cavity fabrication started at CERN, cryostating to be performed at UK and the conceptual design in an advanced stage
- RFD-HL-LHC dressed cavities in-kind contribution from US-AUP - CD2 review upcoming
- RFD-HL-LHC cryostating is approved to be an in-kind from Canada-TRIUMF

- U.S. Accelerator Upgrade Project (AUP) is currently ready to go for Gate 2 approval to complete 10 RFD (8+2) cavities
 - AUP would provide the dressed cavities (minus FPC) – fully processed and characterized
- TRIUMF to assemble, qualify and ship CMs (4+1)
- TRIUMF installation includes with parts from (x)
 - FPCs (CERN), HOM couplers (AUP), pick-up (AUP)
 - Internal rf lines (CERN?- TBD)
 - Tuners – (TRIUMF - mechanics, CERN – warm system (TBD))
 - Hermetic unit assembly – Valves, WCT, CCT, couplers
 - Support structure
 - Establish Alignment
 - Thermal shield, Mu metal, Vacuum vessel,
 - Diagnostics (TS, level probes, heaters, alignment)

Need to sit with
CERN colleagues to
finalize agreement

- Qualify at room temperature
 - the operation of diagnostics
 - Leak check and pressure test – all volumes
 - Warm rf frequency, alignment
- Qualify at 77K
 - Cooldown to 77K
 - leak check, alignment check
- Qualify at 4K
 - Cooldown cold mass to 4K
 - Check alignment
 - Check rf frequency
 - Check operation of tuner
 - Rf and LLRF -
 - 15kW at 400MHz
- Pump to 2K – measure Q, freq, microphonics

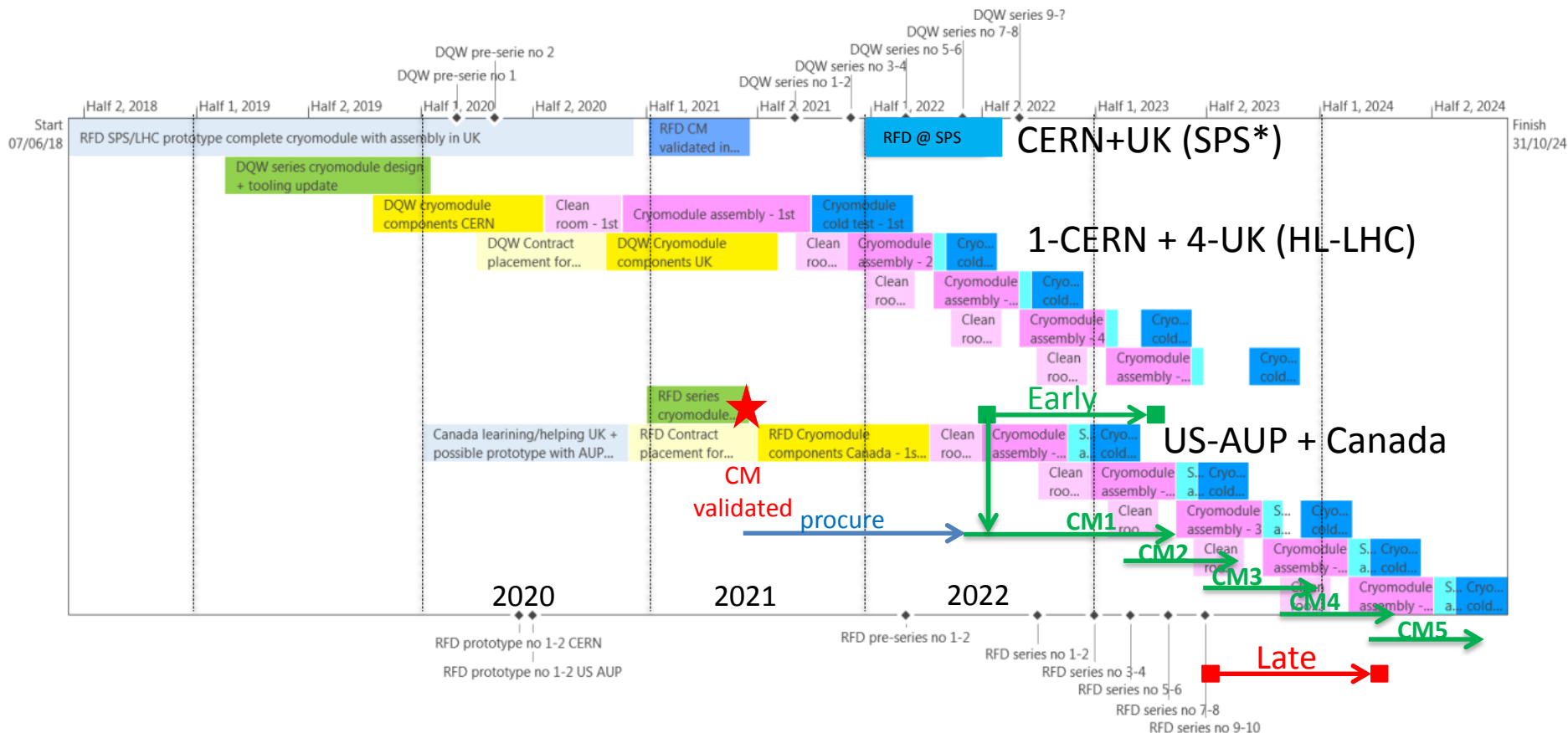


RFD Dressed Cavities

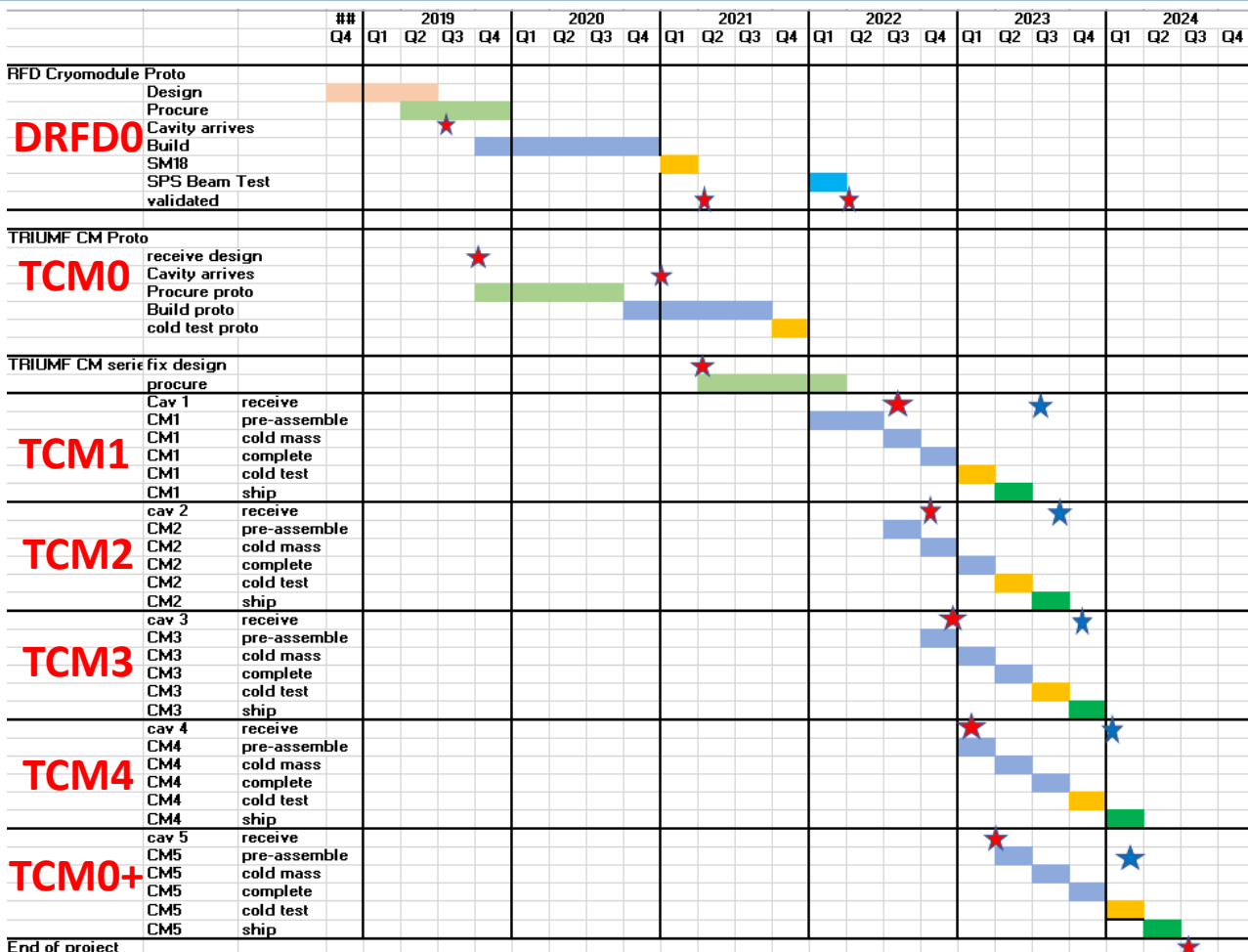
11 months float



	HL project schedule	US project schedule
HCACFDC002-UP000001	July 2022	June 2023
HCACFDC002-UP000002	July 2022	June 2023
HCACFDC002-UP000003	September 2022	September 2023
HCACFDC002-UP000004	September 2022	September 2023
HCACFDC002-UP000005	November 2022	December 2023
HCACFDC002-UP000006	November 2022	December 2023
HCACFDC002-UP000007	January 2023	February 2024
HCACFDC002-UP000008	January 2023	February 2024
HCACFDC002-UP000009	March 2023	May 2024
HCACFDC002-UP000010	March 2023	May 2024



- Strategy - proposal
 - To reduce schedule risk TRIUMF proposes to assemble RFD pre-series cryomodule (TCM-0) in 2021 with cold test in late 2021
 - Would require pre-series dressed cavities from AUP in late 2020 – is it possible?
 - Would enable early completion/validation of clean room tooling and fixturing
 - Would enable early completion/validation of top plate and top assembly fixtures
 - Would allow completion of pre-series TCM-0 for cold test end of 2021 to compare with UK SPS-RFD tests in SM-18 in early 2021
 - Advantages
 - Early start on clean room fixturing, hermetic string assembly and procedures
 - Early start and tweaking series tooling for top assembly
 - Confirmation of TRIUMF readiness for series production
 - Essentially would have two CM prototypes tested in 2021 – DRFD0, TCM0
 - Risks
 - Some parts in TCM-0 may have to be remade after cold test feedback to retro-fit it to series model



TCM0: Would engage TRIUMF earlier and significantly reduce schedule risk once series cavities arrive

Can we get AUP dressed first RFDs at end of 2020?

Would allow early preparation and qualification of tooling , processes, testing well before series production

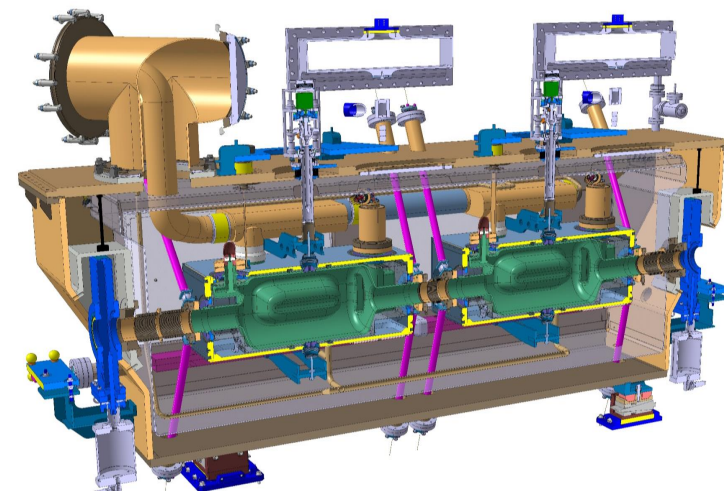
TCM0+ - retro-fit for LHC as required

TCM0+ (TCM5) -> would be a retro-fit of TCM0 with RFD9 and RFD10 – prototype cavities then would be returned to collaboration

Suggest a periodic tele-conference between UK/CERN/TRIUMF

TRIUMF has a large bath cryostat that could be used for cavity qualification if required

Cold testing at TRIUMF near operating voltage requires a 10-15kW 400MHz amplifier





Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Thank you!
Merci!

TRIUMF: Alberta | British Columbia | Calgary |
Carleton | Guelph | Manitoba | McGill | McMaster |
Montréal | Northern British Columbia | Queen's |
Regina | Saint Mary's | Simon Fraser | Toronto |
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