Navigating FRIB: A Guide for New Operators

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U.S. DEPARTMENT OF ENERGY | Office of Science

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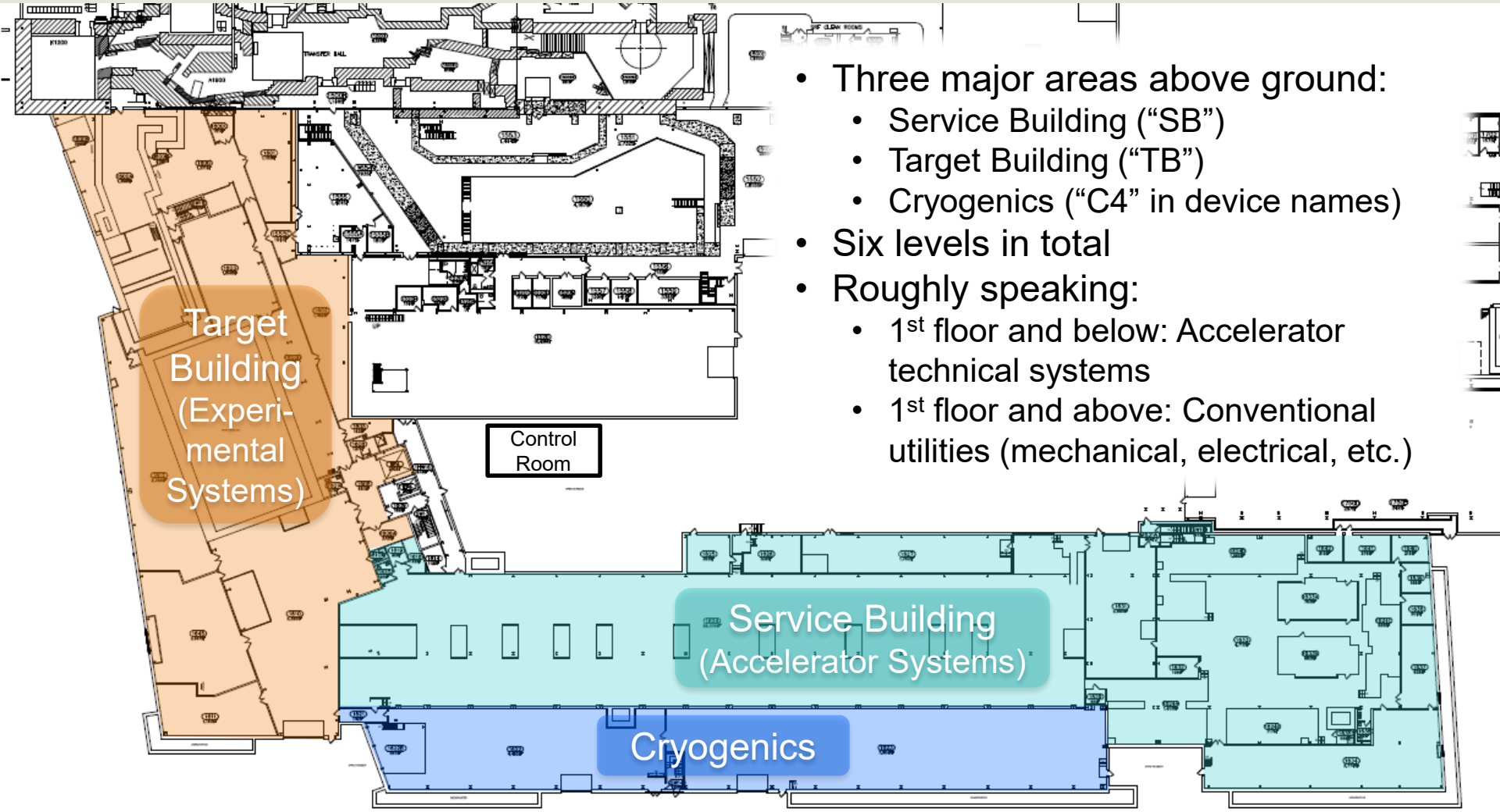
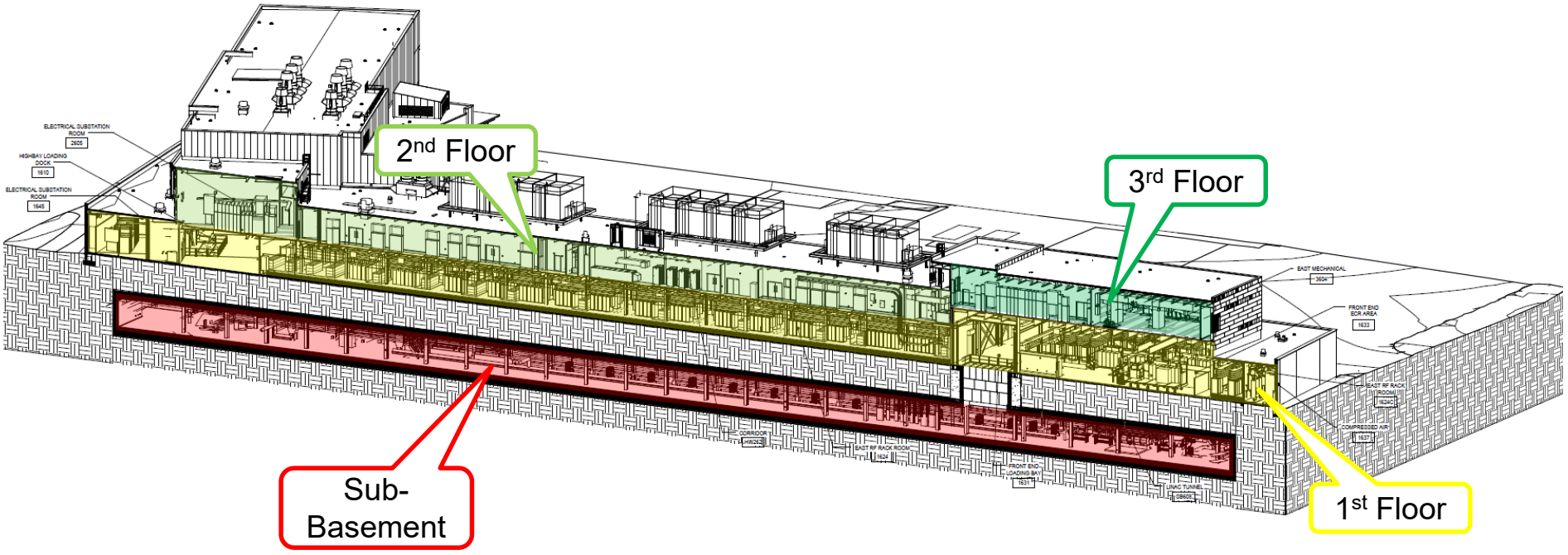
Navigating the FRIB Building

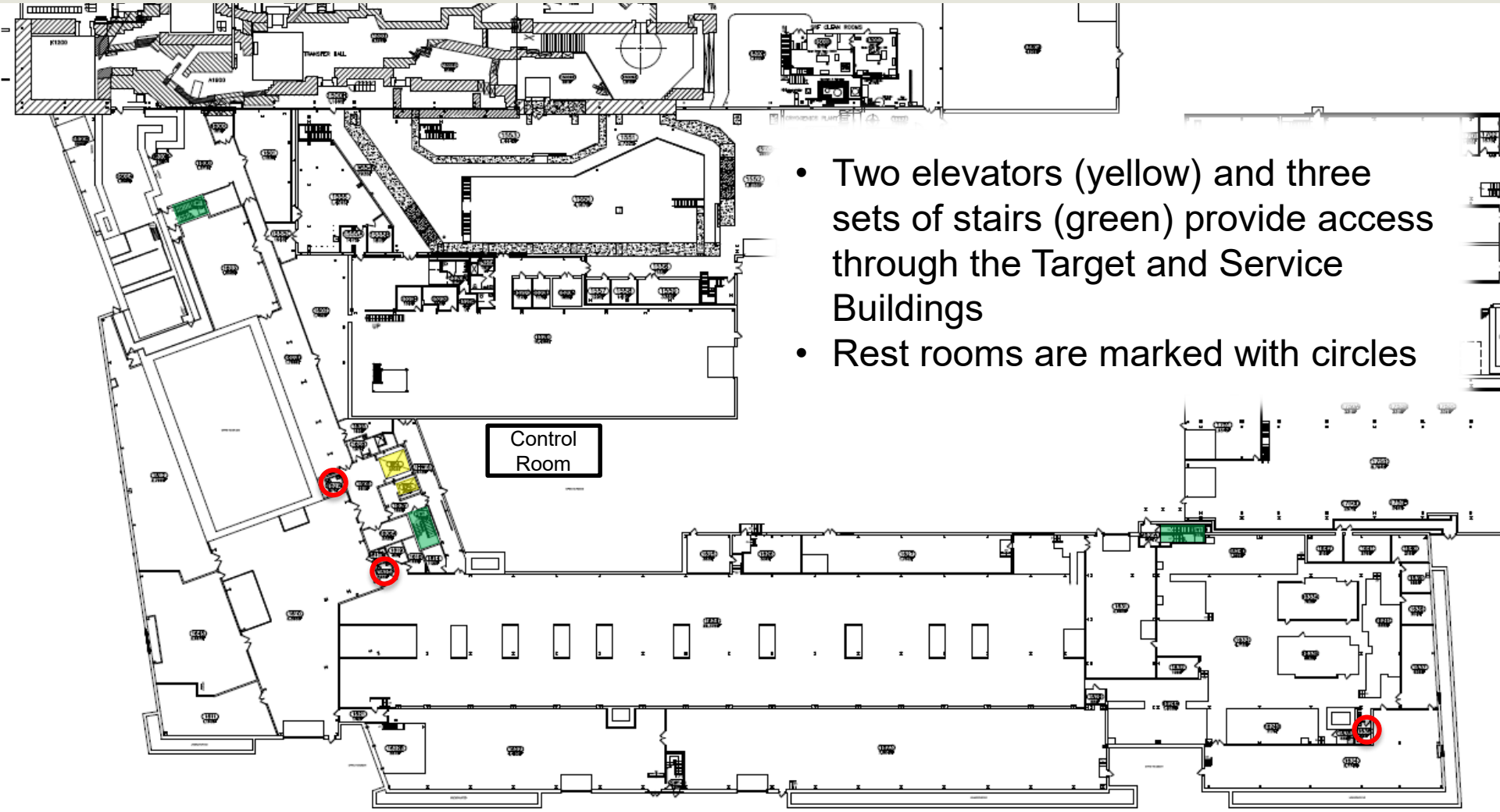


- Three major areas above ground:
  - Service Building (“SB”)
  - Target Building (“TB”)
  - Cryogenics (“C4” in device names)
- Six levels in total
- Roughly speaking:
  - 1st floor and below: Accelerator technical systems
  - 1st floor and above: Conventional utilities (mechanical, electrical, etc.)

Cross-Section Along Tunnel

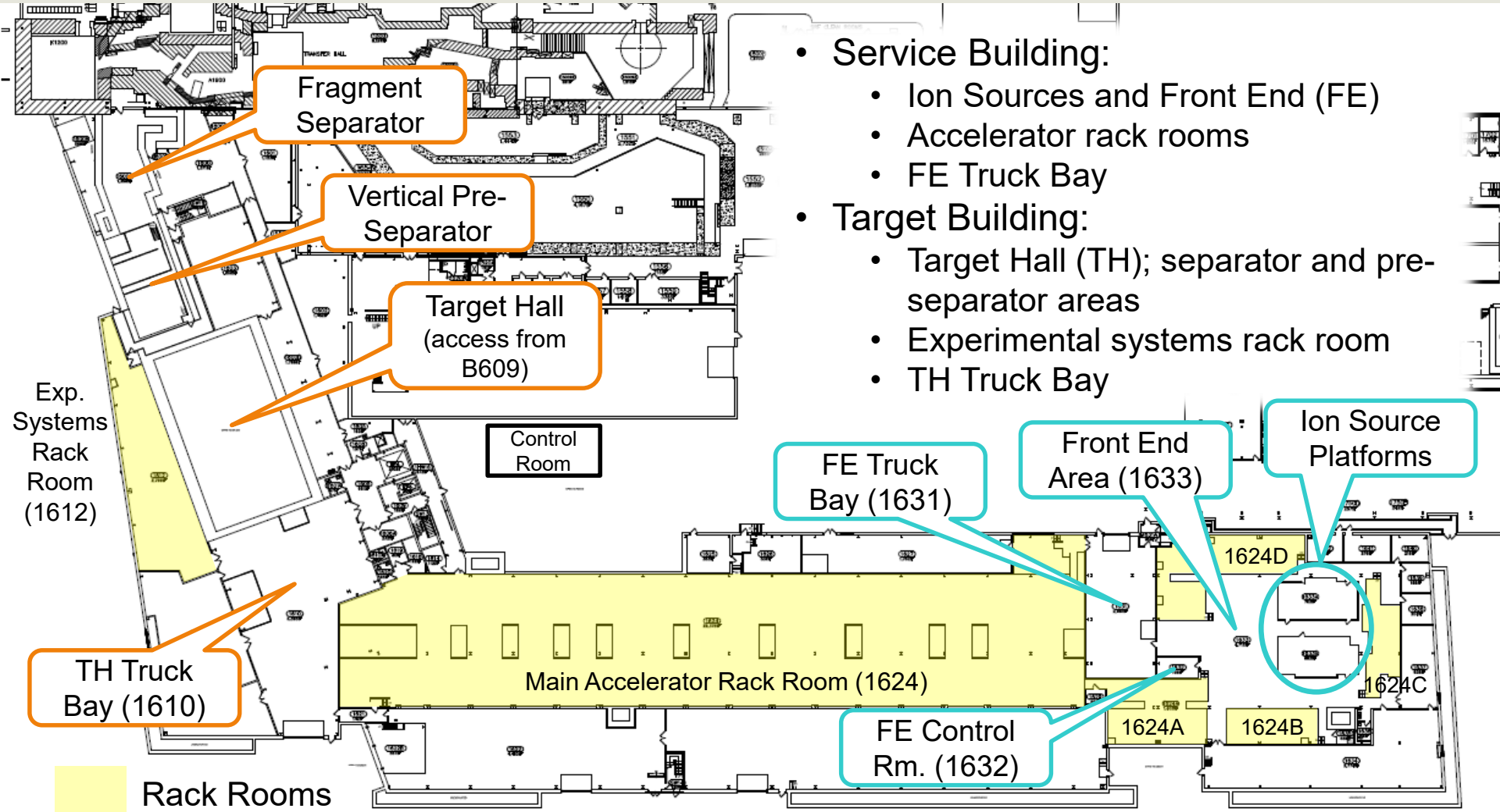


Navigating the FRIB Building



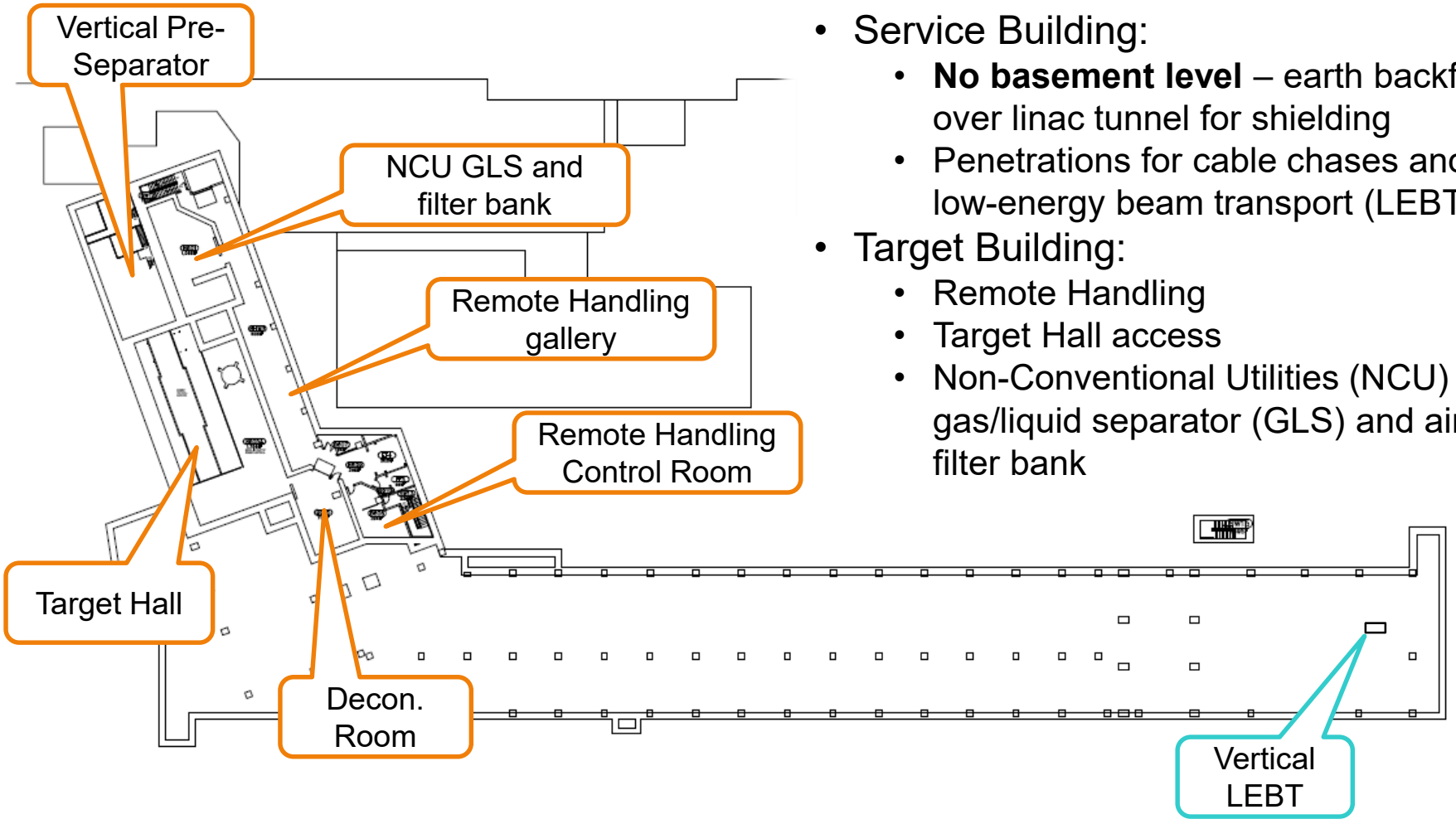
- Two elevators (yellow) and three sets of stairs (green) provide access through the Target and Service Buildings
- Rest rooms are marked with circles

Technical Systems: 1st Floor (16xx)



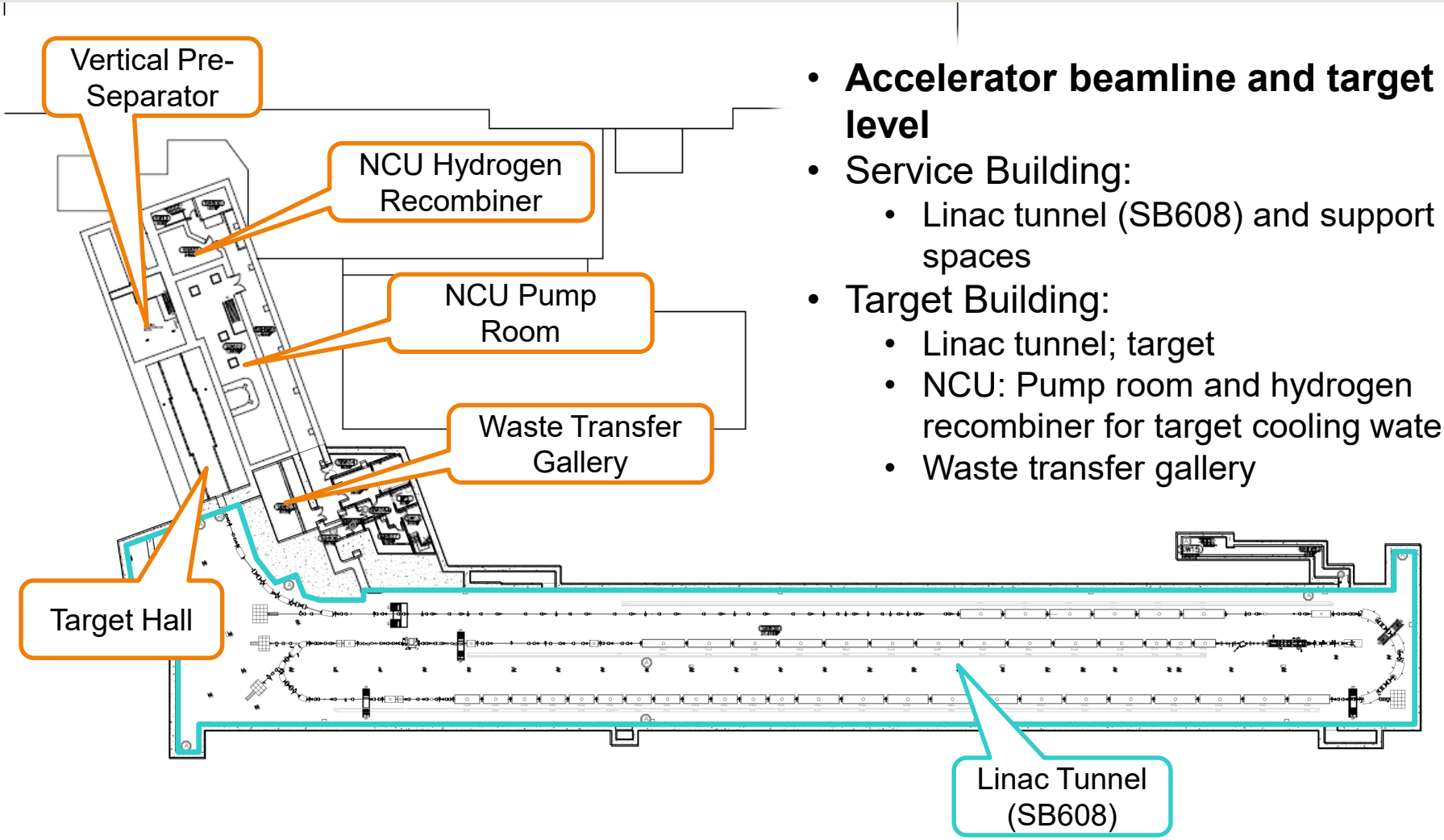
- Service Building:
  - Ion Sources and Front End (FE)
  - Accelerator rack rooms
  - FE Truck Bay
- Target Building:
  - Target Hall (TH); separator and pre-separator areas
  - Experimental systems rack room
  - TH Truck Bay

Basement (B6xx)



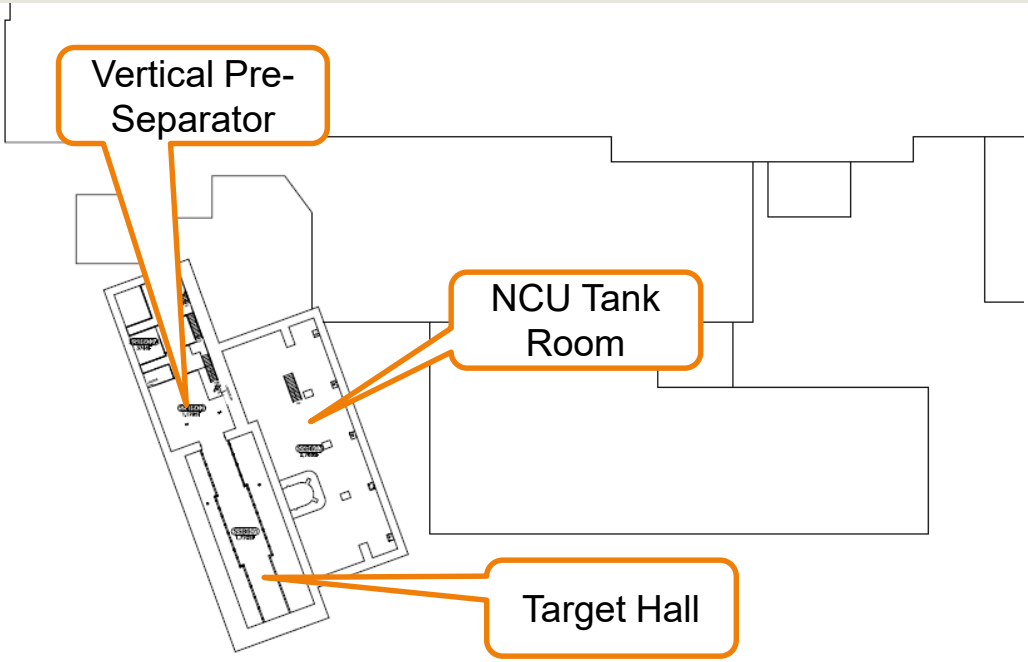
- Service Building:
  - **No basement level** – earth backfill over linac tunnel for shielding
  - Penetrations for cable chases and low-energy beam transport (LEBT)
- Target Building:
  - Remote Handling
  - Target Hall access
  - Non-Conventional Utilities (NCU) – gas/liquid separator (GLS) and air filter bank

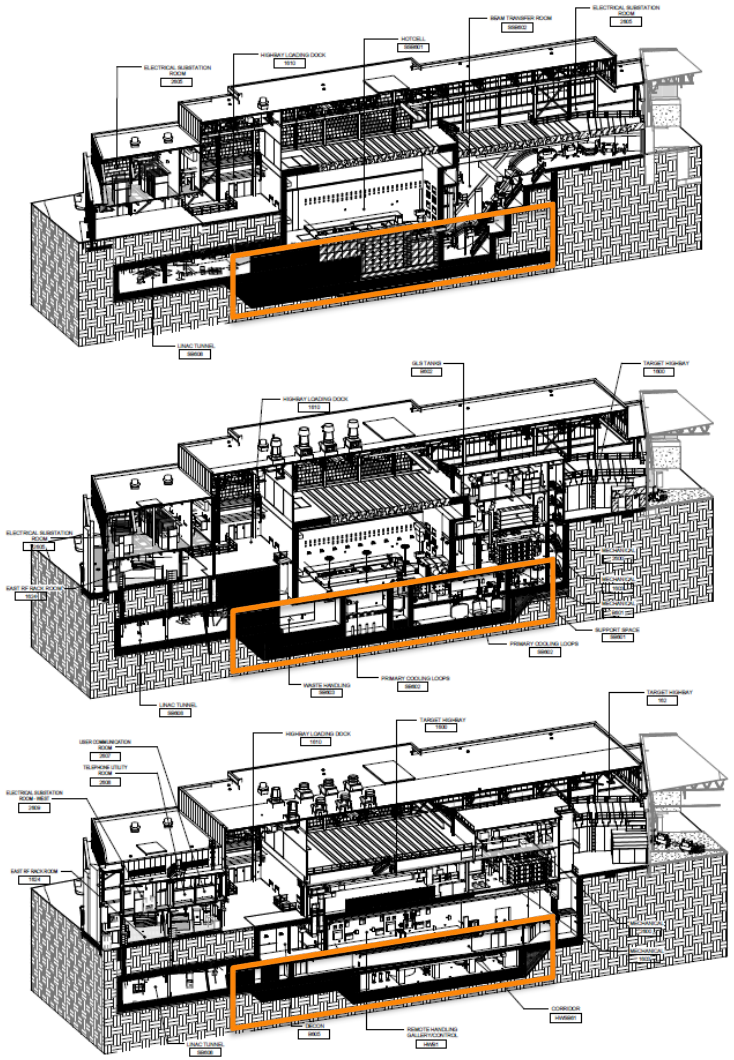
Sub-Basement (SB6xx)



- **Accelerator beamline and target level**
- Service Building:
  - Linac tunnel (SB608) and support spaces
- Target Building:
  - Linac tunnel; target
  - NCU: Pump room and hydrogen recombiner for target cooling water
  - Waste transfer gallery

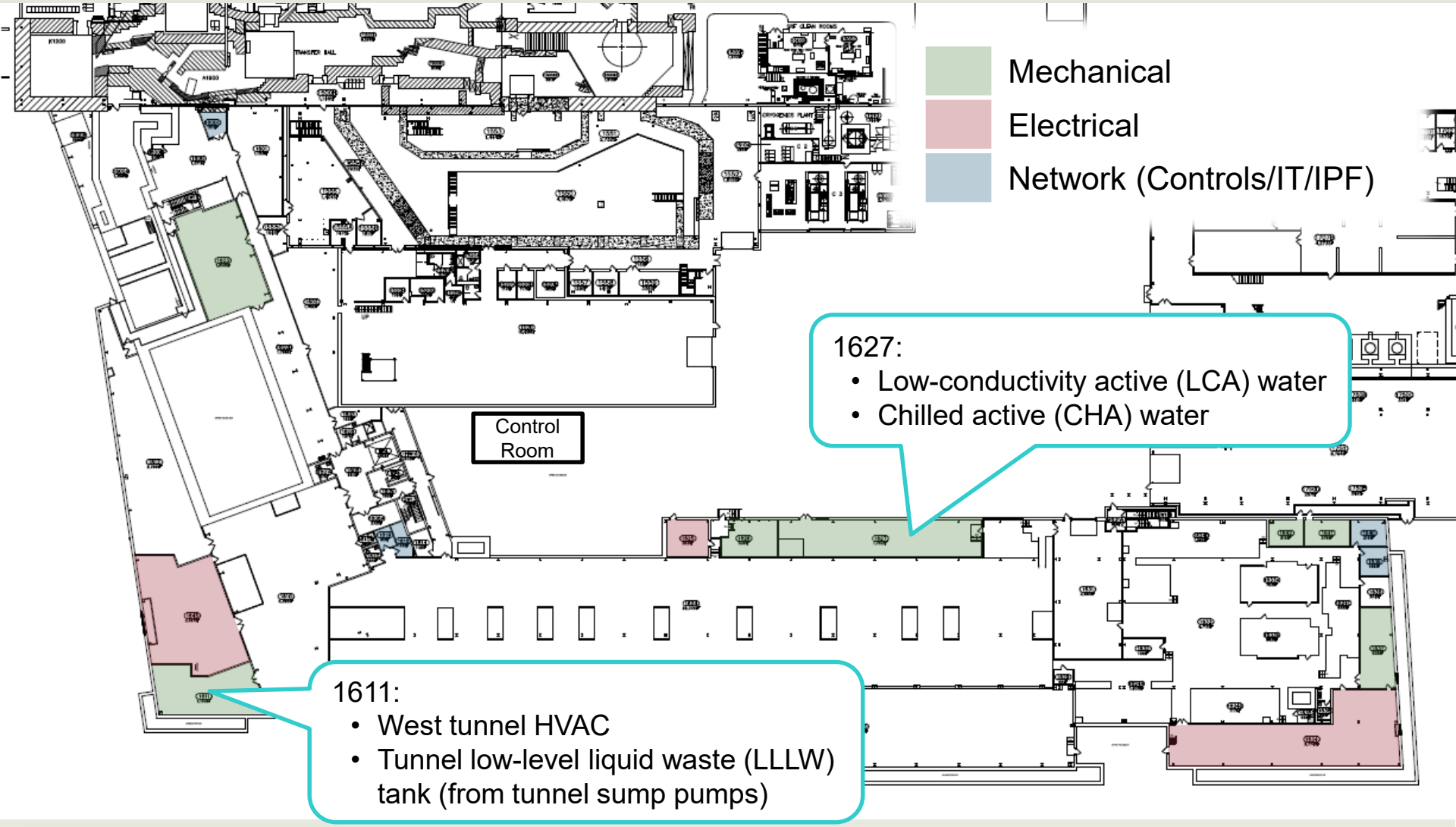
Sub-Sub-Basement (SSB6xx)



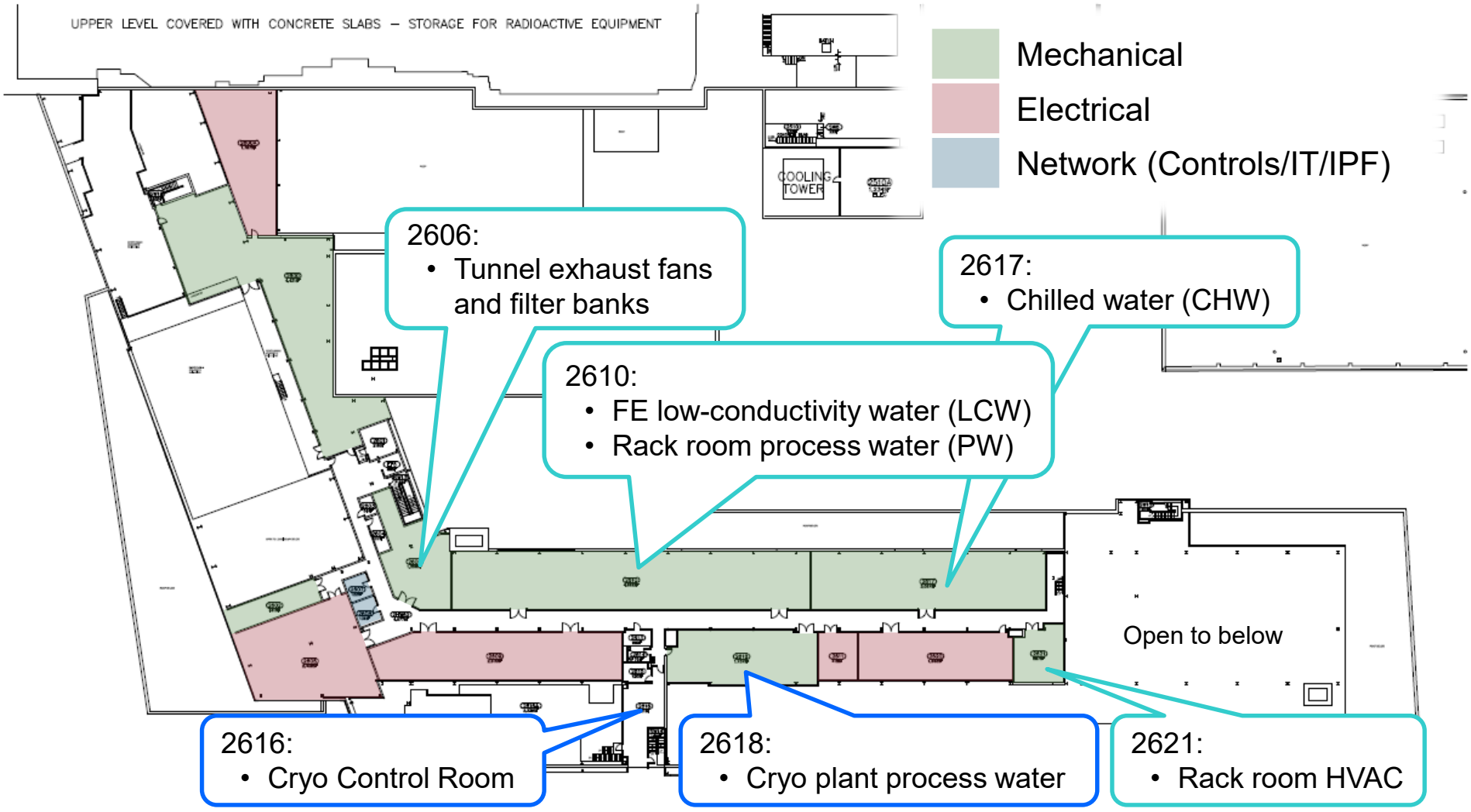


- Bottom level of Target Building:
  - Beam dump and wedge
  - First pre-separator elements
  - NCU tank/filter room for target cooling water – can contain the entire volume if needed
- **Deepest part of FRIB**

Utilities: 1st Floor (16xx)



2nd Floor (26xx)



3rd Floor (36xx)

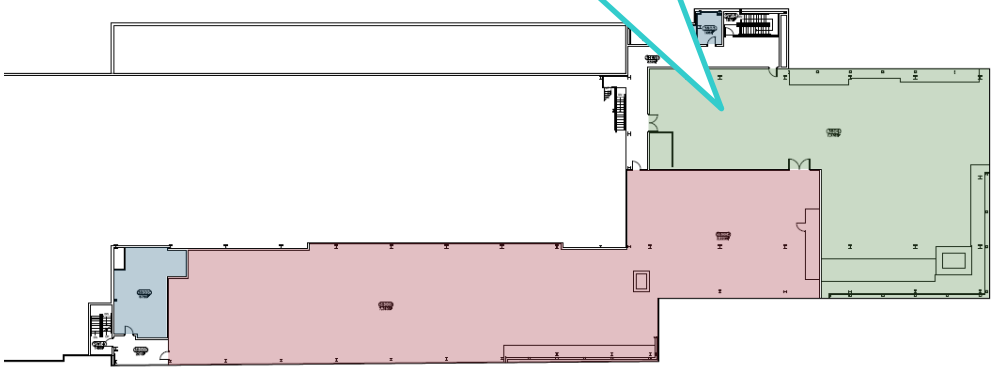
Mechanical

Electrical

Network (Controls/IT/IPF)

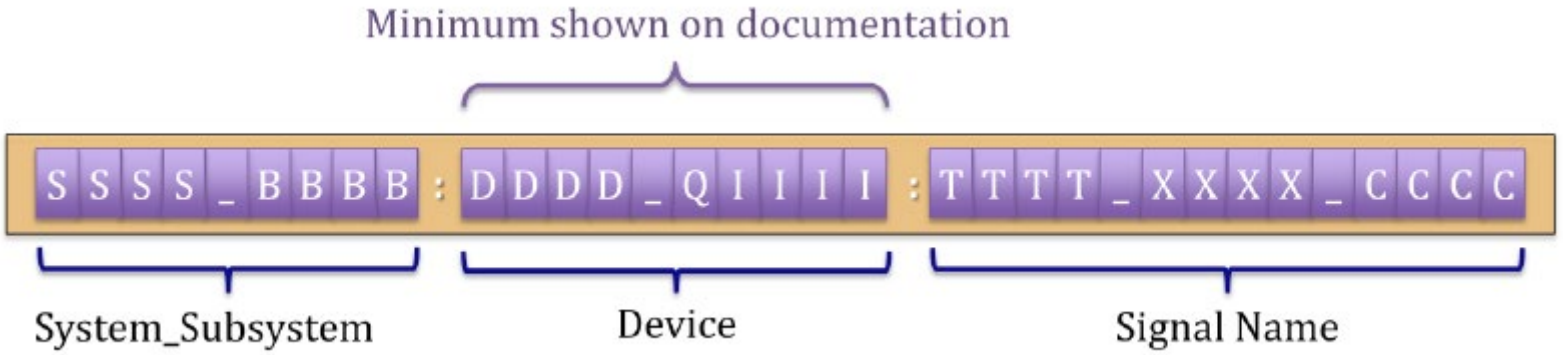
3604:

- Ion source cooling skids
- Front end area HVAC
- East tunnel HVAC



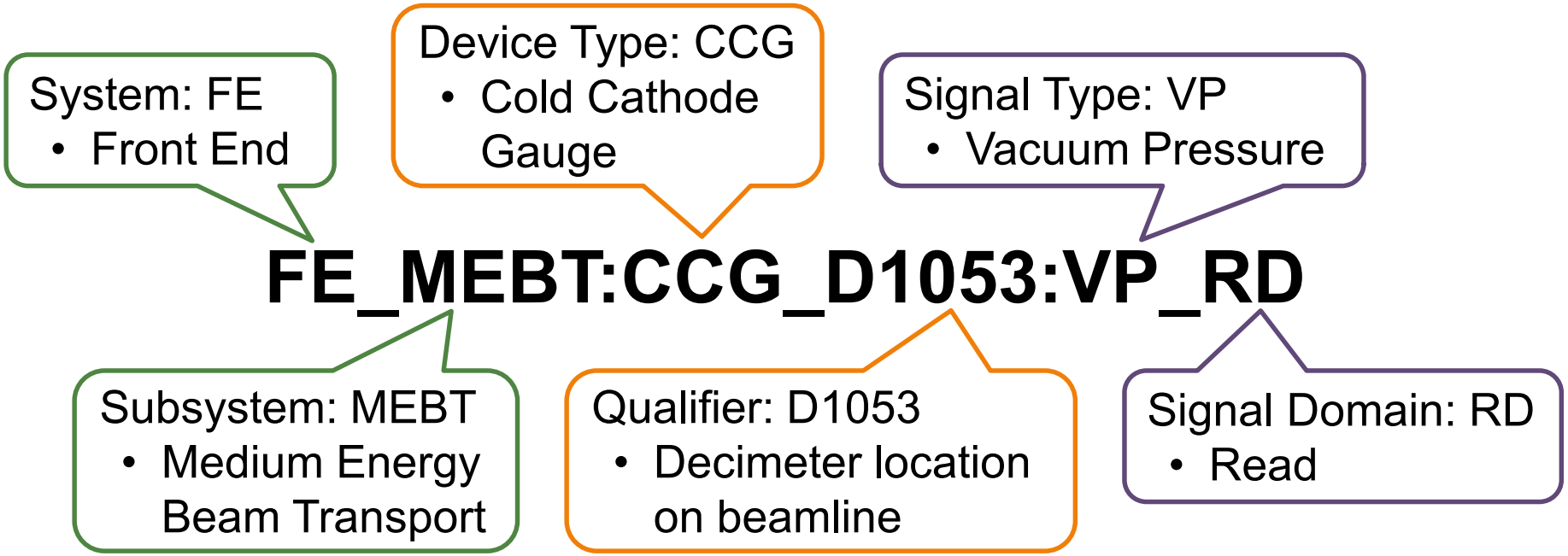
Navigating the FRIB Beamline

- Naming conventions:
  - Slot names follow the *FRIB Naming System* (FRIB-T10500-PR-000001) and are recorded in the Naming Database (https://controls.frib.msu.edu/names/)
  - Names have the following format:



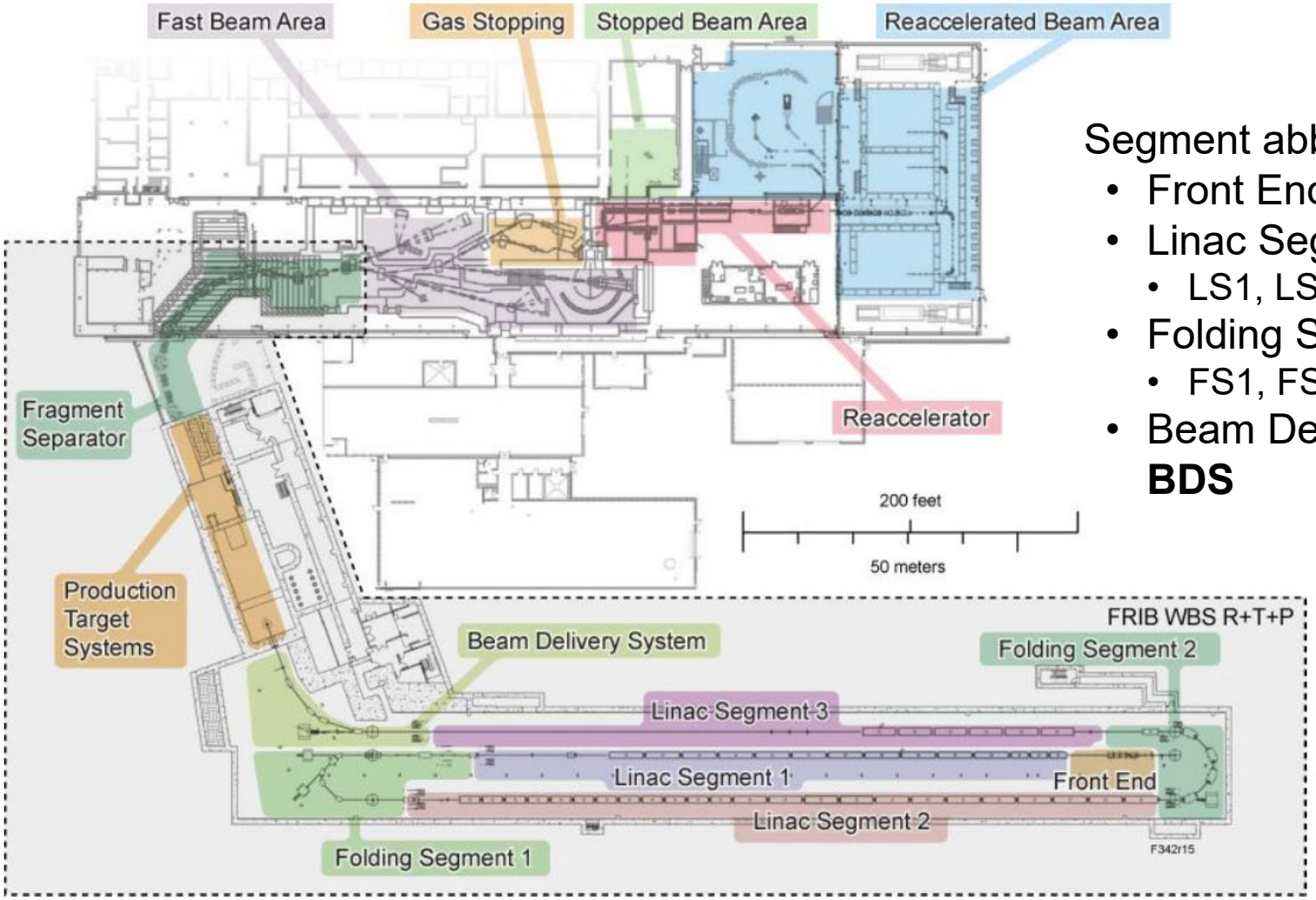
  - For slots along the linac:
    - » SSSS (System): Linac segment
    - » BBBB (Subsystem): Beamline section; may not be required
    - » DDDD: Device type
    - » QIIII ("Qualifier"): One of Dxxx for decimeter location on the beamline, N for a controls identifier, or C for a Cryogenics controls identifier

Example PV



- Decimeter locations ("D values") are set relative to a reference of D=1000 at the entrance of the RFQ

Beamline Systems at FRIB

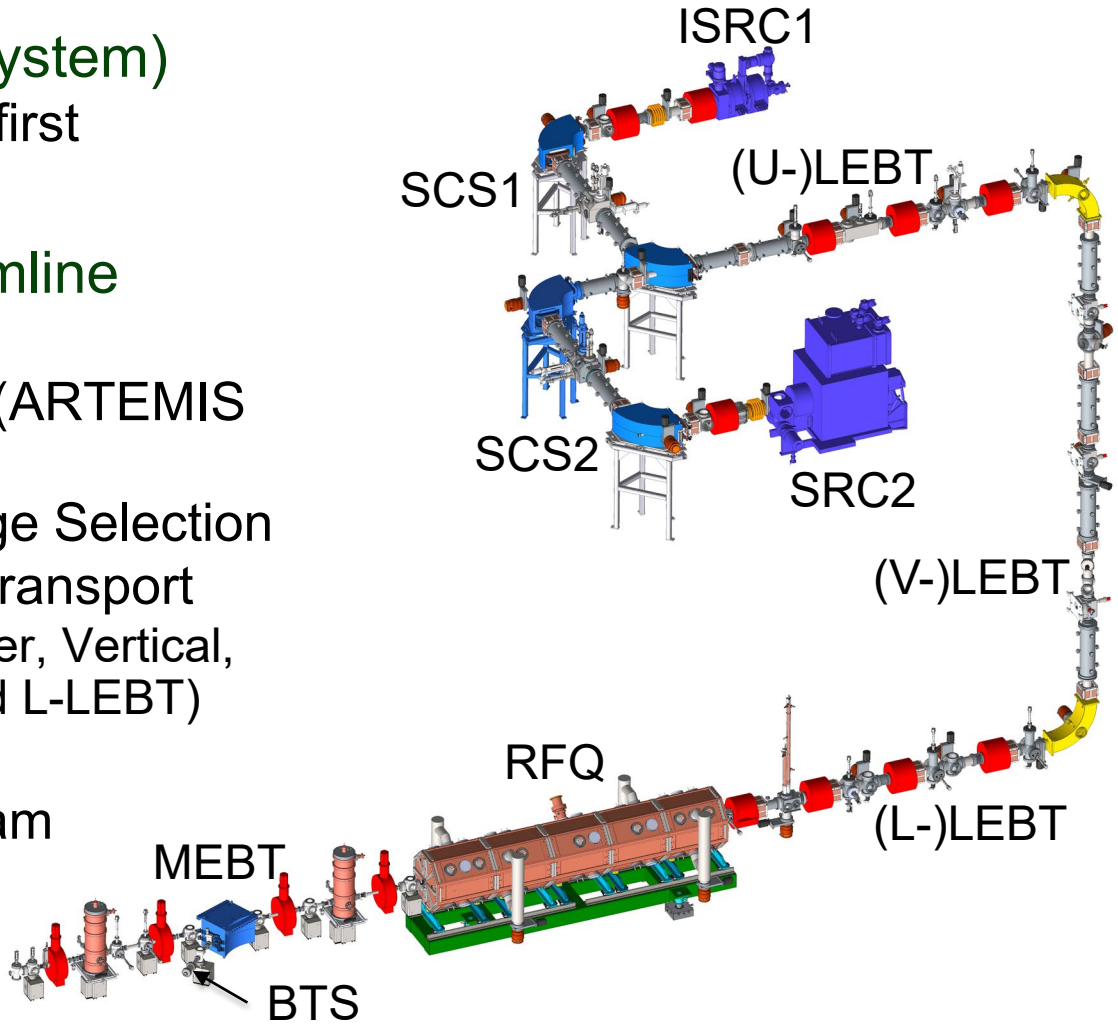


Segment abbreviations:

- Front End: **FE**
- Linac Segment: **LS**
  - LS1, LS2, LS3
- Folding Segment: **FS**
  - FS1, FS2
- Beam Delivery System: **BDS**

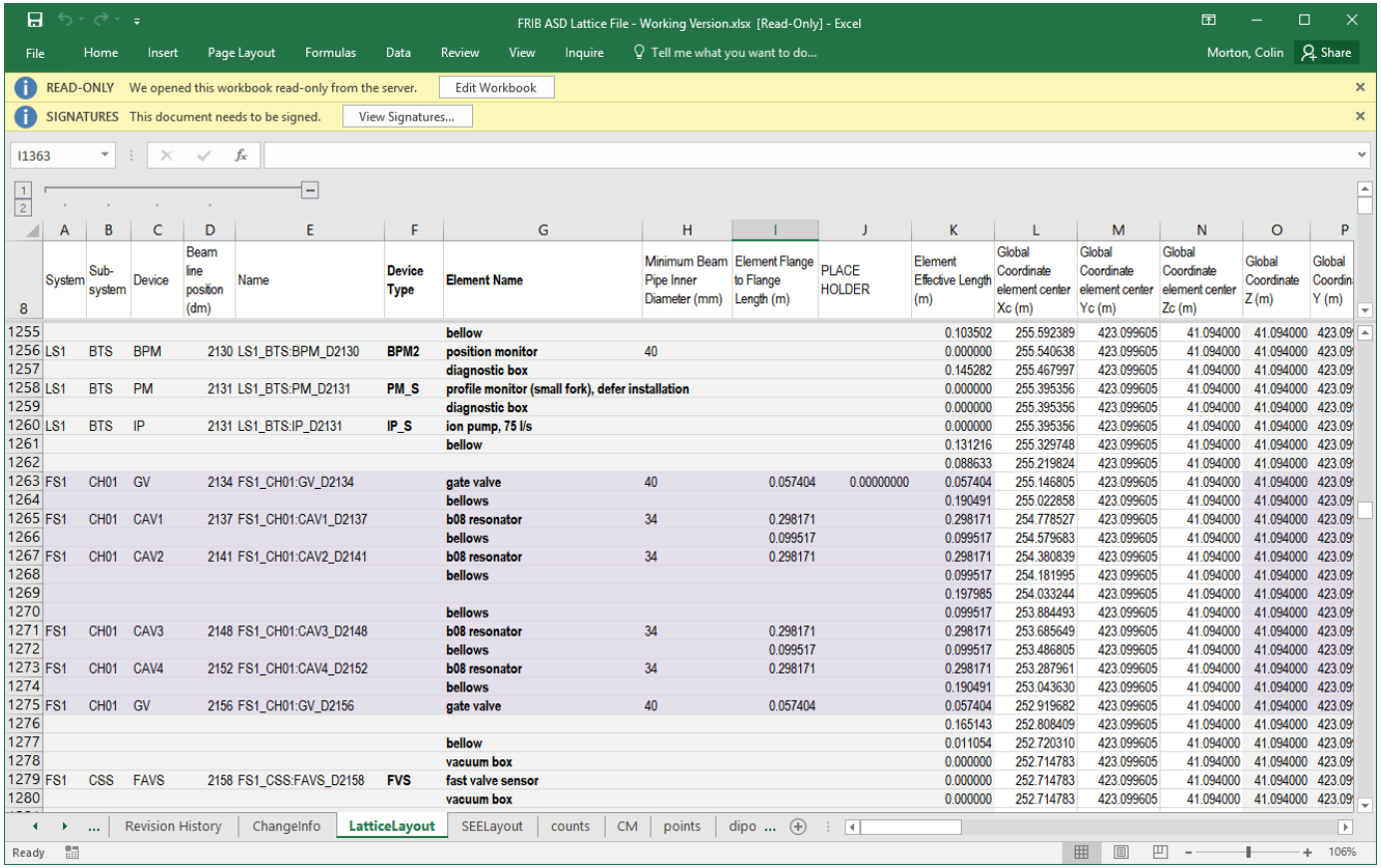
Front End (Detail)

- **FE** accelerator segment (system)
  - Everything upstream of the first cryomodule
- Includes the following beamline sections (subsystems):
  - **ISRC1, SRC2**: Ion sources (ARTEMIS and VENUS)
  - **SCS1, SCS2**: Source Charge Selection
  - **LEBT**: Low-Energy Beam Transport
    - » Colloquially divided into Upper, Vertical, and Lower LEBT (U-, V-, and L-LEBT)
  - **RFQ**
  - **MEBT**: Medium-Energy Beam Transport
  - **BTS**: Beam Transport Section (diagnostics line)



Lattice File

- The canonical list of beamline slots is in the lattice file on Portal:
  - https://portal.frib.msu.edu/sites/accsystems/SitePages/FRIB%20Lattice%20File%20Page.aspx



FRIB ASD Lattice File - Working Version.xlsx [Read-Only] - Excel

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
8	System	Sub-system	Device	Beam line position (dm)	Name	Device Type	Element Name	Minimum Beam Pipe Inner Diameter (mm)	Element Flange to Flange Length (m)	PLACE HOLDER	Element Effective Length (m)	Global Coordinate element center Xc (m)	Global Coordinate element center Yc (m)	Global Coordinate element center Zc (m)	Global Coordinate Z (m)	Global Coordin Y (m)
1255							bellow				0.103502	255.592389	423.099605	41.094000	41.094000	423.09
1256	LS1	BTS	BPM	2130	LS1_BTS:BPM_D2130	BPM2	position monitor	40			0.000000	255.540638	423.099605	41.094000	41.094000	423.09
1257							diagnostic box				0.145282	255.467997	423.099605	41.094000	41.094000	423.09
1258	LS1	BTS	PM	2131	LS1_BTS:PM_D2131	PM_S	profile monitor (small fork), defer installation				0.000000	255.395356	423.099605	41.094000	41.094000	423.09
1259							diagnostic box				0.000000	255.395356	423.099605	41.094000	41.094000	423.09
1260	LS1	BTS	IP	2131	LS1_BTS:IP_D2131	IP_S	ion pump, 75 l/s				0.000000	255.395356	423.099605	41.094000	41.094000	423.09
1261							bellow				0.131216	255.329748	423.099605	41.094000	41.094000	423.09
1262											0.088633	255.219824	423.099605	41.094000	41.094000	423.09
1263	FS1	CH01	GV	2134	FS1_CH01:GV_D2134		gate valve	40	0.057404	0.00000000	0.057404	255.146805	423.099605	41.094000	41.094000	423.09
1264							bellows				0.190491	255.022858	423.099605	41.094000	41.094000	423.09
1265	FS1	CH01	CAV1	2137	FS1_CH01:CAV1_D2137		b08 resonator	34	0.298171		0.298171	254.778527	423.099605	41.094000	41.094000	423.09
1266							bellows		0.099517		0.099517	254.579683	423.099605	41.094000	41.094000	423.09
1267	FS1	CH01	CAV2	2141	FS1_CH01:CAV2_D2141		b08 resonator	34	0.298171		0.298171	254.380839	423.099605	41.094000	41.094000	423.09
1268							bellows				0.099517	254.181995	423.099605	41.094000	41.094000	423.09
1269											0.197985	254.033244	423.099605	41.094000	41.094000	423.09
1270							bellows				0.099517	253.884493	423.099605	41.094000	41.094000	423.09
1271	FS1	CH01	CAV3	2148	FS1_CH01:CAV3_D2148		b08 resonator	34	0.298171		0.298171	253.685649	423.099605	41.094000	41.094000	423.09
1272							bellows		0.099517		0.099517	253.486805	423.099605	41.094000	41.094000	423.09
1273	FS1	CH01	CAV4	2152	FS1_CH01:CAV4_D2152		b08 resonator	34	0.298171		0.298171	253.287961	423.099605	41.094000	41.094000	423.09
1274							bellows				0.190491	253.043630	423.099605	41.094000	41.094000	423.09
1275	FS1	CH01	GV	2156	FS1_CH01:GV_D2156		gate valve	40	0.057404		0.057404	252.919682	423.099605	41.094000	41.094000	423.09
1276											0.165143	252.808409	423.099605	41.094000	41.094000	423.09
1277							bellow				0.011054	252.720310	423.099605	41.094000	41.094000	423.09
1278							vacuum box				0.000000	252.714783	423.099605	41.094000	41.094000	423.09
1279	FS1	CSS	FAVS	2158	FS1_CSS:FAVS_D2158	FVS	fast valve sensor				0.000000	252.714783	423.099605	41.094000	41.094000	423.09
1280							vacuum box				0.000000	252.714783	423.099605	41.094000	41.094000	423.09

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