Building Infrastructure

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PIP-II Beam Transfer Line Workshop

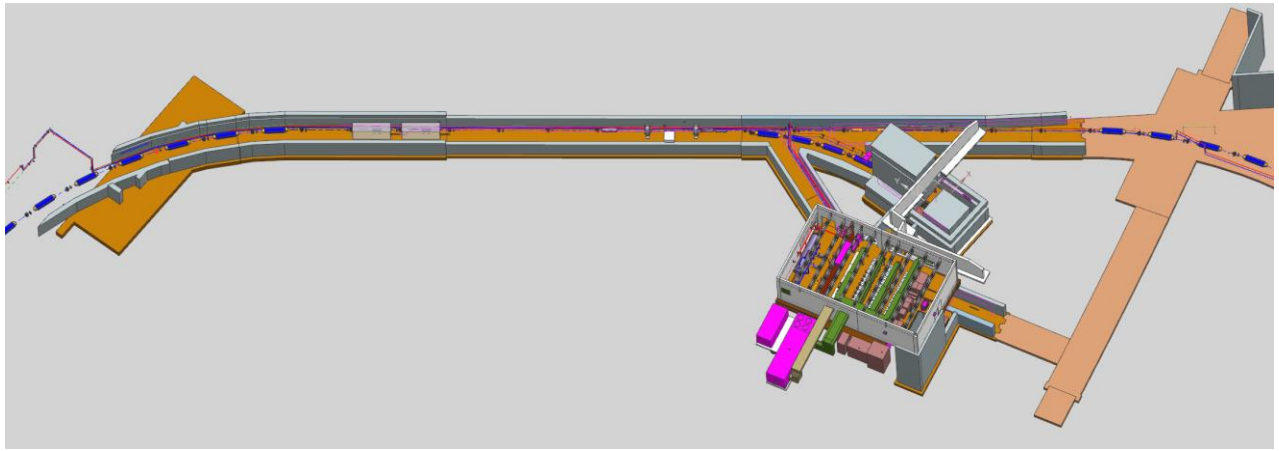
November 30, 2022 – December 1, 2022

A Partnership of:

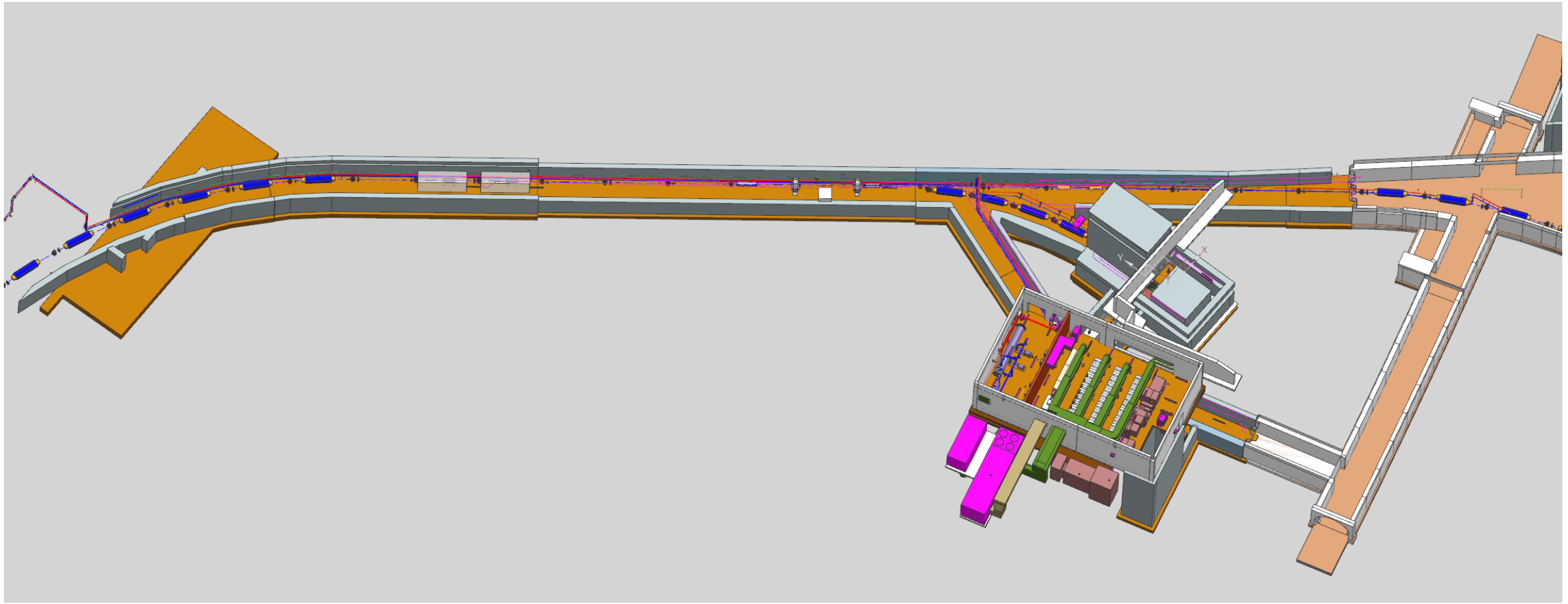
US/DOE
India/DAE
Italy/INFN
UK/UKRI-STFC
France/CEA, CNRS/IN2P3
Poland/WUST

BldgI Mechanical - Scope

- PIP-II Primary LCW System, Compressed Air, Utility Nitrogen
  - Technical Requirements
  - System highlights/flow summary
  - Key Concern Points
  - 3D Model Screenshots
- Absorber RAW Skid
  - Technical Requirements
  - System highlights/flow summary
  - Key Concern Points
  - 3D Model Screenshots



BldgI Mechanical – Scope (Continued)



Helicopter view of BTL showing layout, routing of LCW/CA/N

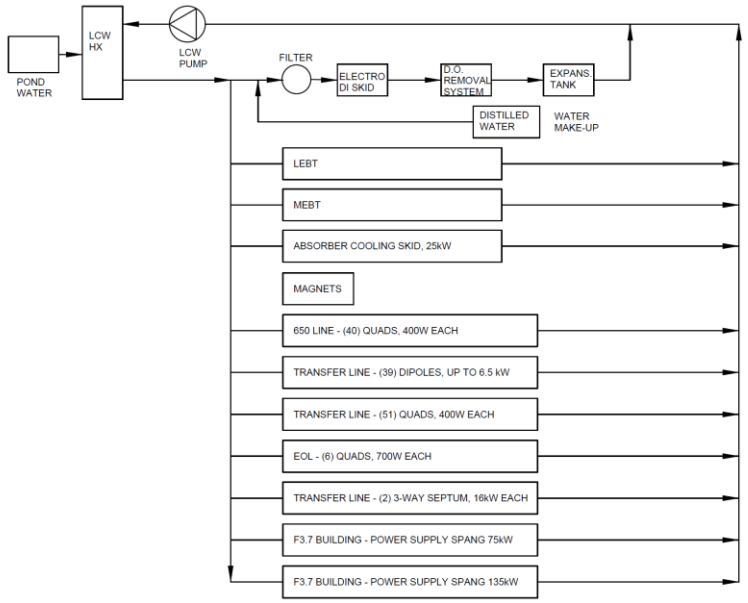
PIP-II Primary LCW System – Technical Requirements/System Highlights

- ASME Category D Piping System
- 304 Stainless Steel Schedule 10 piping material and weld pipe fittings
- Centrifugal Pumps
- Electro-deionization Skid
- Dissolved Oxygen Removal Skid
- Particulate filtration
- Expansion Reservoir Tank – 250 Gallon
- Pump room located in F37 Service Building
- Tube and shell heat exchanger
- Heat exchange with ICW, discharge to F-Sector ponds
- Make up water via – Deionized water from 50 Gallon portable drums
- Nitrogen gas supplied from Utility Nitrogen gas line piping installation from BTL

Requirement #	PARAMETER DESCRIPTION	VALUE
T- ED0012655-A002	Design Pressure	150 psig
T- ED0012655-A003	Discharge Pressure	105 psig
T- ED0012655-A004	Suction Pressure	15 psig
T- ED0012655-A005	Supply Temperature	95ºF +/- 1ºF
T- ED0012655-A006	Delta T (ΔT)	17 Fº
T- ED0012655-A007	Total Heat Load	200 kW
T- ED0012655-A008	Available Flow	400 GPM
T- ED0012655-A009	Side Stream Particulate Filtration	5 micron
T- ED0012655-A010	Resistivity	4 MOhm*cm
T- ED0012655-A011	Oxygen Removal Levels	≥ 20 PPB

PIP-II Primary LCW System – Flow Summary Sheet

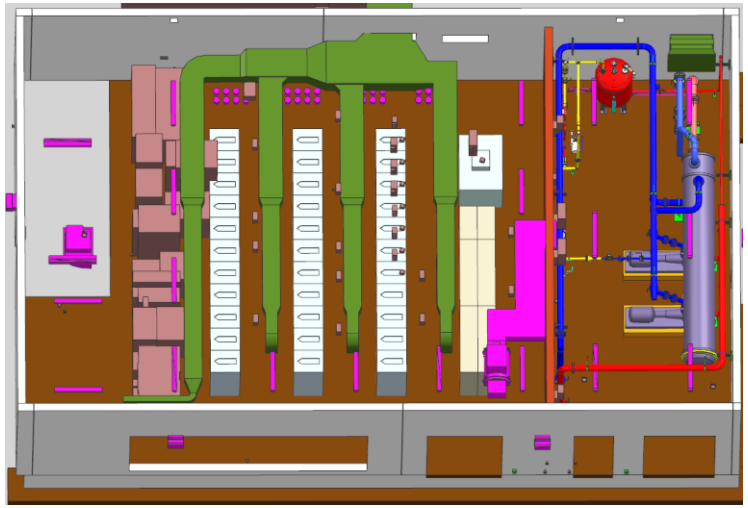
- PIP-II Building Infrastructure – Low Conductivity Water (LCW) System TRS – TC# ED0012655



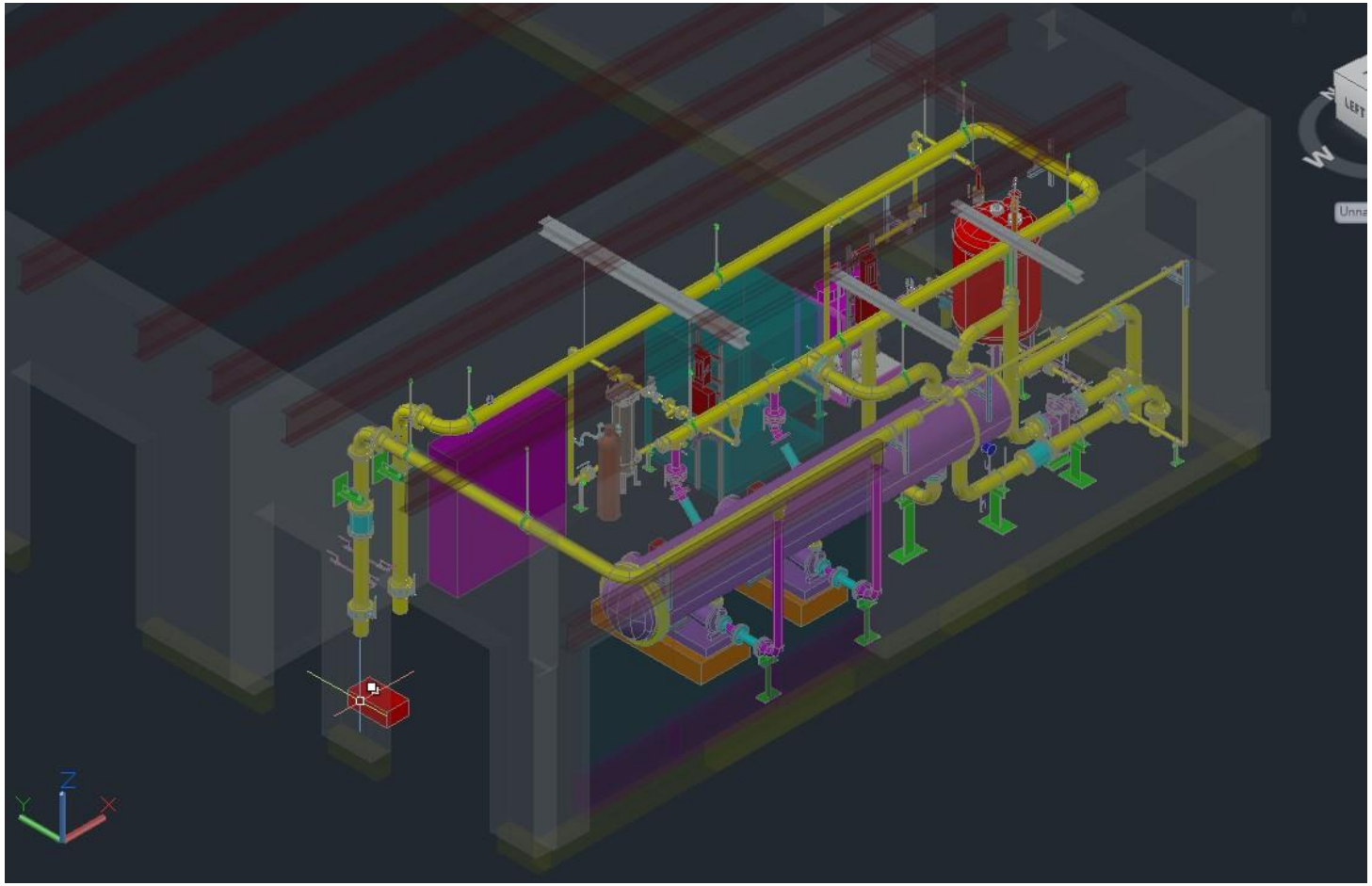
Component	Quantity [#]	Unit Consumption [GPM]	Total Consumption [GPM]
LEBT			
Solenoid #1 - LEBT	1	1.2	1.2
Chopper - LEBT	1	1.4	1.4
Collectors in 30 Magnet chamber - LEBT	1	1.2	1.2
Scraper - LEBT	1	1	1
Solenoid #2 - LEBT	1	1	1
Solenoid #3 - LEBT	1	1	1
Solenoid #4 - LEBT	1	1	1
Electrically isolated diaphragm (EID) #1 - LEBT	1	0.5	0.5
Electrically isolated diaphragm (EID) #2 - LEBT	1	0.5	0.5
Electrically isolated diaphragm (EID) #3 - LEBT	1	0.5	0.5
Electrically isolated diaphragm (EID) #4 - LEBT	1	0.5	0.5
Electrically isolated diaphragm (EID) #5 - LEBT	1	0.5	0.5
MEBT			
Scraper #1 - MEBT	1	0.5	0.5
Bunching Cavity #1 - MEBT	1	3.5	3.5
Scraper #2 - MEBT	1	0.5	0.5
Emittance scanners #1 - MEBT	1	2	2
Emittance Scanner #2 - MEBT	1	2	2
Kicker #1 - MEBT	1	0.5	0.5
Bunching Cavity #2 - MEBT	1	3.5	3.5
Kicker #2 - MEBT	1	0.5	0.5
Absorber #1 - MEBT	1	8	8
Absorber #2 - MEBT	1	8	8
Water jacket (Around beam tube) - MEBT	1	1	1
Scraper #3 - MEBT	1	0.5	0.5
Bunching Cavity#3 - MEBT	1	3.5	3.5
Scraper #4 - MEBT	1	0.5	0.5
Bunching Cavity#4 (in the Linac tunnel) - MEBT	1	3.5	3.5
Linac			
650 Line 400 W Quadrupoles	40	1.3	50.8
BTL			
Absorber Cooling Skid (25 kW)	1	16	16
Transfer Line 6.5 kW Dipoles (37 + 2 EOL)	39	2	78
Transfer line 400 W Quadrupoles	51	1.3	64.8
EOL 700 W Quadrupoles	6	1.3	7.6
Transfer Line 16 kW 3-Way Septum	2	1.7	3.4
F37 Building			
F3.7 Building 75 kW Power Supply Spang (for beamline abort dipole)	1	1.5	1.5
F3.7 Building 135 kW Power Supply Spang (for Septum)	1	3	3
		Total Flow Required (GPM) =	**273.4**

PIP-II Primary LCW System – Key Concern Points – F37 Pump Room

- No direct access to LCW pump room from power supply room
- LCW cooling provided to power supply room
- PLC/Rittal cabinets enclosures located in pump room and power supply room
- LCW provides cooling to Absorber RAW skid heat exchanger



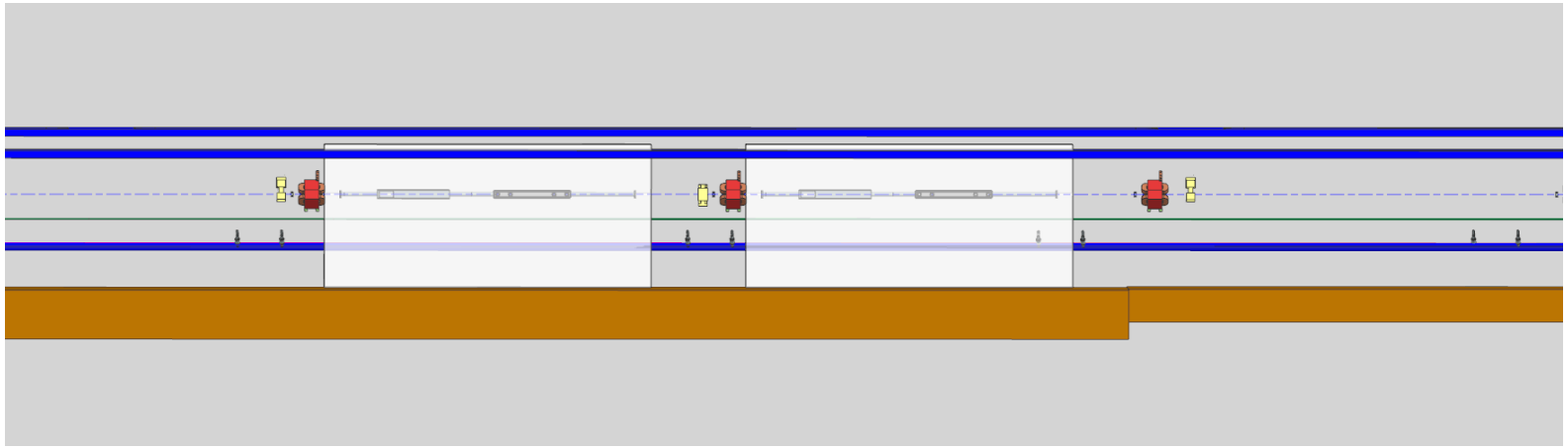
F37 Service Building showing power supply room adjacent to LCW pump room



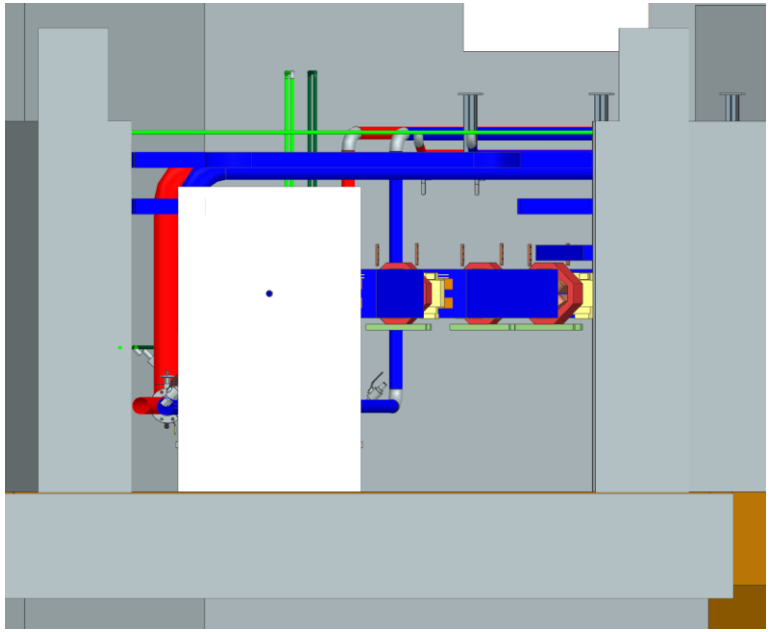
LCW Pump Room in F37 Service Building

PIP-II Primary LCW System – Routing around collimator

- LCW piping positioned low along the wall for equipment clearance
- Valve taps at collimator locations abandoned/replaced with strategic ALARA locations
- “Goldilocks” valve manifold arrangement at strategic locations



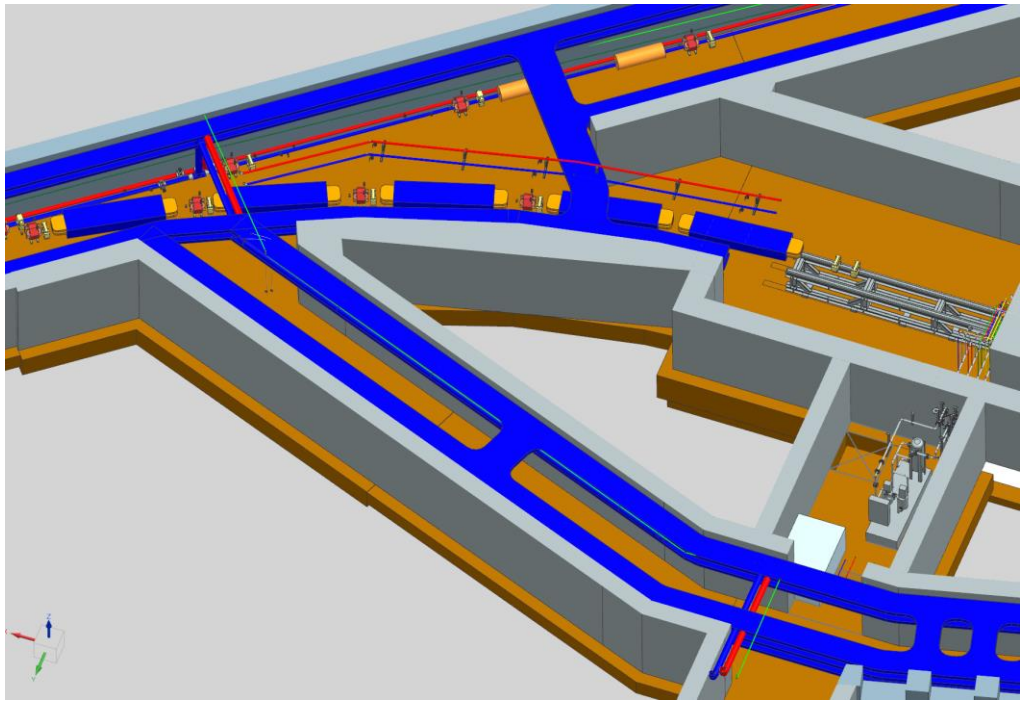
BTL elevation view at Collimator footprint showing LCW valve taps at each warm magnet

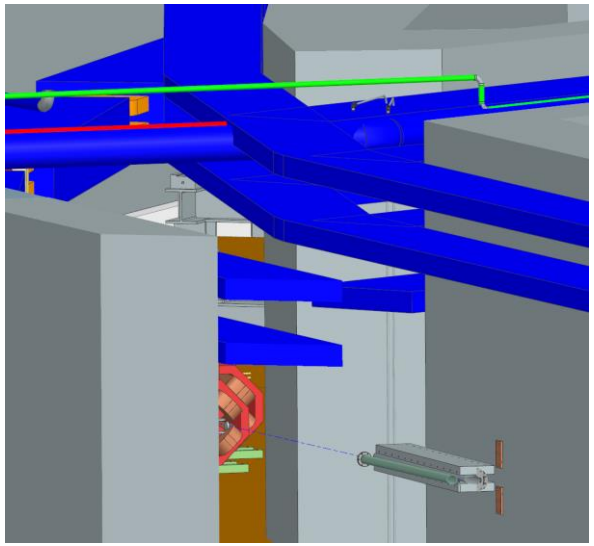


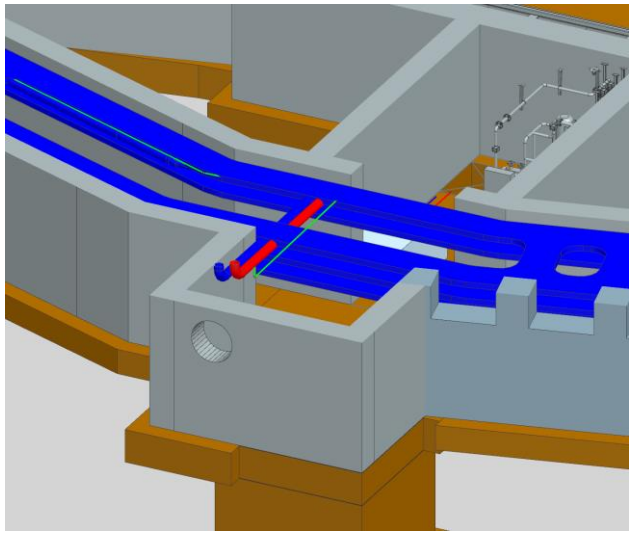
BTL cross-section view at Collimator

PIP-II Primary LCW System – BTL/F37 Labyrinth Intersection

- LCW piping positioned low along the wall for equipment clearance
- Interferences with cable tray at BTL/F37 Labyrinth cleared
- Separate “custom” LCW manifold created for Absorber beamline







Above - Helicopter view looking south
Upper Right – BTL/F37 Labyrinth intersection
Lower Right – F37 Labyrinth near Absorber RAW Room

Compressed Air - Technical Requirements/System Highlights

- PIP-II Building Infrastructure – Compressed Gas Systems TRS – TC# ED0012529
- Actuation of accelerator beam valves for vacuum system in BTL
- 2 - 200 HP Rotary screw air compressors in UPB
- Redundant operation Air compressor arrangement
- Redundant operation desiccant air dryers and particulate filters
- 1500 Gallon reservoir tank
- Water/oil separator
- Electric operated automatic condensate drains

Requirement #	PARAMETER DESCRIPTION	VALUE
T- ED0012529-A002	Design Pressure	150 psig
T- ED0012529-A003	Discharge Pressure	100 psig
T- ED0012529-A004	Total Discharge Flow	1060 SCFM
T- ED0012529-A005	Dewpoint	-40ºC/F
T- ED0012529-A006	Particulate Filtration	0.1 micron with .01 ppmw oil allowance

Compressed Air – Flow Summary Sheet

Component	Quantity	Unit Consumption	Total Consumption
	[#]	[SCFM]	[SCFM]
RFQ Couplers	4	4	16
HWR Couplers	8	1.67	13.4
SSR1 Couplers	16	3.5	56
SSR2 Couplers	35	6.17	216
LB650 Couplers	36	6.17	222.1
HB650 Couplers	36	7.03	253.2
Cryomodule JT Control Valves	25	0.141	3.5
Cryomodule CD Control Valves	25	0.066	1.7
Beam and Vacuum Valves	All	0**	0**
CDS			
Tunnel Control Valves	All	-	28.3
Distribution Box Control Valves	All	-	1.4
Cryoplant			
Coldbox Control Valves	All	-	64.9
Warm Compressor System Control Valves	All	-	14.8
Warm Header Control Valves	2	0.2	0.4
Cryoplant ORS and GMP Control Valves	All	-	11.8
Recovery Compressor Control Valves	All	-	0.2
Liquid Helium Dewar Control Valve	1	0.1	0.1
		Total =	**903.8**

Compressed Air – Key Concern Points

- Routing follows LCW piping
- Usage in BTL footprint only
- No taps to Absorber RAW room or F37 pump room
- Valve taps located at beam valve locations (locations need confirmation)
- Addition miscellaneous valve taps currently not planned (confirmation needed)

Utility Nitrogen – Technical Requirements/System Highlights

- PIP-II Building Infrastructure – Compressed Gas Systems TRS – TC# ED0012529
- Source is boiloff from Nitrogen Dewar located near Cryo Plant Building
- Routing follows LCW piping in BTL
- Usage in Absorber RAW room and F37 pump room only

Requirement #	PARAMETER DESCRIPTION	VALUE
T- ED0012529-A008	Design Pressure	150 PSIG
T- ED0012529-A009	Discharge Pressure	100 PSIG
T- ED0012529-A010	Total Discharge Flow	35.5 SCFM

Technical Requirements

System	Frequency	Pressure	Flow Rate	
		[PSIG]	[-]	[G/S]
LCW – oxygen removal	Continuous	50	10 cfm	5.43
LCW – vessel blanket flow	Continuous	50	2 cfh	0.02
Clean nitrogen for portable cleanroom and vacuum use	Infrequent	100	2000 cf/day (10 cfm instantaneous)	0.75
Cryoplant purifier charcoal bed regeneration	Infrequent	50		10**
			Total =	**16.2**

Process Flow Summary

Utility Nitrogen – Key Concern Points

- No usage in the BTL
- No taps along entire BTL length, Welded stainless steel tubing only
- ODH conducted by CDS to insure ODH 0 conditions

Absorber RAW – Technical Requirements/System Highlights

- Radioactive Water (RAW) system
- Cools the Beam Absorber located in the Beam Transfer Line (BTL)
- Normal Fluid Service
- Nitrogen gas used as tank blanket and to purge Hydrogen gas from system
- Magnetically driven circulating pump, no leaky seals
- Containment basin located under RAW skid, sized to contain entire RAW system volume

Requirement #	PARAMETER DESCRIPTION	VALUE
T- ED0015435-A049	Design Pressure	150 PSIG
T- ED0015435-A050	Discharge Pressure	100 PSIG
T- ED0015435-A051	Suction Pressure	15 PSIG
T- ED0015435-A052	Supply Temperature	100ºF +/- 1ºF
T- ED0015435-A053	Delta T (ΔT)	8.5ºF
T- ED0015435-A054	Total Heat Load @ΔT 23.5° F	25 kW
T- ED0015435-A055	Nominal Flow Required	20 GPM
T- ED0015435-A057	Side Stream Particulate Filtration	5 micron
T- ED0015435-A057	Resistivity	Not a requirement for PCW

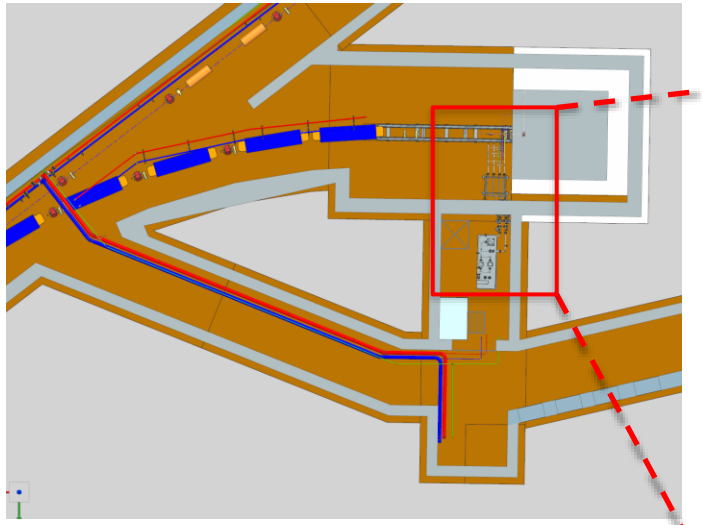
Technical Requirements

Component	Quantity	Unit Consumption	Total Consumption
	[#]	[GPM]	[GPM]
Absorber	1	20	20
		Total =	**20**

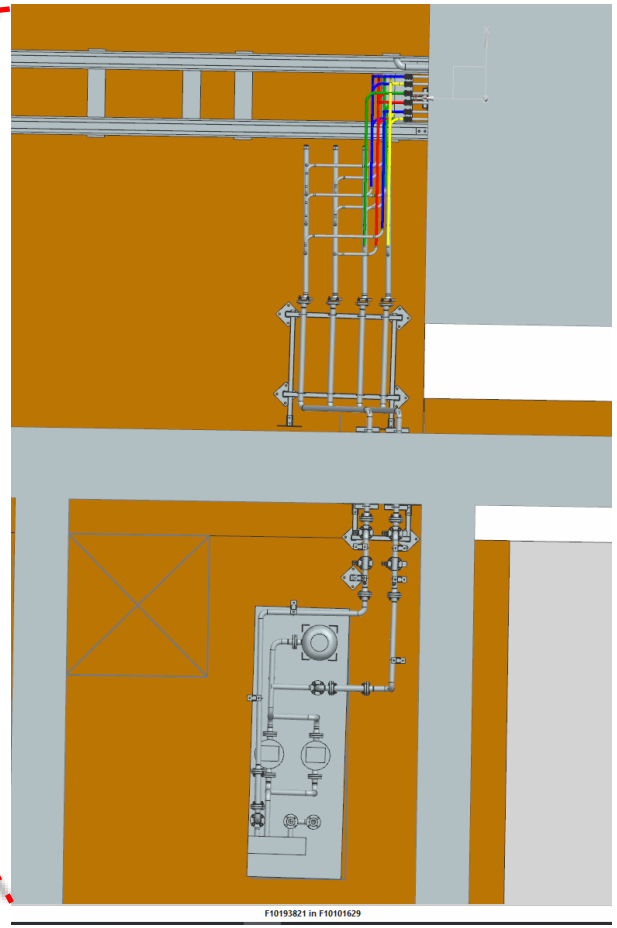
Process Flow Summary

Absorber RAW – Key Concern Points

- Interface between the Absorber and Absorber RAW piping
- Absorber RAW Room Furniture arrangement, includes
  - Floor space for Absorber Air Cooling Skid
  - Wall space for power/controls boxes
- Nitrogen gas supplied from Utility Nitrogen gas line piping installation from BTL
- Ventilation for RAW Room
- Design is complete
- Installation not under BldgI scope



Plan view showing the BTL intersection with the F37 labyrinth and the Absorber beamline footprint



Plan view close up showing the Absorber RAW skid interface with the Absorber RAW piping configuration

BldgI Electrical- Scope

- Design electrical, cable tray and grounding system
  - Installation performed by CF or BTLI
- Relay Racks

BldgI Electrical- Requirements/Drivers

- RDS used for all requirements

	Auto-filled cells	Start Here ↓												Auto-fill
Identifier	WBS Level 2	WBS ID	WBS Name	Space Designation Location	Sub-System	User Defined Sub-System	Component	Description	Quantity	ΔT (F)	Power Requirement	Volts	Amps	Volt-Amperes
DM-001	121.03	121.03.07	Controls	LG-BTL	Computers, Front End	Candidate for F37	Racks	Networking, permits etc.	3		120 V - 1 Phase - 2 Wire	120	10	1,200
DM-002	121.03	121.03.08	SS	LG-BTL	Interlocks	Candidate for F37	Racks	ESS interface	1		120 V - 1 Phase - 2 Wire	120	7	840
DM-003	121.03	121.3.06	Controls	BTL-F3 Building	PLC/LCW Controls	Candidate for F37	Racks, Rittal	Rittal half size cabinet (needs to remain at F3)	1					0
DM-004	121.03	121.03.06	Vacuum	BTL-F3 Building	Ion Pump PS System	Candidate for F37	Racks	Bulk, Ion pump PS, gauge interface, network switch	2		208 V - 3 Phase - 3 Wire	208	16	5,764
DM-005	121.03	121.03.09	Instrumentation	LG-BTL	BPM		Racks		3		120 V - 1 Phase - 2 Wire	120	16	1,920
DM-006	121.03	121.03.09	Instrumentation	BTL-F3 Building	BPM	Candidate for F37	Racks		1		120 V - 1 Phase - 2 Wire	120	16	1,920
DM-008	121.03	121.03.05	Magnets	BTL-F3 Building	Fast Dipole Switch	Candidate for F37	Racks	Pulse Magnet Power Supply	1		480 V - 3 Phase - 3 Wire	480	16	13,302
DM-009	121.03	121.03.05	Magnets	LG-BTL	Fast Dipole Switch	Candidate for F37	Cables	Power Supply	8					0
DM-010	121.03	121.03.05	Magnets	LG-BTL	Fast Dipole Switch	Candidate for F37	Magnets	Power Supply	1					0
DM-011	121.03	121.03.05	Magnets	BTL-F3 Building	Magnets, Dipole		Power Supplies	TeV PS	1		480 V - 3 Phase - 3 Wire	480	125	103,923
DN-012	121.03	121.03.07	Controls	LG-SSR1	Motor Controllers		Racks		1		120 V - 1 Phase - 2 Wire	120	10	1,200
DM-013	121.03	121.03.05	Magnets	BTL-Beamline Tunnel	Magnets, Dipole		Cables	Dipole cables	134					0
DM-014	121.03	121.03.05	Magnets	BTL-Beamline Tunnel	Magnets, Dipole		Cables	Specialty magnet cables	18					0
DM-015	121.03	121.03.05	Magnets	BTL-F3 Building	Magnets, Regular Quadrupole	Candidate for F37	Racks	Quadrupole Power Supplies	3		480Y/277 V - 3 Phase - 4 Wire	480	70	58,197

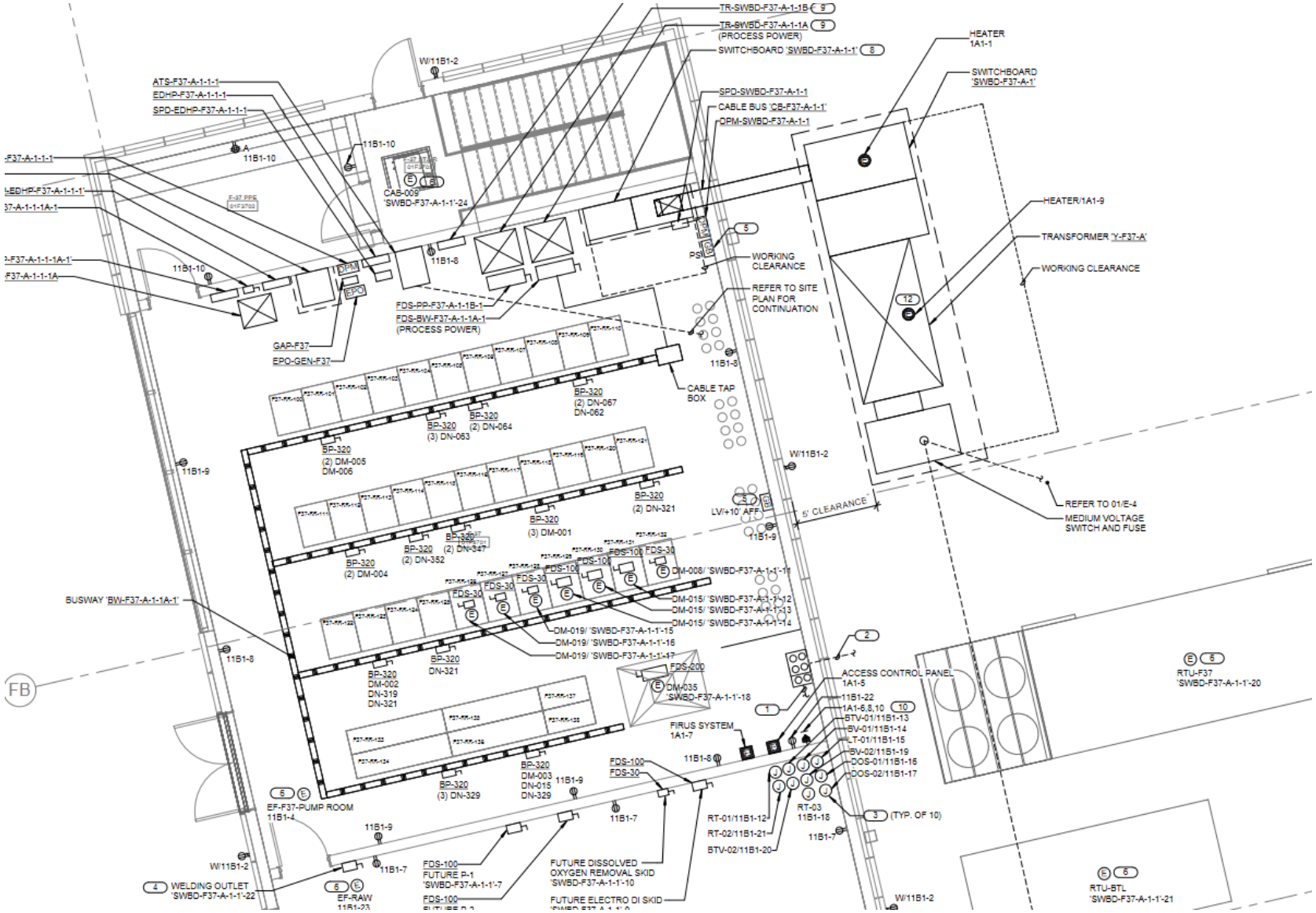
Equipment Location

- Rack equipment will be located as close as reasonably possible to tunnel loads
  - If equipment is located near the start of BTL, the gallery will be used for rack space
- Instrumentation is given priority due to strict requirements
  - Systems that have strict maximum length requirements should make their needs known as soon as possible
- F37 service building, penetrations, and cable tray are maxed out currently
  - RDS shows what equipment is located at F37, please review this information and make BldgI personnel aware if any issues exist

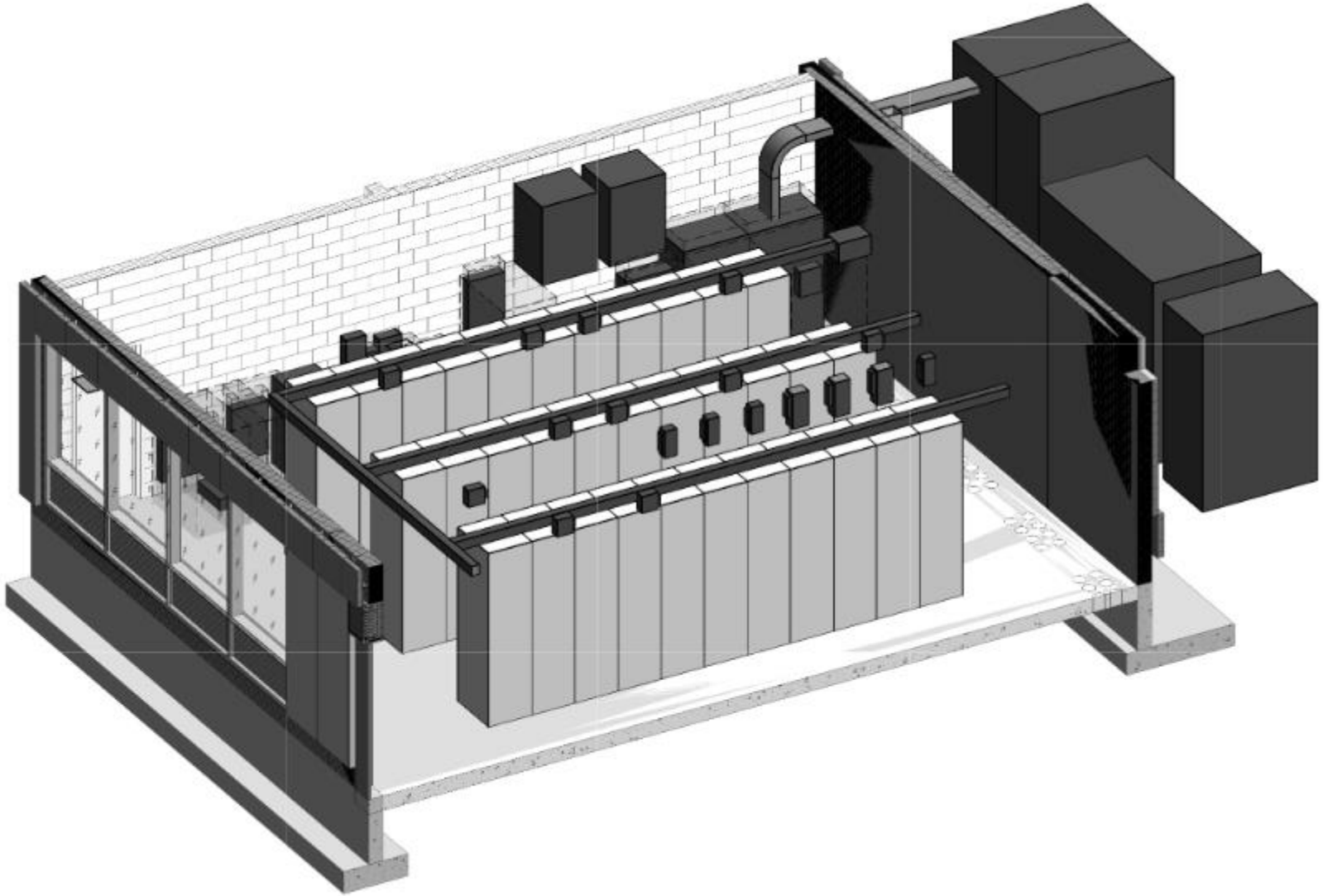
Electrical Systems

- Electrical design based on LINAC gallery
  - Busway used extensively
  - PDUs integrated in racks
  - Plug and Cord design where feasible
- Utility outlets provided throughout the tunnel
  - Every 50ft. at a minimum
    - Includes 4x 120V receptacles
    - Includes 1x 208Y receptacle
  - 480V welding outlet every 100 ft.
    - Can be used for temporary distribution at the 208Y/120V level using distribution carts

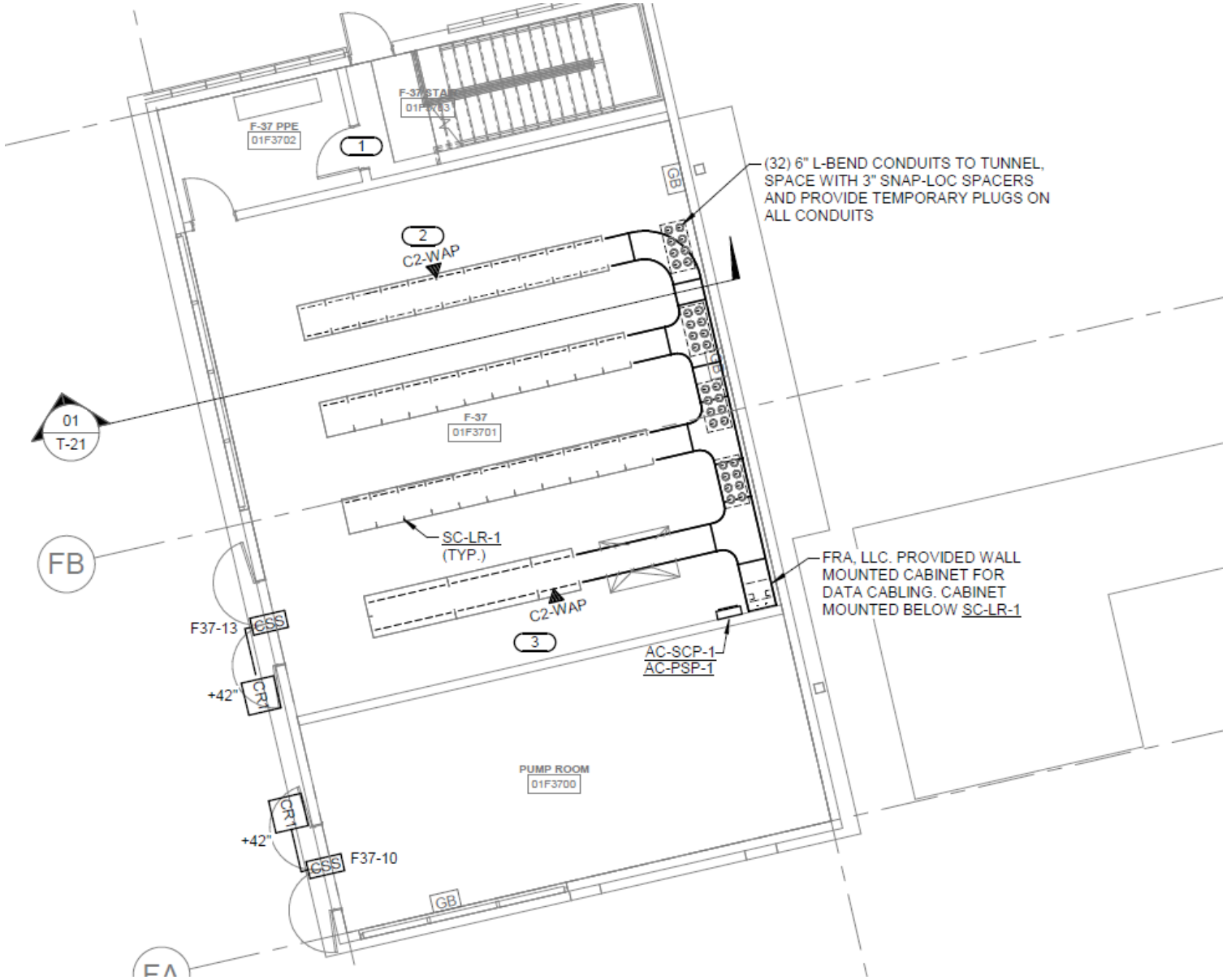
F37


TR-SWBD-F37-A-1-1B
TR-SWBD-F37-A-1-1A
(PROCESS POWER)
SWITCHBOARD 'SWBD-F37-A-1-1'
HEATER 1A1-1
SWITCHBOARD 'SWBD-F37-A-1'
SPD-SWBD-F37-A-1-1
CABLE BUS 'CB-F37-A-1-1'
OPM-SWBD-F37-A-1-1
ATS-F37-A-1-1-1
EDHP-F37-A-1-1-1
SPD-EDHP-F37-A-1-1-1
W/11B1-2
11B1-10
CAB-009 'SWBD-F37-A-1-1'-24
11B1-6
HEATER/1A1-9
TRANSFORMER 'Y-F37-A'
WORKING CLEARANCE
REFER TO SITE PLAN FOR CONTINUATION
FDS-PP-F37-A-1-1B-1
FDS-BW-F37-A-1-1A-1
(PROCESS POWER)
GAP-F37
EPO-GEN-F37
11B1-8
CABLE TAP BOX
BP-320 (2) DN-067 DN-062
BP-320 (2) DN-064
BP-320 (3) DN-063
BP-320 (2) DM-005 DM-006
11B1-9
BP-320 (2) DN-321
BP-320 (3) DM-001
BP-320 (2) DN-352
BP-320 (2) DM-004
LV/+10' AFF
5' CLEARANCE
REFER TO 01/E-4
MEDIUM VOLTAGE SWITCH AND FUSE
BUSWAY 'BW-F37-A-1-1A-1'
FDS-100
FDS-30
DM-008/ 'SWBD-F37-A-1-1'-11
DM-015/ 'SWBD-F37-A-1-1'-12
DM-015/ 'SWBD-F37-A-1-1'-13
DM-015/ 'SWBD-F37-A-1-1'-14
DM-019/ 'SWBD-F37-A-1-1'-15
DM-019/ 'SWBD-F37-A-1-1'-16
DM-019/ 'SWBD-F37-A-1-1'-17
FDS-200
DM-035 'SWBD-F37-A-1-1'-18
BP-320 DM-002 DN-319 DN-321
BP-320 DN-321
ACCESS CONTROL PANEL 1A1-5
11B1-22
1A1-6,8,10
BTV-01/11B1-13
SV-01/11B1-14
LT-01/11B1-15
SV-02/11B1-19
DOS-01/11B1-16
DOS-02/11B1-17
FIRUS SYSTEM 1A1-7
RTU-F37 'SWBD-F37-A-1-1'-20
FB
EF-F37-PUMP ROOM 11B1-4
BP-320 (3) DN-329
BP-320 DM-003 DN-015 DN-329
11B1-7
RT-01/11B1-12
RT-02/11B1-21
BTV-02/11B1-20
RT-03 11B1-18
(TYP. OF 10)
WELDING OUTLET 'SWBD-F37-A-1-1'-22
EF-RAW 11B1-23
FUTURE P-1 'SWBD-F37-A-1-1'-7
FUTURE DISSOLVED OXYGEN REMOVAL SKID 'SWBD-F37-A-1-1'-10
FUTURE ELECTRO DI SKID
RTU-BTL 'SWBD-F37-A-1-1'-21

F37

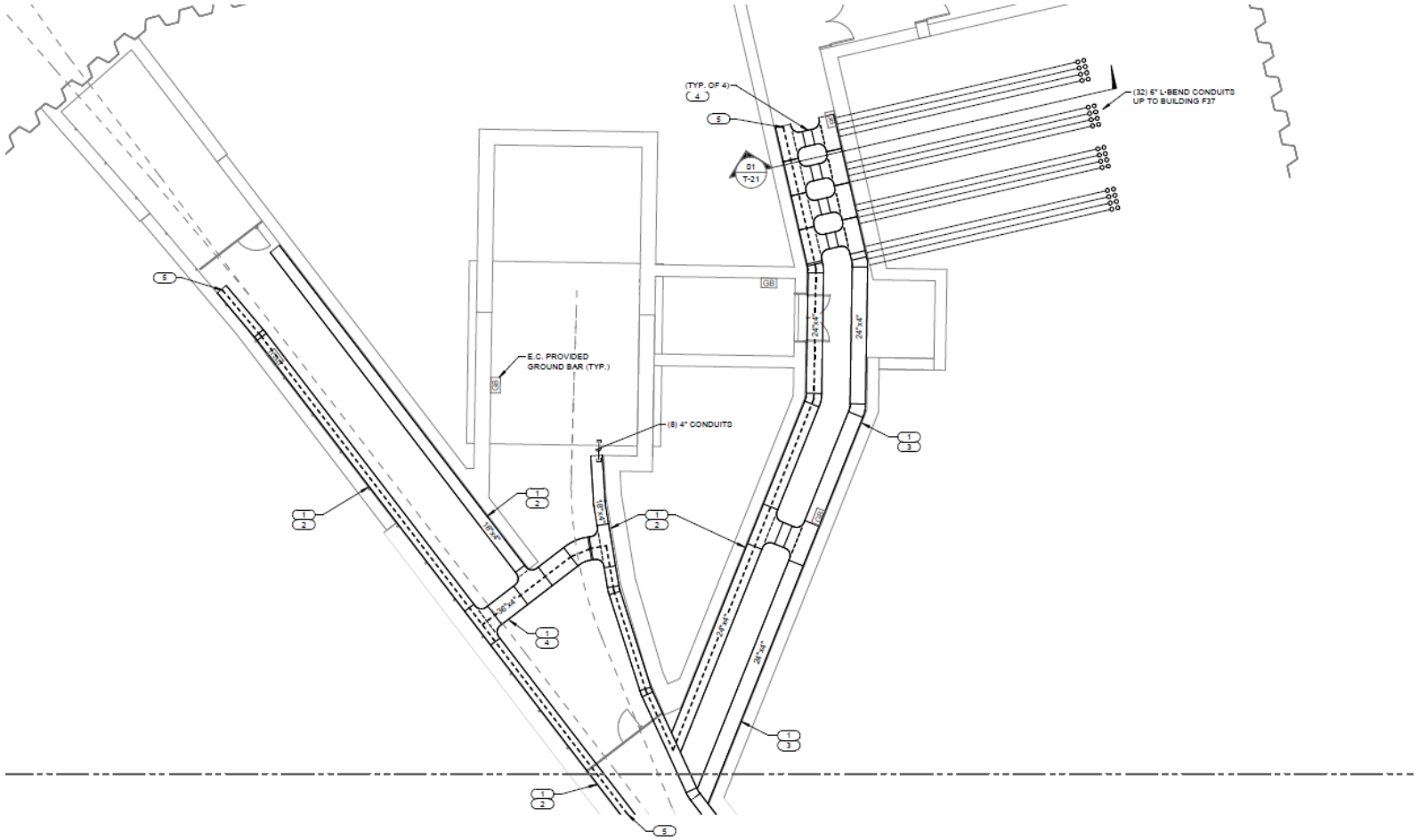


F37


F-37 PPE
01F3702
1
F-37 STA
01F3703
GB
(32) 6" L-BEND CONDUITS TO TUNNEL, SPACE WITH 3" SNAP-LOC SPACERS AND PROVIDE TEMPORARY PLUGS ON ALL CONDUITS
2
C2-WAP
01
T-21
F-37
01F3701
FB
SC-LR-1
(TYP.)
FRA, LLC. PROVIDED WALL MOUNTED CABINET FOR DATA CABLING. CABINET MOUNTED BELOW SC-LR-1
C2-WAP
3
AC-SCP-1
AC-PSP-1
F37-13
CSS
+42"
CRT
PUMP ROOM
01F3700
CRT
+42"
CSS
F37-10
GB
EA

Cable Trays

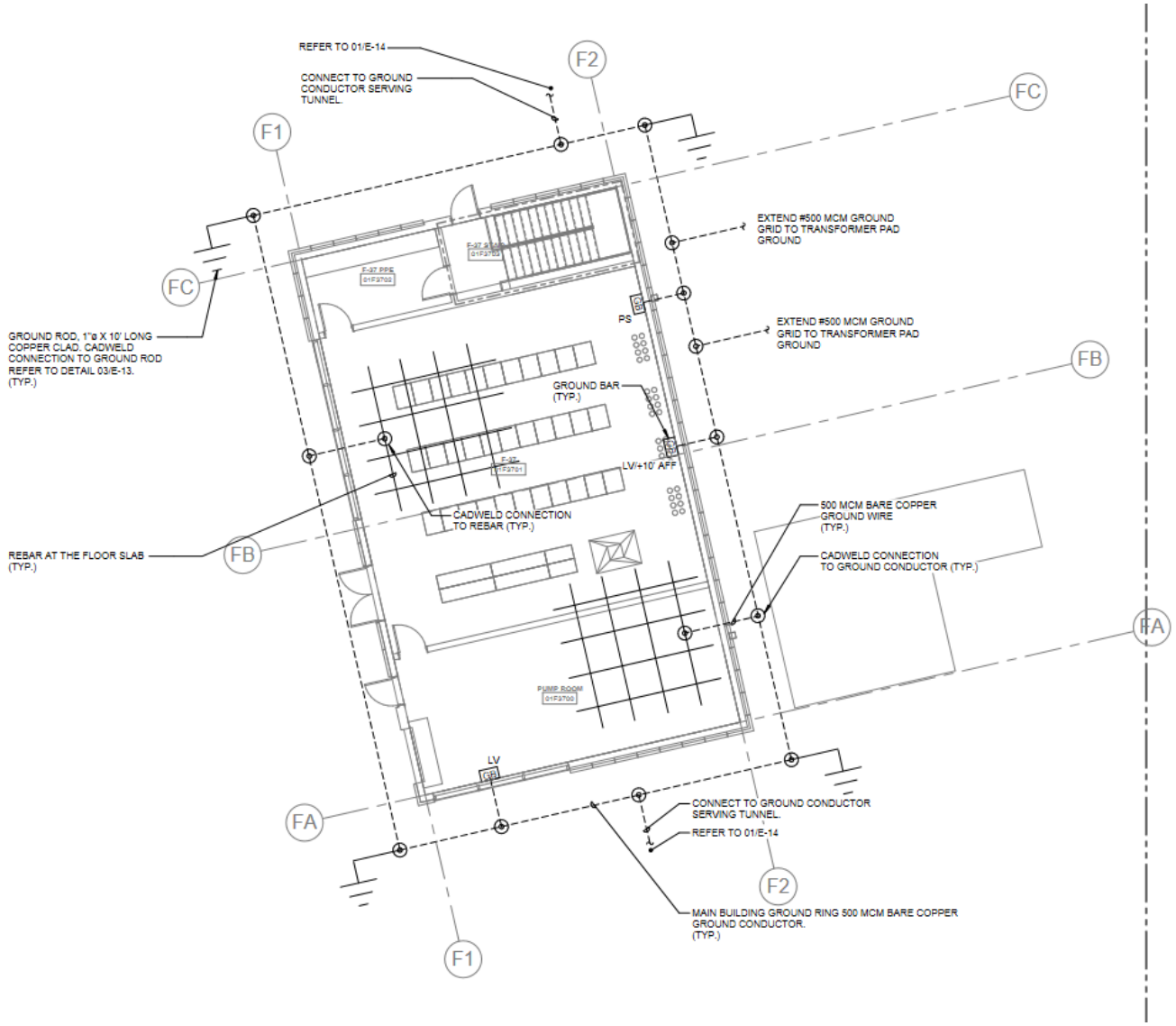
- Part of CF Scope
  - At AUP we are ready to pull cables
- 4 sets of 18” tray
  - 2 on each side of the wall with crossovers
  - Crossovers are 36” wide tray with dividers
  - Crossovers will have a gap, so cable can be installed easily
- F37 section as mentioned previously is “busy”



Grounding

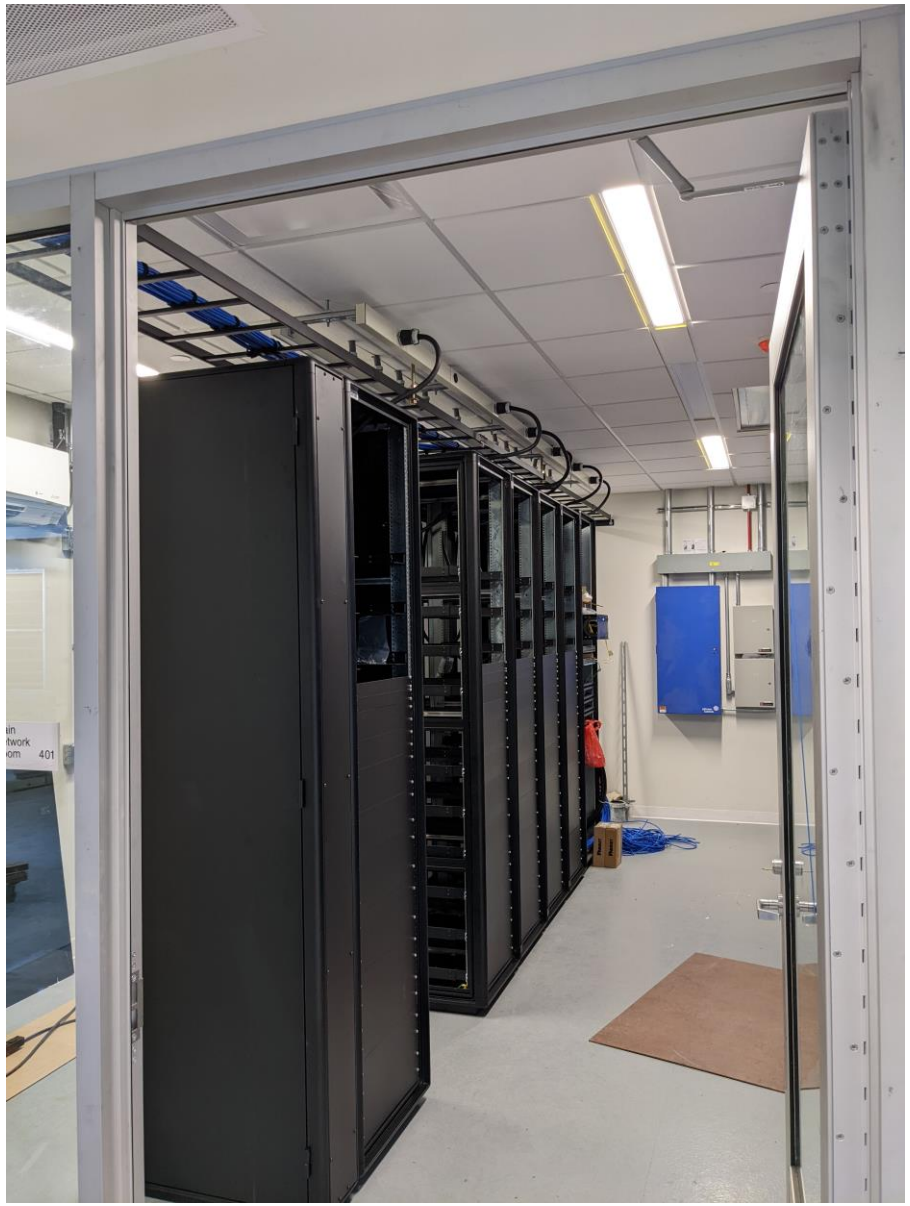
- Grounding design based on LINAC gallery
  - Ground bars located every 100 ft.
  - Each ground bar is tied directly to building ground
  - Ground trunk line runs with cable tray system
- Tie-ins to trunk lines will occur during installation

F37


REFER TO 01/E-14
CONNECT TO GROUND CONDUCTOR SERVING TUNNEL.
F2
FC
F1
EXTEND #500 MCM GROUND GRID TO TRANSFORMER PAD GROUND
F-37 PPE
01F3702
PS
EXTEND #500 MCM GROUND GRID TO TRANSFORMER PAD GROUND
GROUND ROD, 1"ø X 10' LONG COPPER CLAD. CADWELD CONNECTION TO GROUND ROD REFER TO DETAIL 03/E-13. (TYP.)
FB
GROUND BAR (TYP.)
F-02
01F3701
LV/+10' AFF
CADWELD CONNECTION TO REBAR (TYP.)
500 MCM BARE COPPER GROUND WIRE (TYP.)
REBAR AT THE FLOOR SLAB (TYP.)
CADWELD CONNECTION TO GROUND CONDUCTOR (TYP.)
FA
PUMP ROOM
01F3700
LV
CONNECT TO GROUND CONDUCTOR SERVING TUNNEL.
REFER TO 01/E-14
F2
MAIN BUILDING GROUND RING 500 MCM BARE COPPER GROUND CONDUCTOR. (TYP.)
F1

Relay Racks

- Relay racks will be built according to the same specifications used for the gallery
  - Based on system
  - If special needs exist, please make BldgI aware as soon as possible



Questions/Comments