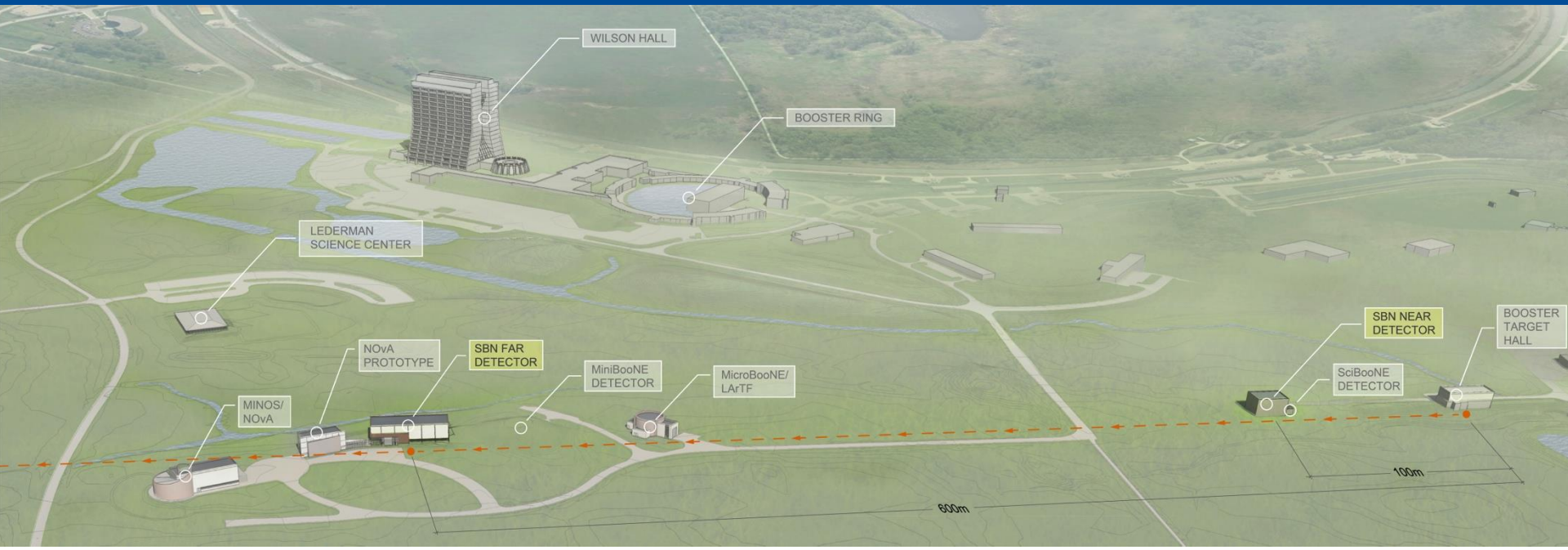


Interfaces and Proximity Cryogenics Integration of SBN

Barry Norris (for CERN-Fermilab Team)

CERN Progress Review of Neutrino SBN Program

14 April 2016

Outline

Intro

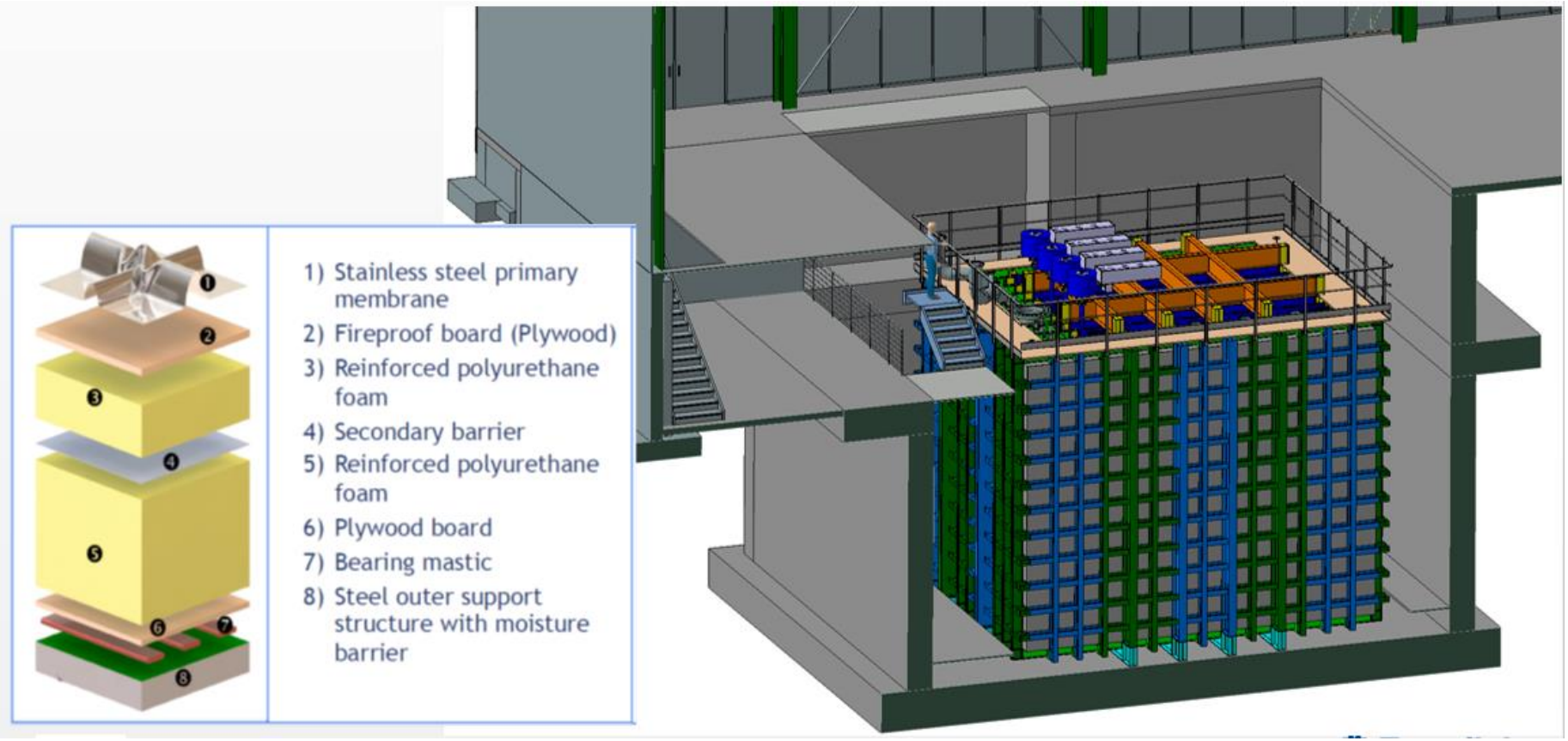
SBND

- Cryostat
- Process Flow Diagram (PFD)
- Process and Instrumentation Diagram (P&ID)
- Interface Documents (FNAL version)
- Piping Layout and 3D Models

SBN-FD

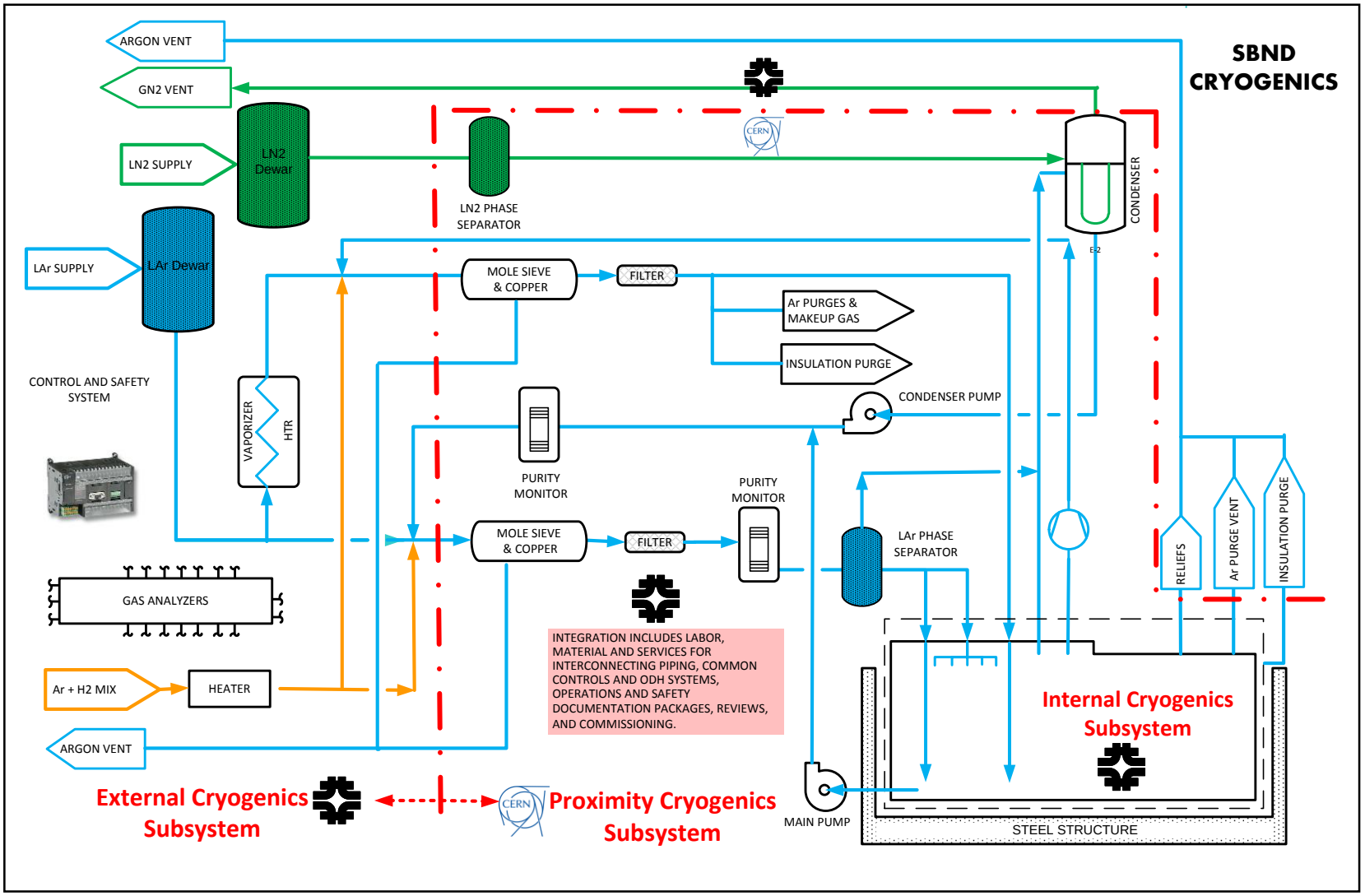
- Process and Instrumentation Diagram (P&ID)
- Interface Documents (FNAL Version)

CERN Model of SBND Cryostat Concept



In this detector the TPC hangs from a removable section of Top plate. All cryogenic connections are on fixed plate section and not required to be disconnected.

SBND Process Flow Diagram and Subsystem Definitions



CERN = Proximity Cryogenics + Cryostat

FNAL = External + Internal Cryogenics + Process Controls

From Process Flow Diagram to P&ID

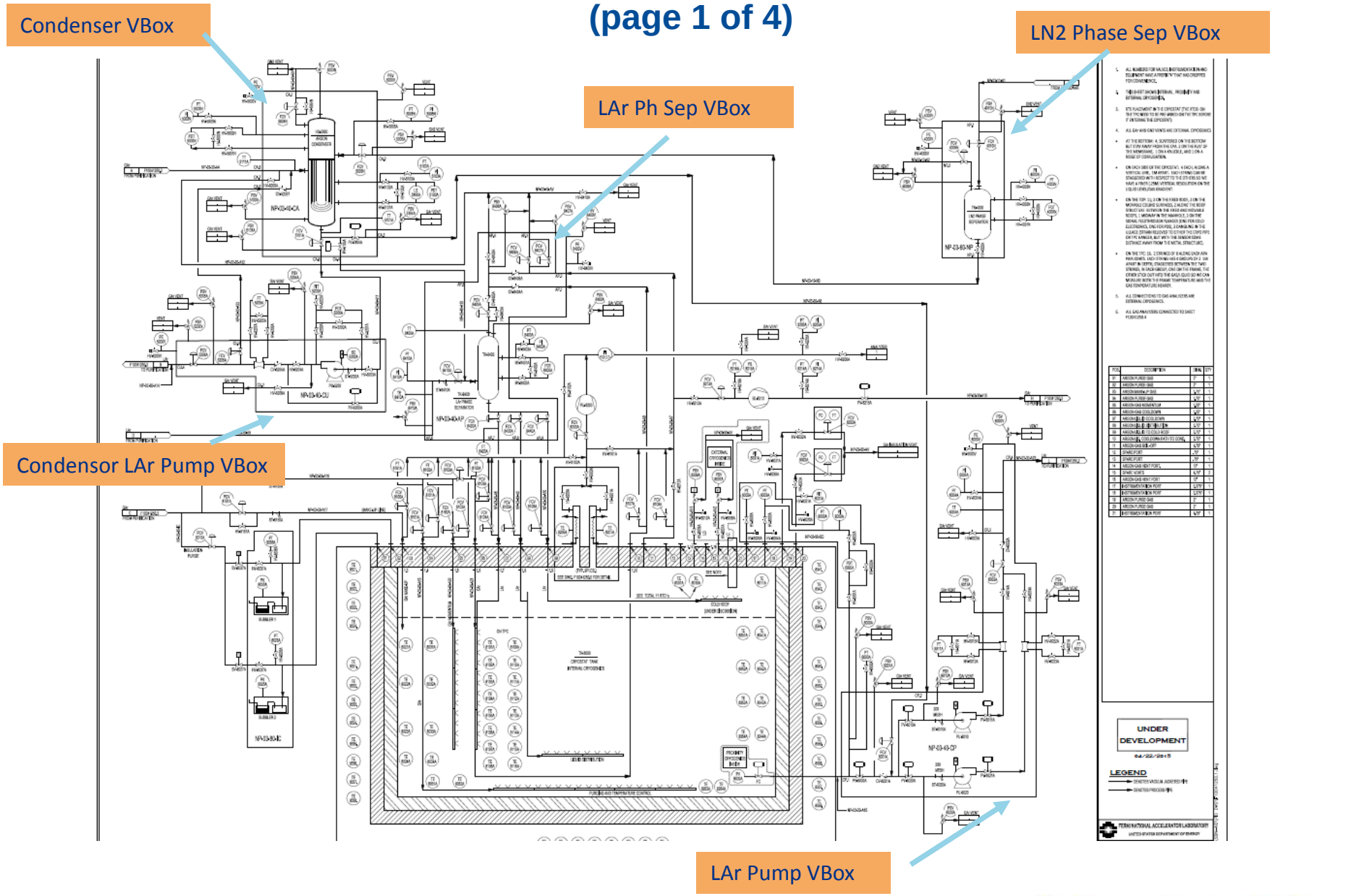
Over the past months, FNAL has used a dedicated drafter for the development of Process and Instrument Diagrams (P&ID) for both SBN detector systems.

This is an iterative and collaborative process between CERN, FNAL and INFN (in the case of the SBN-FD).

These documents are the basis for all discussions related to the modeling presented here, are integral to the interface documents, and identify the combinations of valve boxes, transfer lines and warm piping needed for the Proximity cryogenic deliverables. These P&ID documents have yet to be signed by all parties.

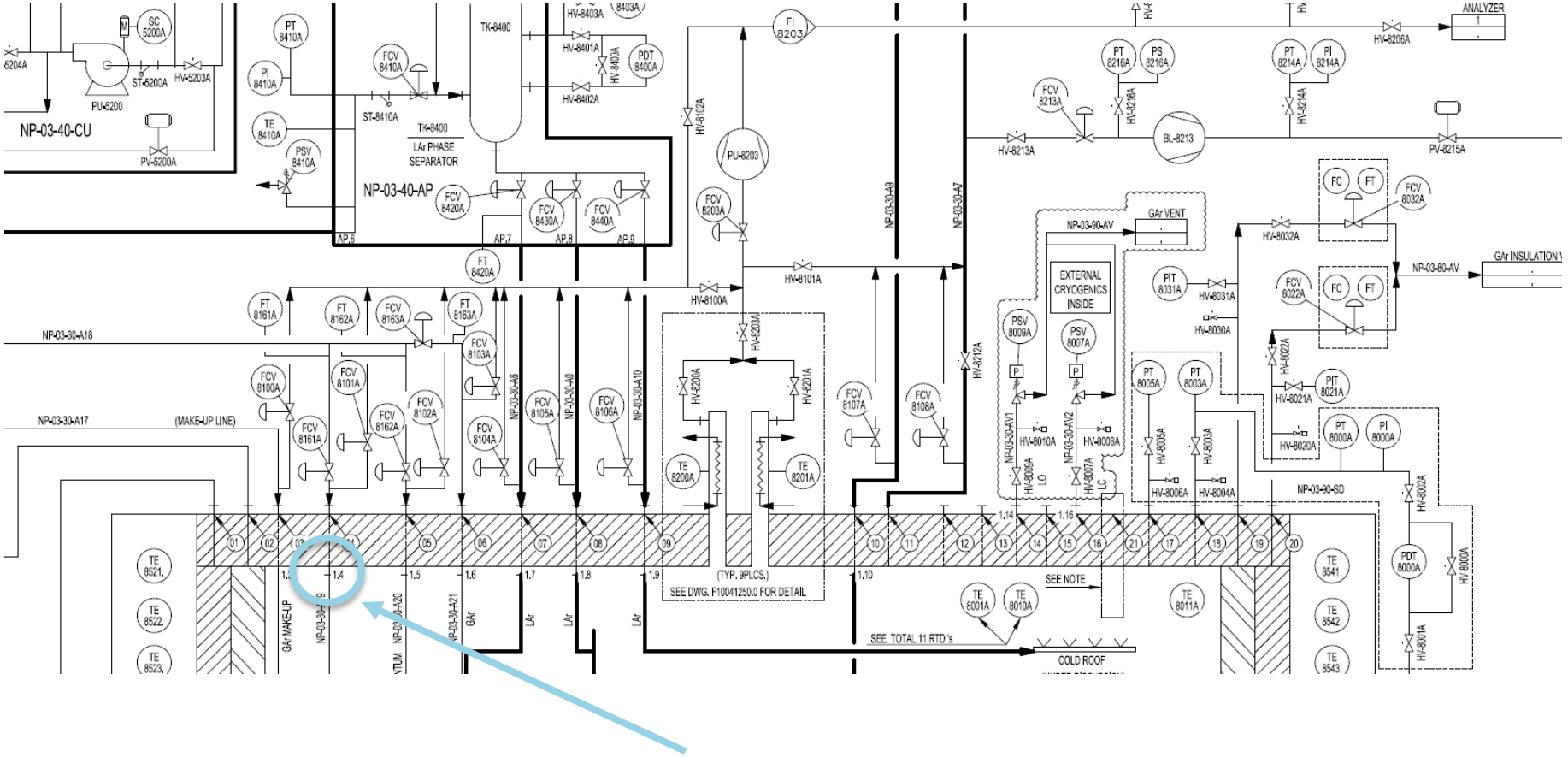
Instrumentation and controls has been preliminarily shown. CERN is to deliver Functional Specification for process controls to FNAL which will, in turn, deliver hardware and PLC software to interface to CERN equipment.

Example of SBND P&ID, Under FNAL Control with CERN Reviewing (page 1 of 4)



Fermilab Short Baseline Neutrino

Cryostat Top Plate and Proximity-Internal Interface



See Numerical identifier for each Proximity-Internal Interface

Fermilab Short Baseline Neutrino

SBND Interface Documents (FNAL Version)

SBND Interface Control Document

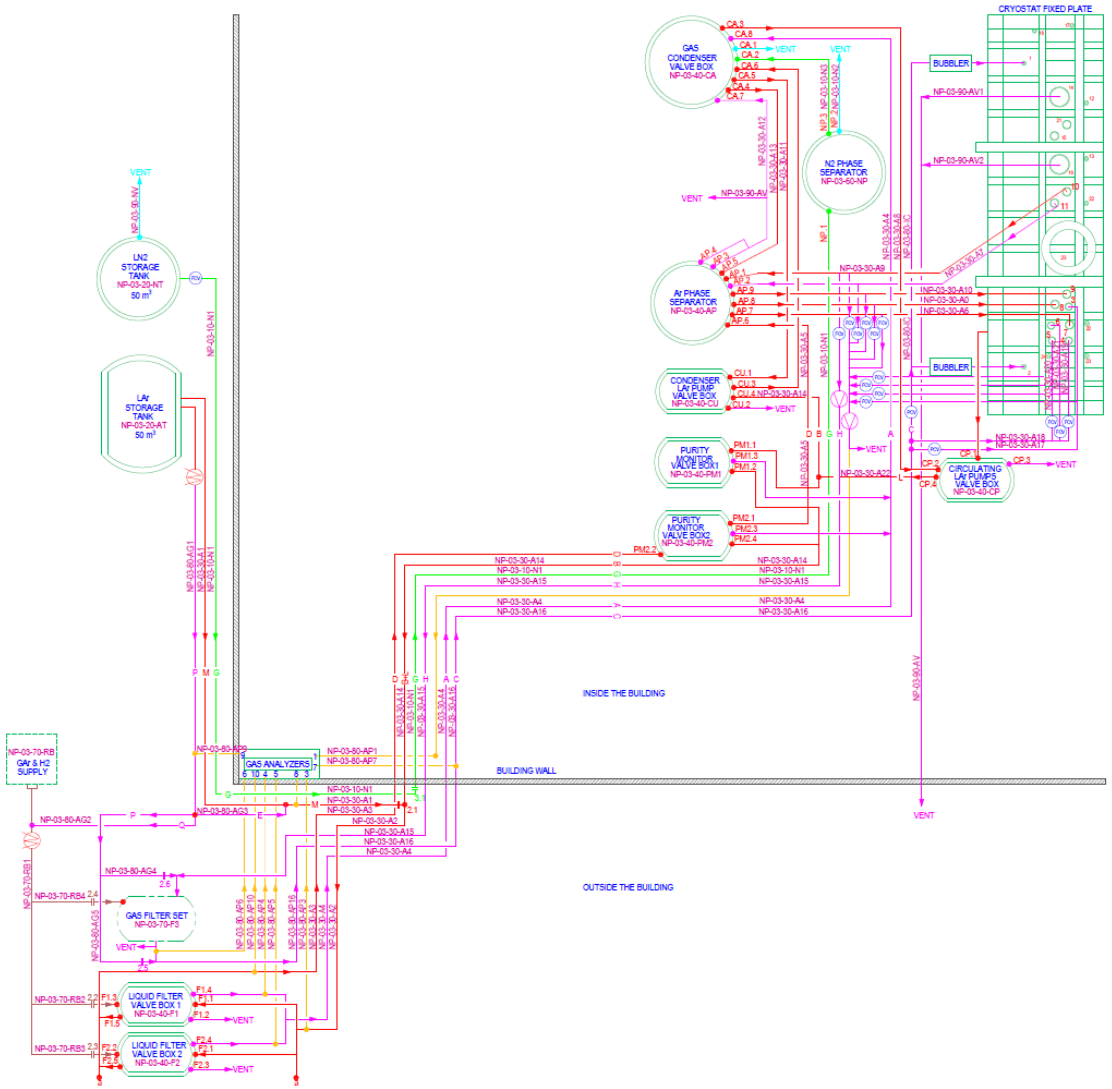
April 11, 2016

SBND INTERFACE POINTS ON P&ID DRAWINGS						Pressure Rating, Barg (psig)		Temperature Rating, K		Flow Rating, kg/s for liquid and m³/hr for gas		Connection	
#	DRAWING NUMBER	FLUID	DESCRIPTION	LOCATION	TYPE	Design	Maximum	Design	Range	Design	Maximum	(described as provided by CERN)	described as provided by Fermilab)
1.3	F10041250.1 Gas line	GAr	Proximity<->Internal: GAr make-up gas	In the cryostat	(Type 3) - Inner: 1.5" x 0.083" w/2.75" CF	0.35 (5.0)	9.0 (132.3)	87	85 – 311	>10 GAr	100 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF. Open to cryostat; no pressure test.
1.4	F10041250.1 Gas line	GAr	Proximity<->Internal: GAr purge gas	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	85 – 311	>40 GAr	100 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.5	F10041250.1 Gas line	GAr	Proximity<->Internal: GAr gas momentum	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	87 – 311	>10 GAr	100 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.6	F10041250.1 Gas line	GAr	Proximity<->Internal: GAr gas cooldown	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	87 – 311	>10 GAr	100 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.7	F10041250.1 NP-03-30-A6	LAr	Proximity<->Internal: NP-03-30-A6 LAr liquid cooldown	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>0.25 LAr	0.6 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.8	F10041250.1 NP-03-30-A0	LAr	Proximity<->Internal: NP-03-30-A0 LAr liquid distribution	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>1 LAr	3.5 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.9	F10041250.1 NP-03-30-A10	LAr	Proximity<->Internal: NP-03-30-A10 LAr liquid to cold roof	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>0.13 LAr	0.3 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.10	F10041250.1 NP-03-30-A9	LAr	Proximity<->Internal: NP-03-30-A9 LAr return to condenser	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>0.25 LAr	0.6 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket

This interface document was developed for FNAL internal use and feeds into CERN Interface Document

Fermilab Short Baseline Neutrino

Integration for SBND Cryogenics - Cryogenics

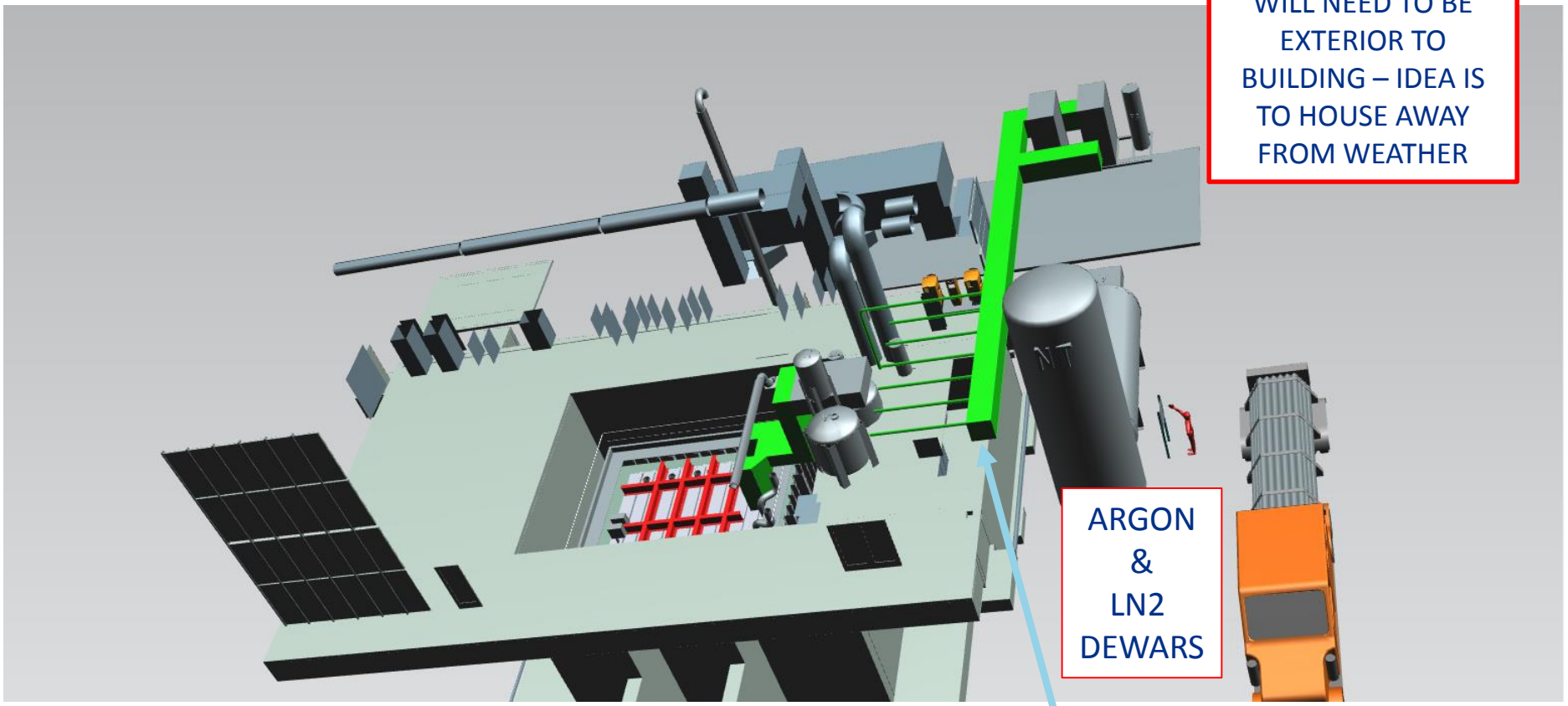


This is layout diagram showing all valve boxes locations and transfer lines connecting equipment.

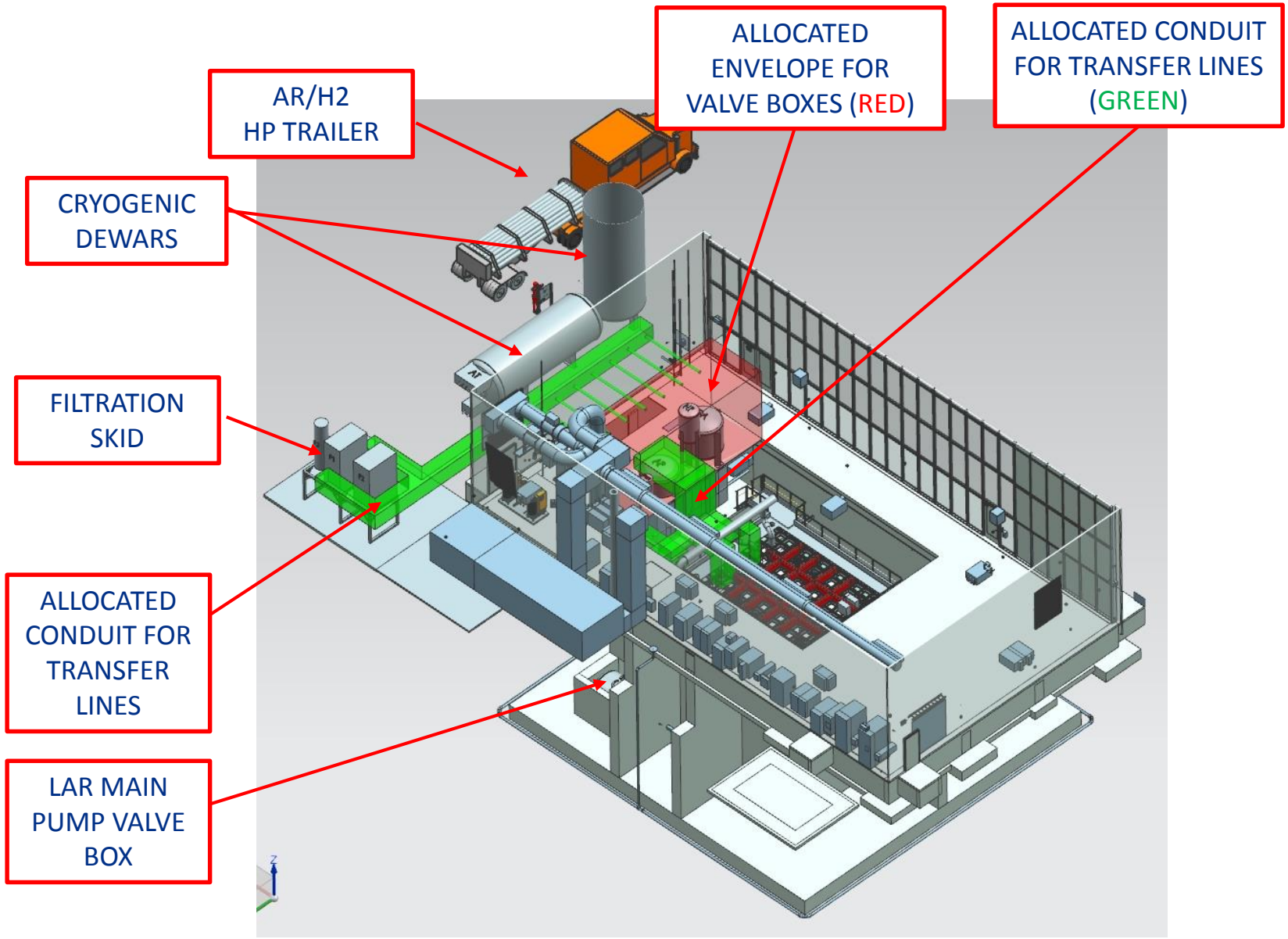
Routing of lines as shown here has been modified.

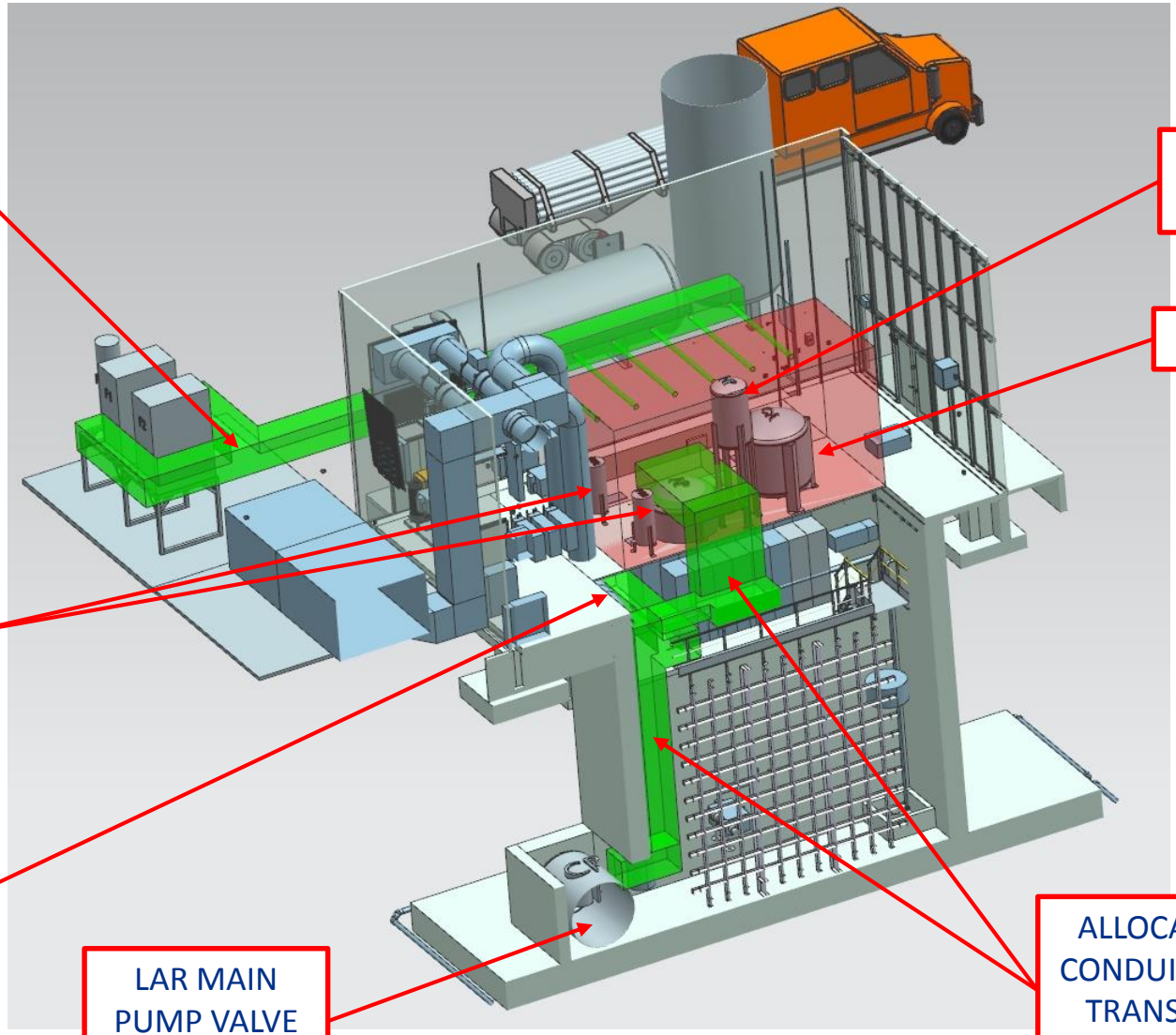
See 3D models to see the volumes of space which are identified for CERN equipment.

Helicopter View of Cryogenics of ND



Fermilab Short Baseline Neutrino


ALLOCATED ENVELOPE FOR VALVE BOXES (RED)
ALLOCATED CONDUIT FOR TRANSFER LINES (GREEN)
AR/H2 HP TRAILER
CRYOGENIC DEWARS
FILTRATION SKID
ALLOCATED CONDUIT FOR TRANSFER LINES
LAR MAIN PUMP VALVE BOX

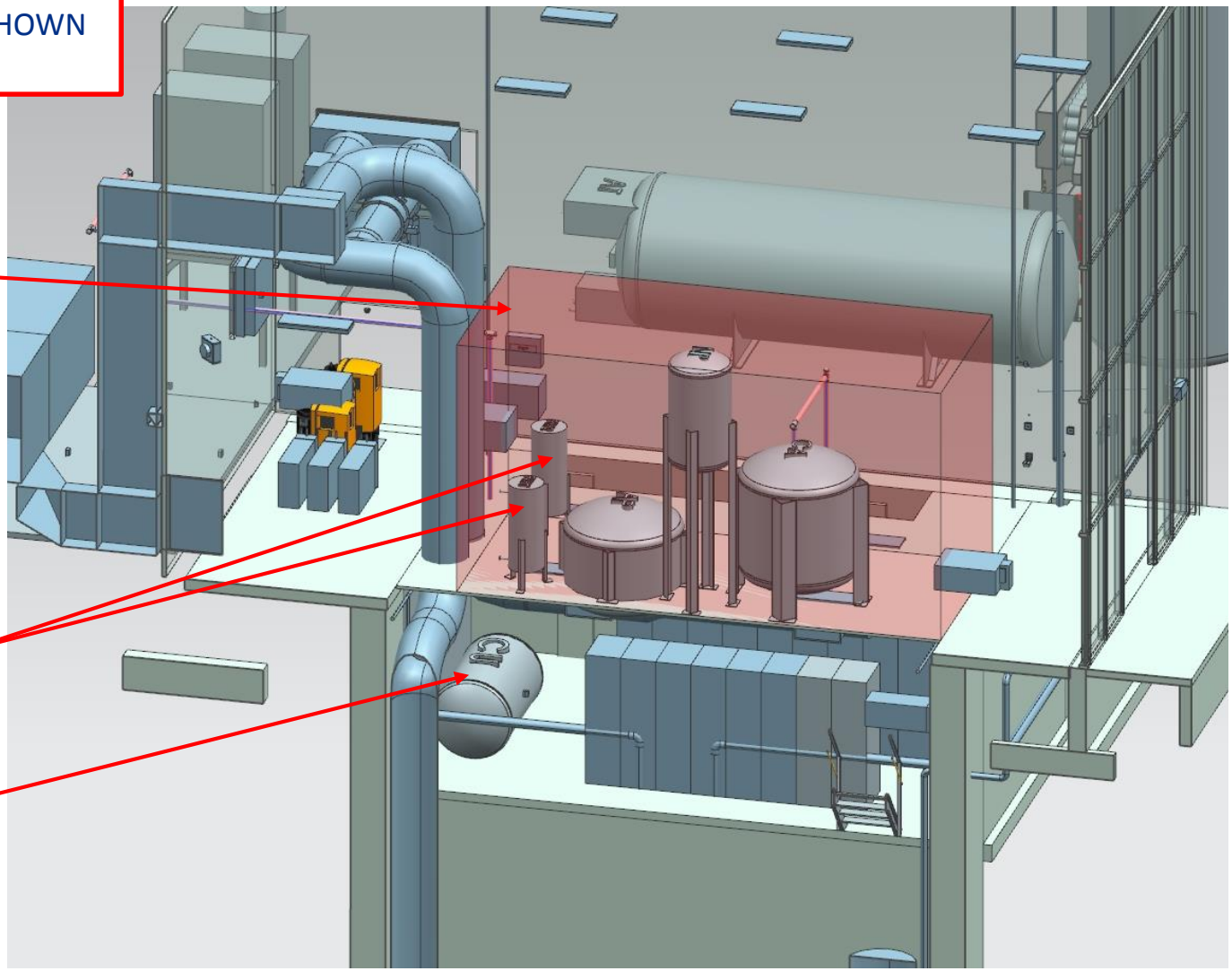

ALLOCATED CONDUIT FOR TRANSFER LINES
LN 2 PHASE SEPARATOR
CONDENSER
PURITY MONITORS
LAR CONDENSER PUMP
LAR MAIN PUMP VALVE BOX
ALLOCATED CONDUIT FOR TRANSFER LINES

ALLOCATED CONDUIT FOR TRANSFER LINES NOT SHOWN FOR CLARITY

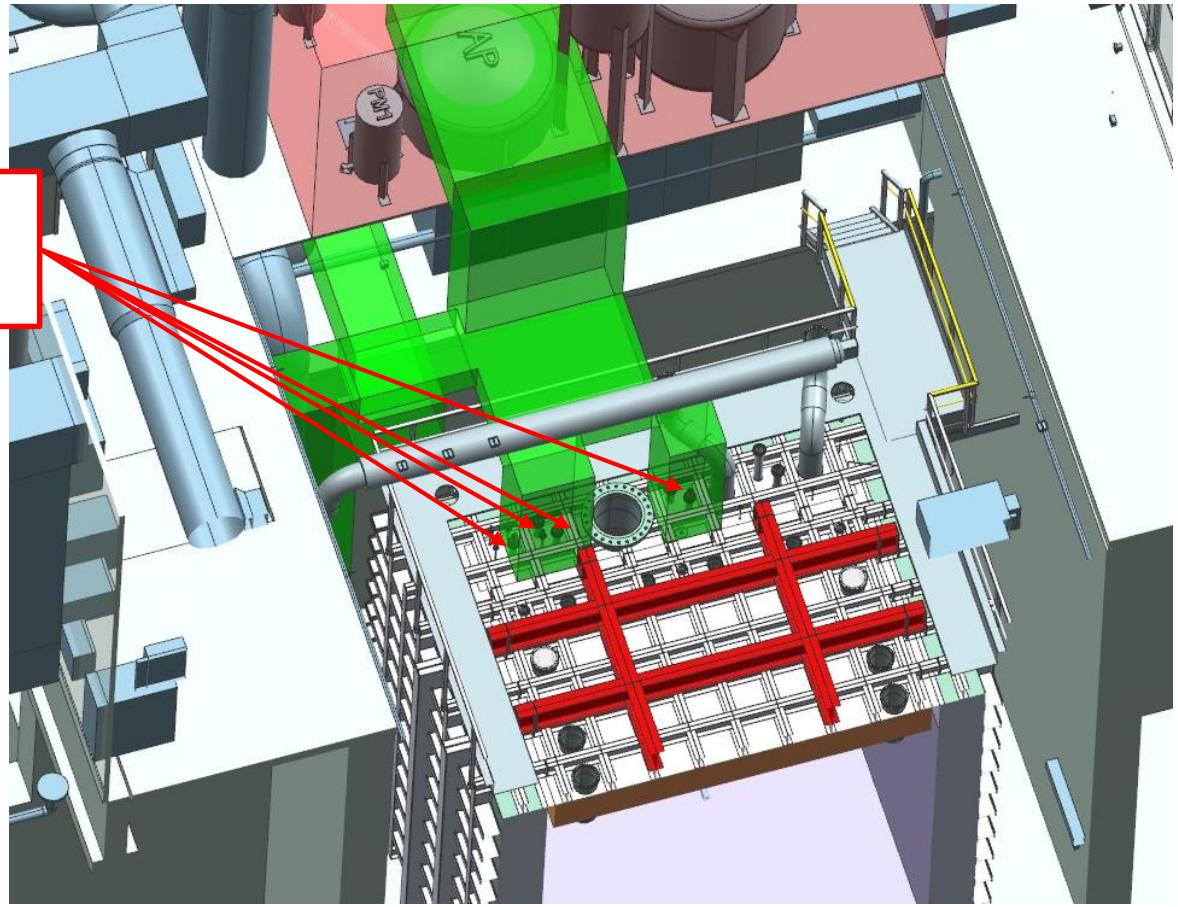
ALLOCATED ENVELOPE FOR VALVE BOXES (RED)

PURITY MONITORS

LAR CONDENSER PUMP

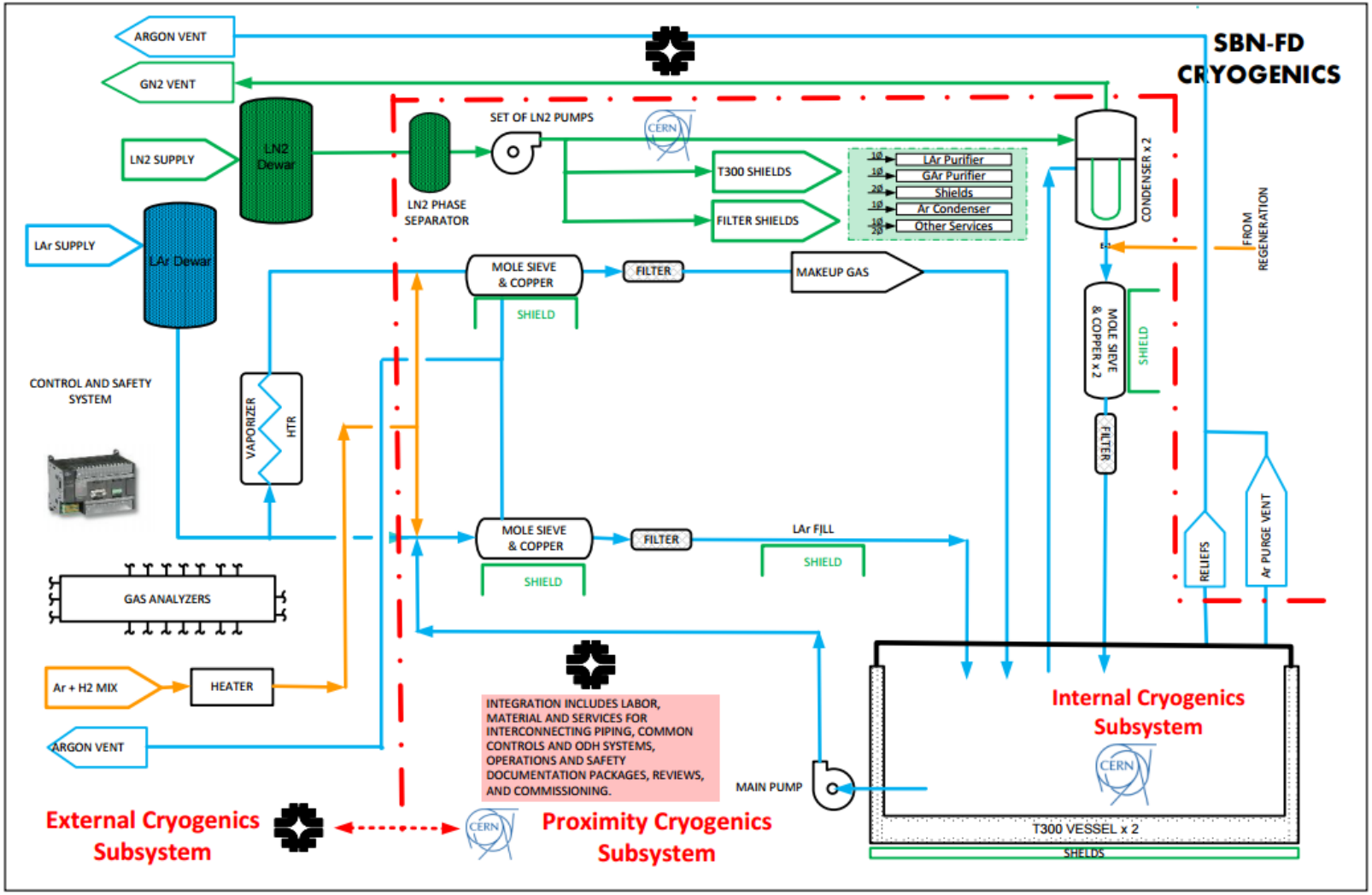


CRYOGENIC CONNECTIONS ON THE TOP PLATE



SBN - FD

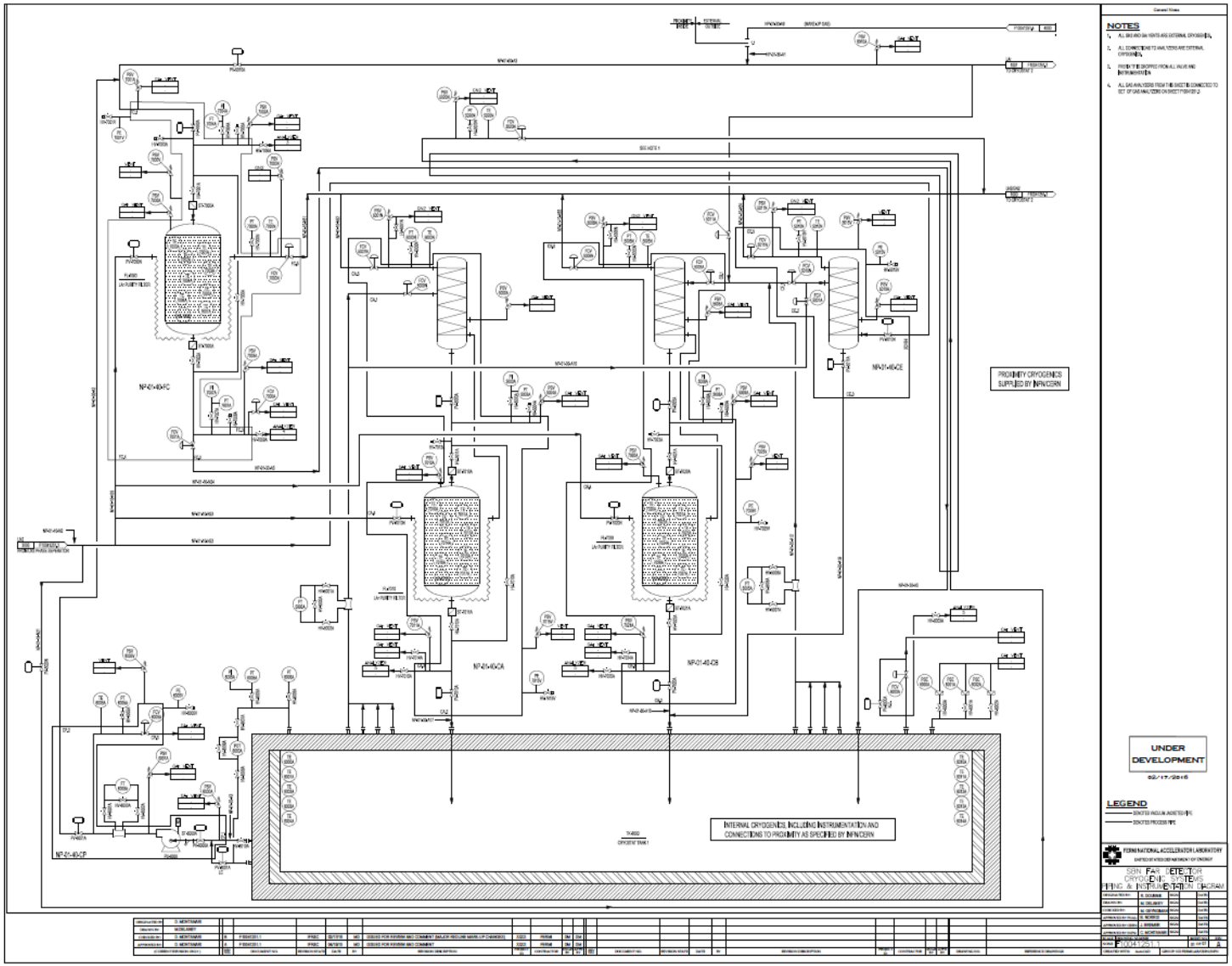
SBN – FD Process Flow Diagram (PFD)



CERN = Proximity Cryogenics + Internal Cryogenics + Cryostat FNAL = External Cryogenics + Process Controls

Fermilab Short Baseline Neutrino

SBN – FD Process and Instrument Diagram (P&ID)



FNAL has drawn SBN-FD P&ID on behalf of our Collaborators.

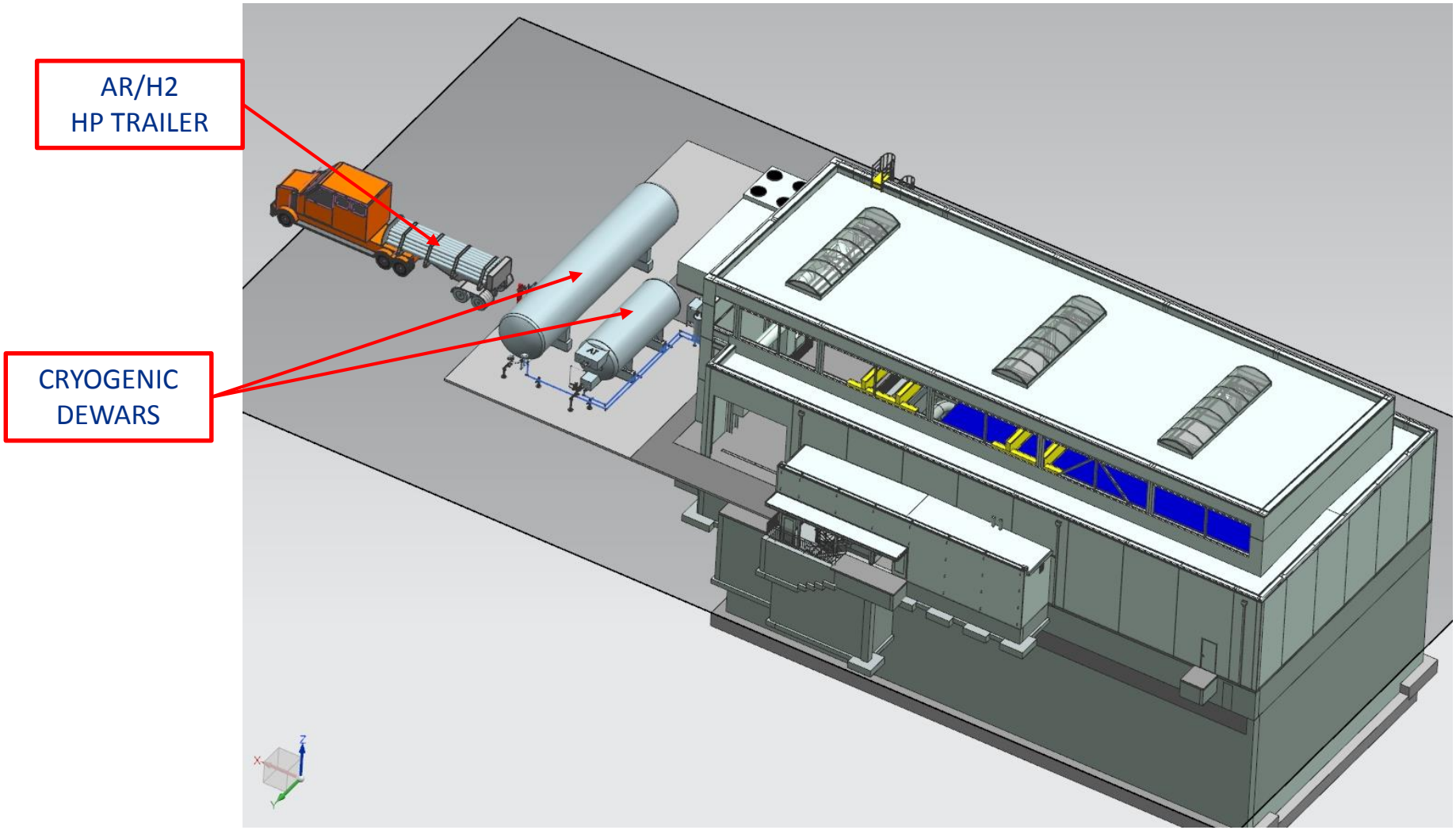
Mike Zuckerbrot of FNAL worked at CERN for six weeks assist with drawing details.

SBN – Interface Documents (FNAL)

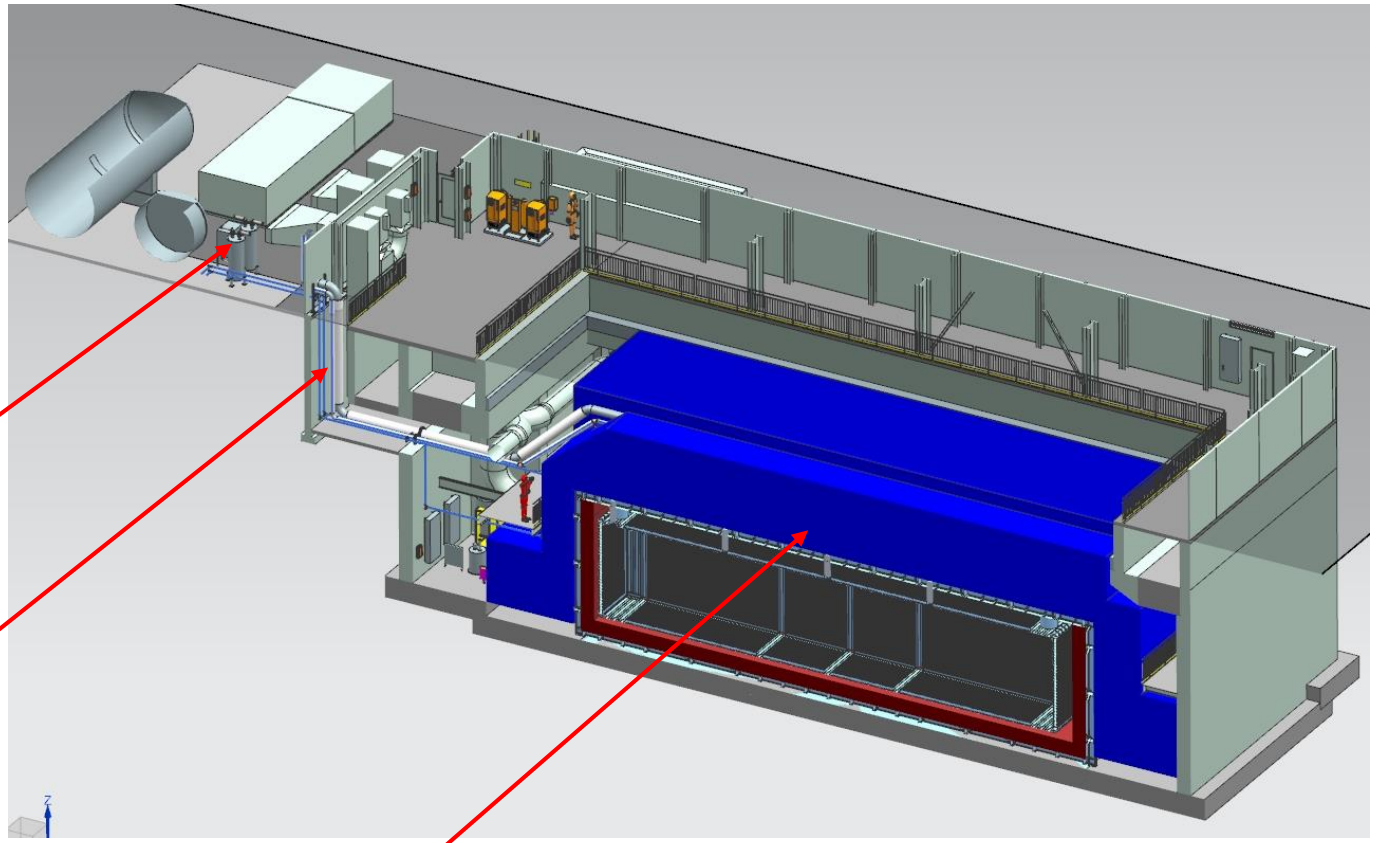
SBNFD INTERFACE POINTS ON P&ID DRAWINGS						Pressure Rating, Barg (psig)		Temperature Rating, K		Flow Rating, kg/s for liquid and m^3/hr for gas		Connection	
# per P&ID	DRAWING NUMBER	FLUID	DESCRIPTION	LOCATION	TYPE	Design	Maximum	Design	Range	Design	Maximum	(described as provided by CERN)	described as provided by Fermilab)
1.1	F10041251.1 NP-01-30-A9	LAr	External<->Proximity: On the NP-01-30-A9 LAr line between outside filters FL7100 and FL7200 and filtration skid FL7000 inside.	Between outside filters FL7100 and FL7200 and filtration skid FL7000 inside	(Fig.1) Socket weld	2.0 (29.4)	16.0 (235.0)	87	85 – 311	1.2	2.4	Inner – DN50 sch.10 capped pipe (comes from CERN pressure tested) Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between PV6010A, PV6510A, PV7102A and PV7202A via PSV6010A Outer – 4"NPS sch.5 with clamshell final weld by FNAL
3.1	F10041251.3 NP-01-10-N1	LN2	External<->Proximity: On the NP-01-10-N1 LN2 supply line from LN2 supply Dewar TK-0001N to N2 Phase separator TK-4000N.	Between PSV-0001N and FCV-0005N	(Fig.1) Socket weld	2.0 (29.4)	9.0 (132.3)	77	75 – 311	0.75	1.5	Inner – DN50 sch.10 capped pipe (comes from CERN pressure tested) Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between FCV0001N and FCV0005N via PSV0001N Outer – 4"NPS sch.5 with clamshell final weld by FNAL
4.1	F10041251.4 NP-01-30-A1	LAr	External<->Proximity: On the NP-01-30-A1 LAr supply line from LAr Dewar TK-0001A to outside LAr filtration skids FL-7100A and FL-7200A	Between FCV-0025A and PV-7101A, PV-7201A	(Fig.1) Socket weld	2.0 (29.4)	16.0 (235.0)	87	85 – 311	1.2	2.4	Inner – DN50 sch.10 capped pipe (comes from CERN pressure tested) Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between FCV0025A, HV0025A, PV7101A, PV7201A and PV4015A via PSV0025A Outer – 4"NPS sch.5 with clamshell final weld by FNAL
4.2	F10041251.4 NP-01-70-RB2	GAr or Gar/H2	External<->Proximity: On the NP-01-70-RB2 GAr line with Ar&H2 for filters regeneration	Between HV-4020A and PV7103A, PV7203A, HV-7300A	Socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 sch.10 capped pipe (comes from CERN pressure tested)	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV-4020A and PV7103A, PV7203A, HV-7300A
4.3	F10041251.4 NP-01-30-A1	LAr	External<->Proximity: On the NP-01-30-A1 LAr line between outside filters FL7100 and FL7200 and filtration skid FL7000 inside	Between outside filters FL7100 and FL7200 and filtration skid FL7000 inside	(Fig.1) Socket weld	2.0 (29.4)	16.0 (235.0)	85	77 – 311	1.2	2.4	Inner – DN50 sch.10 capped pipe (comes from CERN pressure tested) Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between PV6010A, PV6510A, PV7102A and PV7202A via PSV6010A Outer – 4"NPS sch.5 with clamshell final weld by FNAL

Note: Only five interfaces from External Cryo to Proximity. CERN/INFN is responsible for Proximity and Internal

Integration for **SBN-FD** Cryogenics - Cryogenics



Integration for **SBNFD** Cryogenics - Cryogenics



EXTERIOR FILTERS

CRYOGENIC TRANSFER LINES

ALLOCATED ENVELOPE FOR CRYOGENICS (BLUE)

Thanks

Backup Slides

1.14	F10041250.1 Gas line	GAr	Proximity<- >External: GAr to external pressure relief	Outside cryostat above top plate to PSV8009A	(Type 4A) 14" CF	0.35 (5.0)	9.0 (132.3)	300	256 – 311	5500 at design pressure	N/A	14" CF	14" CF
1.16	F10041250.1 Gas line	GAr	Proximity<- >External: GAr to external pressure relief	Outside cryostat above top plate to PSV8007A	(Type 4A) 14" CF	0.35 (5.0)	9.0 (132.3)	300	256 – 311	5500 at design pressure	N/A	14" CF	14" CF
2.1	F10041250.2 NP-03-30-A1	LAr/GAr	External<- >Proximity: Supply LAr/GAr NP-03-30-A1 from the dewar outside the building to purification	Lines E and M (combined) – Pipe tee on the LAr supply line to LAr filter skids	(Fig.1) Inner – 2"NPS sch.10 with socket weld Outer – 4"NPS sch.5 with clamshell	5.0 (73.5)	9.0 (132.3)	93	85 – 311	>30 GAr	150 GAr	Inner – DN50 sch.10 capped pipe Comes from CERN pressure tested. Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between FCV7005A, PV7005A, PV7030A, PV7031A, FCV5206A, FCV6002A, and misc. valves via instrumentation port. Outer – 4"NPS sch.5 with clamshell final weld by FNAL
2.2	F10041250.2 Gas line	GAr/H2	External<- >Proximity: Supply GAr/H2 mixture from external cryogenics	At 1FLVB filter skid valve box - external valve HV7007A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7007A Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7007A and supply manifold of GAr/H2.
2.3	F10041250.2 Gas line	GAr/H2	External<- >Proximity: Supply GAr/H2 mixture from external cryogenics	At 2FLVB filter skid valve box - external valve HV7100A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7100A Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7100A and supply manifold of GAr/H2.
2.4	F10041250.2 Gas line	GAr/H2	External<- >Proximity: Supply GAr/H2 mixture from external cryogenics	At FI7200 filter skid - external valve HV7210A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7210 Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7210A and supply manifold of GAr/H2.
2.5	F10041250.2 Gas line	GAr	External<- >Proximity: Supply GAr from the dewar outside the building to purification and cryostat	At FI7200 filter skid - external tee downstream of valve PV7208A	1.5" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	300	244 – 311	>40 GAr	100 GAr	Inner – DN40 socket connection to HV7211A Comes from CERN pressure tested.	Inner – 1.5"NPS sch.10 with socket weld by FNAL and pressure test between weld and isolation valves supplying GAr to the cryostat.

2.6	F10041250.2 Gas line	GAr	External<->Proximity: Supply GAr from the dewar outside the building to purification and cryostat	At FI7200 filter skid - external tee upstream of valve HV7211A	1.5" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	300	244 – 311	>40 GAr	100 GAr	Inner – DN40 socket connection to HV7211A Comes from CERN pressure tested.	Inner – 1.5"NPS sch.10 with socket weld by FNAL and pressure test between HV7211A and supply manifold of GAr.
3.1	F10041250.3 NP-03-10-N1	LN2	External<->Proximity: Supply LN2 from the dewar outside the building to purification	Line G - On the LN2 supply line (outside) from LN2 supply dewar TK-0050N to N2 phase separator TK-4000N	(Fig.1) Inner – 2"NPS sch.10 with socket weld Outer – 4"NPS sch.5 with clamshell	2.0 (29.4)	9.0 (132.3)	77	75 – 311	0.75 LN2	1.5 LN2	Inner – DN50 sch.10 capped pipe (comes from CERN pressure tested) Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between FCV0101N and FCV4010N via PSV4010N Outer – 4"NPS sch.5 with clamshell final weld by FNAL

Integration for **SBND** Cryogenics - Cryogenics

SBND INTERFACE POINTS ON P&ID DRAWINGS						Pressure Rating, Barg (psig)		Temperature Rating, K		Flow Rating, liter/min for liquid and m³/hr for gas		Connection	
#	DRAWING NUMBER	FLUID	DESCRIPTION	LOCATION	TYPE	Design	Maximum	Design	Range	Design	Maximum	(described as provided by CERN)	described as provided by Fermilab)
1.3	F10041250.1	GAr	Proximity<->Internal: GAr make-up gas	In the cryostat	(Type 3) - Inner: 1.5" x 0.083" w/2.75" CF	0.35 (5.0)	9.0 (132.3)	87	85 – 311	>10 GAr	50 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF. Open to cryostat; no pressure test.
1.4	F10041250.1	GAr	Proximity<->Internal: GAr purge gas	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	85 – 311	>40 GAr	100 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.5	F10041250.1	GAr	Proximity<->Internal: GAr gas momentum	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	87 – 311	>10 GAr	50 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.6	F10041250.1	GAr	Proximity<->Internal: GAr gas cooldown	In the cryostat	(Type 3) Inner: 1.5" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	300	87 – 311	>10 GAr	50 GAr	Inner – 1.5" x 0.083" w/2.75" CF Comes from CERN pressure tested.	Inner – 1.5" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench.
1.7	F10041250.1	LAr	Proximity<->Internal: LAr liquid cooldown	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>10 LAr	25 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.8	F10041250.1	LAr	Proximity<->Internal: LAr liquid distribution	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>30 LAr	150 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.9	F10041250.1	LAr	Proximity<->Internal: LAr liquid to cold roof	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>5 LAr	25 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.10	F10041250.1	LAr	Proximity<->Internal: LAr return to condenser	In the cryostat	(Type 1) VJ: 3.5" x 0.049" Inner: 1.75" x 0.083" w/2.75" CF	2.0 (29.4)	9.0 (132.3)	87	85 – 311	>10 LAr	25 LAr	Inner – 1.75" x 0.083" w/2.75" CF Comes from CERN pressure tested. Outer: vacuum jacket	Inner: 1.75" x 0.083" w/2.75" CF Pressure tested at Fermilab on the bench. Outer: vacuum jacket
1.14	F10041250.1	GAr	Proximity<->External: GAr to external pressure relief	Outside cryostat above top plate to PSV8009A	(Type 4A) 14" CF	0.35 (5.0)	9.0 (132.3)	300	256 – 311	5500 at design pressure	N/A	14" CF	14" CF
1.16	F10041250.1	GAr	Proximity<->External: GAr to external pressure relief	Outside cryostat above top plate to PSV8007A	(Type 4A) 14" CF	0.35 (5.0)	9.0 (132.3)	300	256 – 311	5500 at design pressure	N/A	14" CF	14" CF
2.1	F10041250.2	LAr/GAr	External<->Proximity: Supply LAr/GAr from the dewar outside the building to purification	Lines E and M (combined) – Pipe tee on the LAr supply line to LAr filter skids	(Fig.1) Inner – 2"NPS sch.10 with socket weld Outer – 4"NPS sch.5 with clamshell	5.0 (73.5)	9.0 (132.3)	93	85 – 311	>30 GAr	150 GAr	Inner – DN50 sch.10 capped pipe Comes from CERN pressure tested. Outer – DN100 sch.5 capped (with vacuum break)	Inner – 2"NPS sch.10 with socket weld by FNAL and pressure test between FCV7005A, PV7005A, PV7030A, PV7031A, FCV5206A, FCV6002A, and misc. valves via instrumentation port. Outer – 4"NPS sch.5 with clamshell final weld by FNAL
2.2	F10041250.2	GAr/H2	External<->Proximity: Supply GAr/H2 mixture from external cryogenics	At 1FLVB filter skid valve box - external valve HV7007A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7007A Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7007A and supply manifold of GAr/H2.
2.3	F10041250.2	GAr/H2	External<->Proximity: Supply GAr/H2 mixture from external cryogenics	At 2FLVB filter skid valve box - external valve HV7100A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7100A Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7100A and supply manifold of GAr/H2.
2.4	F10041250.2	GAr/H2	External<->Proximity: Supply GAr/H2 mixture from external cryogenics	At FI7200 filter skid - external valve HV7210A	1" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	460	244 – 500	>10 GAr	50 GAr	Inner – DN25 socket connection to HV7210 Comes from CERN pressure tested.	Inner – 1"NPS sch.10 with socket weld by FNAL and pressure test between HV7210A and supply manifold of GAr/H2.
2.5	F10041250.2	GAr	External<->Proximity: Supply GAr from the dewar outside the building to purification and cryostat	At FI7200 filter skid - external tee downstream of valve PV7208A	1.5" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	300	244 – 311	>40 GAr	100 GAr	Inner – DN40 socket connection to HV7211A Comes from CERN pressure tested.	Inner – 1.5"NPS sch.10 with socket weld by FNAL and pressure test between weld and isolation valves supplying GAr to the cryostat.
2.6	F10041250.2	GAr	External<->Proximity: Supply GAr from the dewar outside the building to purification and cryostat	At FI7200 filter skid - external tee upstream of valve HV7211A	1.5" NPS sch. 10 socket weld	2.0 (29.4)	9.0 (132.3)	300	244 – 311	>40 GAr	100 GAr	Inner – DN40 socket connection to HV7211A Comes from CERN pressure tested.	Inner – 1.5"NPS sch.10 with socket weld by FNAL and pressure test between HV7211A and supply manifold of GAr.

Example of interface document prepared by Fermilab showing interfaces between internal-proximity-external cryogenics.

Areas of Integration for **SBND** and **SBNFD** Cryogenics

- Integration of proximity-internal-external cryogenics into common building space
- Integration of proximity-internal-external cryogenics into common cryo system via interconnecting piping
- Integration proximity-internal-external cryogenics via electrical and controls
- Integration via engineering and safety documentation
- Integration via management of procurement, delivery, installation locally
- Integration via commissioning