PIP-II Integrated Model

BTL Workshop

PIP-II CAD Team

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Nov 30, 2022

PIP-II is a partnership of:

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

Outline

- Integrated Model Goals and Scope
- CAD Modeling Practices
- Data Exchange Techniques
- Current BTL Model Status
- Path to BTL Model Integration

3D CAD Model Integration - Goals

- Establish uniform CAD standards for PIP-II
  - Units, coordinate systems, conventions
  - Input from PIP-II partners via PIP-II Design Coordination Group
- Integrate 3D geometry for all technical designs (FNAL-performed and partner performed)
  - Dynamic in-process design context
  - Eventually authoritative documentation of these designs
- Integrate 3D geometry for Conventional Facility CF
  - as design context – NOT as BIM or authoritative representation of CF
- Establish traceability from highest level (PIP-II) to lowest level (component detail design)
  - Drives need for data abstraction techniques
- Implement abstraction/visualization techniques to keep the model useable and manageable

3D CAD Model Integration - Scope

Integrated 3D CAD model is used to manage design for all of PIP-II

- Model captures:
  - Accelerator Physics lattice
  - Detailed individual 3D system designs
  - Partner designs
  - Simplified abstractions of detailed designs (where needed)
  - Not-to-exceed envelopes bounding designs
  - Conventional Facility (CF) designs from A&E firm
- Model integrates design geometry from multiple sources
  - FNAL designs implemented in Siemens *NX® 1980 CAD* software
  - Partner designs implemented in other systems (e.g., CEA – *CATIA®*)
  - CF design implemented in *Revit®*
- Model is updated dynamically with maturing design
  - Initially critical systems defined by not-to-exceed envelopes which bound the designs
  - Elaborated with detailed 3D model designs as systems mature
  - CF designs verified via the 3D model

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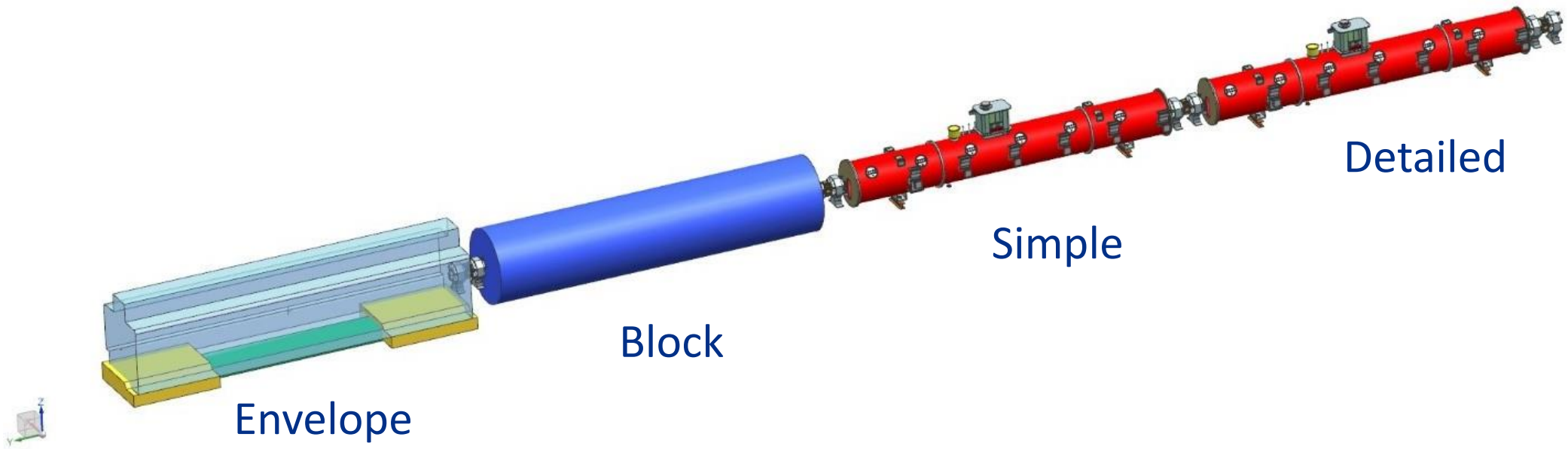
PIP-II CAD Practices

- Defined in PIP-II document ED0009698
- Establishes modeling practices
  - Coordinate system definitions
    - Enables lattice-based model population
  - Unit convention: metric units
    - Facilitates international contributions
    - Mixed units greatly complicate data import/export in NX
    - Exceptions for CF-integrated systems (e.g. LCW piping)
  - Top-to-bottom assembly tree traceability implementation methods
  - Use of “Arrangement” feature in NX to control data suppression/display

Data Abstraction

- Simplification of complicated geometry and assemblies
  - Necessary at multiple levels to make visualization and drawings feasible
  - Managed in NX arrangements (controlling suppression state)
  - Default arrangement = Simple or Block

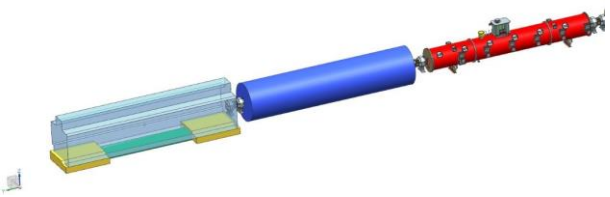


Not-To-Exceed Envelopes

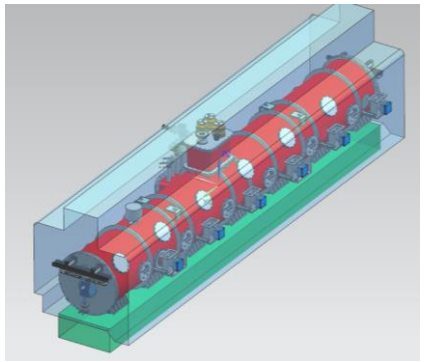
- NTE envelopes are based on actual design or planned similar reasonably achievable designs
- They provide a boundary that a system must stay within to avoid interference with other equipment (constraints on system design)
- Allows for parallel progress and interface verification between systems at different levels of design maturity
- Formalized in a 2-D drawing, reviewed and approved by stakeholders, and controlled in Teamcenter
- Developed from the PIP-II 3D model

MODEL	DRAWING	IDENTIFIER
F10104753	F10104753	ENVELOPES, TRANSVERSE, PIP-II SCL ENCLOSURE AND GALLERY
F10145924	F10104753	ENVELOPE, LLRF REFERENCE LINE
F10106227	F10104753	ENVELOPE, LASER TRANSPORT SYSTEM, ENCLOSURE
F10104755	F10113422	ENVELOPE, CDS, TRANSFERLINE
F10106225	F10113422	ENVELOPE, CDS, WARM PIPING
F10113822	F10113422	ENVELOPE, CDS ACCESS PLATFORM
F10106226	F10113422	ENVELOPE, LCW ENCLOSURE PIPING
F10103409	F10127878	ENVELOPE, TRANSVERSE, SSR1 CRYOMODULE
F10103728	F10127878	ENVELOPE, TRANSVERSE, SSR2 CRYOMODULE
F10103730	F10127878	ENVELOPE, TRANSVERSE, LB650 CRYOMODULE
F10103732	F10127878	ENVELOPE, TRANSVERSE, HB650 CRYOMODULE
FC0065708	F10105039	ENVELOPE, RF AMPLIFIER MODULE, SSR1
FC0065709	F10106147	ENVELOPE, RF AMPLIFIER MODULE, SSR2
FC0065710	F10106148	ENVELOPE, RF AMPLIFIER MODULE, LB650
FC0065711	F10106150	ENVELOPE, RF AMPLIFIER MODULE, HB650
F10105038	F10105038	INTERFACE CONTROL DRAWING, WARM UNIT, 650MHZ
F10104144	F10105038	ENVELOPE, DIPOLE CORRECTOR MAGNET, PIP2 650MHZ SECTION
F10104139	F10105038	ENVELOPE, QUADRUPOLE MAGNET, PIP2 650MHZ SECTION
F10104395	F1010503	TATION, PIP2 650MHZ SECTI

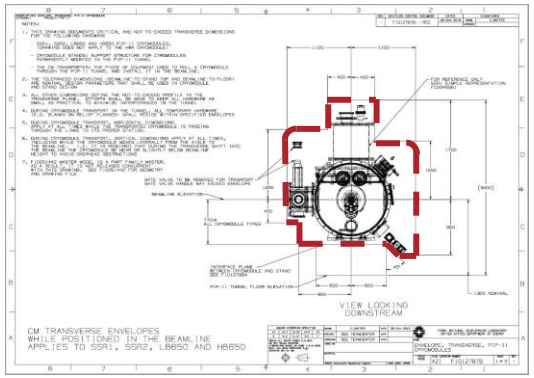
List of NTEs



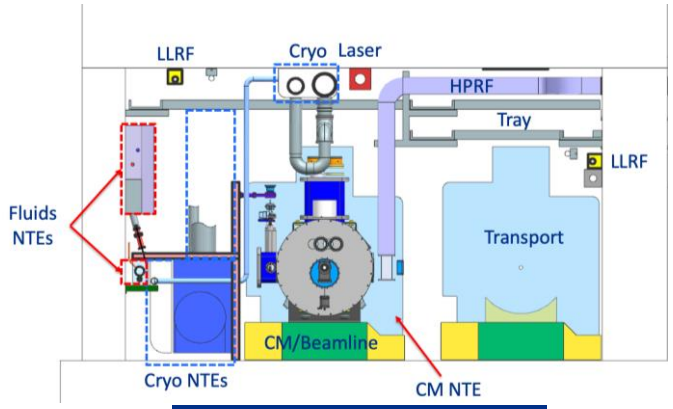
HB650 NTE development



HB650 NTE 3-D Model



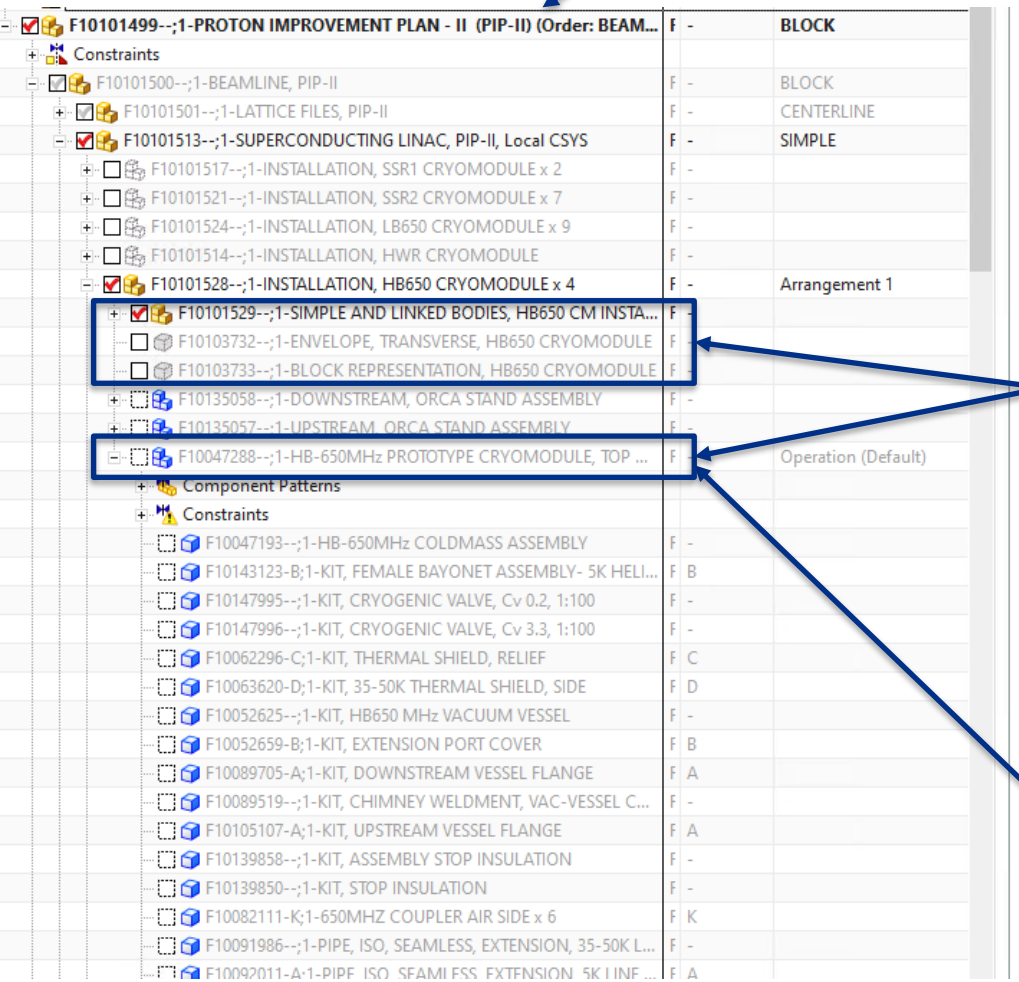
NTE 2-D Drawing



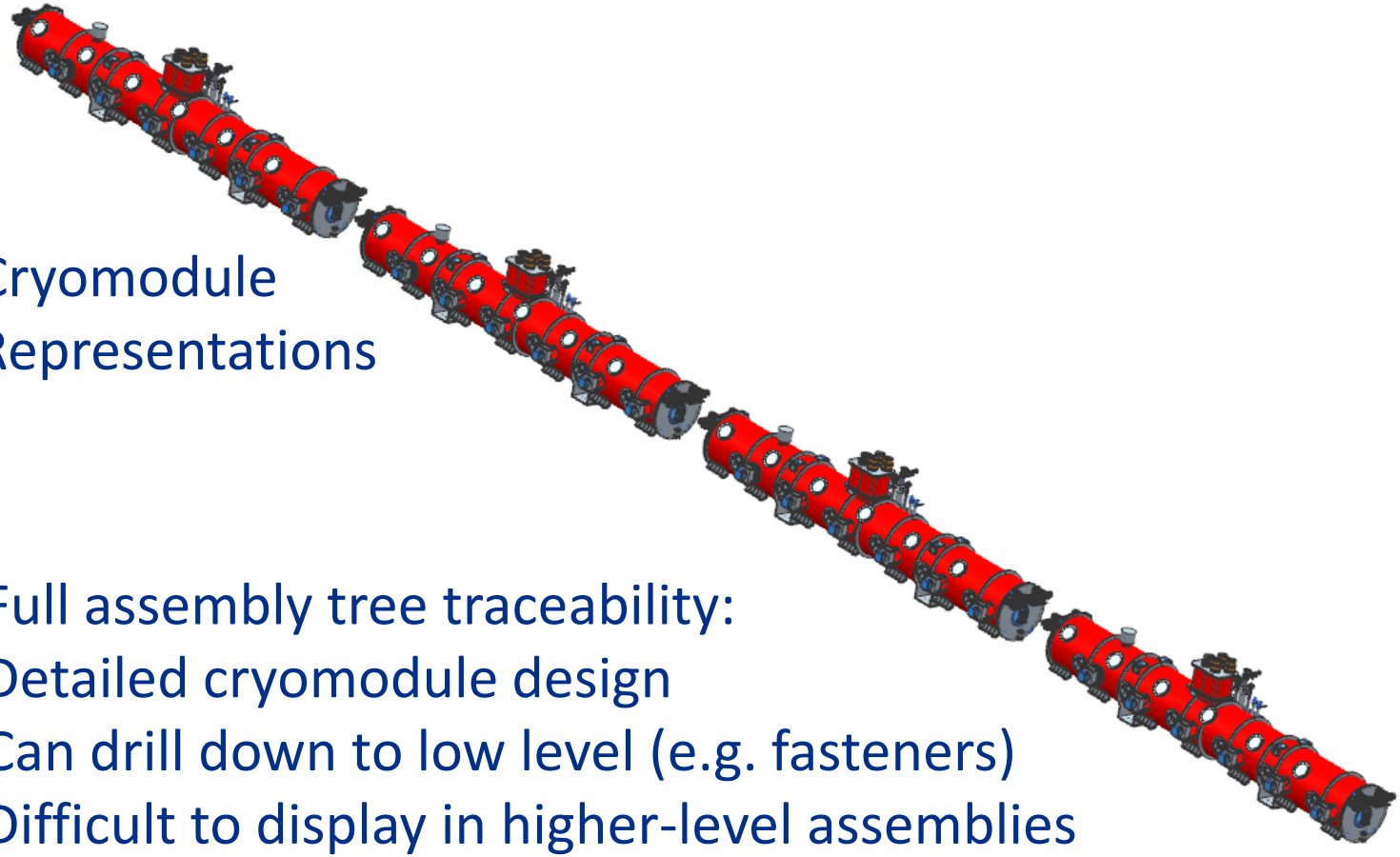
PIP-II Tunnel Section

Assembly Tree Traceability

Top level model

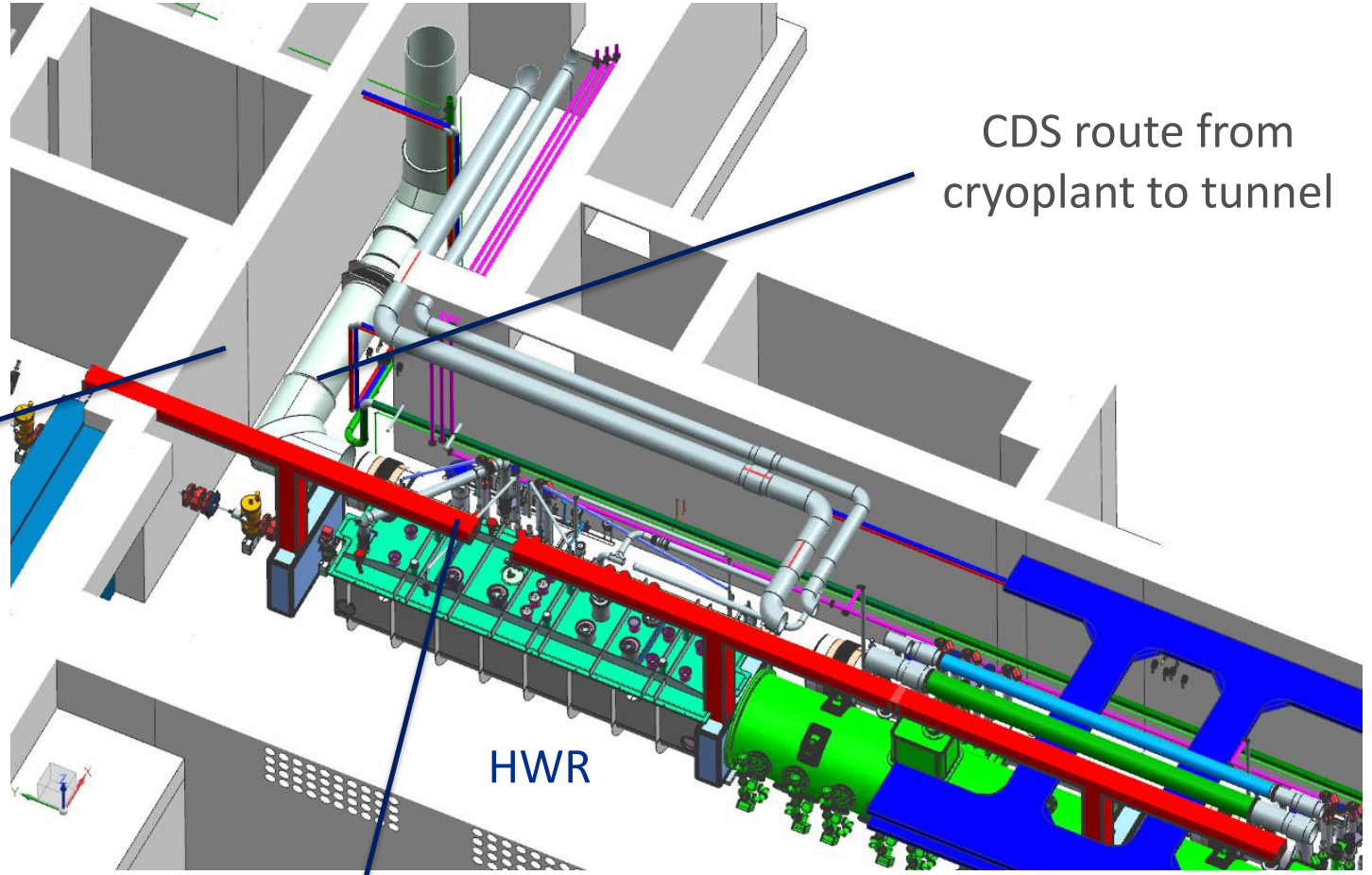


Cryomodule Representations



Full assembly tree traceability:
Detailed cryomodule design
Can drill down to low level (e.g. fasteners)
Difficult to display in higher-level assemblies

Model Integration Example



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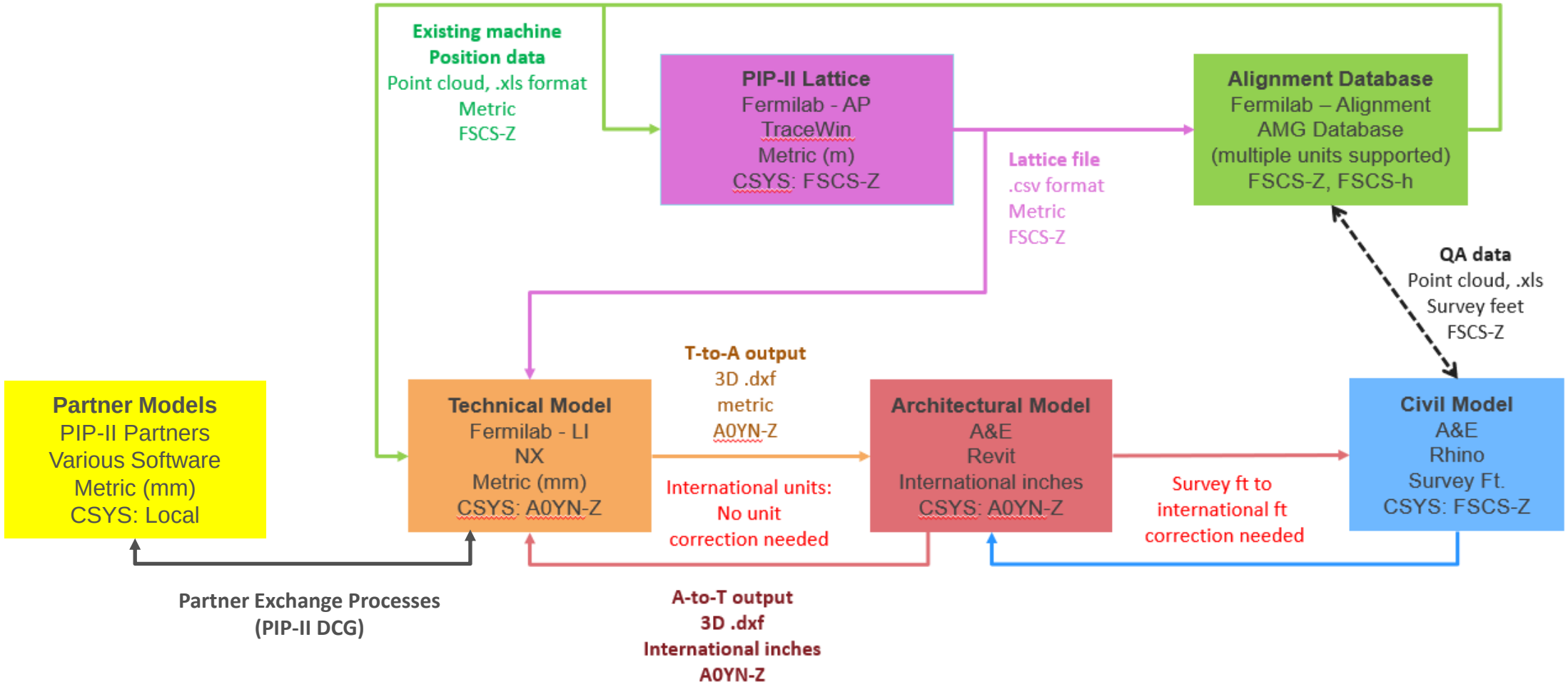
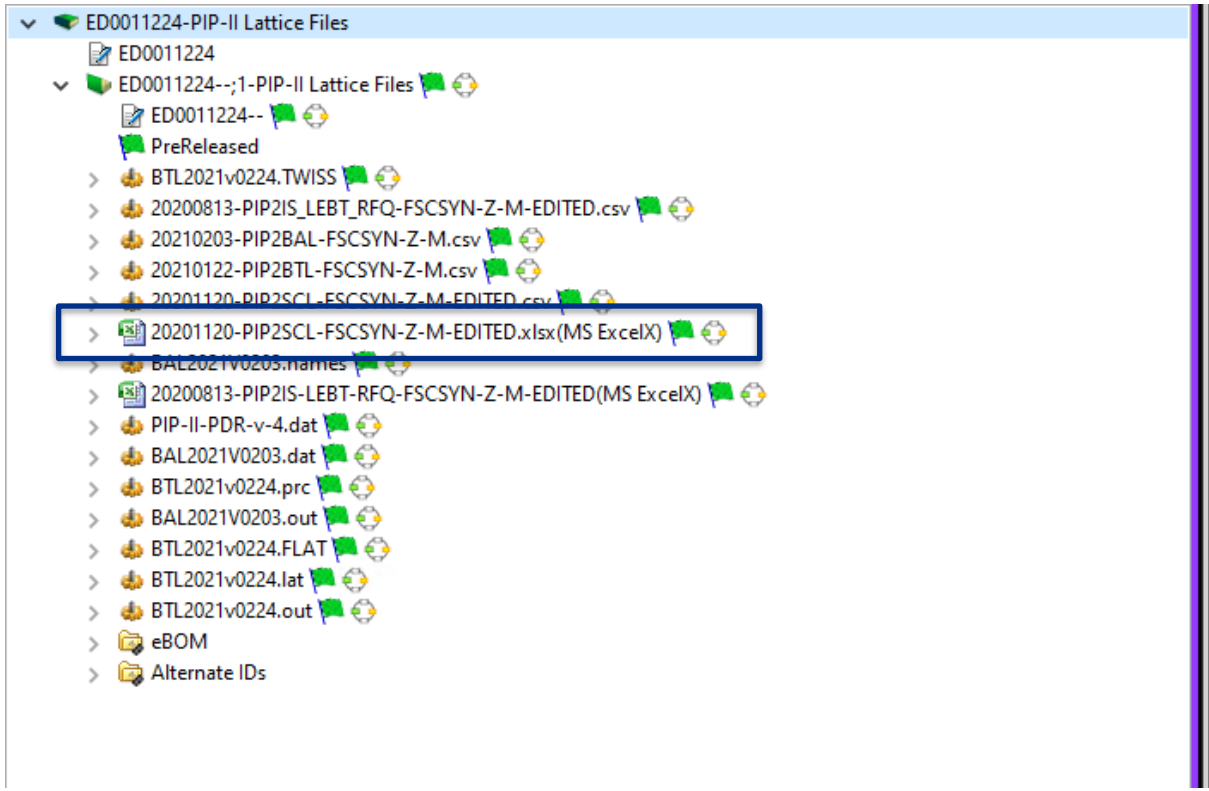
3D CAD Model Data Exchange

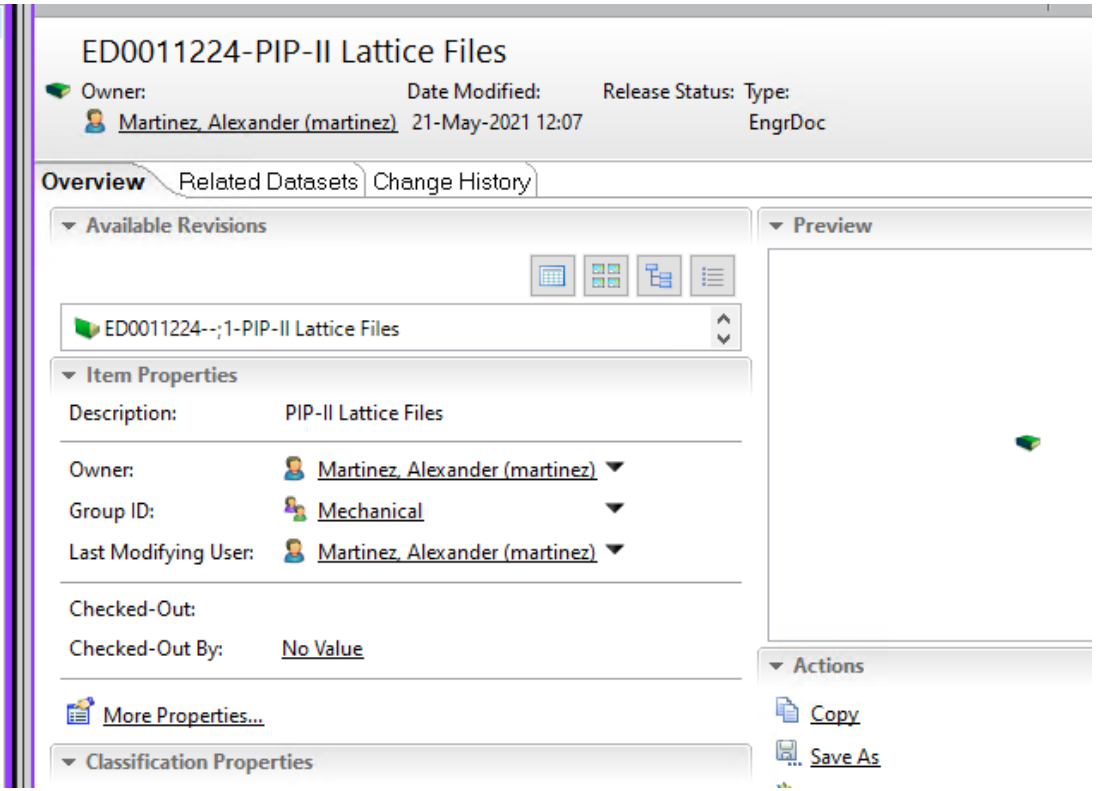
Rigorous data exchange protocols utilized



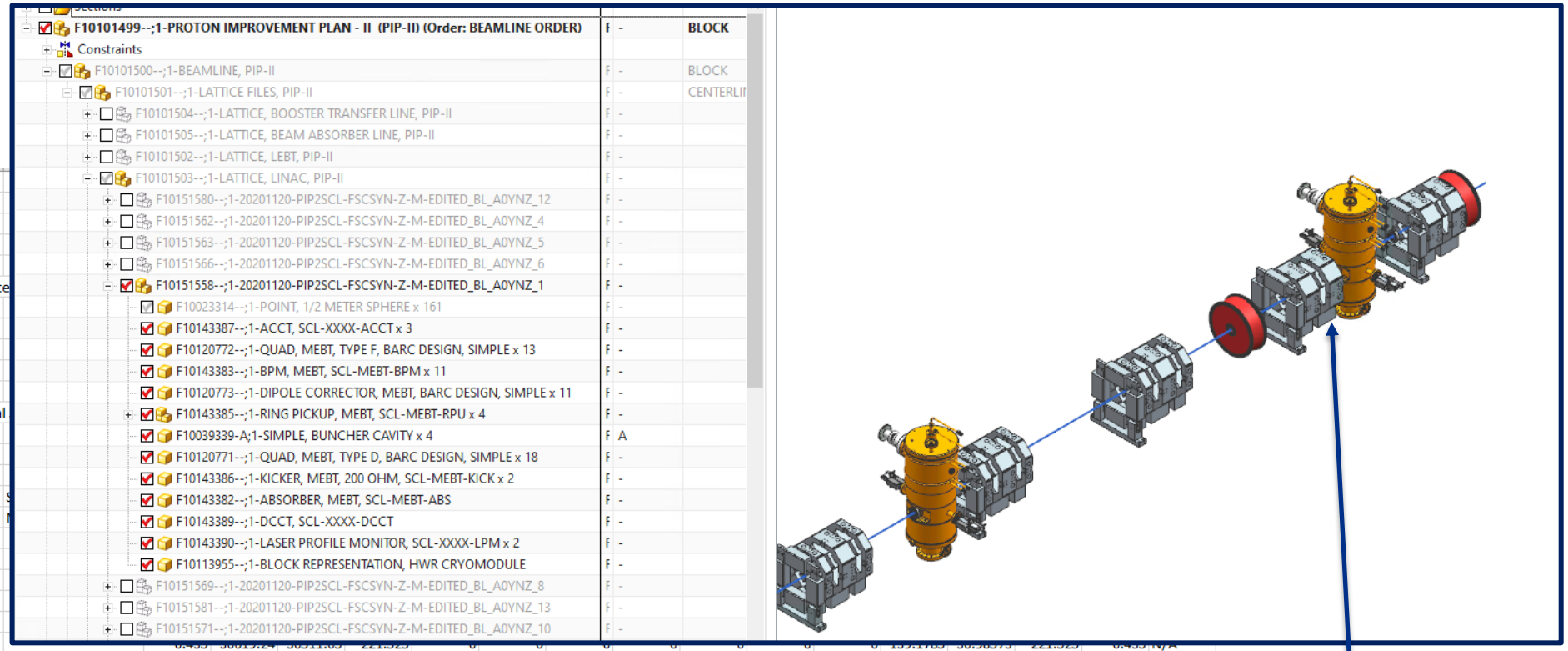
Data Exchange with Accelerator Physics

- The Accelerator Physics (AP) team owns the lattices
  - Managed in Teamcenter ED0011224
  - Includes native files and .csv files readable in Excel
  - Excel file generates lattice CAD model via NX script





Data Exchange with Accelerator Physics



#
#
PIP-II SCL Lattice
Author: A. Saini
11/20/2020 13:14
#NOTES: Coordinates are given for the device in FSCS-YN-Z coordinate syste
#Site +x-axis (EAST); site +y-axis (NORTH); Site z-axis (ELEVATION)
Positive bearing is ccw wrt site EAST
Pitch is the vertical angle about the x-y plane.
Elevation offsets (dZ) are with respect to site coordinates
Transverse offsets (dX) are with respect to beam trajectory.
Comments: additional 75mm SSR1 cavity spacing incorporated, additional

#FSCS coordinate system

Line	Location	Typ_Code															
N/A	N/A	N/A															
0	SCL-MEBT-Start	Marker															
1	SCL-MEBT-ACCT-0100-CT	SCL-XXXX-ACCT															
2	SCL-MEBT-QD-0101-UP	Marker															
3	SCL-MEBT-QD-0101-CT	SCL-MEBT-QUAD-F															
4	SCL-MEBT-QD-0101-DN	Marker															
5	SCL-MEBT-BPM-0102-CT	SCL-MEBT-BPM															
6	SCL-MEBT-QF-0103-UP	Marker	0.47	30619.24	30511.01	221.525	0	0	0	0	0	0	0	139.1785	30.95073	221.525	0.47	N/A
7	SCL-MEBT-QF-0103-CT	SCL-MEBT-QUAD-F	0.52	30619.24	30510.96	221.525	0	0	0	0	0	0	0	139.1785	30.90073	221.525	0.52	N/A
8	SCL-MEBT-QF-0103-DN	Marker	0.57	30619.24	30510.91	221.525	0	0	0	0	0	0	0	139.1785	30.85073	221.525	0.57	N/A
9	SCL-MEBT-XCOR-0104-CT	SCL-MEBT-XYCOR	0.629	30619.24	30510.85	221.525	0	0	0	0	0	0	0	139.1785	30.79173	221.525	0.629	N/A
10	SCL-MEBT-YCOR-0105-CT	Marker	0.629	30619.24	30510.85	221.525	0	0	0	0	0	0	0	139.1785	30.79173	221.525	0.629	TYPE CODE (
11	SCL-MEBT-RPU-0106-CT	SCL-MEBT-RPU	0.6784	30619.24	30510.8	221.525	0	0	0	0	0	0	0	139.1785	30.74233	221.525	0.6784	N/A
12	SCL-MEBT-COL-0107-CT	Marker	0.7784	30619.24	30510.7	221.525	0	0	0	0	0	0	0	139.1785	30.64233	221.525	0.7784	N/A
13	SCL-MEBT-CAV-0108-UP	Marker	0.8784	30619.24	30510.6	221.525	0	0	0	0	0	0	0	139.1785	30.54233	221.525	0.8784	N/A
14	SCL-MEBT-CAV-0108-CT	SCL-MEBT-CAV	0.9984	30619.24	30510.48	221.525	0	0	0	0	0	0	0	139.1785	30.42233	221.525	0.9984	N/A
15	SCL-MEBT-CAV-0108-DN	Marker	1.1184	30619.24	30510.36	221.525	0	0	0	0	0	0	0	139.1785	30.30233	221.525	1.1184	N/A
16	SCL-MEBT-QD-0109-UP	Marker	1.2	30619.24	30510.28	221.525	0	0	0	0	0	0	0	139.1785	30.22073	221.525	1.2	N/A
17	SCL-MEBT-QD-0109-CT	SCL-MEBT-QUAD-F	1.25	30619.24	30510.23	221.525	0	0	0	0	0	0	0	139.1785	30.17073	221.525	1.25	N/A
18	SCL-MEBT-QD-0109-DN	Marker	1.3	30619.24	30510.18	221.525	0	0	0	0	0	0	0	139.1785	30.12073	221.525	1.3	N/A
19	SCL-MEBT-BPM-0110-CT	SCL-MEBT-BPM	1.335	30619.24	30510.15	221.525	0	0	0	0	0	0	0	139.1785	30.08573	221.525	1.335	N/A

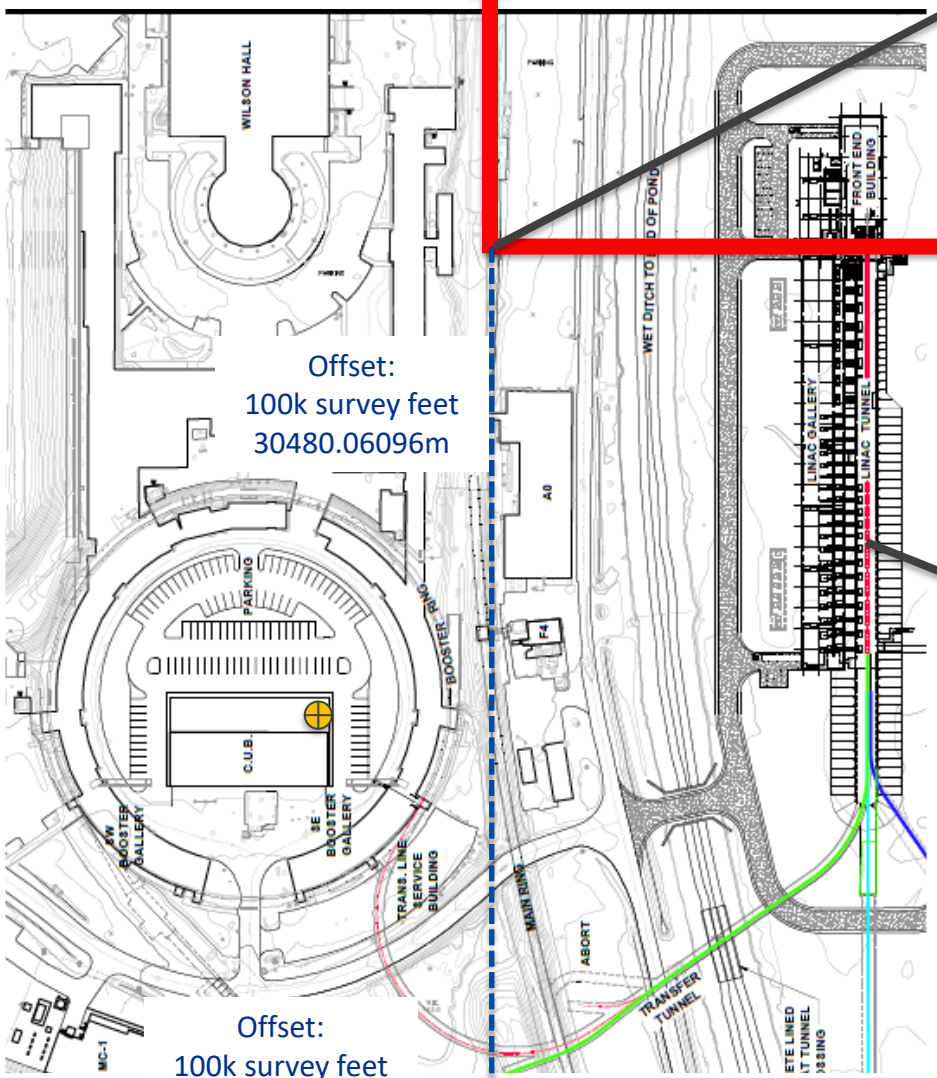
Data Exchange with Conventional Facilities

- The CF A&E firm works in Autodesk Revit ®
  - Not directly compatible with Siemens NX ®
  - Data exchange implemented in 3D DXF format
  - Data exchange from FNAL performed at CF design start and at significant design change stages
  - Data exchange from CF A&E firm performed at major design milestones (30, 60, 90, 100%) and as needed
  - Careful management of coordinate systems and non-standard survey units (survey ft) required
  - Model checked and verified after data exchange

Data Exchange with CF – Implementation Details

- Coordinate units and coordinate systems…
  - …But do not rely solely upon that coordination for absolute position
  - CF designs can deal with vast length scales, but due to NX limitations the technical CAD model cannot

Coordinate Systems



+Y A0YN-Z

+X A0YN-Z

This is an illustrative cartoon only. Position of origin relative to background image not exact

PIP-II linac beam runs parallel to the –Y axis of either system

True North

Offset:
100k survey feet
30480.06096m

+Y FSCS-Z

+X FSCS-Z

Offset:
100k survey feet
30480.06096m

A note on units

- Basic Units
  - Metric: 1m
  - International inches: 0.0254000m
  - International foot: 12 international inches, 0.3048000m
  - Survey foot: 1200/3937m = .3048006096m
- Because FSCS coordinate system is centered far from the PIP-II site, 2ppm discrepancy between international feet and survey feet results in ~3” discrepancy at the PIP-II site
- Most technical CAD systems do not support “survey foot” units, but civil drawings typically use survey foot exclusively
- Care must be taken in converting between survey foot and international units. One must be clear on who converts

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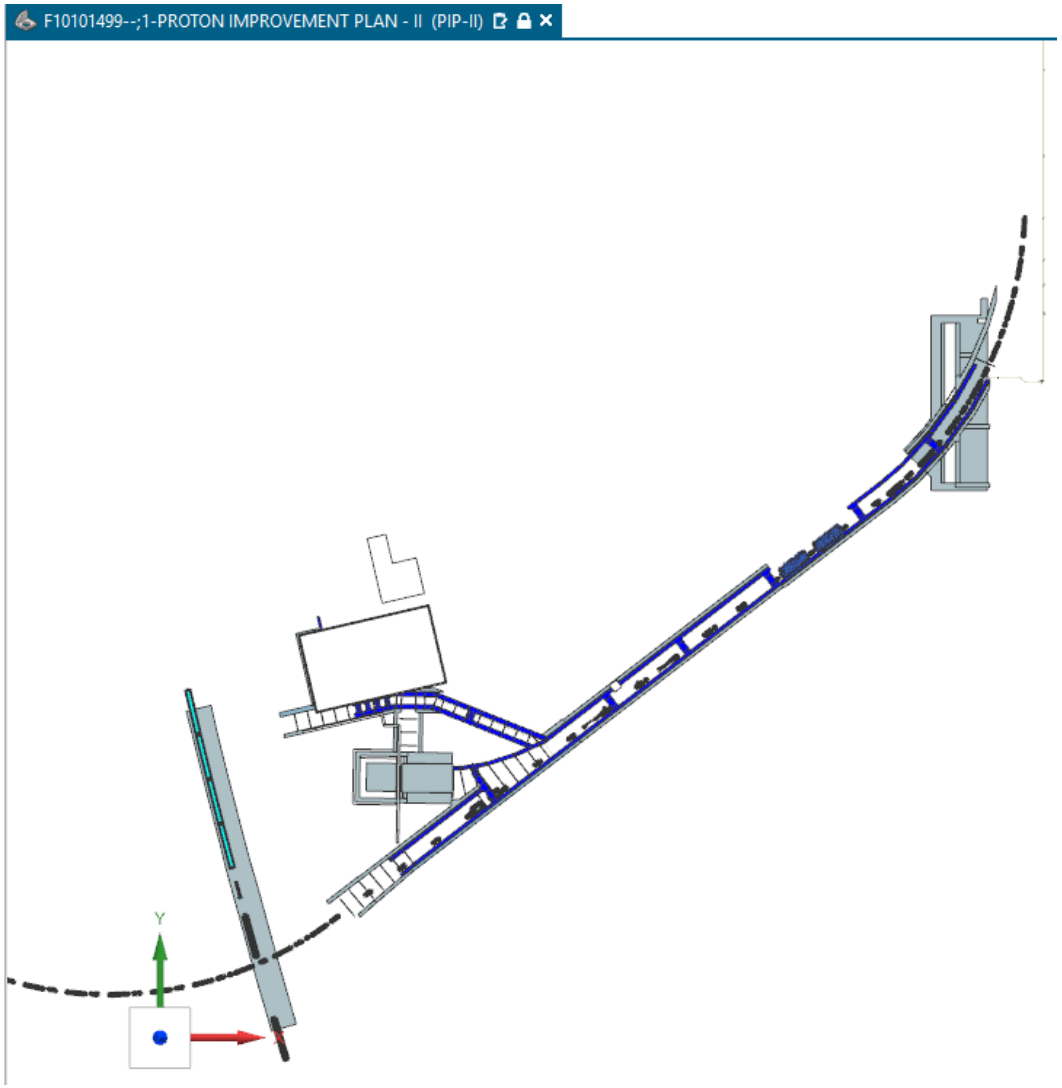
BTL Model Status

- Conventional Facility
  - CF models implemented for both BTL construction packages
  - This includes CF-installed components (cable tray, fluids)
- Existing Booster
  - Based on 2020 3D scan of PIP-II Injection Region
- Beamline Components
  - Lattice driven beamline model in place
  - Detailed designs of collimators and absorber implemented
  - Notional representation of magnets based on dimensions provided by Meiqin/Bruce
  - Envelope for cavities based on dimensions provided by Eduard
  - No instrumentation geometry that we have been made aware of
- Other Components
  - No other geometry that we have been made aware of

CF – Complex Package

Assembly Navigator

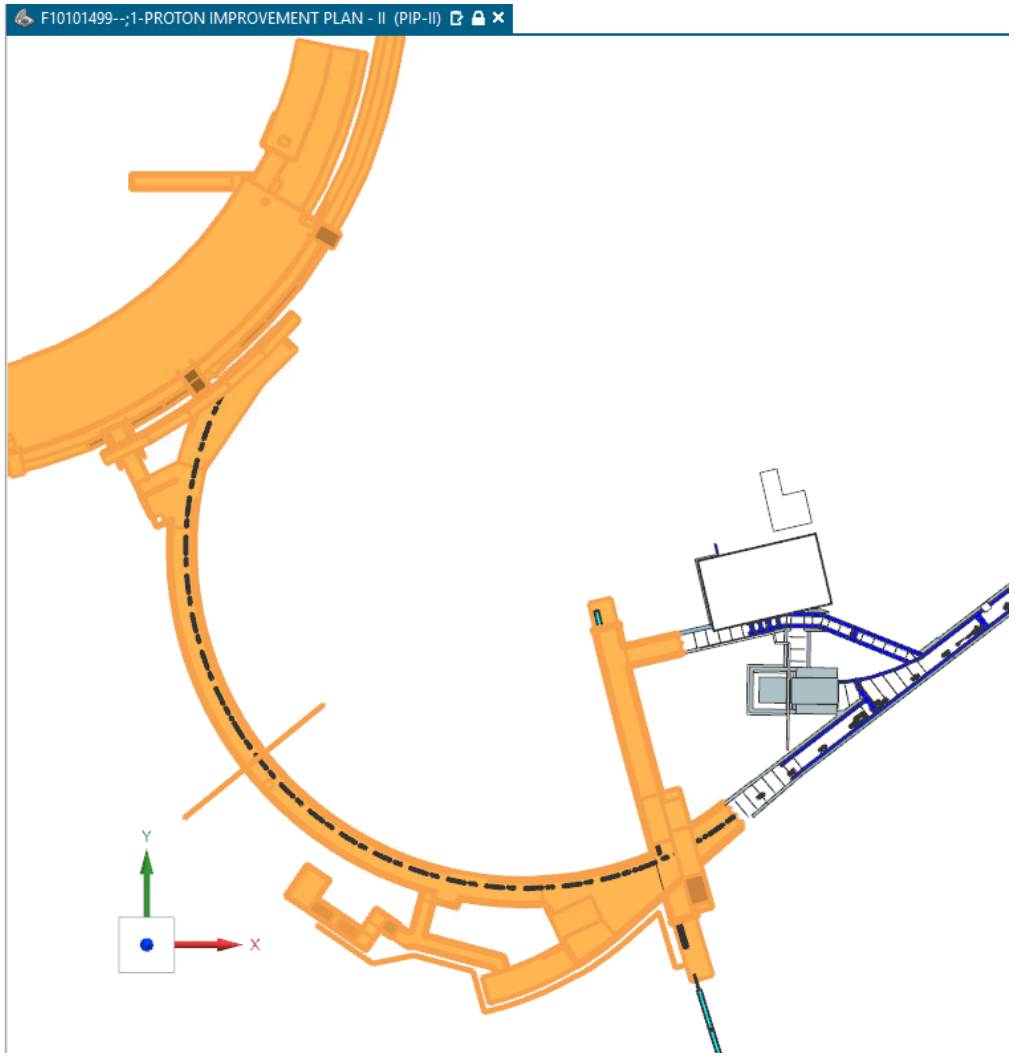
Object	R...	Arrangement
Session Component Groups		
Component Groups in Part		
Sections		
F10101499--;1-PROTON IMPROVEMENT PLAN - II (PIP-II) (Order: Chronological)	-	**BTL & BAL ONLY**
Constraints		
F10152386--;1-LOCAL CSYS, PIP2 BEAMLINE AT DOWNSTREAM END OF RFQ	-	
F10174011--;1-F37 S.B., INSTALLATIONS, PIP-II AT A0YNZ	-	
F10101611-B;1-INSTALLATION, CRYOGENIC DISTRIBUTION SYSTEM	B	
F10159689--;1-CRYOPLANT BUILDING ASSEMBLY, PIP-II, A&E MODEI 20210510, at A0YN CSYS	-	
F10101626--;1-CONVENTIONAL FACILITY, PIP-II, at A0YNZ	-	BTL & BAL ONLY
F10126726--;1-HIGHBAY GALLERY EQUIPMENT LAYOUT	-	
F10151133--;1-TEMPORARY IMPORTS-EXPORTS, PIP-II, A0YN CSYS	-	BTL & BAL ONLY
F10191032--;1-GALLERY, CF LC FNAL_4-3-5_2022feb28, ED0012055-F-	-	
F10179920--;1-ENCLOSURES, CF LC FNAL_4-3-5_2022FEB28, ED0012055-F-, ISSUED	-	Arrangement 1
F10173116--;1-CF LC FNAL_4-3-5 20211221 ASSY	-	
F10104753--;1-ENVELOPES, TRANSVERSE, PIP-II SCL ENCLOSURE AND GALLERY	-	
F10141756--;1-ALIGNMENT NETWORK, PIP-II	-	
F10134805--;1-CRYOPLANT BUILDING, PIP-II at A0YN CSYS	-	
F10127062--;1-STUDY, MAIN RING AT PIP-II CROSSING	-	Arrangement 1 (Default)
F10126601--;1-BOOSER POINT CLOUD FROM 2019-JULY SURVEY	-	
F10101616--;1-LINAC GALLERY INSTALLATIONS, PIP-II AT LOCAL CSYS	-	
F10101614--;1-BAL TUNNEL INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101612--;1-BTL TUNNEL INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101609--;1-SCL TUNNEL INSTALLATIONS, PIP-II at LOCAL CSYS	-	
F10101606--;1-HIGHBAY INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101500--;1-BEAMLINE, PIP-II	-	Arrangement 1



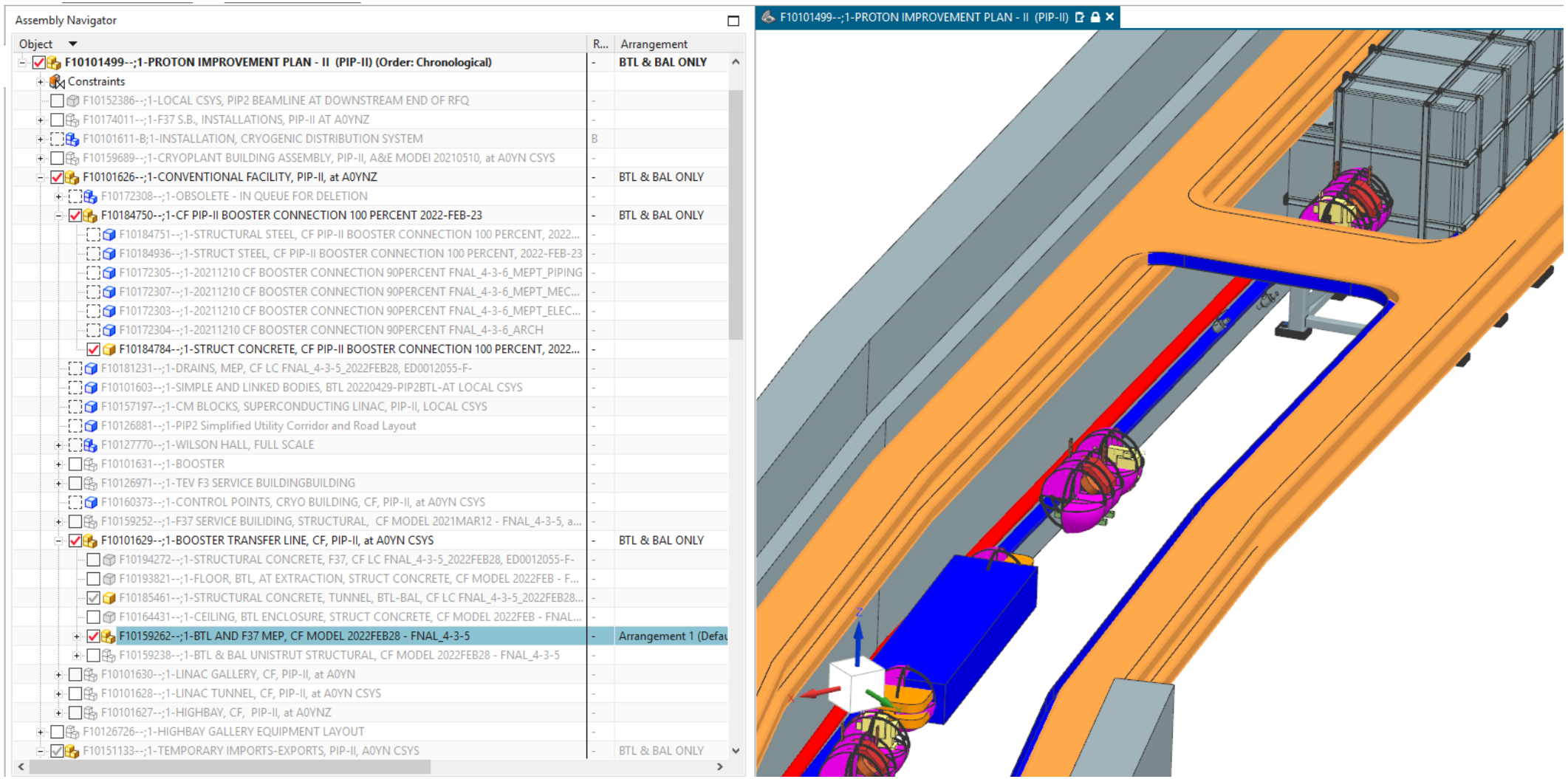
CF – Booster Connection Package

Assembly Navigator

Object	R...	Arrangement
Session Component Groups		
Component Groups in Part		
Sections		
F10101499--;1-PROTON IMPROVEMENT PLAN - II (PIP-II) (Order: Chronological)	-	**BTL & BAL ONLY**
Constraints		
F10152386--;1-LOCAL CSYS, PIP2 BEAMLINE AT DOWNSTREAM END OF RFQ	-	
F10174011--;1-F37 S.B., INSTALLATIONS, PIP-II AT A0YNZ	-	
F10101611-B;1-INSTALLATION, CRYOGENIC DISTRIBUTION SYSTEM	B	
F10159689--;1-CRYOPLANT BUILDING ASSEMBLY, PIP-II, A&E MODEI 20210510, at A0YN CSYS	-	
F10101626--;1-CONVENTIONAL FACILITY, PIP-II, at A0YNZ	-	BTL & BAL ONLY
F10172308--;1-OBSOLETE - IN QUEUE FOR DELETION	-	
F10184750--;1-CF PIP-II BOOSTER CONNECTION 100 PERCENT 2022-FEB-23	-	BTL & BAL ONLY
F10184751--;1-STRUCTURAL STEEL, CF PIP-II BOOSTER CONNECTION 100 PERCENT, 2022...	-	
F10184936--;1-STRUCT STEEL, CF PIP-II BOOSTER CONNECTION 100 PERCENT, 2022-FEB-23	-	
F10172305--;1-20211210 CF BOOSTER CONNECTION 90PERCENT FNAL_4-3-6_MEPT_PIPING	-	
F10172307--;1-20211210 CF BOOSTER CONNECTION 90PERCENT FNAL_4-3-6_MEPT_MEC...	-	
F10172303--;1-20211210 CF BOOSTER CONNECTION 90PERCENT FNAL_4-3-6_MEPT_ELEC...	-	
F10172304--;1-20211210 CF BOOSTER CONNECTION 90PERCENT FNAL_4-3-6_ARCH	-	
F10184784--;1-STRUCT CONCRETE, CF PIP-II BOOSTER CONNECTION 100 PERCENT, 2022...	-	
F10181231--;1-DRAINS, MEP, CF LC FNAL_4-3-5_2022FEB28, ED0012055-F-	-	
F10101603--;1-SIMPLE AND LINKED BODIES, BTL 20220429-PIP2BTL-AT LOCAL CSYS	-	
F10157197--;1-CM BLOCKS, SUPERCONDUCTING LINAC, PIP-II, LOCAL CSYS	-	
F10126881--;1-PIP2 Simplified Utility Corridor and Road Layout	-	
F10127770--;1-WILSON HALL, FULL SCALE	-	
F10101631--;1-BOOSTER	-	
F10126971--;1-TEV F3 SERVICE BUILDINGBUILDING	-	
F10160373--;1-CONTROL POINTS, CRYO BUILDING, CF, PIP-II, at A0YN CSYS	-	
F10159252--;1-F37 SERVICE BUILIDING, STRUCTURAL, CF MODEL 2021MAR12 - FNAL_4-3-5, a...	-	
F10101629--;1-BOOSTER TRANSFER LINE, CF, PIP-II, at A0YN CSYS	-	
F10101630--;1-LINAC GALLERY, CF, PIP-II, at A0YN	-	
F10101628--;1-LINAC TUNNEL, CF, PIP-II, at A0YN CSYS	-	
F10101627--;1-HIGHBAY, CF, PIP-II, at A0YNZ	-	
F10126726--;1-HIGHBAY GALLERY EQUIPMENT LAYOUT	-	
F10151133--;1-TEMPORARY IMPORTS-EXPORTS, PIP-II, A0YN CSYS	-	BTL & BAL ONLY
F10104753--;1-ENVELOPES, TRANSVERSE, PIP-II SCL ENCLOSURE AND GALLERY	-	
F10141756--;1-ALIGNMENT NETWORK, PIP-II	-	
F10134805--;1-CRYOPLANT BUILDING, PIP-II at A0YN CSYS	-	

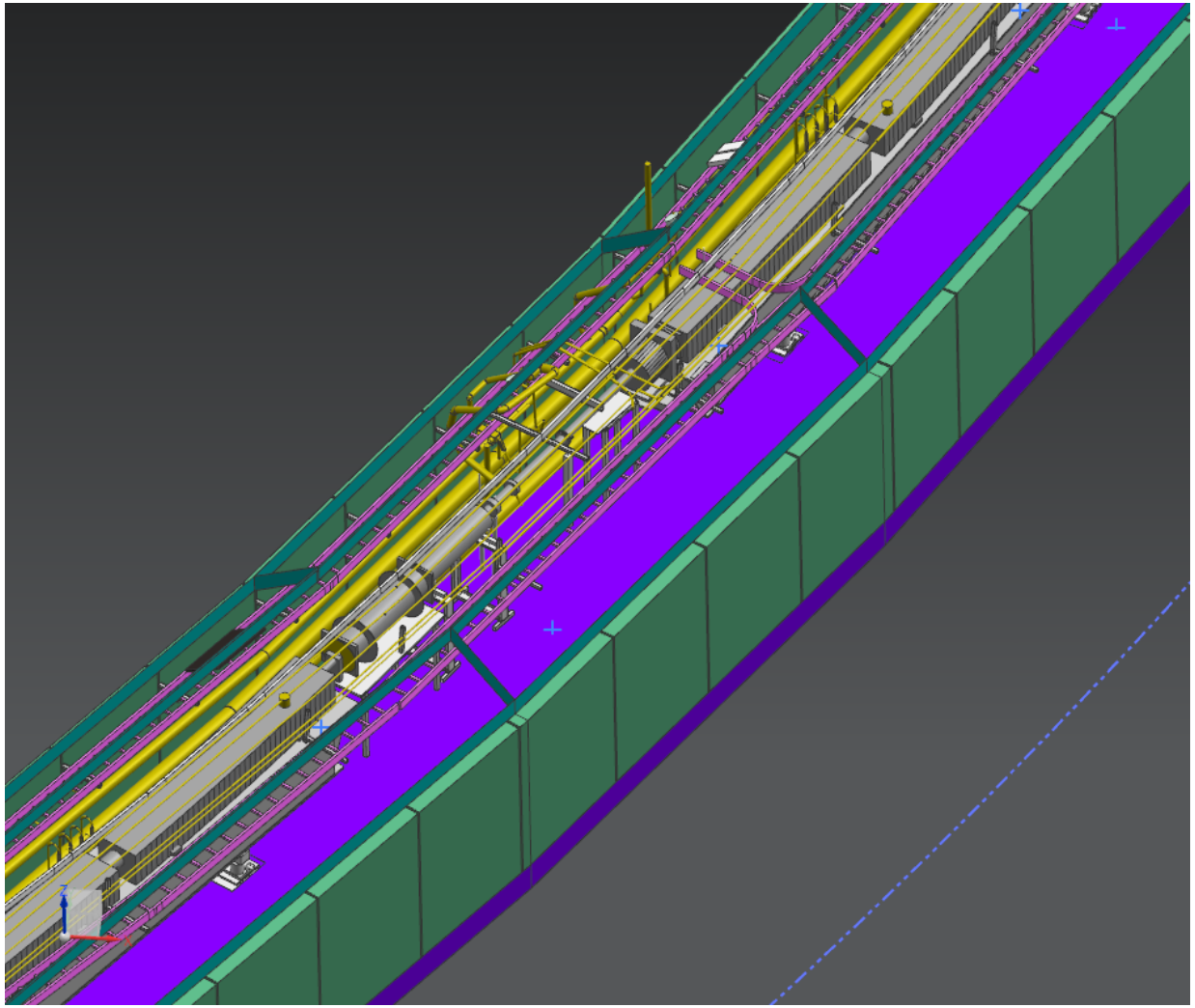


CF – Piping in work



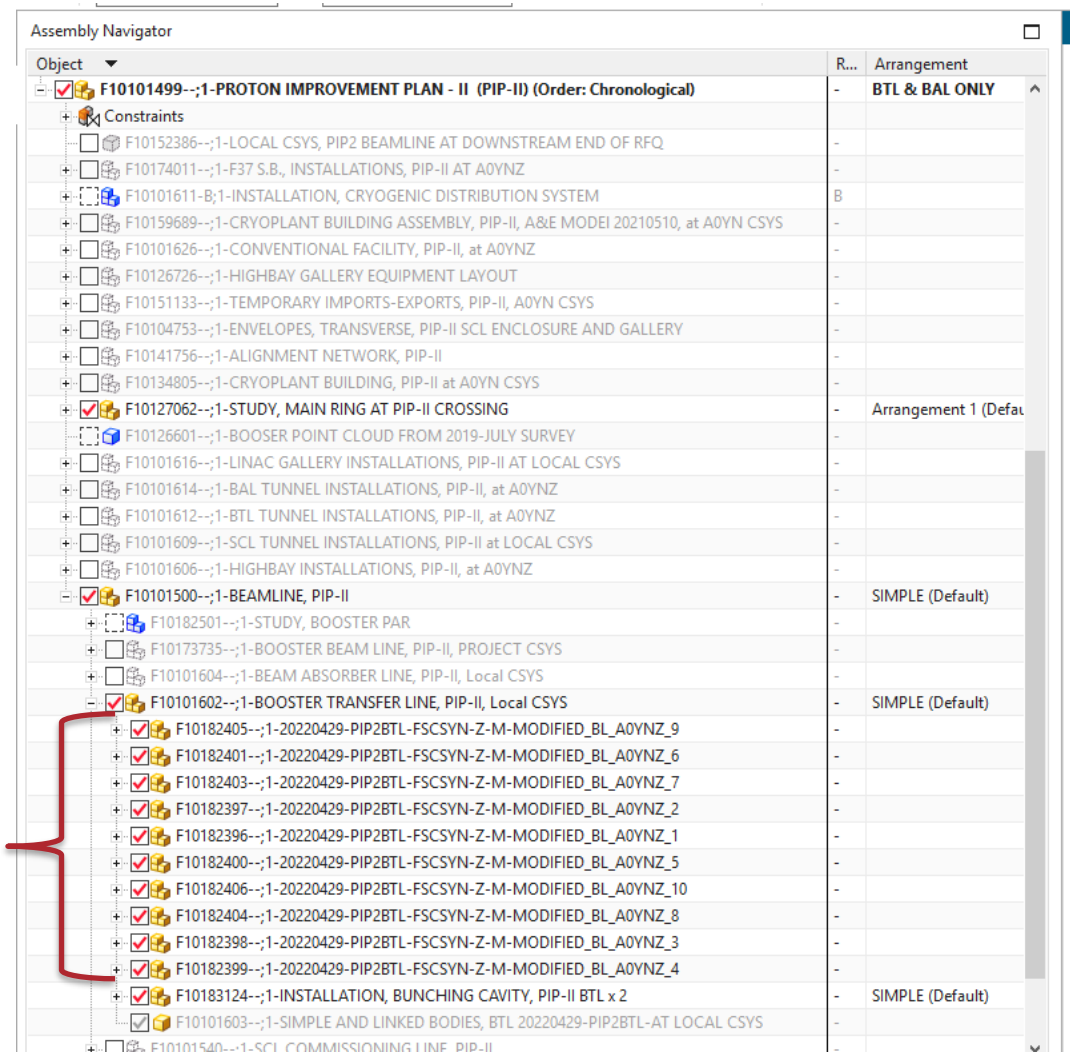
Existing Booster 3D Scan

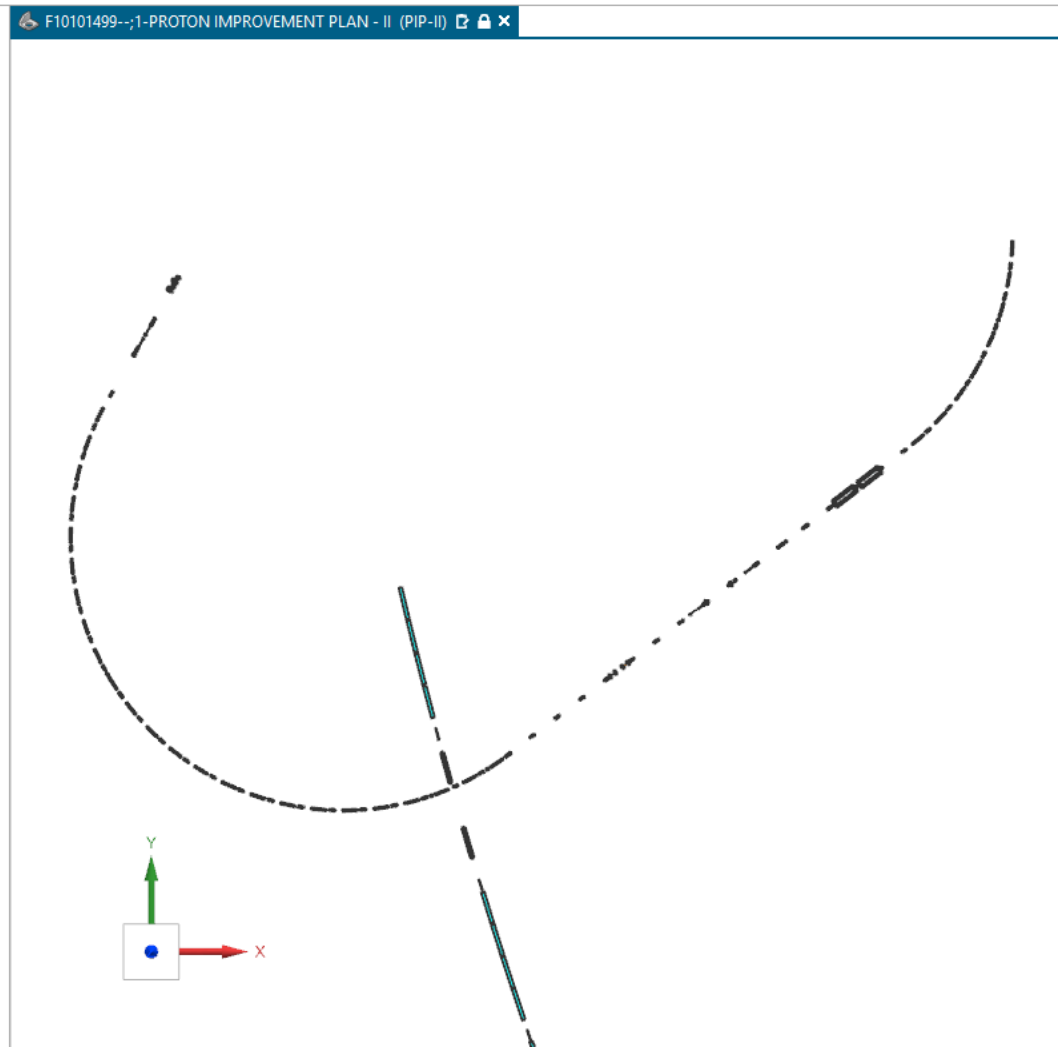
- For historical reasons, there is no integrated CAD model of the Booster in NX/Teamcenter
- We did a 3D scan of the PIP-II injection region in 2020
- Alignment fiducials are captured in scan and included in CAD model and allow for correct global positioning



Beamline - Lattice

Lattice files

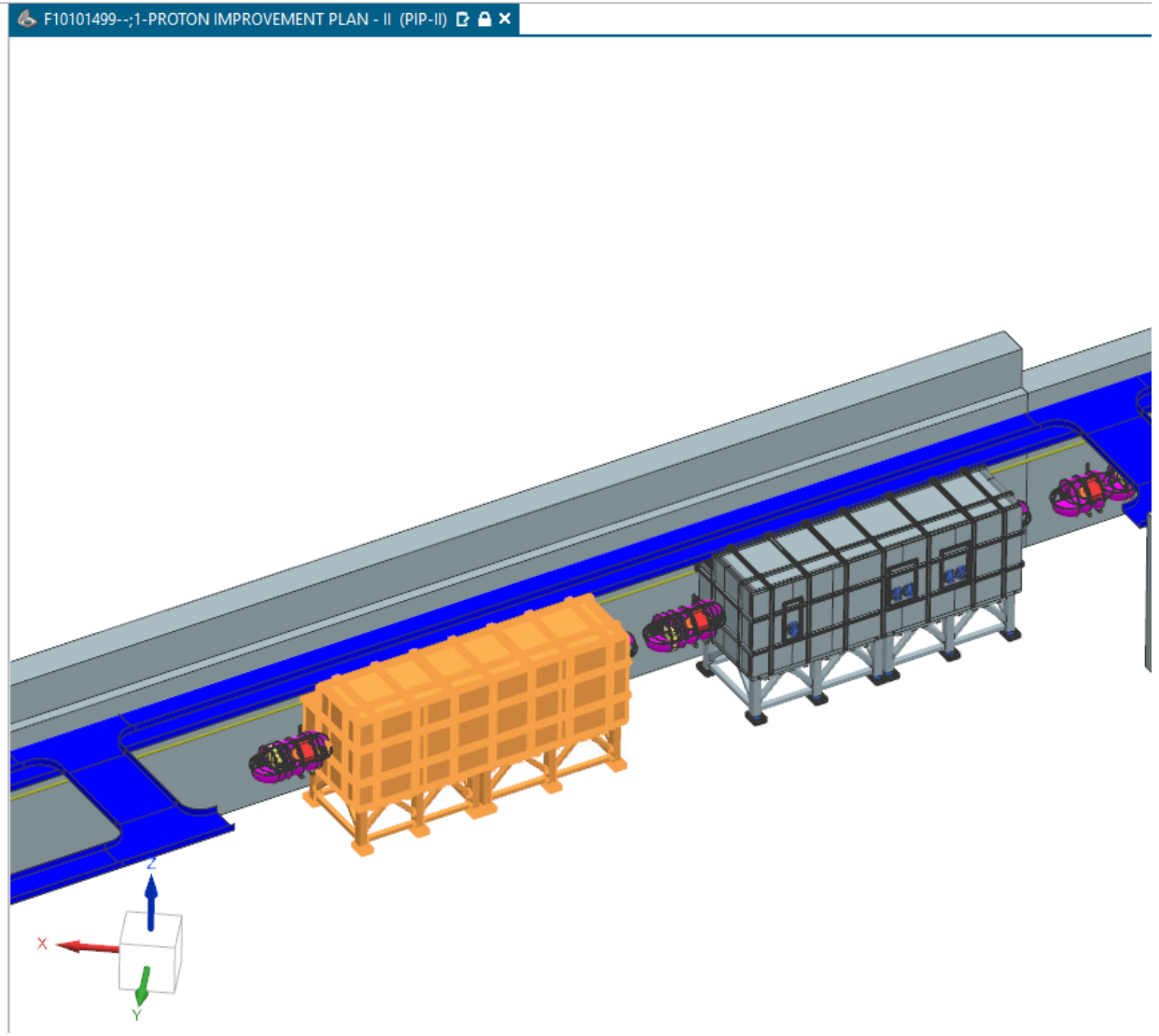




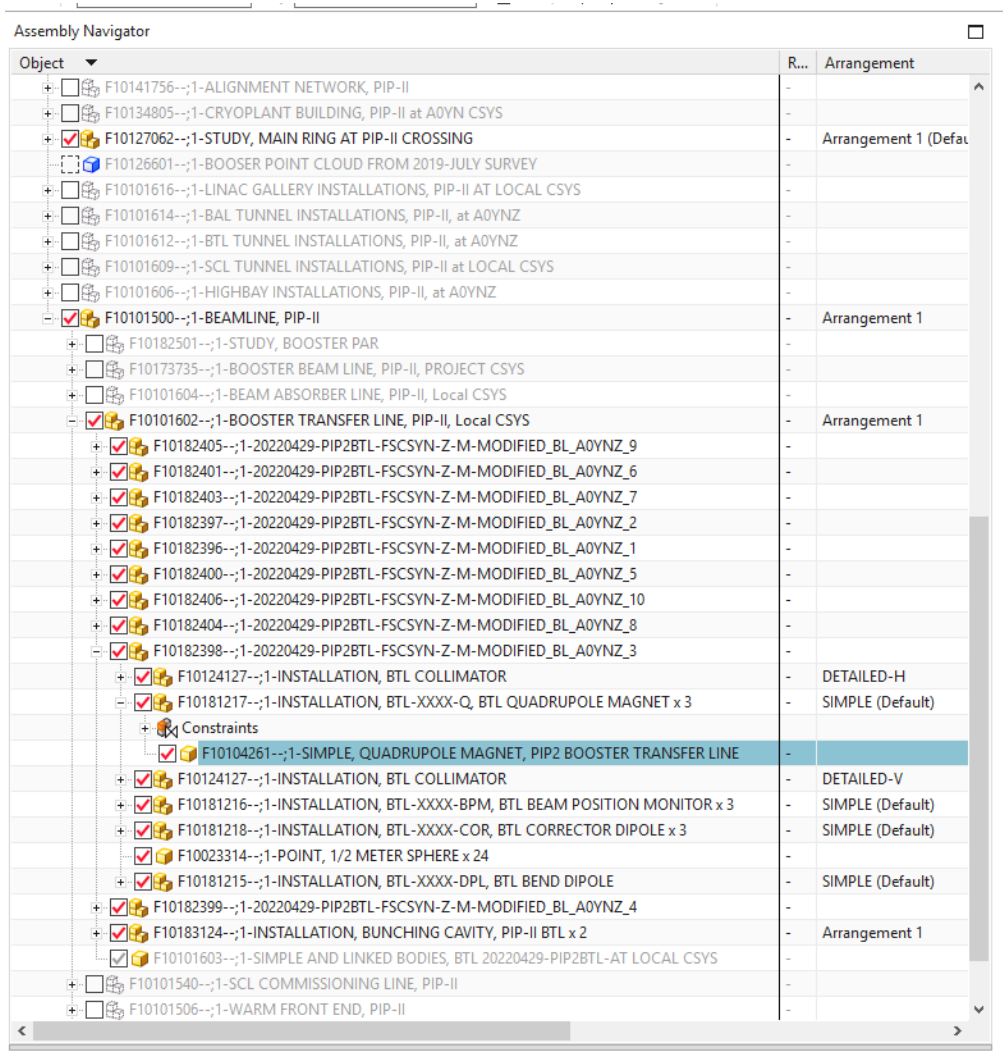
Beamline – Mature Integration (BTL Collimators)

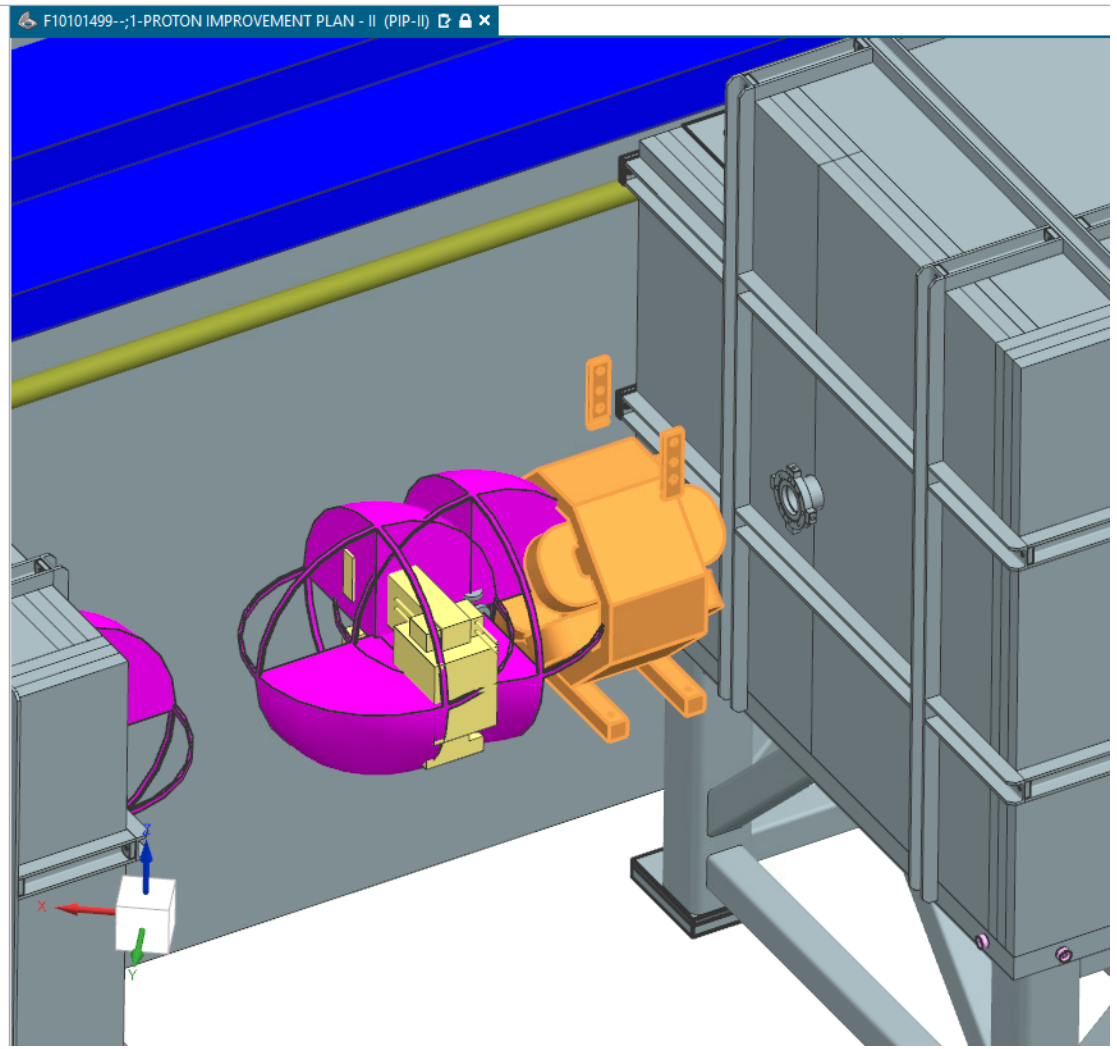
Assembly Navigator

Object	R...	Arrangement
F10134805--;1-CRYOPLANT BUILDING, PIP-II at A0YN CSYS	-	
F10127062--;1-STUDY, MAIN RING AT PIP-II CROSSING	-	Arrangement 1 (Defau
F10126601--;1-BOOSER POINT CLOUD FROM 2019-JULY SURVEY	-	
F10101616--;1-LINAC GALLERY INSTALLATIONS, PIP-II AT LOCAL CSYS	-	
F10101614--;1-BAL TUNNEL INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101612--;1-BTL TUNNEL INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101609--;1-SCL TUNNEL INSTALLATIONS, PIP-II at LOCAL CSYS	-	
F10101606--;1-HIGHBAY INSTALLATIONS, PIP-II, at A0YNZ	-	
F10101500--;1-BEAMLINE, PIP-II	-	Arrangement 1
F10182501--;1-STUDY, BOOSTER PAR	-	
F10173735--;1-BOOSTER BEAM LINE, PIP-II, PROJECT CSYS	-	
F10101604--;1-BEAM ABSORBER LINE, PIP-II, Local CSYS	-	
F10101602--;1-BOOSTER TRANSFER LINE, PIP-II, Local CSYS	-	Arrangement 1
F10182405--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_9	-	
F10182401--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_6	-	
F10182403--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_7	-	
F10182397--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_2	-	
F10182396--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_1	-	
F10182400--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_5	-	
F10182406--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_10	-	
F10182404--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_8	-	
F10182398--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_3	-	
F10124127--;1-INSTALLATION, BTL COLLIMATOR	-	DETAILED-H
F10181217--;1-INSTALLATION, BTL-XXXX-Q, BTL QUADRUPOLE MAGNET x 3	-	SIMPLE (Default)
F10124127--;1-INSTALLATION, BTL COLLIMATOR	-	DETAILED-V
F10174544--;1-PIP-II BTL Vertical Collimator Assembly	-	
F10174728--;1-PIP-II BTL Horizontal Collimator assembly	-	
F10124128--;1-ENVELOPE, BTL COLLIMATOR	-	
F10181216--;1-INSTALLATION, BTL-XXXX-BPM, BTL BEAM POSITION MONITOR x 3	-	SIMPLE (Default)
F10181218--;1-INSTALLATION, BTL-XXXX-COR, BTL CORRECTOR DIPOLE x 3	-	SIMPLE (Default)
F10023314--;1-POINT, 1/2 METER SPHERE x 24	-	
F10181215--;1-INSTALLATION, BTL-XXXX-DPL, BTL BEND DIPOLE	-	SIMPLE (Default)
F10182399--;1-20220429-PIP2BTL-FSCSYN-Z-M-MODIFIED_BL_A0YNZ_4	-	
F10183124--;1-INSTALLATION, BUNCHING CAVITY, PIP-II BTL x 2	-	Arrangement 1
F10101603--;1-SIMPLE AND LINKED BODIES, BTL 20220429-PIP2BTL-AT LOCAL CSYS	-	
F10101540--;1-SCL COMMISSIONING LINE, PIP-II	-	

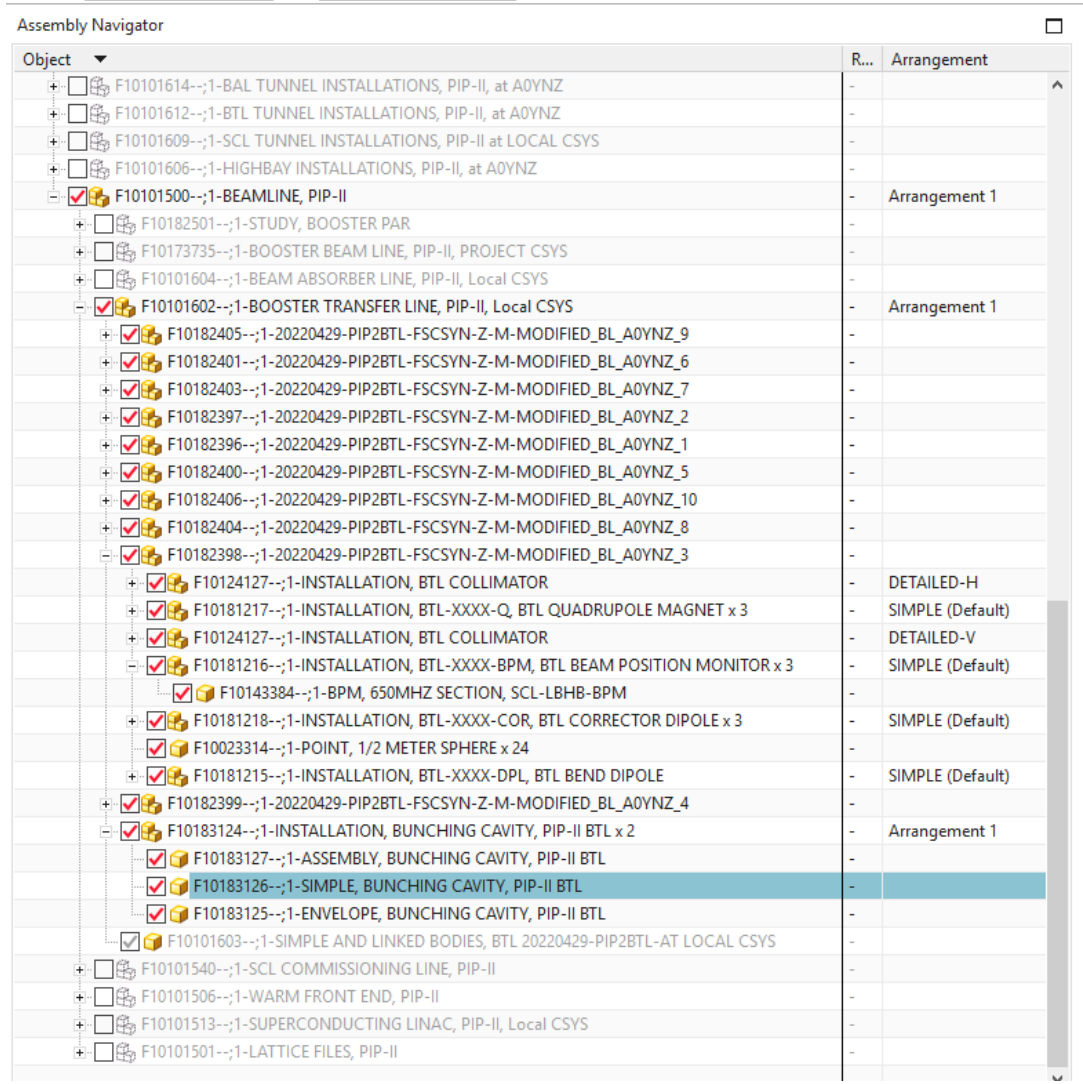


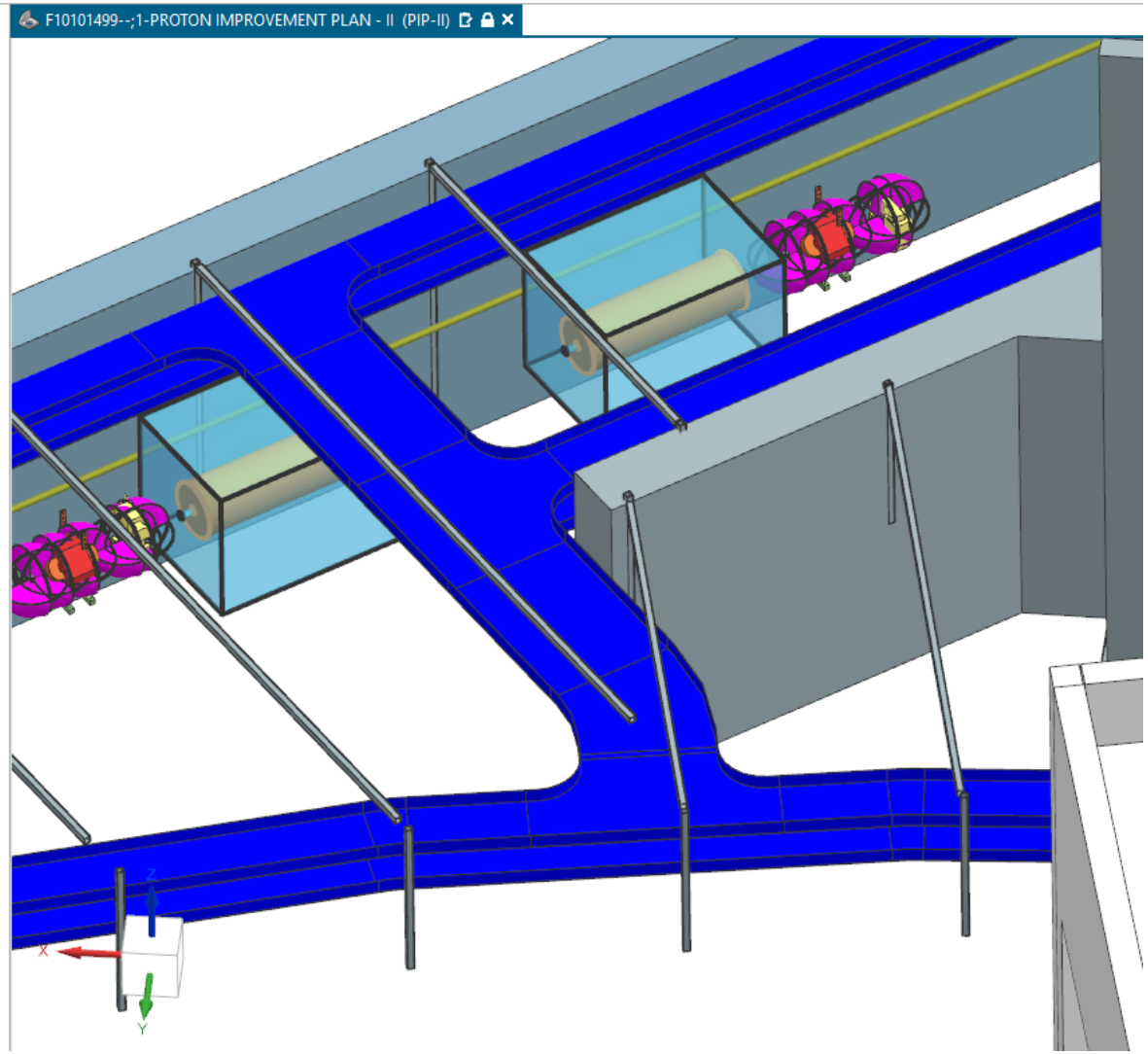
Beamline – Simplified Placeholder Integration (Magnets)



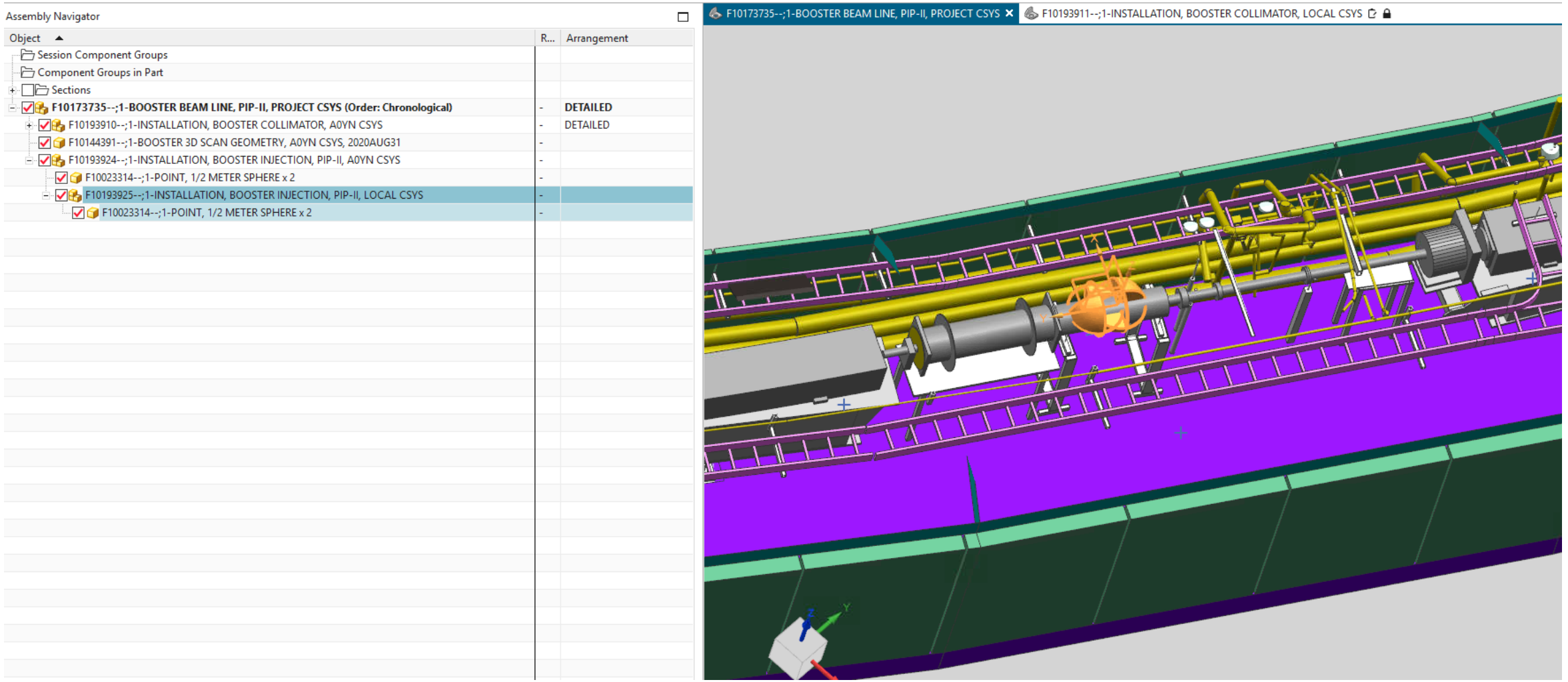


Beamline – Preliminary Envelope Integration (BTL Cavities)





Beamline – CSYS Integration (Injection Girder)



Components not currently represented/integrated

- Booster injection
- Instrumentation
- Vacuum
- Stands
- Anything/everything else

Outline

- Goals and Scope
- CAD Modeling Practices
- Data Exchange Techniques
- Current BTL Model Status
- Path to BTL Model Integration

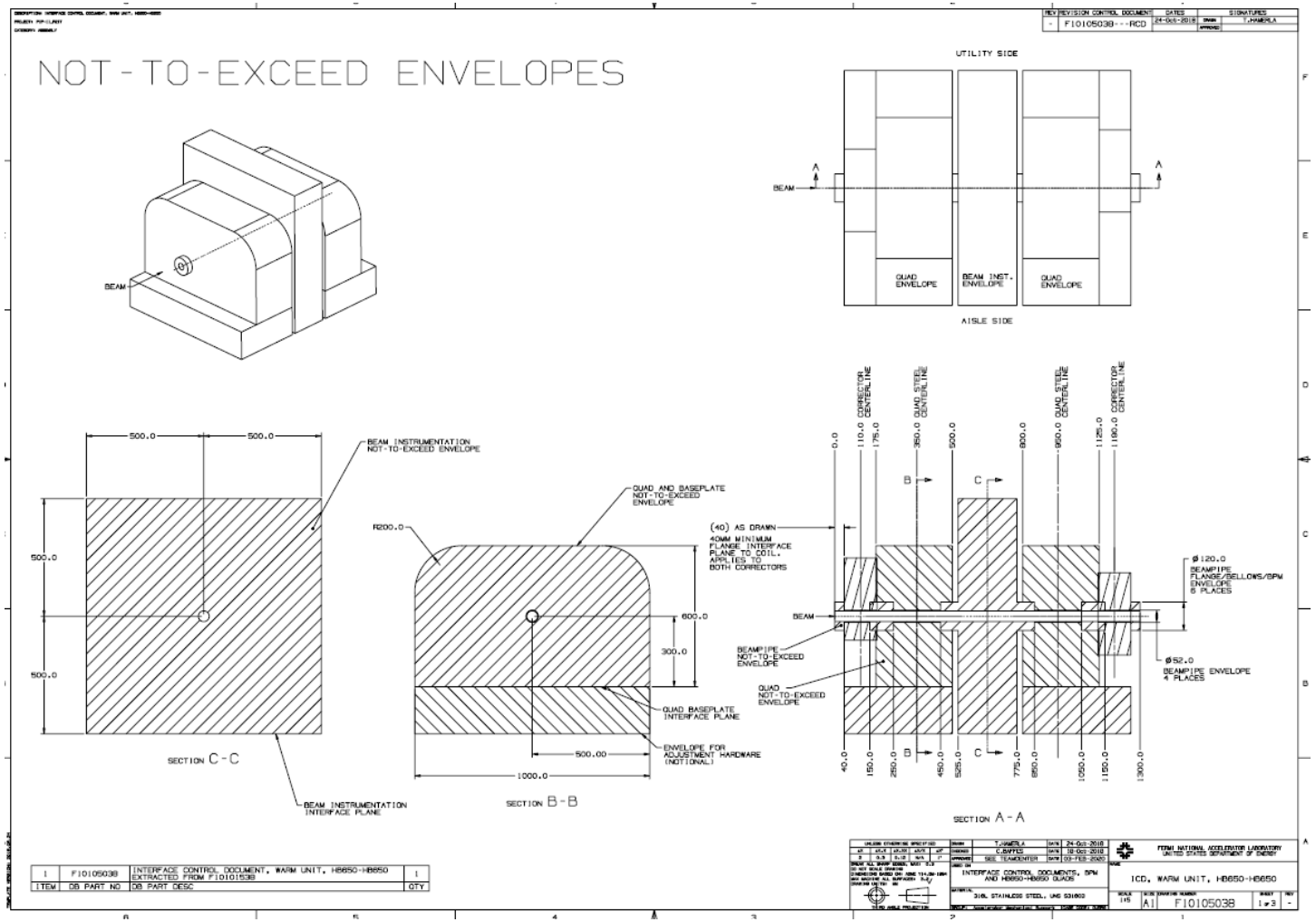
Path to BTL Model Integration

- When should model integration happen?
  - As soon as you can define a coordinate system and location for a design
  - If you can provide a volume envelope, that's helpful also
  - The later integration happens, the more likely it becomes that we will have problems

- Next steps for hardware to be designed in the future
  - Interfacing parties can agree on volume envelopes
  - We can create these envelopes and placeholder assembly structure
  - These can facilitate specification development (e.g. for magnets)
  - Allows design-in-context from the beginning

Path to BTL Model Integration

- Example of NTE envelopes used as interface specification



Path to BTL Model Integration

- Next steps for hardware already in design
  - Responsible engineers should make sure their models are integrated in the top-level model
  - Responsible engineers/designers should use the top-level models to understand context, verify fit, and work issues

What LI CAD Team Will and Will Not Do

- LI CAD Team Will
  - Continue to implement lattice and CF files
  - Create appropriate assembly structures
  - Work with design teams to optimize loading and visualization
    - 2-way communication about model issues
    - we can create arrangements that you need
    - we can create component groups for visualization
- LI CAD Team Will Not
  - Drive envelopes and interfaces in the BTL/BAL/Booster
  - Systematically hunt down interferences and problems
  - Create geometry beyond simple placeholder geometry
  - Create interface or installation drawings for BTL/BAL/Booster components or systems
  - Some combination of owning, interfacing and installing L3s are responsible for all this

Questions/Discussion