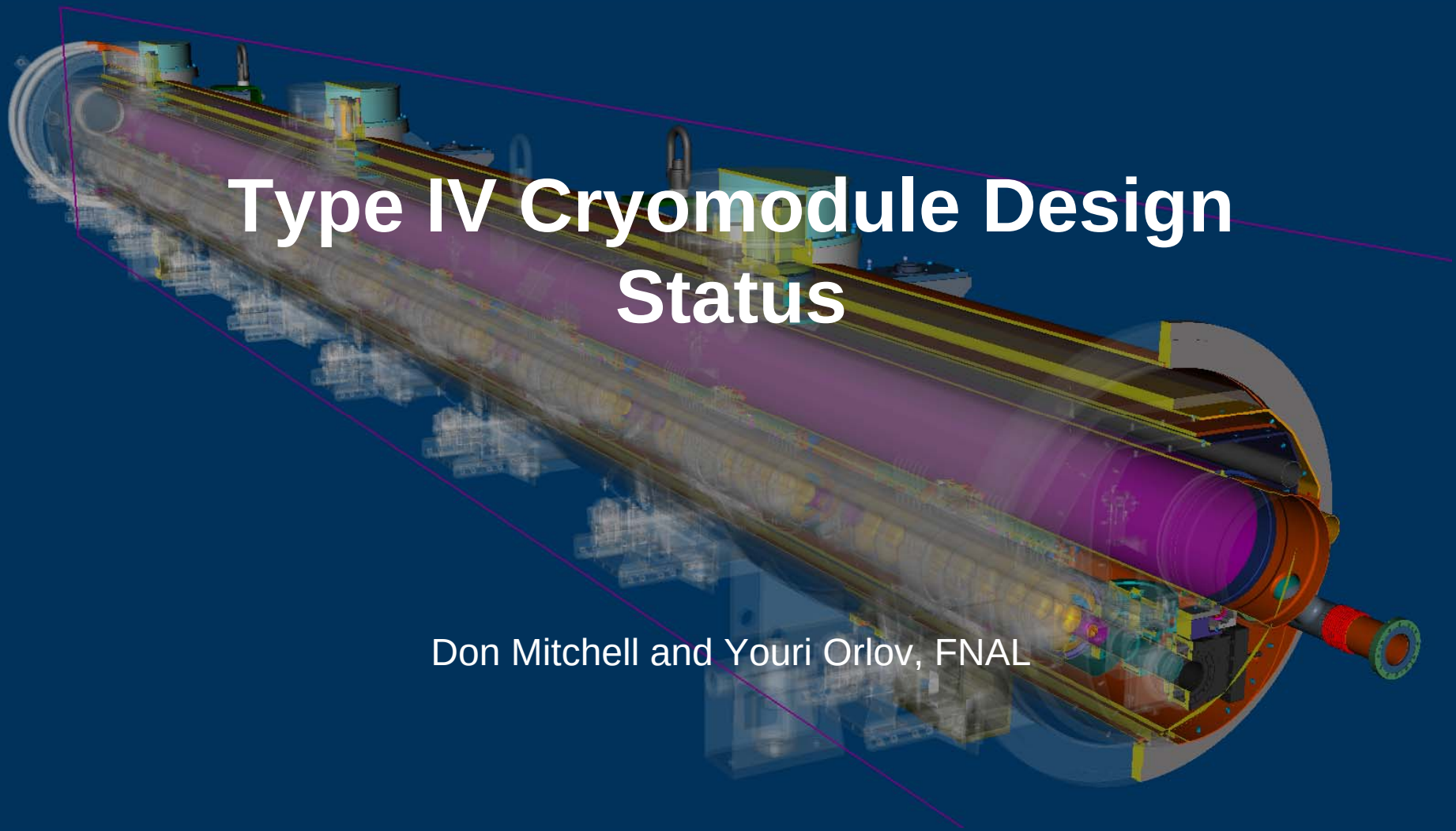
Type IV Cryomodule Design Status



Don Mitchell and Youri Orlov, FNAL

Outline:

1. January 2007 Meeting. Milan, Italy (summary)
2. Type IV Cryomodule Design Status

January 2007 Meeting. Milan, Italy

- During the T4CM collaboration meeting held in Milan, Italy, the design team held a meeting to discuss the strategy for the construction of the first two cryomodules to be built at Fermilab as well as future plans for the development of the T4CM.

- Specific attention was placed on the cavity, helium vessel design, and the helium gas return pipe for the second cryomodule. Due to cavity orders that are already placed, helium vessels and bladetuners that already exist, and a new bladetuner design being prototyped, a plan to minimize the workload and to bring each institution into equal agreement was necessary.

- doc # *828181 was created located in Desy EDMS System.

January 2007 Meeting. Milan, Italy

Work plan for 2007

INFN (LASA, Milan), ITALY:

- Provide FNAL with 1.3GHz helium vessel bladetuners (old and new)
- Work on new helium vessel design for the T4CM cavities.
  - ✓ short style cavity with a standard end-group configuration
  - ✓ cavity not modified
  - ✓ more simplified, low cost vessel with a much improved load path.
- Work on a new cavity end-group / helium vessel design for future ILC cavities.

INFN (Pisa), ITALY:

- Flow induced vibration study with FNAL.
- Cavity-to-cavity interconnect re-design for lower force and reduced cost.
- Bi-metallic transition study (titanium to stainless). Share notes between DESY, CERN, INFN, FNAL, and Russian scientists.
- Drafting details of all components for a possible European cryomodule construction.

January 2007 Meeting. Milan, Italy

Work plane for 2007

KEK, JAPAN:

- Continue research and testing on internal magnetic shielding.

FNAL, USA:

- Design and procure new cavity-to-cavity bellows for cryomodule #2.
- Modify the TTF III+ cryomodule 3-D model to reflect all of the changes in cryomodule #2 and place this model in the ILC EDMS.
- Design and procure external magnetic shielding for cavities.
- Americanize the INFN helium vessel w/ bladetuner design and fabricate for cryomodule #2.
- Provide a “baseline” T4CM design 3-D model for team review by mid-March ’07.
- Horizontal test 1.3 GHz cavities w/ bladetuners.
- Design Quad magnet/steering magnet package and implement into T4CM.
- Design BPM and integrate into the magnet package.
- Design conductively cooled magnetic leads for magnet package and design vessel interface.

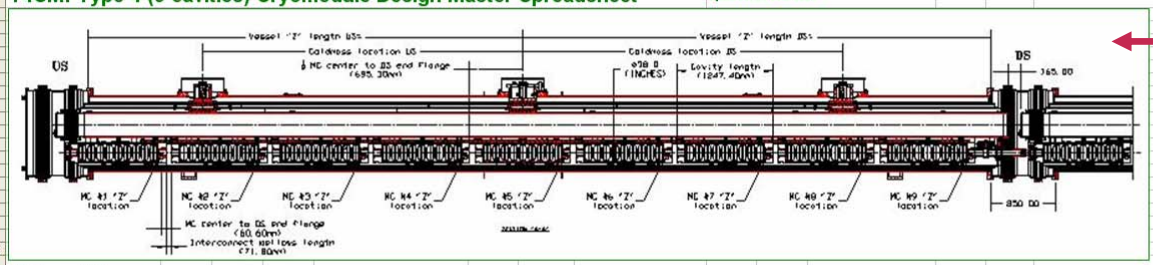
T4CM Design Status. FNAL

- Two cryomodules will be designed:
  - 9 cavities w/o magnet
  - 8 cavities w/ magnet package.
- The first focus will be to design the 8 cavity cryomodule with a dummy magnet since the design of a functioning quad magnet package is still far from a reality.
- The deadline for completing a drawing package for the first cryomodule has been set by Fermilab to be October 1, 2007.

T4CM Design. The Master Spreadsheet

Microsoft Excel - T4CM_9_MASTER-022807.xls

T4CM: Type 4 (9 cavities) Cryomodule Design Master Spreadsheet — updated: 27 Mar 2007



US = Upstream, DS = Downstream

Cryostat DATA	inches	mm
Vessel Diameter	38	965.20
Vessel Wall	0.375	9.53
US Cav. Flange-to-US Vessel Flange=	9.200	233.67
DS Cav. Flange-to-DS Vessel Flange=	7.959	202.17
Vessel Flange-to-vessel shell DS=	-0.807	-20.50
Vessel Flange-to-vessel shell US=	0.610	15.50
Vessel "Z" length US=	-223.104	-5666.83
Vessel "Z" length DS=	240.063	6097.00
Vessel Length (flange-to-flange)=	463.368	11769.50
Vessel shell length US=	-222.493	-5651.33
Vessel shell length DS=	239.456	6082.17
Cav. String to Vessel CL=	9.724	247.00
VESSEL SUPPORT DS	190.945	4850.00 ?
VESSEL SUPPORT US	-171.260	-4350.00 ?
VESSEL PICKUP DS	118.110	3000.00 ?
VESSEL PICKUP US	-118.110	-3000.00 ?

Cavity/Helium Vessel DATA	mm	
Cavity length=	1247.400	
Interconnect bellows length=	71.800	
MC center-to-lug1 distance=	196.862	? (last mod)
MC center-to-lug2 distance=	946.862	? (last mod)
MC center to DS end flange=	60.600	
Invar mount center to end flange=	156.732	? (last mod)
"Z" shrinkage, invar post-to-MC=	0.257	?-Ti
"Z" shrinkage, invar post-to-Lug1=	0.269	?-Ti
"Z" shrinkage, invar post-to-Lug2=	2.271	?-Ti
String length (cav-to-cav flange	10481.80	

CAVITY_5_DATA	mm
Cavity_5_US Flange "Z" =	-623.7
Cavity_5_DS Flange "Z" =	623.700
Port "A" Z-location=	
Port "B" Z-location=	
Port "C" Z-location=	
Port "D" Z-location=	

COLDMASS SUPT DATA	mm
Coldmass Supt hole diam=	414
Coldmass location US=	-4175
Coldmass location DS=	4175
HGR Centerline=	356
ColdMass Support post warm-US=	-4175
ColdMass Support post warm-DS=	4175
ColdMass Support post Shrink.-US	21.668
ColdMass Support post Shrink.-DS	21.668

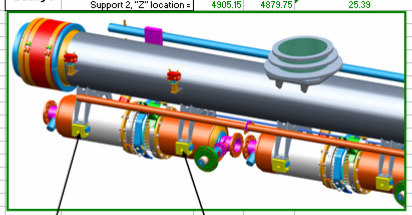
Misc. DATA	mm	
Beamline Vertical Shrinkage=	1.9	(was=1.5mm)
MC port hole diameter=	325.2	
coef. Thermal exp. Stainless steel =	0.0000730 mm/mm/c	0.0000103
coef. Thermal exp. Invar 36 =	0.000002 mm/mm/c	0.00000127
temperature delta =	300 deg C	
HGR pipe "Y" location from vessel cen.=	109 mm	
MC's Warm "Y" location=	0	
MC's Cold "Y" location=	0.9	(was=1.5mm)
MC's Warm "X" location=	0	
MC's Cold "X" location=	0.2	(was=0.2mm)
Coef. Termal exp. **Ti**	0.0000085 mm/mm/c	0.0000053
Coef. Termal exp. **Niobium**		0.0000049

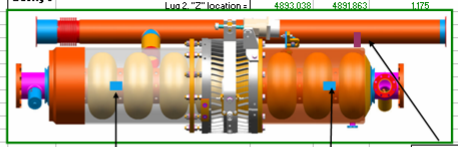
Main Coupler Location DATA	"Z" Warm	"Z" Cold	"Z" Shrinkage (mm)
	mm	mm	
MC #1 "Z" location=	-4713.70	-4711.07	2.629
MC #2 "Z" location=	-3394.50	-3392.66	1.838
MC #3 "Z" location=	-2075.30	-2074.25	1.046
MC #4 "Z" location=	-756.10	-755.85	0.255
MC #5 "Z" location=	563.10	562.56	0.537
MC #6 "Z" location=	1882.30	1880.97	1.328
MC #7 "Z" location=	3201.50	3199.38	2.120
MC #8 "Z" location=	4520.70	4517.79	2.911
MC #9 "Z" location=	5839.90	5836.20	3.703

Cavity Flanges Distance	Warm	Cold
1--2	71.800	72.842
2--3	71.800	72.842
3--4	71.800	72.842
4--5	71.800	72.842
5--6	71.800	72.842
6--7	71.800	72.842
7--8	71.800	72.842
8--9	71.800	72.842

HGR Support Location DATA		"Z" Warm	"Z" Cold	"Z" Shrinkage (mm)
Cavity 1	Support 1, "Z" location =	-4921.73	-4896.24	25.49
	Support 2, "Z" location =	-5672.67	-5643.29	29.38
Cavity 2	Support 1, "Z" location =	-3599.50	-3580.86	18.64
	Support 2, "Z" location =	-4350.44	-4327.91	22.53
Cavity 3	Support 1, "Z" location =	-2277.27	-2265.48	11.79
	Support 2, "Z" location =	-3028.22	-3012.53	15.69
Cavity 4	Support 1, "Z" location =	-955.04	-950.10	4.95
	Support 2, "Z" location =	-1705.99	-1697.15	8.84
Cavity 5	Support 1, "Z" location =	367.18	365.28	1.90
	Support 2, "Z" location =	-383.76	-381.77	-1.99
Cavity 6	Support 1, "Z" location =	1689.41	1680.66	8.75
	Support 2, "Z" location =	938.47	933.61	4.85
Cavity 7	Support 1, "Z" location =	3011.64	2996.04	15.59
	Support 2, "Z" location =	2260.69	2248.99	11.70
Cavity 8	Support 1, "Z" location =	4333.87	4311.42	22.44
	Support 2, "Z" location =	3582.92	3564.37	18.55
Cavity 9	Support 1, "Z" location =	5656.09	5626.81	29.29
	Support 2, "Z" location =	4905.15	4879.75	25.39

Cavity/Helium Tank Location DATA		"Z" Warm	"Z" Cold	"Z" Shrinkage (mm)
Cavity 1	Lug 1, "Z" location =	-4910.562	-4907.407	3.155
	Lug 2, "Z" location =	-5660.562	-5655.405	5.157
Cavity 2	Lug 1, "Z" location =	-3591.362	-3588.999	2.363
	Lug 2, "Z" location =	-4341.362	-4336.996	4.366
Cavity 3	Lug 1, "Z" location =	-2272.162	-2270.590	1.572
	Lug 2, "Z" location =	-3022.162	-3018.588	3.574
Cavity 4	Lug 1, "Z" location =	-952.962	-952.182	0.780
	Lug 2, "Z" location =	-1702.962	-1700.179	2.783
Cavity 5	Lug 1, "Z" location =	366.238	366.227	0.011
	Lug 2, "Z" location =	-383.762	-381.771	-1.991
Cavity 6	Lug 1, "Z" location =	1685.438	1684.635	0.803
	Lug 2, "Z" location =	935.438	936.638	-1.200
Cavity 7	Lug 1, "Z" location =	3004.638	3003.044	1.594
	Lug 2, "Z" location =	2254.638	2255.046	-0.408
Cavity 8	Lug 1, "Z" location =	4323.838	4321.452	2.386
	Lug 2, "Z" location =	3573.838	3573.455	0.383
Cavity 9	Lug 1, "Z" location =	5643.038	5639.861	3.177
	Lug 2, "Z" location =	4893.038	4891.863	1.175



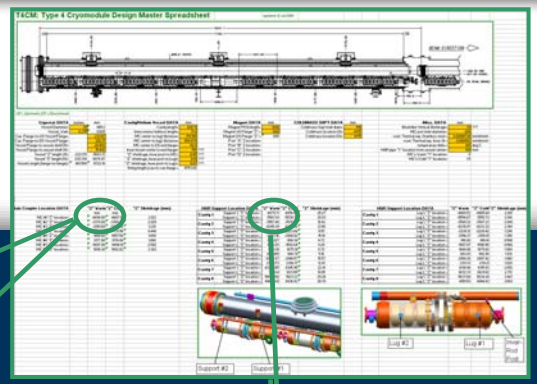


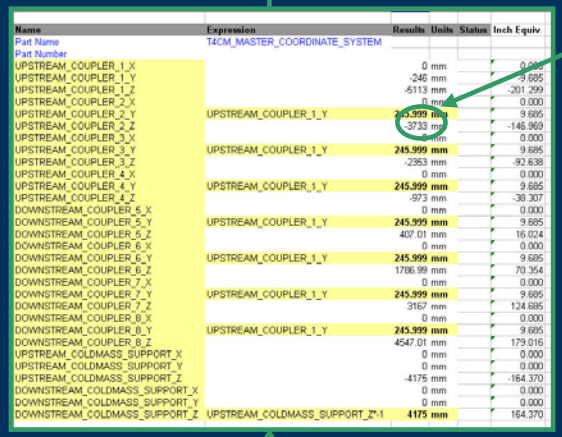
Hyperlinked to a detailed PDF drawing

Values which can be modified

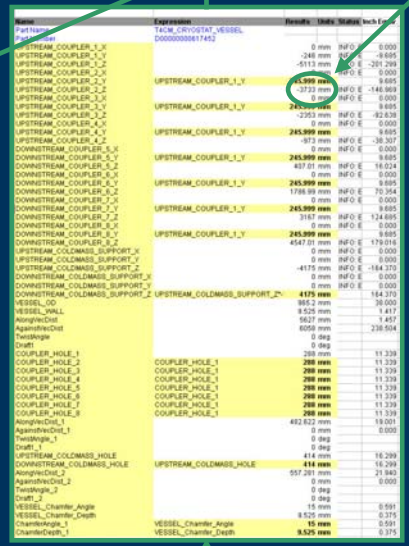
Shrinkage Calculations

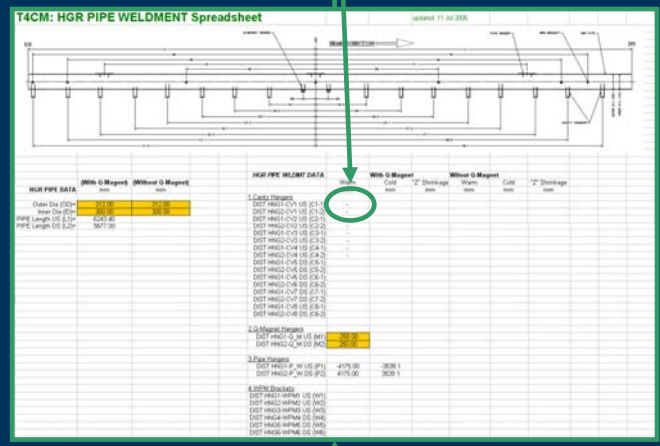
T4CM Design. Managing the CAD Assembly with Excel & I-DEAS

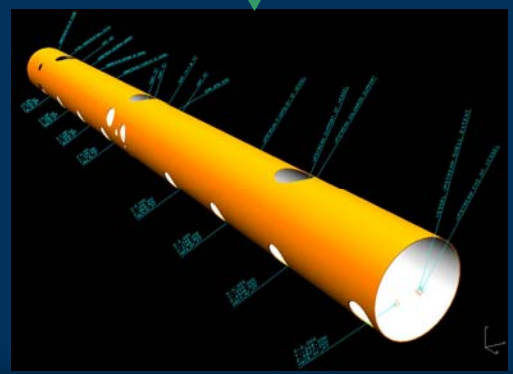


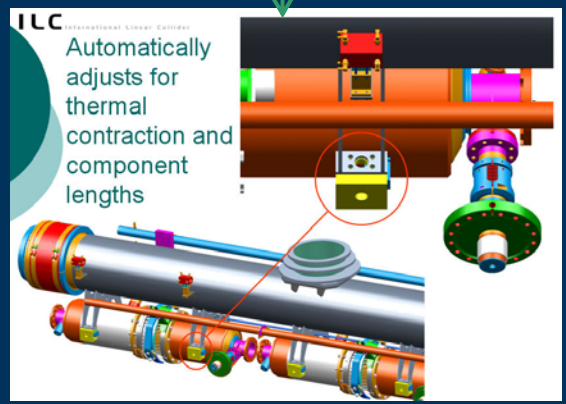


Name	Expression	Results	Units	Status	Inch Equiv
Part Name	T4CM_MASTER_COORDINATE_SYSTEM				
Part Number					
UPSTREAM_COUPLER_1_X		0	mm		0.000
UPSTREAM_COUPLER_1_Y		-246	mm		9.685
UPSTREAM_COUPLER_1_Z		-5113	mm		-201.299
UPSTREAM_COUPLER_2_X		0	mm		0.000
UPSTREAM_COUPLER_2_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
UPSTREAM_COUPLER_2_Z		-3733	mm		-146.969
UPSTREAM_COUPLER_3_X		0	mm		0.000
UPSTREAM_COUPLER_3_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
UPSTREAM_COUPLER_3_Z		-2353	mm		-92.638
UPSTREAM_COUPLER_4_X		0	mm		0.000
UPSTREAM_COUPLER_4_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
UPSTREAM_COUPLER_4_Z		-973	mm		-38.307
DOWNSTREAM_COUPLER_5_X		0	mm		0.000
DOWNSTREAM_COUPLER_5_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
DOWNSTREAM_COUPLER_5_Z		407.01	mm		16.024
DOWNSTREAM_COUPLER_6_X		0	mm		0.000
DOWNSTREAM_COUPLER_6_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
DOWNSTREAM_COUPLER_6_Z		1786.99	mm		70.354
DOWNSTREAM_COUPLER_7_X		0	mm		0.000
DOWNSTREAM_COUPLER_7_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
DOWNSTREAM_COUPLER_7_Z		3167	mm		124.685
DOWNSTREAM_COUPLER_8_X		0	mm		0.000
DOWNSTREAM_COUPLER_8_Y	UPSTREAM_COUPLER_1_Y	245.999	mm		9.685
DOWNSTREAM_COUPLER_8_Z		4547.01	mm		179.016
UPSTREAM_COLDMASS_SUPPORT_X		0	mm		0.000
UPSTREAM_COLDMASS_SUPPORT_Y		0	mm		0.000
UPSTREAM_COLDMASS_SUPPORT_Z		-4175	mm		-164.370
DOWNSTREAM_COLDMASS_SUPPORT_X		0	mm		0.000
DOWNSTREAM_COLDMASS_SUPPORT_Y		0	mm		0.000
DOWNSTREAM_COLDMASS_SUPPORT_Z	UPSTREAM_COLDMASS_SUPPORT_Z*-1	4175	mm		164.370



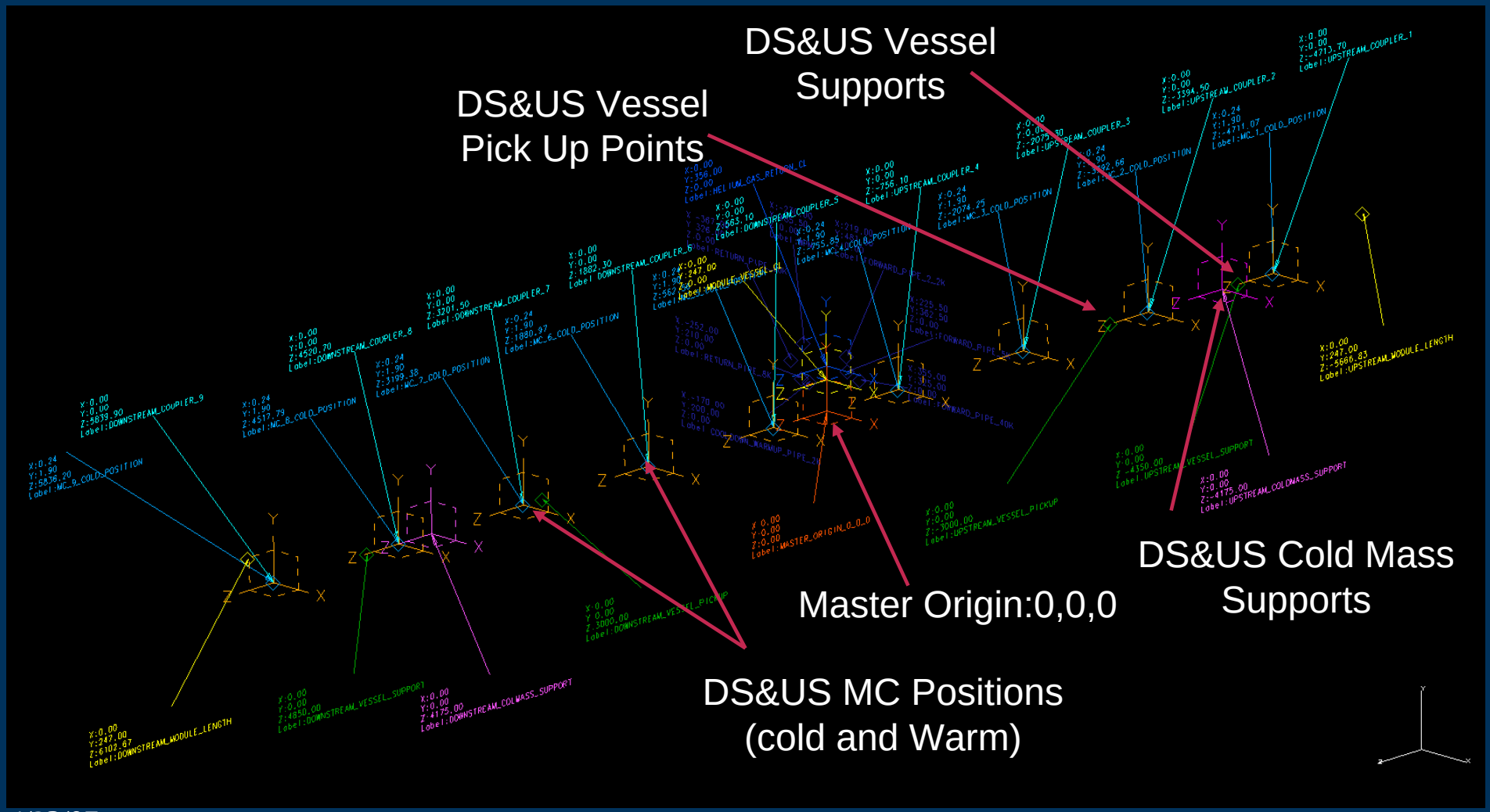




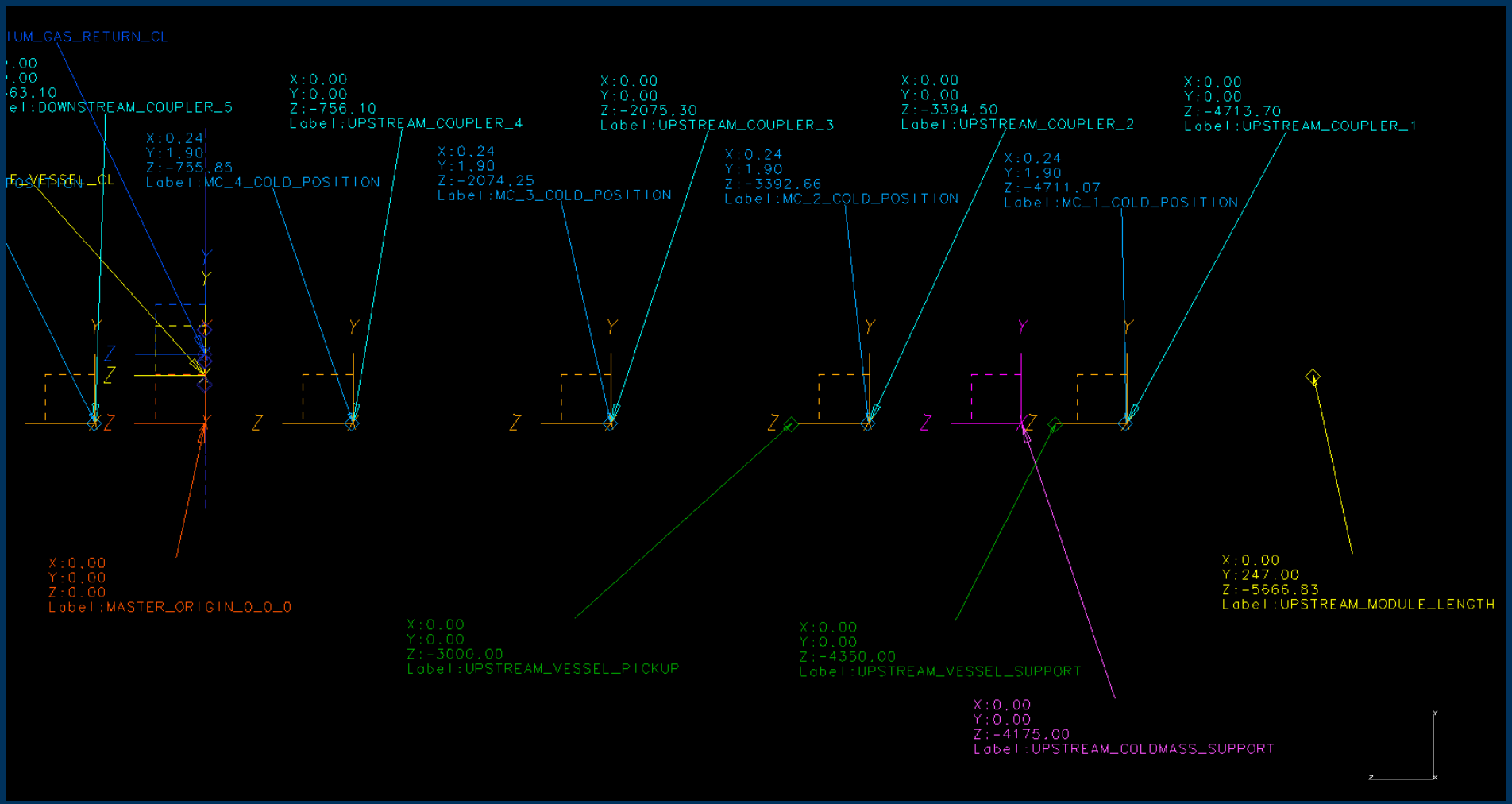


T4CM Design. Master Coordinate System

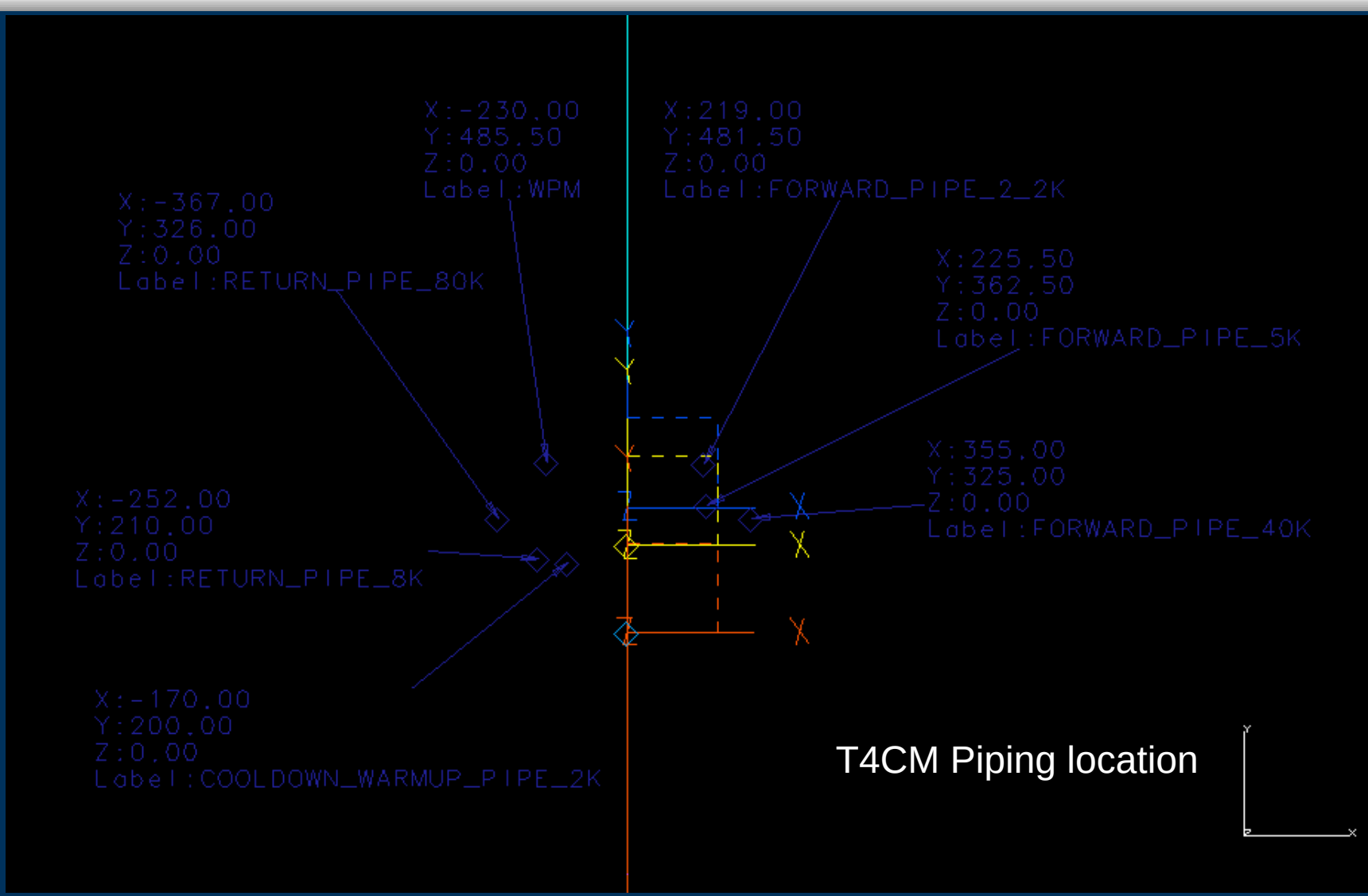
The ILC cryomodule Master C.S.



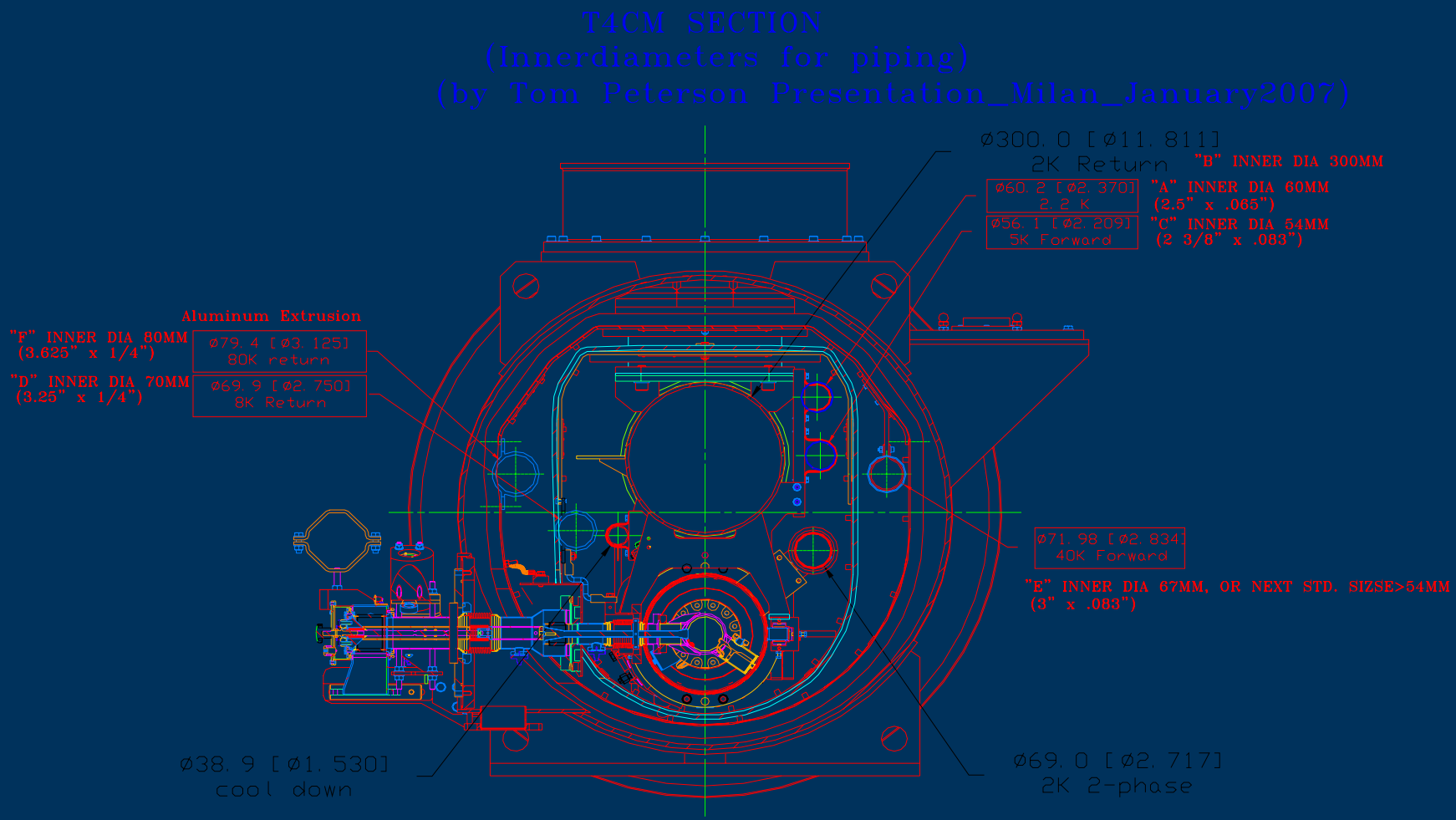
T4CM Design. Master Coordinate System continued



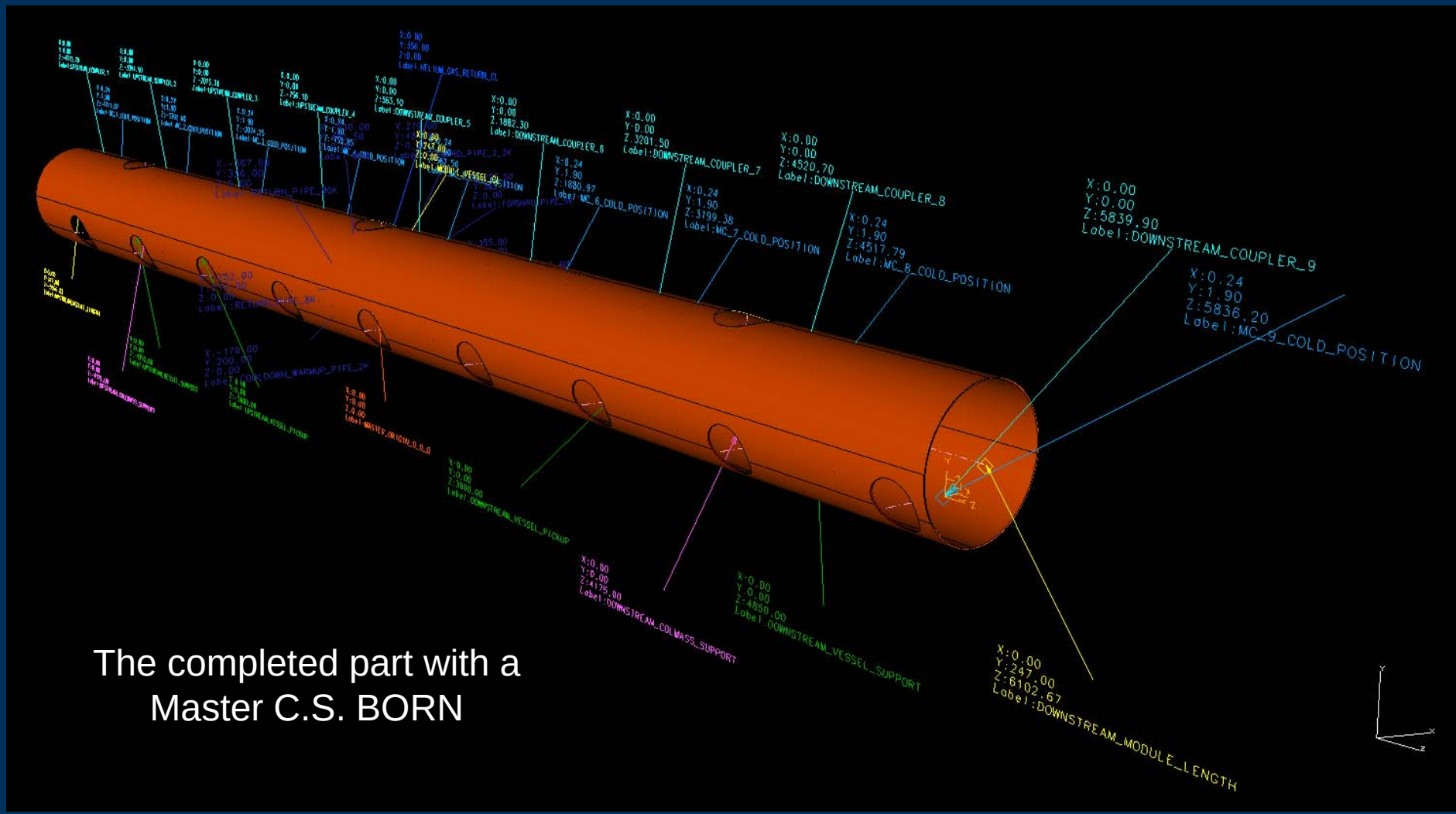
T4CM Design. Master Coordinate System continued



T4CM PIPING DIMENSIONS

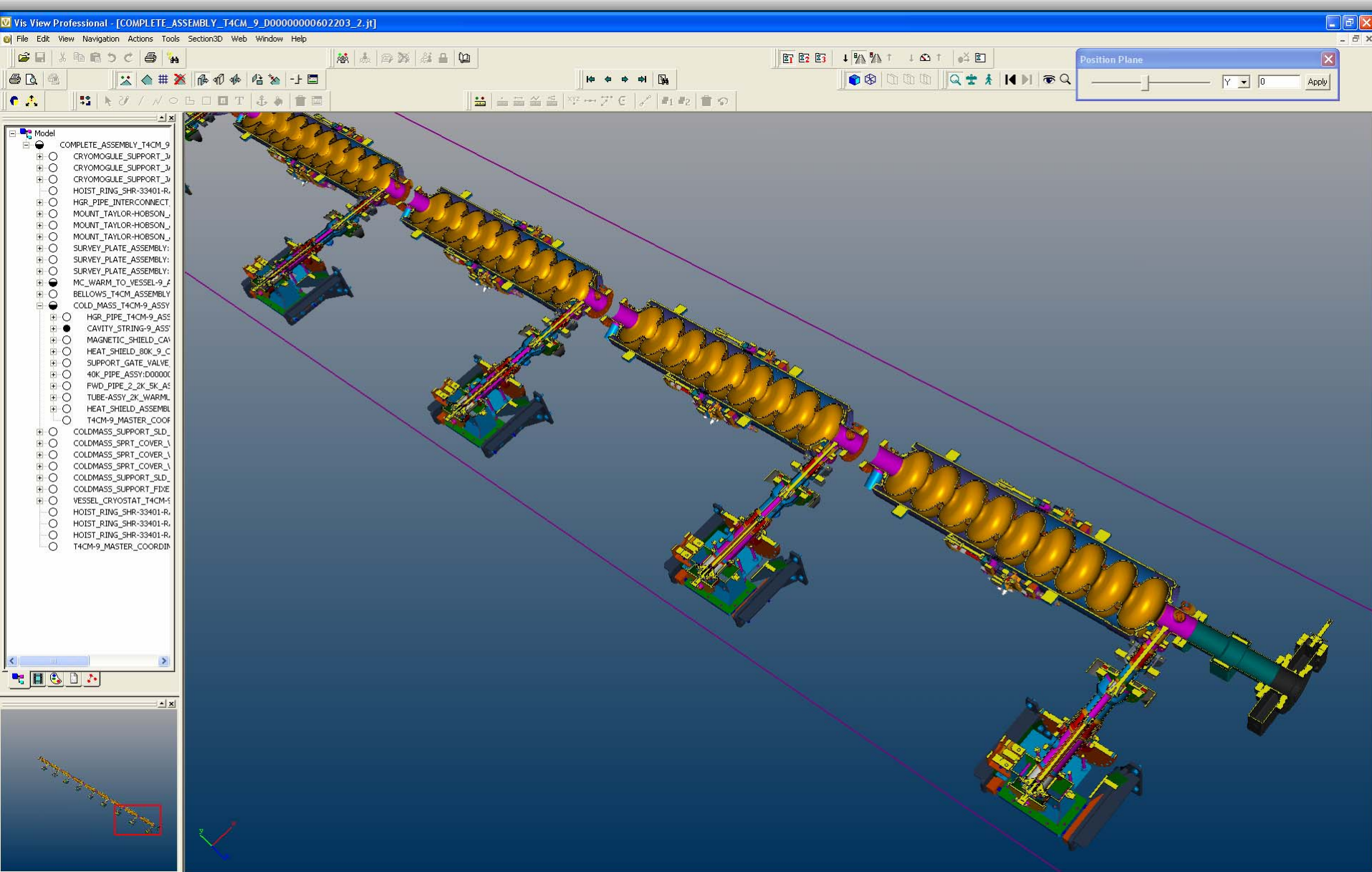


T4CM Design. “Key” Parts built with the Master C.S.

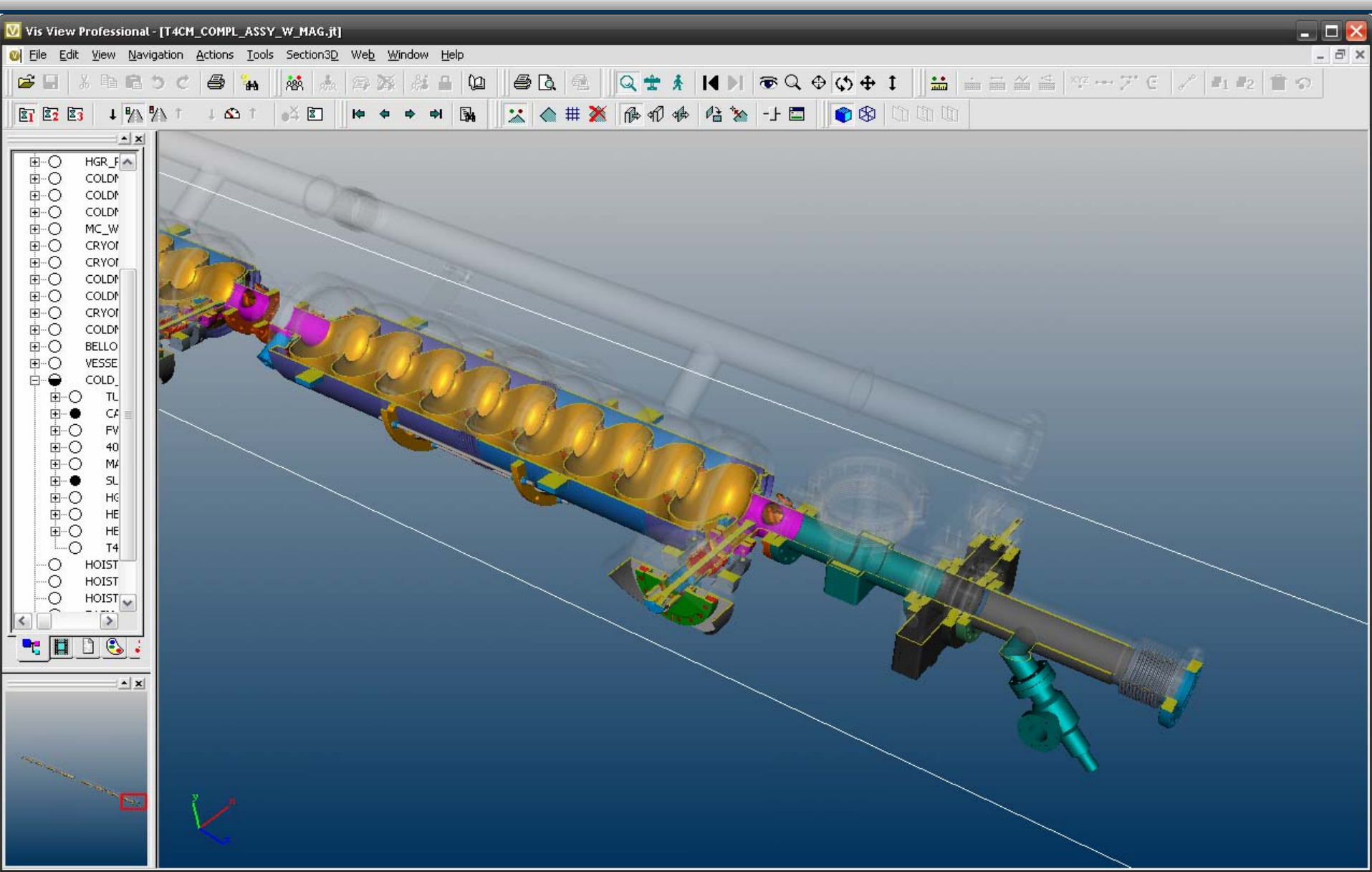


The completed part with a Master C.S. BORN

T4CM Design. CRYOMODULE WITH 9 CAVITIES



T4CM Design. CRYOMODULE WITH QUAD



Conclusion

- Continue to develop the cryomodule details
- Continue with R&D efforts on:
  - Seals
  - Flanges
  - Vibrations
  - Magnetic shielding
- Put more effort onto the quad magnet package development
- Resolve the current EDMS data issues
- Finalize plans to meet again in July at FNAL.