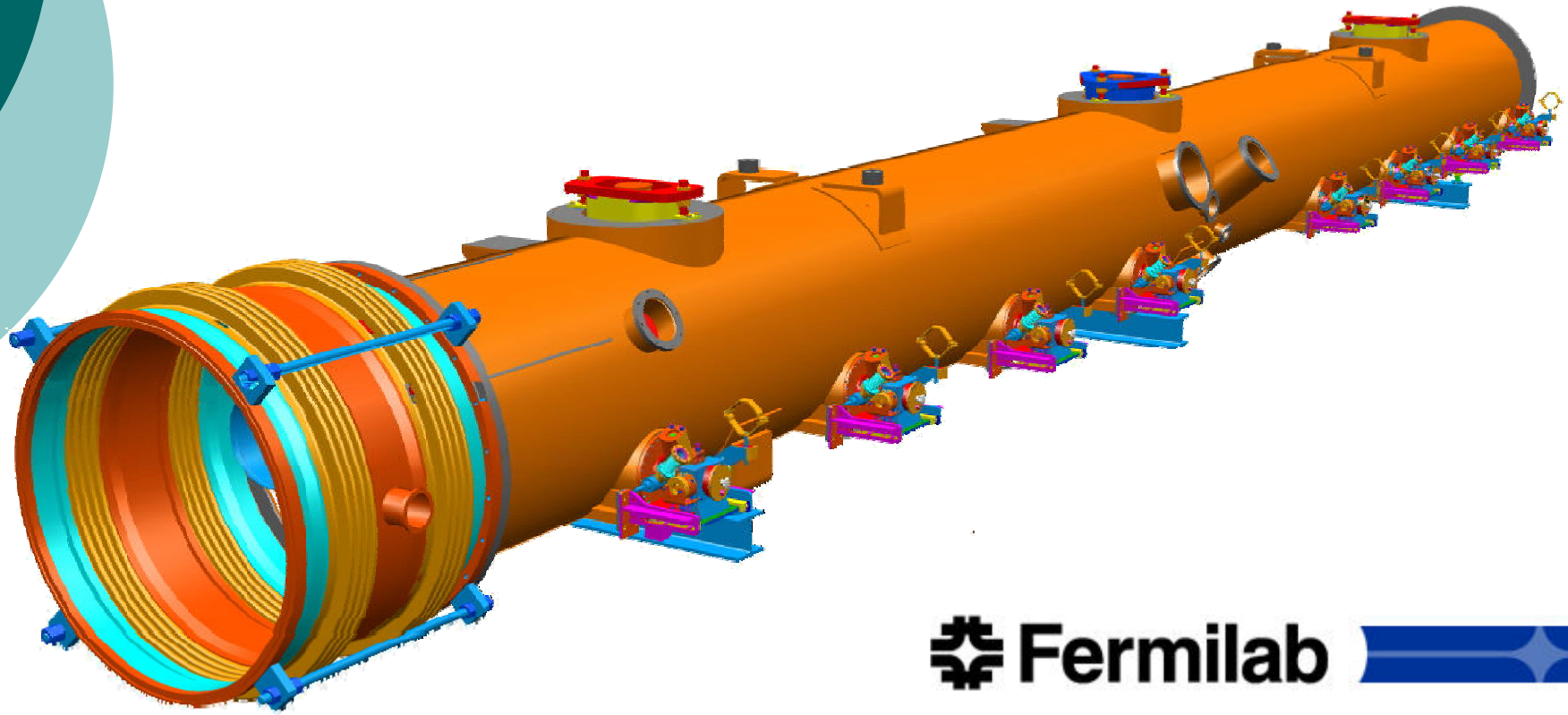
ILC International Linear Collider

Type IV Cryomodule Design Status

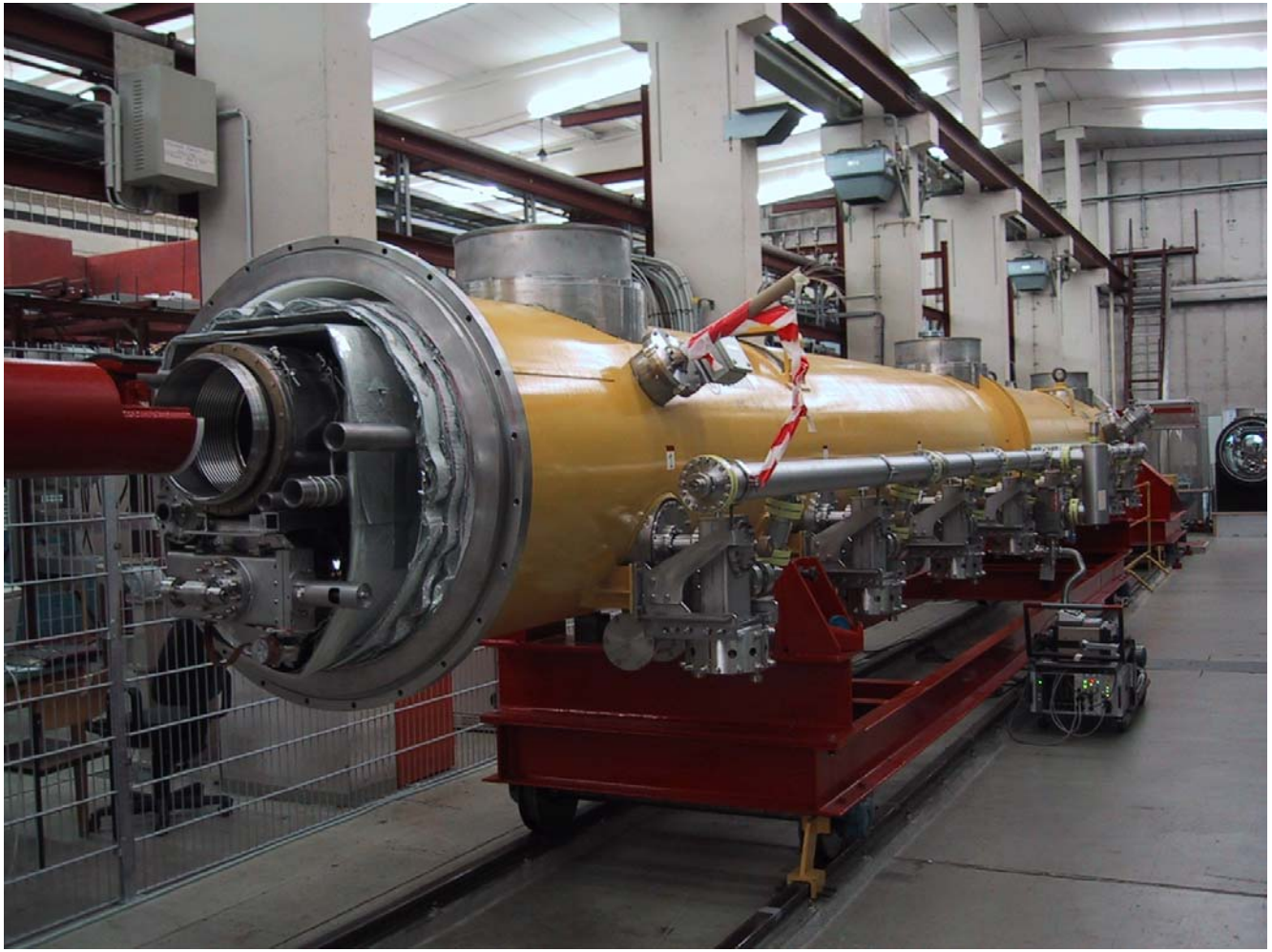
(T4CM)



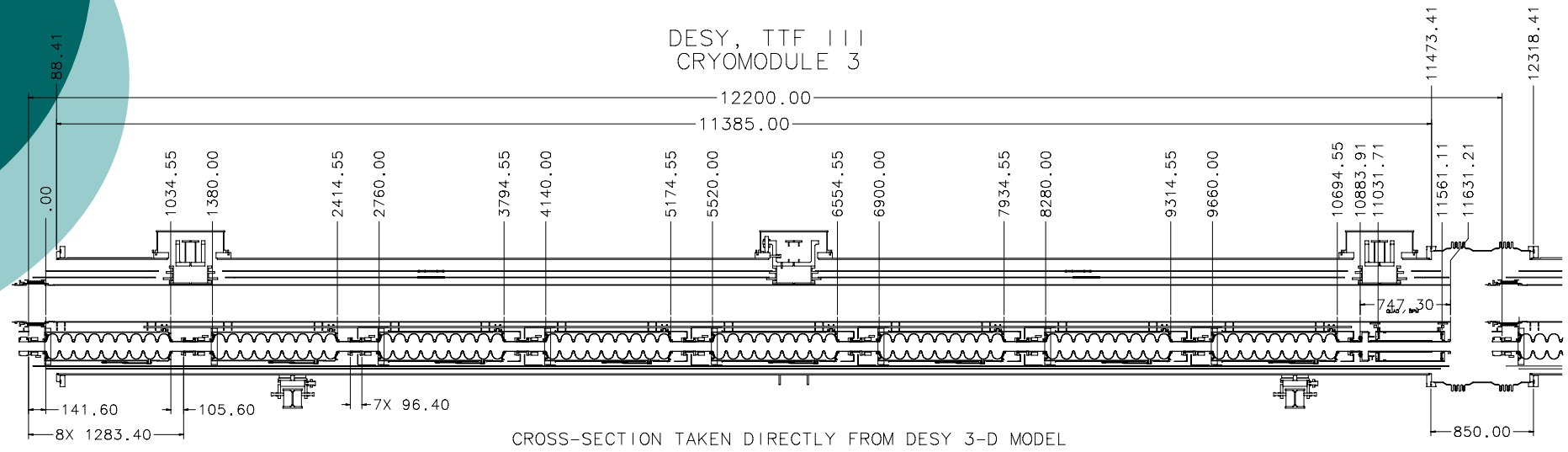
Fermilab

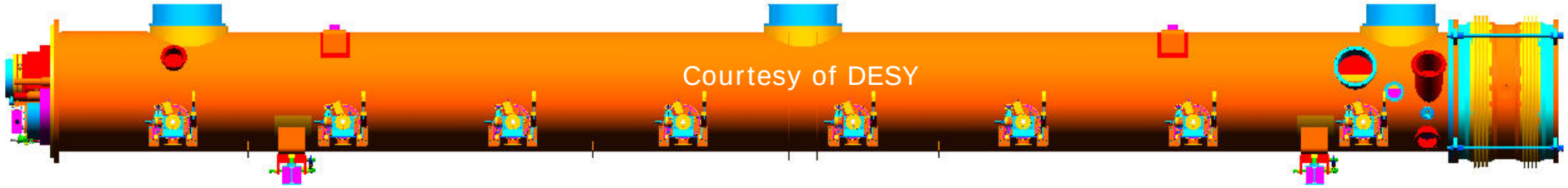
Don Mitchell, 13 JUL 2006

Design Reference: TTF III+



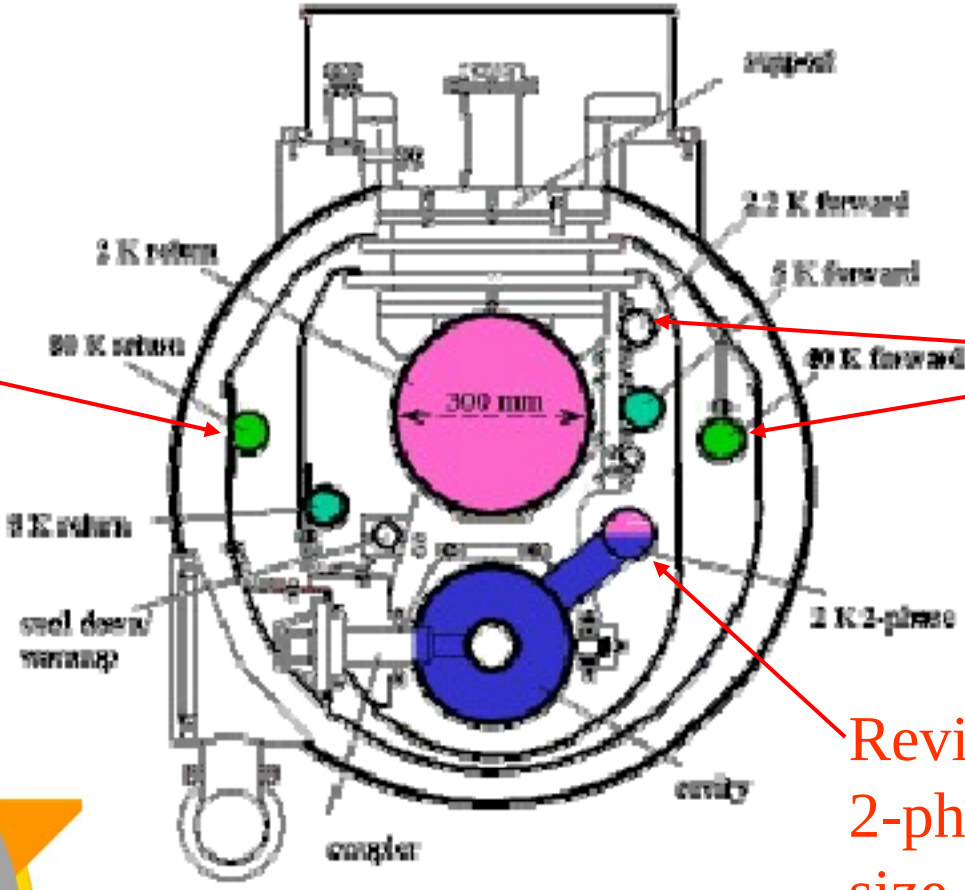
TTF III+ Cryomodule





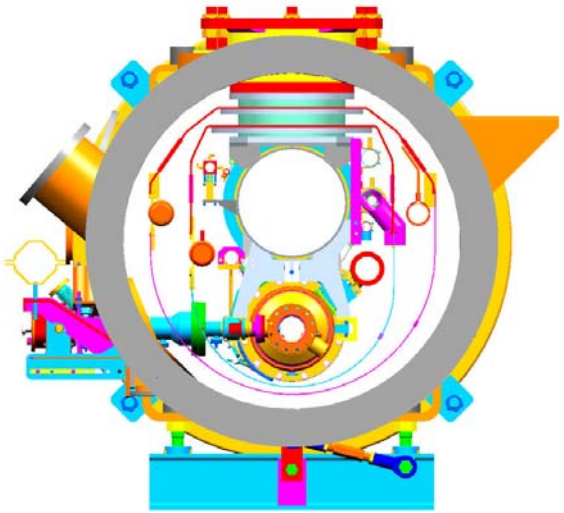
T4CM Cryo Design Considerations

- Move quad package to middle of cryomodule to achieve better support and alignment.
- Shorten cavity-to-cavity interconnect and simplify for ease of fabrication and cost reduction. Possible superconducting joint.
- Overall improved packing factor.
- Minimize direct heat load to cavity through MC.
- Simplify the assembly procedure.
- MLI redesign to reduce hands-on labor costs.
- More robust design to survive shipping.
- Reliability of tuner motors in cold operation.
- Etc. (we've heard many suggestions)



Increase diameter beyond X-FEL

Increase diameter beyond X-FEL

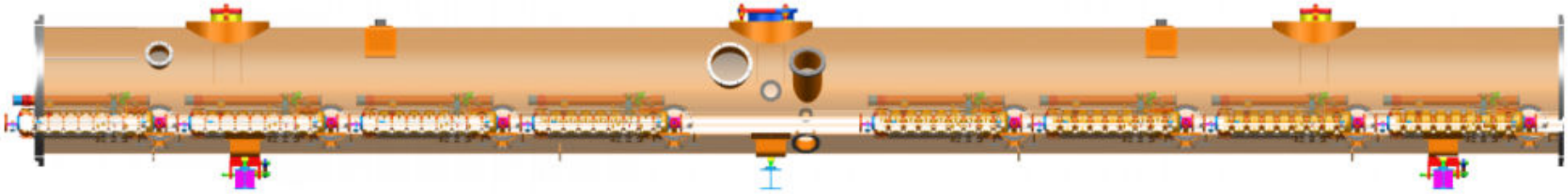


Review 2-phase pipe size and effect of slope

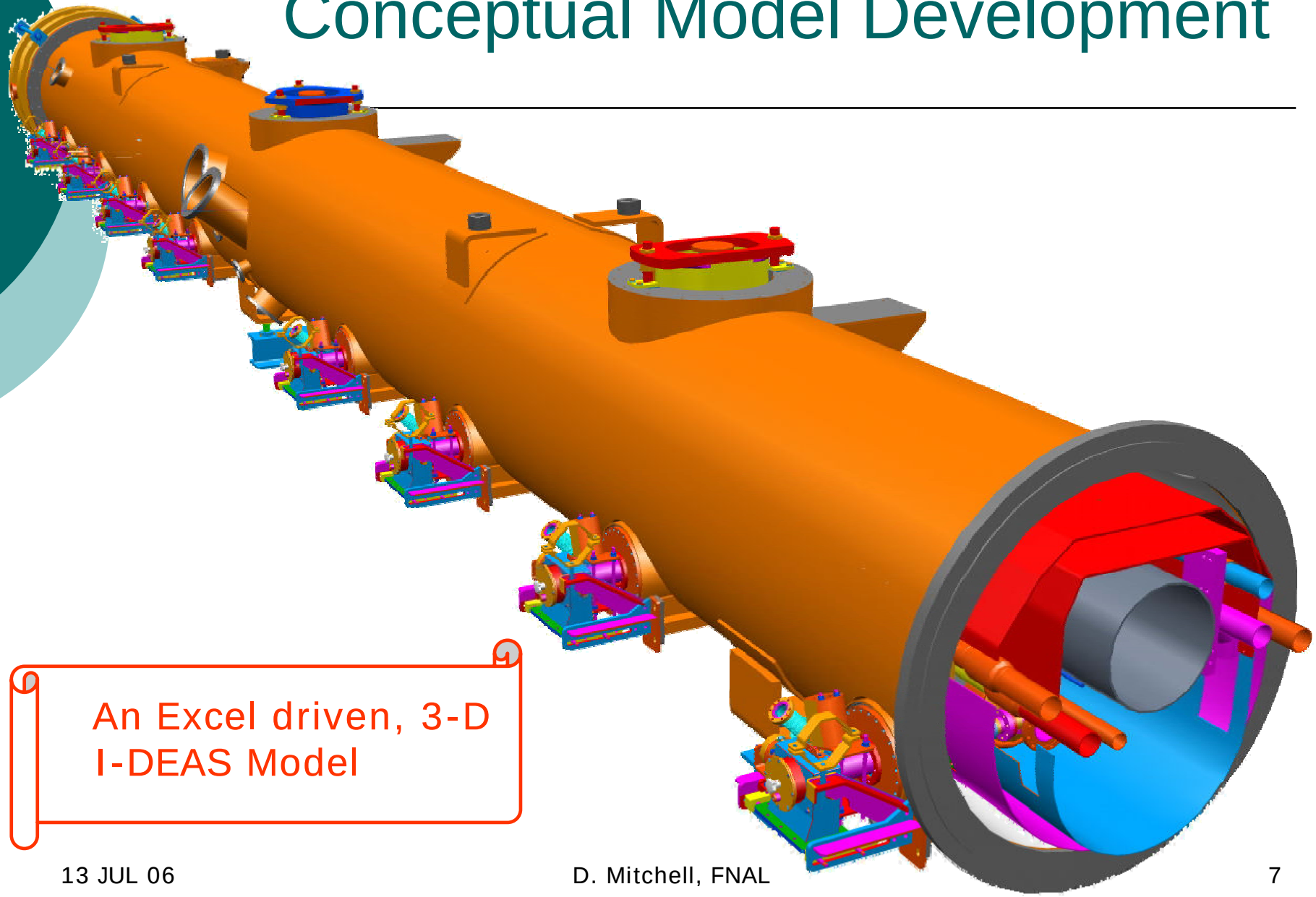
T4CM Proposal (the final ILC design??)

Minor changes to address major concerns.

- Magnet alignment, stability, and vibration issues.
- Cryomodule with and without magnet package
- Define BPM, Steering, and Quad parameters
- Reduced cavity length (Bladetuner design)
- Reduced cavity spacing (new interconnect)
- Need for functional Fast-Tuner (great WIP!)



Conceptual Model Development

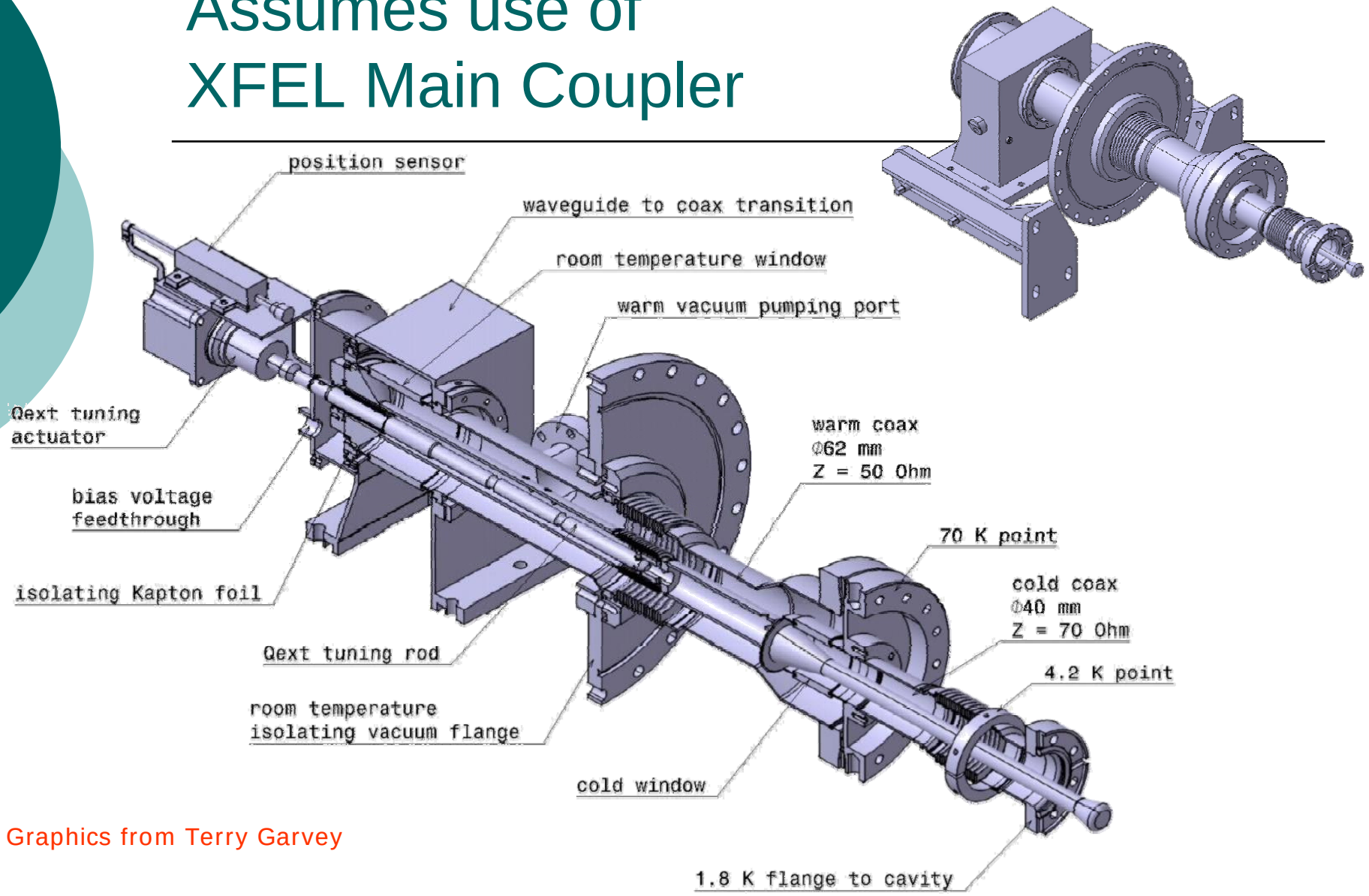


An Excel driven, 3-D I-DEAS Model

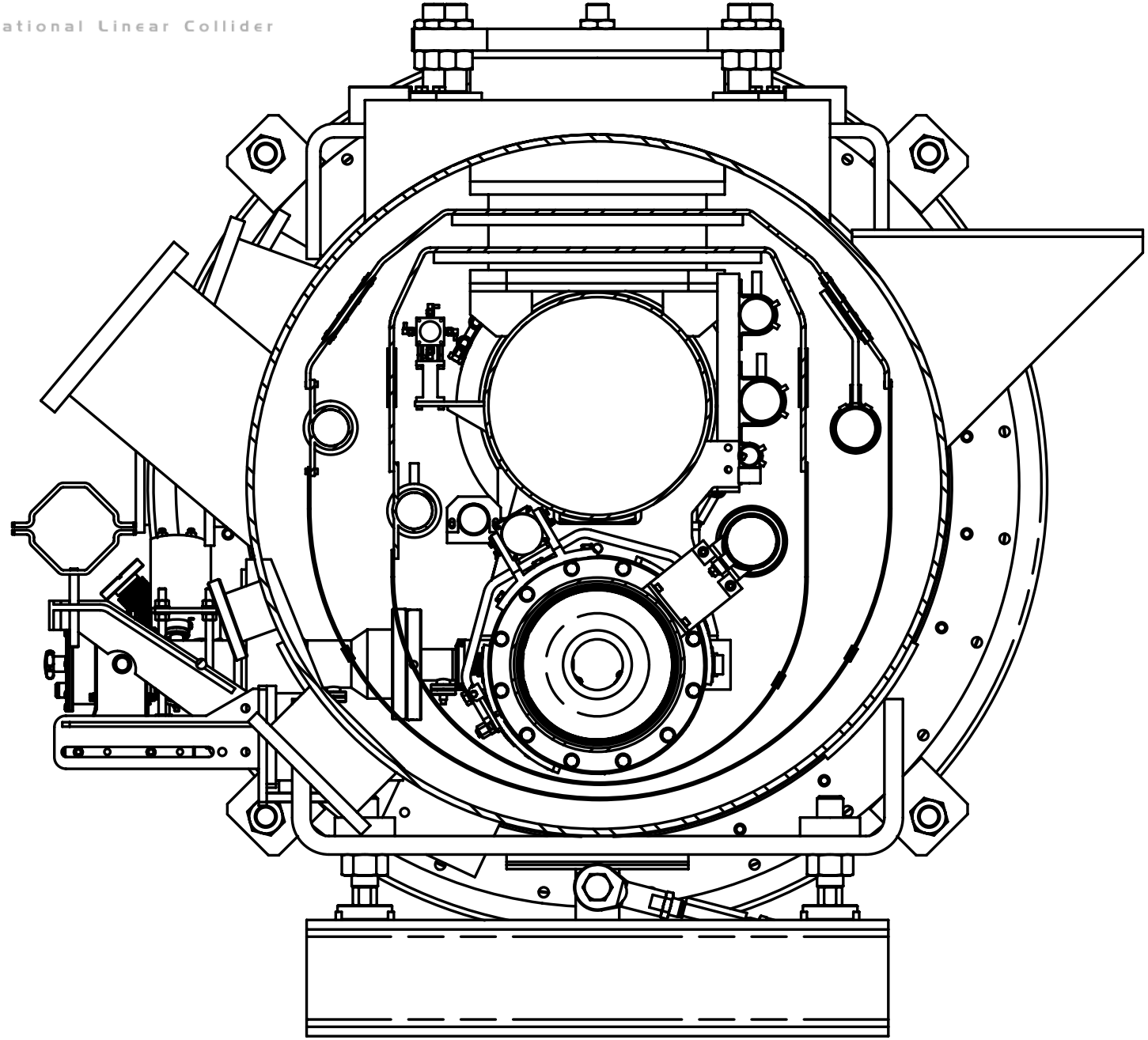
A 3-D working Model

- Flexible, accurate, and easy to modify to reduce design time
- Uses a common coordinate system
- Metric design (wherever possible)
- 3-D centric (all CAD in 3-D)
- Uses a common database (EDMS)

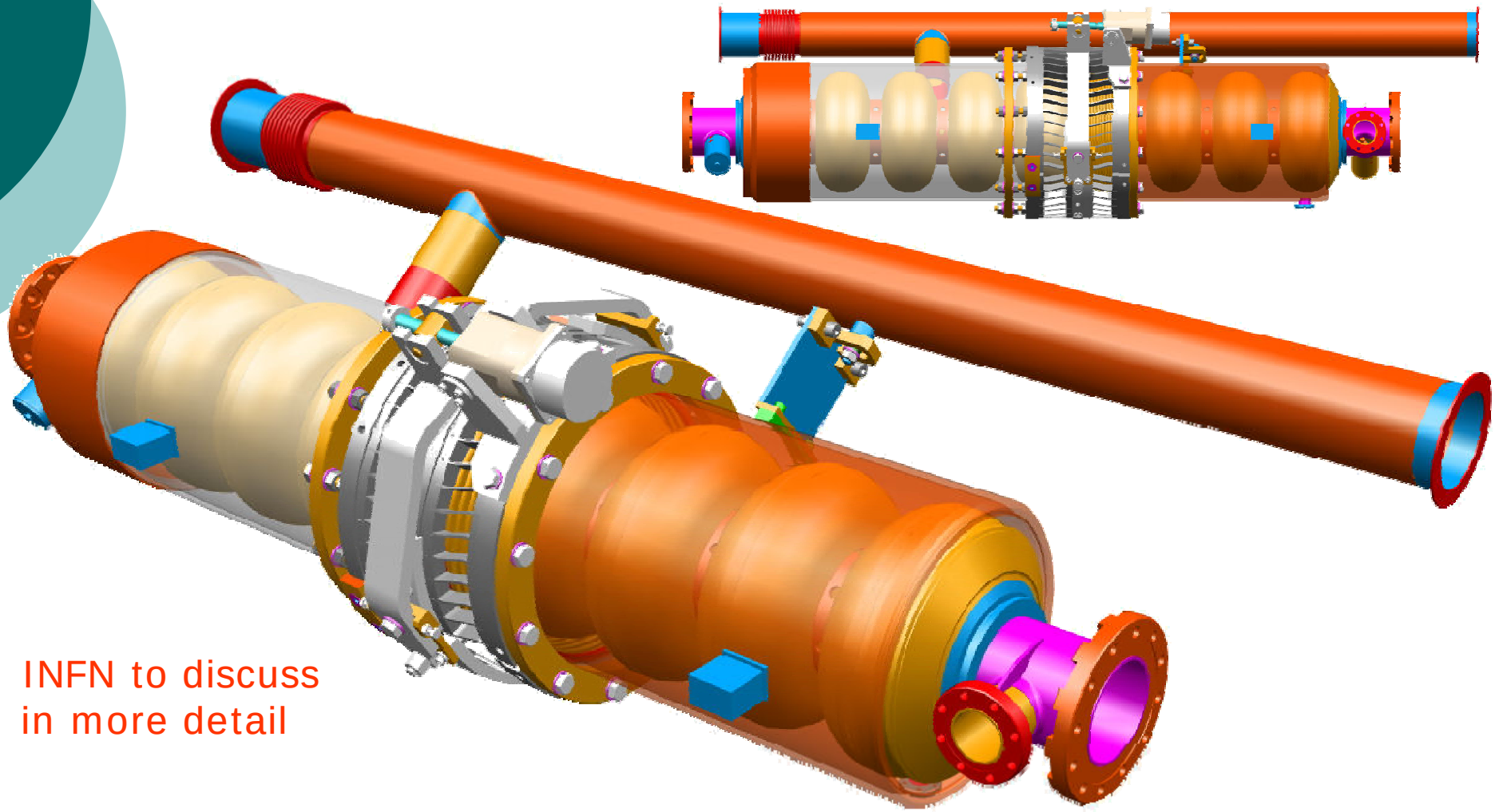
Assumes use of XFEL Main Coupler



Graphics from Terry Garvey

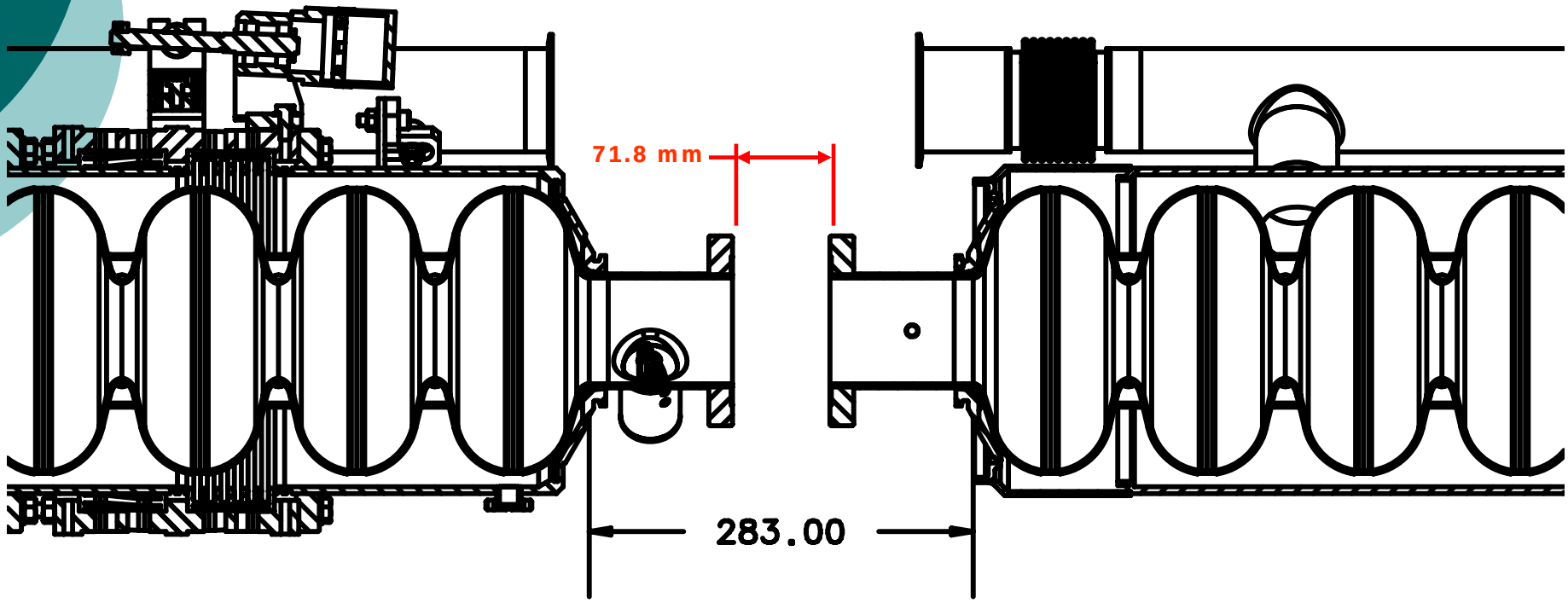


T4CM Proposed Cavity w/ Bladetuner



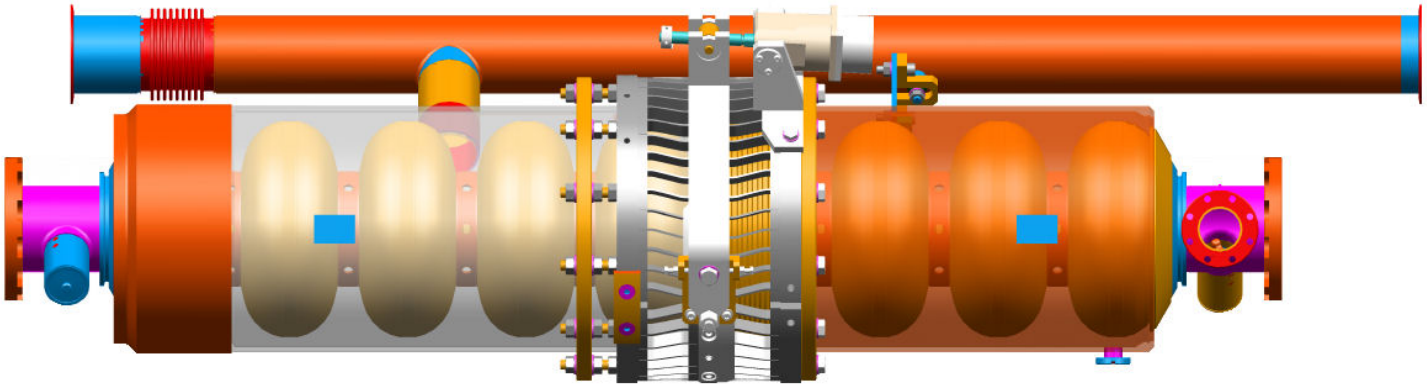
INFN to discuss
in more detail

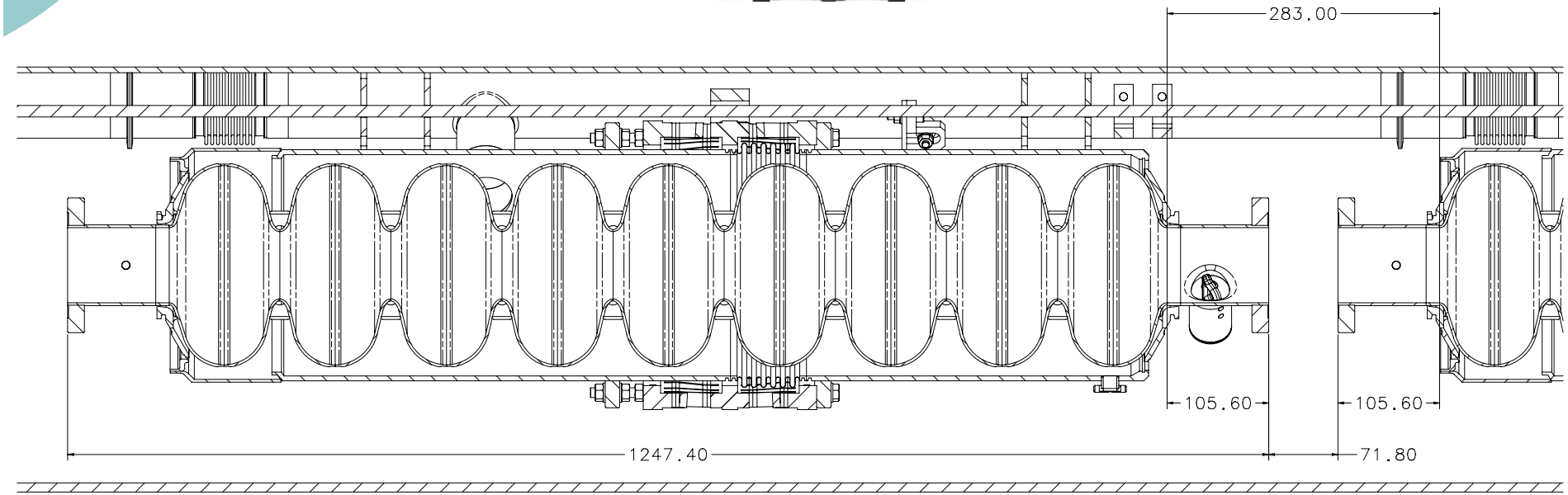
Cavity Spacing



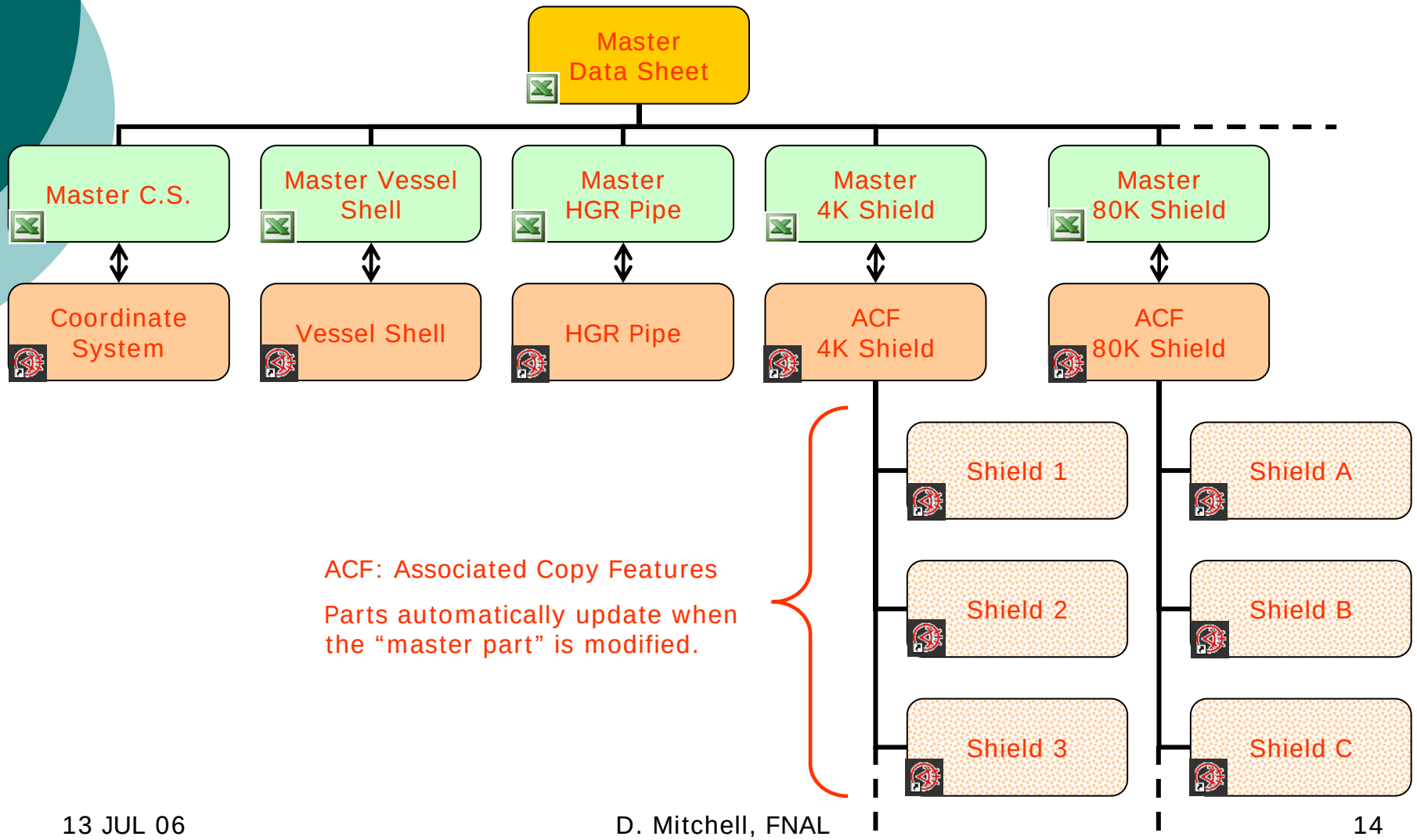
Cavity Dimensions

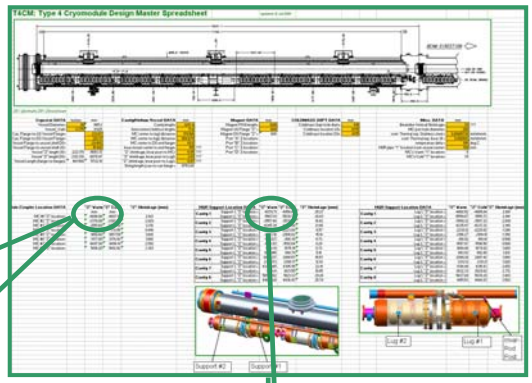
Designed with short end-tubes



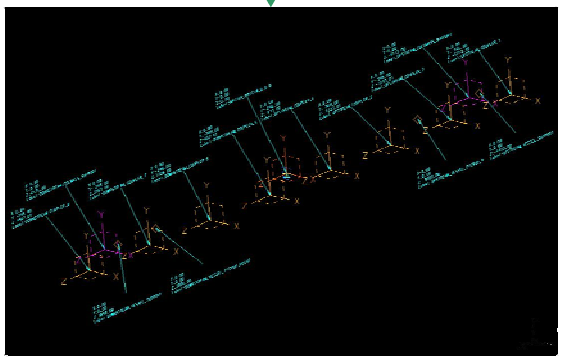


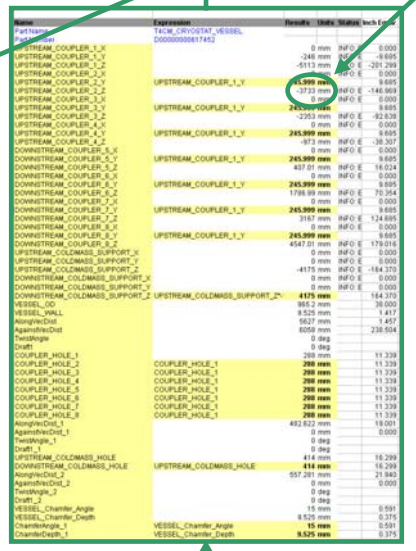
Managing the CAD Model with Excel & I-DEAS

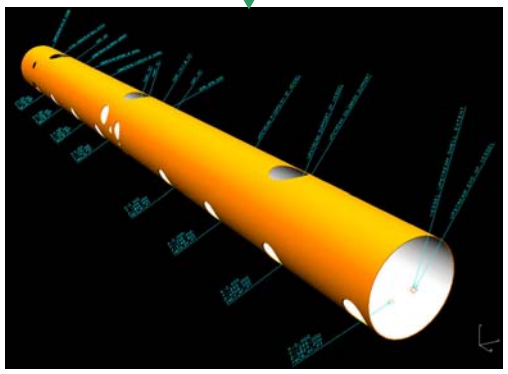


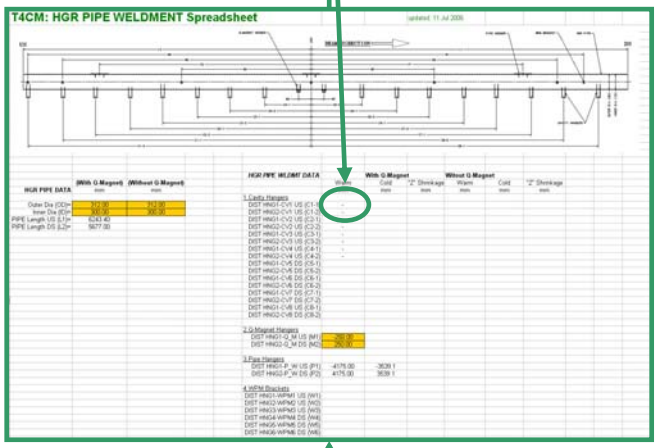


Name	Expression	Results	Units	Status	Inch Equiv
Part Name	T4CM_MASTER_COORDINATE_SYSTEM				
Part Number					
UPSTREAM_COUPLER_1_X		0	mm		0.000
UPSTREAM_COUPLER_1_Y		-246	mm		-9.685
UPSTREAM_COUPLER_1_Z		-5113	mm		-201.299
UPSTREAM_COUPLER_2_X		0	mm		0.000
UPSTREAM_COUPLER_2_Y	UPSTREAM_COUPLER_1_Y	245.999	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









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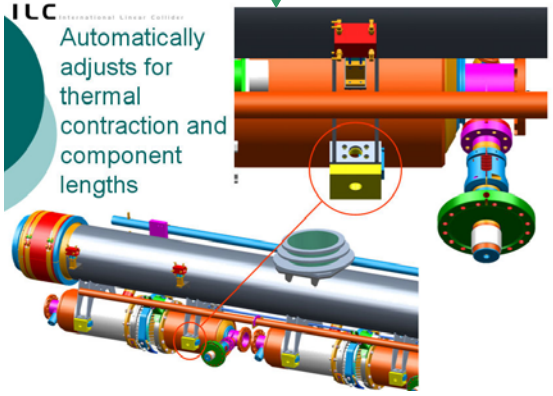
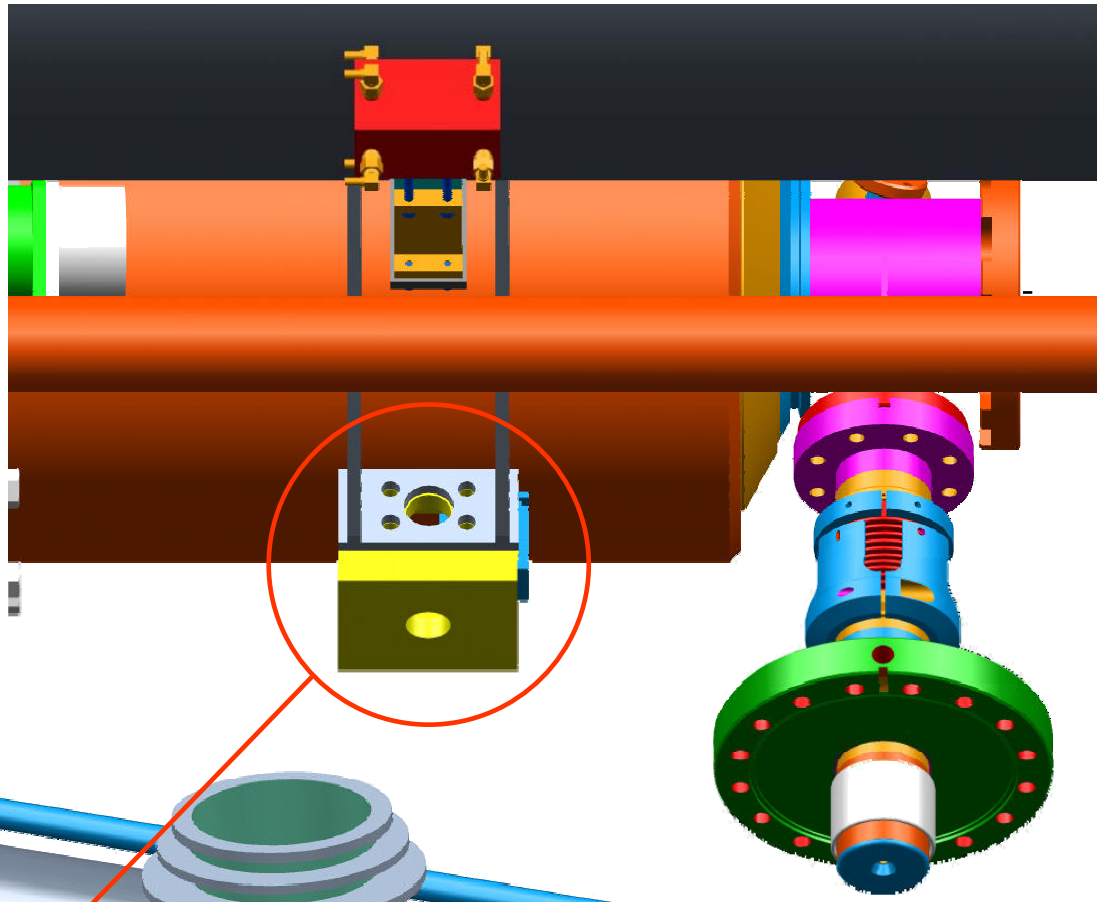
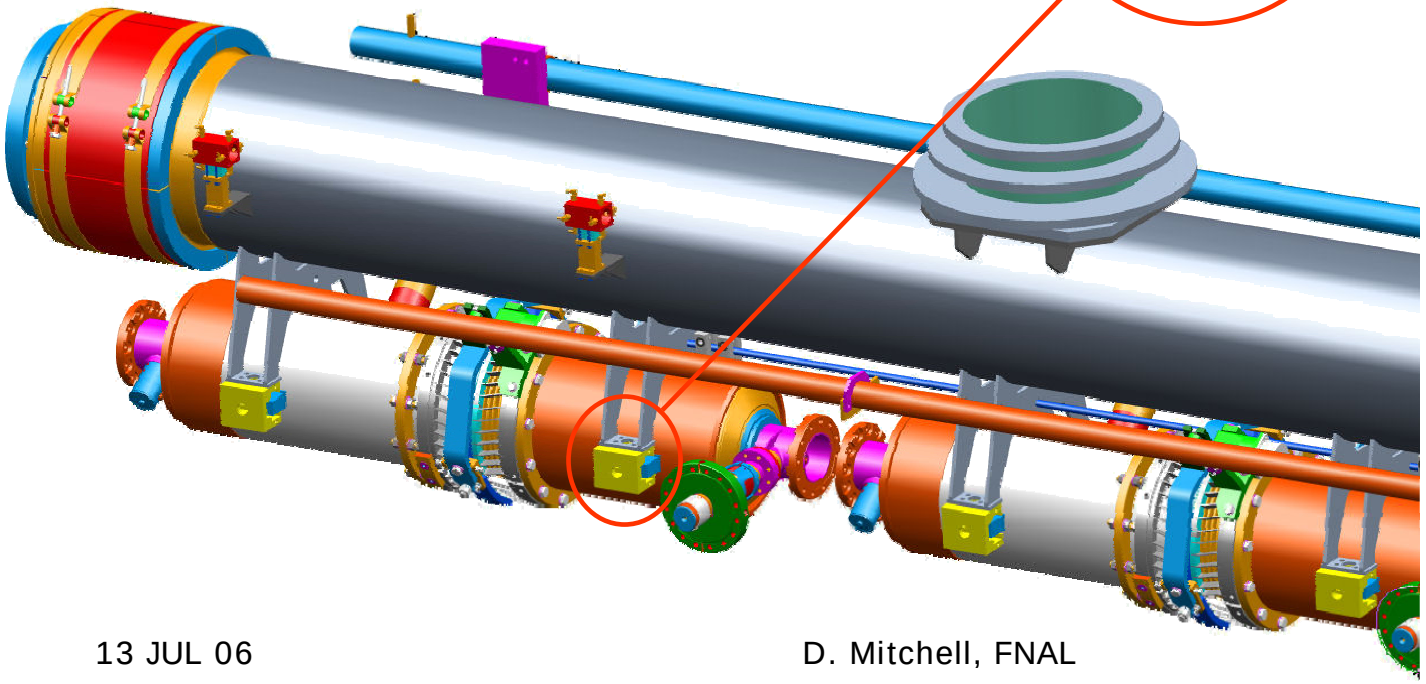
Automatically adjusts for thermal contraction and component lengths

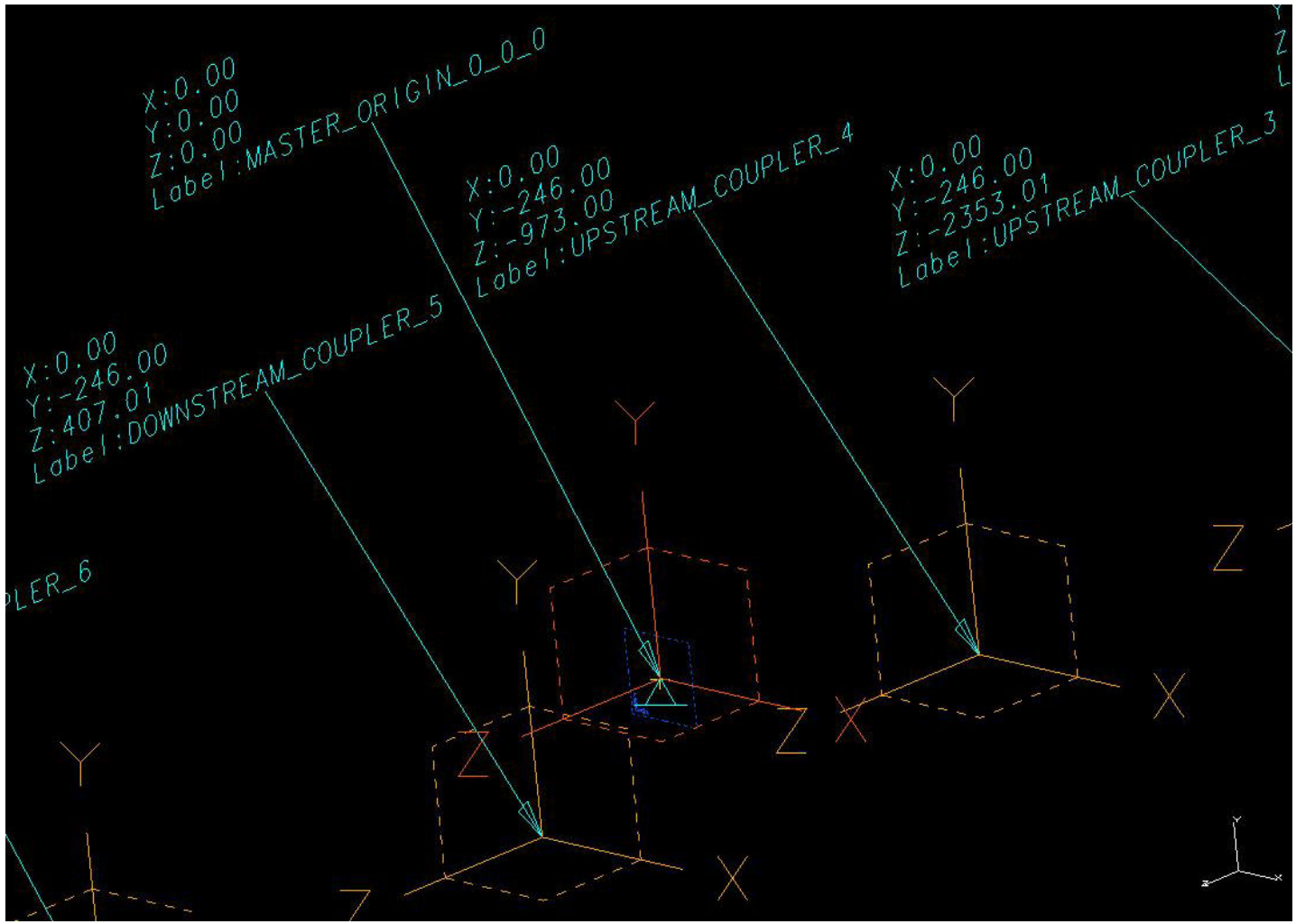


Automatically adjusts for thermal contraction and component lengths

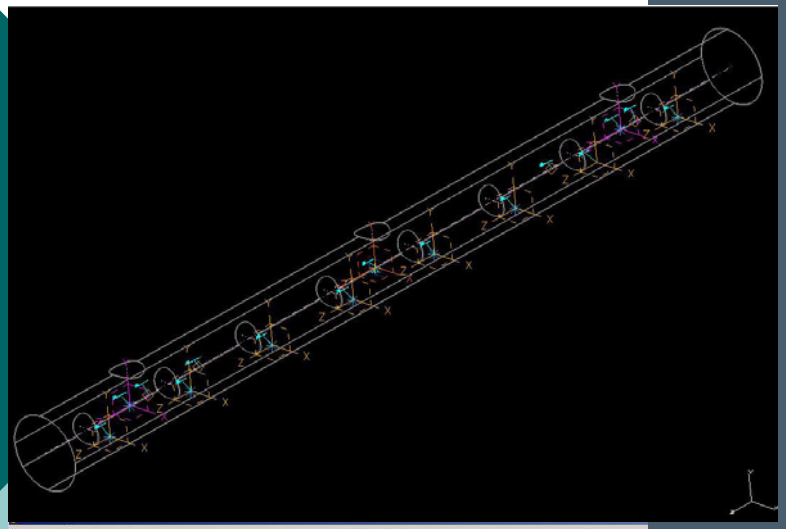


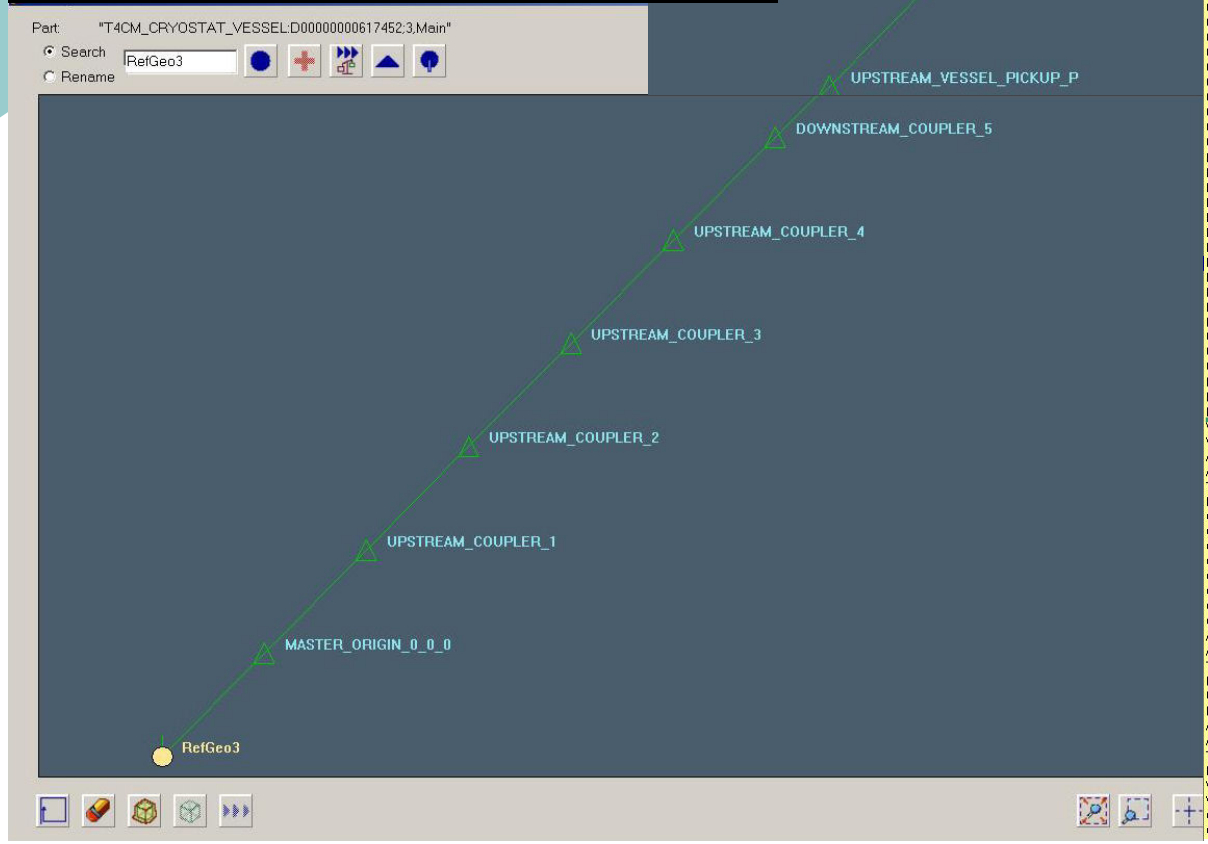


Master Coordinate System



ILC International Linear Collider





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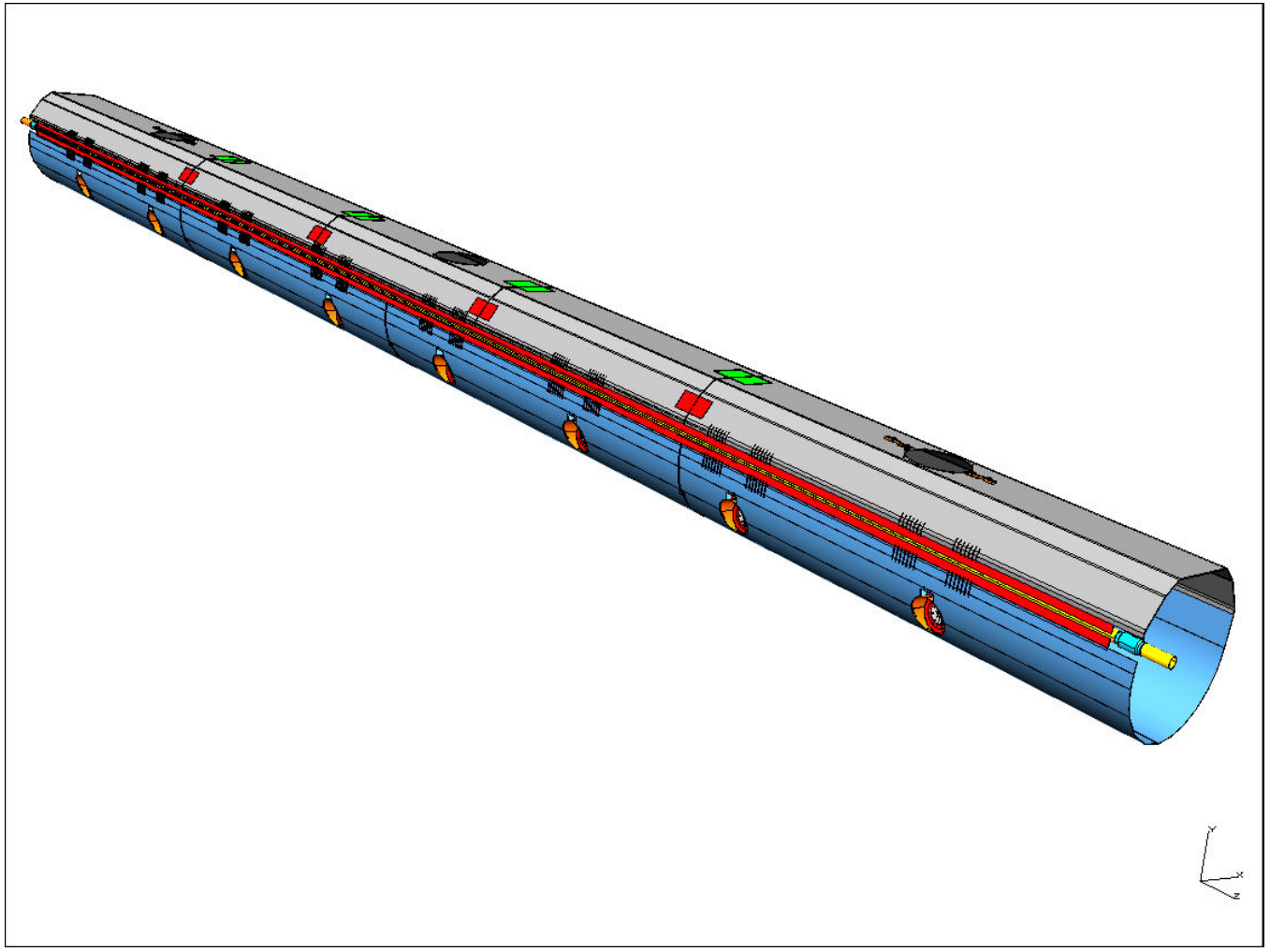
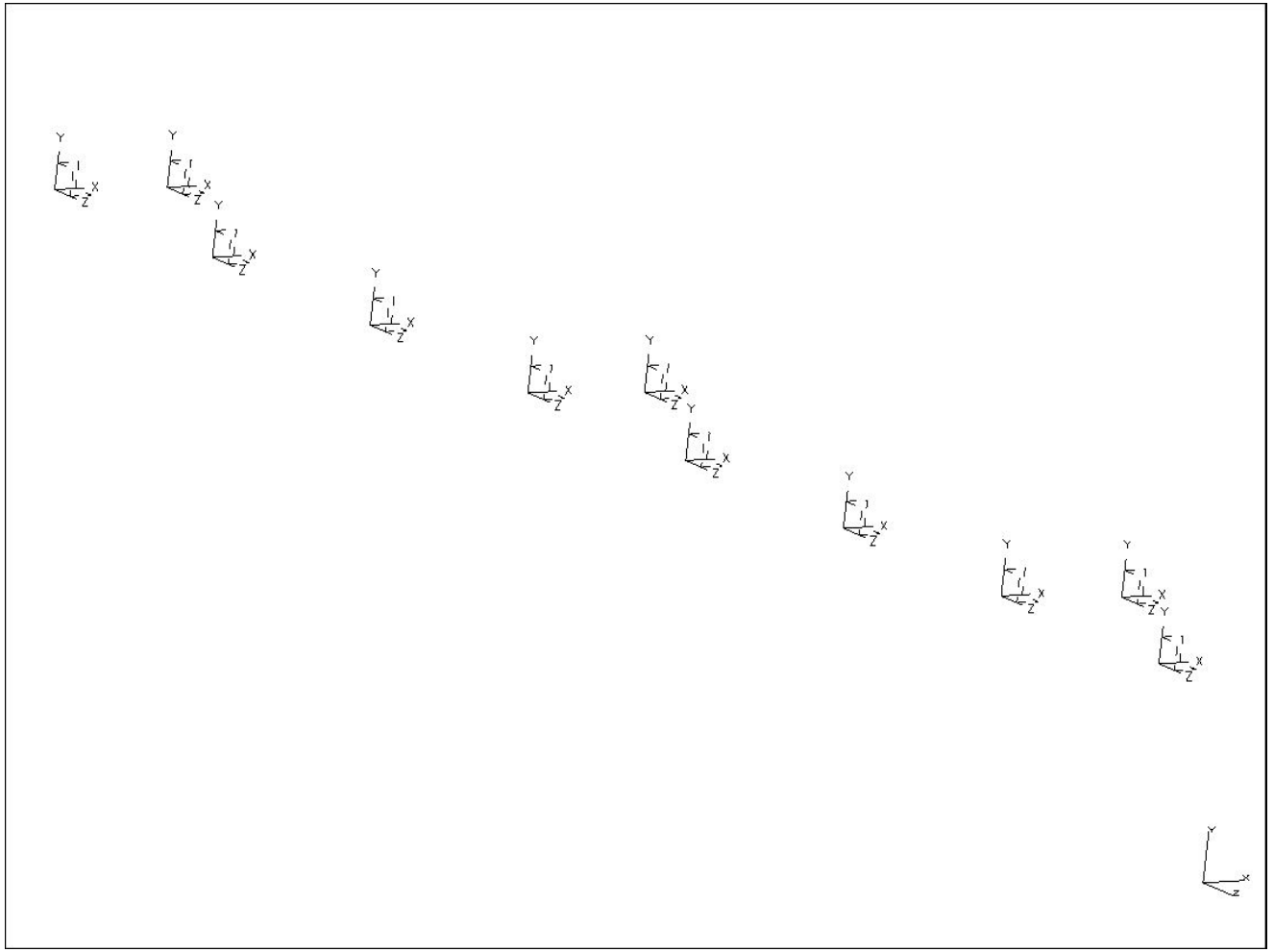
UPSTREAM_COUPLER_1_Y		-246	mm	INFO: E	-9.685
UPSTREAM_COUPLER_1_Z		-5113	mm	INFO: E	-201.299
UPSTREAM_COUPLER_2_X		0	mm	INFO: E	0.000
UPSTREAM_COUPLER_2_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
UPSTREAM_COUPLER_2_Z		-3733	mm	INFO: E	-146.969
UPSTREAM_COUPLER_3_X		0	mm	INFO: E	0.000
UPSTREAM_COUPLER_3_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
UPSTREAM_COUPLER_3_Z		-2353	mm	INFO: E	-92.638
UPSTREAM_COUPLER_4_X		0	mm	INFO: E	0.000
UPSTREAM_COUPLER_4_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
UPSTREAM_COUPLER_4_Z		-973	mm	INFO: E	-38.307
DOWNSTREAM_COUPLER_5_X		0	mm	INFO: E	0.000
DOWNSTREAM_COUPLER_5_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
DOWNSTREAM_COUPLER_5_Z		407.01	mm	INFO: E	16.024
DOWNSTREAM_COUPLER_6_X		0	mm	INFO: E	0.000
DOWNSTREAM_COUPLER_6_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
DOWNSTREAM_COUPLER_6_Z		1786.99	mm	INFO: E	70.354
DOWNSTREAM_COUPLER_7_X		0	mm	INFO: E	0.000
DOWNSTREAM_COUPLER_7_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
DOWNSTREAM_COUPLER_7_Z		3167	mm	INFO: E	124.685
DOWNSTREAM_COUPLER_8_X		0	mm	INFO: E	0.000
DOWNSTREAM_COUPLER_8_Y	UPSTREAM_COUPLER_1_Y	**245.999**	**mm**		9.685
DOWNSTREAM_COUPLER_8_Z		4547.01	mm	INFO: E	179.016
UPSTREAM_COLDMASS_SUPPORT_X		0	mm	INFO: E	0.000
UPSTREAM_COLDMASS_SUPPORT_Y		0	mm	INFO: E	0.000
UPSTREAM_COLDMASS_SUPPORT_Z		-4175	mm	INFO: E	-164.370
DOWNSTREAM_COLDMASS_SUPPORT_X		0	mm	INFO: E	0.000
DOWNSTREAM_COLDMASS_SUPPORT_Y		0	mm	INFO: E	0.000
DOWNSTREAM_COLDMASS_SUPPORT_Z	UPSTREAM_COLDMASS_SUPPORT_Z*	**4175**	**mm**		164.370
VESSEL_OD		965.2	mm		38.000
VESSEL_WALL		9.525	mm		1.417
AlongVecDist		5627	mm		1.457
AgainstVecDist		6058	mm		238.504
TwistAngle		0	deg		
Draft1		0	deg		
COUPLER_HOLE_1		288	mm		11.339
COUPLER_HOLE_2	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_3	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_4	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_5	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_6	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_7	COUPLER_HOLE_1	**288**	**mm**		11.339
COUPLER_HOLE_8	COUPLER_HOLE_1	**288**	**mm**		11.339
AlongVecDist_1		482.622	mm		19.001
AgainstVecDist_1		0	mm		0.000
TwistAngle_1		0	deg		
Draft1_1		0	deg		
UPSTREAM_COLDMASS_HOLE		414	mm		16.299
DOWNSTREAM_COLDMASS_HOLE	UPSTREAM_COLDMASS_HOLE	**414**	**mm**		16.299
AlongVecDist_2		557.281	mm		21.940
AgainstVecDist_2		0	mm		0.000
TwistAngle_2		0	deg		
Draft1_2		0	deg		
VESSEL_Chamfer_Angle		15	mm		0.591
VESSEL_Chamfer_Depth		9.525	mm		0.375
ChamferAngle_1	VESSEL_Chamfer_Angle	**15**	**mm**		0.591
ChamferDepth_1	VESSEL_Chamfer_Depth	**9.525**	**mm**		0.375

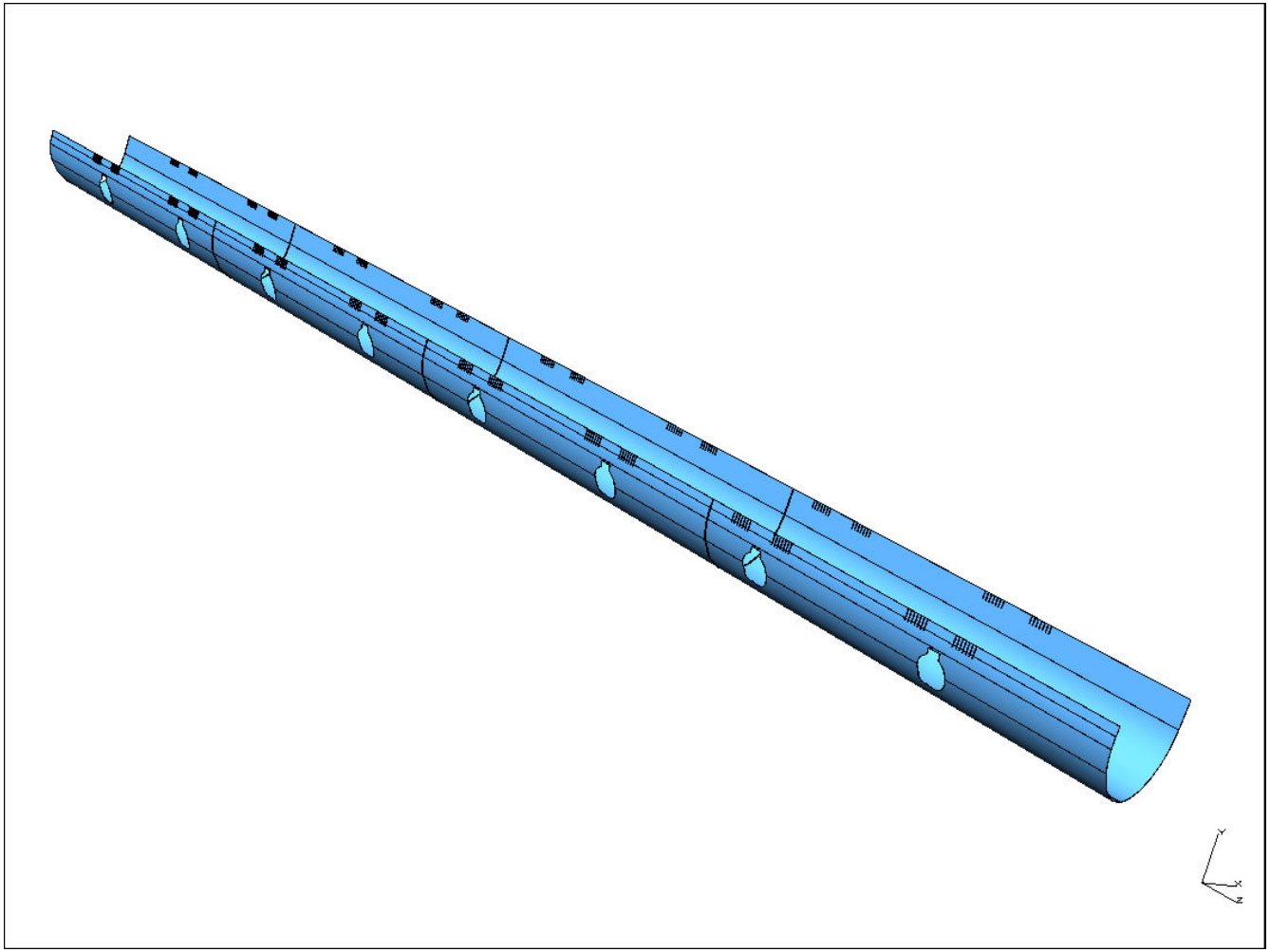
80K Heat Shield “ACF” Example



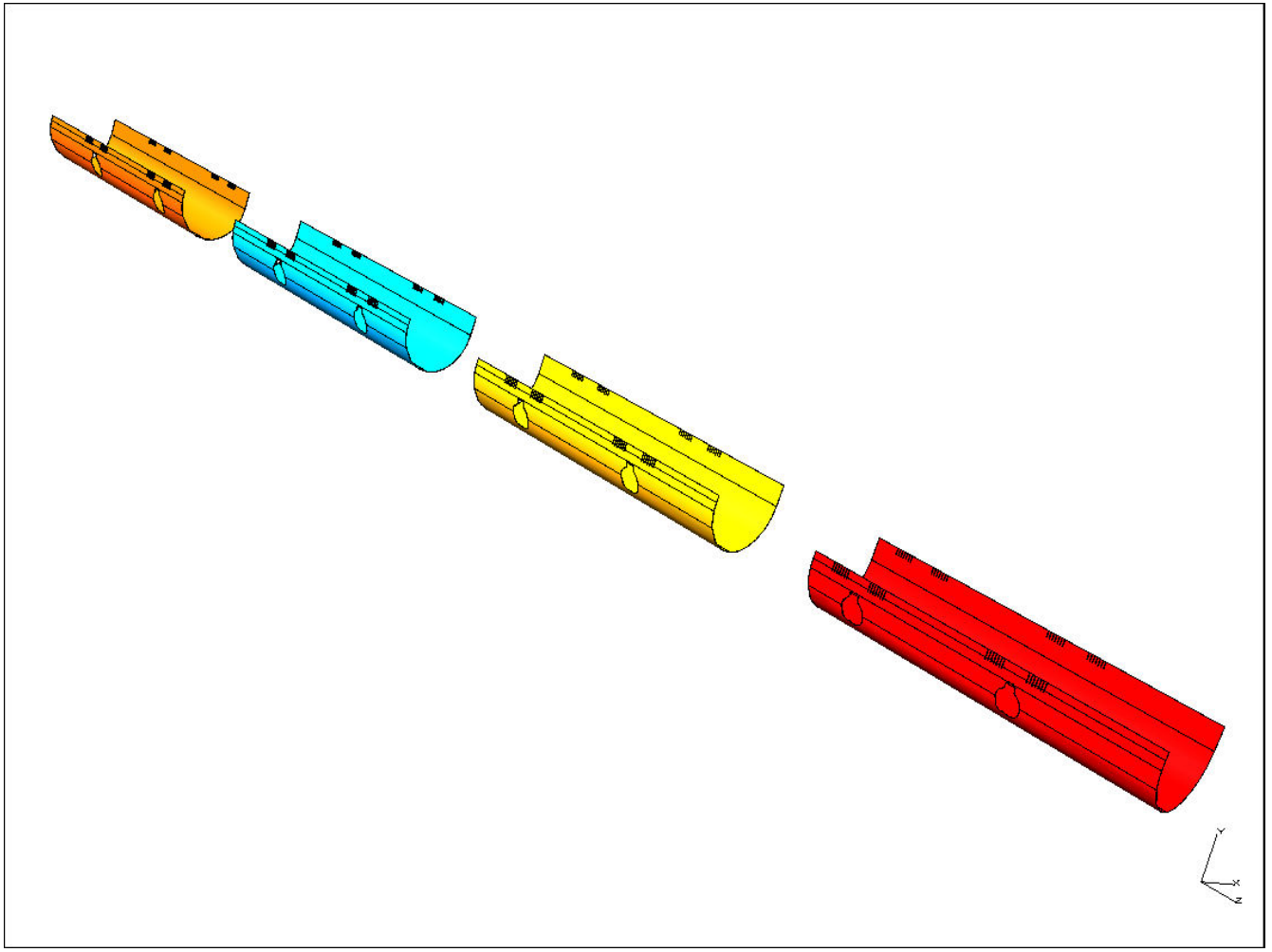
C.S. is foundation of Master Part



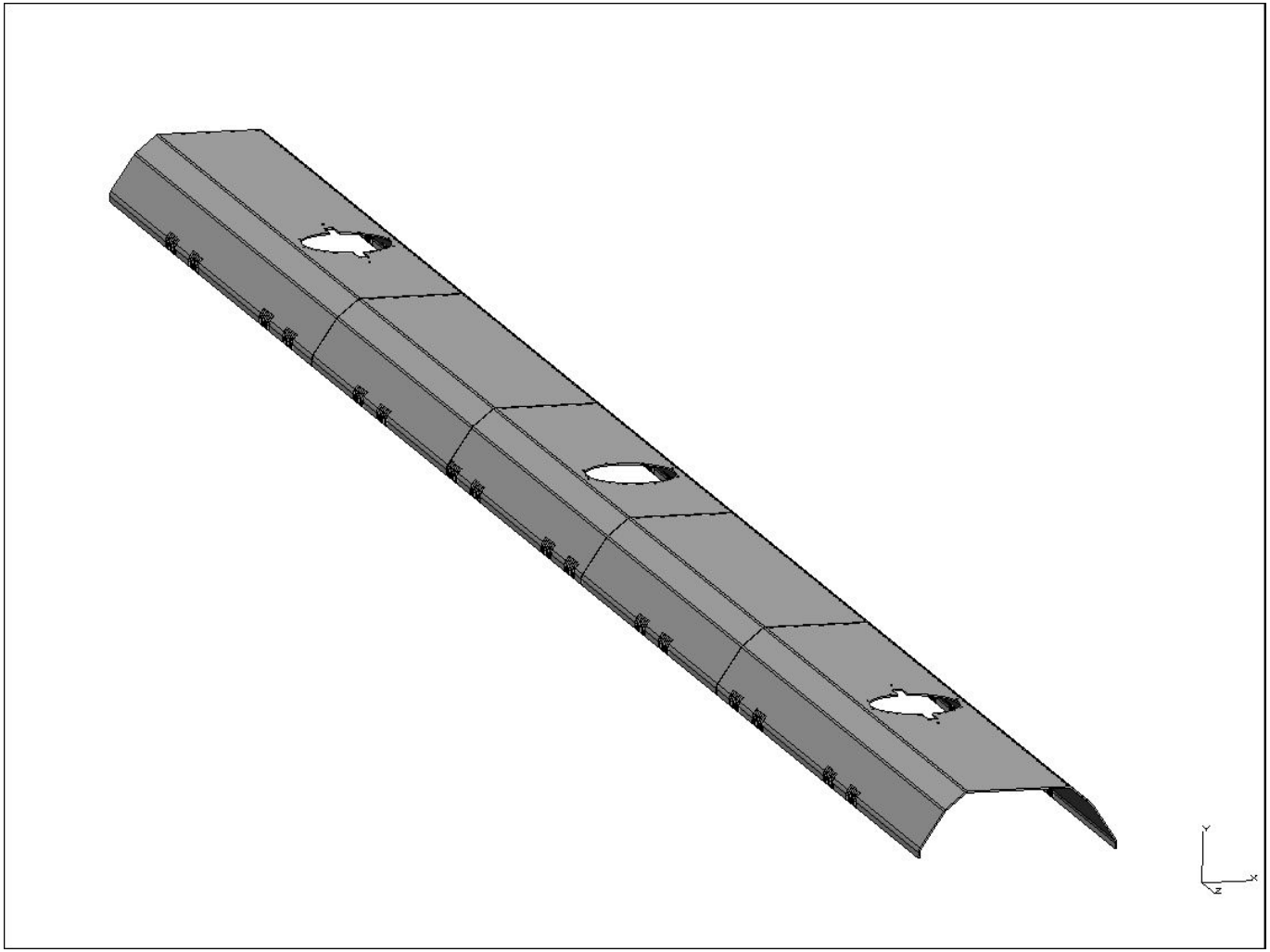
Bottom Shield is modeled as 1 part



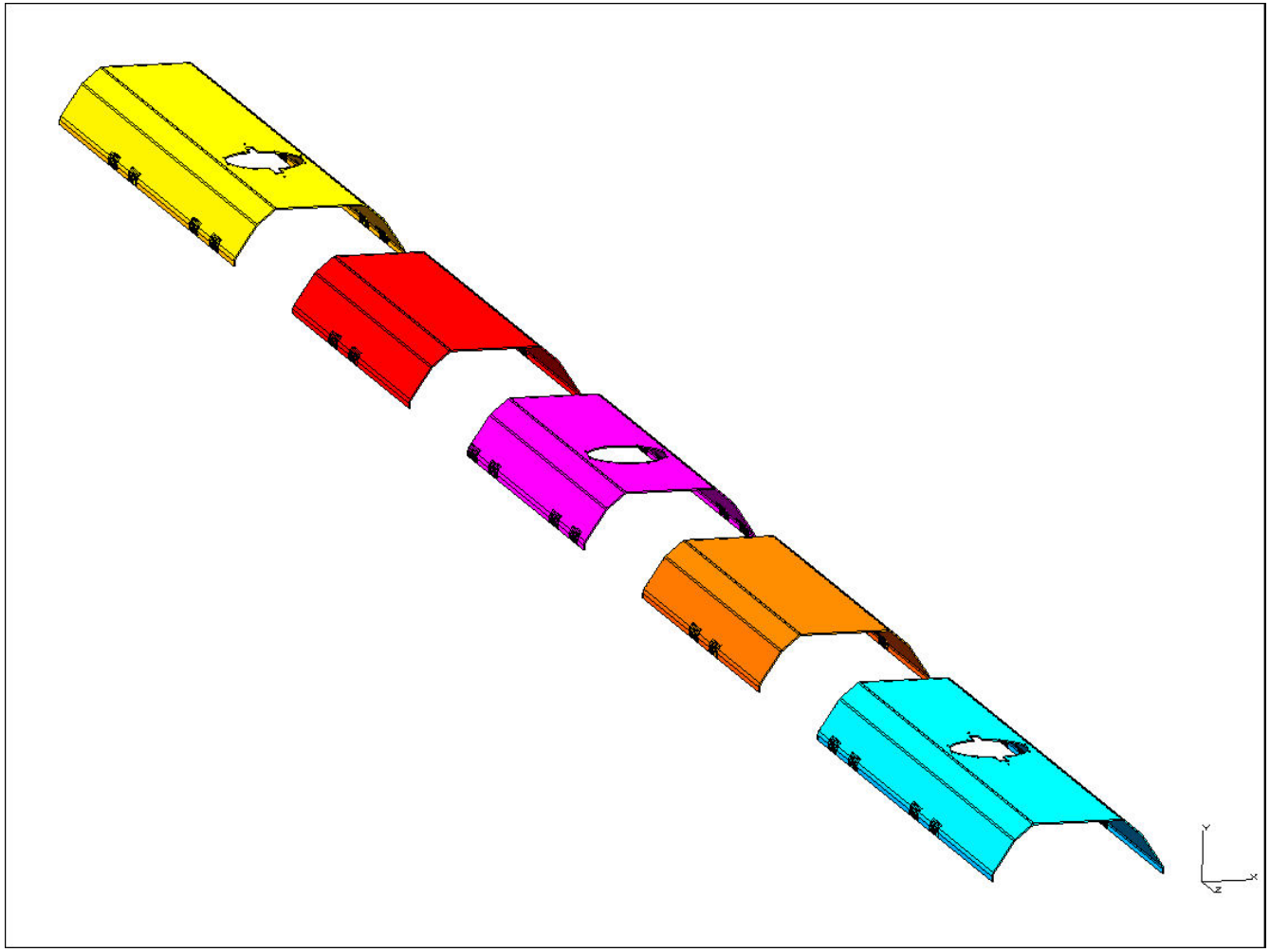
Using ACF, new parts are created for each individual shield segment. When the “master” is modified, the associated parts will automatically update.



Master 80K Upper Shield



ACF part creation for upper shield



Don’t be fooled! No matter how simple the proposed changes are, this is no small task!

- Concept development/Collaboration
- Part design/modification
- Engineering analysis to appropriate standards plus documentation
- 3-D modeling (concepts to reality)
- ~750 parts / assembly drawings
- Vendor integration
- Procurement process
- Tooling & Fixtures
- Fabrication

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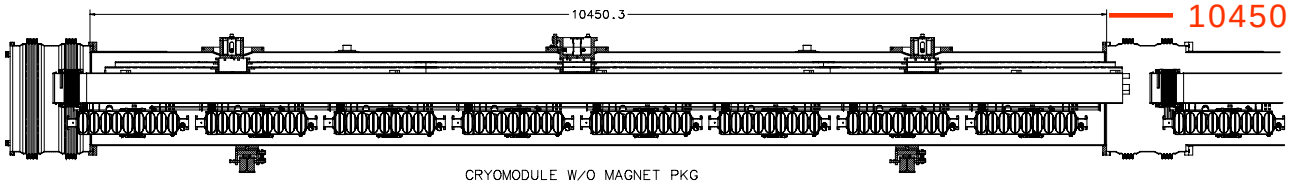
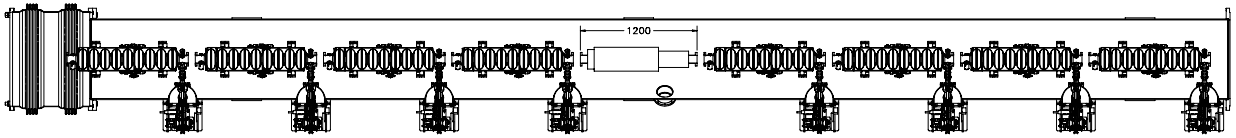
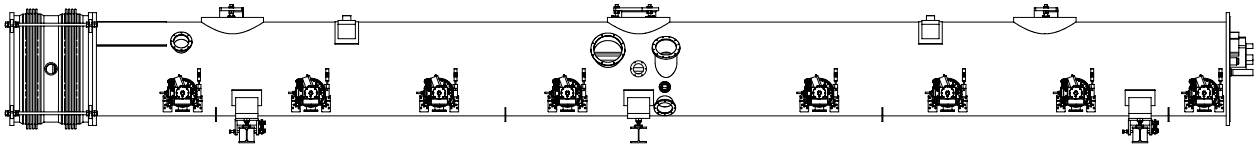


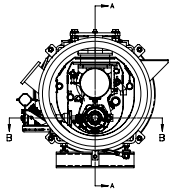
10450 mm

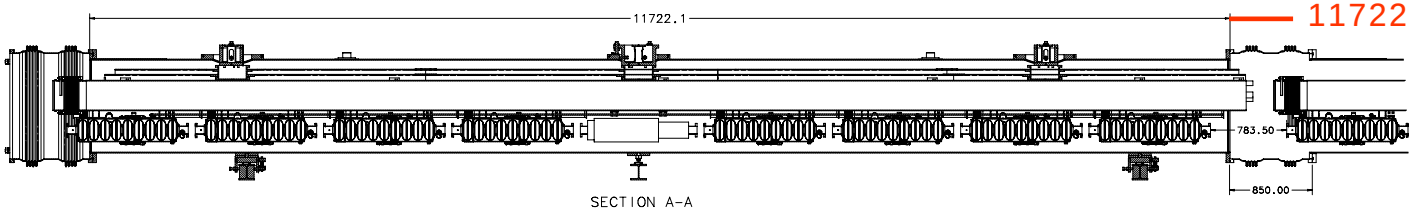
CRYOMODULE W/O MAGNET PKG



SECTION B-B







11722 mm

SECTION A-A

REV	DESCRIPTION	DRAWN / APPROVED	DATE

UNLESS OTHERWISE SPECIFIED	ORIGINATOR	D.MITCHELL	10-JAN-2006
	DRAWN	D.MITCHELL	10-JAN-2006
± ± ±	CHECKED	D.MITCHELL	
1. BREAK ALL SHARP EDGES	APPROVED	D.MITCHELL	
USED ON			
MATERIAL	SEE PARTS LIST		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

ILC CRYOMODULE - TYPE IV
ASSEMBLIES - UPPER LEVEL
T4CM CONCEPT LAYOUT

SCALE	DRAWING NUMBER	SHEET	REV
1:10	4904.001-ME-440307	1 OF 1	

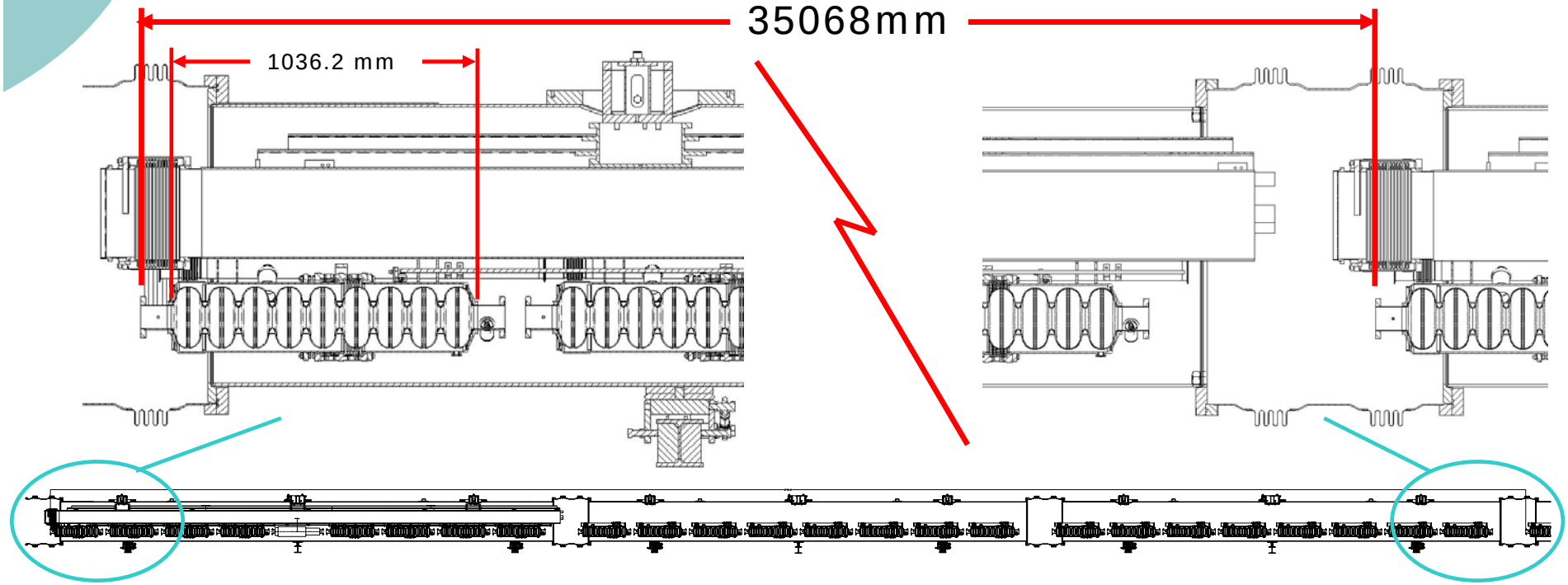
CREATED WITH: Inventor11IckSeries | GROUP: TD/SRF-DEVELOPMENT

Packing factor

Note: Does not include other components installed within the accelerator nor a possible increased magnet package length.

Active length = 1036.2 mm x 24 cavities = 24868.6 mm

Packing Factor = 24868.6 / 35068 = 0.71



Proposed 4th Generation Design

- 2 Vessels, ΔLength=1272 mm (w & w/o Magnet package)
- Cavity string supported and aligned by 3 support posts.
- Magnet independently aligned but still supported from the 300mm HGR pipe.
- Support post locations may be identical in both vessels to simplify the tooling.
- HOM absorber in interconnect region. What length/design?
- Smaller cavity-to-cavity connection (71.8mm)
- BPM, Quad magnet, and steering magnets are combined into one magnet package. Total length currently assumed to be 1200 mm.
- TTF III cavity utilizes short end-tube for both ends. Length reduced to 105.6 mm.
- Use of Bladetuner due to the shortened cavity length.
- New Magnetic Shield design is required.
- Fabrication of support posts.
- All ports and flanges will be metric. ISO or DIN?
- ASME & ISO drafting standards will be used.

Some critical open design issues

- Quad/corrector/BPM package is a major unknown right now and goes into the heart of the module.
- Tuner details, slow and fast, but especially fast tuner
- Cavity-to-cavity interconnect design.
- Vibrational analysis, which will be compared to measurements for verification of the model for future design work.
- Magnetic shield re-design.
- Verification of cavity positional stability with thermal cycles.
- Alignment verification. New scheme?
- Design of test instrumentation for the module.
- Robustness for shipping, analysis of shipping restraints and loads, shipping specifications.