

Cryomodule Development at Fermilab

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Fermilab
Project-X

FNAL Cryomodule Effort

- **2008: CM1 built at FNAL with ALL components provided by DESY and INFN (Zanon) – Type III+**
- **3rd Harmonic Cryomodule shipped to DESY in April 2009. Completely designed and built at Fermilab.**
- **2009: Summer – begin building CM2 at FNAL Type III+ design, FNAL providing cavities. Coldmass and Cryostat provided by INFN (Zanon)**
- **Ordering T4CM components Now. Some design elements currently in final stages.**
 - **Fermilab procurement**
 - **Fermilab to assemble and install at NML**
- **2009: Begin working with US industry to procure 2 more T4CMs. Deliver in 2011.**
 - **Help develop US industry capabilities**
 - **Utilize FNAL facilities for cryomodule assembly**
 - **Develop at least 2 suppliers**

SRF Infrastructure



International Collaboration

The slide features a background of various sized gears in a light gray color. A thick blue horizontal bar is positioned below the title. A dotted yellow line runs along the top edge of the blue bar.

- **3 years building a team of engineers and designers from around the world who collaborate on cryomodule design and R&D.**
- **Developed skills in CAD and database management in support of an international design effort.**
- **Added contractors as needed.**
- **Exploring alternate designs for cost savings.**

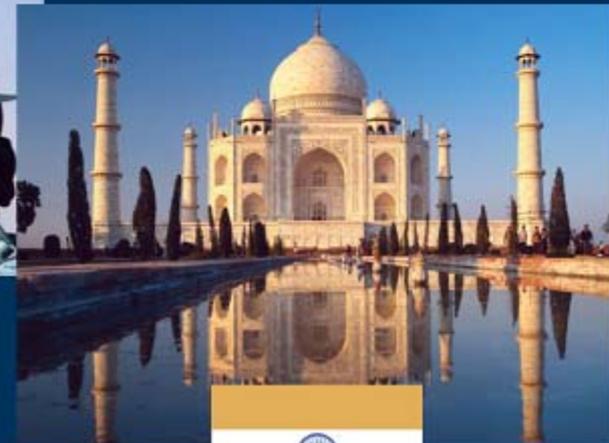
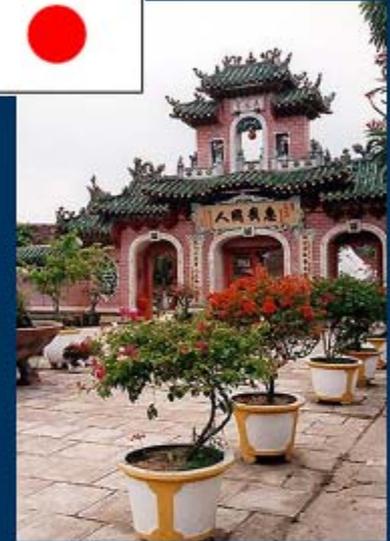
An International Cryomodule Design Team founded in May 2006

November 2006: Training EDMS
to the international team.

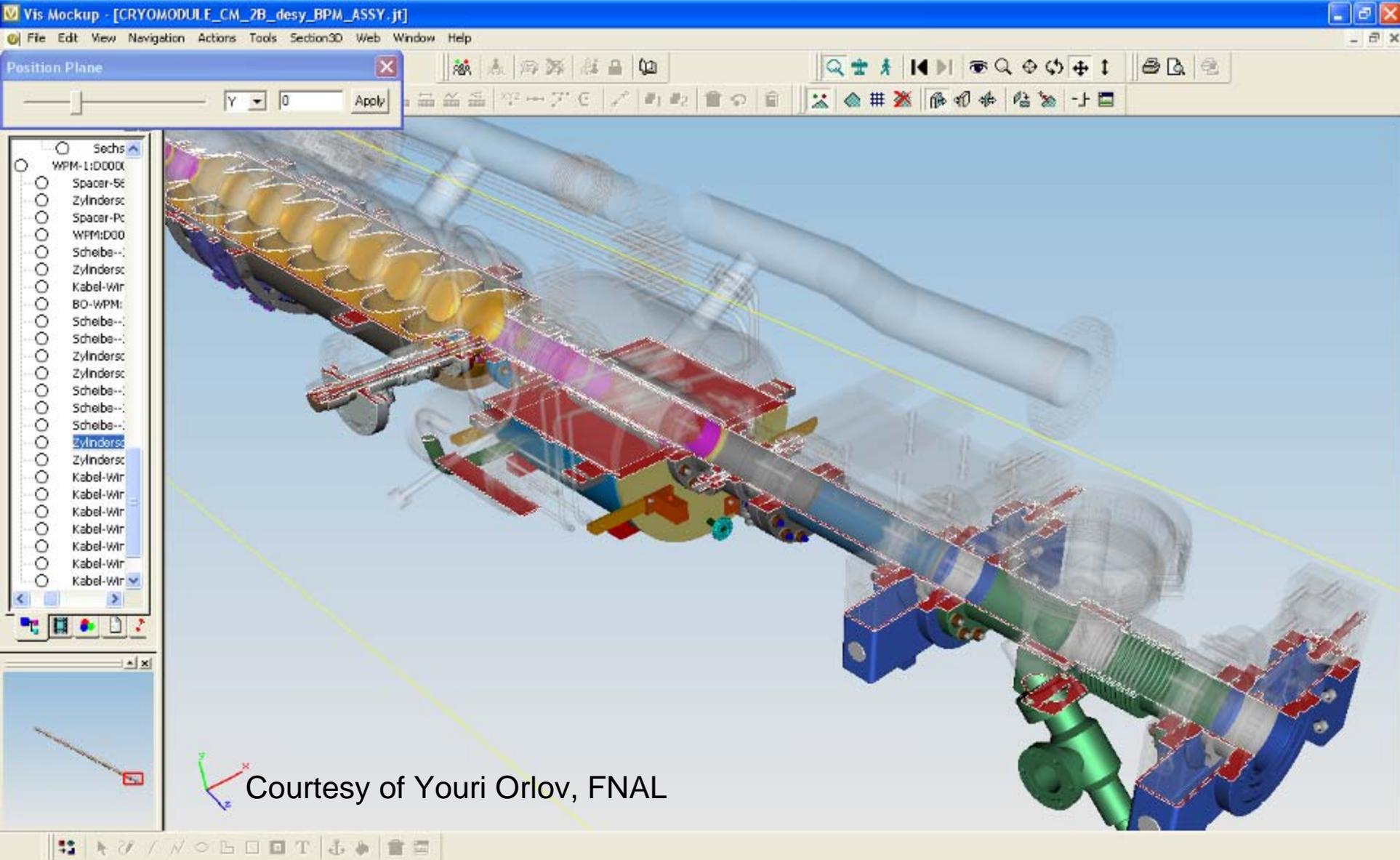


Collaboration Team:

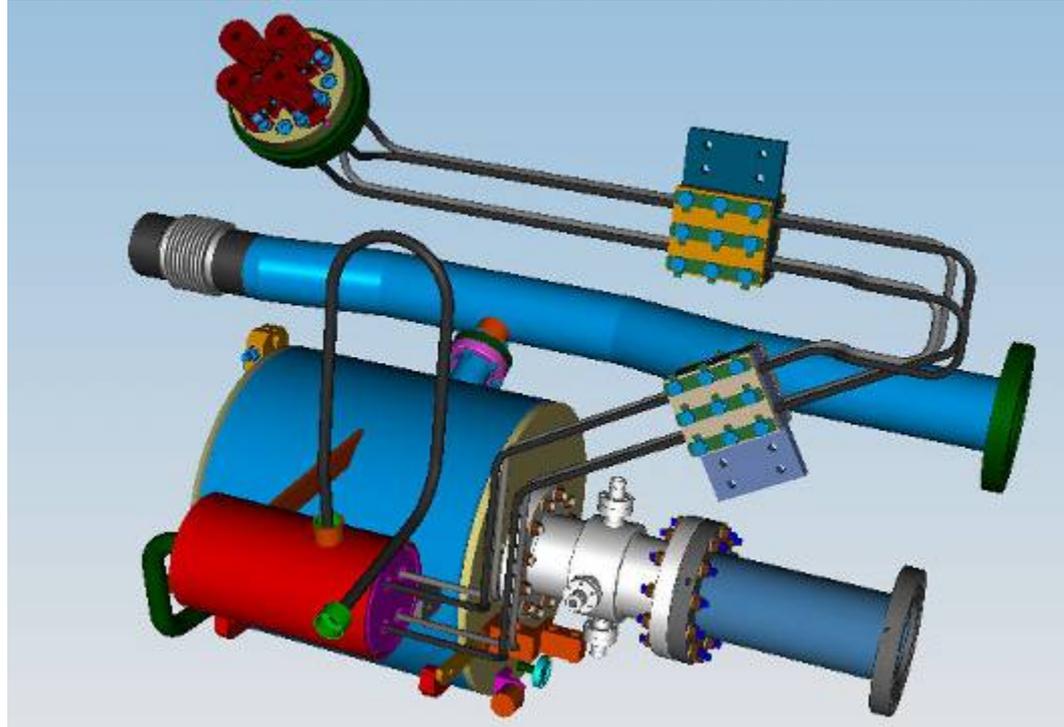
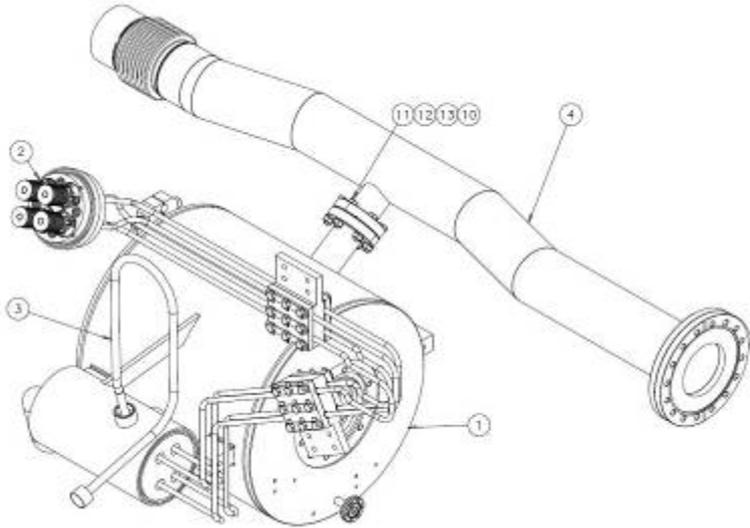
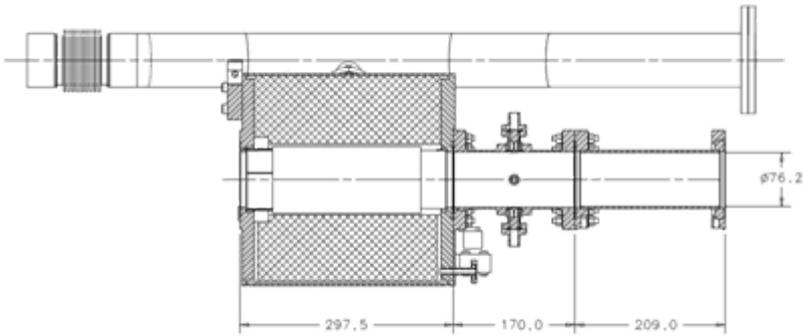
- ▶ FNAL (USA)
- ▶ INFN (Pisa, Italy)
- ▶ INFN (Milan, Italy)
- ▶ KEK (Japan)
- ▶ RRCAT (India)
- ▶ DESY (Germany)



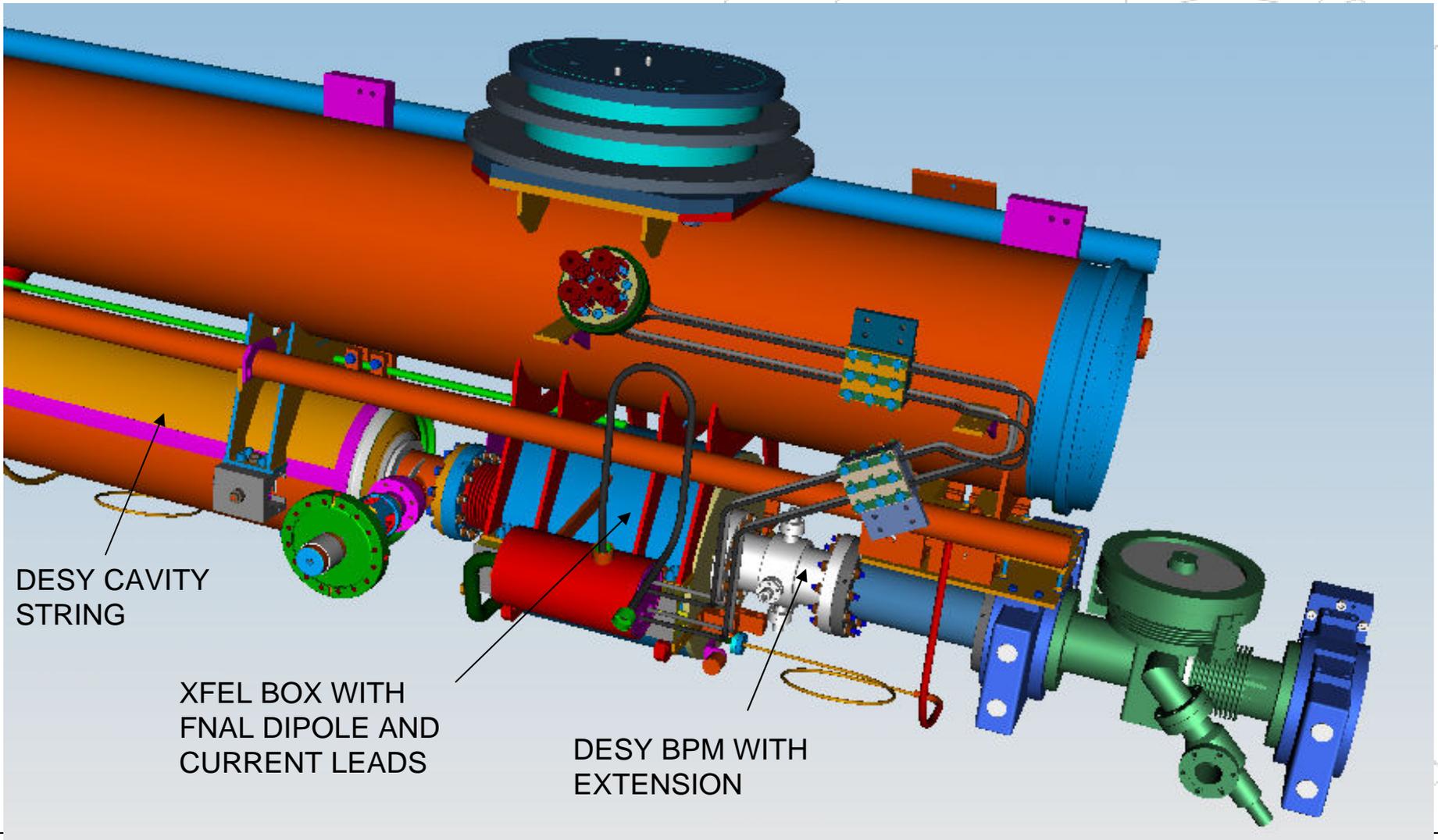
CRYOMODULE 2 (CM2) Design



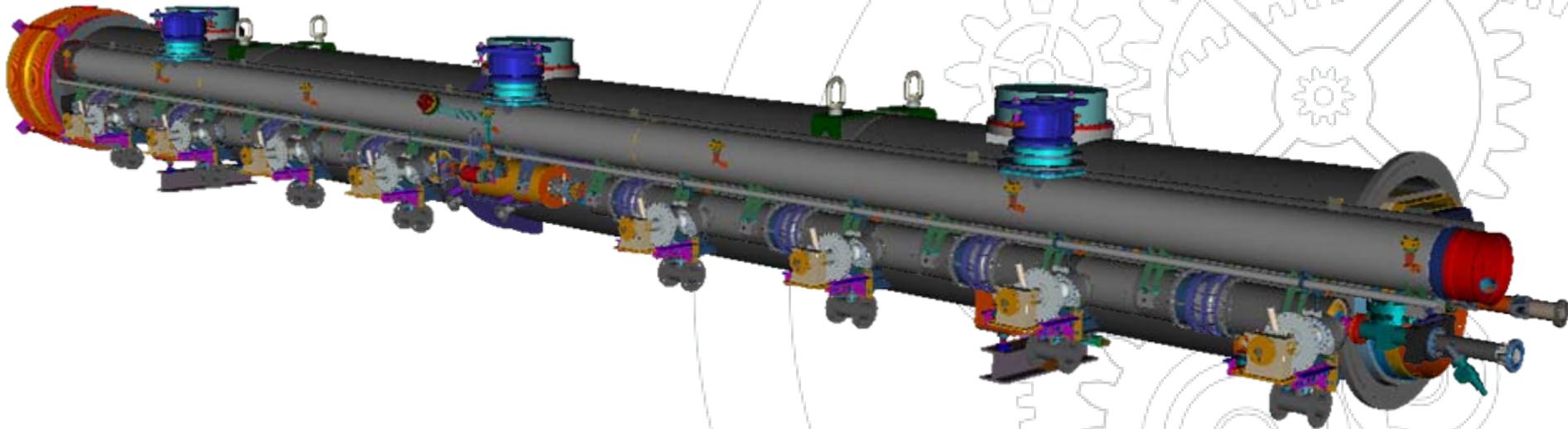
CM2 Magnet Development



DIPOLE MAGNET w/ DESY BPM

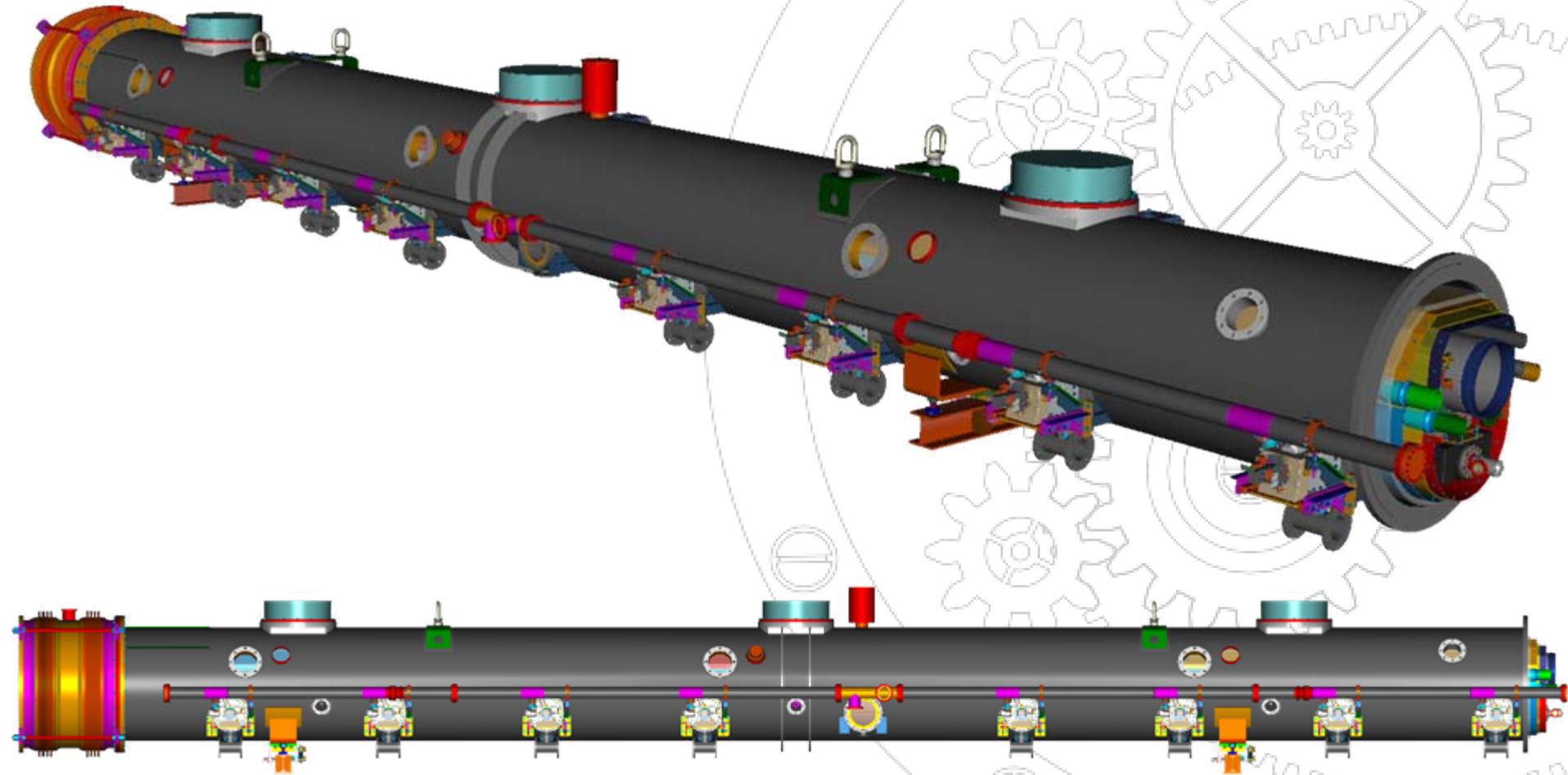


Type IV Cryomodule (T4CM)



↑
**Magnet Package located
under center post for
more stability**

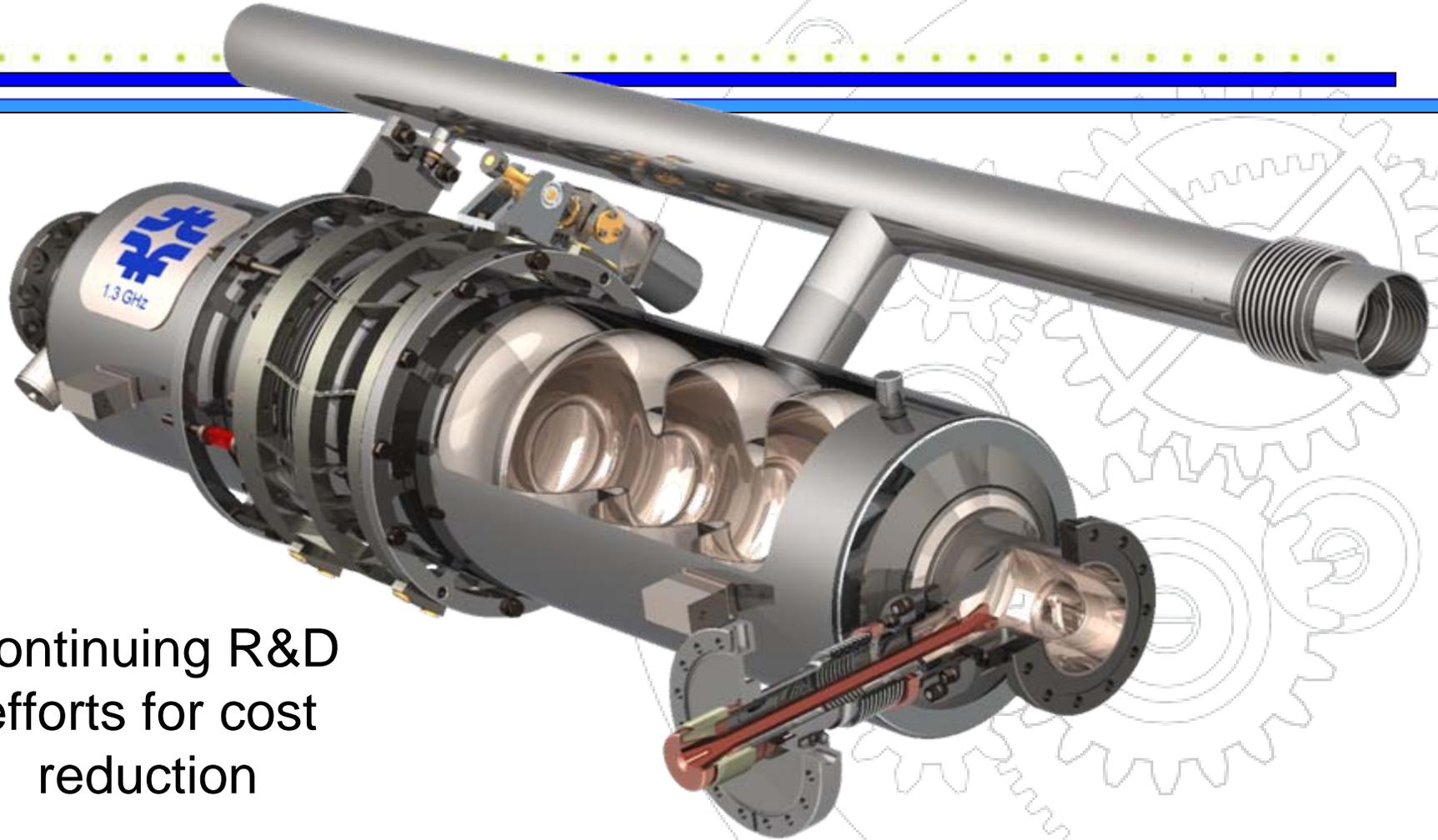
Project-X Cryomodule



Cryomodule Schedule

Cryomodule Name	Type	Coldmass	Cavities	Design	Assembly	Installation	Comments
CM1	Type III+	DESY/INFN	DESY	N/A	2008	2009	Currently at NML
3rd Harmonic	3.9 GHz	FNAL	FNAL	Complete			Shipped to DESY
CM2	Type III+	DESY/INFN	AES/Accel	Mag Pkg.	2009	2010	Components at FNAL. Dressing cavities.*
CM3	T4CM	FNAL	AES/Accel	Aug-09	2010	2011	Final design tweaks. Procurement in process.*
CM4	T4CM	Vendor 1	AES/Accel	2010	2011	2012	CM3 design. Vendor to procure and assemble.*
CM5	T4CM	Vendor 2	AES/Accel	2010	2011	2012	CM3 design. Vendor to procure and assemble.*
CM6	T4CM	Vendor	AES/Accel	2011	2012	2013	Vendor to cost-reduce, redesign, assemble.*

*All assembly will be completed at Fermilab using Fermilab facilities and infrastructure.

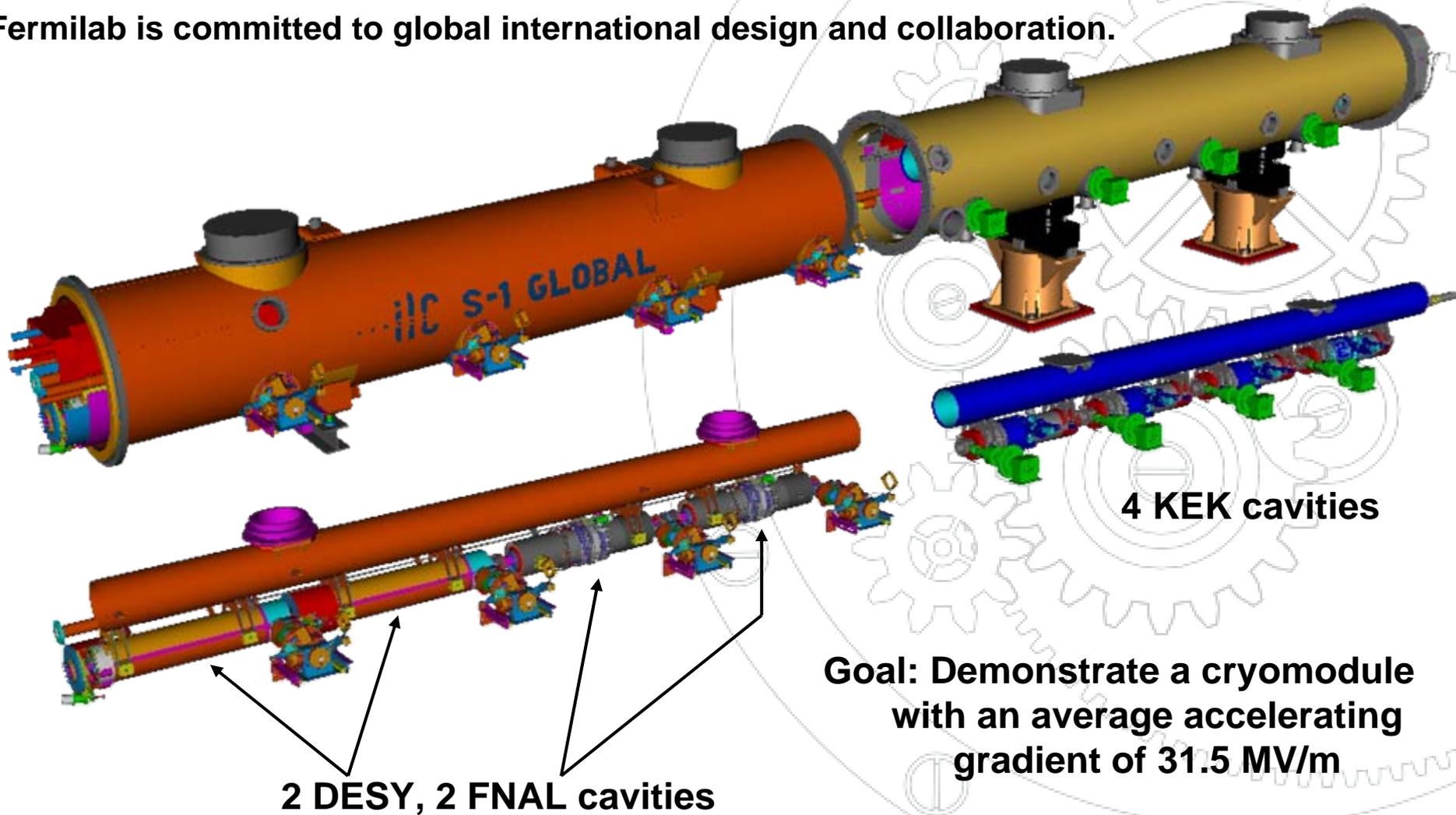


Continuing R&D
efforts for cost
reduction

INFN Bladetuner, FNAL procured cavity and He vessel

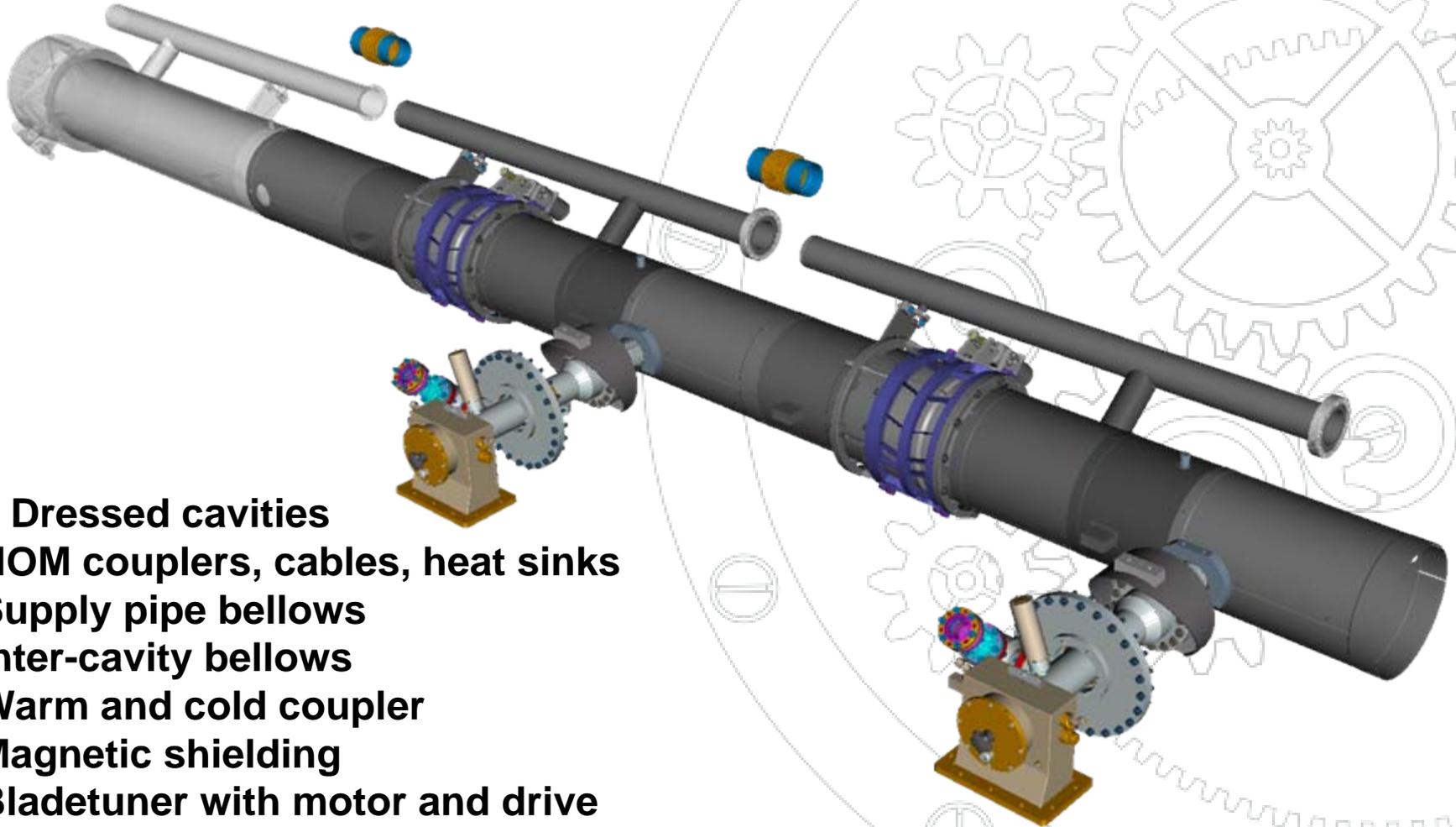
S1-Global Cryomodule

Fermilab is committed to global international design and collaboration.



Goal: Demonstrate a cryomodule with an average accelerating gradient of 31.5 MV/m

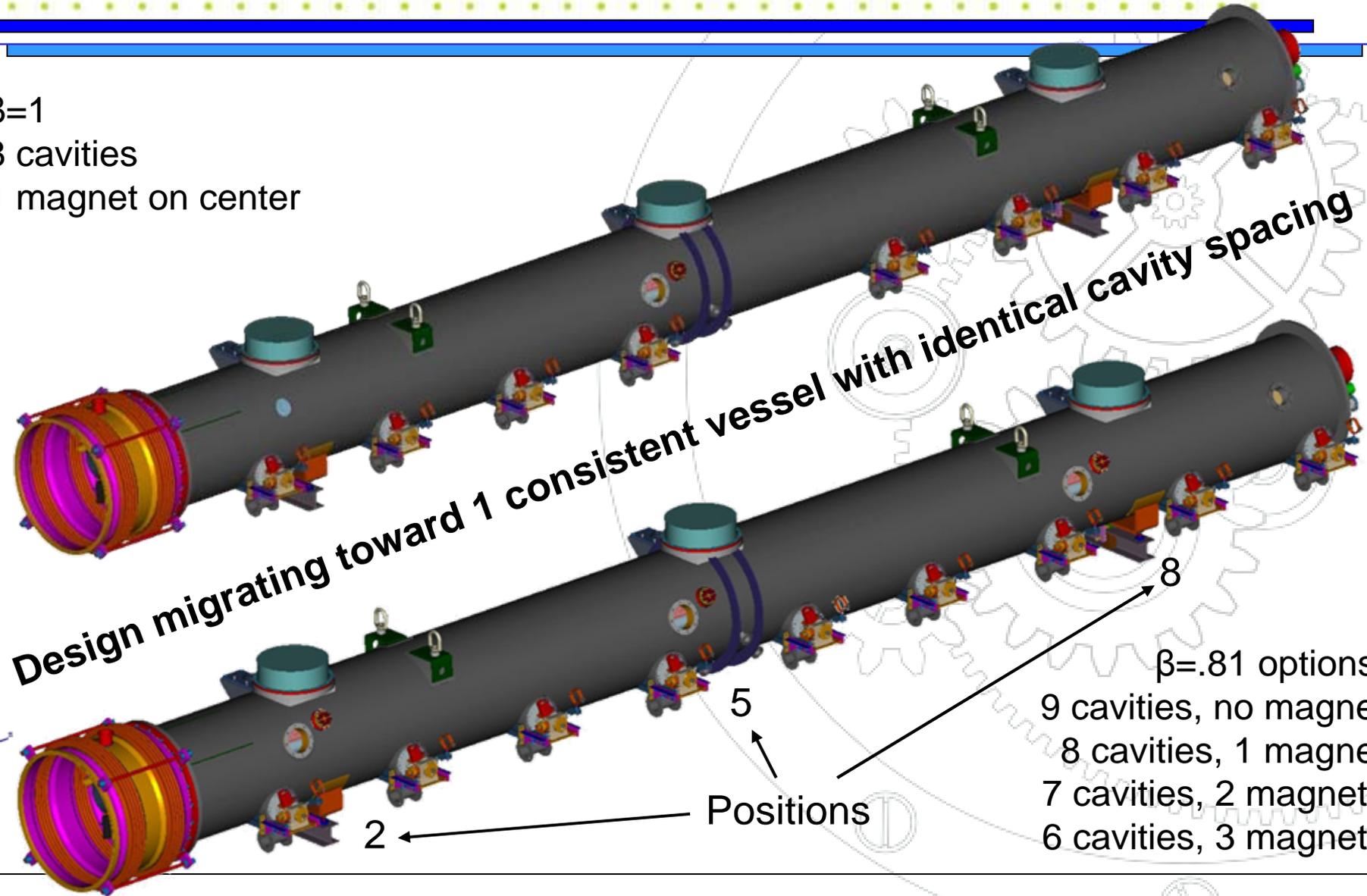
Deliverable for S-1 Global



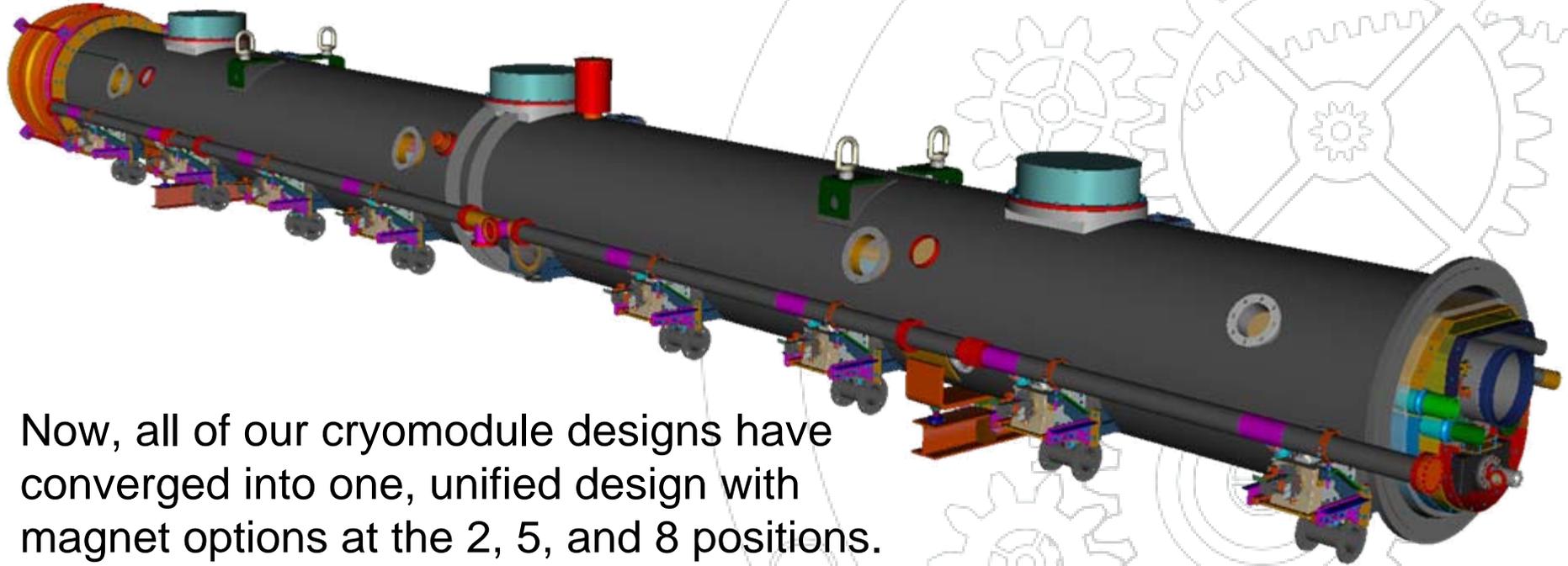
- 2 Dressed cavities
- HOM couplers, cables, heat sinks
- Supply pipe bellows
- Inter-cavity bellows
- Warm and cold coupler
- Magnetic shielding
- Bladetuner with motor and drive
- Seals, cables, and mounting hardware

$\beta=1$ and $\beta=.81$ cryomodules

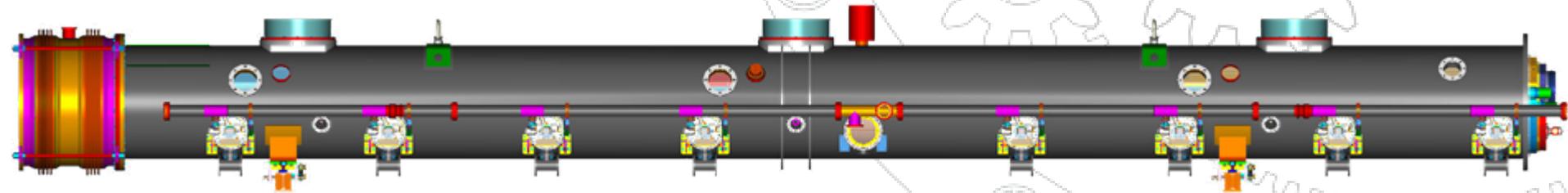
$\beta=1$
8 cavities
1 magnet on center



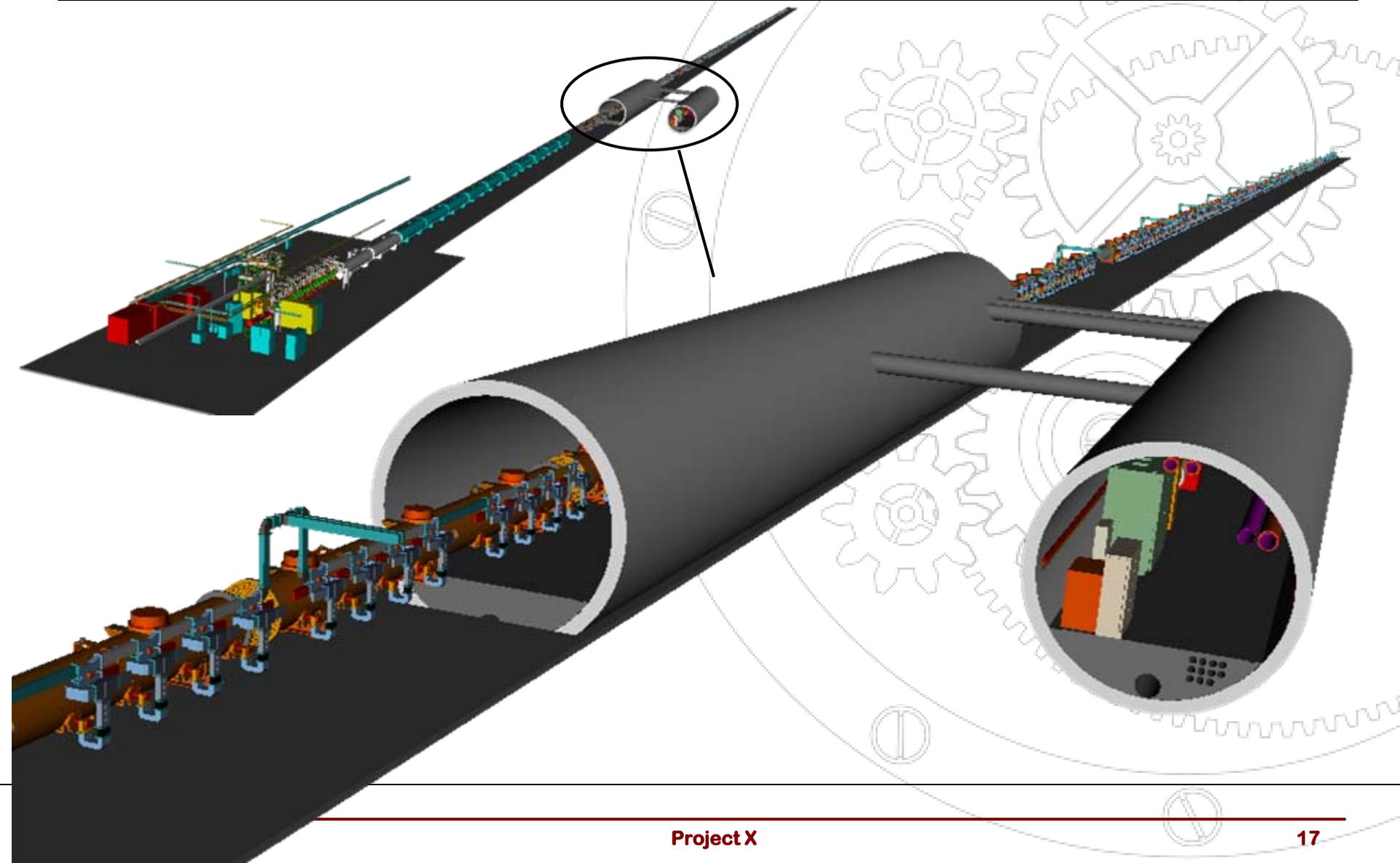
Project-X Unified Cryomodule



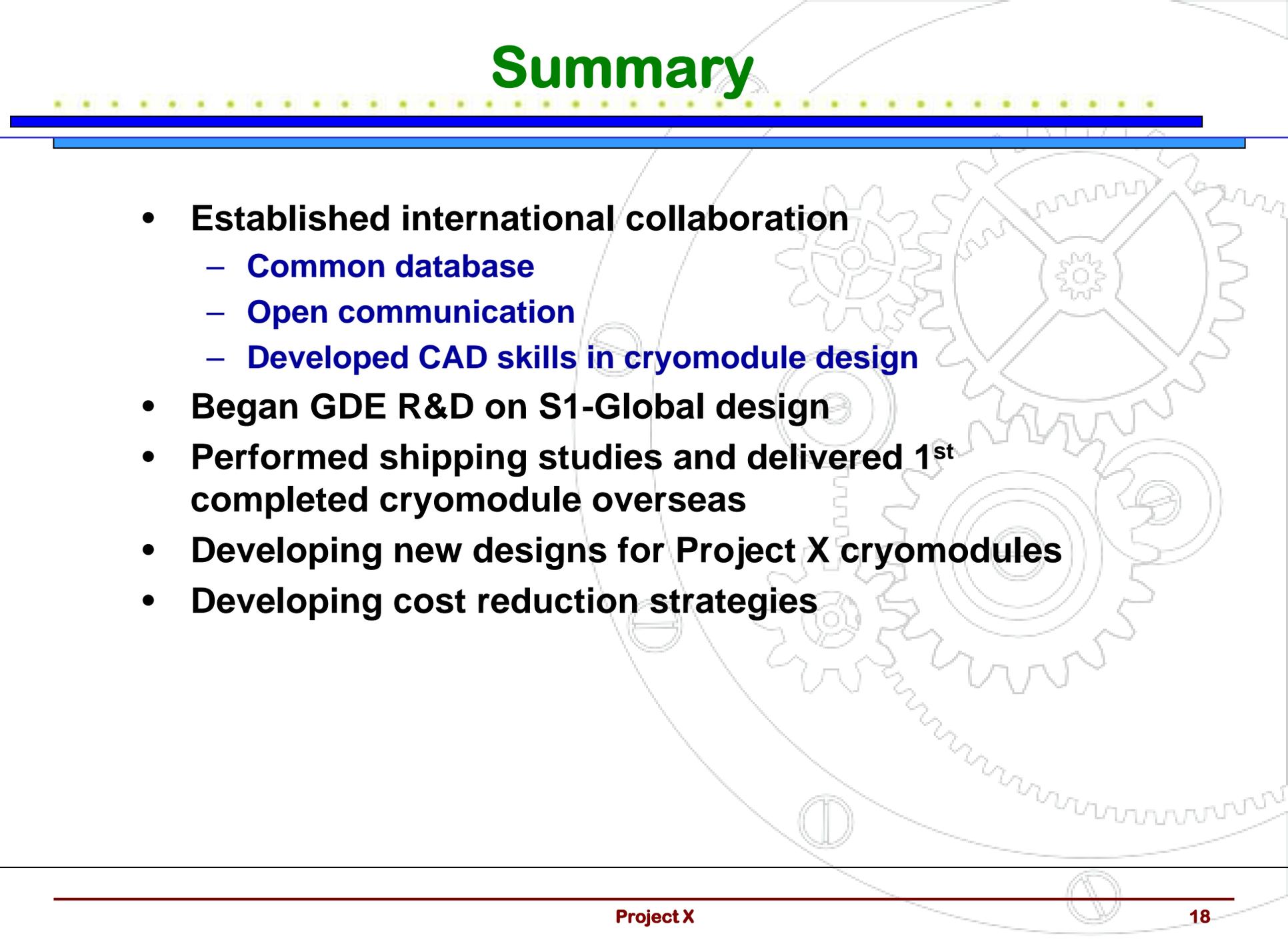
Now, all of our cryomodule designs have converged into one, unified design with magnet options at the 2, 5, and 8 positions.



Project X Layout



Summary

The slide features a background of various sized gears in a light gray color. A thick blue horizontal bar is positioned below the title. A dotted yellow line runs along the top edge of the slide, just below the title.

- **Established international collaboration**
 - **Common database**
 - **Open communication**
 - **Developed CAD skills in cryomodule design**
- **Began GDE R&D on S1-Global design**
- **Performed shipping studies and delivered 1st completed cryomodule overseas**
- **Developing new designs for Project X cryomodules**
- **Developing cost reduction strategies**