

Superconducting Module Test Facility

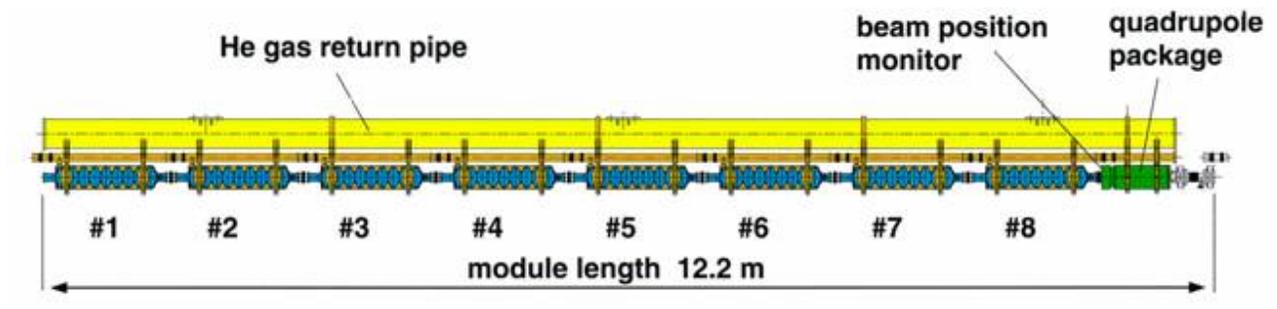
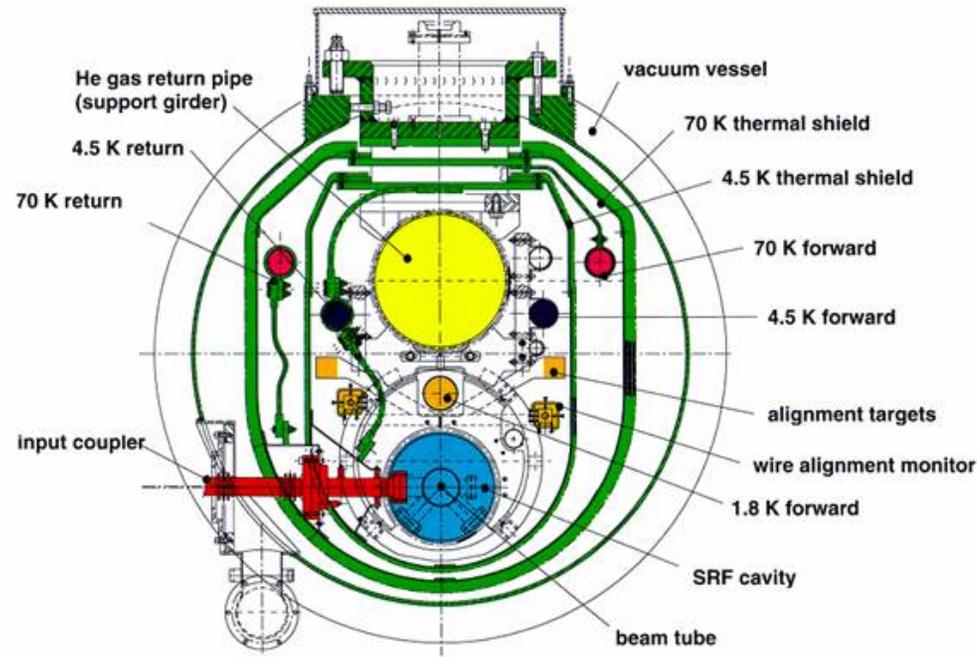
Cryomodule Cryostat Fabrication and Final Cryomodule Assembly

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Presentation Outline

- **Discuss basics of assembling a TESLA module**
 - Assembly process presented is dated, but macroscopically hasn't changed significantly
- **Develop a schedule for producing cryostat components and an assembled cryomodule**
 - Assumes that cavities are available when required for module assembly.
 - Assumes that all collaborations, agreements and intellectual property issues are in place or resolved on DAY 1.
- **Briefly discuss US Industry participation**

The TESLA 8-Cavity Cryomodule (1st Generation)

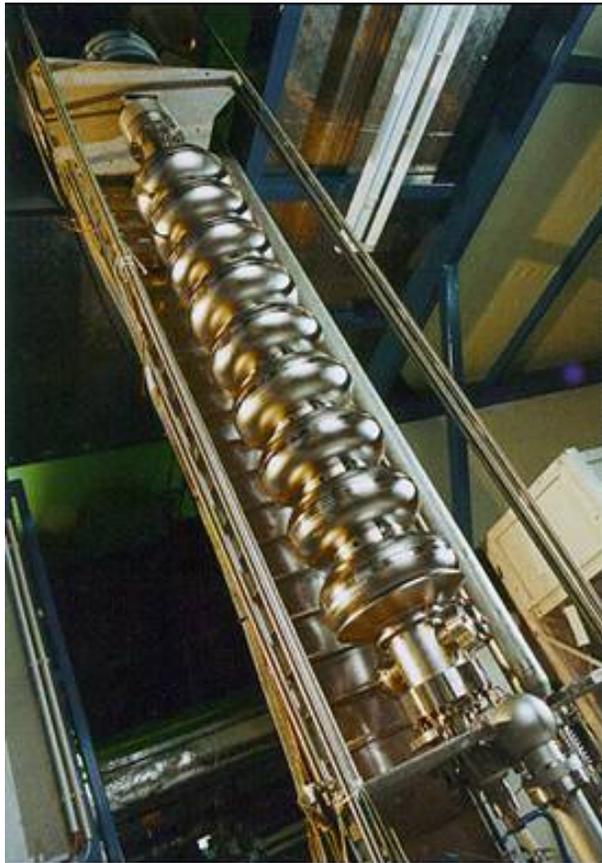


From DESY un-numbered drawings by H. Weise, October 30, 1997.

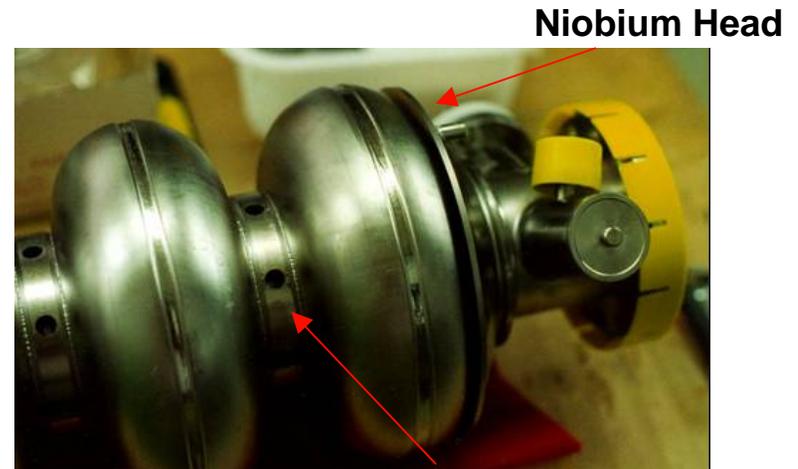
Major Steps of Cryomodule Construction

- **Fabricate the bare cavities**
- **Process the bare cavities**
- **Vertical test the bare cavities**
- **Start dressing the cavities**
 - Weld on He Vessel & He Supply/Return Line, Cooldown line, etc.
- **Assemble cavity string**
 - Includes 8 cavities, couplers' cold end, and 1 quadrupole magnet
 - Modified tooling required for particular clean-rooms used
- **Complete dressing of the cavities**
 - Mount tuner cold parts, 2 K MLI, magnetic shielding, etc.
- **Assemble the cold mass**
 - Couple cavity string to gas-return pipe assembly and align
 - Apply 4.5 and 70 K MLI, magnetic shielding, BPM, etc.
 - Significant tooling required
- **Insert and mount cold mass into vacuum-vessel**

TESLA Nine-Cell Cavity



From DESY'98, *Das Jahrbuch des Forschungszentrums DESY*



Niobium Head

Perforated Ring to Handle Lorentz Forces

Titanium Cryogen-Supply/Return Line

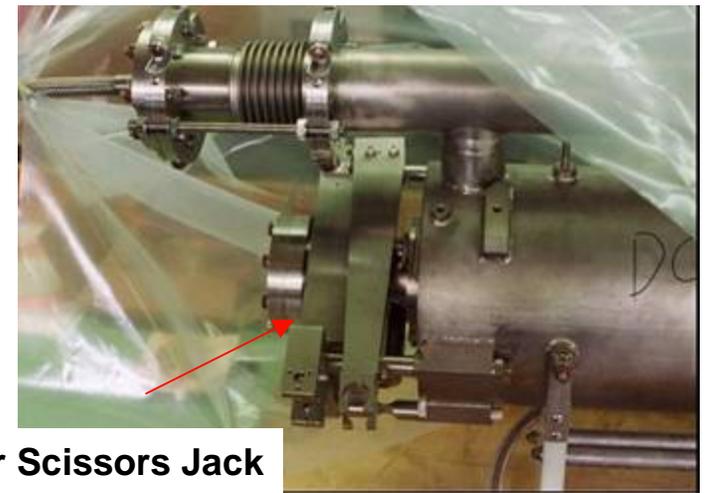
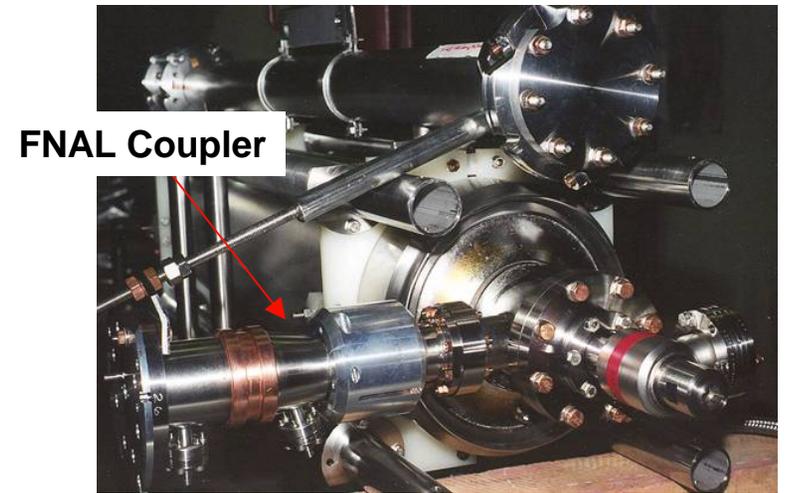
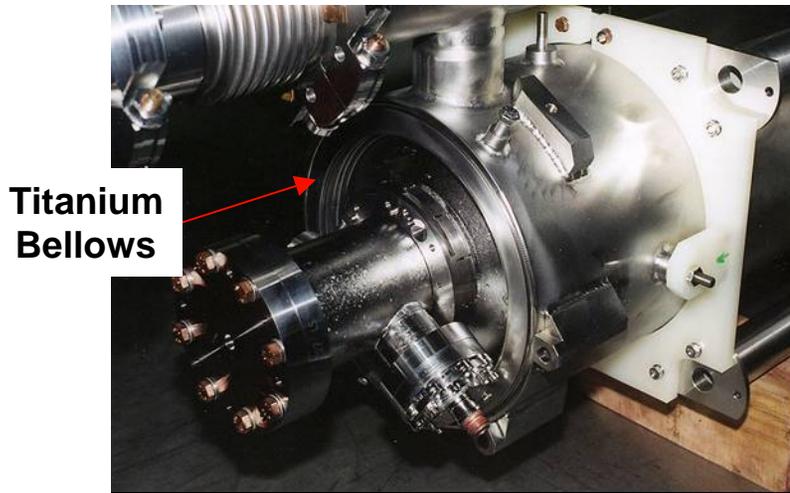


Titanium Helium Vessel

Cooldown Supply Line

Tuner Cage

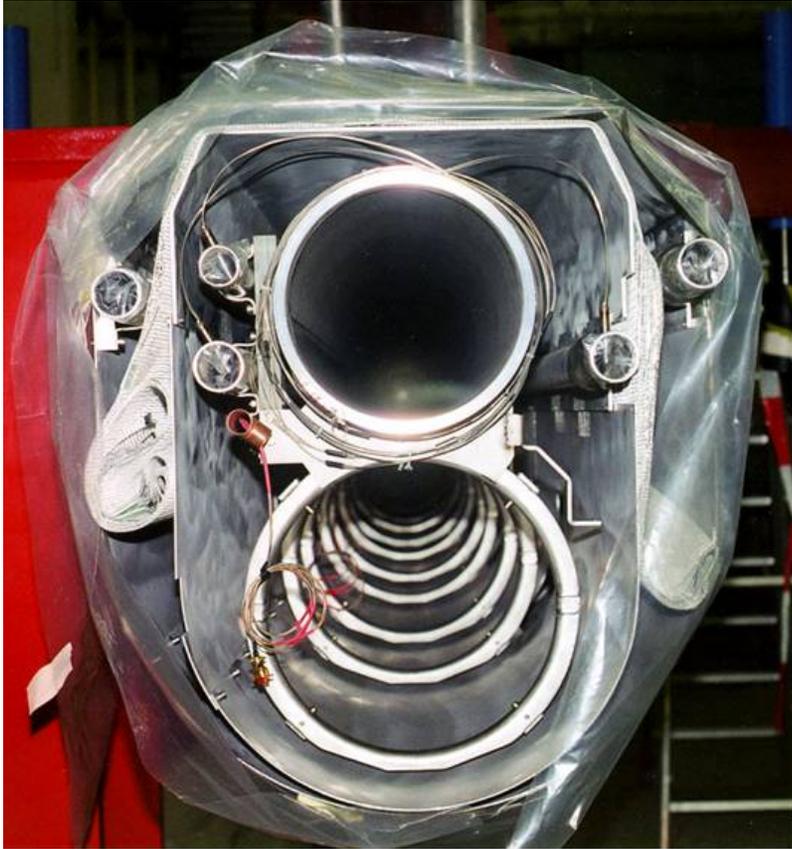
Dressing the Cavity and Assembling the String



From DESY'98, Das Jahrbuch des Forschungszentrums DESY

Cryomodule Assembly I

**Gas-Return Pipe Assembly
(Cold Mass without Cavities)**



**Area where cavity string is coupled
to the gas-return pipe assembly**



**Diamond plate covering sliding track on
which cavity string is mounted**

**Columns (4) on which the fixture supporting the
Cold mass is mounted for coupling the gas-return
pipe to the cavity string**

Cryomodule Assembly II

**Gas-Return Pipe Assembly
on Cantilever Fixture**

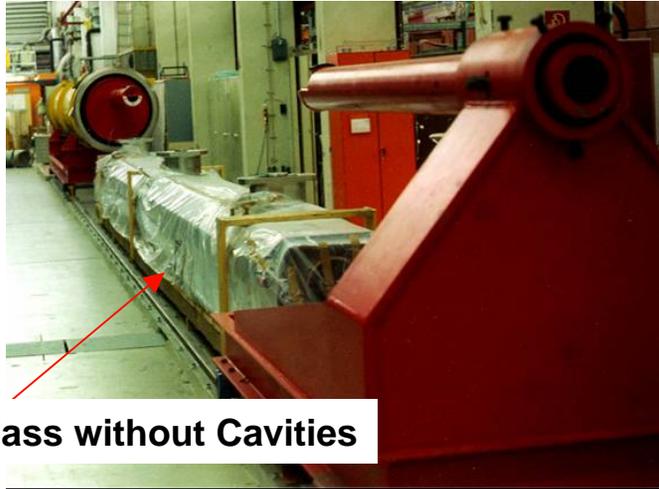


**Final Assembly of Cold Mass
on Cantilever Fixture**

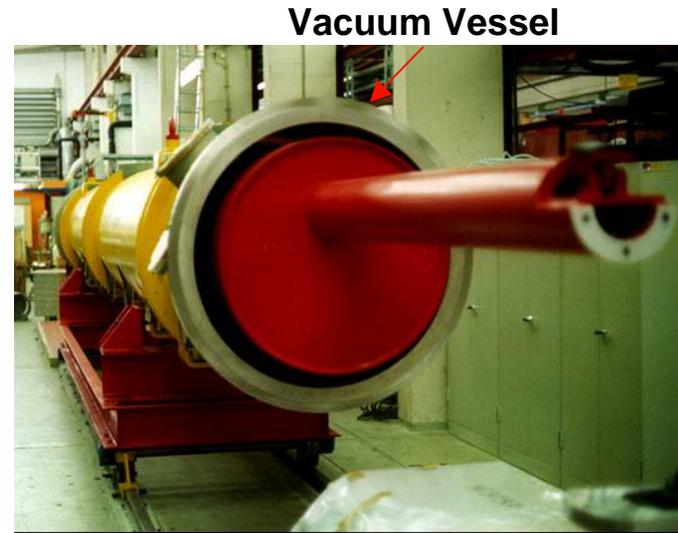


From DESY'98, Das Jahrbuch des Forschungszentrums DESY

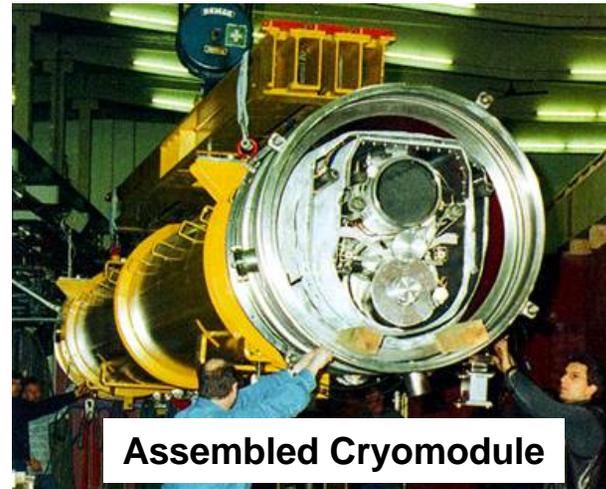
Final Cryomodule Assembly Tooling



Cold Mass without Cavities



Vacuum Vessel



Assembled Cryomodule

From DESY'98, Das Jahrbuch des Forschungszentrums DESY

Assumptions Made for Schedule Preparation - I

- **Three TESLA 8-cavity cryomodules & 26 cavities and couplers are required.**
- **All collaborations and agreements are in place.**
- **FNAL acts as prime contractor. Other labs are subcontractors.**
- **All project organizational elements are in place.**
- **All drawings, specifications and procedures are available on Day 1.**
 - **There is no redesign of any cryomodule components required.**
- **The “A” Team is available on Day 1.**
- **Funding is available.**
- **No tooling is available from DESY. All tooling must be built.**
- **Cavities and couplers are available when required.**
- **DESY string-assembly tooling designs are modified to satisfy local clean-room requirements.**
- **No pre-qualifying of vendors is required.**

Assumptions Made for Schedule Preparation - II

- **For the major module subassemblies, the first article is built, then additional units are built in parallel.**
 - **Final assembly of the 3 modules done in Series.**
- **SC Quad built in industry with significant lab oversight.**
- **Workforce has general experience in the technologies, but not with the TESLA module.**
- **Lab that assembles the string also assembles the cryomodule.**

Cryomodule Cryostat Fabrication - US Industrial Participation

- **Involve/develop US Industry as much as is practical without jeopardizing schedule.**
 - **Work performed by US industry**
 - **Welding helium vessel, supply/return & cooldown piping to cavity assembly.**
 - **SC Quadrupoles**
 - **Beam-position monitor package**
 - **Major cryostat components (vacuum vessel, gas-return pipe assembly)**
 - **Build cavity string tooling**
 - **Build cold mass and final assembly tooling**
 - **Assembly by labs**
 - **Build cavity string (large clean-room required)**
 - **Cold mass assembly**
 - **Final module assembly**

Cryomodule Cryostat Manufacturers

- **These companies can build/subcontract/integrate short cryomodule cryostat manufacturing runs**
 - Meyer Tool
 - PHPK
 - Linde BOC Process Systems
 - Ability
 - Chart (?)
- **Specialized Fabricators (i.e. for titanium welding)**
 - Titanium Fabricators
 - Sciaky
 - Other?
- **SC Quadrupoles**
 - Suggestions are welcomed!

Cryomodule Cryostat Production Schedule

ID	Task Name	Duration	1																		
			Q1	Q2	Q3	Y2		Q6	Y3			Q10									
1	Milestones	0 days	◆																		
2	Funding Available	0 days	◆																		
3	Provide Cryomodule/Coupler/Cavity Drawings & Specs.	0 days	◆																		
4	Provide Cryomodule/Coupler/Cavity Tooling Drawings	0 days	◆																		
5	Provide Cavity Processing/Assembly Procedures	0 days	◆																		
6	Provide Cryomodule/Coupler Assembly Procedures	0 days	◆																		
7	Provide Niobium Specification	0 days	◆																		
8	Provide Cryomodule to Feed-end can Interface Control Docs.	0 days	◆																		
9	Provide Cryomodule to Facility Interface Control Docs.	0 days	◆																		
10	Provide Quadrupole Drawings	0 days	◆																		
11	All Memorandums of Understanding/Agreements/Etc. in place	0 days	◆																		
12	All Project Organizational Elements are in place	0 days	◆																		
13																					
14	Cavity Production through Vertical Dewar Testing (Hasan)	303 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
19																					
20	Procure SC Quadrupole (Three Units)	312 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
32																					
33	Procure/Produce BPM Module (3) (Assumes feedthrus procured elsewhere)	188 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
43																					
44	Start Dressing Bare Cavities (add helium vessels, He supply/return line, coolc	195 days																			
62																					
63	Build Cavity String Tooling	251 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
73																					
74	Assemble Cavity String	111 days																			
78																					
79	Build/Procure Vacuum Vessel/Gas-Return Pipe Assembly (Three Sets)	383 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
90																					
91	Build Cold Mass and Final Module Assembly Tooling (One Set)	236 days	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
99																					
100	Final Module Assembly (complete cavity dressing, mate string to gas-return a	140 days																			

Comments on Schedule

- Cryomodule Cryostat Manufacture and Cryomodule Assembly can be completed in ~ 25 months.
 - This is a **SUCCESS ORIENTED Schedule** and assumes many things are in place on **DAY 1**.
- We assumed cavities were available when required
 - Assuming the same start date for the cavities, this suggests that the time required for *Cavity Preparation through completion of Vertical Dewar Testing*, 26 cavities, is 16 ½ months.
 - Probably not a realistic timeframe for procuring niobium, cavity manufacture, preparation, qualification, and vertical testing.
 - **Cavity fabrication and preparation is likely to be the critical path for cryomodule production.**