WENDELSTEIN 7-X PROGRESS

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on behalf of the W7-X team

Outline

- Introduction- Design parameters
- The W7-X machine concept
- Superconducting coils, mechanical structure, plasma vessel, thermal shields, ECRH
- Assembly
- Conclusions

Introduction

• The WENDELSTEIN 7-X (W7-X) fusion experiment is the next step device in the stellarator line of IPP and is presently under construction at the Greifswald Branch of the Max-Planck-Institut für Plasmaphysik.

• It will be the world‘s largest stellarator-type fusion device.

• W7-X aims at demonstrating the inherent steady state capability of the stellarator at reactor relevant plasma parameters.

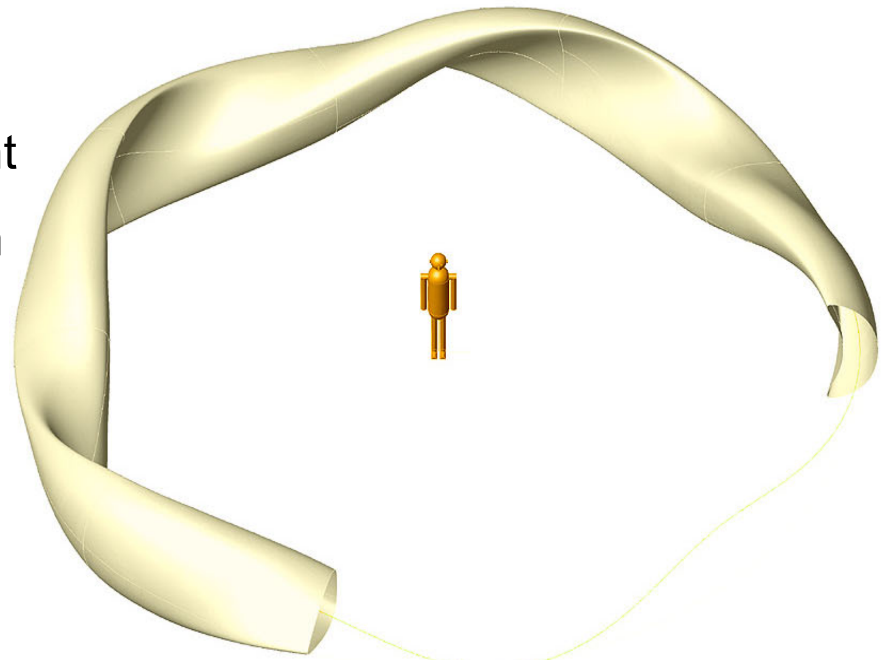
Main design parameters of W7-X

Major plasma radius	5.5 m
Minor average plasma radius	0.53 m
Plasma volume	30 m^3
Machine height	4.5 m
Machine diameter	16 m
Machine mass	725 t
Cold mass	425 t
Max. magnetic field on the plasma axis	3 T
Max. magnetic field on coils	6.8 T
Magnetic energy	600 MJ
Heating power (1st/ 2nd stage)	15/30 MW
Plasma pulse length	30 min with 10 MW ECR heating, 10 s with full NBI and ICR heating power

Magnetic Field and Plasma Shape in W7-X

Optimised magnetic configuration to obtain

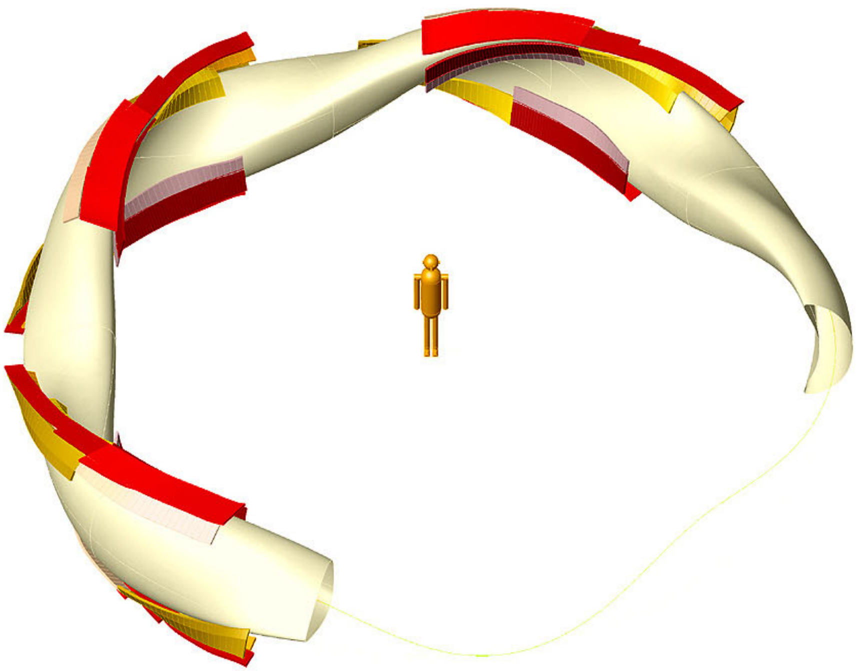
- good plasma confinement
- Stable plasma equilibrium up to ß=5%



Field accuracy $\Delta B / B_o < 2x10^{-4}$

control coils/ correction coils

Divertor and First Wall

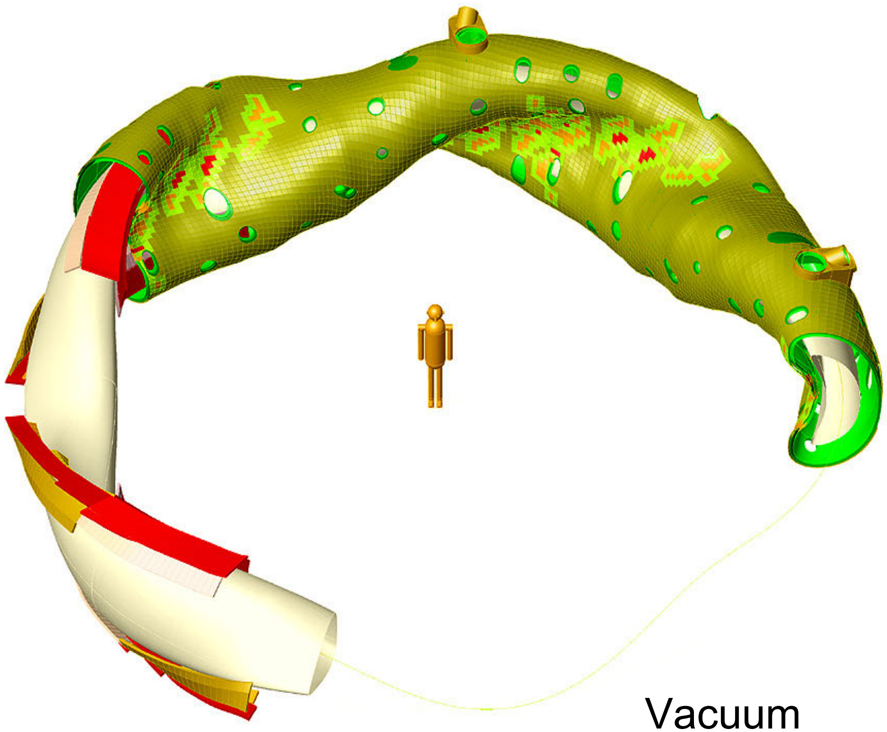


Target elements (10 MW/m^2): CFC brazed on CuCrZr

Baffles (0.5 MW/m^2): graphite tiles

First wall B_4C (0.2 MW/m^2)

Plasma Vessel



Volume 110 m^3

Surface 200 m^2

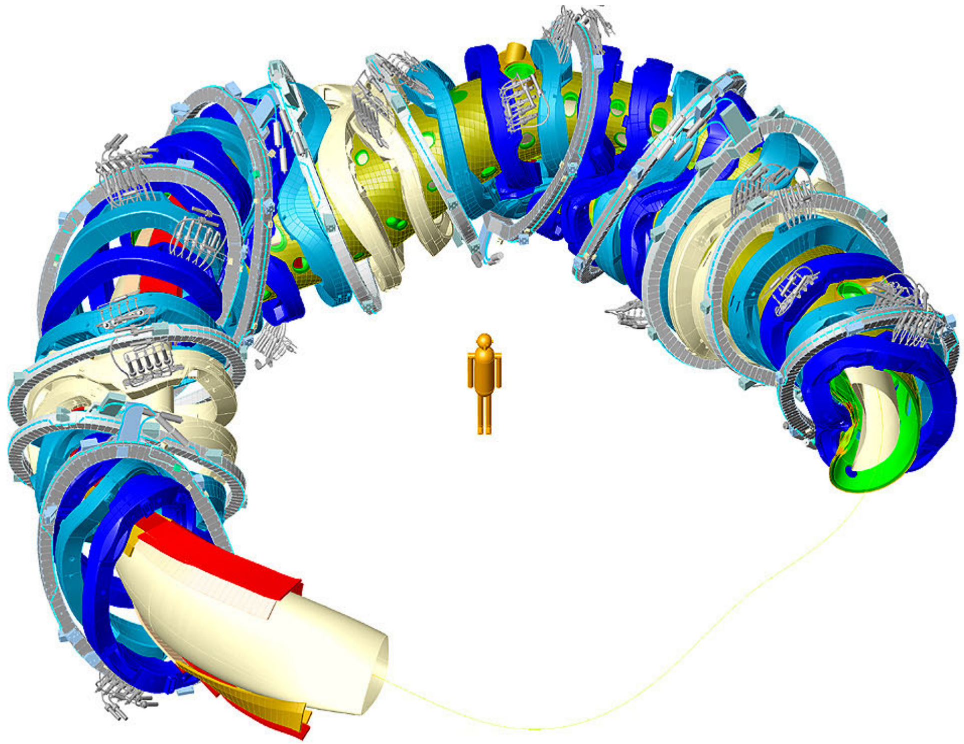
Weight 35 t

Vacuum < 10^{-8} mbar

Baking 150° C

Tolerance <± 2 mm

Coil Systems



Magnetic field on plasma axis 2.5 T (≤ 3T)

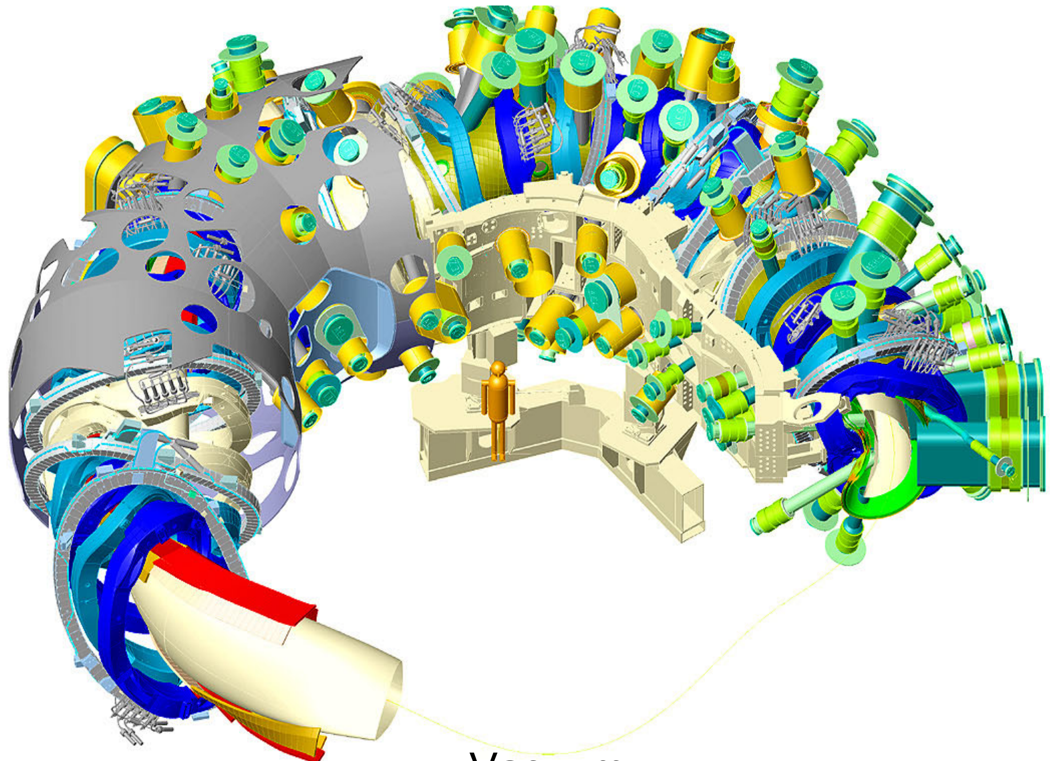
Magnetic field on the coils 6.8 at 17.8 kA

NbTi Superconductor (> 3.4 K)

50 Non Planar Types – 5 Types

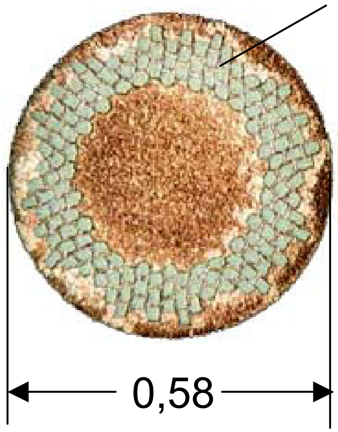
20 Planar Coils – 2 Types

Outer Vessel and Ports

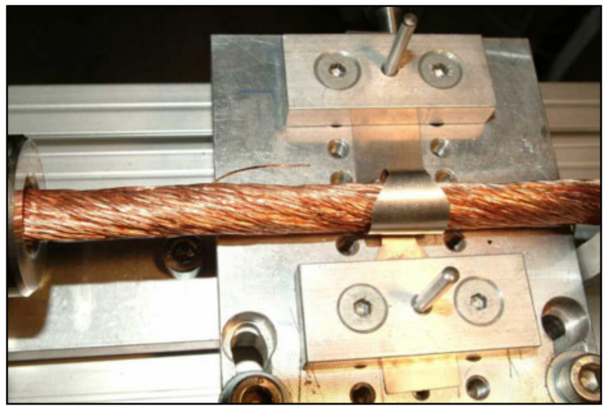


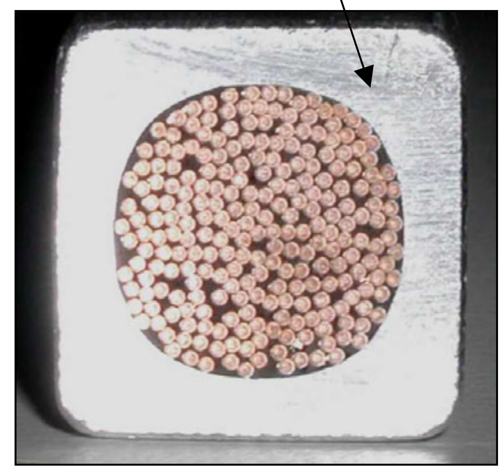
Volume	525 m³	Vacuum	< 10^{-5} mbar
Surface	480 m²	Number of Openings	~ 1200
Weight	150 t	Number of Ports	299

Superconducting Cable



Strand in Nb-Ti

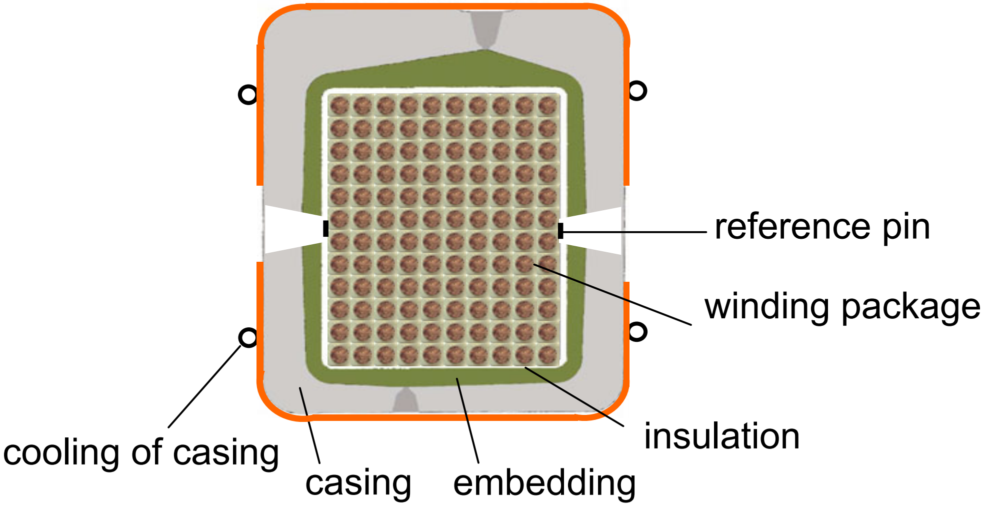




Jacket produced by co-extrusion

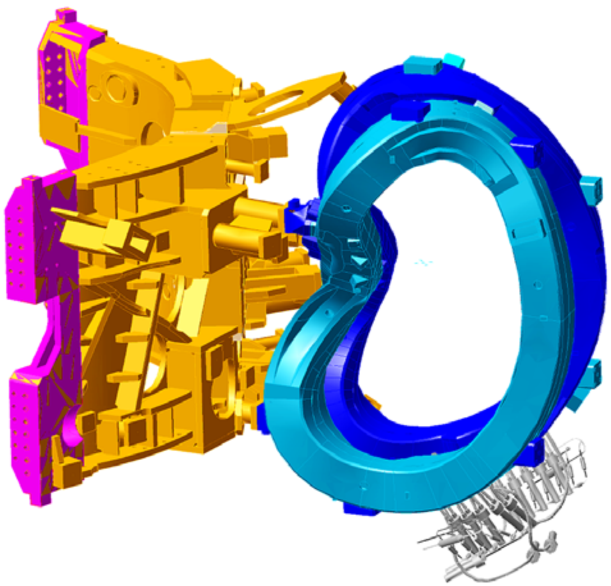
- Strand critical current (4.2 K/ 6 T) > 150 A
- Conductor void fraction 37 %
- Nominal current 17.6 kA

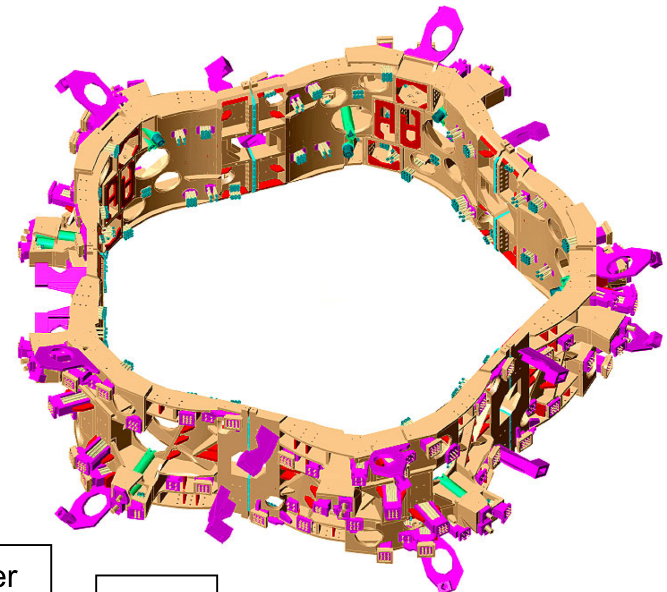
Superconducting Coils

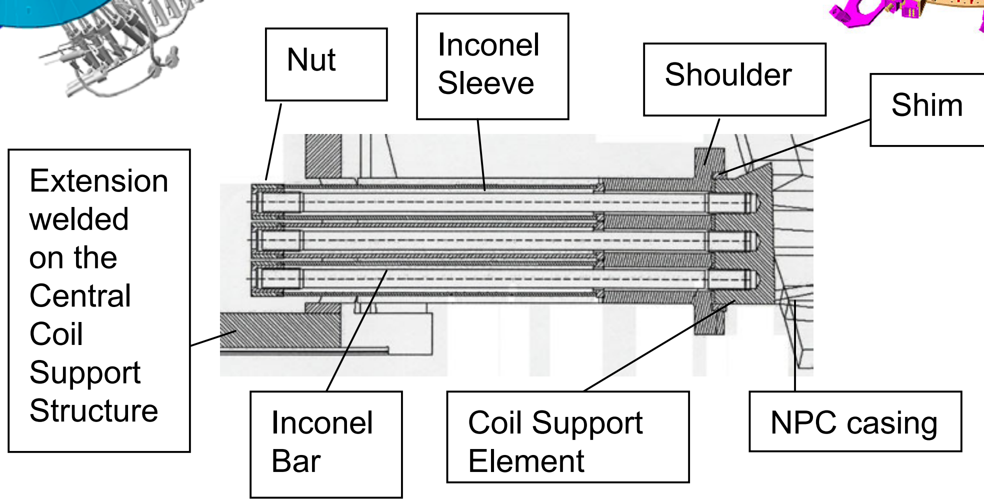


Central Support Ring

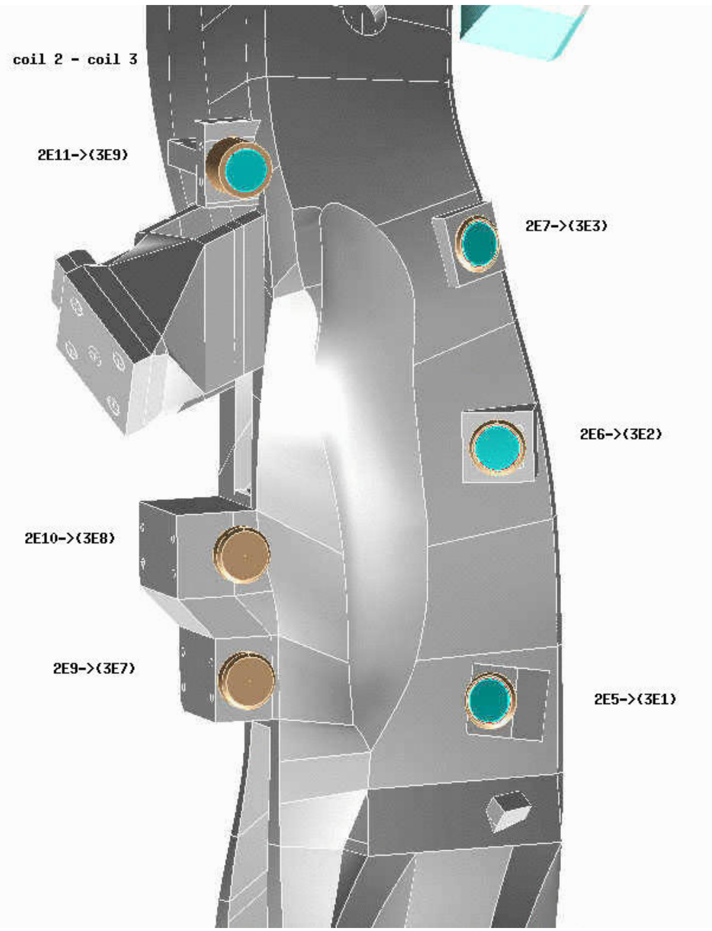
Central Support

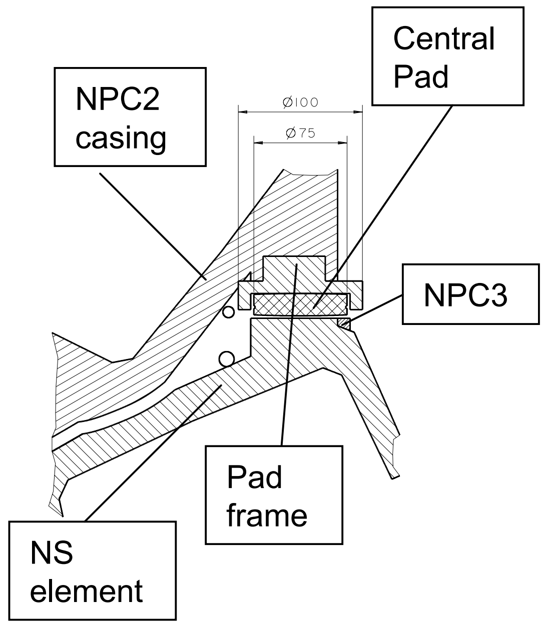




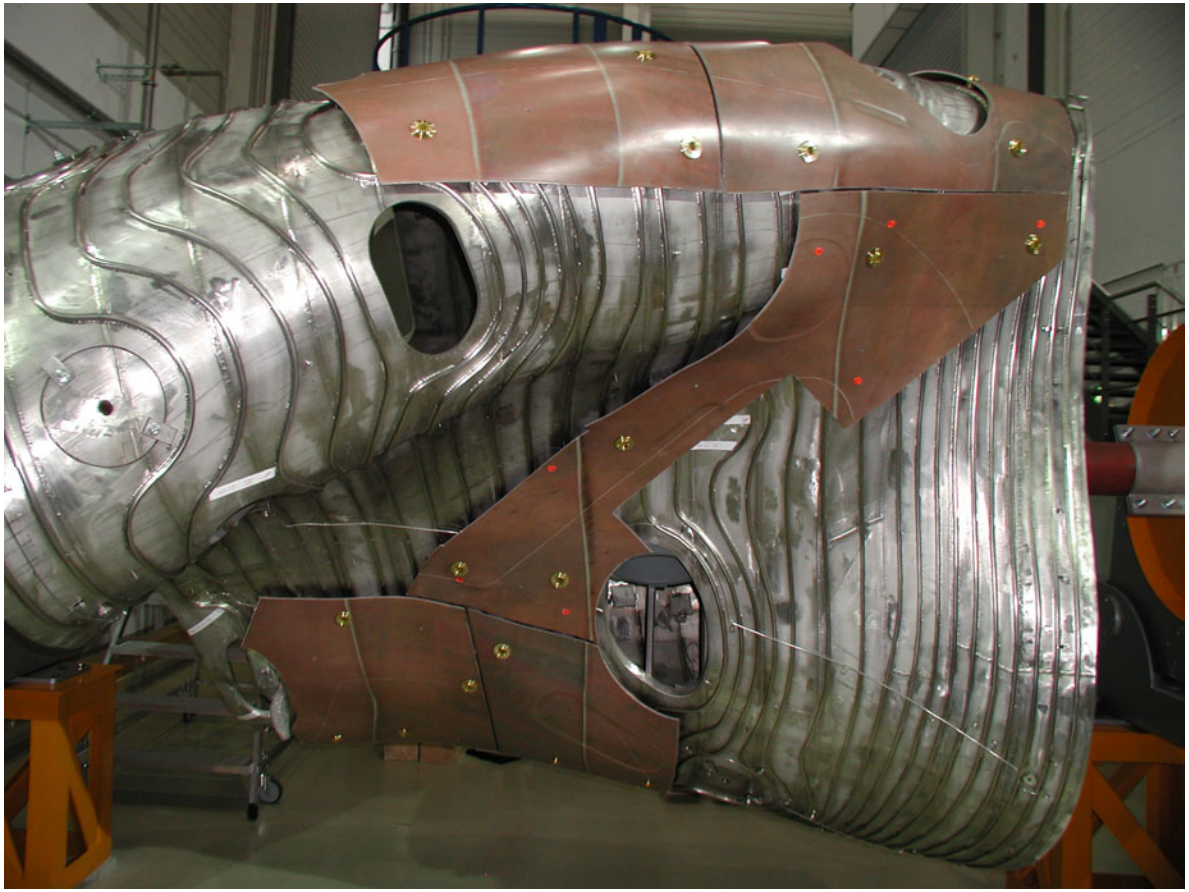


Narrow Supports





Plasma Vessel Sector

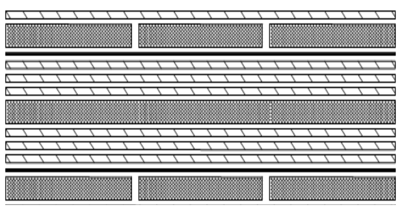


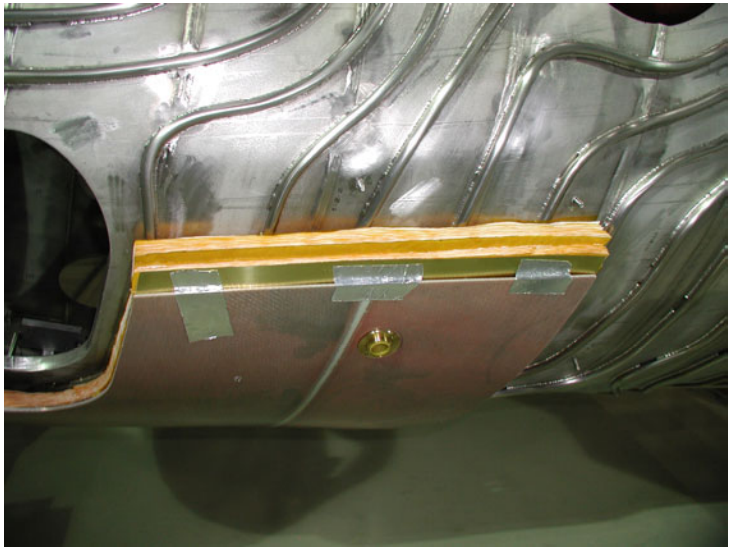
Thermal Insulation

Multi-Layer Insulation (aluminised crinkled Kapton foils) supported by actively cooled thermal shields

- heat flux to the coil 1.5 W/m^2
- with 15 mm MLI thickness thermal losses limited to 0.62 W/ m^2

Panel made of pre- impregnated glass layer with 3 embedded copper meshes.





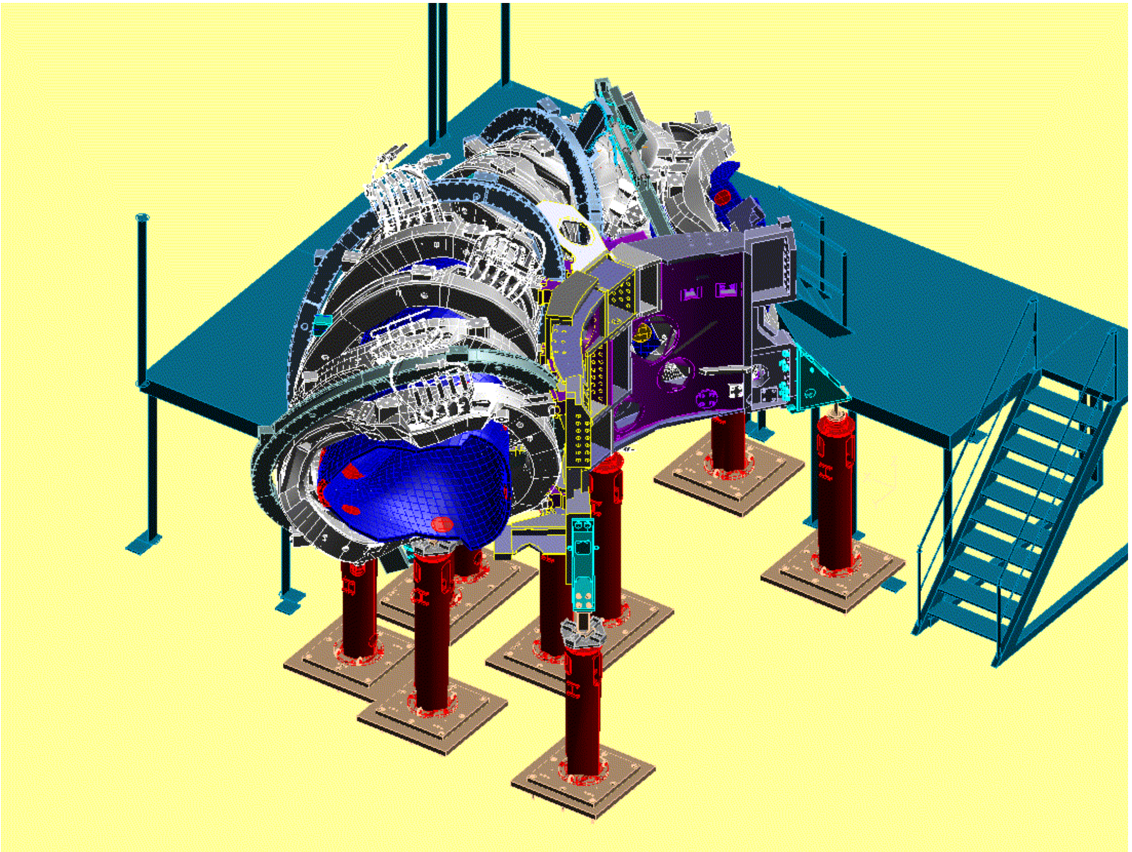
Prototype of W7-X Gyrotron

- 140 GHz - 1 MW
- Two prototypes developed in Europe and USA
- CW tests on progress

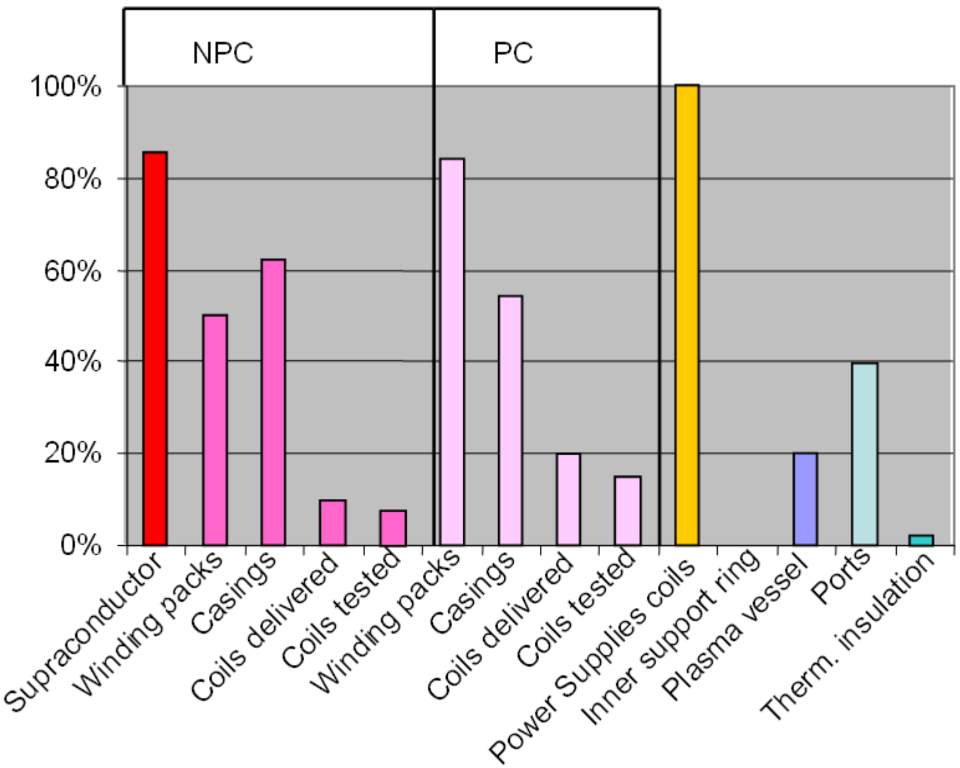
Non Planar Coil Assembly Tool

Mounting Stand II

mechanical connection of two half-modules



Conclusions



Assembly phase will start at the end of 2004

Scientific use planned to start in 2010