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Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

PF Winding

DTT info-day

C.R. ENEA Frascati (Rome), Italy

The DTT team

Outline

- PF conductor and coil description
- PF modules manufacturing approach
- Coil winding

Iz2

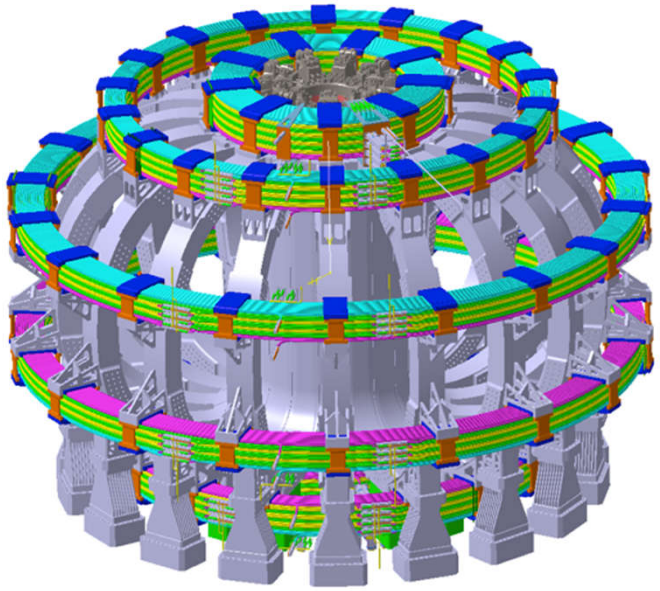
PF Coil Overview

Requirements:

- 6 PF coils Identical in pairs to guarantee full top-down symmetry
- NbTi (PF2 & PF5) CICC: 27.1 kA – 4.2 T
- NbTi (PF3 & PF4) CICC: 28.6 kA – 5.4 T
- Nb_3Sn (PF1 & PF6) CICC: 28.3 kA – 9.1T

Main design choices:

- **PF1&PF6** wound in **4 QP+1 DP** to minimize joint number;
- **PF2 to 5** wound in **DP**



Diapositiva 4

lz2 lorenzo zoboli; 05/10/2019

lz4

PF coil: CICC

Conductor	PF1/6	PF2/5	PF3/4
Radial Ext. Dim. (mm)	23.4	26.4	26.4
Vertical Ext. Dim. (mm)	28.2	27.7	27.7
Jacket thickness (mm)	3.0	3.0	3.0
Inner Corner Radius (mm)	3.5	3.5	3.5
Central Channel (OD/ID; mm)	7/5	7/5	7/5
Inter-turn insulation (mm)		1.8	
# SC strands (0.82mm)	180 (Nb_3Sn)	162 (NbTi)	324 (NbTi)
Strand Cu no-Cu ratio	1	1.9	1.9
# Cu strands (0.82mm)	216	324	162
Total strand number	396	486	486
Void fraction	29.9% (*)	30.2%	30.2%
			

Present reference CICC solution based on:

1. rectangular (or square) geometry, with constant thickness steel jacket;
2. **EITHER** very short twist pitch cable configuration (*ITER CS-like*) **OR** long twist pitch & low Void Fraction (*HFML / NHMFL-like*)
3. Assumption: e_{eff} **= - 0.65%**

KDEMO-LF sample

Diapositiva 5

lz4 lorenzo zoboli; 05/10/2019

Iz3

PF coil: main features

Coil	PF1/6	PF2/5	PF3/4
Bmax (T) (input data)	9.1	4.2	5.3
MAturns max (input data)	10.19	4.34	5.61
Double Pancake Insulation		1mm	
R (mm)	1416	3068	4335
ΔR (mm)	542	302	422
Z (mm)	±2760	±2534	±1015
ΔZ (mm)	590.4	516.8	452.2
Ground Insulation (to be added to ΔR&ΔZ)		5mm	
# turns (radial)	20	10	14
# turns (vertical)	18	16	14
N turns totali	360	160	196
I_{op} max (kA)	28.3	27.1	28.6
ΔT_{margin} (T_{op}: 4.5K)	1.8	1.9	1.7
V_{max} (V)	2150	1350	3290
Weight (ton)	15	16	28

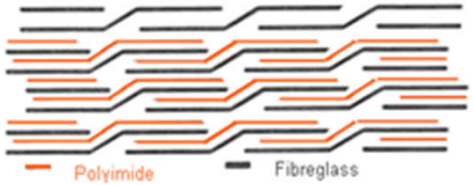
Diapositiva 6

lz3 lorenzo zoboli; 05/10/2019

lz4

PF coil: turn insulation

- turn insulation should consist of layers of interleaved kapton and fiberglass.
- 1.8mm turn insulation thickness is conservative in order to have a large margin, thus making a turn-to-turn and DP-to-DP insulation fault very unlikely
- analyses to evaluate voltage values in normal and faulted conditions are on going



ITER PF like turn insulation layout

for PF2 to PF5 turn insulation is thought to be performed during winding

for PF1 & PF6 manufacturing approach should be:

Wind & React → Insulate → Impregnate

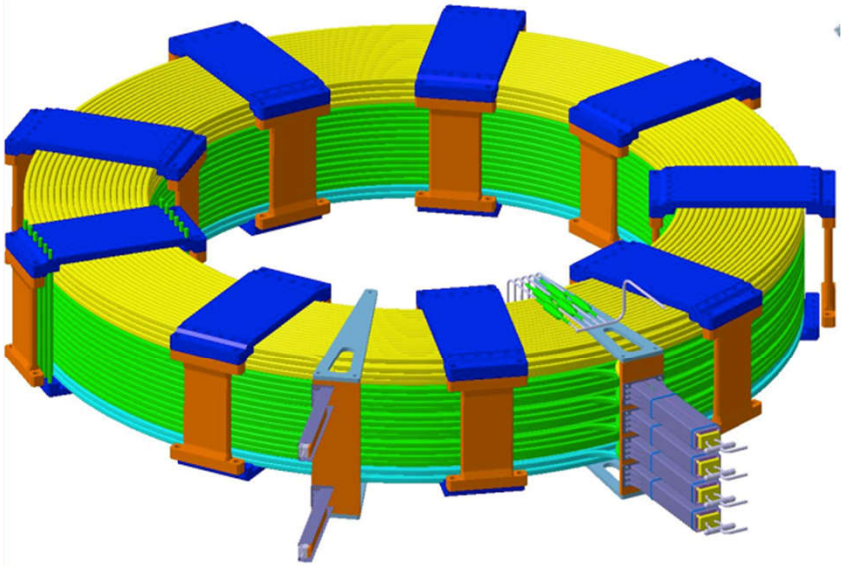
so that a technical solution must be foreseen for turn insulation after the reaction of QP and DP

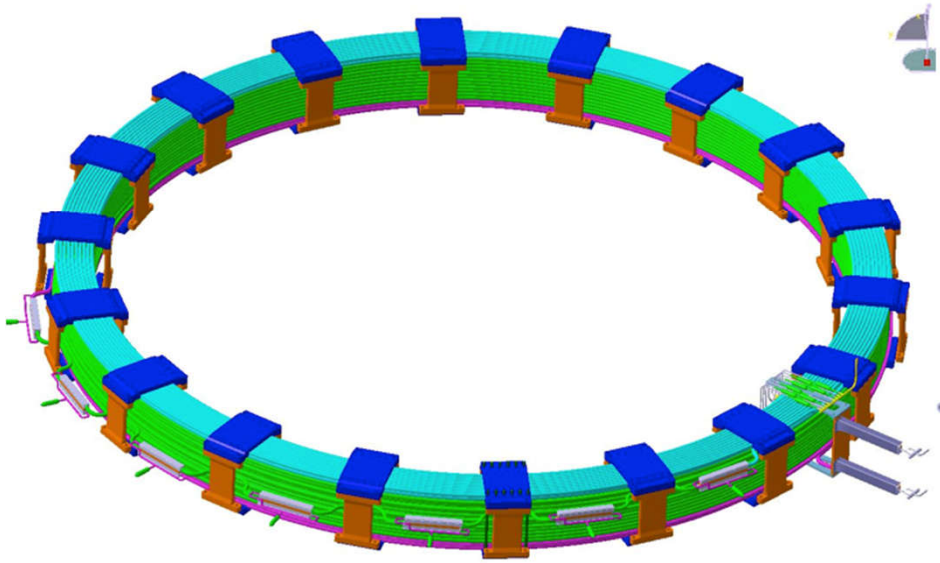
Diapositiva 7

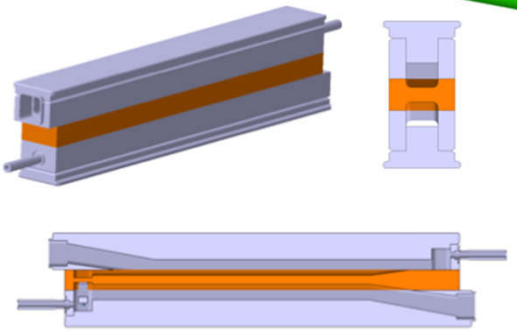
lz4 lorenzo zoboli; 05/10/2019

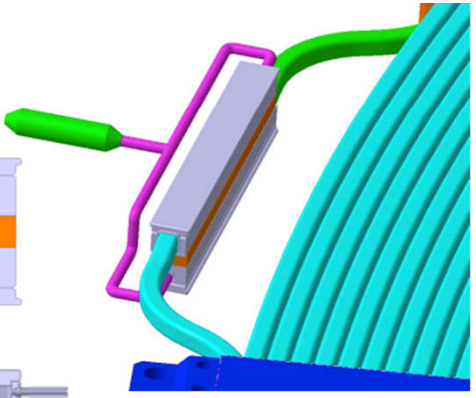
PF module: winding

- due to narrow spaces available at the polar regions of DTT, the joints (whose number has been decreased by QP choice) will be placed along radial direction, of twin box type, praying hands configuration;
- for PF2&5 and PF3&4, the joints will be twin-box type, in shaking hands configuration, distributed along the external circumference
- final orientation of termination has to be assessed according to the available space and possible interference with other structures









QUESTIONS?

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