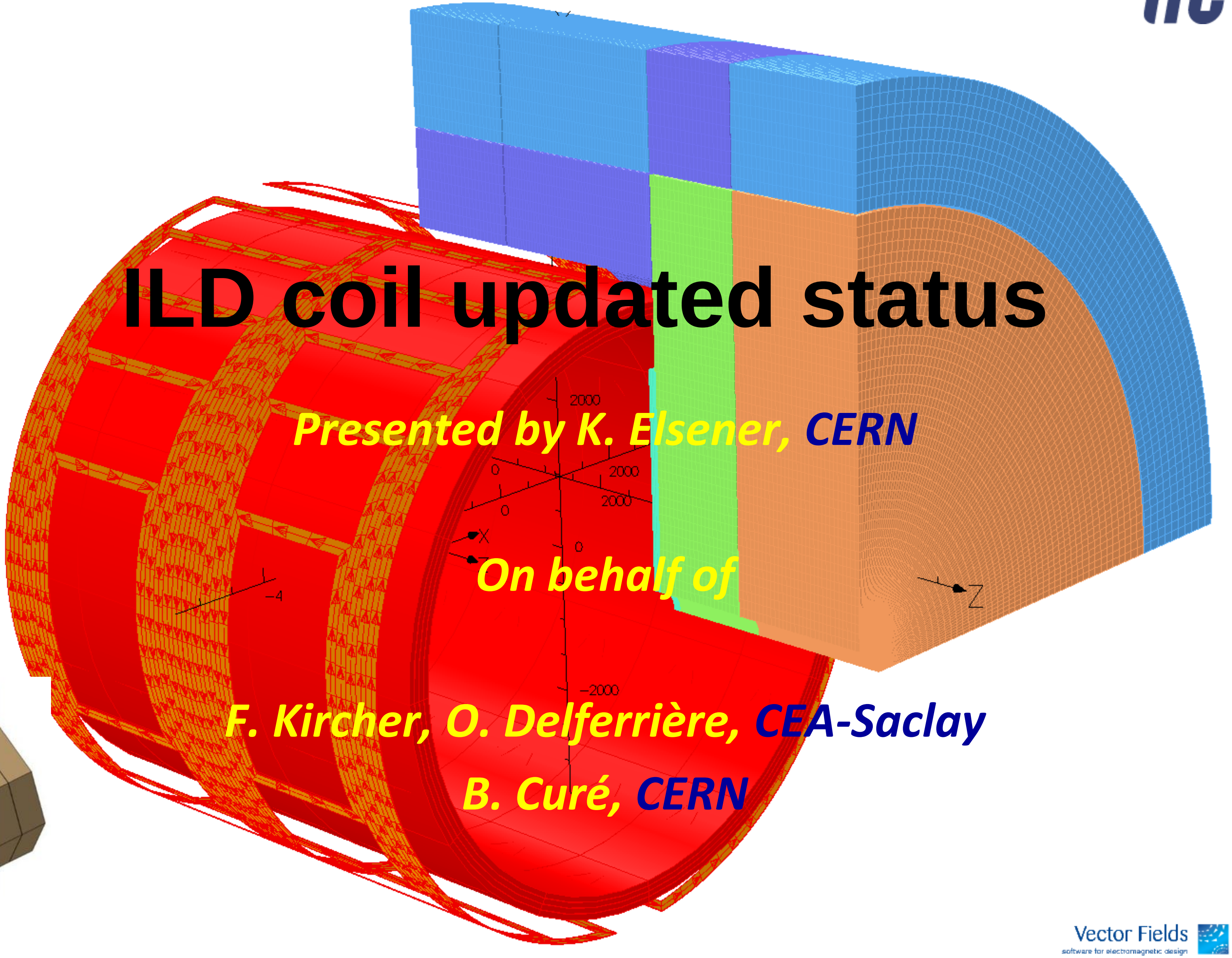


ILD coil updated status

Presented by K. Elsener, CERN

On behalf of

F. Kircher, O. Delferrière, CEA-Saclay

B. Curé, CERN

ILD
International
Large
Detector

Summary

- Introduction
- Requests for physics
- Magnet constitution
- Coil main parameters and geometrical dimensions
- Conductor
- Main options for the coil
- Anti DiD
- Conclusions

Introduction

- Important decisions concerning the ILD magnetic field requirements were taken in 2011:

1. No more request for a high field homogeneity
2. Introduction of an anti-DiD

- These decisions requested an update of the magnet configuration described in the LoI

- The results presented here are the new ones to be taken into account for the DBD. These results, although mainly final, will be consolidated during the redaction of the DBD

- It is worth mentioning that a CERN working group with B. Cure is now participating to this study

ILD magnet conception

- The ILD magnet consists of:

1. The main solenoid coil (4 T at IP)
2. An anti DiD (Dipole in Detector)
3. The magnetic yoke, subdivided into the barrel yoke and the two end-cap yokes

- This presentation deals with points 1 and 2.

The yoke (point 3) has been studied by the DESY team (Uwe Schneekloth) and is not concerned by the new requests concerning the magnetic field

Request for physics

• Design central field	4 T
• Useful (warm) aperture radius	3 440 mm
• Coil length	7 350 mm
• Field homogeneity	no more special request

- Fringing field
  - in the radial direction (z = 0):
    less than 50 G @ R = 15 m from IP
  - in the Longitudinal direction (R = 0):
    less than 100 G @ z = 10 m from IP **(?)**

- Anti- DiD to clean the beam around the IP
  - present value used:
    0.025 T at z = 2m (from R. Versteegen's thesis)

  This value must be confirmed

Coil main parameters (1)

- As the ILD coil parameters are very similar to the CMS's ones, many options are similar: conductor, external mandrel, indirect cooling, protection in case of quench, tie rod suspension…

- Due to the shorter length of the ILD coil, it can be made of 3 modules, each 2.45 m long (instead of 5 modules for CMS). Same number of layers (4) for ILD and CMS modules

The reasons for the choice of 3 modules, rather than 2 or 1, are the followings:

. Fabrication of the external supports easier
. Winding and impregnation easier and less risky
. Shorter unit length of conductor
. Electrical joints positioned on the outer radius of the external mandrel, in the low field region
. Transport and handling of the modules easier

This choice needs a study and some tooling for the assembly of the modules. This can be rather similar to what was done for CMS

Coil main parameters (2)

Central field at IP(T)	**4.0 (nominal)**
Maximum field on conductor (T)	**4.5**
Field integral (T*m)	**32.65**
Equivalent magnetic length (m)	**8.16**
Operating current (kA)	**21.7**
Total Ampere-turns (Mat)	**27.35**
Stored energy (GJ)	**2. 17**
Inductance (H)	**9.26**
Stored energy per unit of cold mass (kJ/kg)	**11.7**

Coil main geometrical dimensions

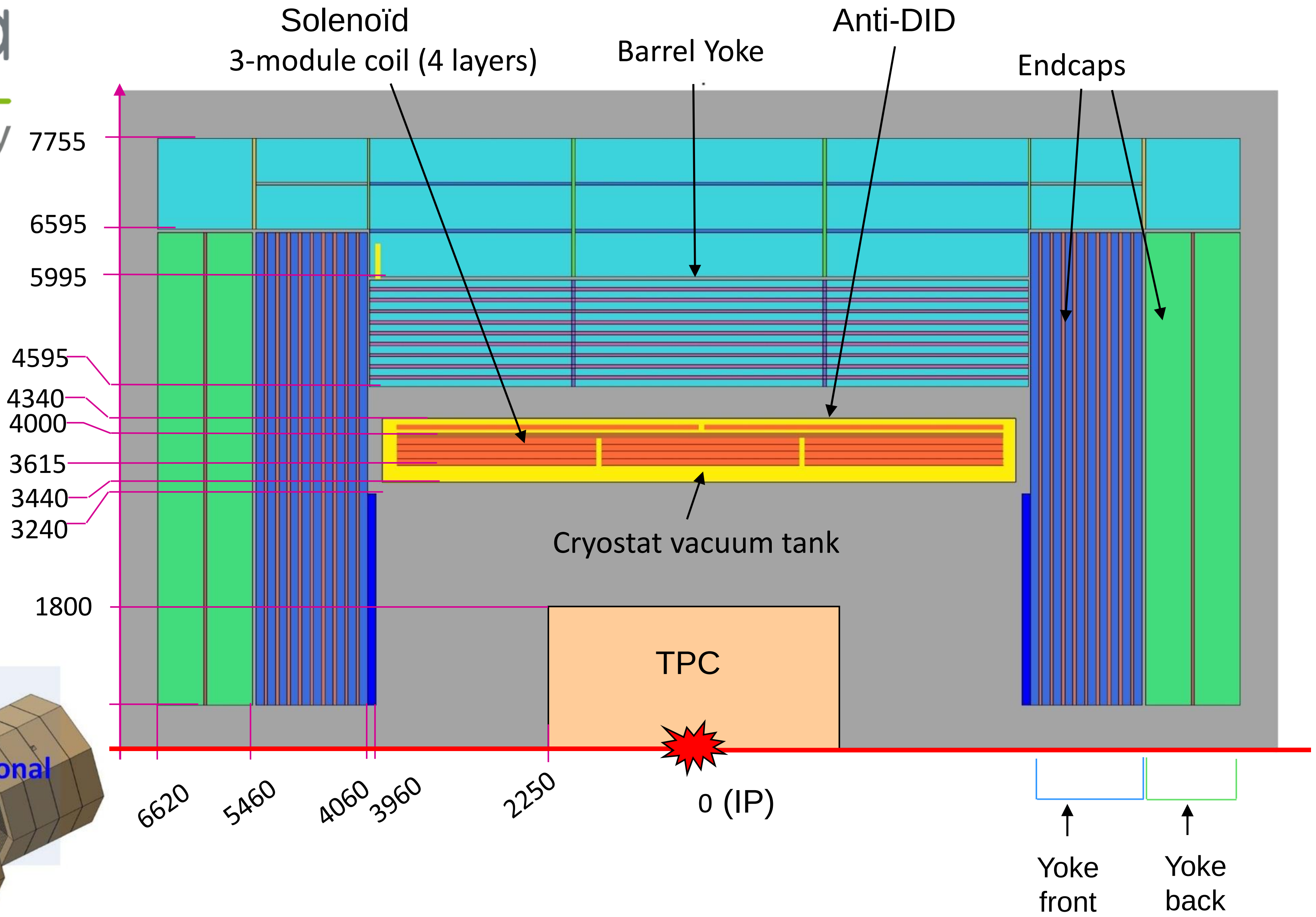
- Cryostat

Inner radius	3440 mm
Outer radius	4340 mm
Overall length	7820 mm

- Coil

Inner radius	3615 mm
Outer radius	4000 mm
Overall length	7350 mm

ILD magnet cross section



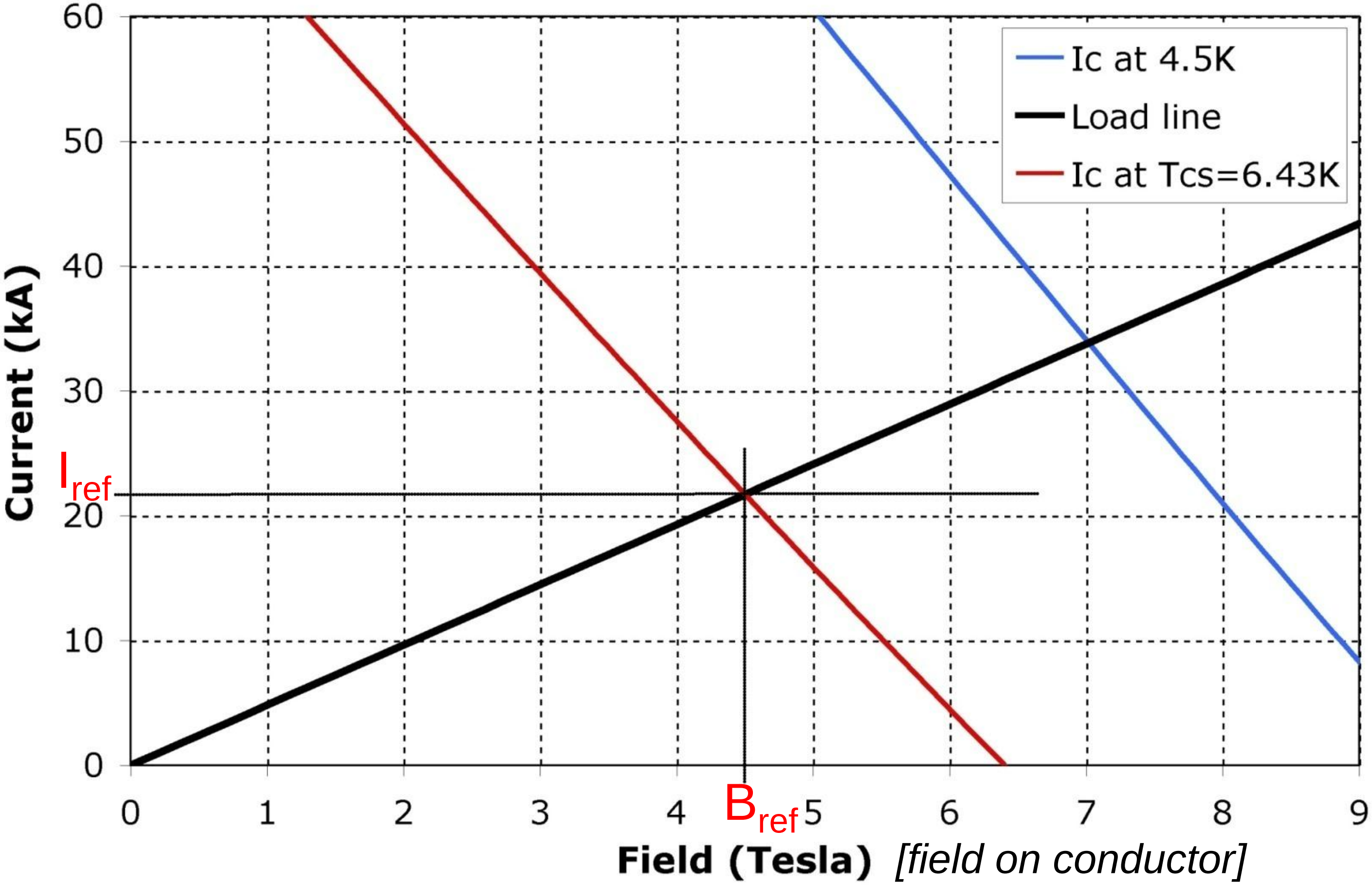
Conductor

- Very similar to the CMS one
- 36 strands in the cable, instead of 32, to take into account the larger nominal current
- Larger reinforcement width to take into account the larger hoop stress *[hoops -> iron bands of a wooden barrel]*
- Overall bare dimensions 73 * 22.3 mm^2
- 250 µm fiber glass insulation
- Temperature margin 1.93 K *[->next]*
- 1260 turns (3*4*105)
- 2 solutions possible for reinforcement: micro-alloyed material (R&D on Al-Ni underway) or ‘à la CMS’ (Al-alloy + High purity alu)

Conductor Load Line

Conductor properties from CMS NbTi/Cu strand data

I_c=3000A/mm^2 at 4.2K & 5T



Main options for the coil

- Conductor more or less ‘à la CMS’

- 3 modules, 4 layers

- External cylinder: 4 roles: winding mandrel, mechanical support, quench back tube, cold path for the LHe indirect cooling

- Vacuum impregnation of each module before assembly

- Indirect cooling by conduction, with cooling tubes working in the thermo-siphon mode for helium circulation

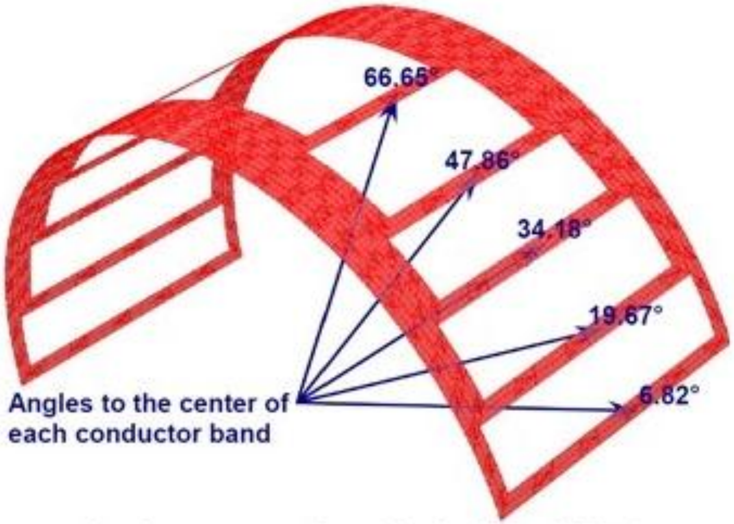
- Several sets of tie-rods to support the coil inside the vacuum tank, and taking into account forces due to gravity, misalignment of the coil in the yoke and seismic forces

Anti DID coil definition

- Superconducting coil
- Located on the outer solenoid support
- Mechanical frame supported on the coil mandrel
- Use of the same cooling circuit as the solenoid
- NbTi, Nb_3Sn or MgB_2 used as superconductor (temp. margin vs. sensitivity to deformation)

- Magnetic design and implementation under way (based on B. Parker's design).

Choice of SC will depend of the implementation.



Conductors are reflected in the *XY* and *XZ* planes

Conclusions and remarks

- Magnet design frozen

- Main solenoid and yoke dimensions defined

- Conductor design to be finalized

- Magnetic and mechanical designs of the anti-DiD underway

- Assembly scenario similar to CMS, with anti-DiD integration, to be defined

- These results will be consolidated during the writing of the DBD (due end of August 2012), and they will be detailed in specific technical reports (end of 2012)