E-JADE is a Marie Sklodowska-Curie Research and Innovation Staff Exchange (RISE) action, funded by the EU under Horizon2020

E-JADE

ILD Technical and Optimisation Issues

Karsten Buesser

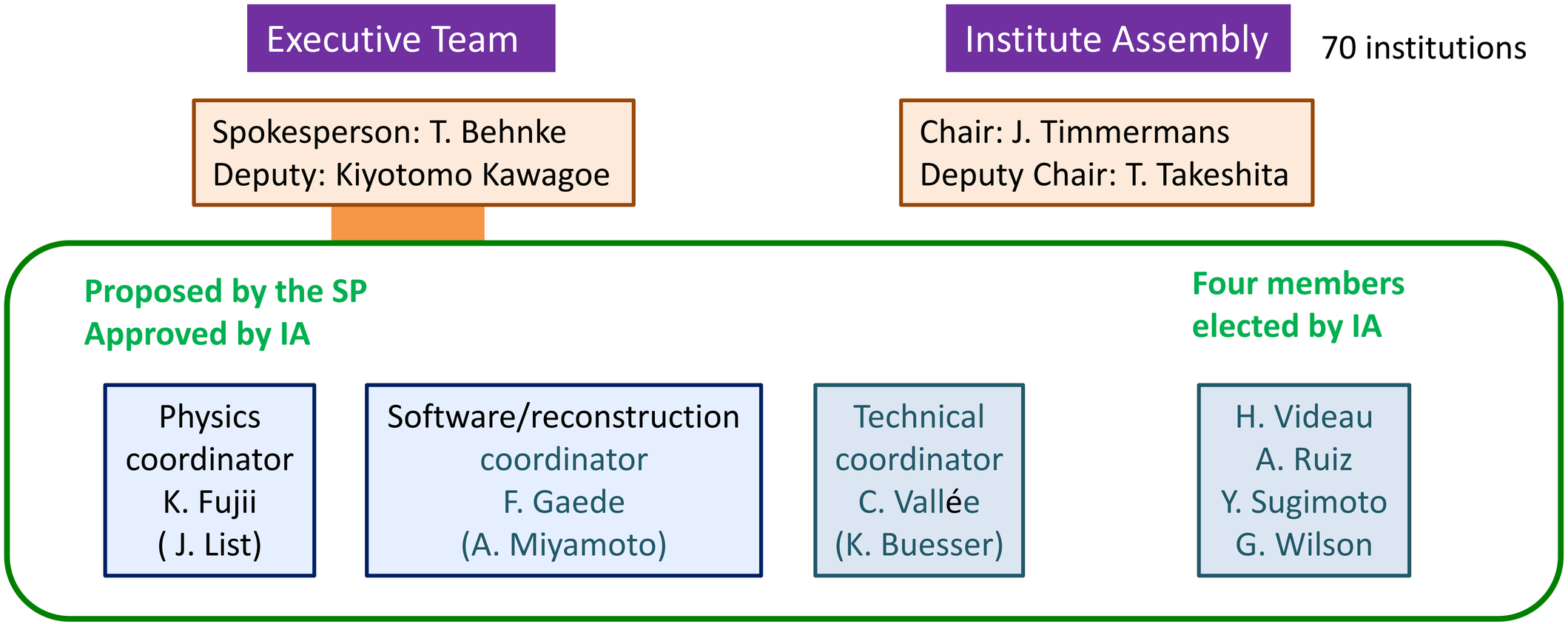
Mini-Workshop on Infrastructure and CFS for Physics and Detectors

KEK
30.09.2016

New ILD Management Structure

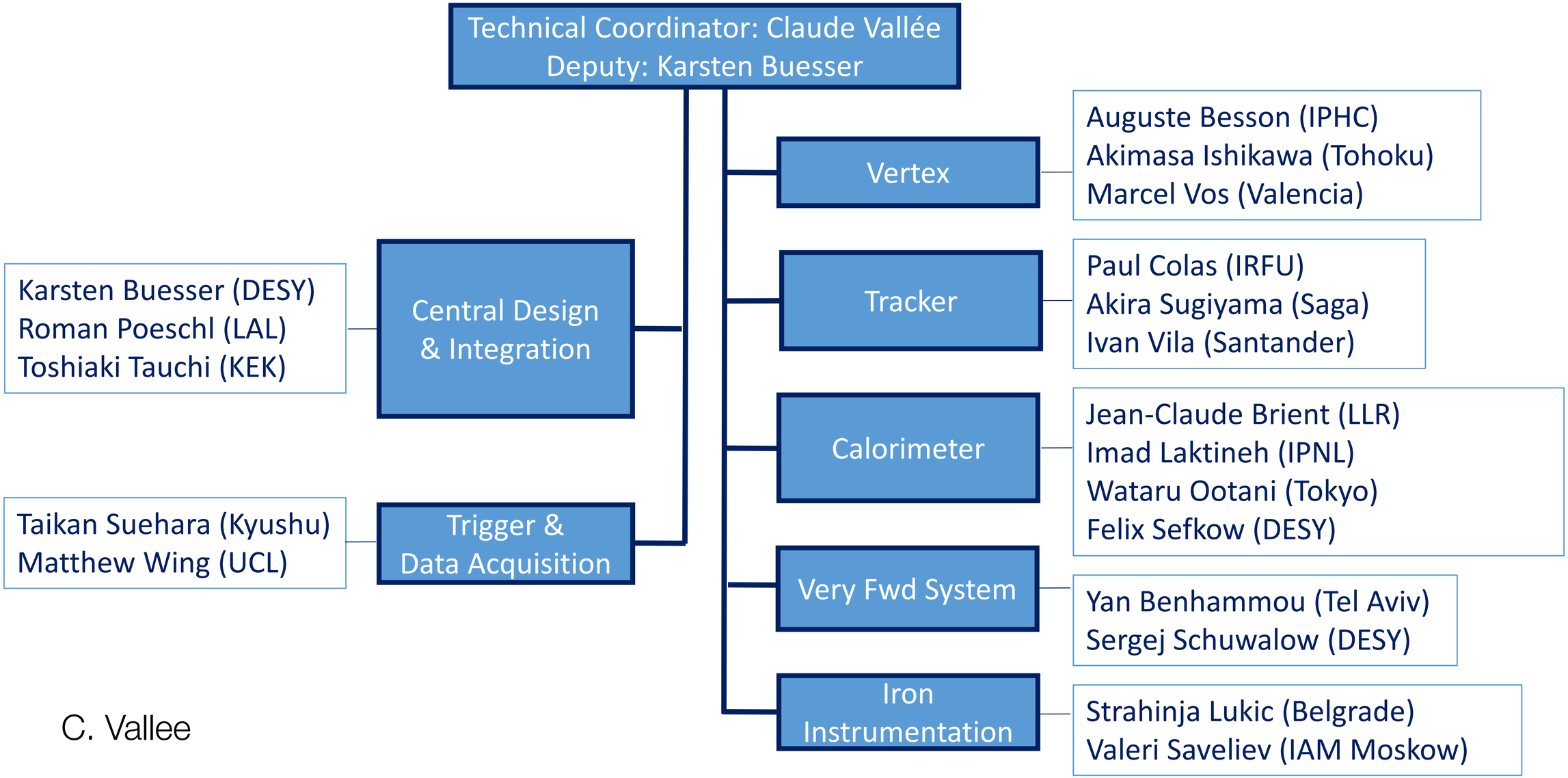
ILD Management

- New ILD Structure in place



T. Behnke

ILD Technical Conveners

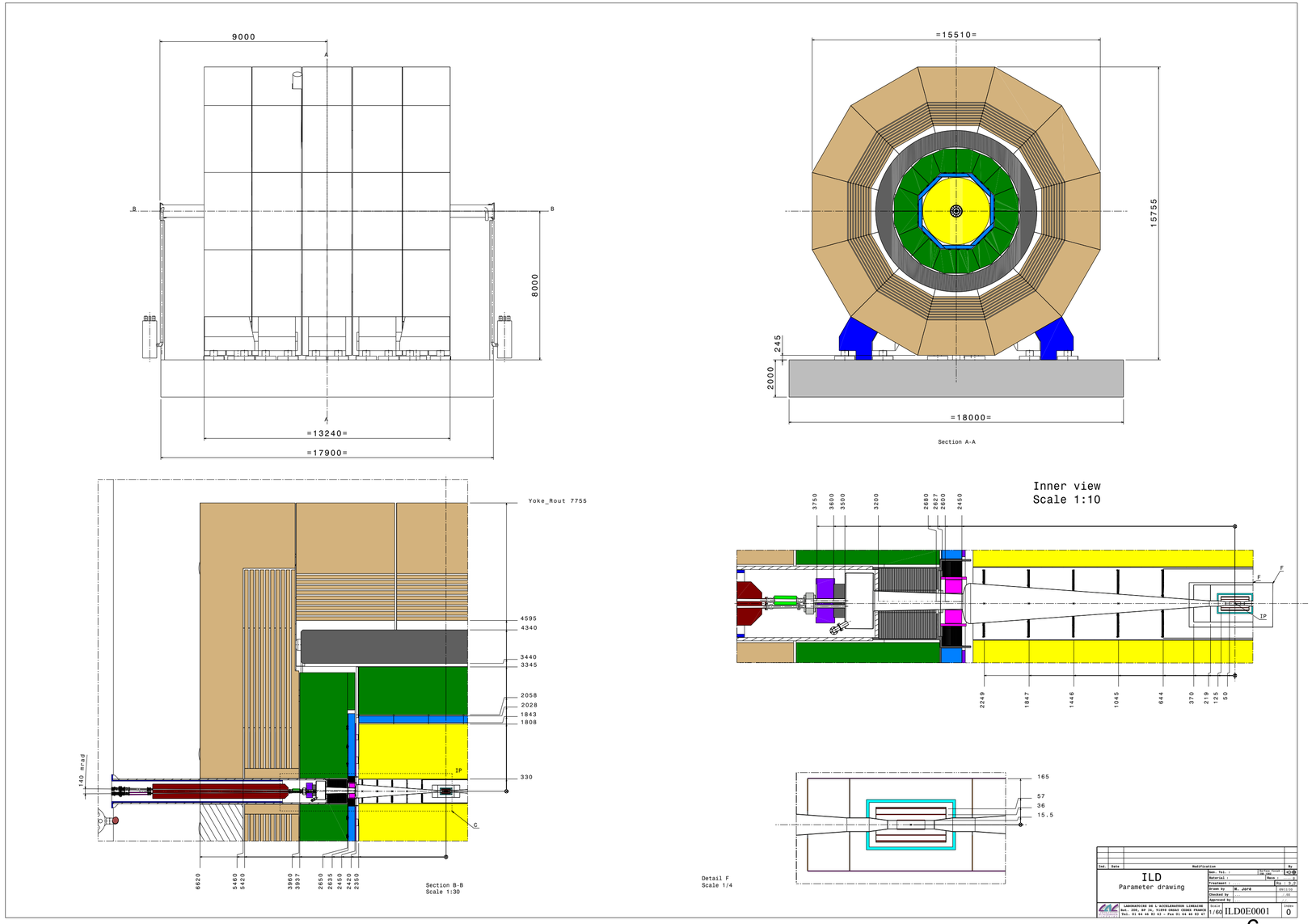


C. Vallee

ILD Engineering Model

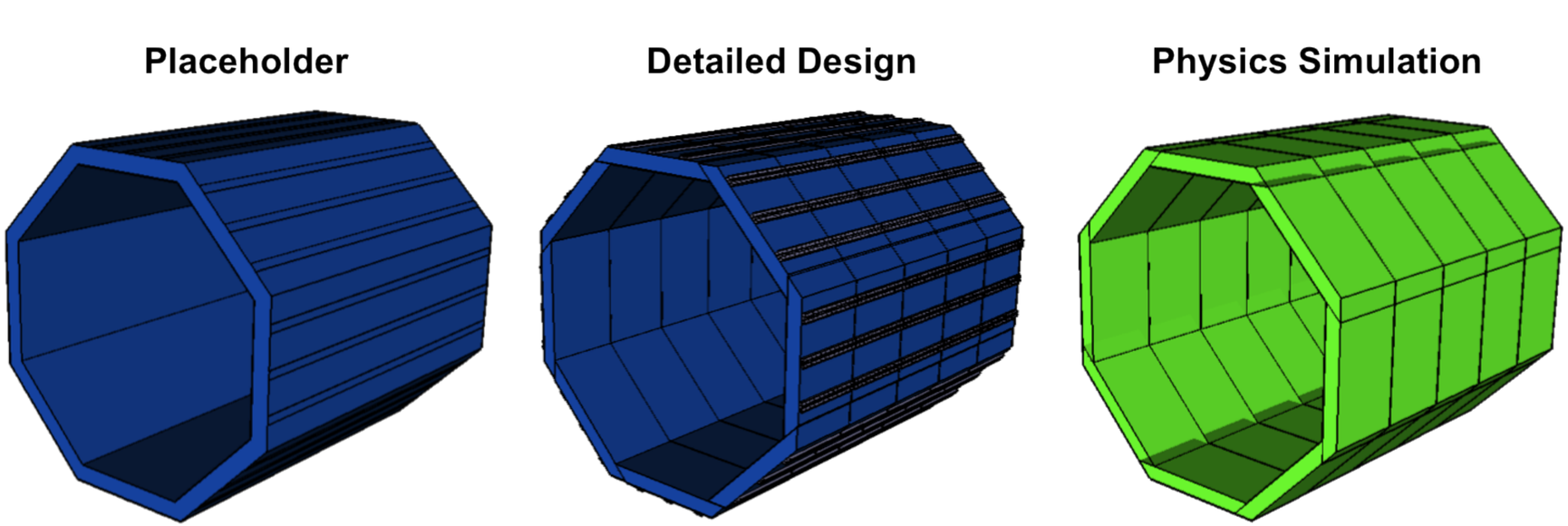
ILD CAD Model

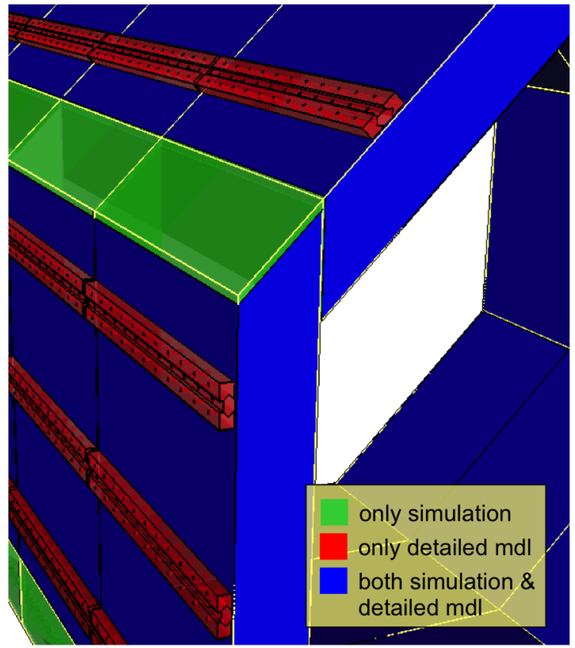
- The ILD engineering model is kept in ILC-EDMS
- Manager of the model is Christian Bourgeois (LAL)
- Combination of different CAD sources to a unified model with help from DESY IPP
- Need to evolve model to keep up with design work in subdetector collaborations
- Have started an initiative to define the interfaces in a more formalised way



ILD Placeholder Model

- There is also a placeholder model of ILD in EDMS
- Should try to synchronise this with the simulation envelopes





- Exercise has been done in 2010, tools to compare Geant4 and CAD models
- Should revive these activities in view of optimisation efforts
  - we probably don't have the resources to keep detailed engineering models of ILD for all optimisation steps

New ILD Simulation Baseline Model

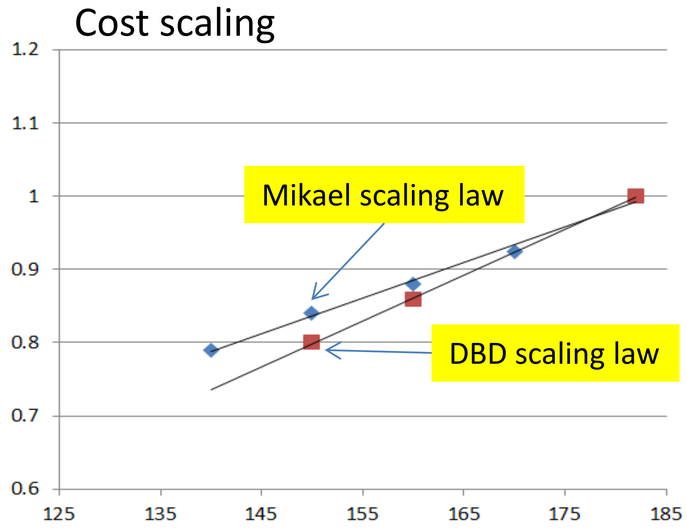
Evolving the ILD Baseline

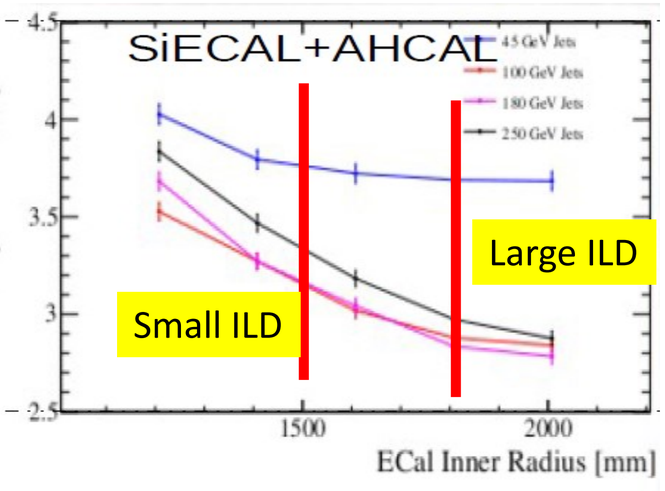
ILD-S

- Based on discussions at Santander ILD meeting:
- Comparable to ILD-L
- Comparable to CLIC

- Since the TPC length is the same, all z-values remain unchanged between ILD-S and ILD-L

Detektor	DBD (ILD-L)	Small ILD (ILD-S)
B-Field	3.5 T	4 T
VTX inner radius	1.6 cm	1.6 cm
TPC inner radius	33 cm	33 cm
TPC outer radius	180 cm	146 cm
TPC length (z/2)	235cm	235 cm
Inner ECAL radius	184 cm	150 cm
Outer ECAL radius	202.5 cm	168.5 cm
Inner HCAL radius	206 cm	172 cm
Outer HCAL radius	335 cm	301 cm
Coil inner radius	344 cm	310 cm





There are two aspects to the optimization:

- Detailed studies on particular issues (hardware, physics, single particle …) to understand what is driving what, and to understand dependencies

- “Global” study to see the overall impact on a menu of physics observables to demonstrate that our detector (whichever) can deliver a broad physics program.

T. Behnke

ILD Simulation Models

MORE DETAILS ON ILD MODELS FOR PHYSICS BENCHMARK SIMULATIONS

(see Ties' presentation)

Detector	DBD	Small ILD
B-Field	3.5 T	4 T
VTX inner radius	1.6 cm	1.6 cm
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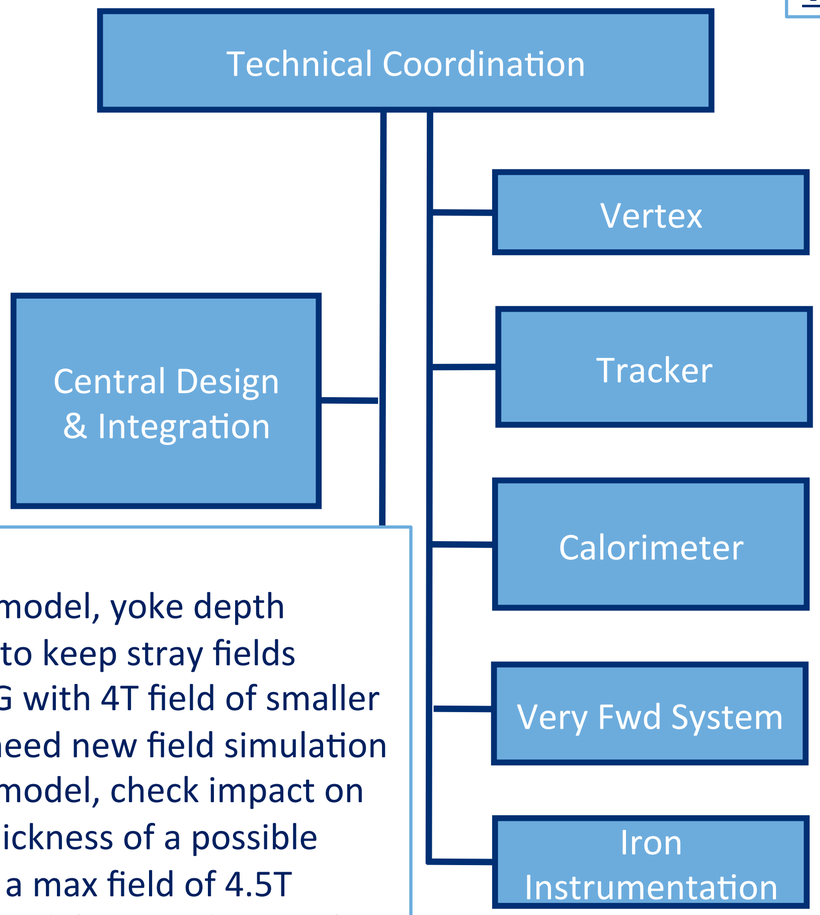
Subdetector groups will be provided a new set of detector envelopes for both models, to be defined by the technical and software coordination

General principles:

- One large model with same dimensions and B field (3.5T) as DBD, updated for new L*, and one small model with Santander proposed dimensions, with B field increased to 4T and vertex inner radius, TPC inner radius and ECAL-HCAL depths same as for large model.
- Gaps between subdetectors same for both models.
- For both models, simulation of subdetectors to be updated for new L* geometry, known bugs, intrinsic material simulation improvements and improved service description.
- For large model, all subdetector internal parameters left unchanged compared to DBD, unless a clear better configuration has been found since then.
- For small model, same internal configuration as for large model, apart for parameters related to overall size (e.g. cell sizes) which can be adapted.
- Optimisation of parameters not related to the 2 model sizes (e.g. #calolayers) left to focused studies.

Subdetector Questions

Questions to subdetectors



Vertex: for both models, same geometry as for DBD ?

Tracker/Si:
- For both models, same FTD geometry as for DBD ?
- For both models, do we need a more realistic SIT/SET geometric implementation ?
- For small model, needs adapted SET geometry.

Tracker/TPC: for small model, decrease pad sizes along reduction of TPC level arm, or keep pads unchanged ?

CALO:
- For small model, adapt the cell sizes/ granularity to reduced radius ?
- For both models, agree to remove pre-shower Si-layer in the barrel (assuming SET remains in simulation) ?

VFS: for both models, needs adaptation to new L* and to include new simulation for LHcal

Iron: for small model, adapt iron instrumentation to intrumentation gaps with smaller radius (same number of gaps as in large model)

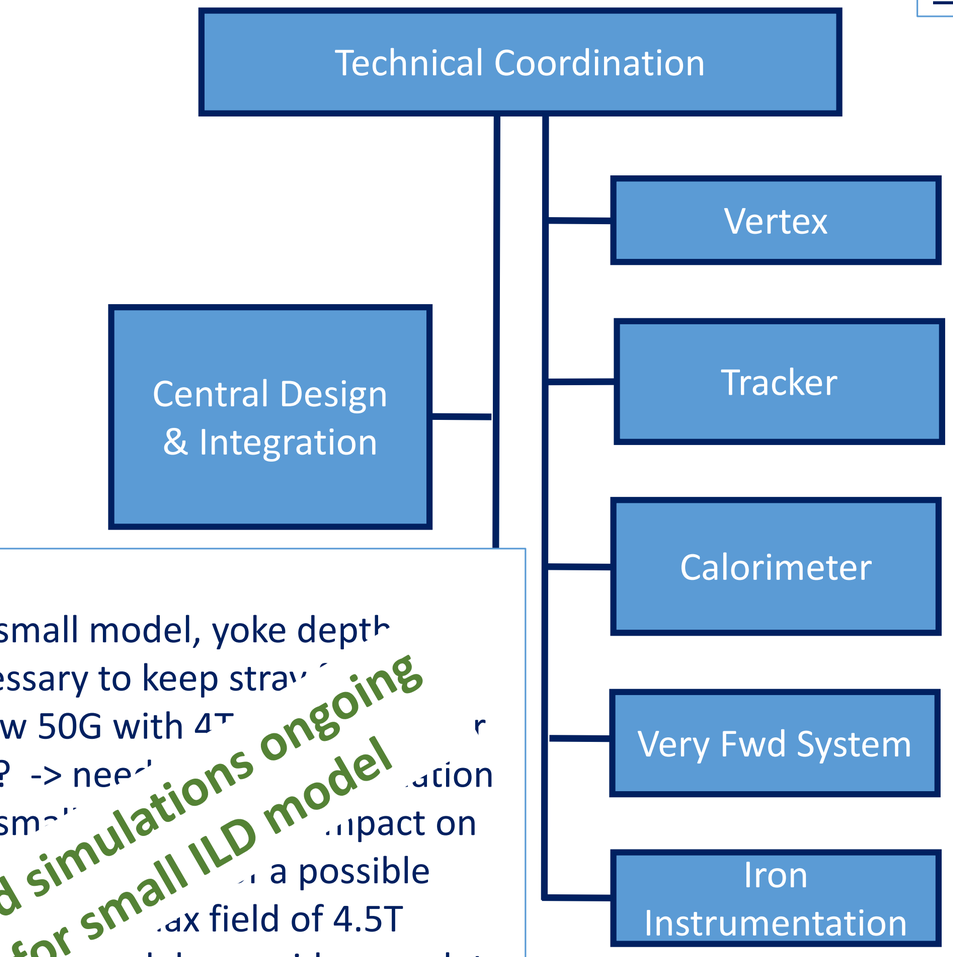
CDI:
- For small model, yoke depth necessary to keep stray fields below 50G with 4T field of smaller coil ? -> need new field simulation
- For small model, check impact on magnet thickness of a possible design for a max field of 4.5T
- For both models, provide complete field map for simulation

Report from the techni

C. Vallee

Subdetector Answers

Subdetectors inputs to ILD models



Vertex: for both models, same geometry as for DBD ? **Yes !**

Tracker/Si:
- For both models, same FTD geometry as for DBD ? **Yes ?**
- For both models, do we need a more realistic SIT/SET geometric implementation ?
- For small model, needs adapted SET geometry.

Tracker/TPC: for small model **Keep pads unchanged** reduction of TPC level arm, or keep pads unchanged ?

CALO:
- For small model, a **Keep cells unchanged** to reduced radius ?
- For both models, agree to remove pre-shower Si-layer in the barrel (assuming SET remains in simulation) **Yes !**

VFS: for both models, needs adaptation to new L* and to include new simulation for LHcal

Iron: for small model, adapt iron instrumentation to intrumentation gaps with smaller radius (same number of gaps as in large model)

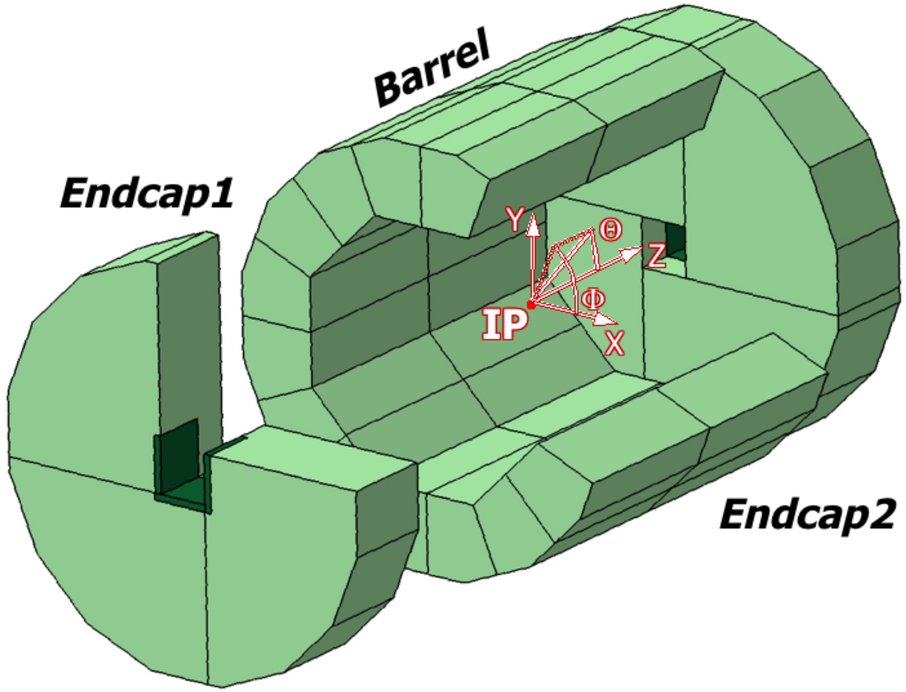
CDI:
- For small model, yoke depth necessary to keep stray ... below 50G with 4T ... coil ? -> need ... ation
- For small ... impact on ma... a possible ...ax field of 4.5T
- ... models, provide complete t... map for simulation

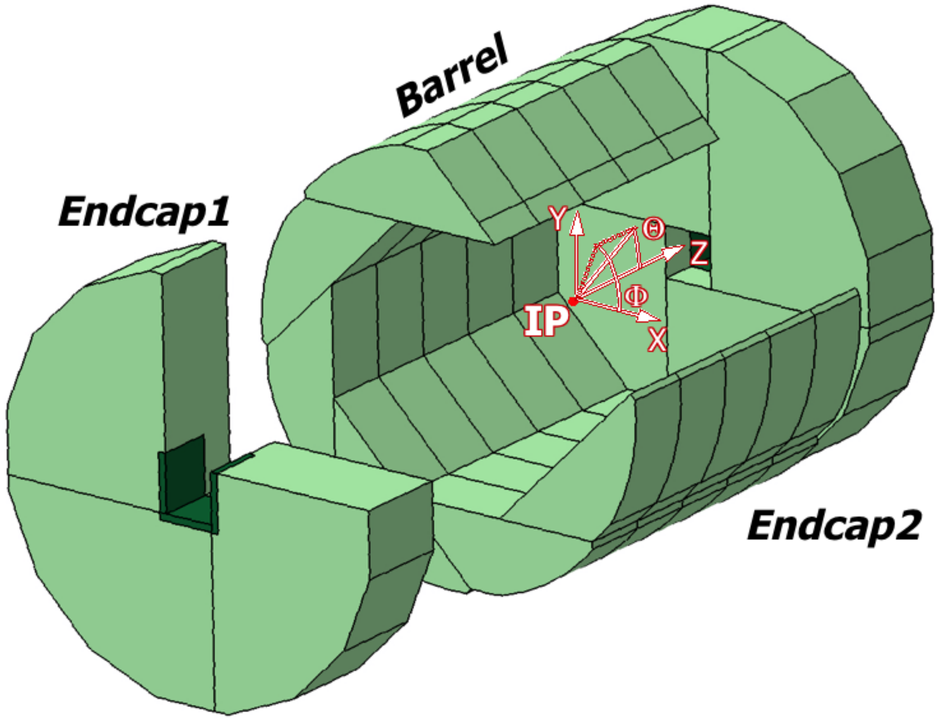
Field simulations ongoing for small ILD model

HCAL Absorber Structure

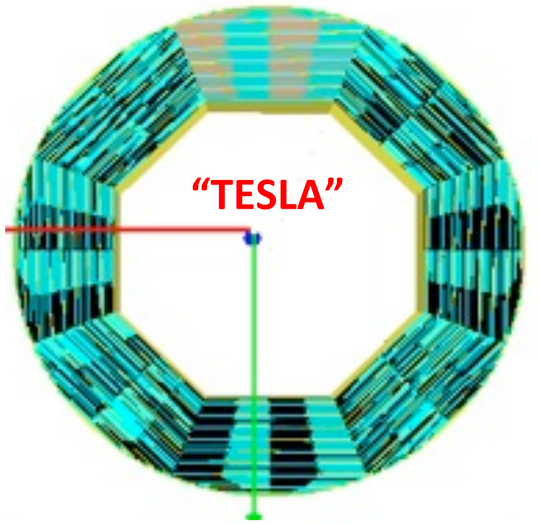
TESLA vs Videau-Structure

- ILD has for historic reasons two options for the HCAL absorber structure
  - there are also different readout technology options, though there is no need to keep the matrix diagonal
- For the both detector models (S-ILD, L-ILD) try to define only one structure for the main simulation run





ILD VT Task Force



“VT TASK FORCE”

Investigate the two proposed HCAL mechanical options

Task Force members:

CDI conveners: K. Buesser, R. Poeschl, T. Tauchi

CALO conveners: J-C. Brient, I. Laktineh, W. Ootani, F. Sefkow

Issues to be addressed:

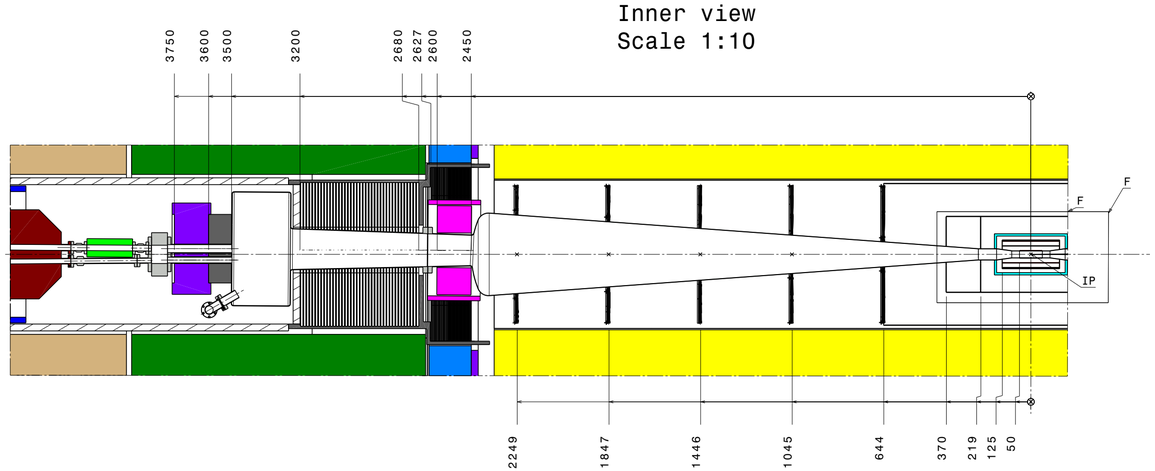
- Effect on physics of φ and z cracks (90^{o} and barrel-endcap transition)
- Mechanical stability (static and dynamic), to be also evaluated with a potentially smaller radius
- Transport / assembly procedures.
- Impact on ECAL design.
- Signal paths and electronics accessibility/reliability
- Implementation in ILD software

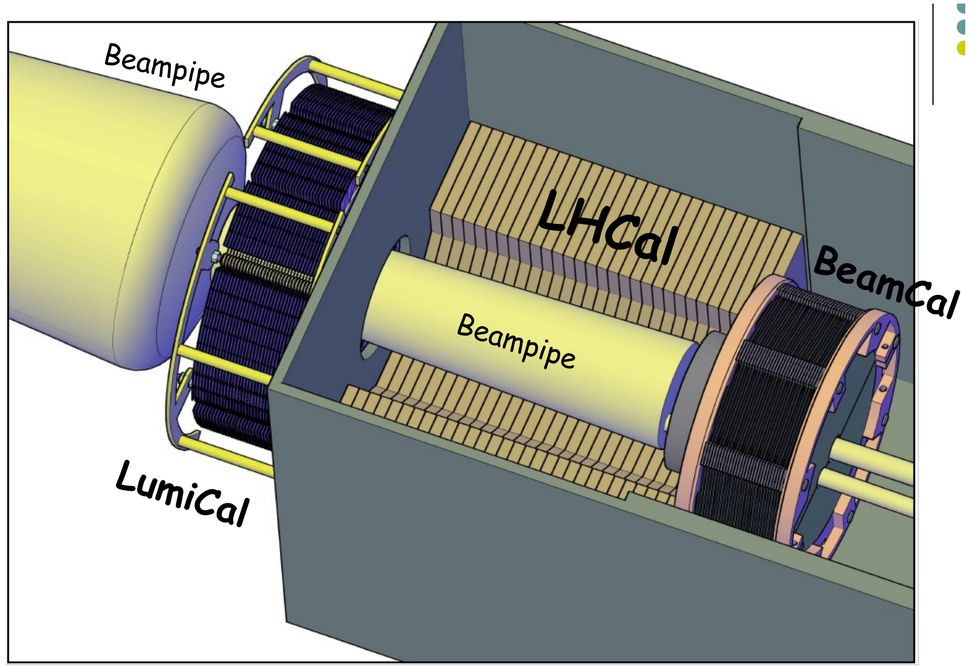
C. Vallee

L* and Anti-DID

Forward Region Changes

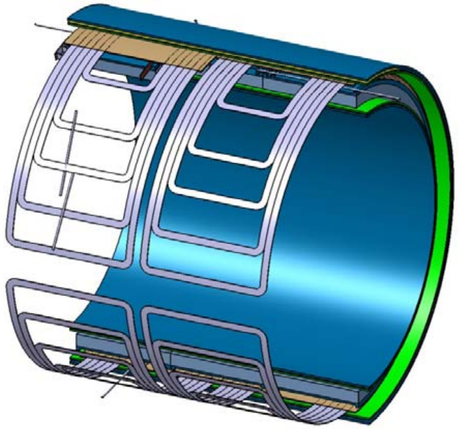
- ILD had L*=4.4m
- Change Request for L*=4.1m accepted
  - plus additional 10cm for BPM on incoming beam
- Now:
  - remove vacuum pump (30cm)
    - beam-gas scattering under control (R. Karl)
    - new vacuum solutions under study (LAL)
  - re-design LHCAL/BeamCal
    - work done in FCAL collaboration (S. Schuwalow)
- Need to study:
  - impact on backgrounds
  - magnetic field configurations
  - integration scheme with realistic LHCAL

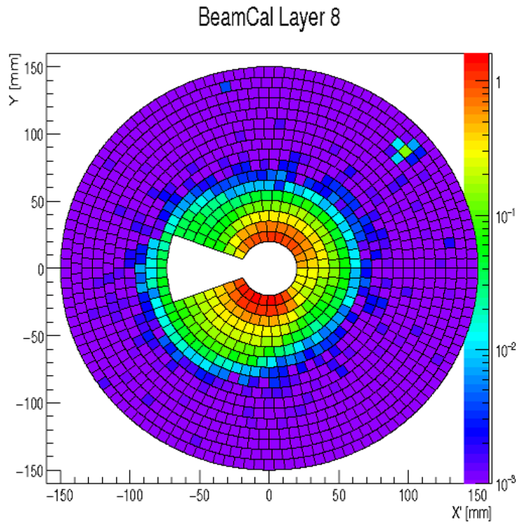




Anti-DID

- Detector Integrated Dipole field was invented by Andrei Seryi and Brett Parker to make the net magnetic field parallel to incoming beams
  - polarisation tuning, reduce emittance growth due to synchrotron radiation
- Turned out that these problems were not as bad and could be corrected without DID
- Then proposed Anti-DID: make net magnetic field parallel to outgoing beam
  - reduce background on BeamCal as low energetic charged background particles are guided to exit hole



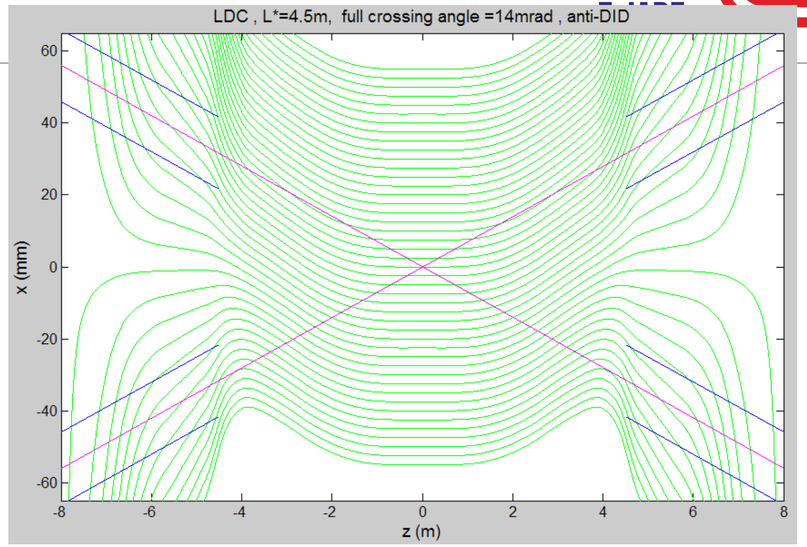


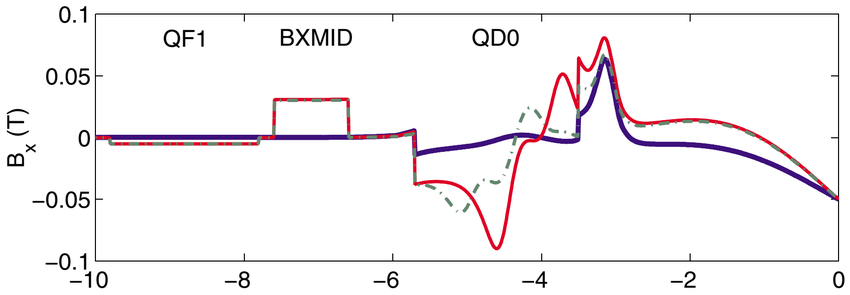
Forward Region Magnetic Fields

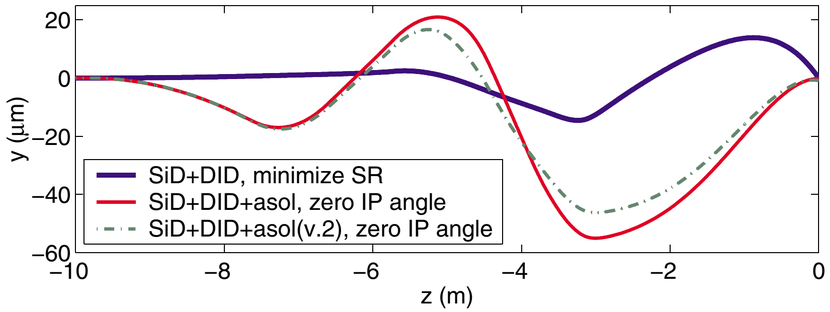
Seryi et al. SLAC-PUB-11662

- The magnetic fields that determine the background distribution in the forward regions are complicated overlays:
  - Detector solenoid (fringe) fields
  - QD0 quadrupole (fringe) fields
  - Anti-solenoid (fringe) fields
  - Anti-DID (fringe) fields
- A detailed 3D model of all fields would be needed to do proper background simulations.

- This needs to be done anyhow for the new L* geometries
  - collaboration with machine experts required
  - probably hard to get in view of resources at machine groups…



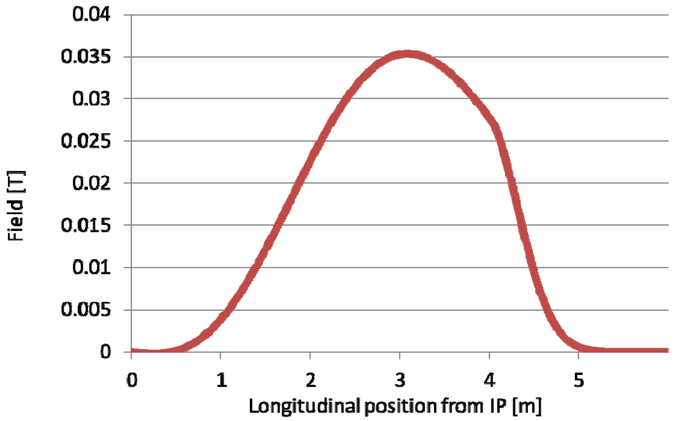




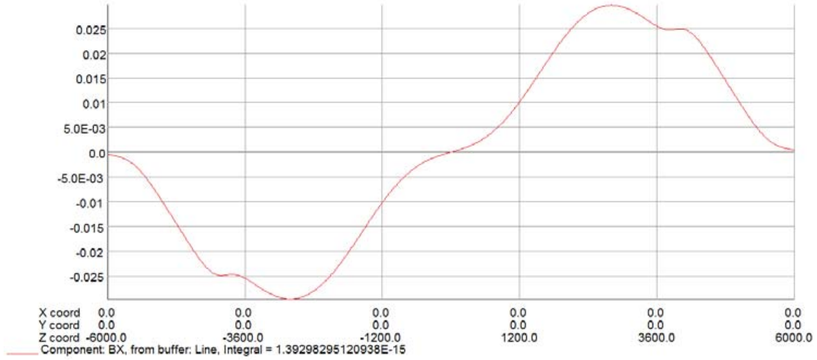
Parker, Seryi, PR STAB 8.041001

Realistic Anti-DID?

- Technical realisation studied for TDR
  - LC-DET-2012-81
- Conclusion: current field assumed in Mokka (2012) has no technical solution at this time. Need common effort between physics groups and magnet experts.
- We are in discussions with SiD; their preliminary conclusion: Anti-DID in the proposed form as a dipole cannot be built or will be very expensive.
- SiD is even looking into solution with two tilted solenoids
  - would fix the crossing angle forever
- SiD is seriously considering to abandon the Anti-DID



Mokka 2012



Kircher et al. LC-DET-2012-81

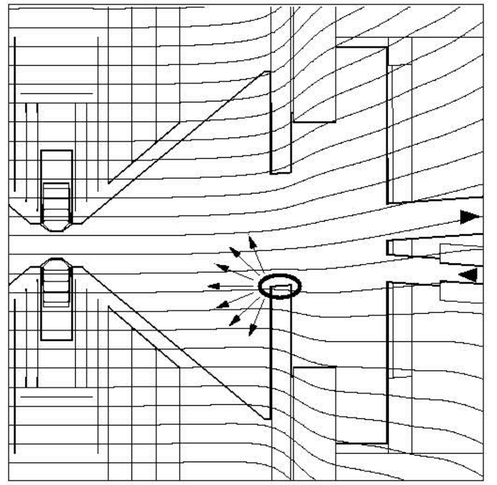
ILD Anti-DID Task Force

“ANTI-DID TASK FORCE”

Investigate need and feasibility of an anti-DID

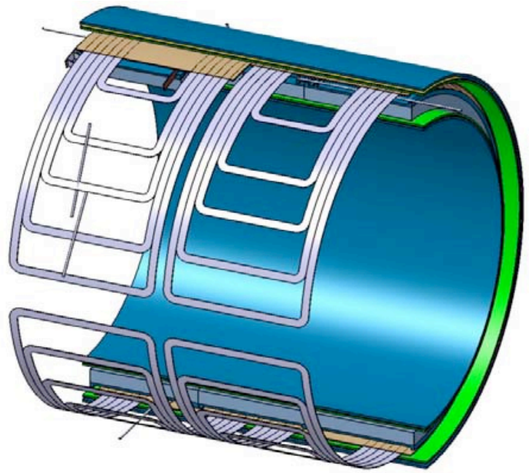
Task Force members:

CDI conveners: K. Buesser, R. Poeschl, T. Tauchi
VFS conveners: Y. Benhammou and S. Schuwalow
VTX representative: A. Ishikawa
TPC representative: P. Colas
Coil expert: Ch. Berriaud (Saclay)
BG simulator: tbn



Issues to be addressed :

- Technical feasibility of the anti-DID coil and the required B field map
- Compatibility of the B field and TPC requirements
- Combined optimization for both direct beamstrahlung and backscattered particles
- Effect on polarimetry
- Maximum tolerable occupancies of the Vertex and TPC
- Alternative simulation options (anti-DID dependent BG files)



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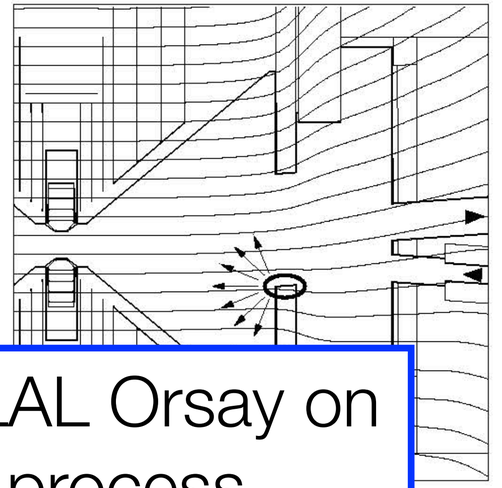

Both Task Forces will meet at LAL Orsay on November 7/8 to start the process

Issues to be addressed :

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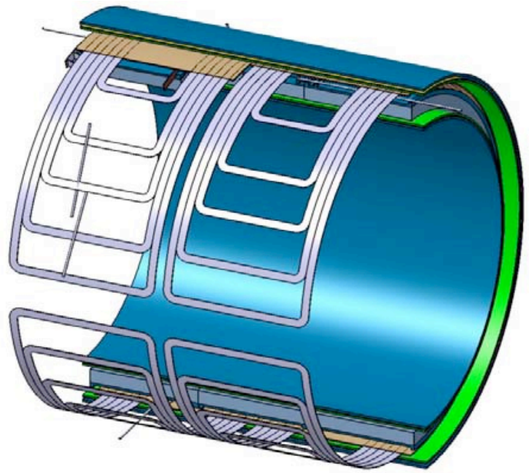
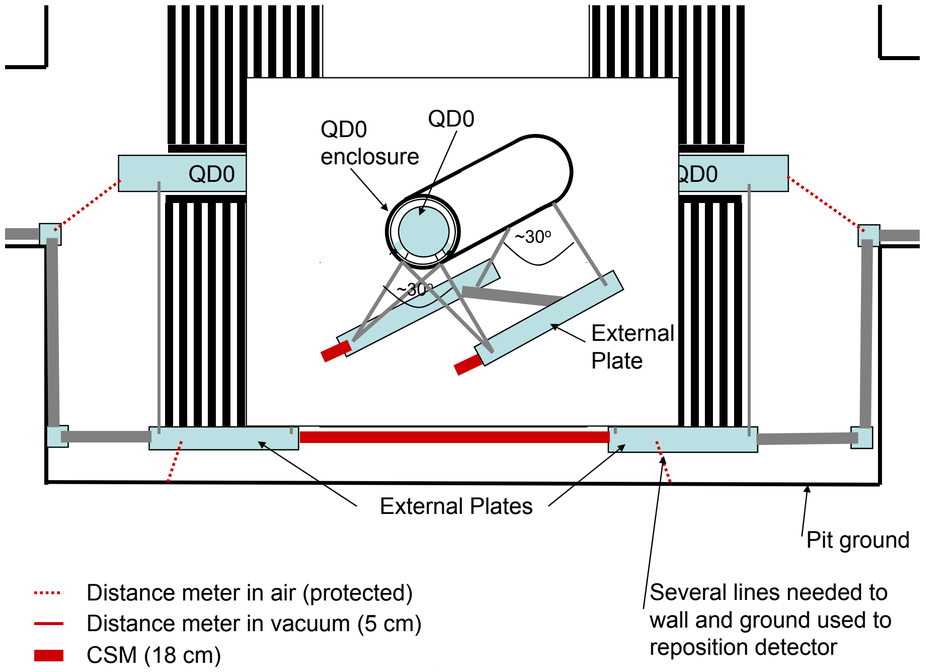


ILD Alignment

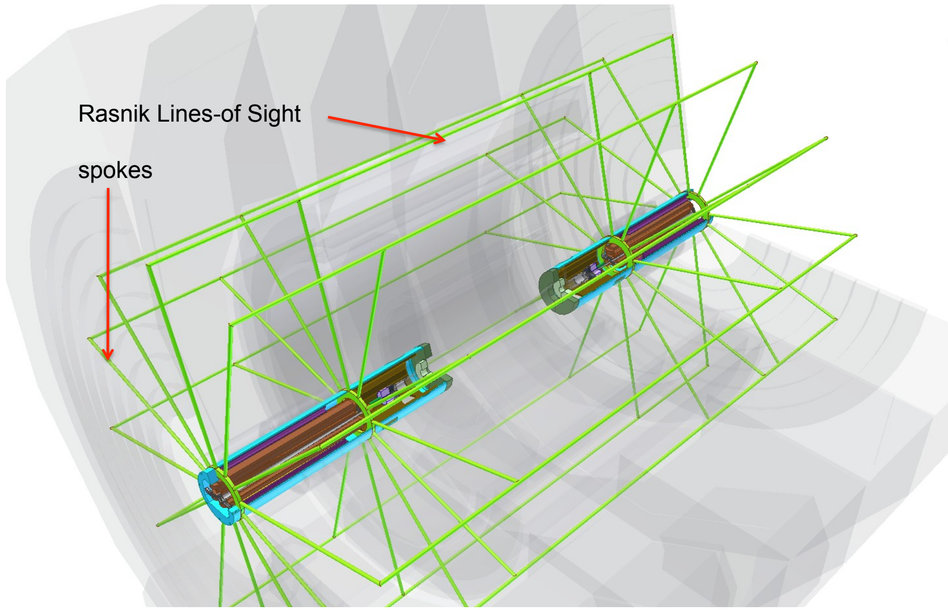
ILD Alignment Strategy

- Many parts of ILD have tight alignment requirements
  - e.g. QD0 magnets, LumiCal, Si Tracker, etc.
- Some require alignment systems and those need space
- Reviewing the ILD alignment strategy could be a topic for a joint Integration/Software effort

- QD0:
  - Laser interferometer
  - Rasniks
  - ??



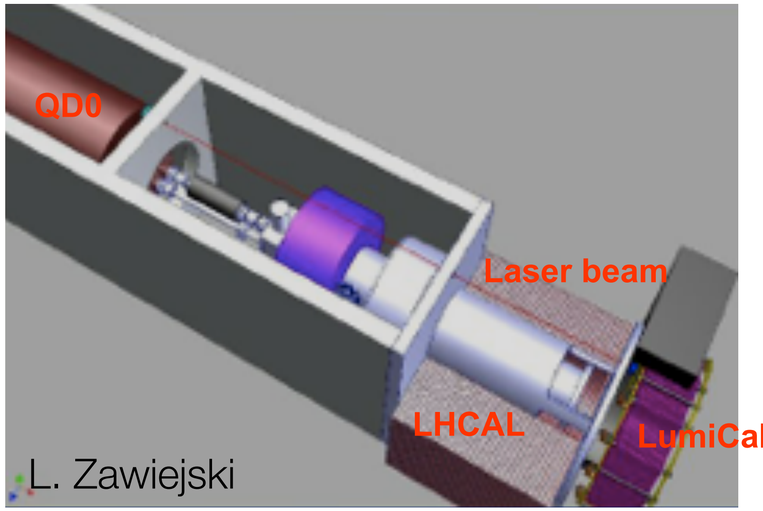
D. Urner

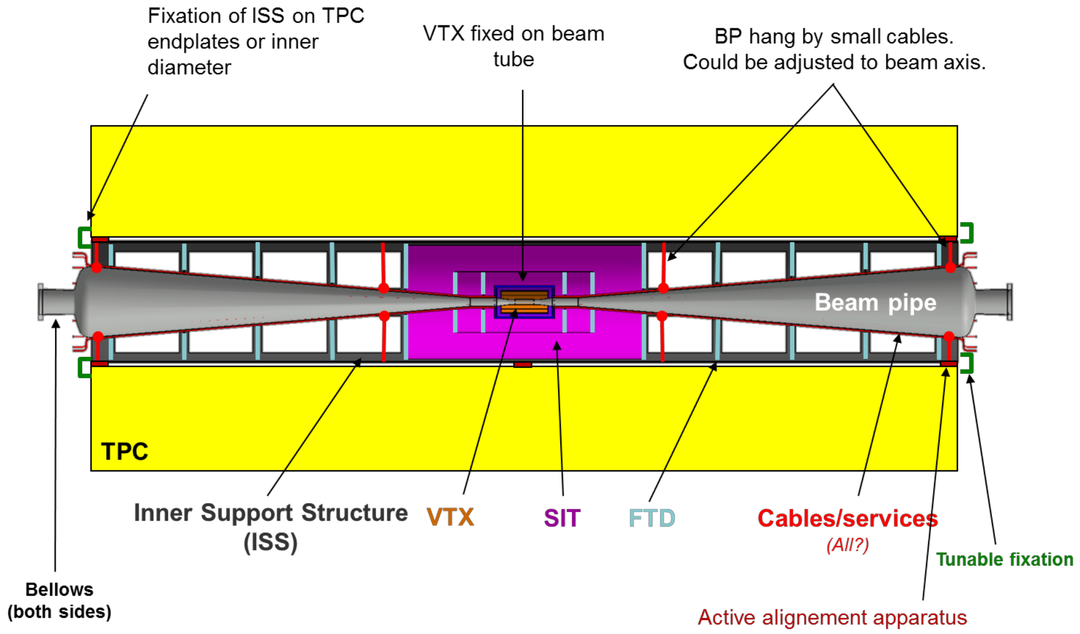


H. v.d. Graaf

ILD Inner Detector Alignment

- FCAL collaboration did a study on the alignment of forward calorimeters (LumiCal)
- Laser system couples left and right forward regions
- Lasers need to pass the inner tracking system
  - which needs its own alignment system…





- And we do push-pull: inner detector support would be movable and aligned after each pp cycle
- Engineering solutions exist only on conceptual level, input on material budget not clear

ILD Assembly
(selected examples)

AHCAL Assembly

Kitakami Side

or anywhere in any detector

HELMHOLTZ ASSOCIATION

Slide from Karsten Gadow

DESY

AHCAL Assembly

solution: all needed AHCAL parts fit into here

AUSSENMASSE		
Länge	mm	6058
	ft	19' 10 ½"
Breite	mm	2438
	ft	8'
Höhe	mm	2591
	ft	8' 6"

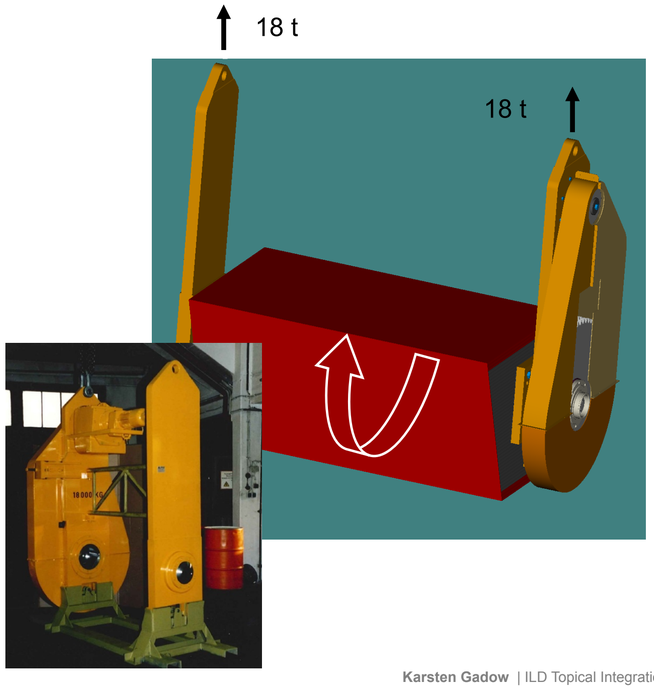
GEWICHT		
Tara	kg	2700
	pd	5950
Max. Zuladung	kg	27780
	pd	61250
Max. Bruttogewicht	kg	30480
	pd	67200

the container fits to standard transport systems

as ships, railways, trucks and through tunnels…..

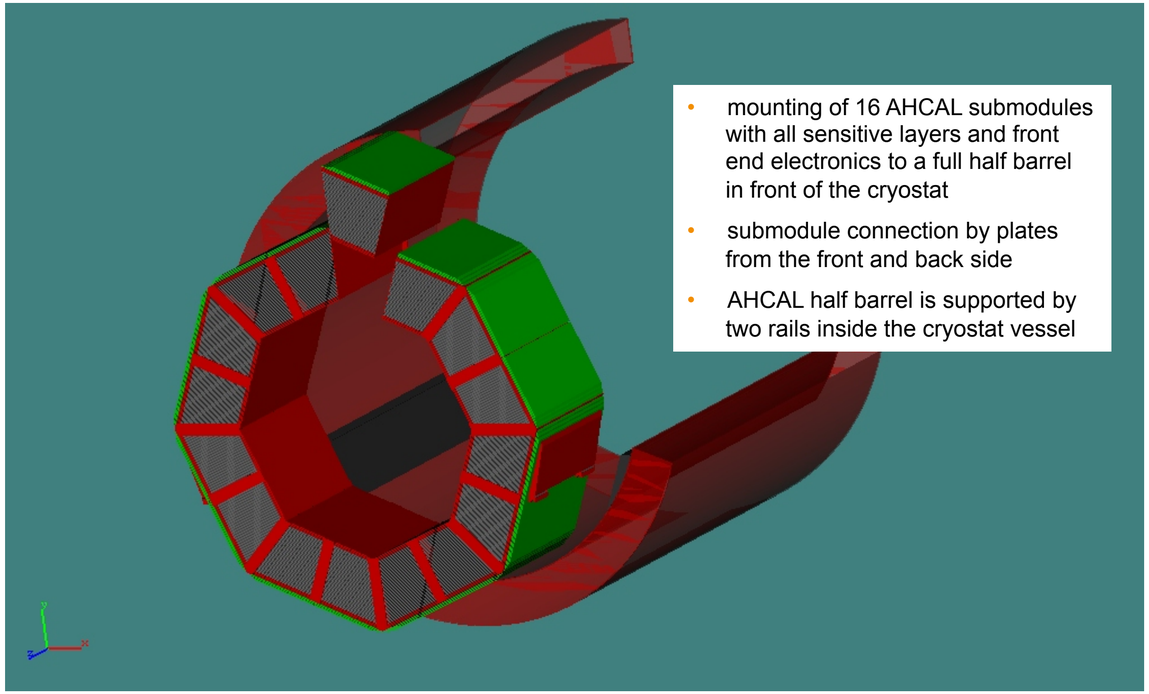
Slide from Karsten Gadow

AHCAL barrel integration tools



- lifting and turning tool for AHCAL barrel absorber submodules available
  - 2 x 18 t capacity
  - operation with 2 hooks (z angle adjustment)
  - precise motor controlled turning
  - design for adaptation for sub-modules with and without sensitive layers started
- mounting, support and insertion frame
  - insertion frame design ready
  - insertion frame support design depends on final yoke size and useable space
- push and pull tool available
  - must be modified to the rail distance and rail shape/size

AHCAL half barrel absorber installation
step 1



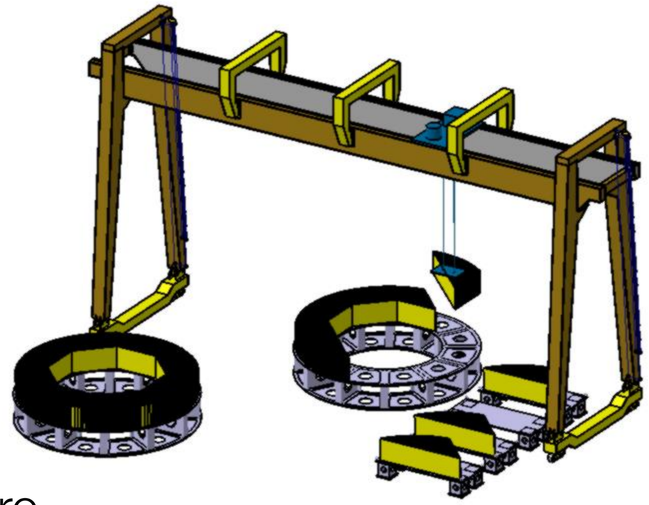
- mounting of 16 AHCAL submodules with all sensitive layers and front end electronics to a full half barrel in front of the cryostat
- submodule connection by plates from the front and back side
- AHCAL half barrel is supported by two rails inside the cryostat vessel

Slides from Karsten Gadow

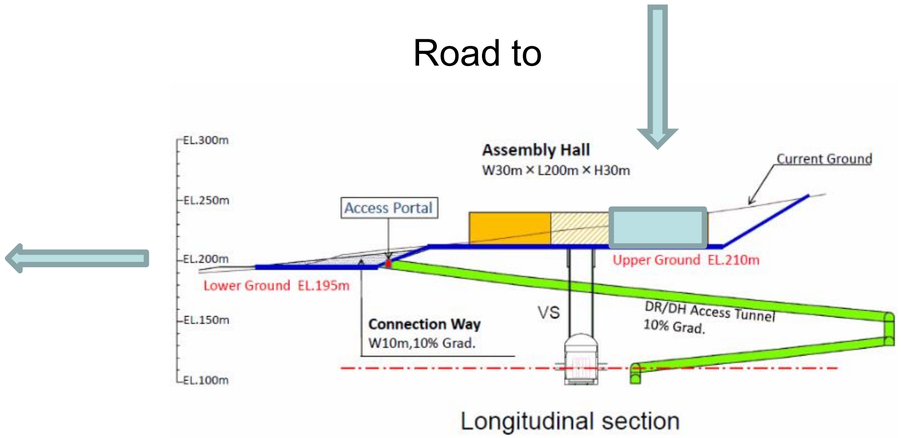
- Wheel Building in **Assembly Hall** : 8 modules x 5

Transport to Assembly Hall with normal truck - ILD area

- **Step 1** : Wheel structure transport (8 travels) & assembly
- **Step 2** : Modules transport 40 travels with 11 t
- **Step 3 :** Modules assembly on the wheel structure with 100 t crane
  - 8 modules in position on specific tool & screwing/welding



Road to



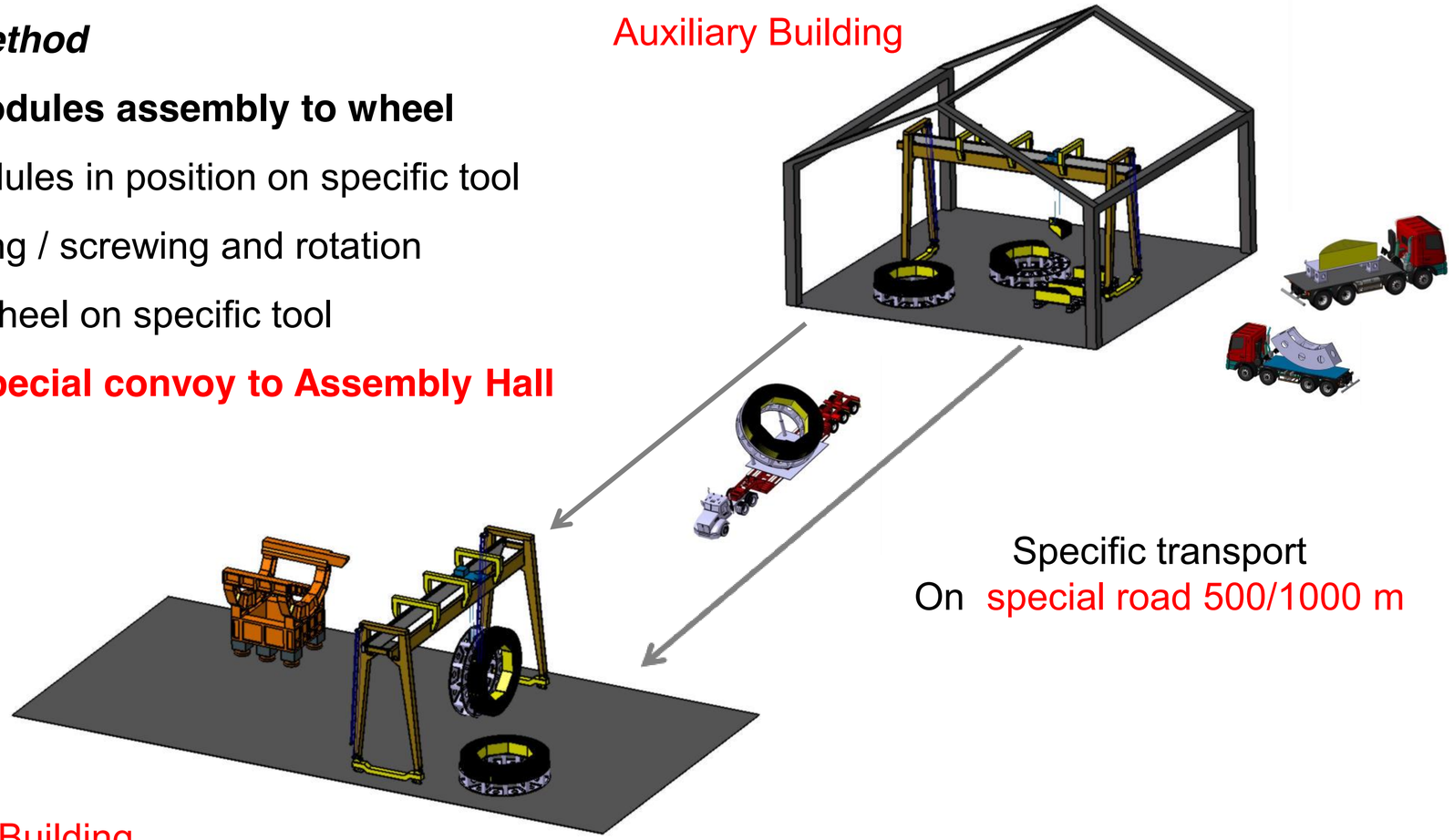
Longitudinal section

Slide from J.C. Ianigro

Wheel assembly in Auxiliary building : s

Building Method

- **Step 1 : Modules assembly to wheel**
  - 8 modules in position on specific tool
  - welding / screwing and rotation
- **Step 2 :** Wheel on specific tool
- **Step 3** : **Special convoy to Assembly Hall**



Slide from J.C. Ianigro

Wheel assembly in Auxiliary building : 8 modules => 5 wheels

Building Method

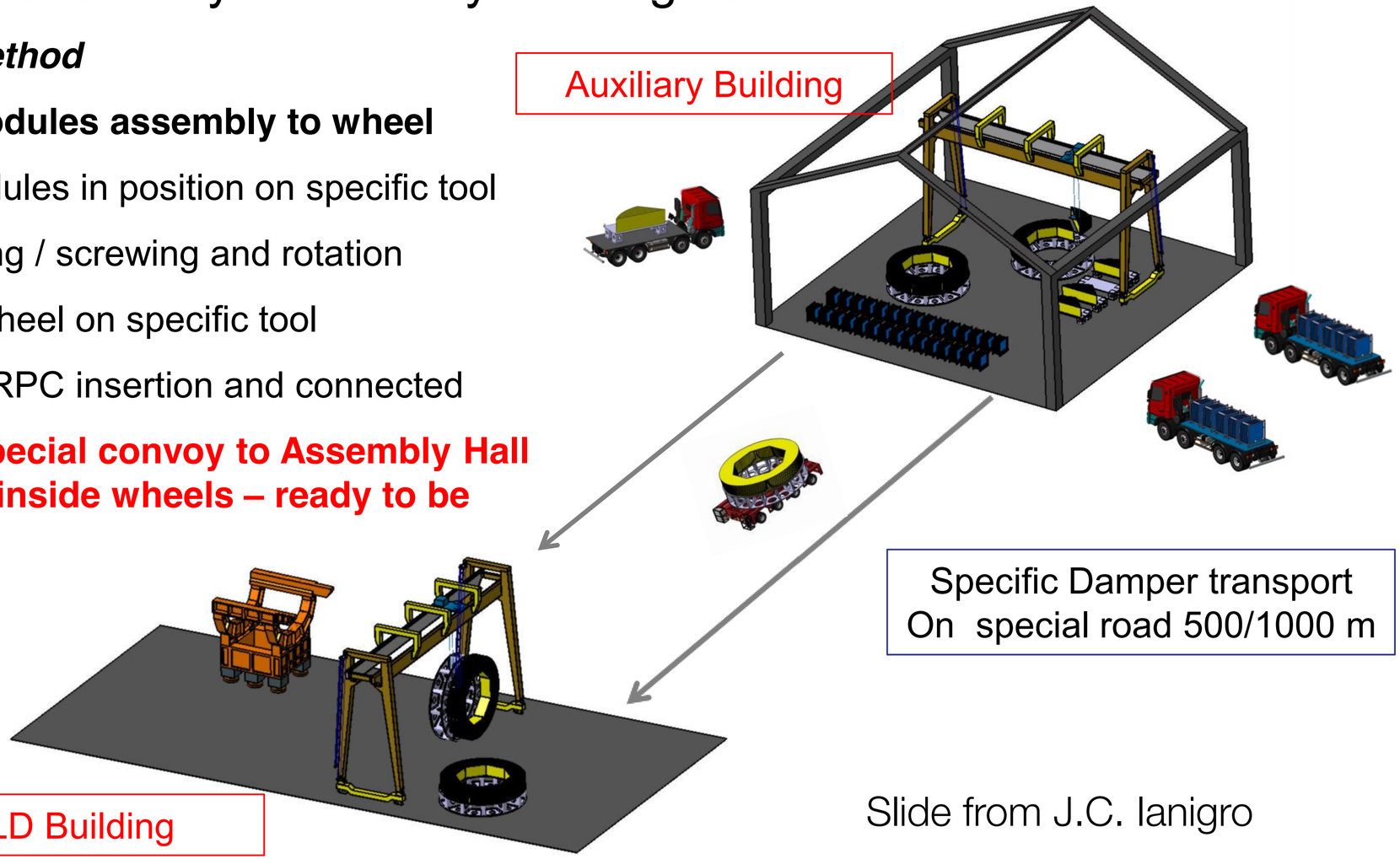
•**Step 1 : Modules assembly to wheel**

- 8 modules in position on specific tool
- welding / screwing and rotation

• **Step 2 :** Wheel on specific tool

• **Step 3** : GRPC insertion and connected

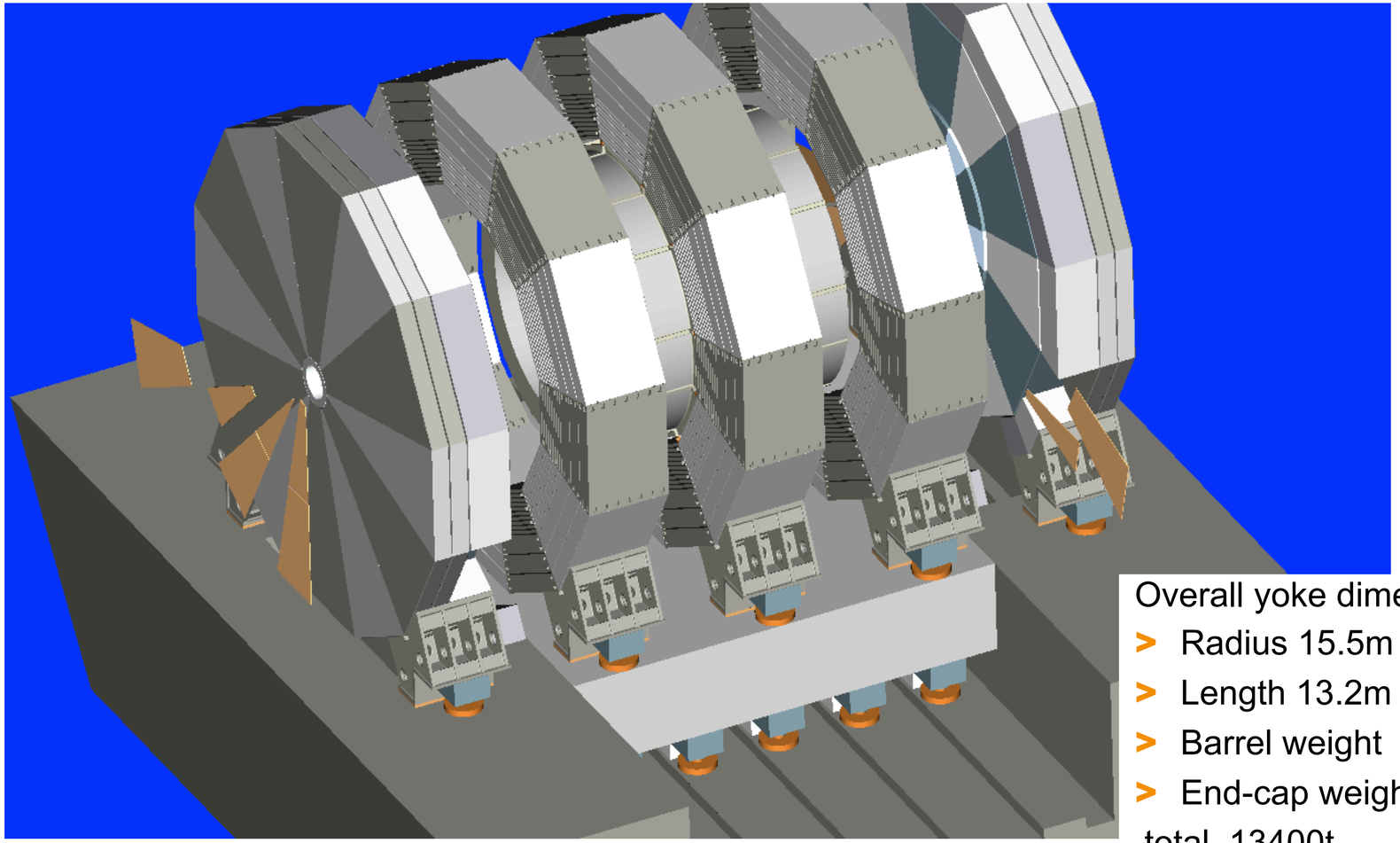
• **Step 4** : **Special convoy to Assembly Hall with GRPC inside wheels – ready to be connected**



Slide from J.C. Ianigro

Heaviest Problem: Iron Yoke

Present Design



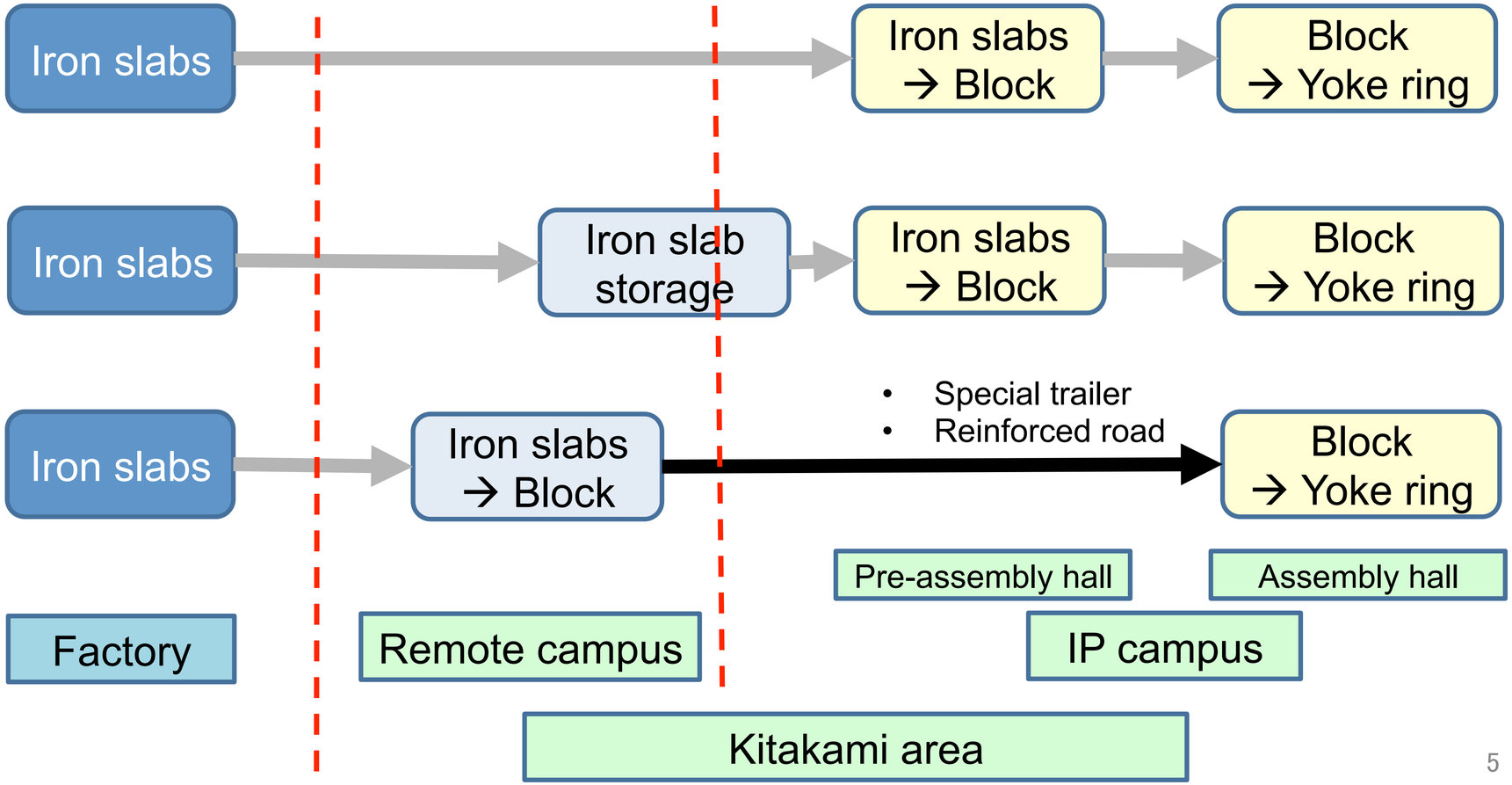
Overall yoke dimensions
- Radius 15.5m
- Length 13.2m
- Barrel weight 6900t
- End-cap weight 6500t

total 13400t

Slide from Uwe Schneekloth

Assembly scenario

- There are three options



Slide from Uwe Schneekloth

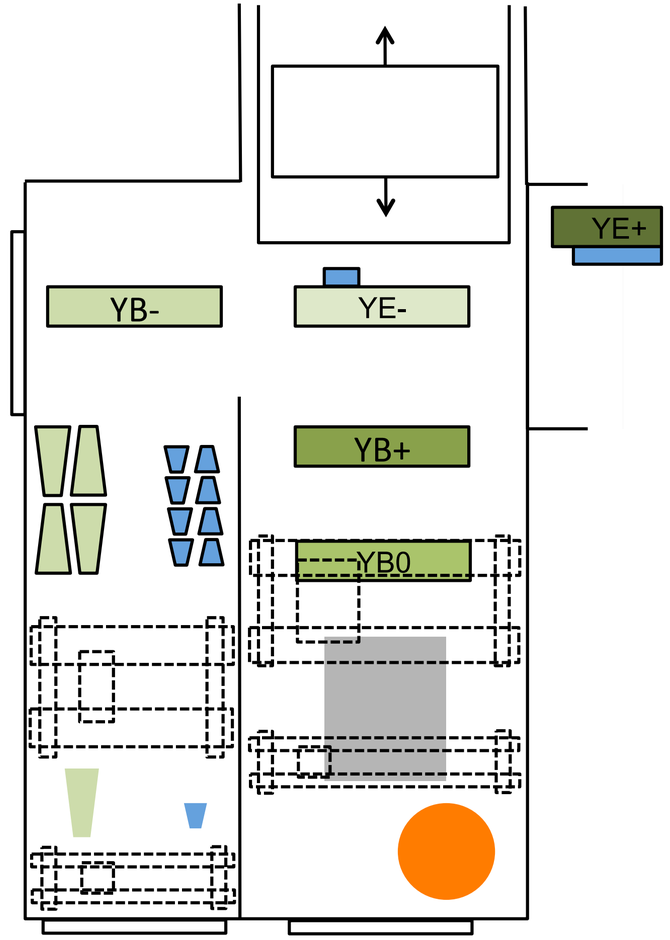
Assembly Study

- Try to optimise the ILD assembly in a possible Kitakami scenario
- Biggest uncertainty:
  - where and how to build the coil
- A combined effort between sub-detectors, CFS group, ILD integratior team is required to come up with a realistic assembly scenario for ILD
- Where can we do what?
  - at vendours/home institutes
  - at central lab campus
  - at IP campus
- This is cost relevant!

Integration Proposal

> YB-: production + assembly
  - One production lane for about 6 months (12 modules)
  - In parallel: solenoid assembly
  - In parallel: finalisation of muon installation in YE+ and begin muon installation in YB0 (120 days)

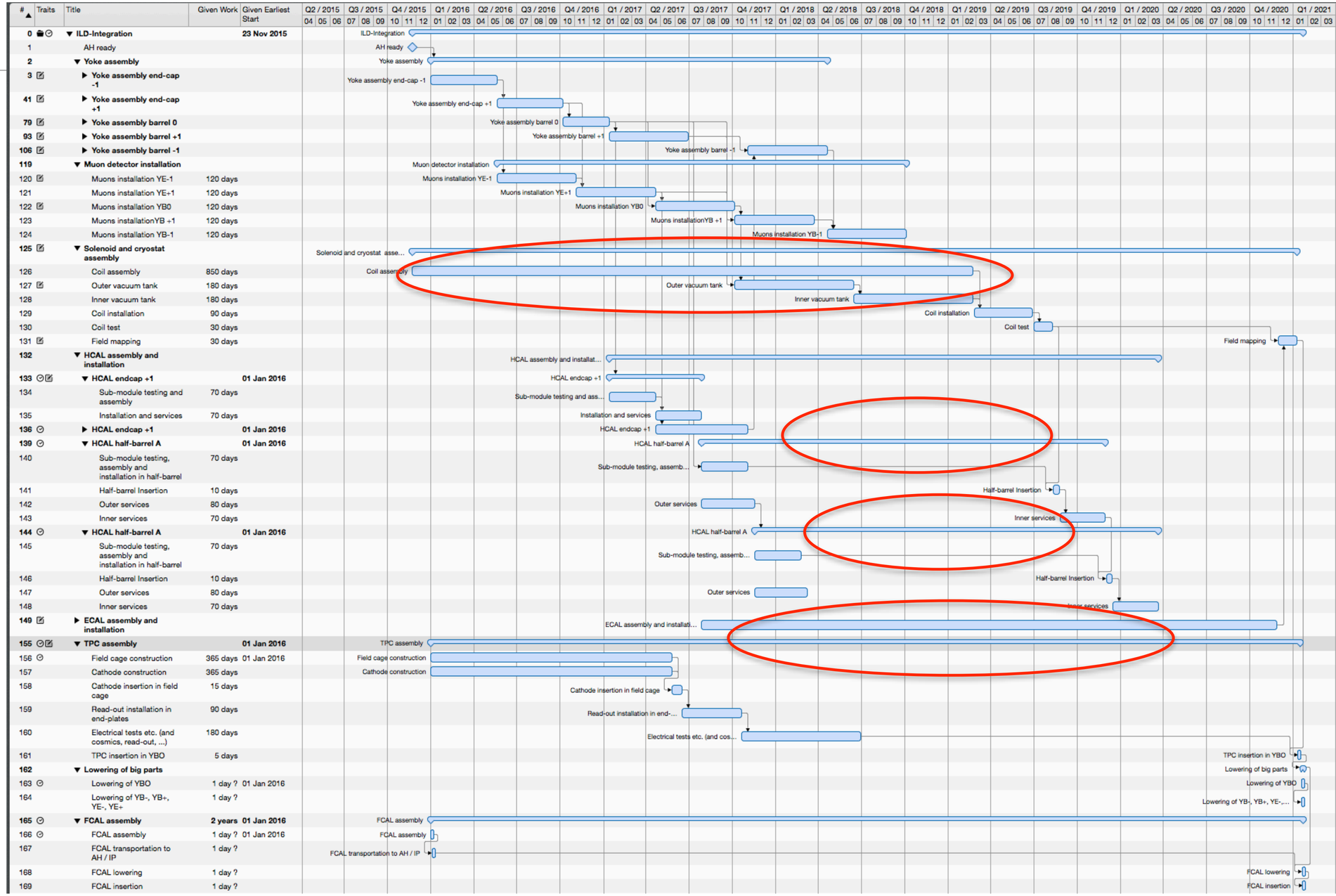
> HCAL production for endcaps
  - Mounting YE- HCAL
  - Start YB- yoke assembly once YE-HCAL is ready or assemble YB- wheel in garage



Slide from Thomas Schörner-Sadenius

ILD Assembly Plan

- Goal: one central plan - coordinated with sub-detectors
- Biggest uncertainty:
  - Coil schedule!
  - Vendours might need considerable R&D time before construction can start
  - and where should it be built? On-site, at vendour?



Risks (a.k.a. the container ship slides)

„MOL Comfort“ 17.6.2013 (as shown at LCWS15/Whistler)

- Indian Ocean between Singapore and Jeddah

Foto: IANS

„MOL Comfort“ - Failed Salvage Operation

Foto: gCaptain

Foto: Indian Coast Guard

„MOL Comfort“ - Failed Salvage Operation

Foto: gCaptain

Foto: Indian Coast Guard

„MOL Comfort“ - Failed Salvage Operation

Foto: gCaptain

Foto: Indian Coast Guard

„MOL Comfort“ - Failed Salvage Operation

Why should we care?

Foto: gCaptain

Foto: Indian Coast Guard

„MOL Comfort“ - Failed Salvage Operation

Why should we care?

A Toshiba klystron for the XFEL was on board of this ship….

Foto: gCaptain

Foto: Indian Coast Guard

„CSCL Indian Ocean“

- Container vessel of the newest generation 400mx59m
- Ran on ground in the river Elbe (~20 km upstream of Hamburg) on 03.02.2016 ~22:00
- Problems with the steering gear

- Unfortunate: happened during a tide that was higher than normal due to heavy weather in the North Sea

Foto: Havariekommando

Salvage Operation (09.02.2016, ~02:10)

- Third try was successful
- 5 days of preparatory work: dredging the river bed, pumping of ballast water and fuel
- At spring tide, with the help of 12 tug boats (including 2 very large oceangoing tugs)

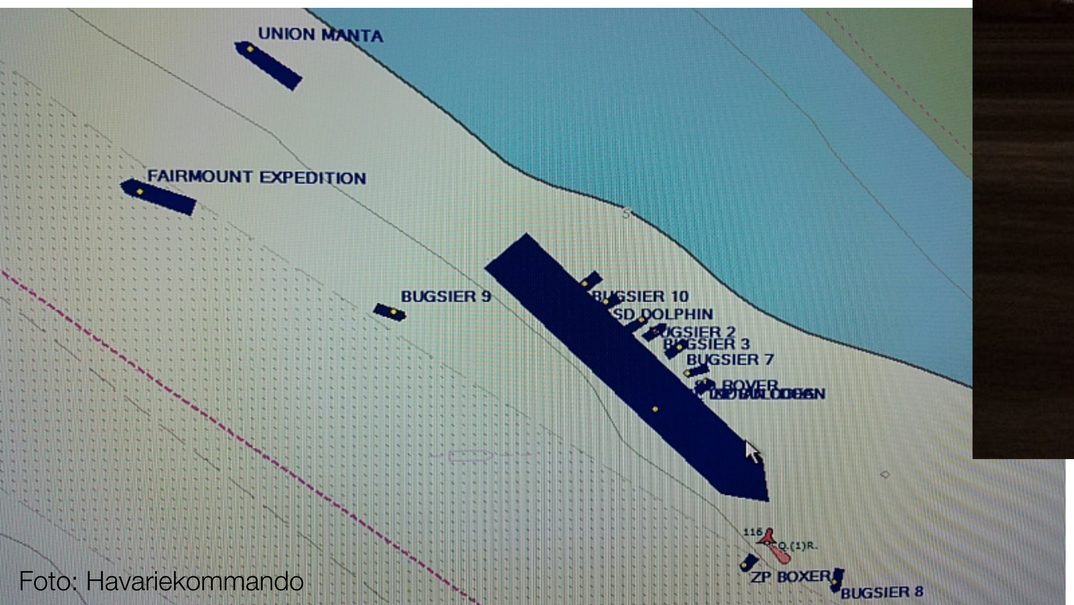


Foto: Havariekommando

Foto: Fabian. forum-schiff.de

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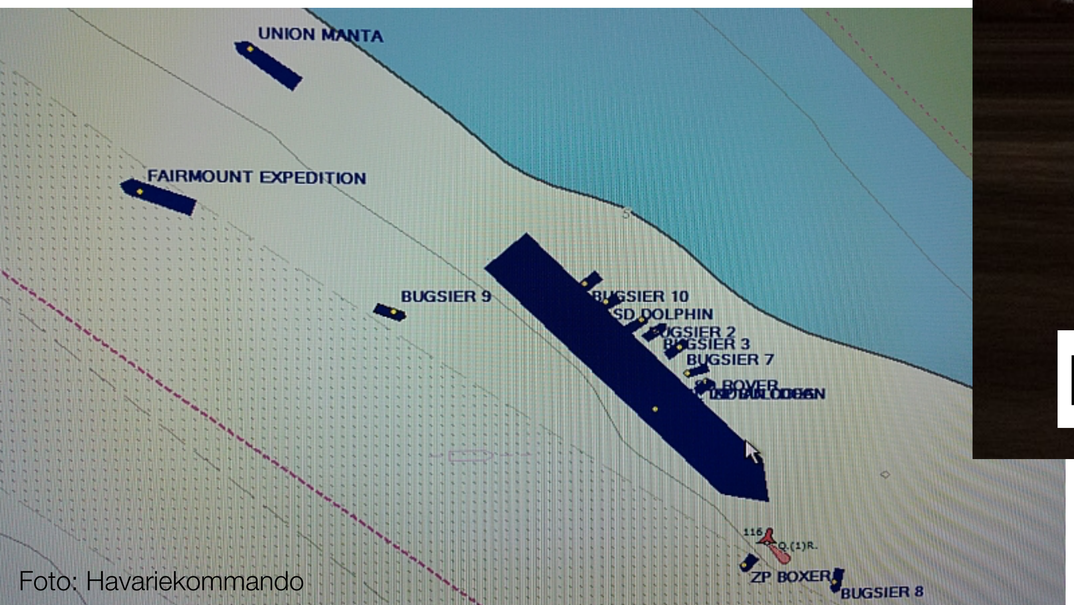
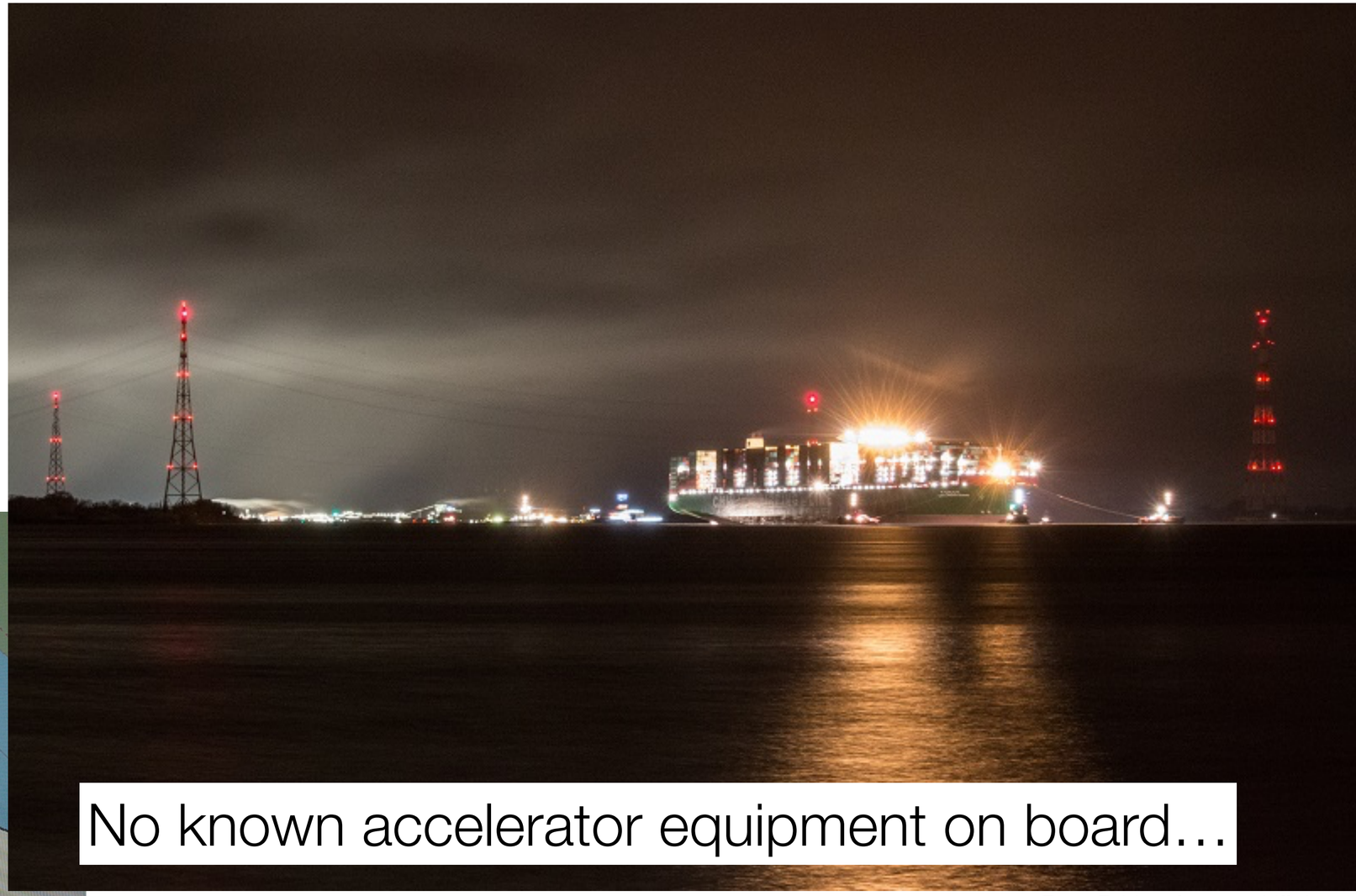


Foto: Havariekommando



No known accelerator equipment on board…

Foto: Fabian. forum-schiff.de

Summary

- ILD has new management structure that includes organization of the technical groups
- ILD is currently undergoing an optimization round that aims for a smaller (and cheaper) detector
  - this has implications on the integration of ILD into the ILC environment
- A rather detailed engineering model of ILD is kept in EDMS
- A round of updates to this model is required, e.g. implementation of the new forward region, new smaller detector model
- There are open engineering topics that could have an impact on optimization studies
- The planning for the layout and infrastructure at the Kitakami site is advancing
- Need to understand the dependencies on local conditions, e.g. transportation limits, on detector assembly and maintenance philosophy
- ILD is working on common installation timeline including planning status of all subdetector collaborations

This work was partially supported by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 645479.