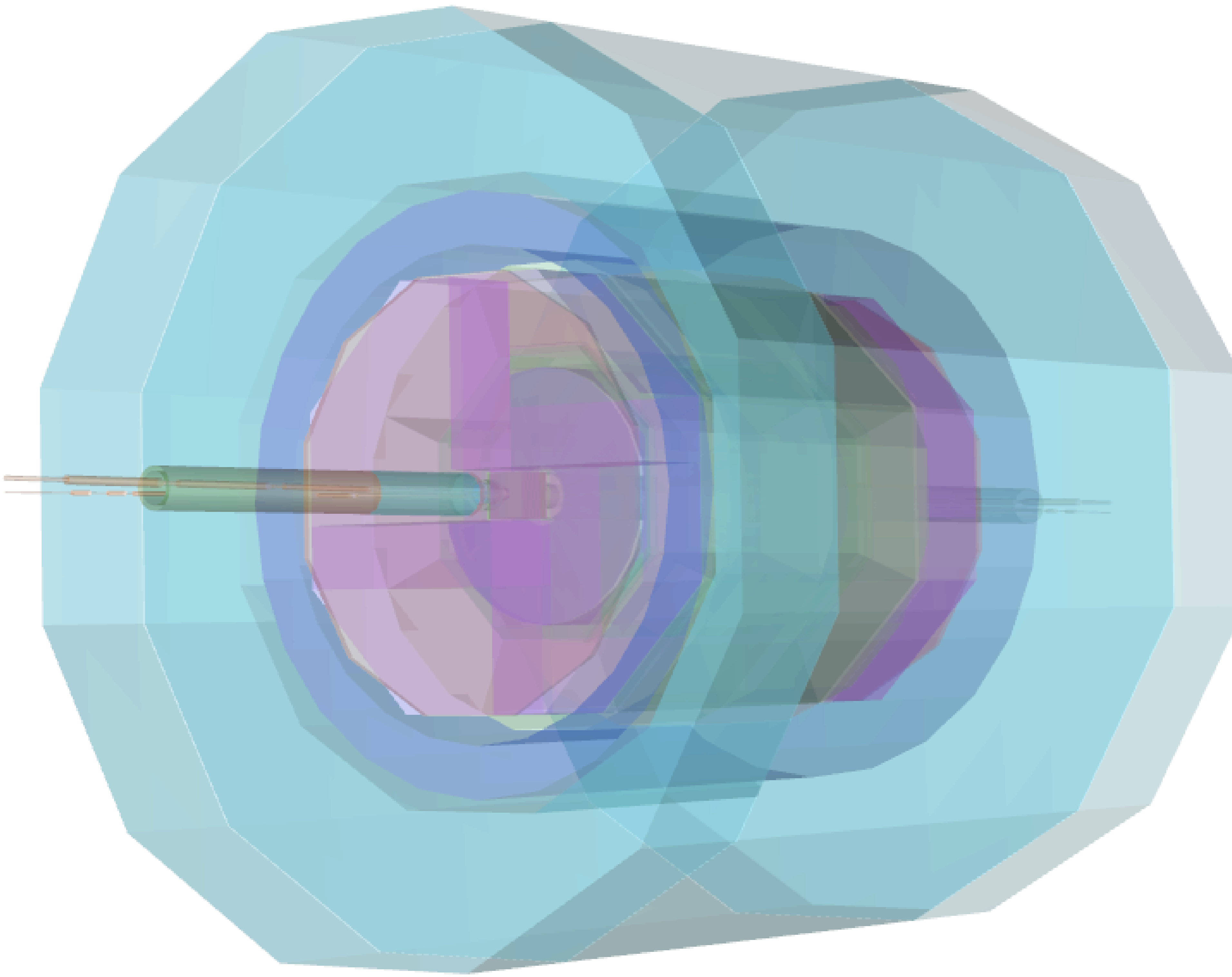
Status of ILD Detector MDI work

T. Tauchi,

LCWS2008, UIC, Chicago, 17 November 2008

ILD00 - Mokka 3D model for full simulation



Overall size : 14m in diameter, 13.2m in total length (Tentative, Nov.08)

ILD MDI Issues

1. Experimentation at Linear Collider

Background : machine@BDS, beam-beam interactions

QD0 : L* > 4 m

QF1 : 9.5m from IP - the hall width

Opening the detector on the beam line

2. Detector assembling within 5 years

Surface assembling like as CMS

Integration - gaps for cables, pipes and services, too

3. Push-pull scheme for 2 detectors

The operation in a few days or less than a week

The garage@15m from IP - stray B field, radiation

Platform (20 x 20 x 2 m^3) as the baseline

Background - IR

Tolerances in Detectors

Sources : pairs | disrupted beams/pairs | beam halo

Detector	Hits	Neutrons	Muons
VTX	1×10^4 hits/cm^2/train	1×10^{10} n/cm^2/year	-
TPC	4.92×10^5 hits/50μsec	4×10^4 n*/50μsec	$1.2 \times 10^3 \mu$/50μsec
CAL	1×10^{-4} hits/cm^3/100nsec	-	0.03 μ/m^2/100nsec

* : The neutron conversion efficiency is assumed to be 100% in the TPC.

1 hit in TPC consists of 5 pads(1mmx6mm) x 5 buckets(50nsec)

A muon creates 1 pad x 2000 buckets in parallel to the beam line.

A neutron creates 10 hits in TPC.

Above numbers shall be re-evaluated by ILD sub-detectors. Machine parameters : nominal and low-P as well.

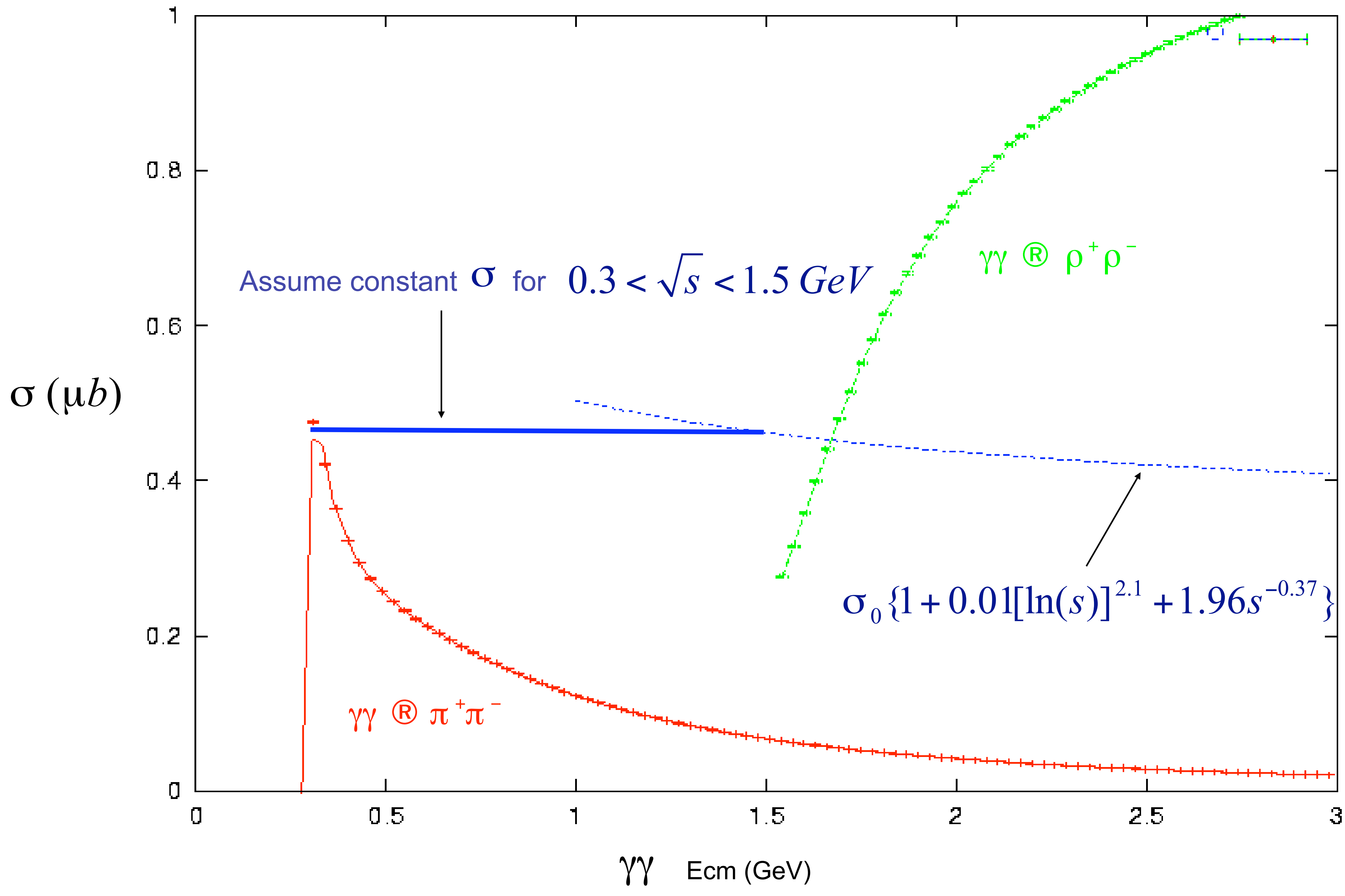
Detailed studies by A. Vogel and Japanese colleagues

Let's check in ILD, too.

Minijet issue (T.Barklow, 2004) to be evaluated

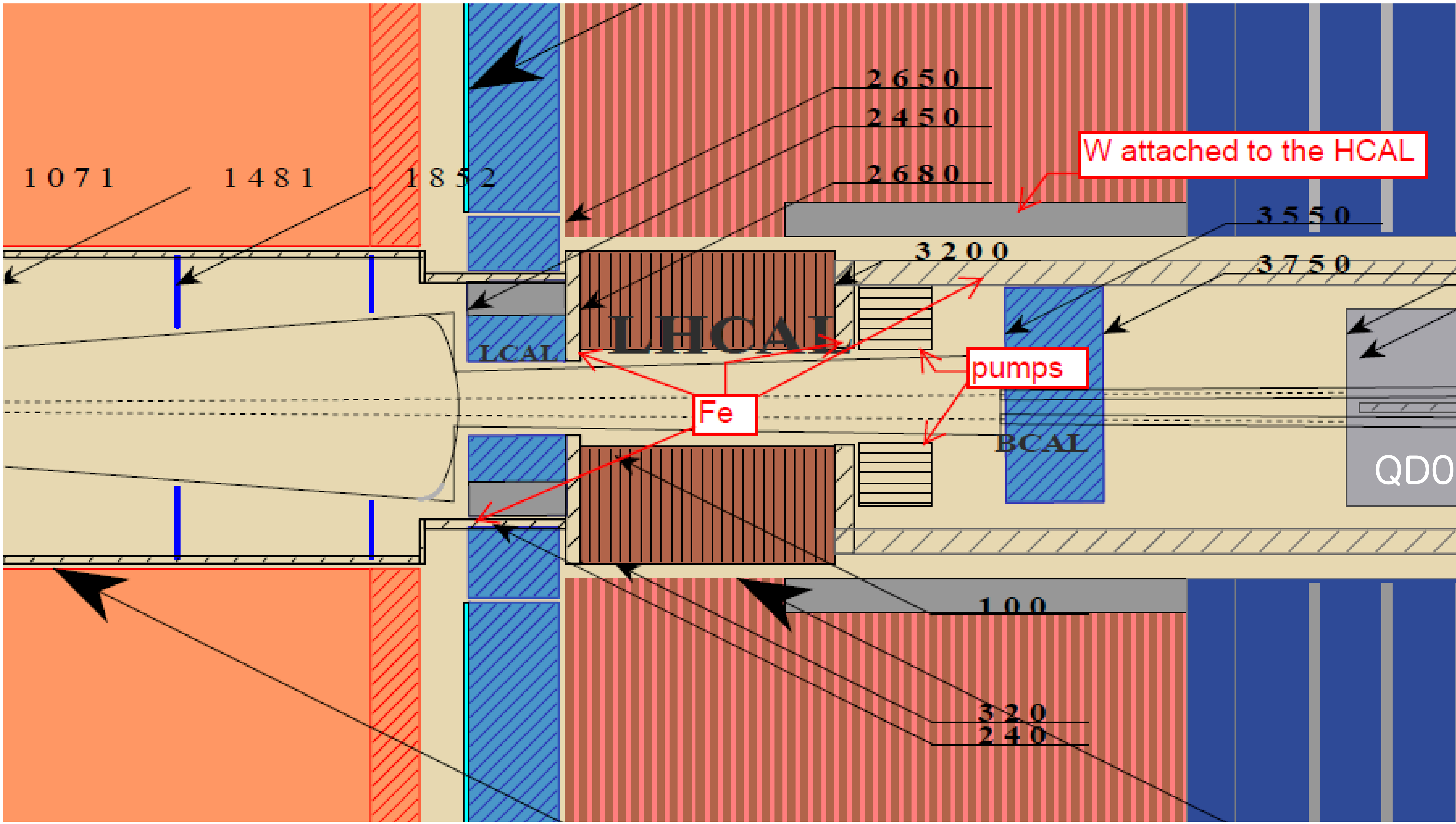
i.e. primary positive ion effect in TPC - inner radius

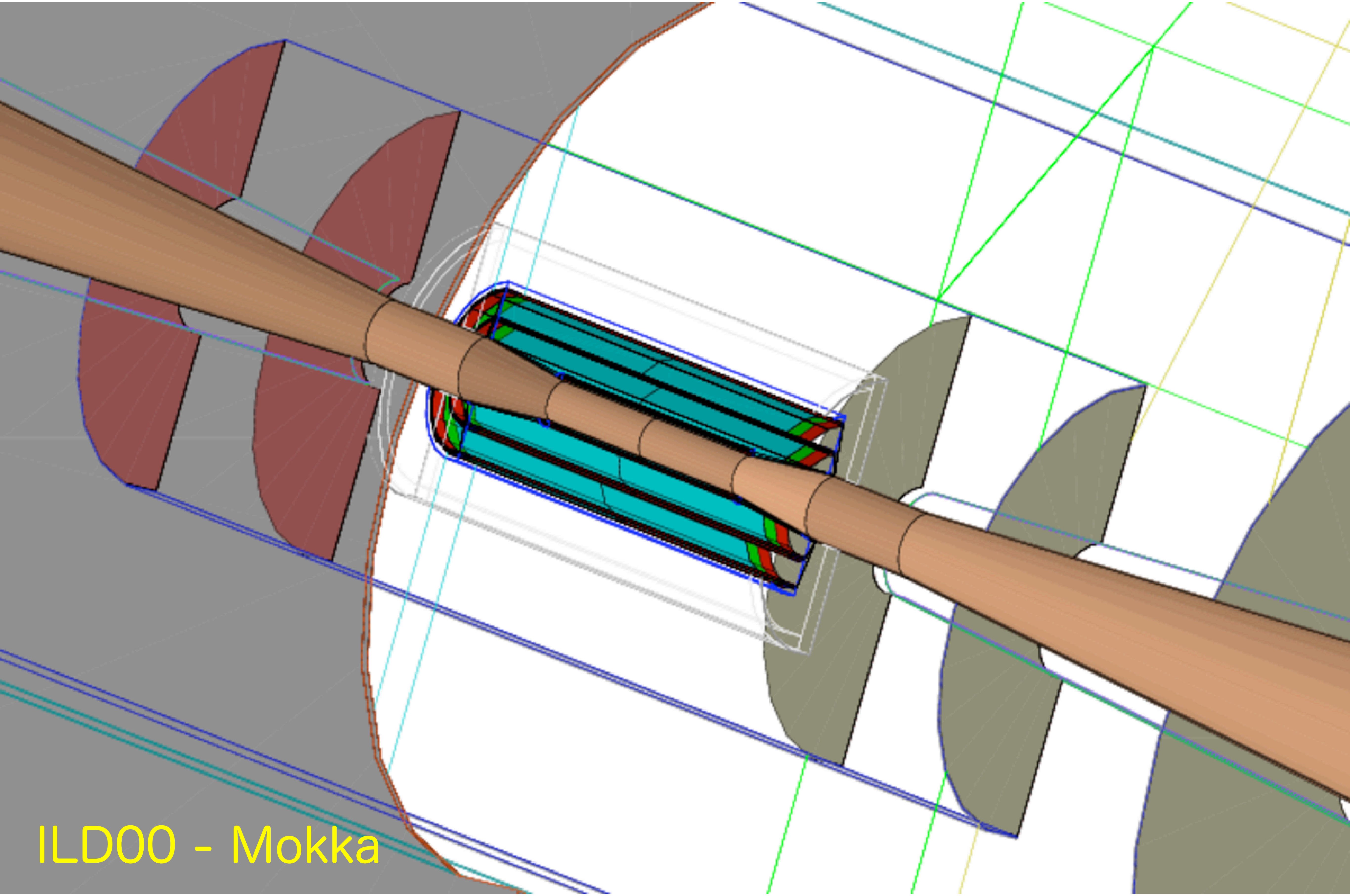
e.g. mini-jets could be 750 events/train, 2 tracks/event (no Pt cut)



ILD0 - engineering 3D model: Forward region

L* of QD0 > 4m

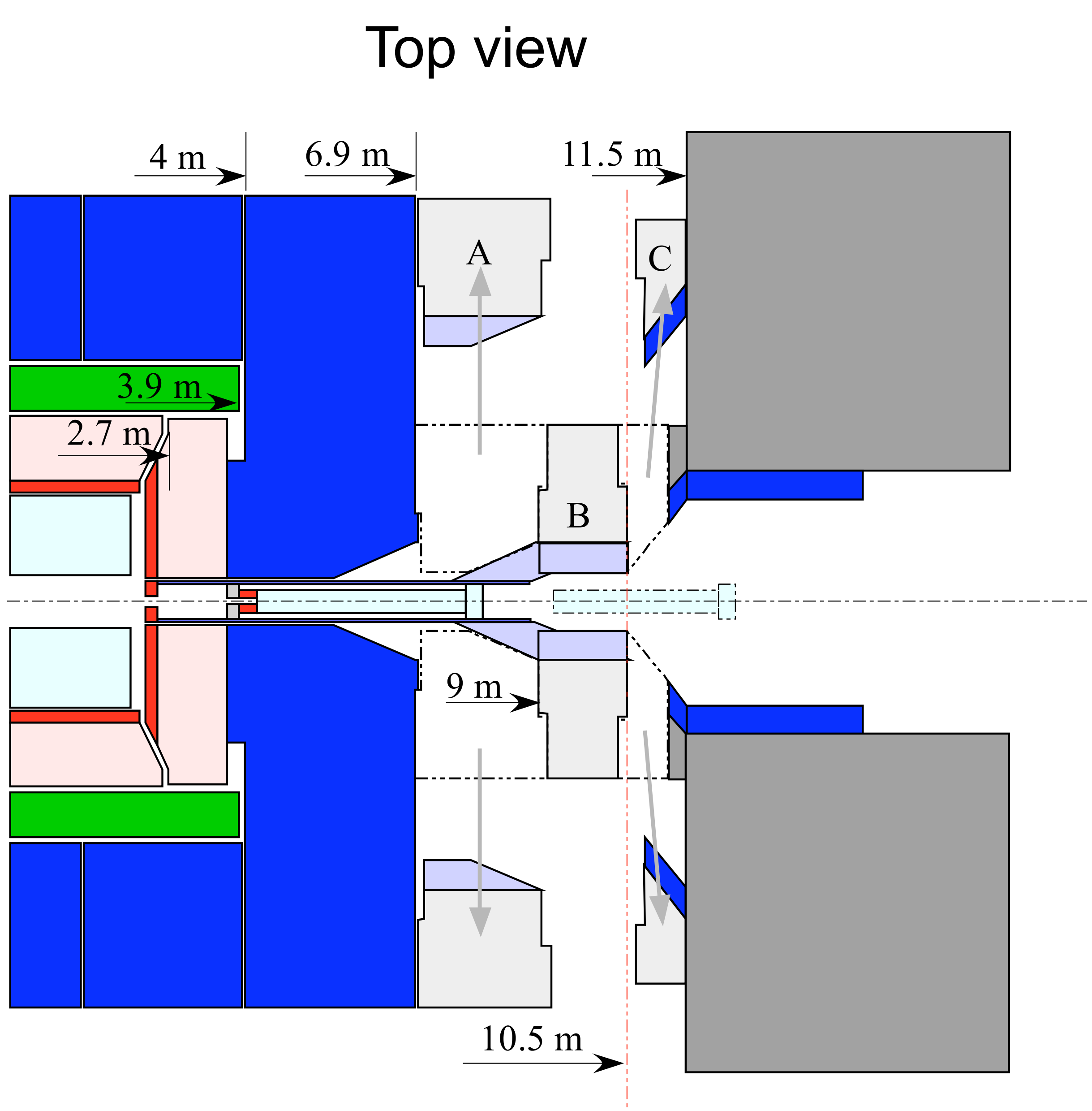


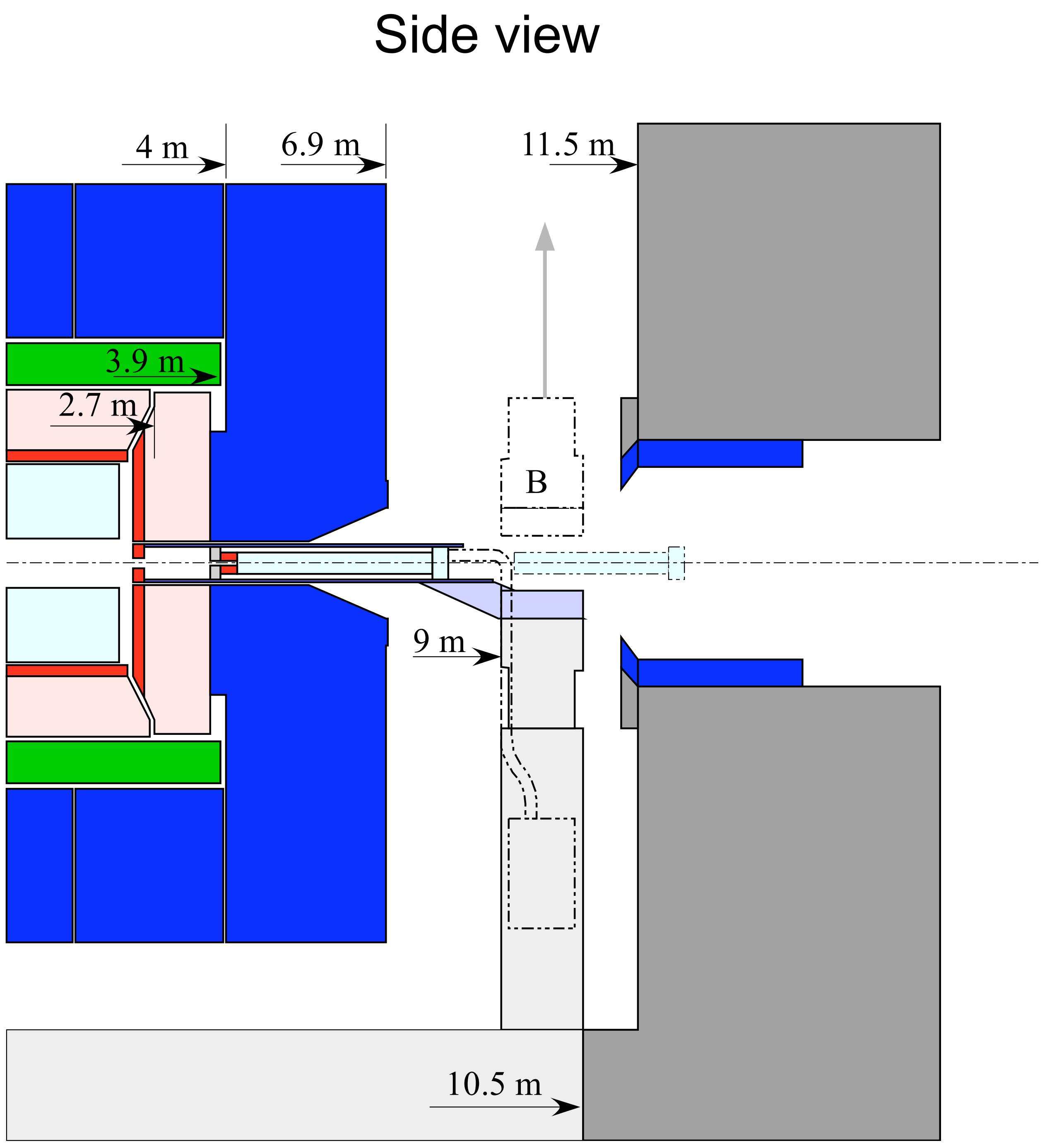

ILD00 - Mokka

Y. Sugimoto

Push-pull Operation -1

QF1 at 9.5m fixed





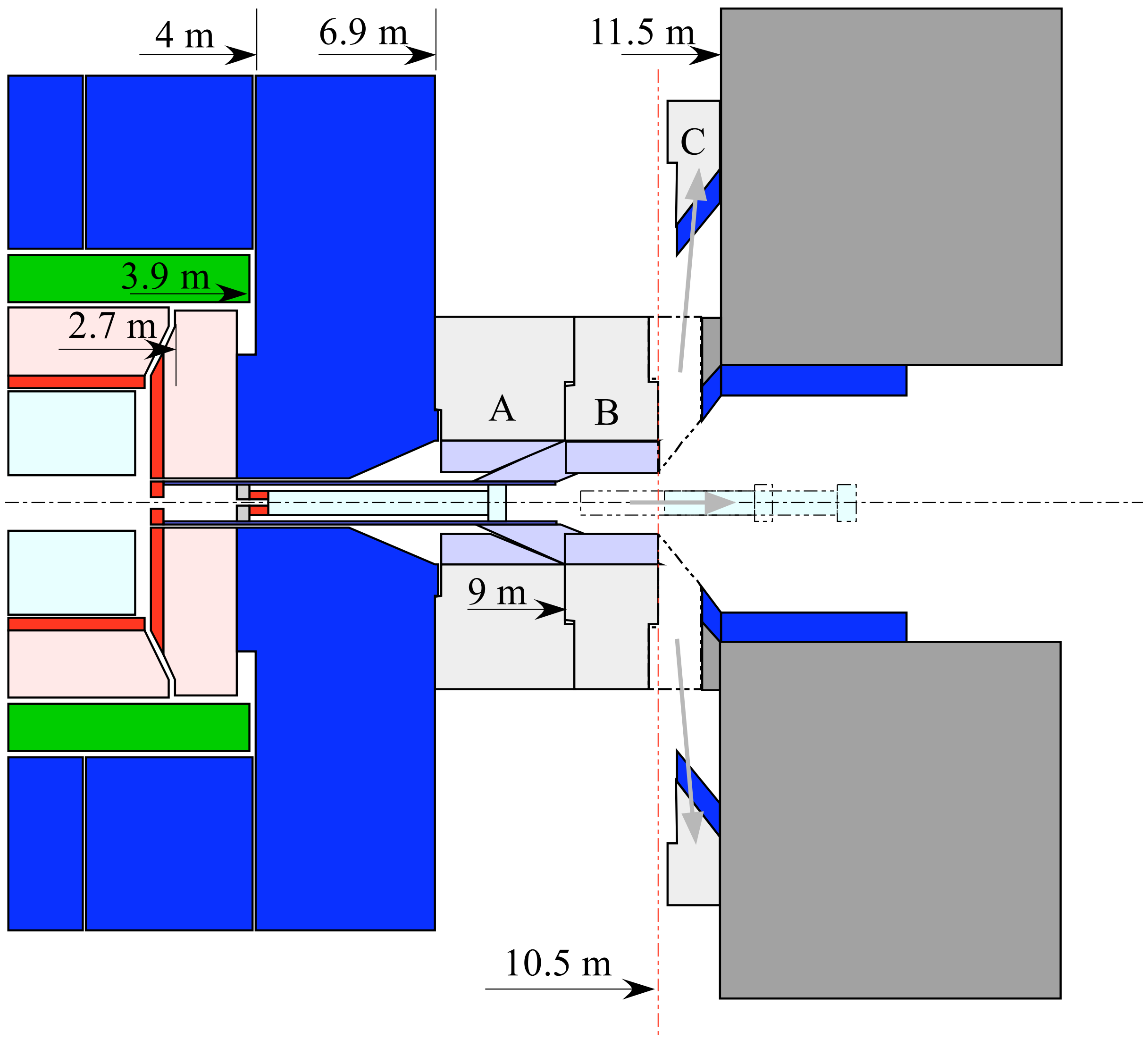
A, B-top and C parts will be moved out

Y. Sugimoto

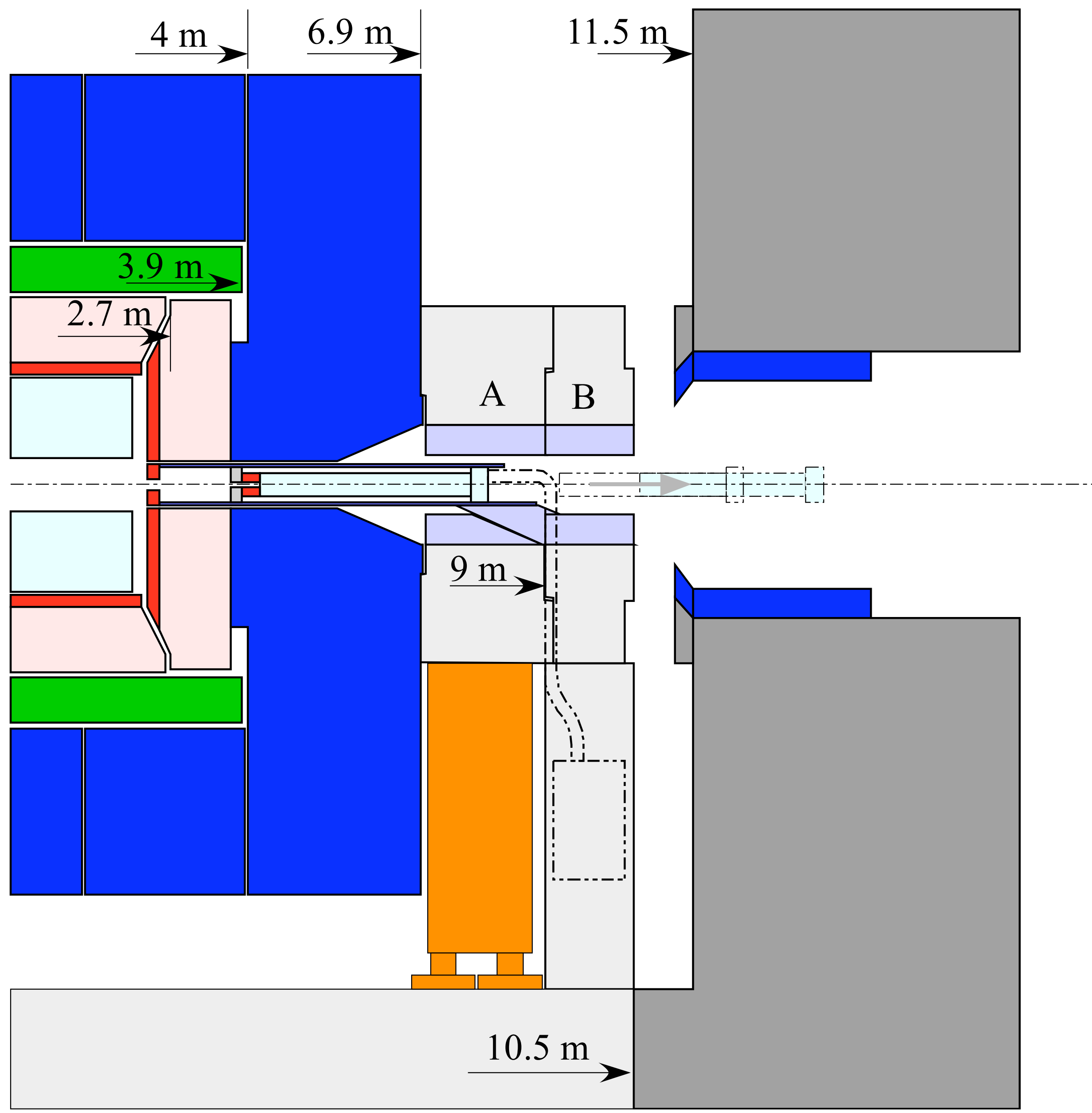
Push-pull Operation -2

retractable QF1 by 1m, upstream

Top view



Side view



Only C parts will be moved out

Buckling analysis on the beam pipe by minimizing the thickness

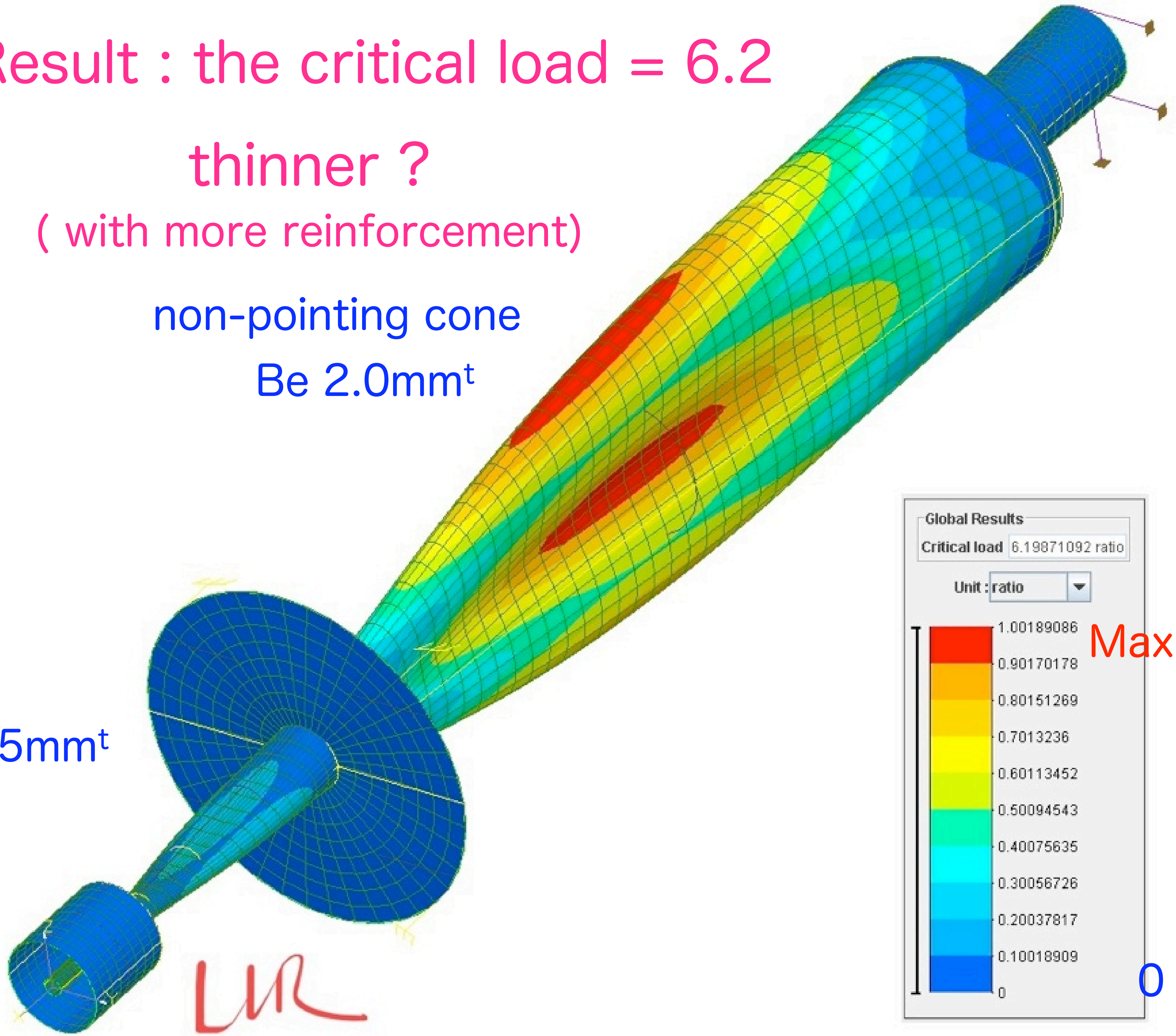
Result : the critical load = 6.2

thinner ?

(with more reinforcement)

non-pointing cone

Be 2.0mm^t



Max. deformation

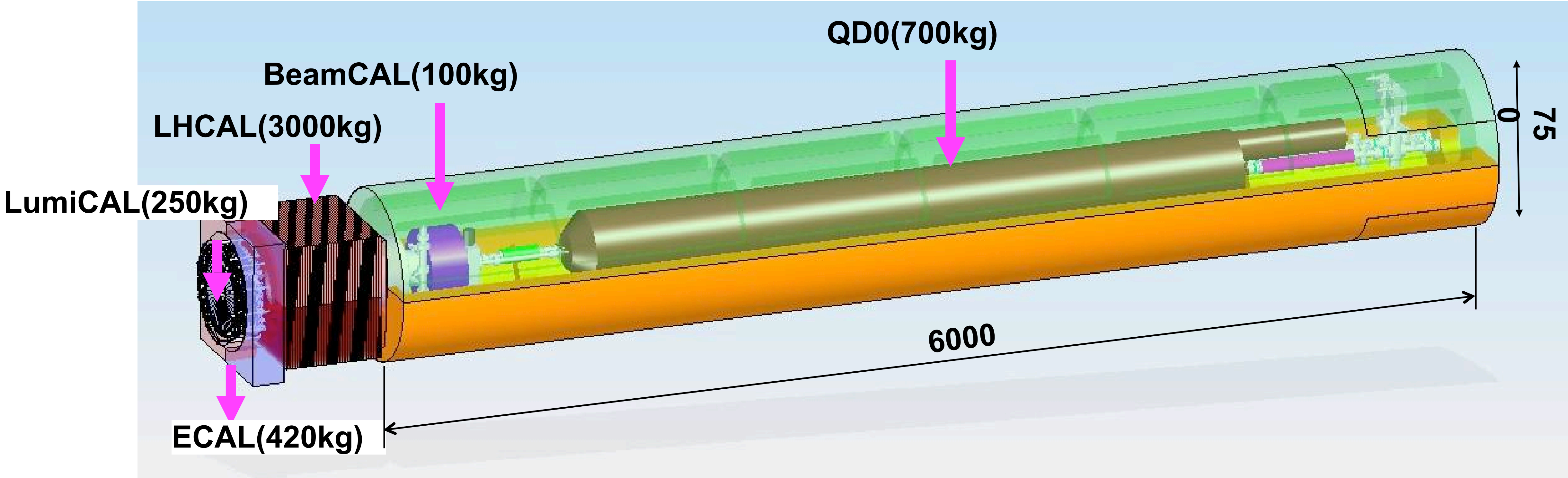
0 deformation

Be 0.75mm^t

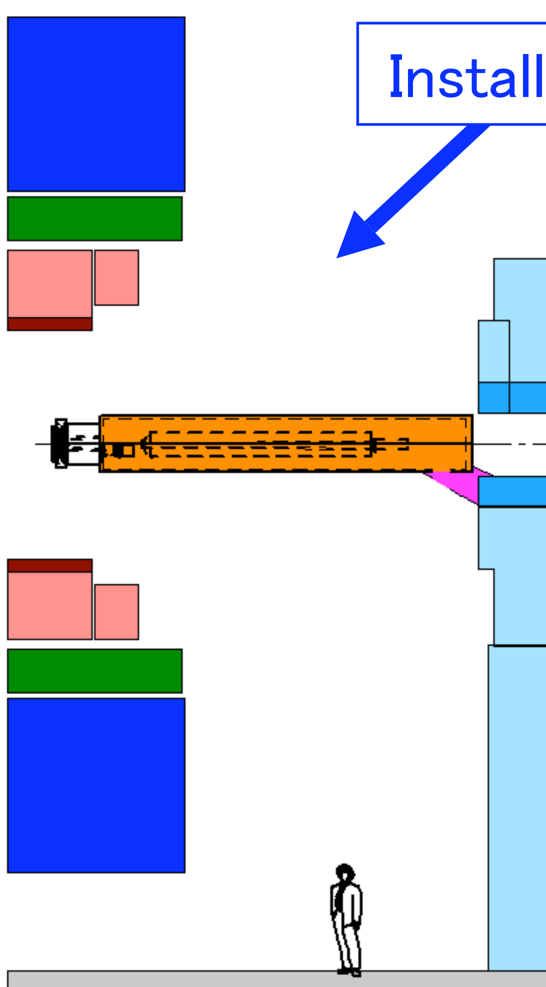
Be 0.5mm^t

analysis by Marc Anduze (Matthieu Jore for the structure)

Cylindrical Support Tube

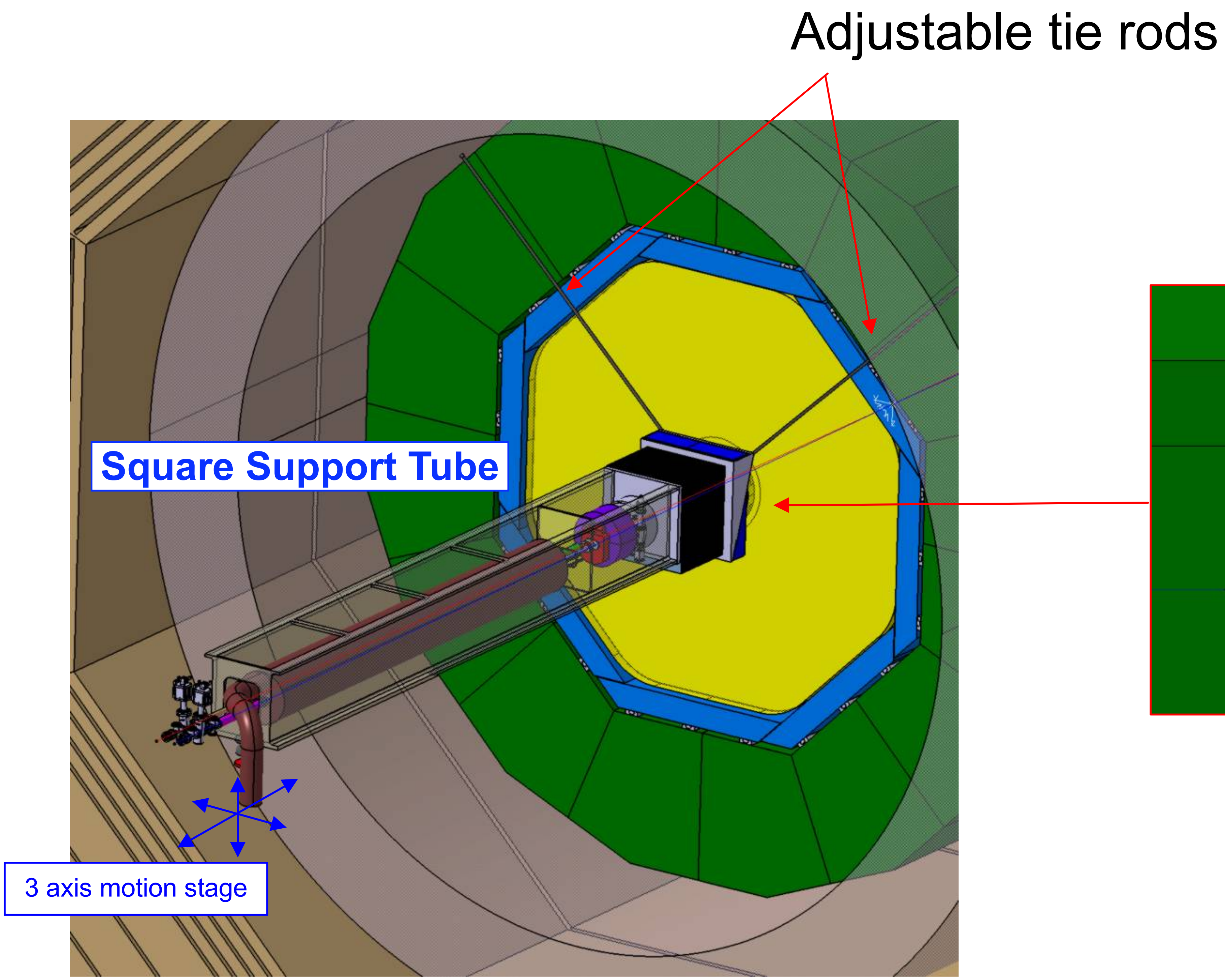


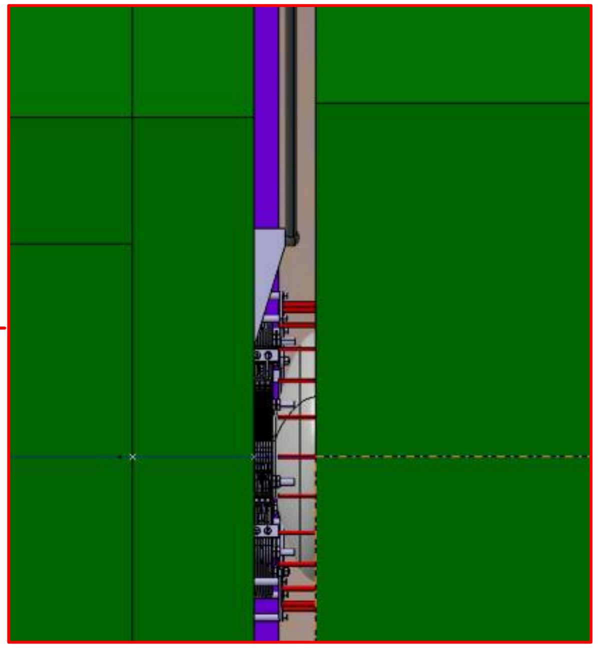
Installation method



H.Yamaoka will present the details at LCWS2008.

Alignment method





Platform issue

The platform has been proposed a simple, fast and robust solution of the push-pull operation as well as good isolation against earthquake and vibration by A. Heve.

The detector system must be secure and stable in the operation.   ILD takes advantage of platform in order to design the detector.

Nominal size of 20 x 20 x 2 m^3 to be checked .

ILD0 - engineering 3D model for integration

Deep site

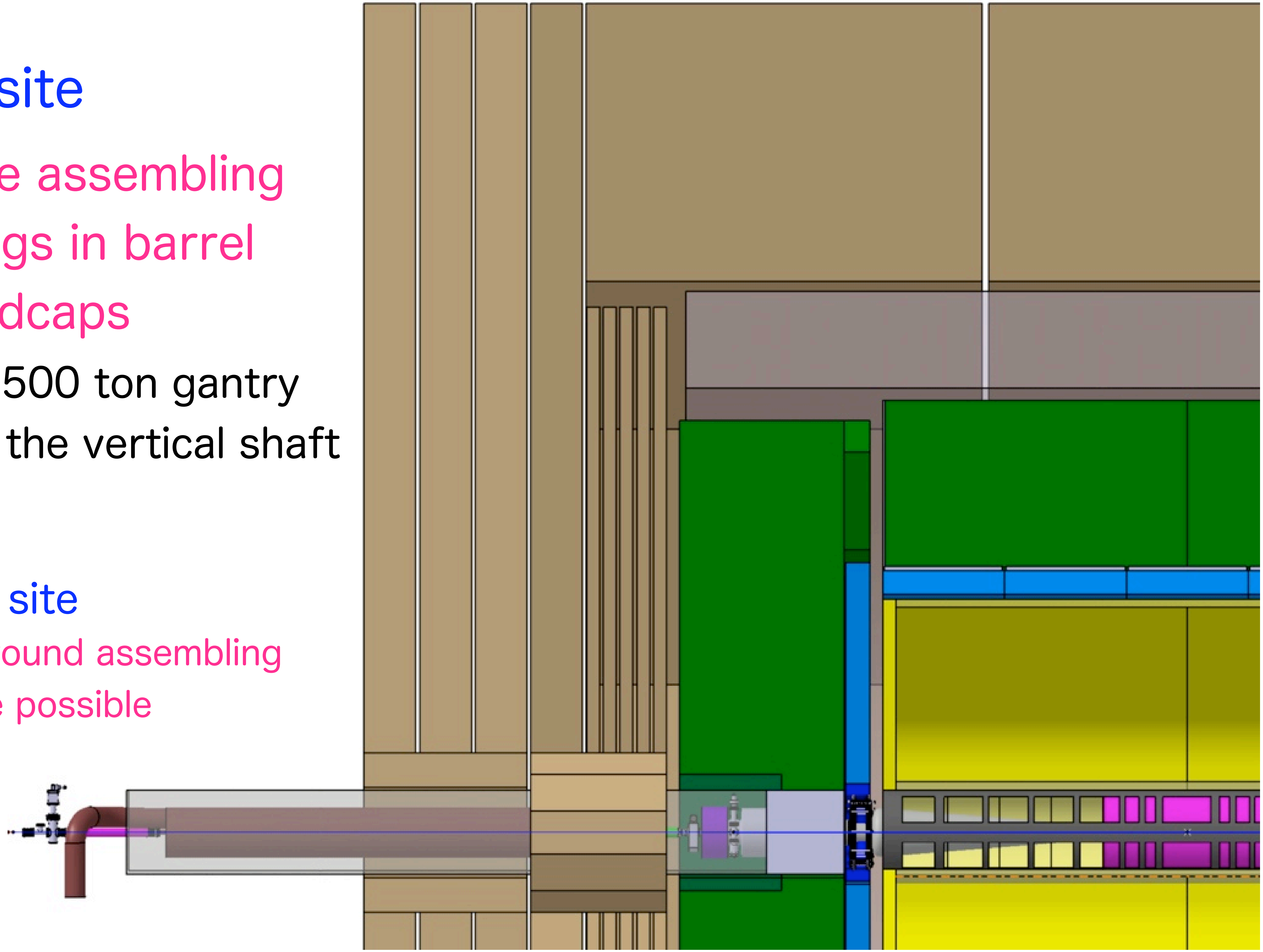
Surface assembling

- 3 rings in barrel
- 2 endcaps

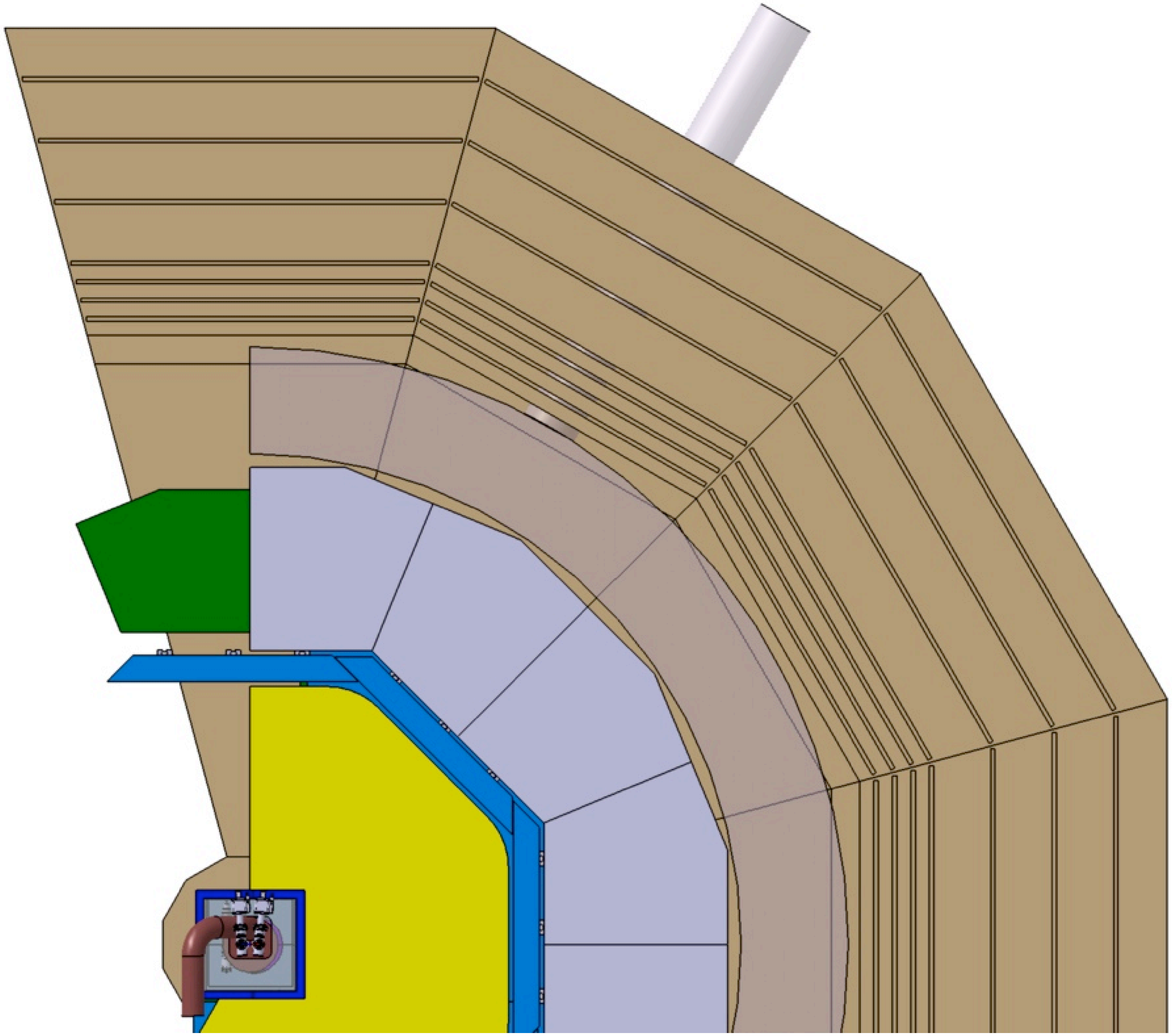
2000-2500 ton gantry cane in the vertical shaft

Shallow site

Underground assembling could be possible

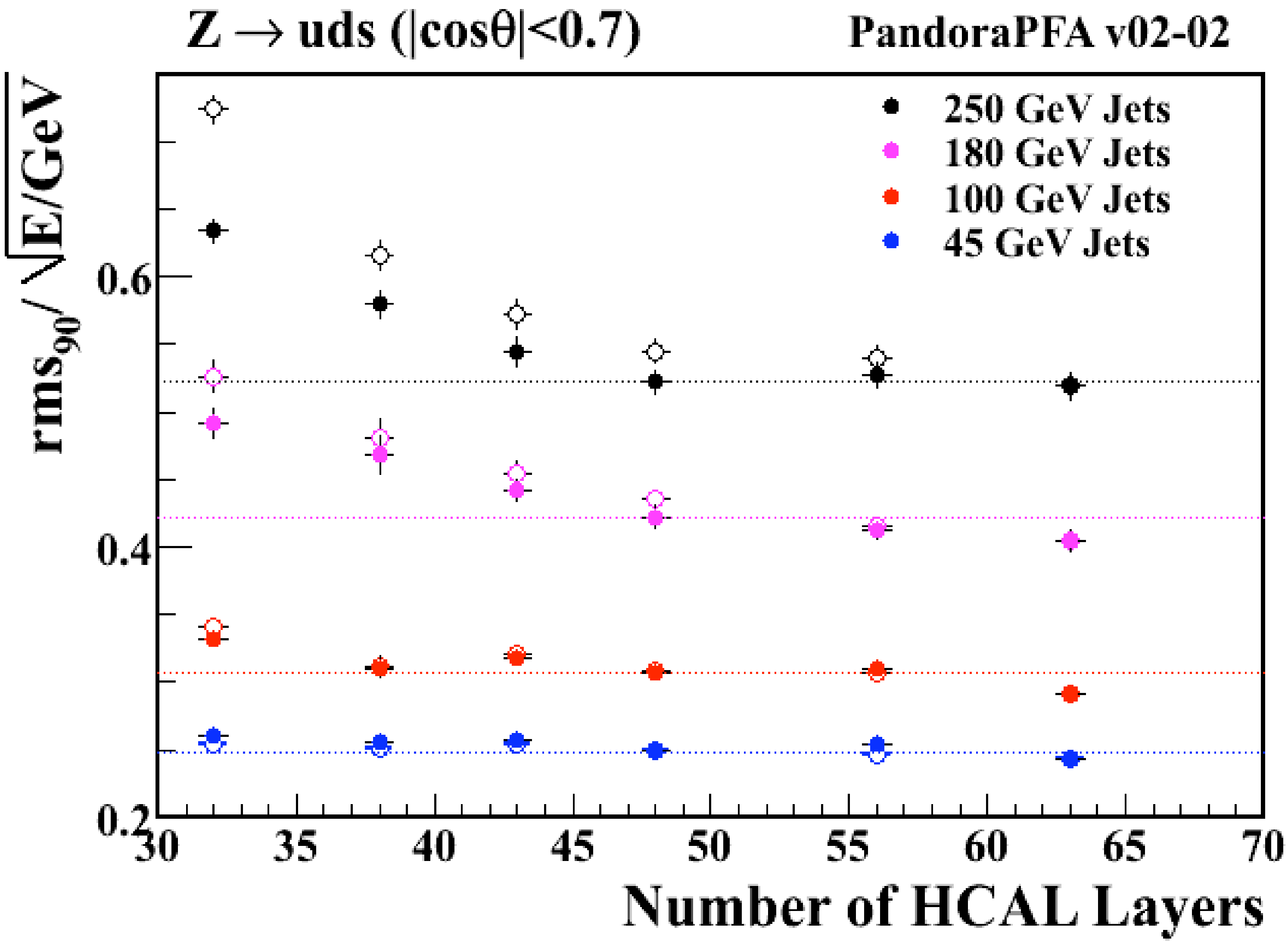


ILD0 - engineering 3D model for integration



HCAL Depth Results

- **Open circles** = no use of muon chambers as a "tail-catcher"
- **Solid circles** = including "tail-catcher"



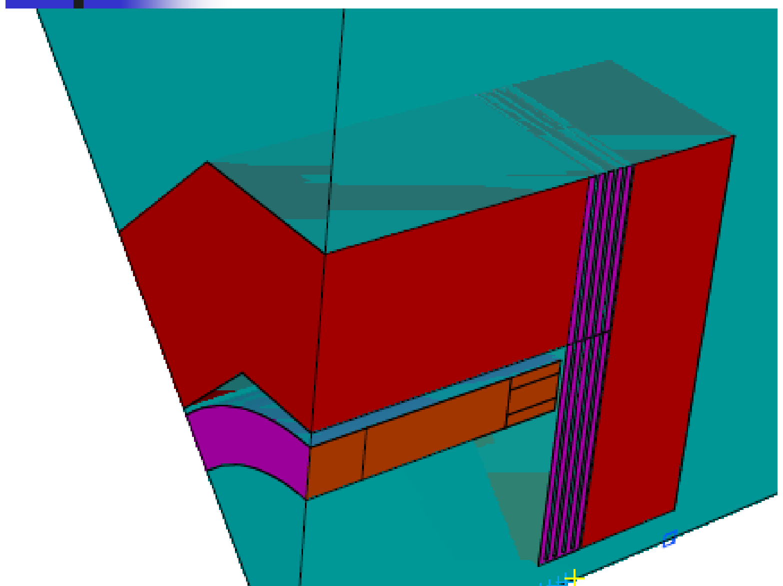
HCAL Layers	λ_I	
	HCAL	+ECAL
32	4.0	4.8
38	4.7	5.5
43	5.4	6.2
48	6.0	6.8
63	7.9	8.7

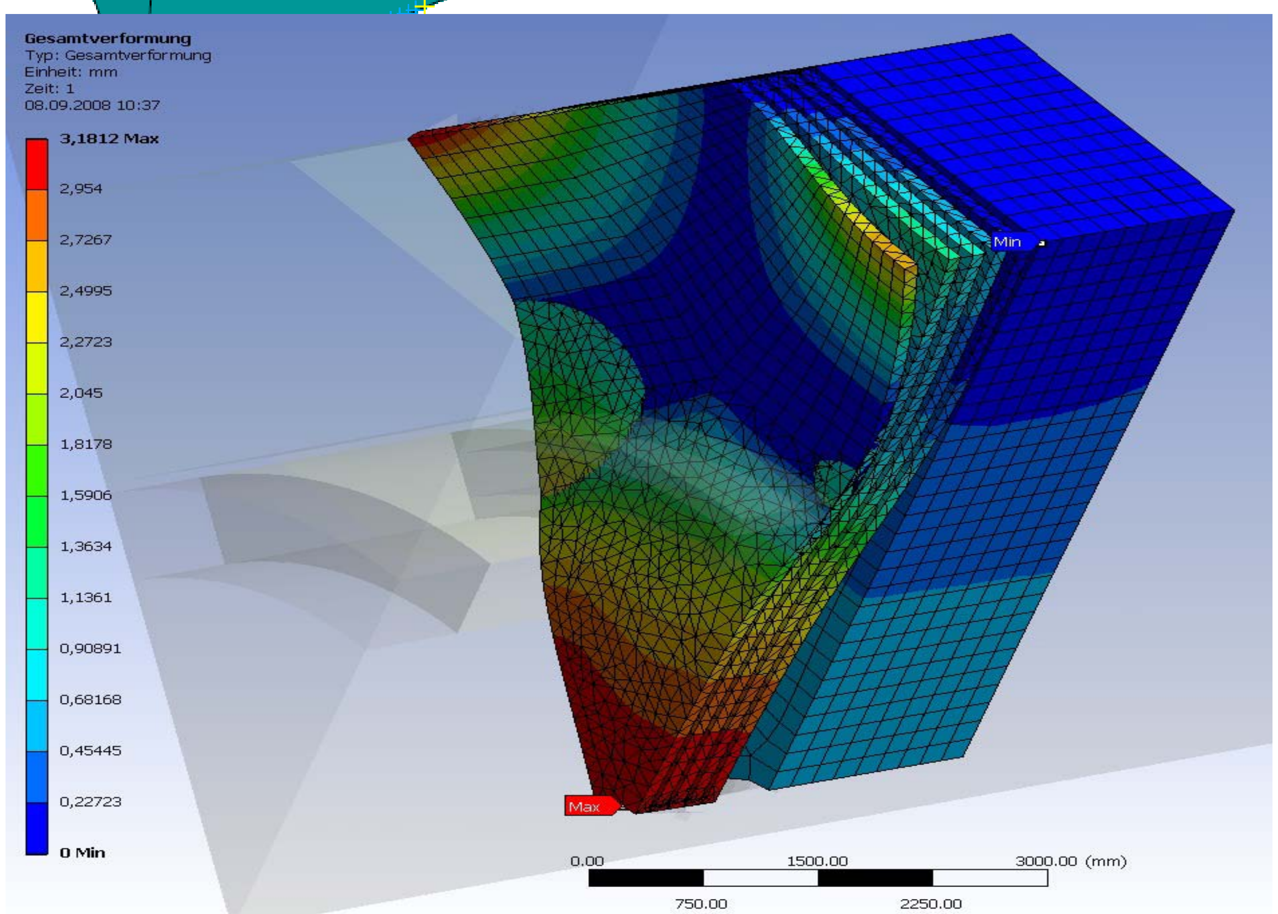
ECAL : λ_I = 0.8
HCAL : λ_I includes scintillator

★ Little motivation for going beyond a 48 layer (6 λ_I) HCAL
★ Depends on Hadron Shower simulation
★ "Tail-catcher": corrects ~50% effect of leakage, limited by thick solenoid

For 1 TeV machine "reasonable range" ~ 40 – 48 layers (5 λ_I - 6 λ_I)

Deformation due to Magnetic Forces





C.Martens

Deformation of inner thin end-cap section with radial rips

- So far not connected to outer end-cap
- Plates connected at inner tube
- Very preliminary results max. deformation
  - 3mm at 3T
  - 4.5mm at 4T

Confident that a 'thin' plate inner end-cap can be built

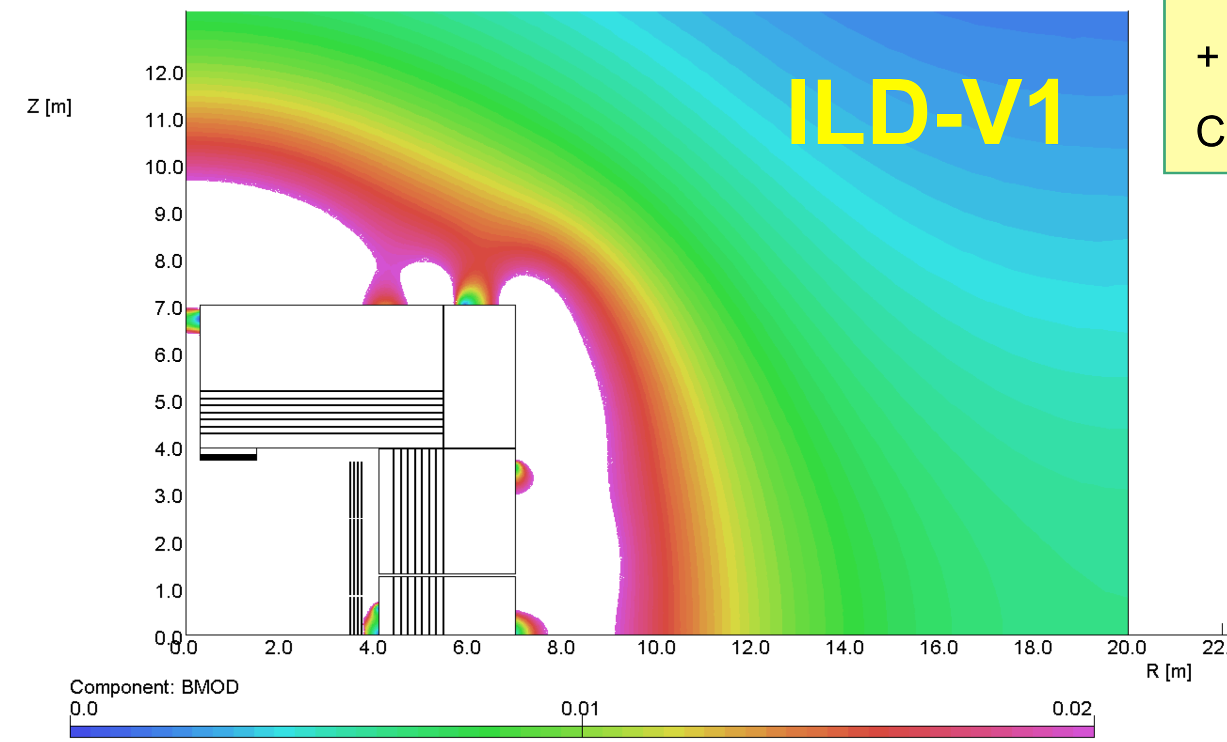
Solenoid by F.Kircher

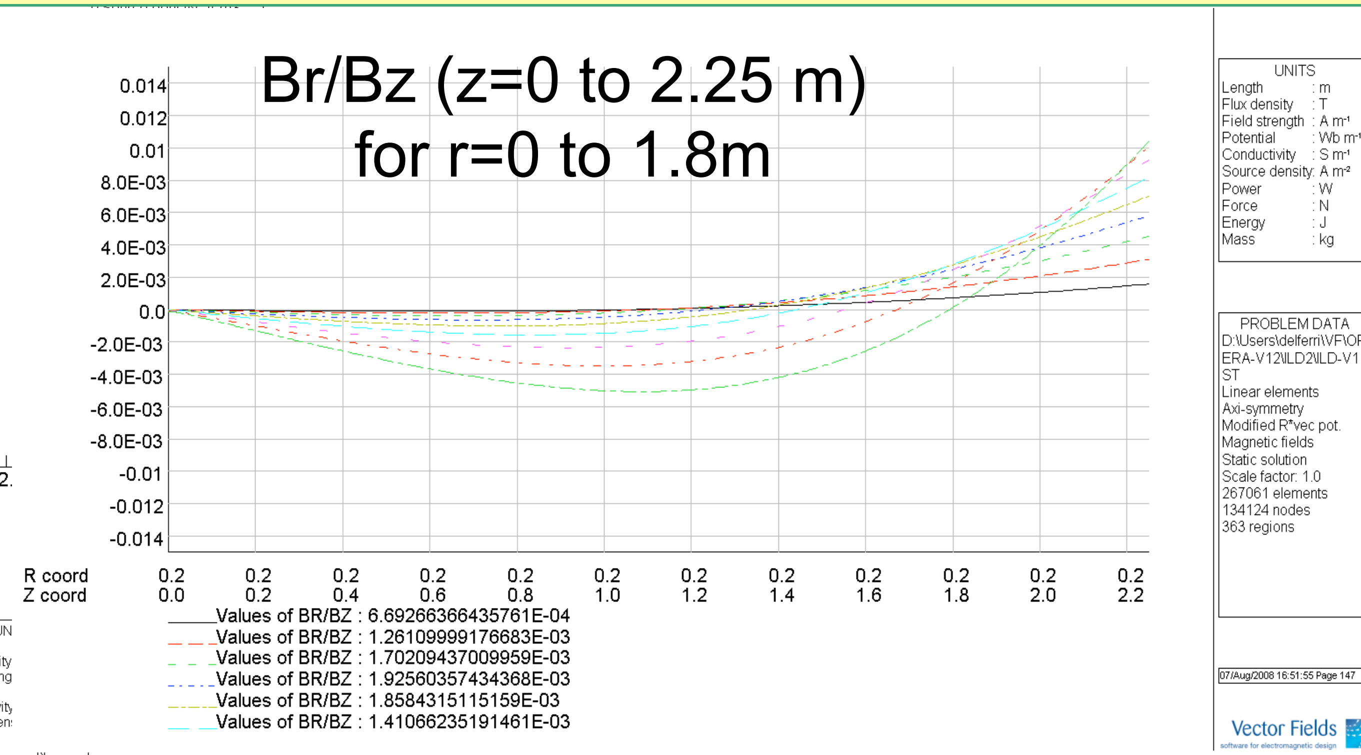
ILD-V1 configuration

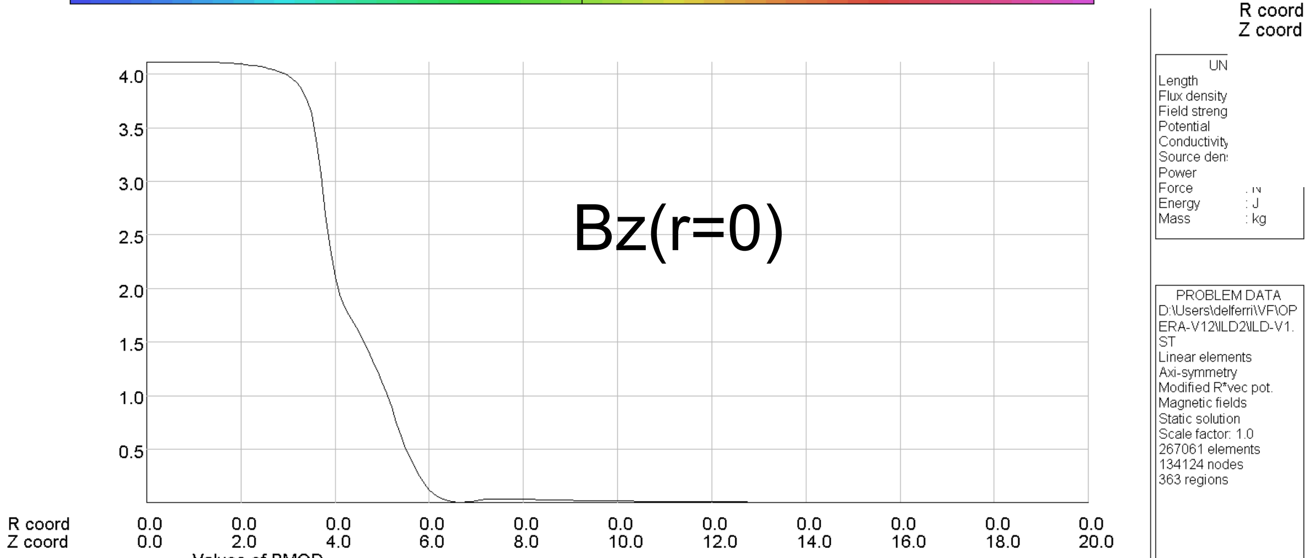
Iron : up to R=7m, up to Z=+/-7m (~3m thickness)

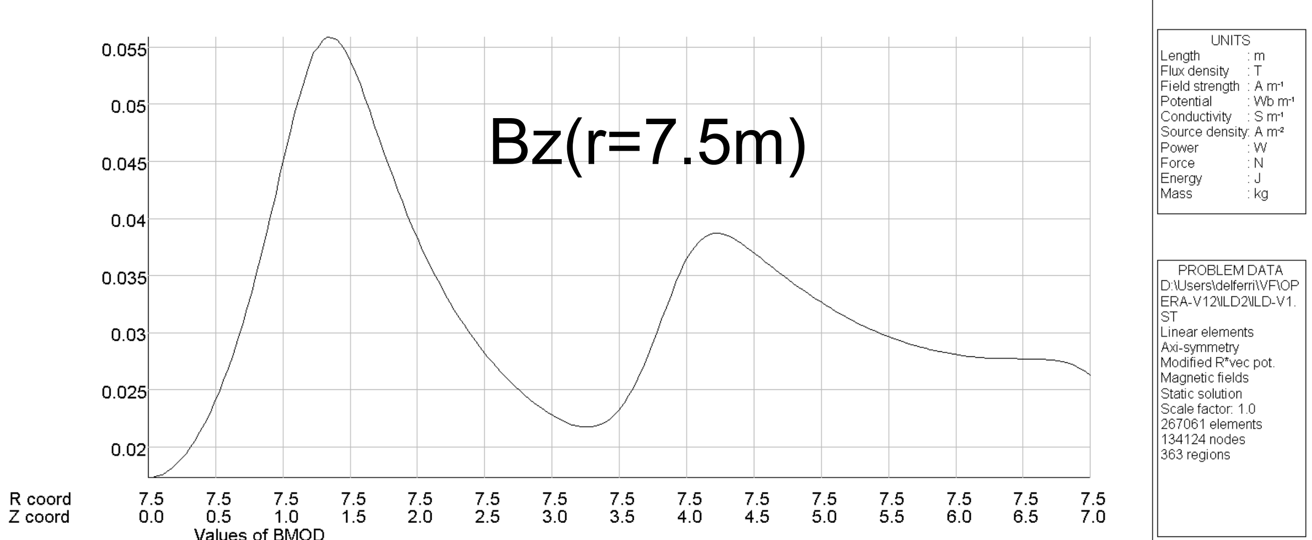
+ 100 mm FSP (Field Shaping Plate)

Coil : 4 layers ,7.35 m length subdivided in 5 parts

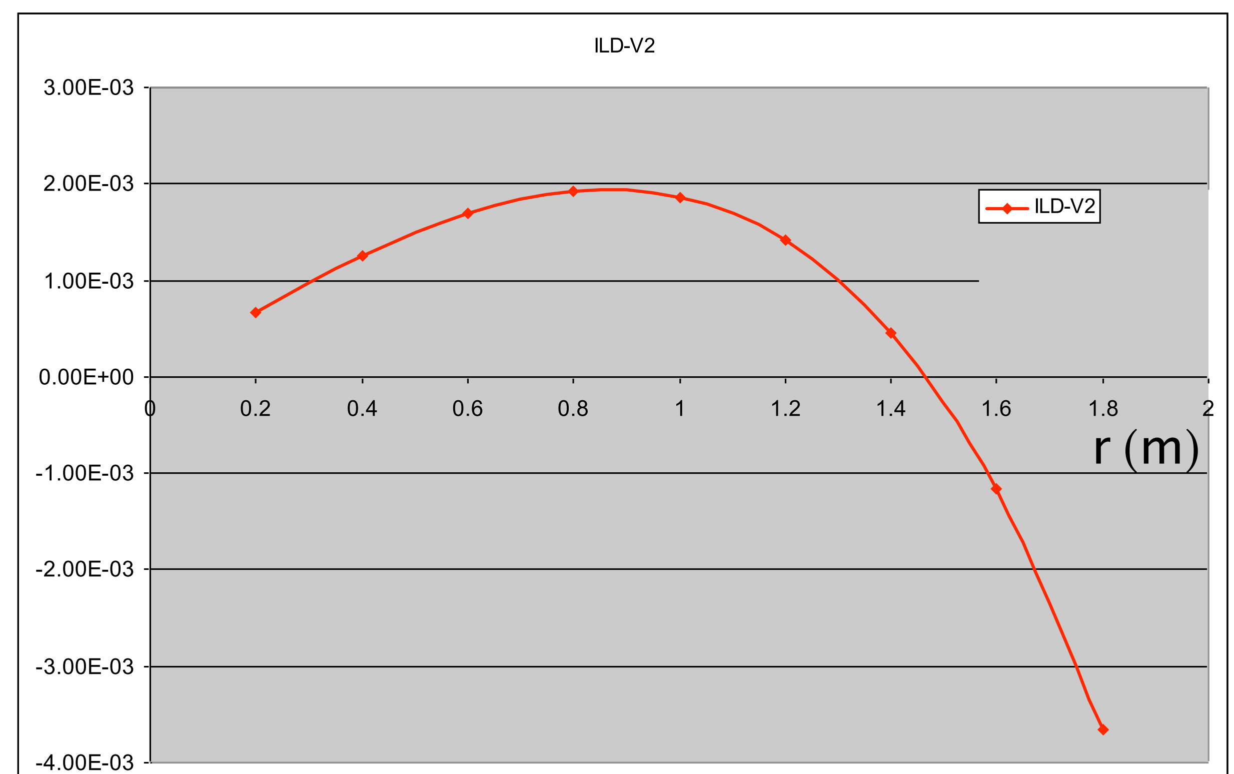








∫(Br/Bz) vs r (z=0 to 2.25 m)



Current Estimation of Gaps in ILD

(1) ILD Barrel Yoke Inner Radius, U. Schneekloth

Space between the cryostat and the yoke in barrel region was estimated.

About 210mm is needed for;

- 98mm component services (cables, pipes etc.) - 37mm@TPC, 11mm@AHCAL,
- 4mm yoke deformation,
- 5mm assembly tolerance,
- 50mm clearance for moving barrel ring (CMS)
- 50mm space for inner muon chamber

,while the barrel corners are available as CMS uses for alignment system

(2) Gap between barrel rings, Y. Sugimoto, U. Schneekloth, A. Herve

About 110mm is needed for;

- 100mm component services (cables, pipes etc.),
- 10mm in addition for precisely machined hard stops

It could be reduced to 70mm on the outside.

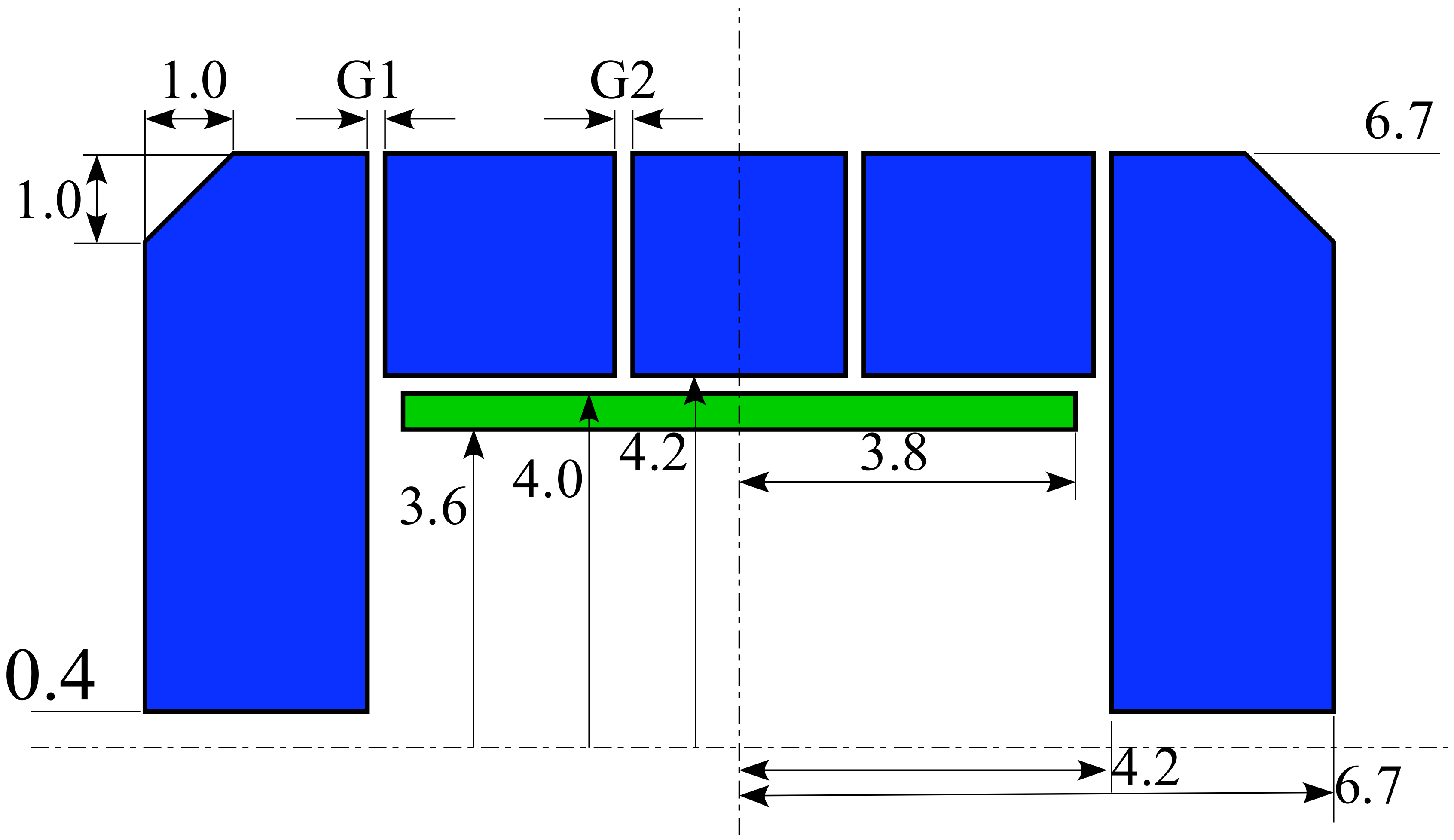
It is not easy to spread cables etc. in ϕ at time of actual cabling, piping (CMS),

A better solution is to tapered both barrel faces to prevent holes at the gaps.

Y. Sugimoto

Model

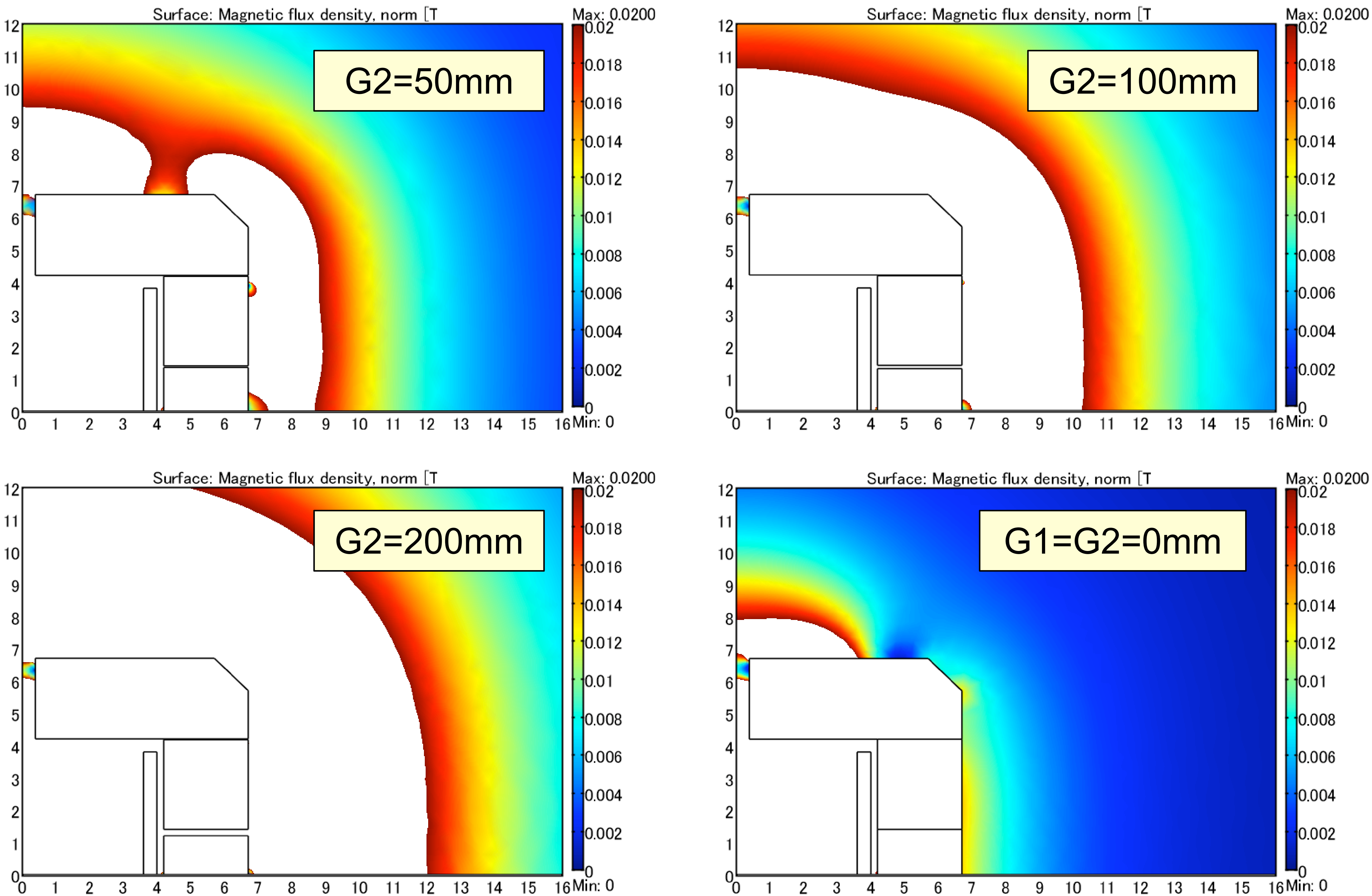
- Simple 2D model (B=3.5T)



G1 (mm)	G2 (mm)
25	50
25	100
25	200
50	50
100	50
200	50

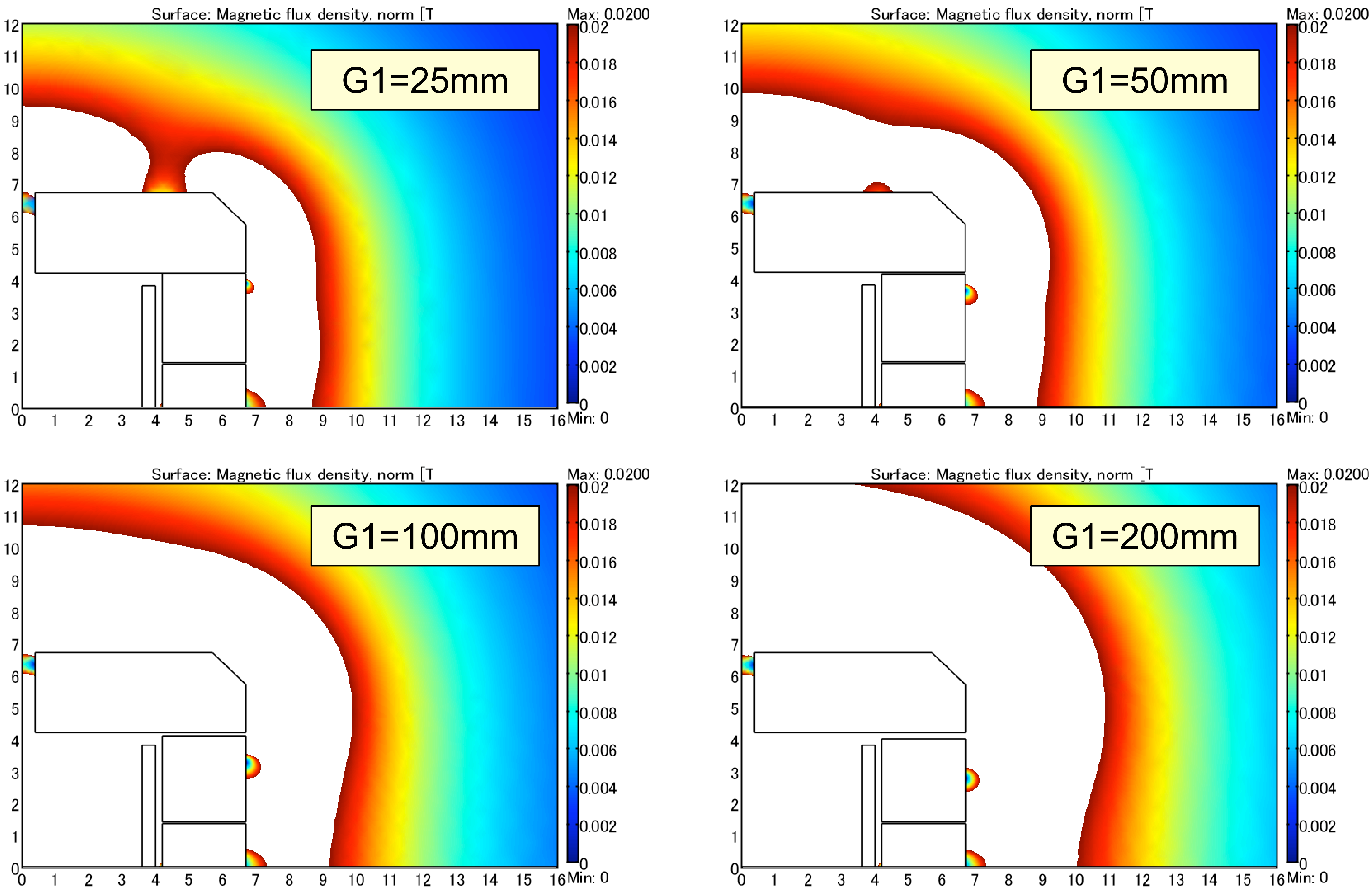
Y. Sugimoto

Stray field (G1=25mm)



Y. Sugimoto

Stray field (G2=50mm)



Radiation Shield of Detector

(1) Self-shielded in ILD, which (GLDc) has been estimated by T. Sanami

(2) Nominal operation : < 0.5 μSv/hour near the offline detector

(3) Accident :

< 250 mSv/hour for maximum credible beam

(simultaneous loss of both beams anywhere near IP)

The integrated dose < 1mSv / accident

(4) Remarks

gaps in CMS style assembly and PACMAN at beam line

Conclusions

1. Establishment of ILD model (V.00)
   both for engineering and simulation
2. Engineering studies have been started for LoI.
   - Push-pull operation on a platform
   - Super-conducting coil: uniformity, anti-DID, coil support
   - Iron yoke structures: deformation, gaps, stray fields
   - Support structures of sub-detectors
   - Beam pipes: shape, minimum thickness
   - Support tube system for QD0, Forward CALs
   - Self-shield of radiation accident
3. Background will be re-evaluated.
4. Assembling, opening procedures will be decided.
   Also, check the timeline of 5 years for assembling, test

MDI issues and personnel in ILD

1. platform in the push pull scheme : A.Herve, J.Amann
2. background : A.Vogel
   - minijets (T.Barklow,Jan.04) for positive ion in TPC
   - anti-DID for BCAL as well as TPC background
3. beam pipe : Y.Sugimoto, M.Winter, M.Jore
   - heating : H.Yamamoto, Y.Suetsugu
   - vacuum pump system : Y.Suetsugu
   - engineering design (buckling analysis) : M.Anduze
4. self-shield for radiation in ILD : T.Sanami
5. iron structure : U.Schneekloth, H.Yamaoka, Y.Sugimoto
   - tail catcher - M.Thomson's study
   - CMS style for surface assembly
   - gaps (assembly, cables, cooling pipes) and stray field

6. solenoid; 3.5T operation but design at 4T

: F. Kircher, H. Yamaoka (cryostat, coil support)

- strong coil support for the push pull
- coil design for stability
- uniformity

7. anti-DID : B. Parker, Y. Iwashita for passive anti-DID

8. support of final quadrupole magnets, forward calorimeters :

H. Yamaoka, M. Jore

9. assembling/installation and maintenance method :

Y. Sugimoto, H. Yamaoka, U.Schneekloth, H. Videau

- period - 5 years as in the RDR

10. option in machine parameters : K.Buesser, H.Videau, T.Tauchi

- new Low-P
- L*= 7 -8 m