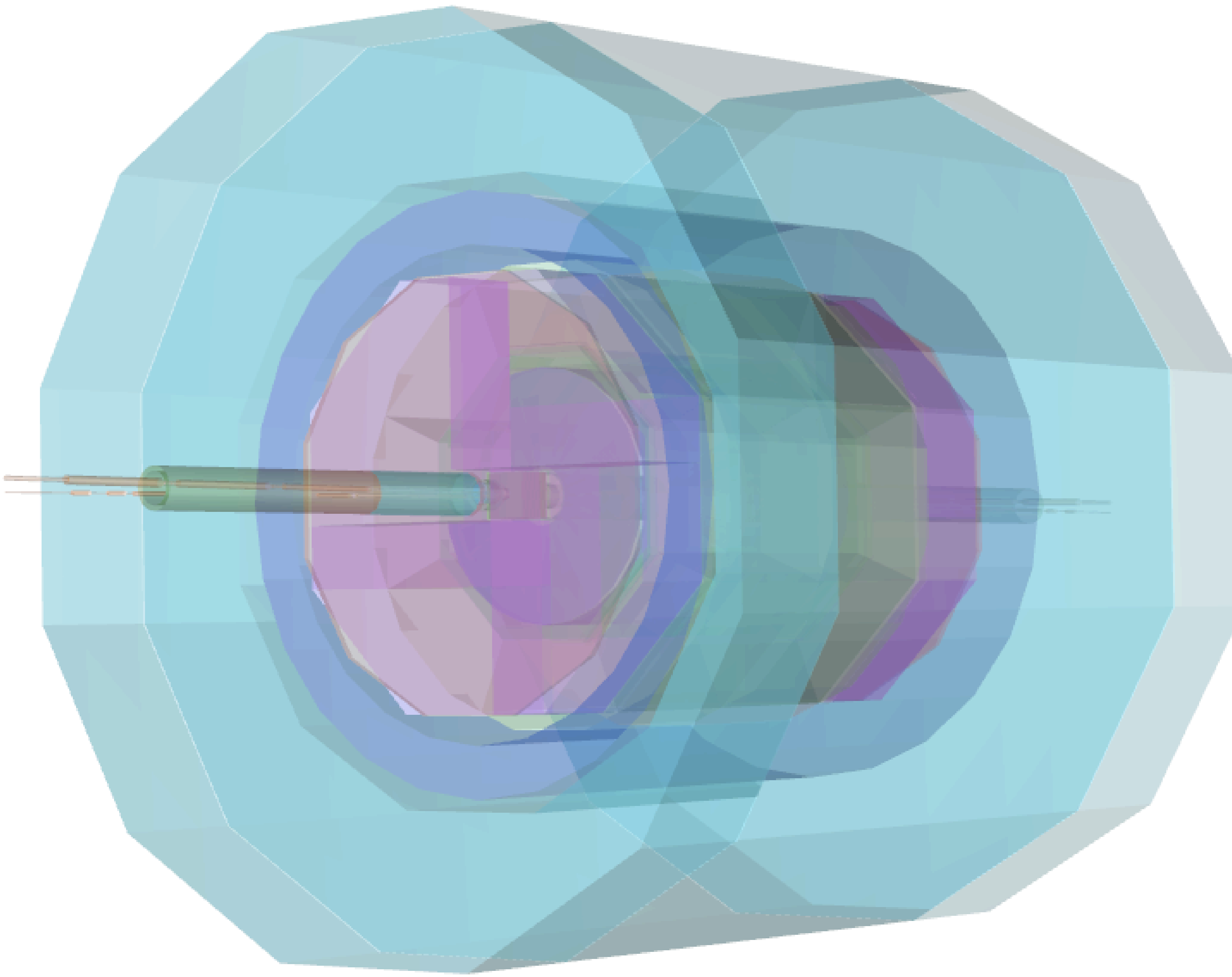
Status of ILD Detector MDI work

T. Tauchi,

LCWS2008, UIC, Chicago, 17 November 2008

ILD00 - Mokka 3D model for simulation



Overall size : 8.88m in diameter, 8.09m in total length (Tentative, Nov.08)

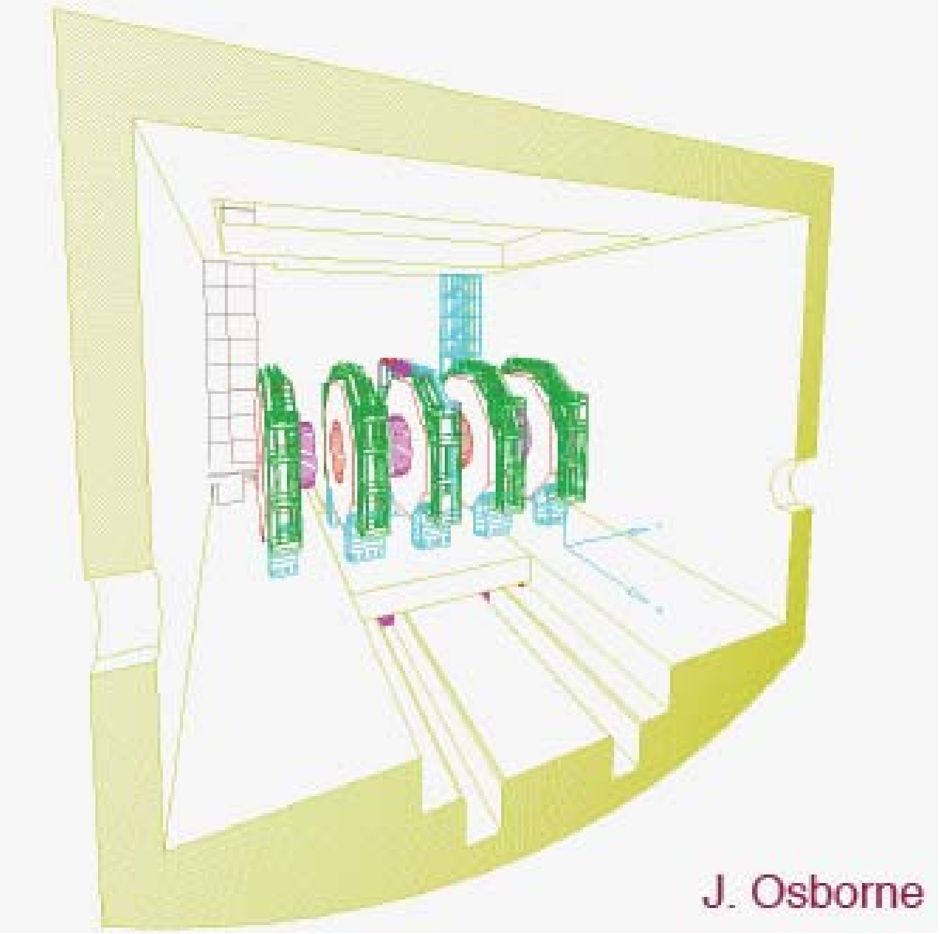
MDI issues in ILD

1. platform in the push pull scheme : A.Herve, John
2. background : Adrian
   - minijets (T.Barklow,Jan.04) for positive ion in TPC
   - anti-DID
3. beam pipe : Sugimoto, Suetsugu, M.Winter, FCAL-collab.
   - heating
   - vacuum pump system
   - passive anti-DID option
   - engineering design
4. self-shield for radiation in ILD : Sanami
5. iron structure : Uwe, Yamaoka
   - tail catcher - M.Thompson's study
   - CMS style for surface assembly
   - gaps (assembly, cables, cooling pipes) and stray field

Push Pull

- Platform
  - Would make movement of detector easier
  - Need ~2m deeper hall (quite expensive)
  - So far no work on-going within ILD
  - Preliminary work at SLAC on stability and strength of platform on hold
  - Will assume platform for LOI
  - Check whether detector design is compatible with no platform
- Concern by F. Kircher
  - Vibrations may destroy coil titanium support structures. Need careful design

    -> previous talk



Vertex Detector – Results

Hits on the vertex detector

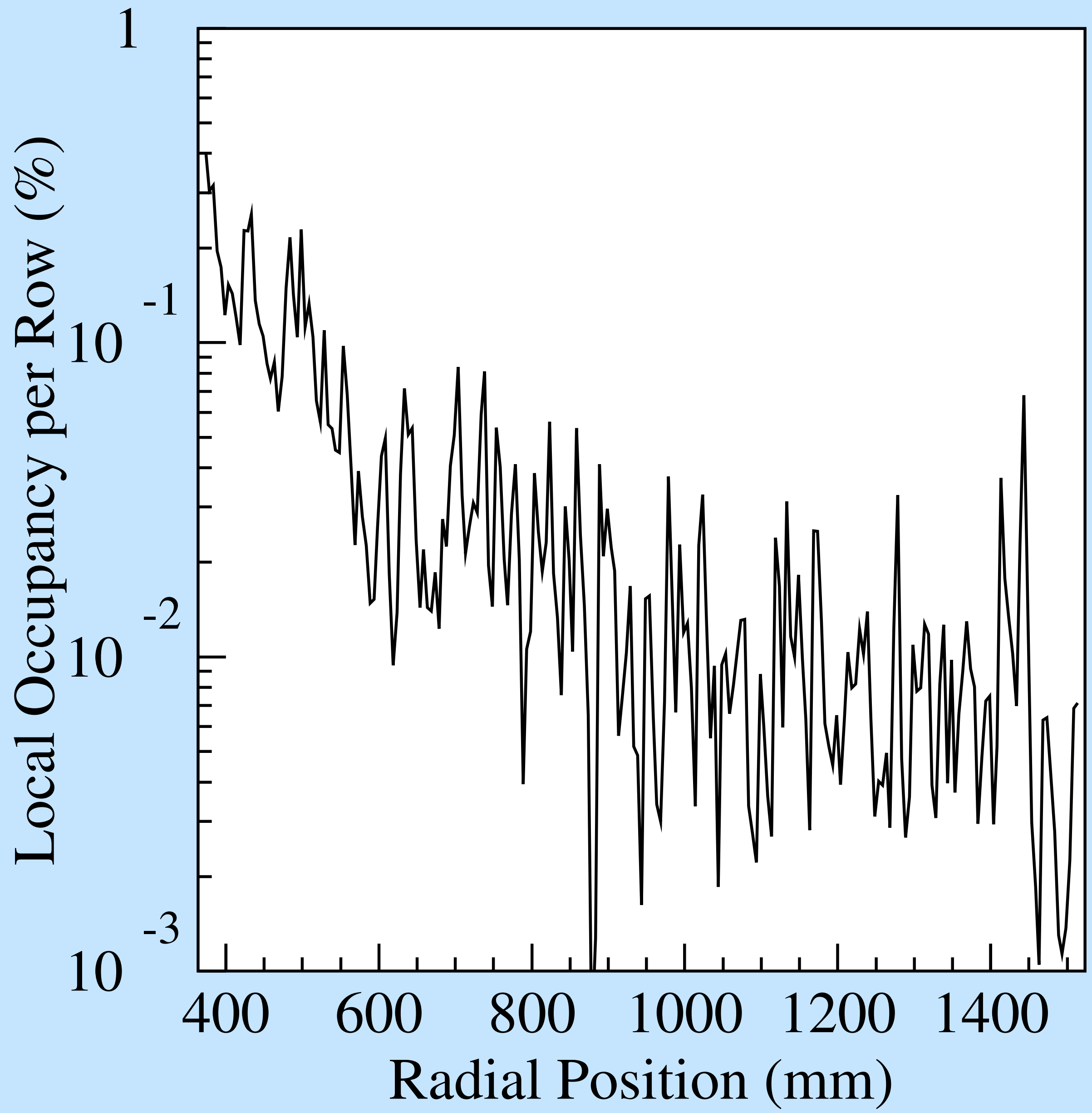
- innermost layer has 400–800 hits / BX
- most hits direct, but also from backscatterers
- background levels drive the VTX design
- resulting backgrounds are still manageable

Neutron fluence in the vertex detector

- extrapolation from 100 BX to 500 fb^{-1} total run time
- energy-dependent weighting of neutrons (NIEL model)
- fluence (10^8 n / cm^2) is uncritical for all layers

TPC – Occupancy

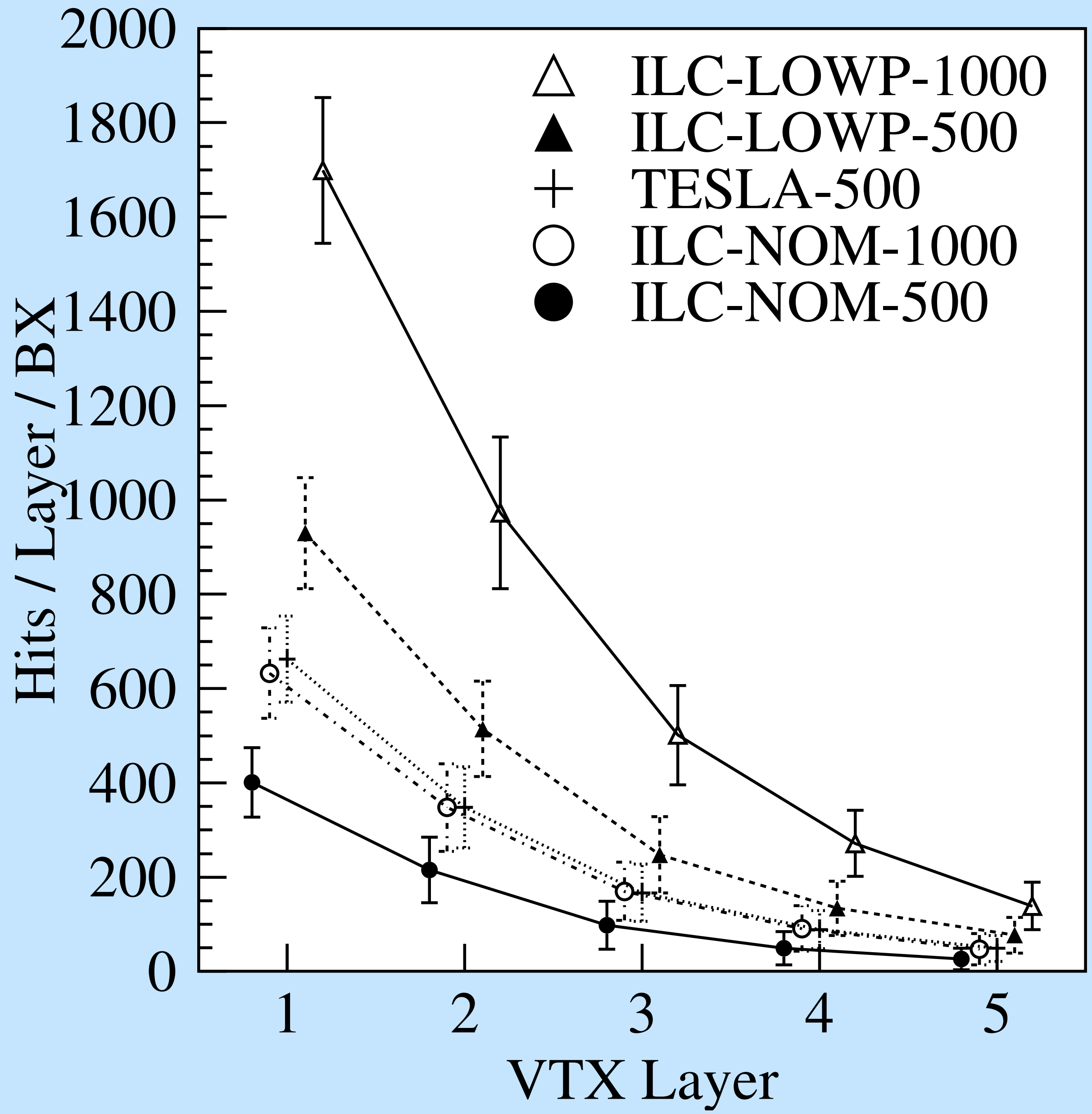
- highest occupancies at small radii
- overall value stays very well below 1 %
- outside-in tracking always possible
- n-p scattering gives negligible contribution
- backgrounds will be no problem for the TPC



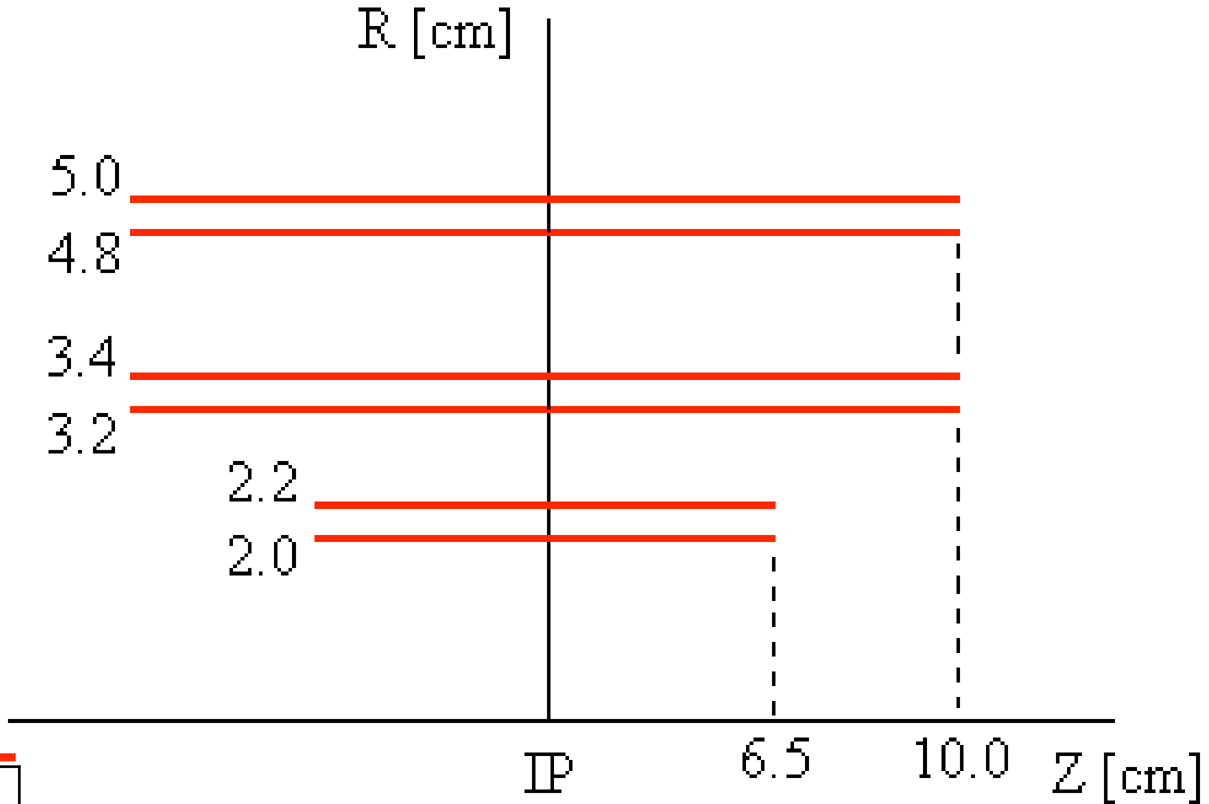
Overlay of 100 BX

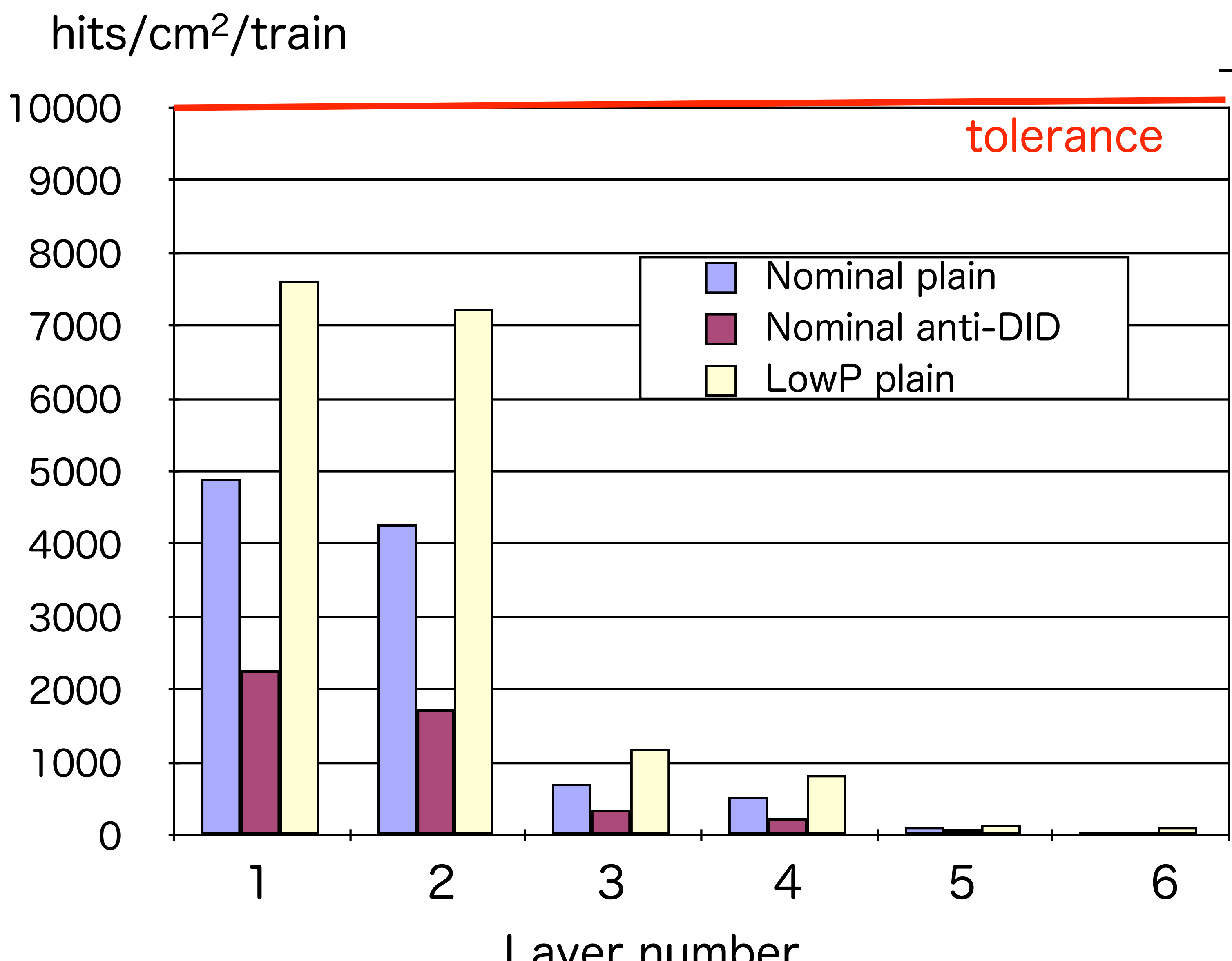
ILC Beam Parameters – Backgrounds

- "Low Power" option:
  2.5 times more hits
- But: half the number
  of bunches per train
- Integrated backgrounds
  (over a fixed time)
  do not change much
- Upgrade to 1000 GeV:
  2 times more hits



VTX hit distribution



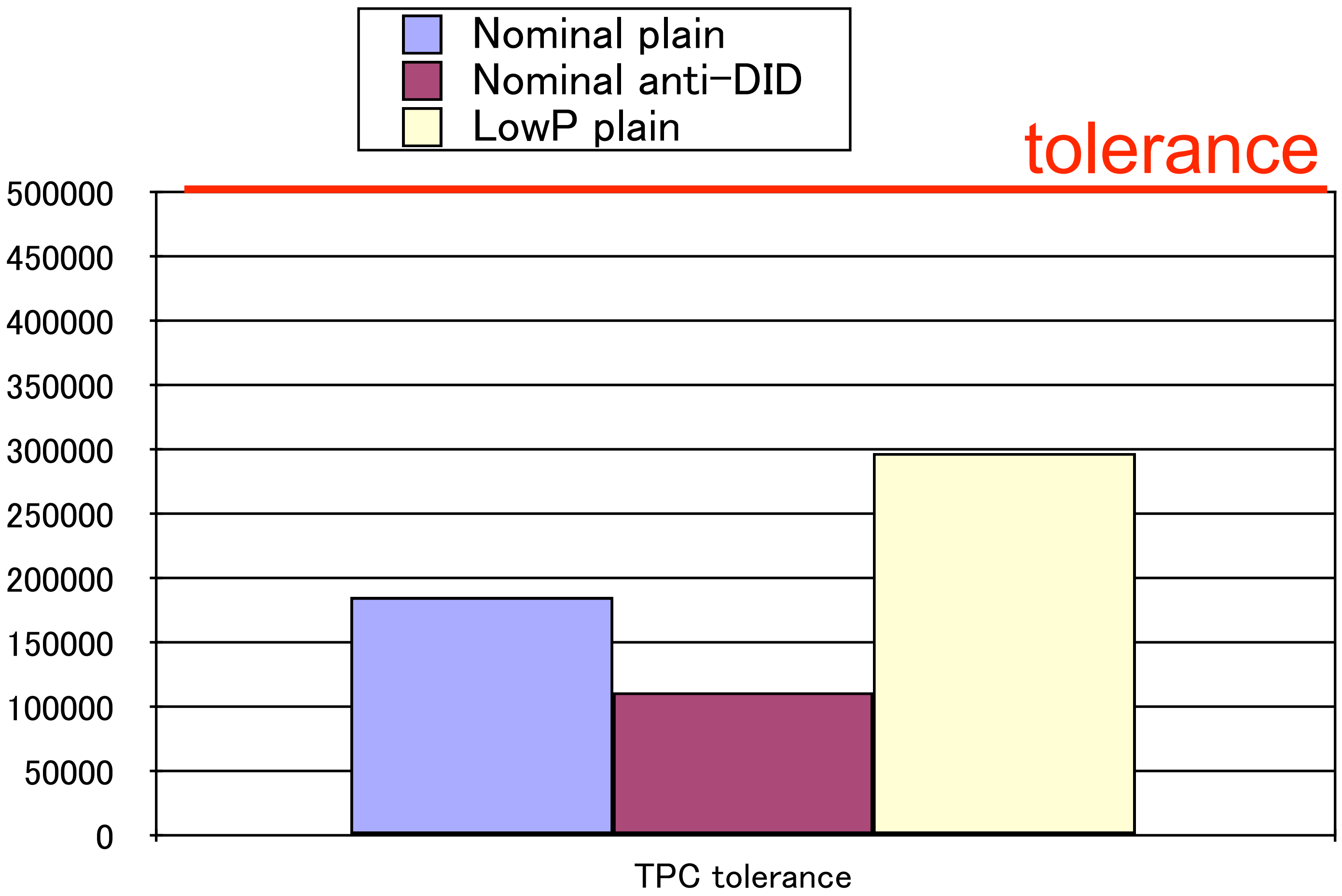


Nominal plain:20bunch

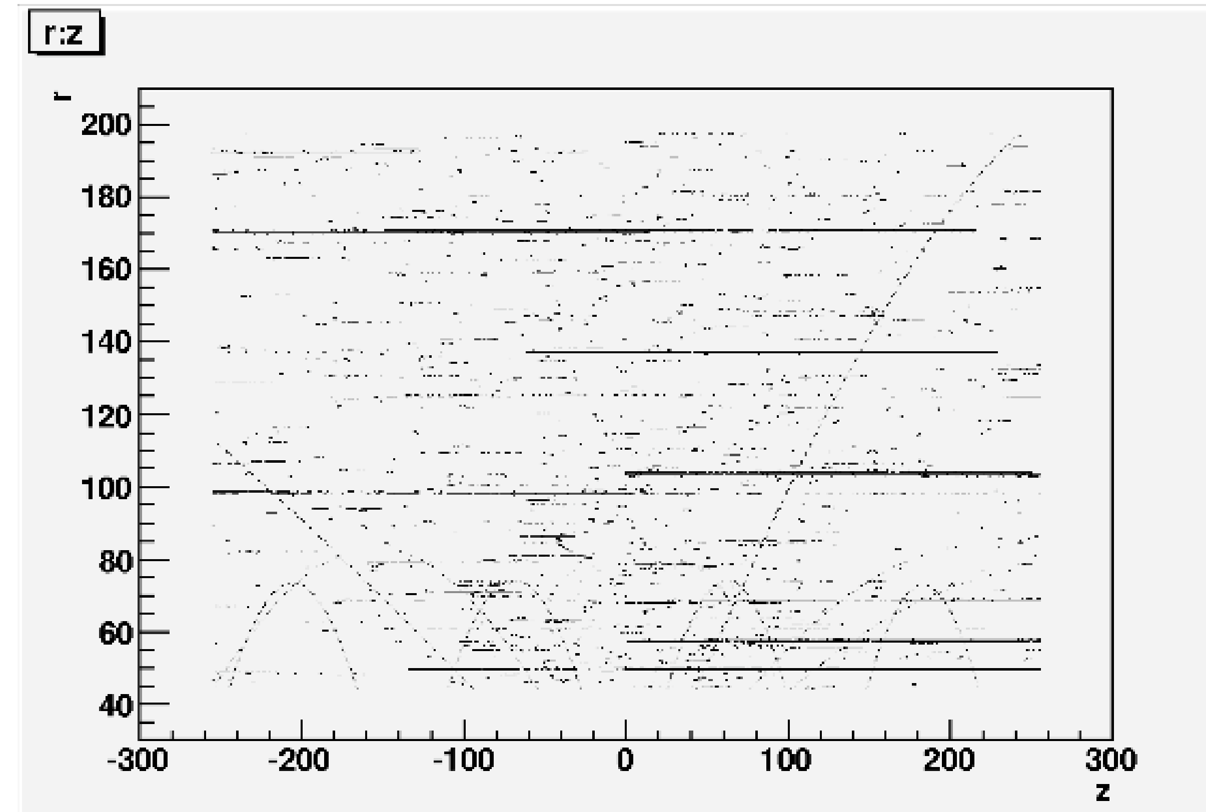
Nominal anti-DID:10bunch

Low P plain:1bunch

TPC hit



TPC digital hits

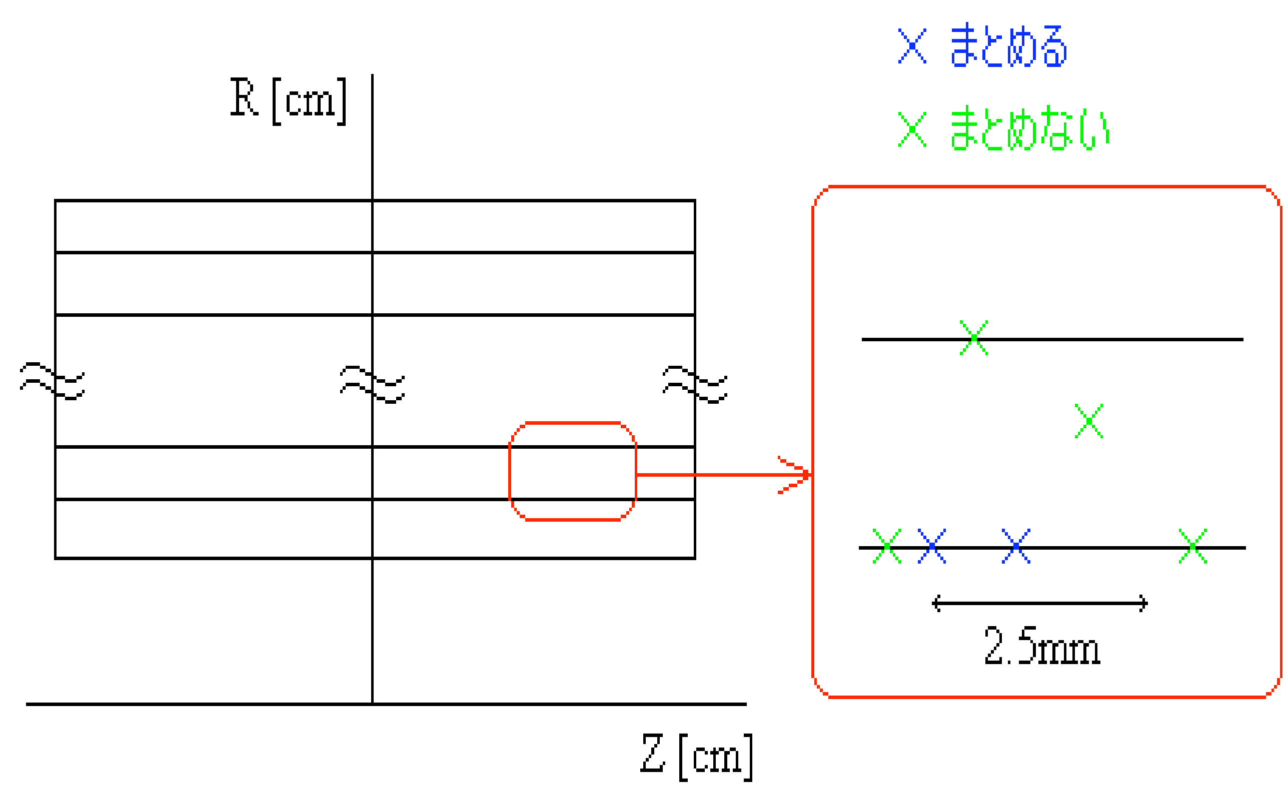


TPC Exact hits

Nominal plain:20bunch

Nominal anti-DID:10bunch

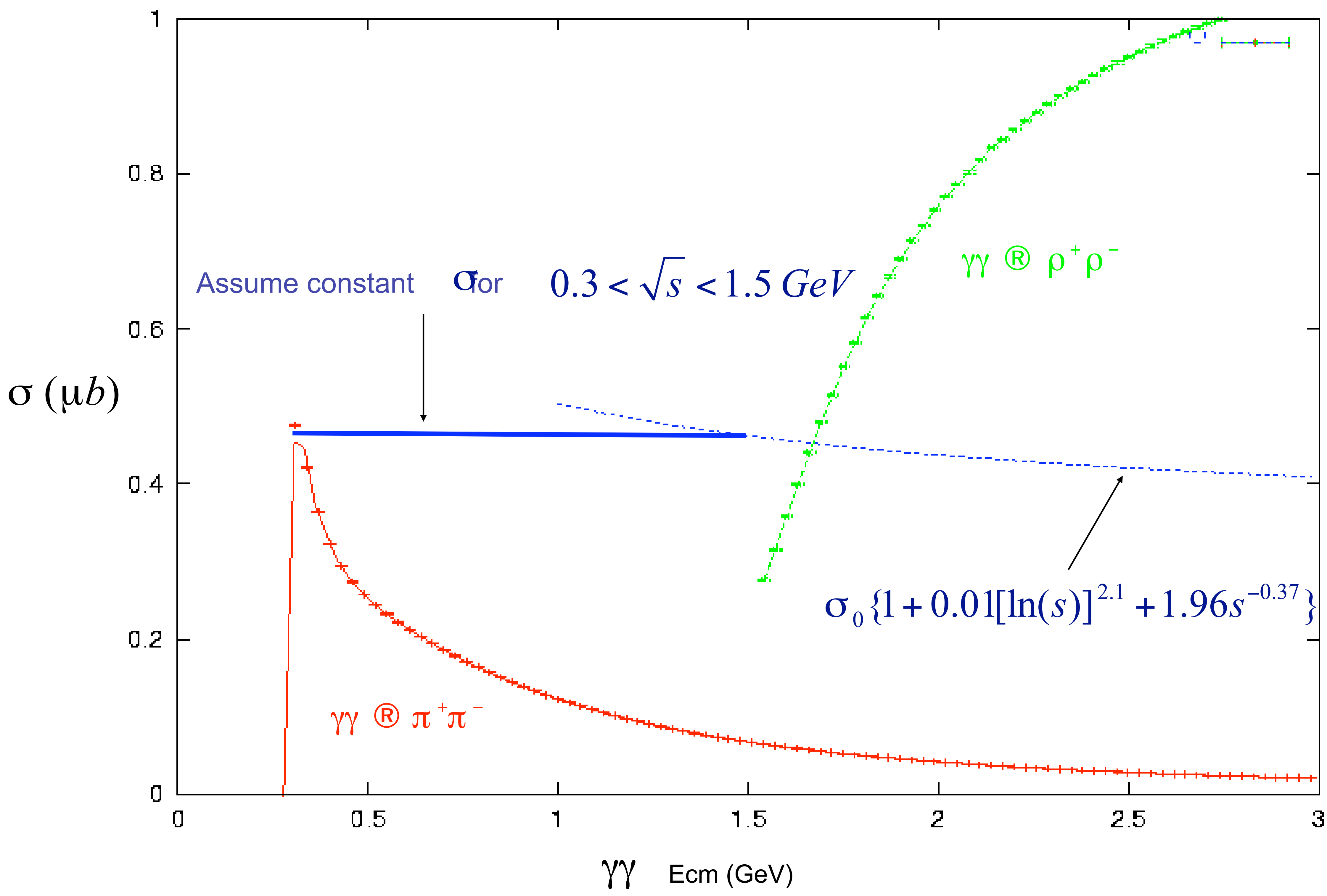
Low P plain:1bunch



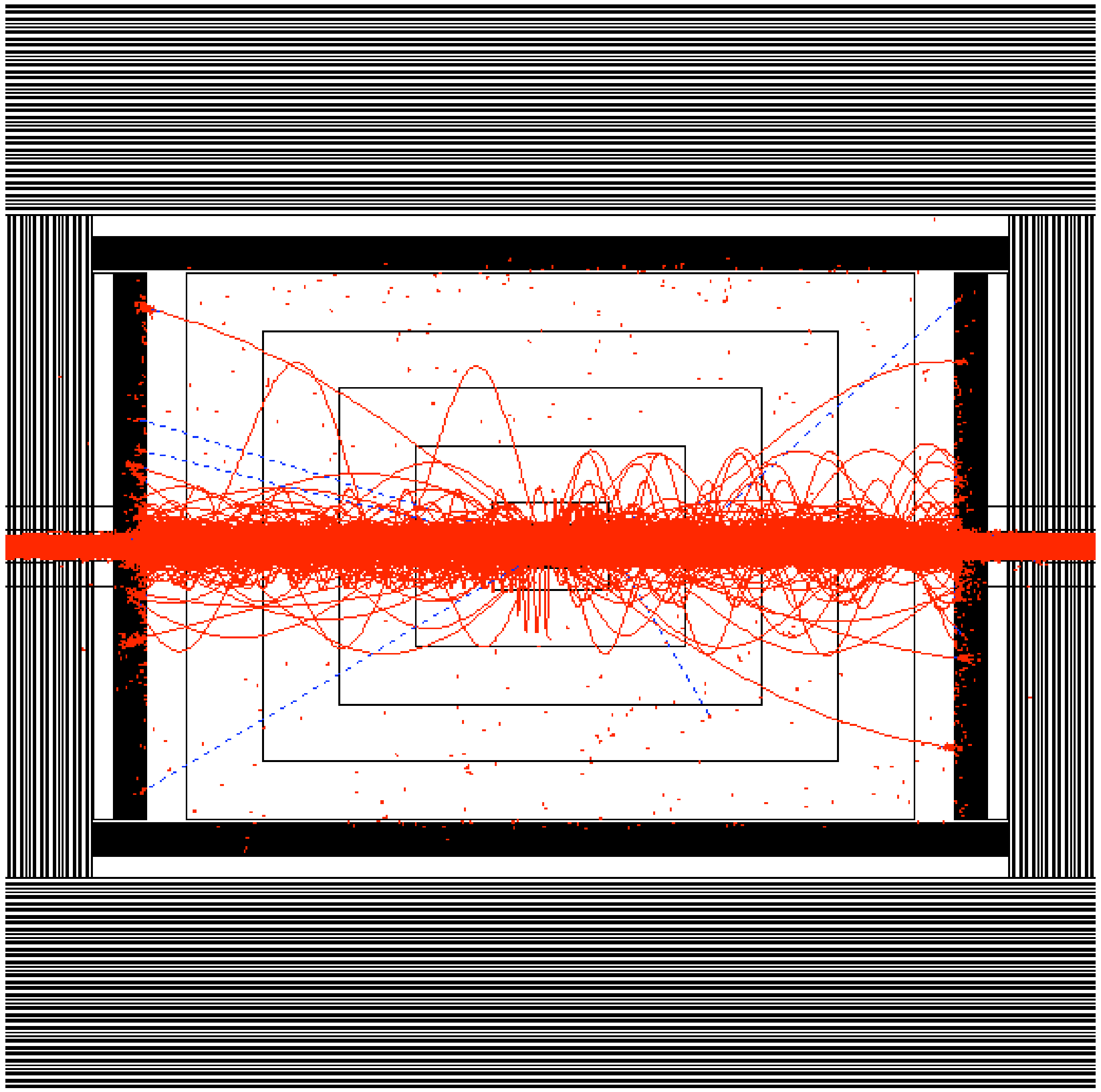
Update on $\gamma\gamma$ ® *hadrons* Calculation

Tim Barklow
SLAC

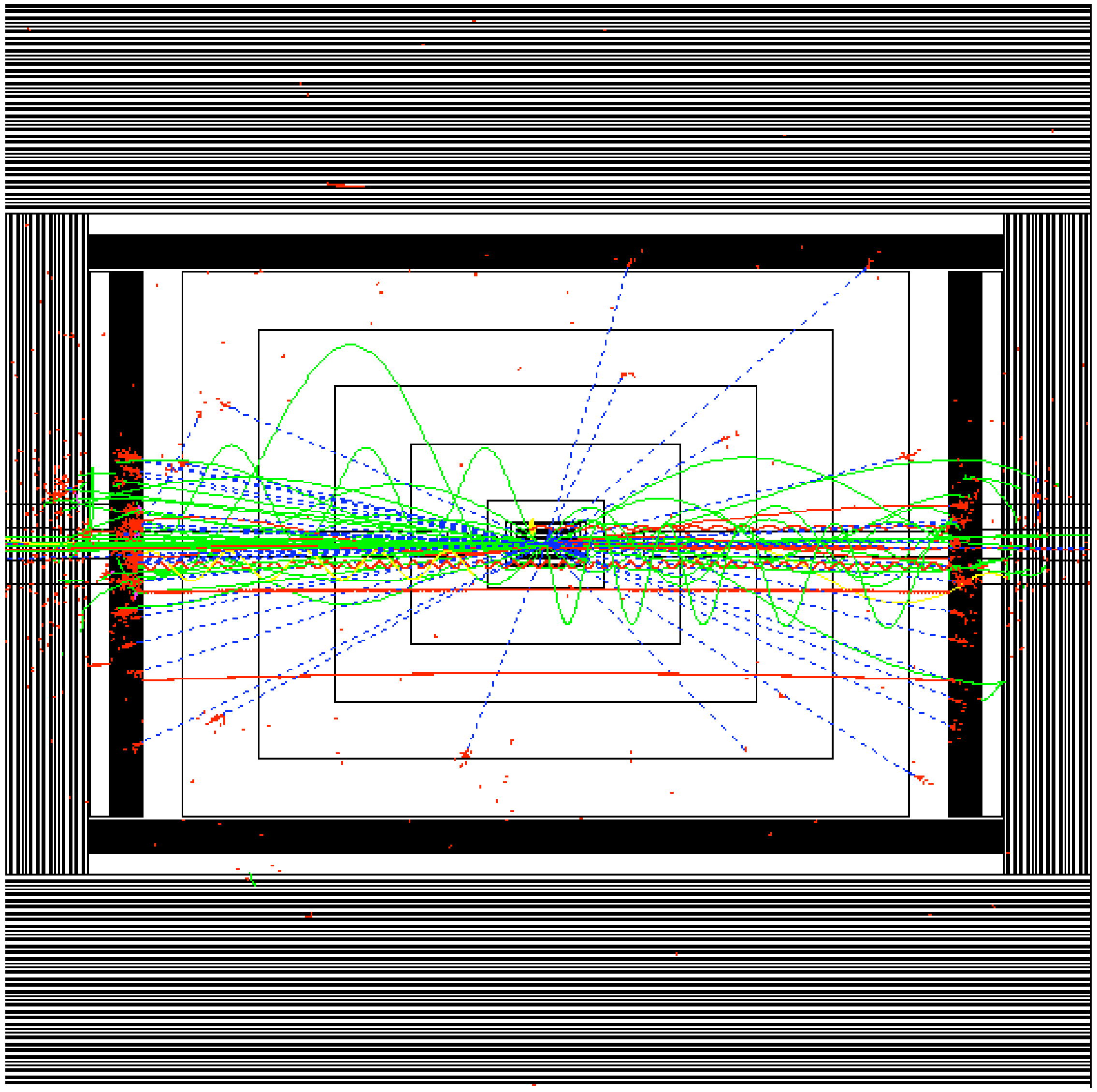
January 8, 2004



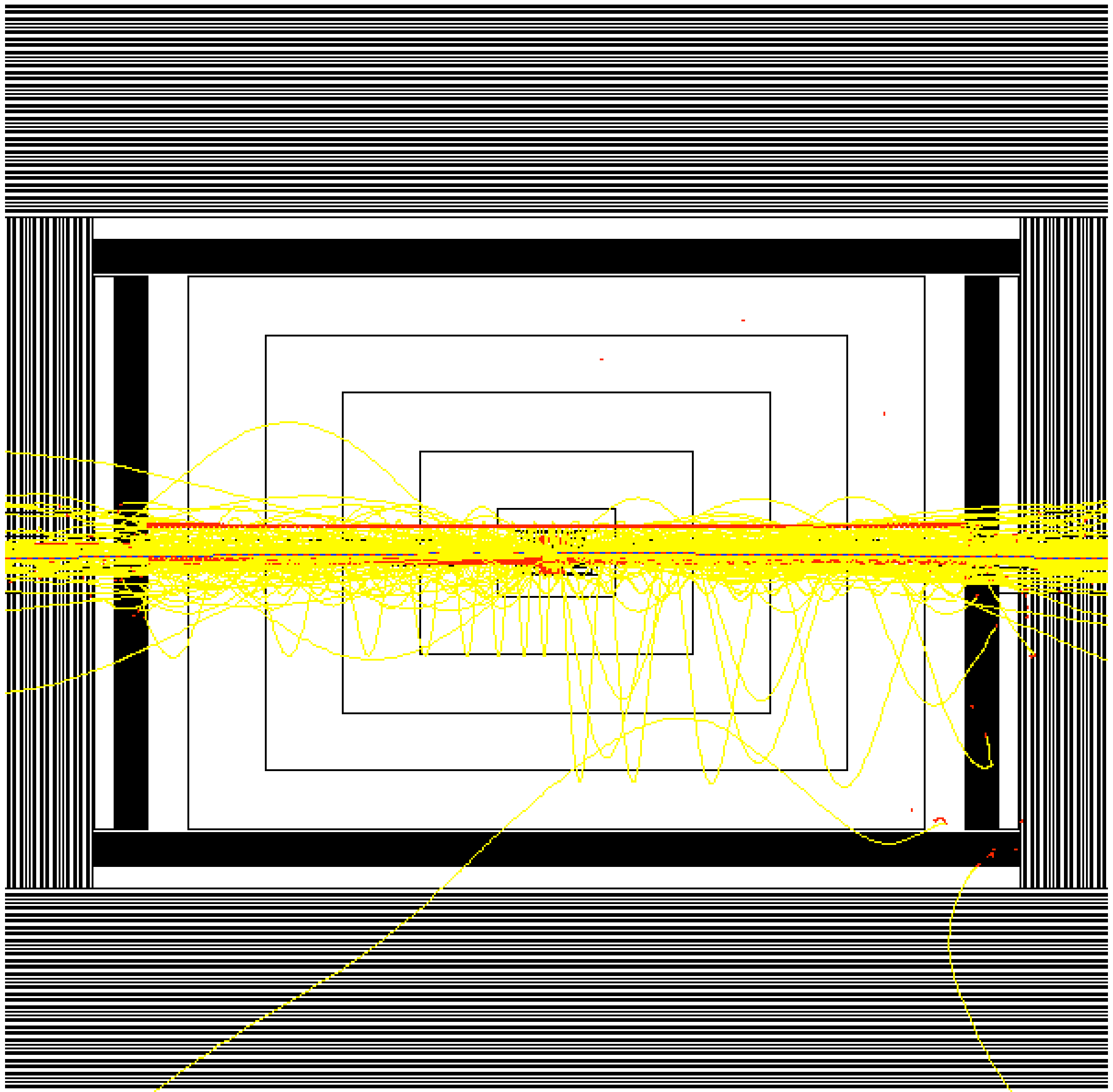
Assume constant σ for $0.3 < \sqrt{s} < 1.5\ GeV$
γγ ® ρ⁺ρ⁻
γγ ® π⁺π⁻
$\sigma_0\{1 + 0.01[\ln(s)]^{2.1} + 1.96 s^{-0.37}\}$
σ (μb)
γγ Ecm (GeV)
0
0.2
0.4
0.6
0.8
1
0
0.5
1
1.5
2
2.5
3



$8600\ e^+e^-$ pairs / train strike detector



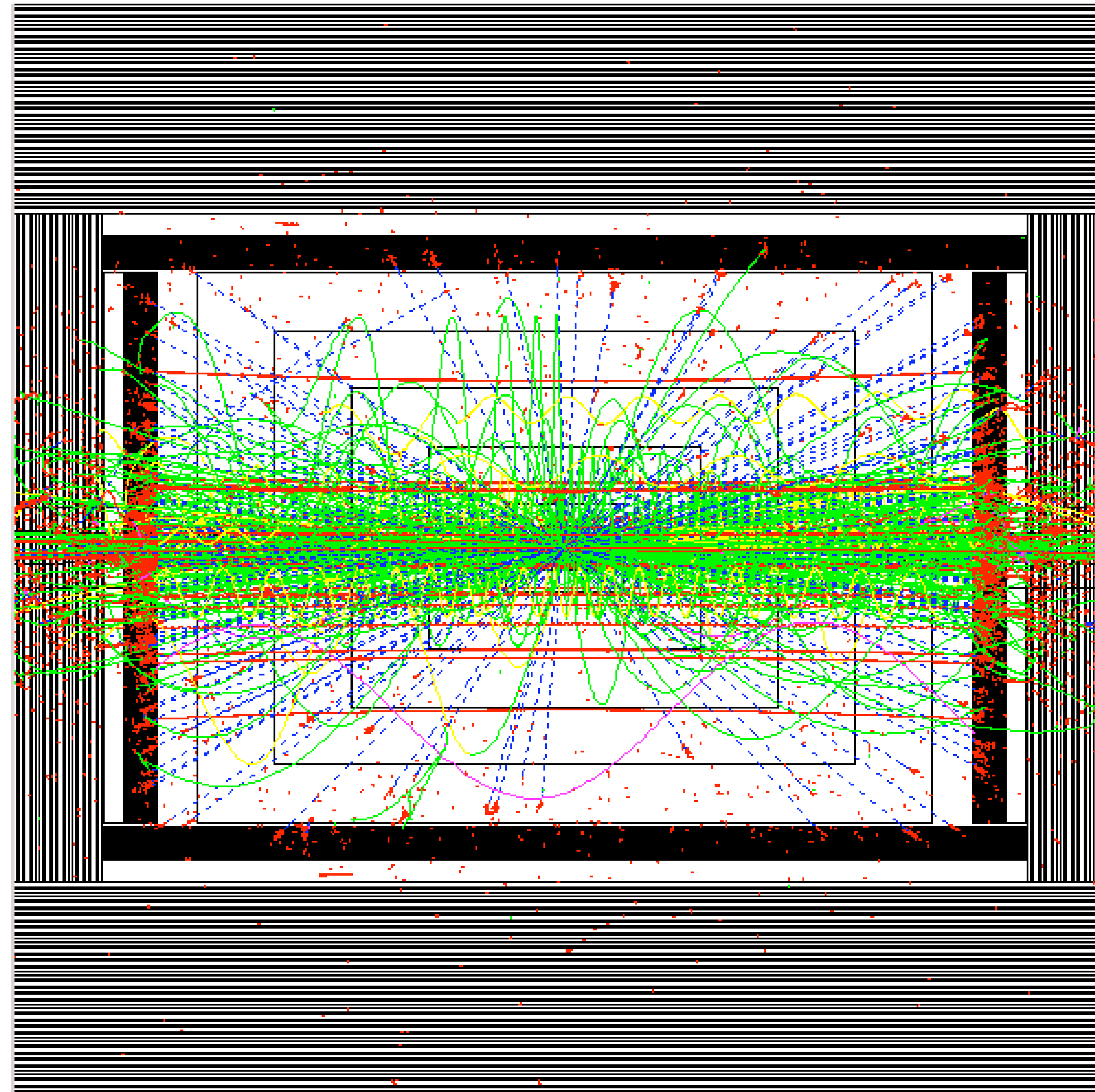
1.8 hadronic events / train with pt>2.2GeV
(TESLA TDR definition of hadronic bkgnd)
79 GeV / train detected energy
14.6 detected charged tracks / train



$154\ \mu^+\mu^-$ pairs / train

56 GeV / train detected energy

24 detected charged tracks / train



56 hadronic events / train

no pt cut; Ecm down to $\pi^+\pi^-$ threshold

454 GeV / train detected energy

100 detected charged tracks / train

Pressure profile

- Pumps
  - **NEG strip : ST707 (SAES Getters), for ex.**
  - **Aligned at the circumference of pipe**

4m NEG strip in total

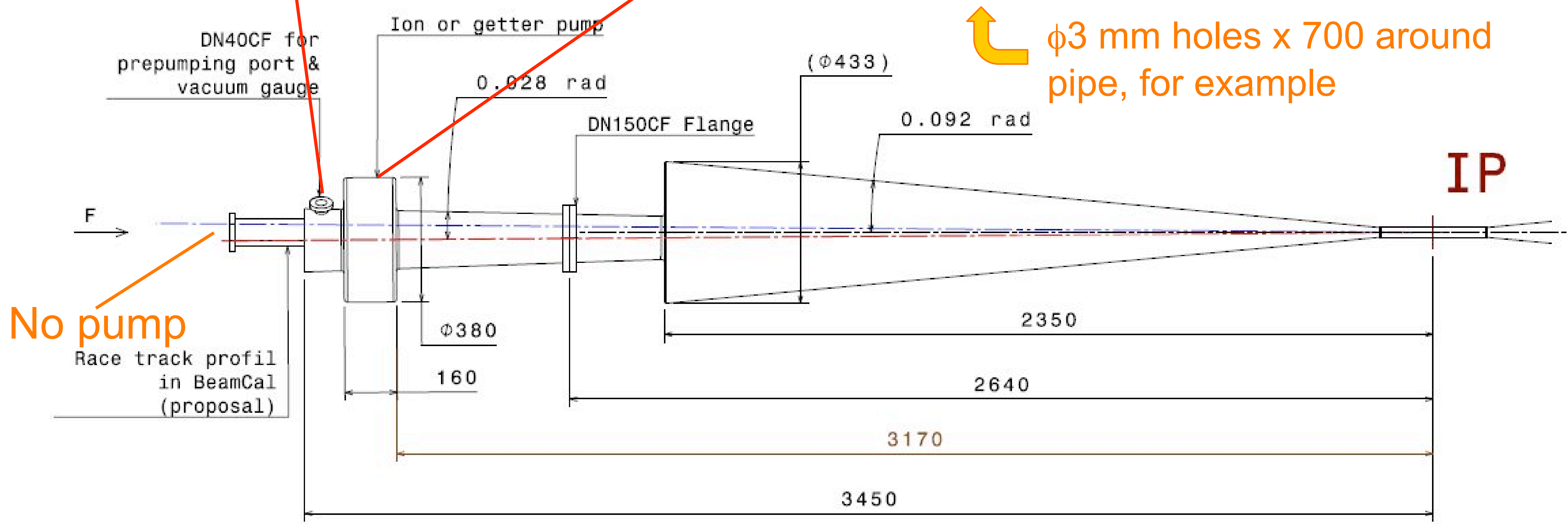
S_{eff} =

To a small ion pump (and rough pumps)

CO: 0.2 m^3/s, C = 0.3 m^3/s → 0.12 m^3/s

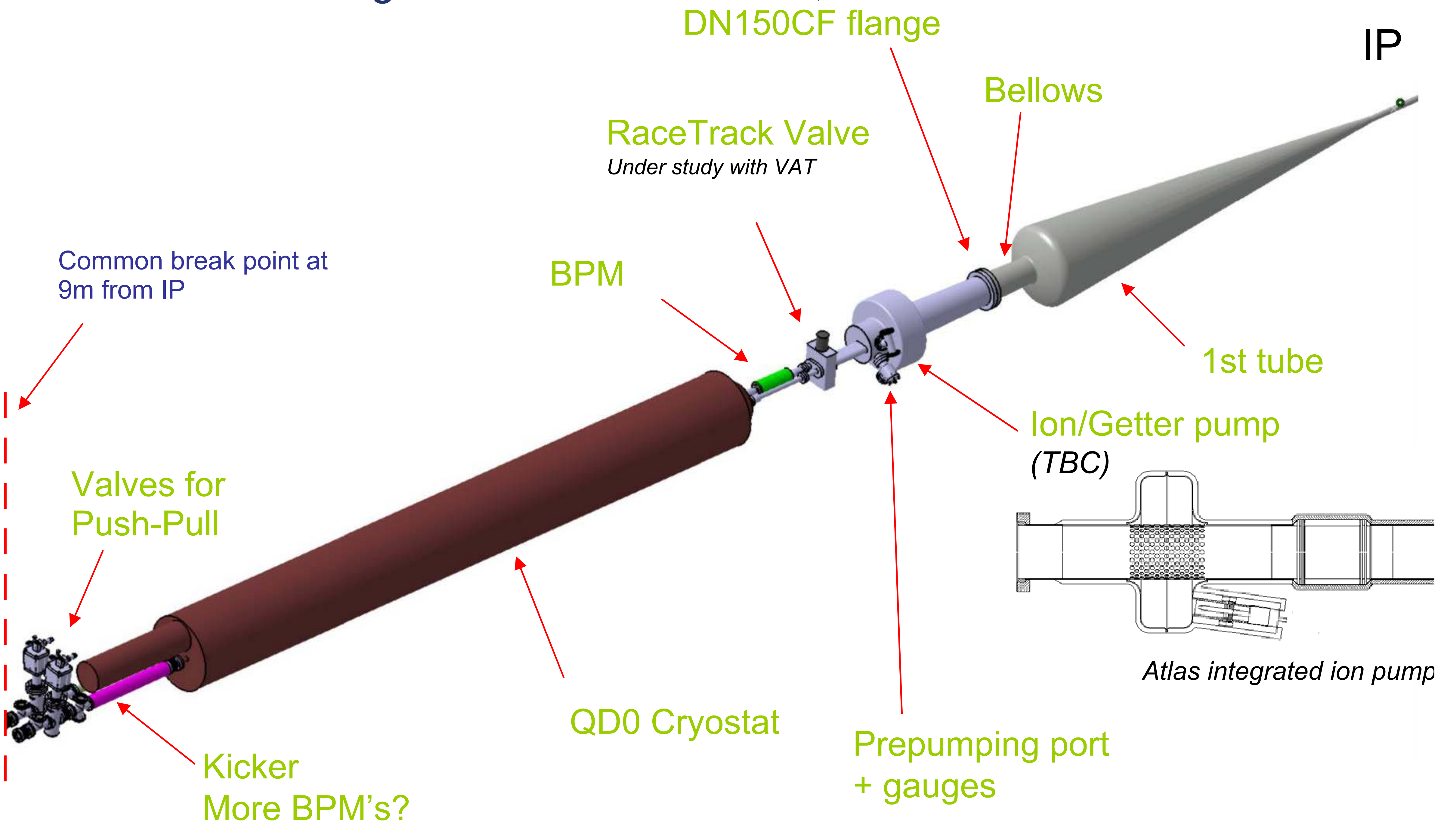
H_2: 2 m^3/s, C = 1.1 m^3/s → 0.72 m^3/s

ϕ3 mm holes x 700 around pipe, for example



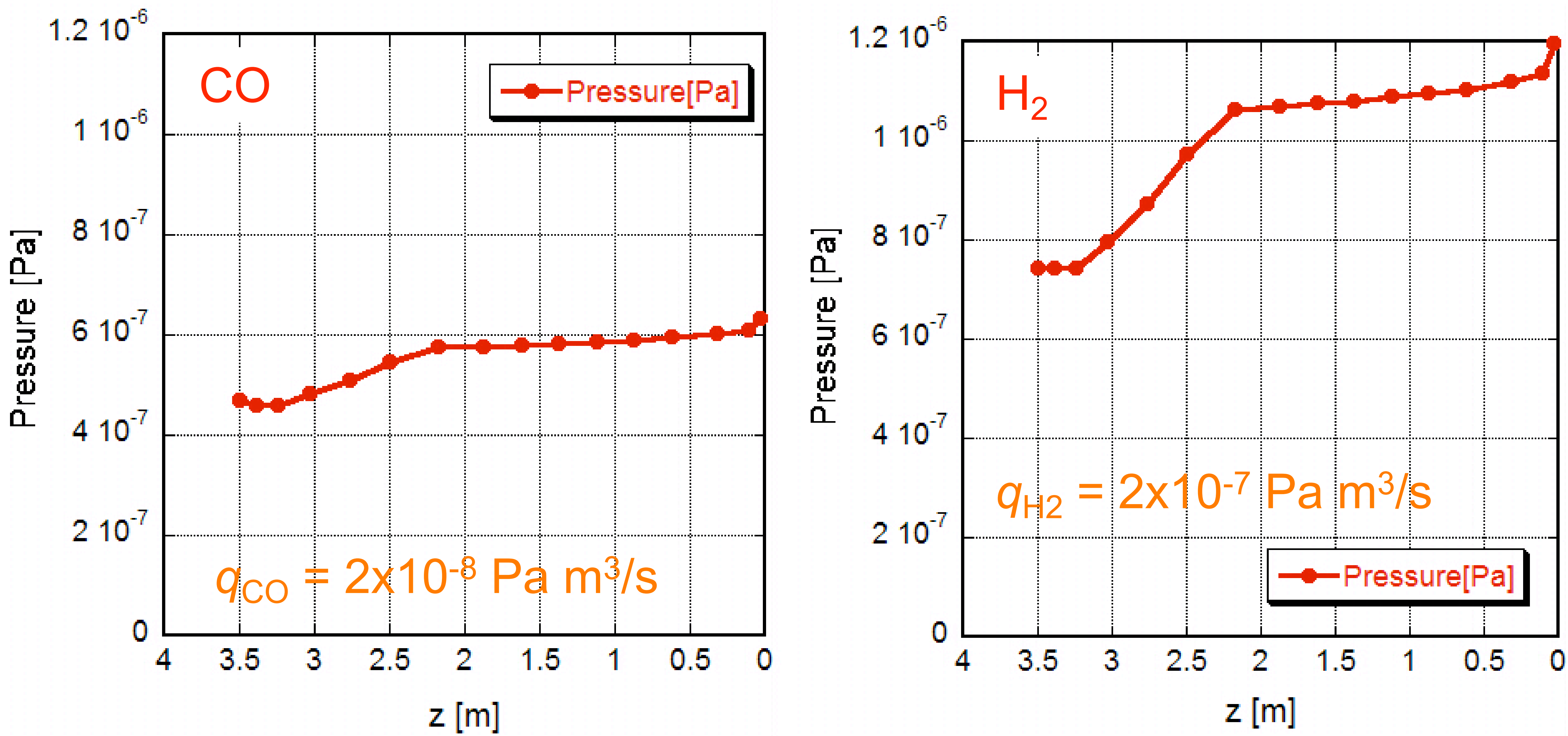
Beampipe Engineering Design

- Beam line design for 14mrad and L* 4,5m



Pressure profile

- Results

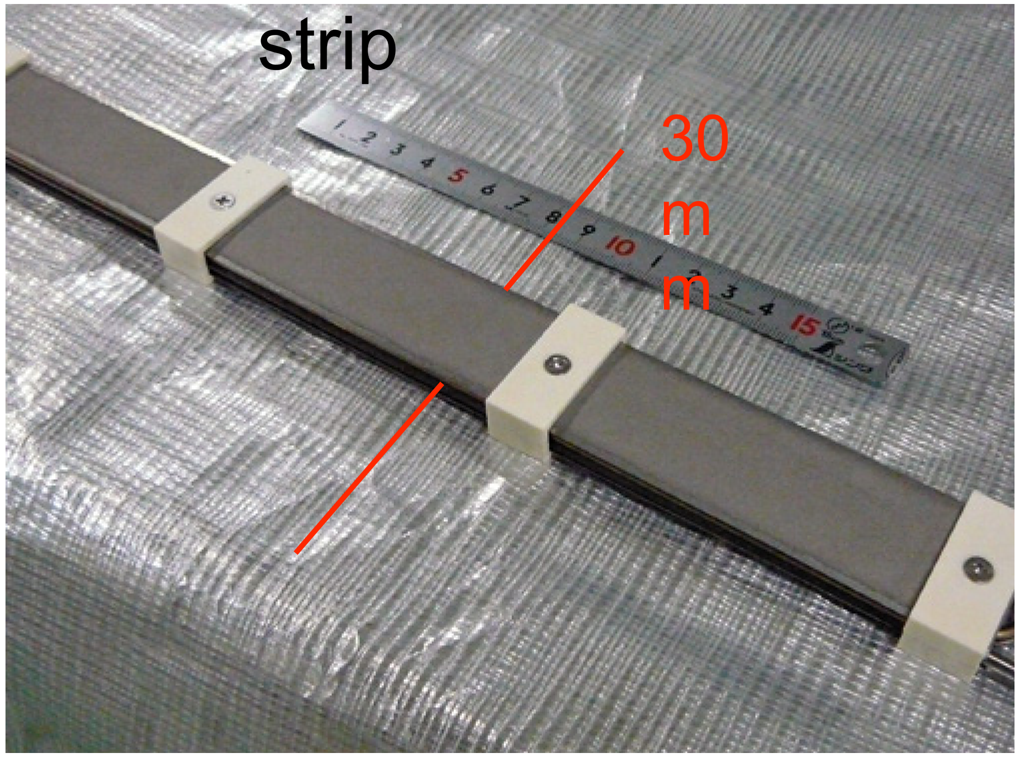


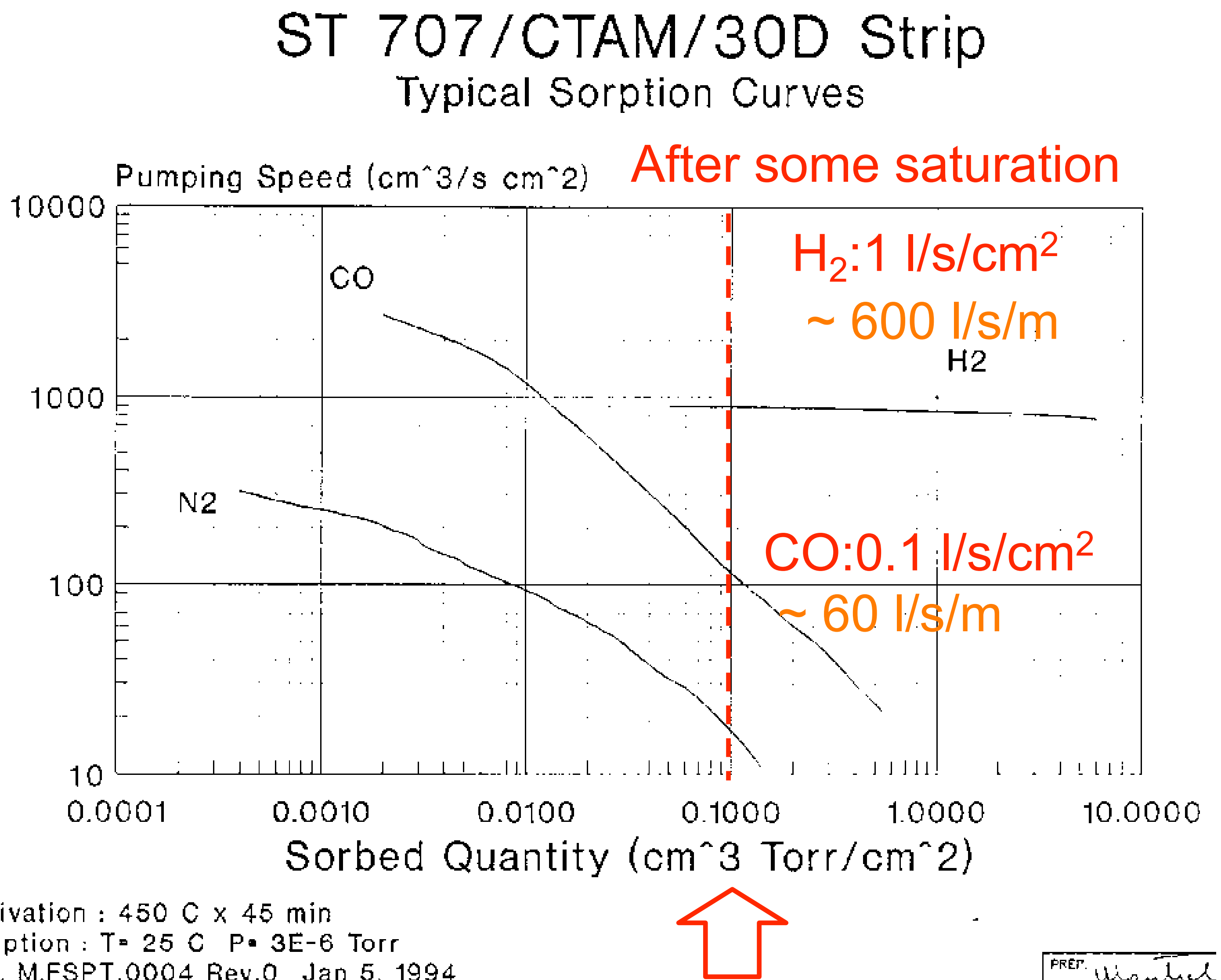
P ~ 1x10^{-6} Pa for H_2.

The assumed pumping speed is the minimum.

- Assumptions
  - **Distributed pumping to effectively evacuate these conductance-limited beam pipes**
  - **Use NEG strip : ST707 (SAES Getters), for ex.**

St707 NEG strip





Radiation Shield of Detector

(1) Self-shielded or additional local fixed/movable shielding wall

(2) Nominal operation : < 0.5 μSv(0.05 mrem)/hour near the offline detector

(3) Accident case :

< 250 mSv(25rem)/hour for maximum credible beam

(simultaneous loss of both beams anywhere near IP)

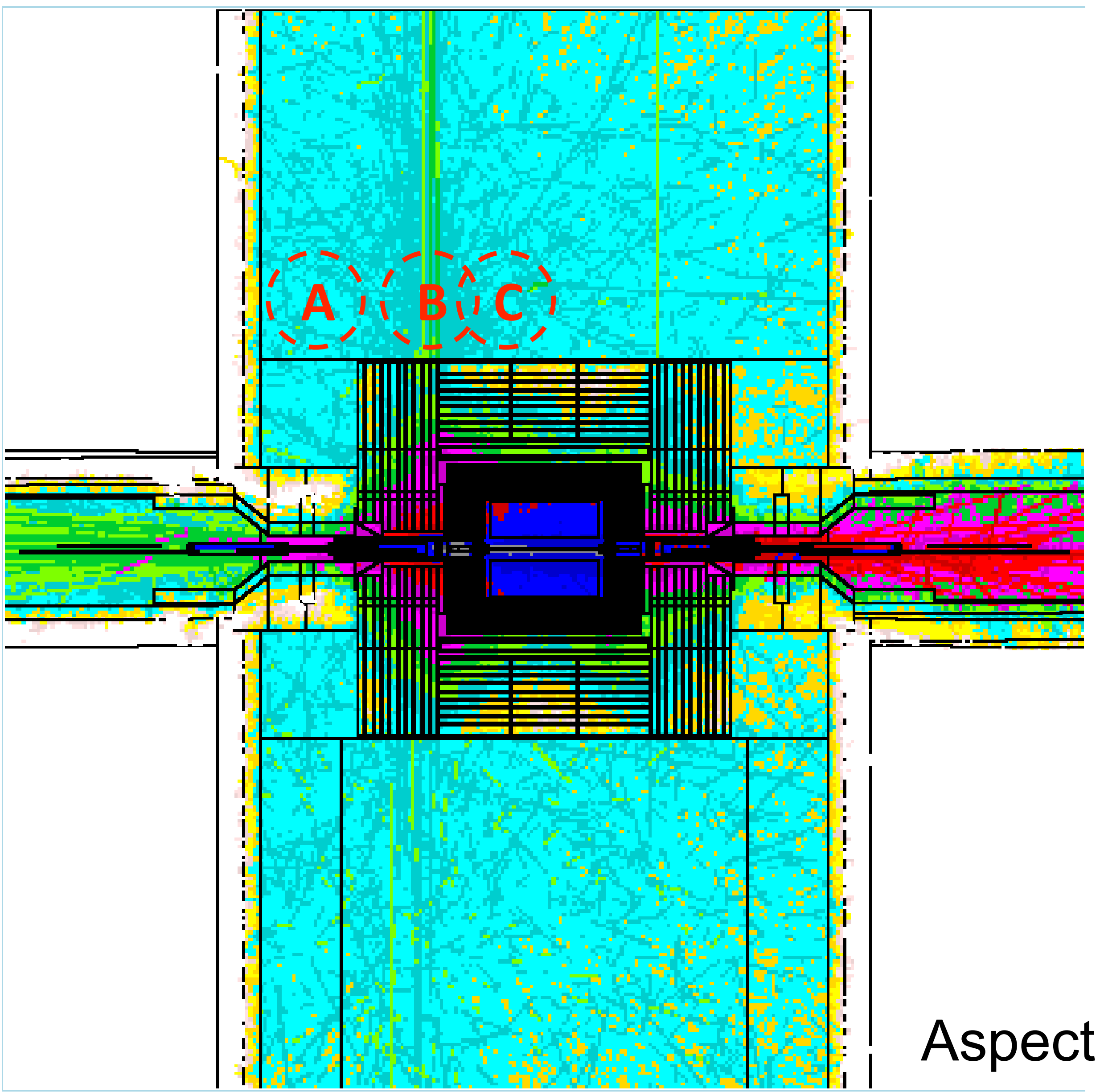
The integrated dose < 1mSv(100mrem) / accident

(4) Remarks

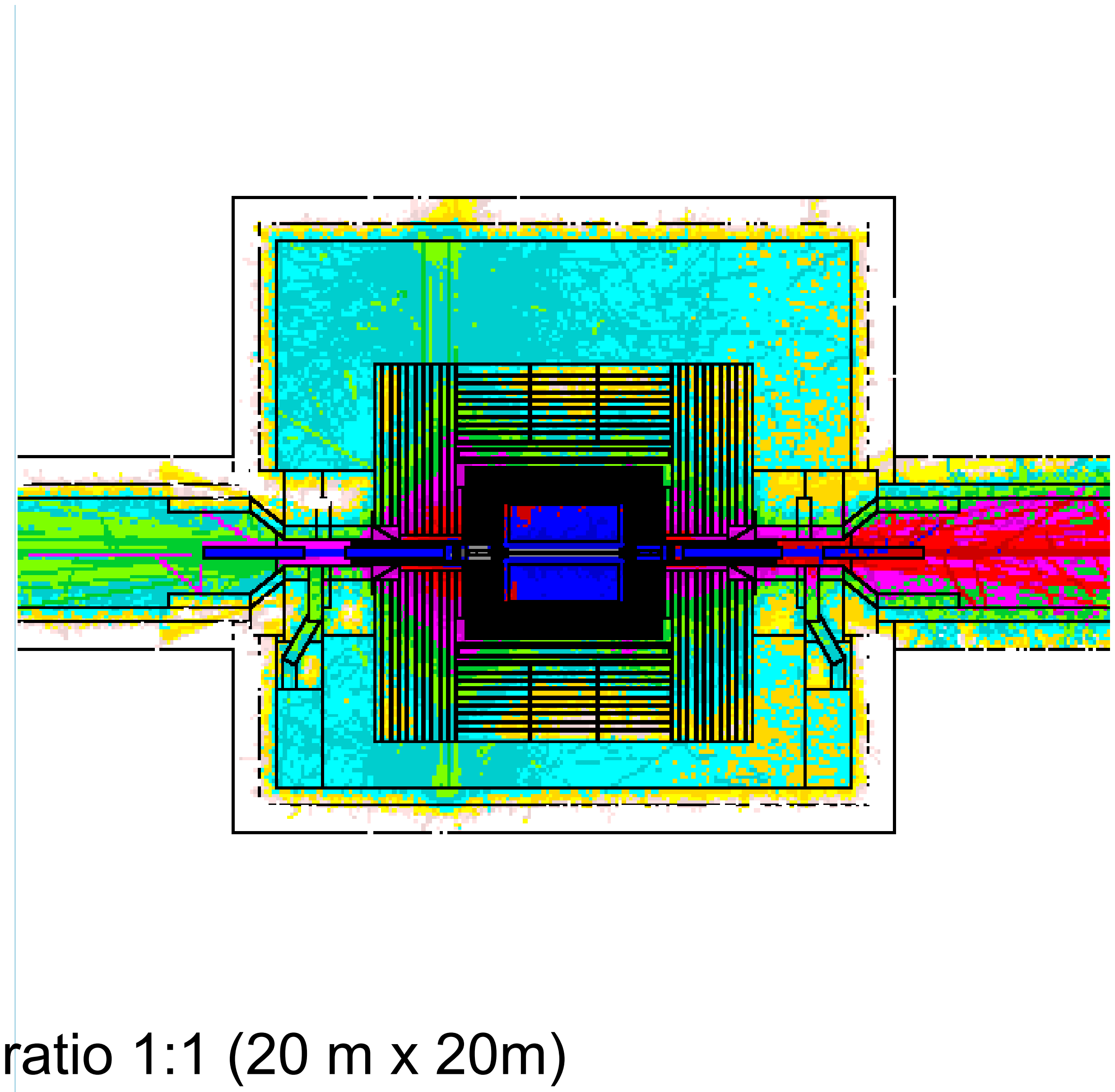
gaps in CMS style assembly and PACMAN at beam line

Result of dose rate evaluation in IR hall

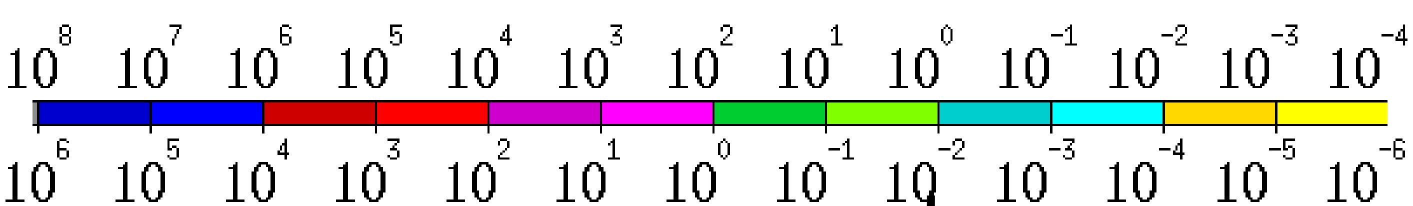
Plan view



Elevation view



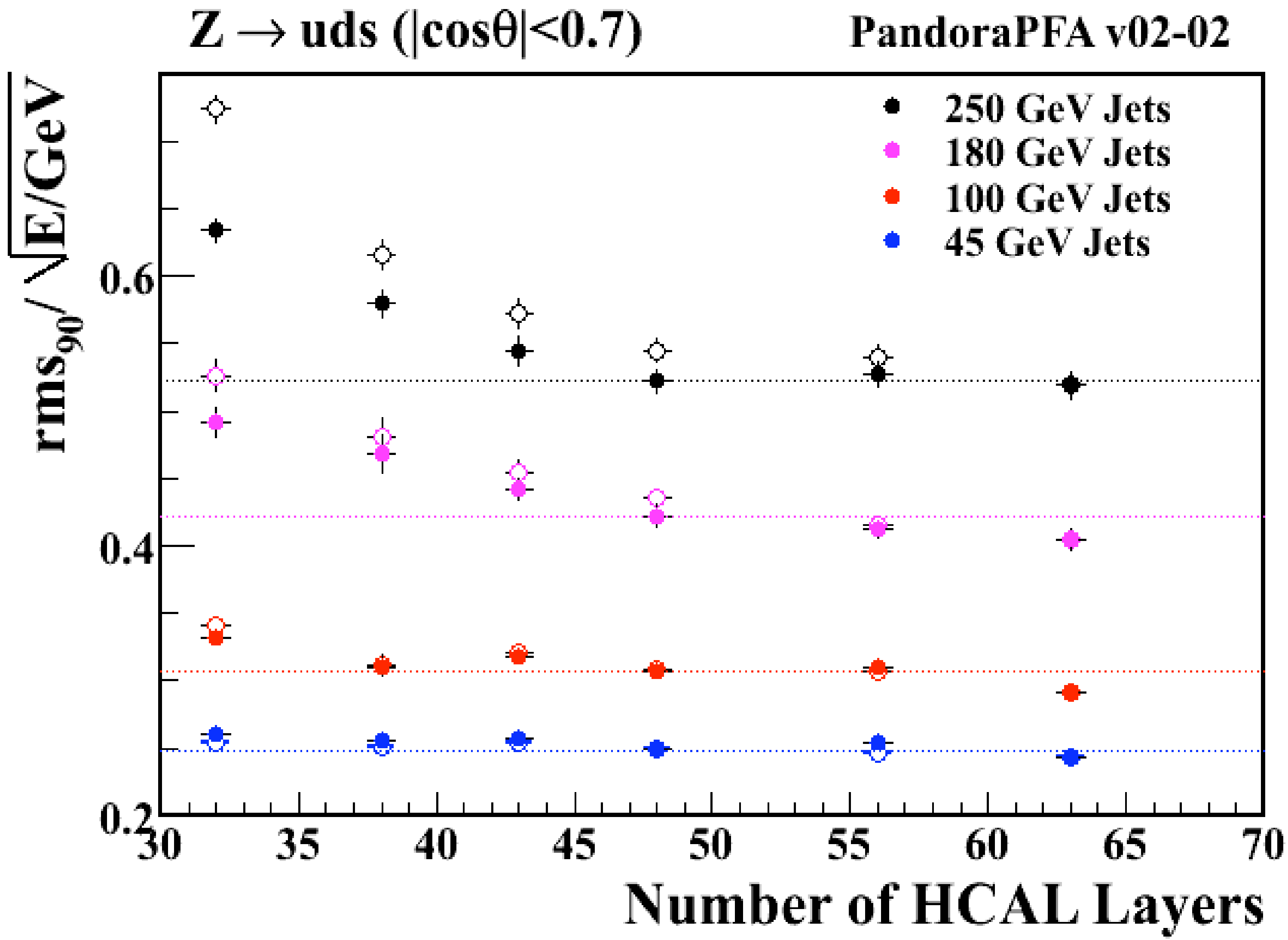
Aspect ratio 1:1 (20 m x 20m)



1.39×10^{-2} [mSv/h/kW] (250mSv/h / 18 MW)

HCAL Depth Results

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



HCAL Layers	λ_I HCAL	λ_I +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

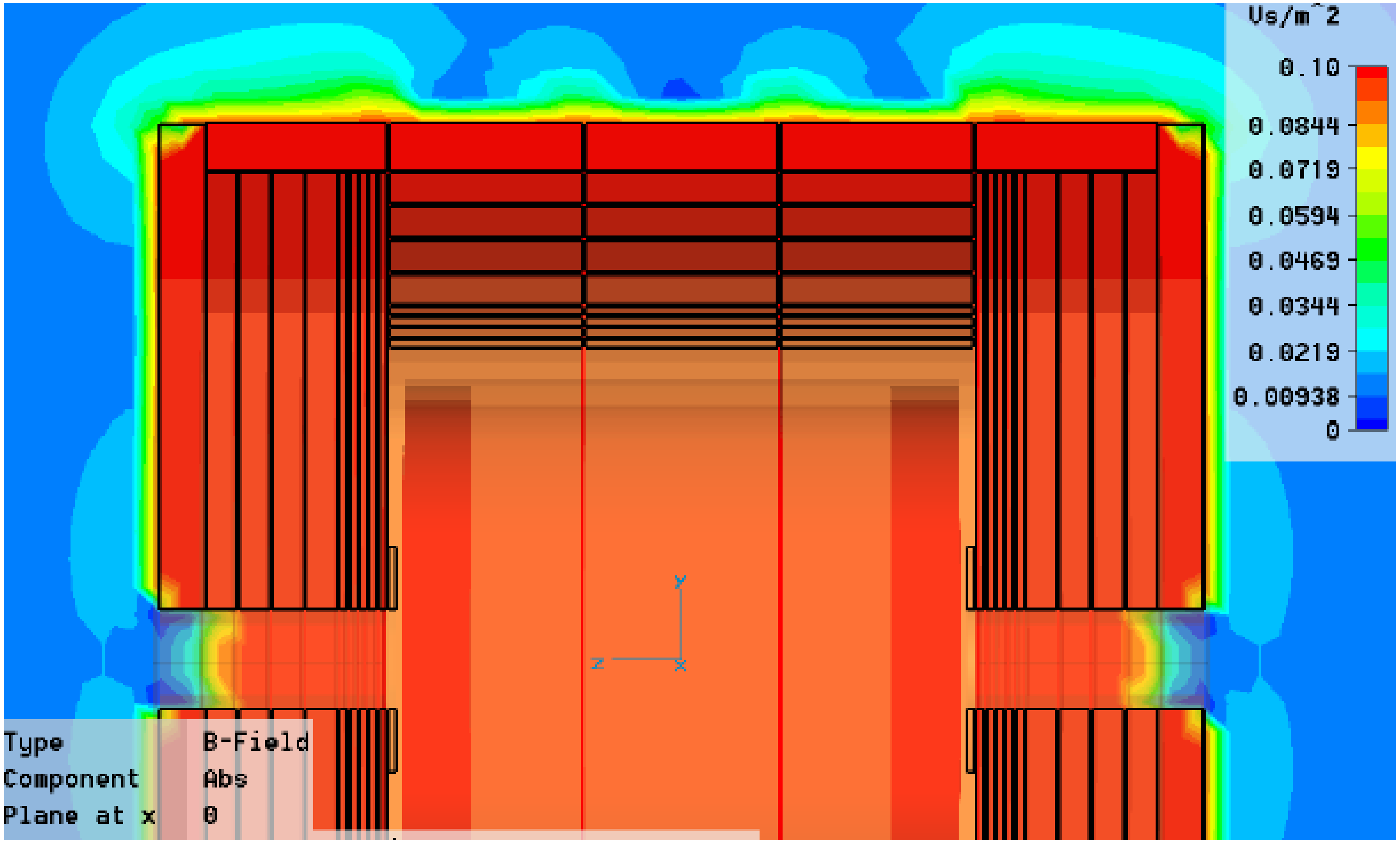
ECAL : λ_I = 0.8
HCAL : λ_I includes scintillator

★ 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

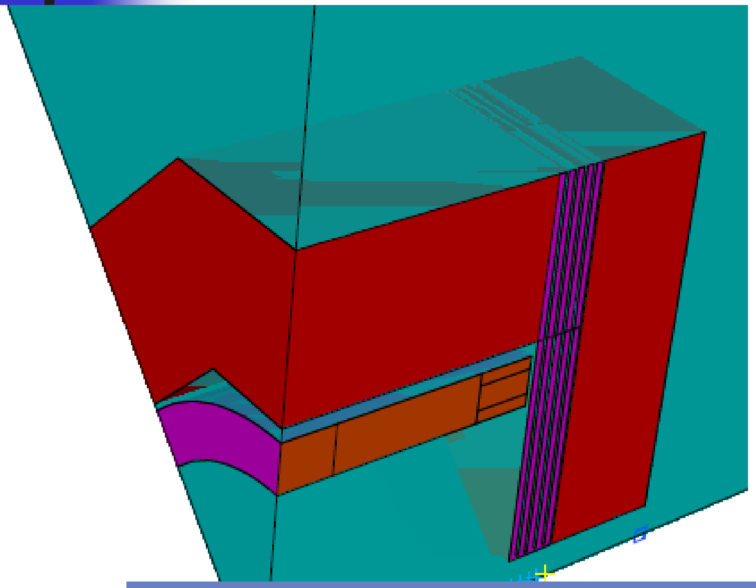
For 1 TeV machine "reasonable range" ~ 40 – 48 layers (5 λ_I - 6 λ_I)

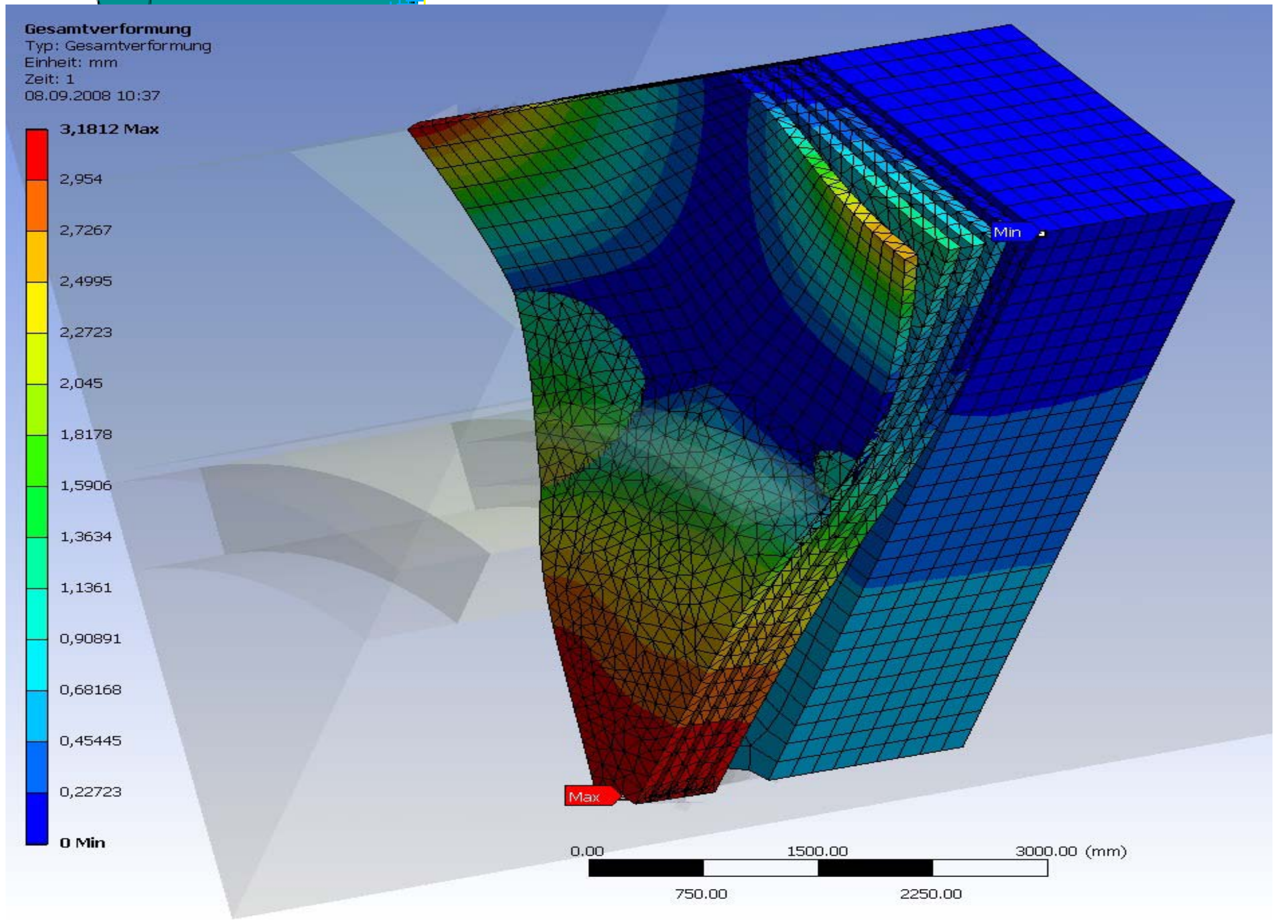
B Field Calculations

Added 60cm of iron to reduce stray field, bounding box 15m



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

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

: Francois Kircher, Yamaoka (cryostat, coil support)

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

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

8. support of final quadrupole magnets, forward calorimeters :

Yamaoka, Matthieu

9. assembling/installation and maintenance method :

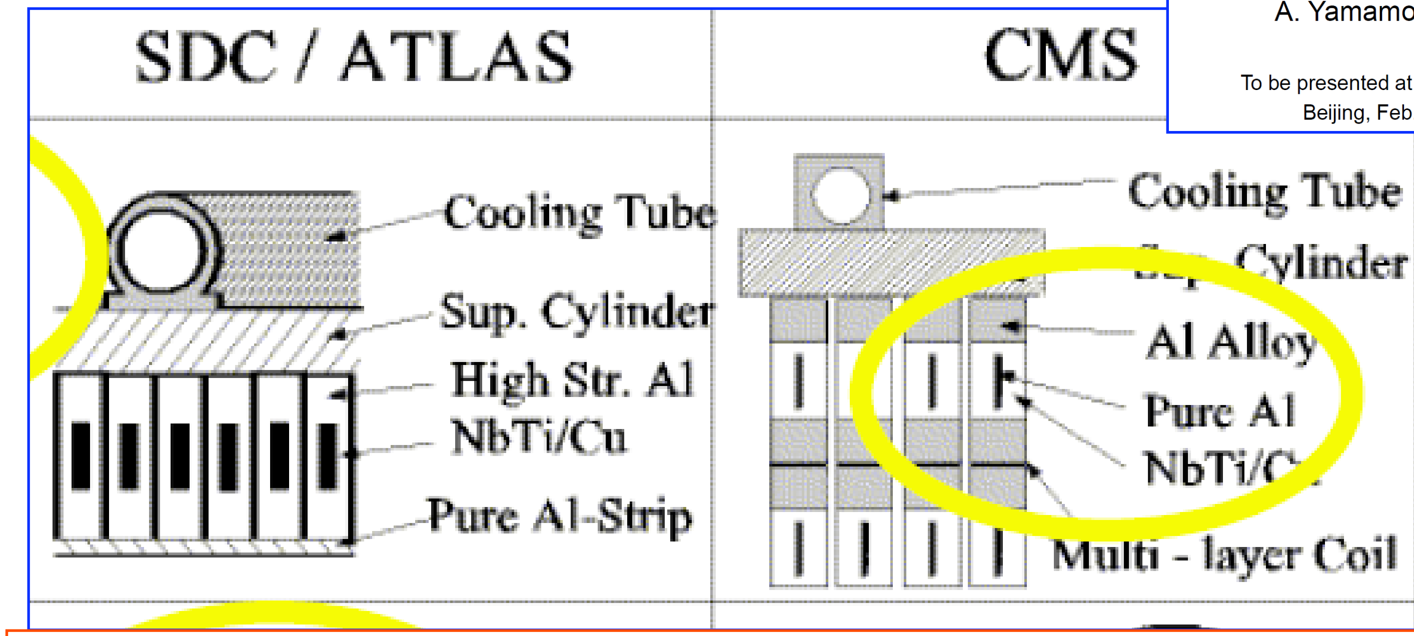
Sugimoto, Yamaoka, Uwe, Henri

- period - 5 years as in the RDR

10. option in machine parameters : Karsten, Henri, Tauchi

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

SC Coil Design

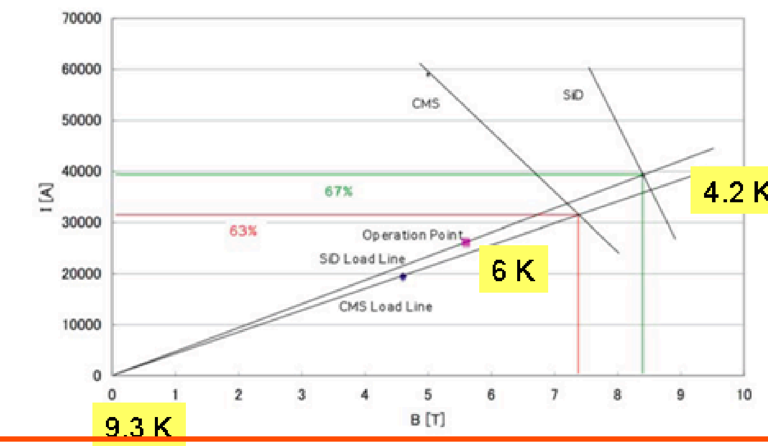


Superconducting Magnets
for ILC Detectors

A. Yamamoto (KEK)

To be presented at ACFA Meeting,
Beijing, Feb. 4, 2007

NbTi Superconductor Facing Limit with Temperature Margin



- A load line ratio of < 70 % should be kept to keep a temperature margin of >> 1 K.
- A useful field of 5 T reaching the practical limit of NbTi

Ref: **CMS: The Magnet Project - Technical Design Report**

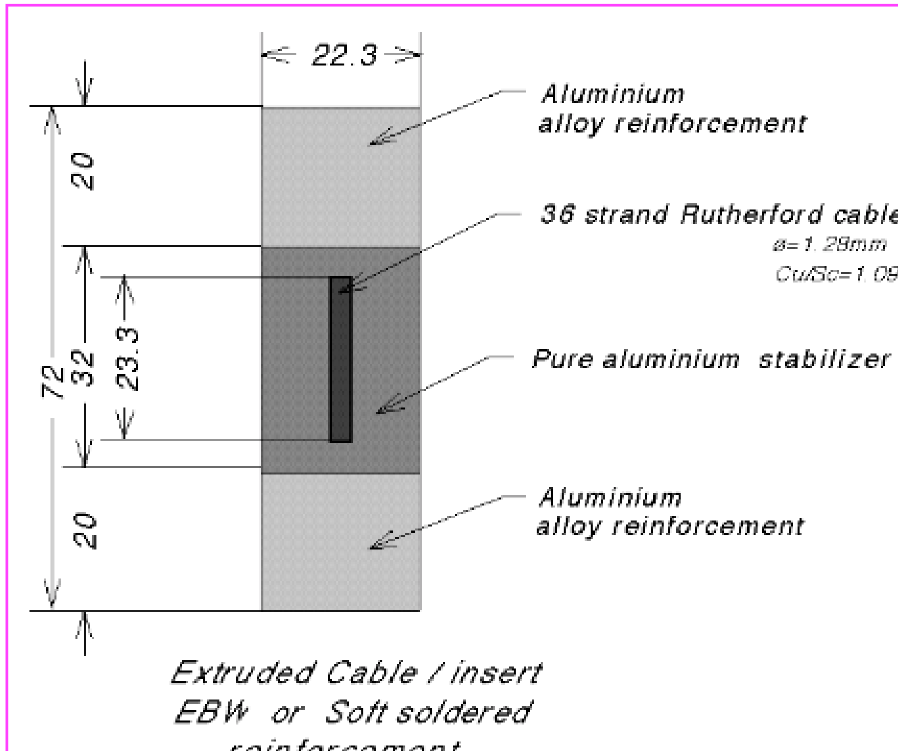
12.3 Mechanical consideration

The thin, aluminium stabilised solenoids developed in the past 15 years show common characteristics. As an example for all these magnets (CDF, TOPAZ, VENUS, H1, ZEUS, DELPHI, ALEPH, etc.) This solution minimises the bonding area between conductors and reinforcement leading to some disadvantages.

- The structural part is far from the conductor, so that its heat capacity plays no role (or a minor role) in determining the stability margins.

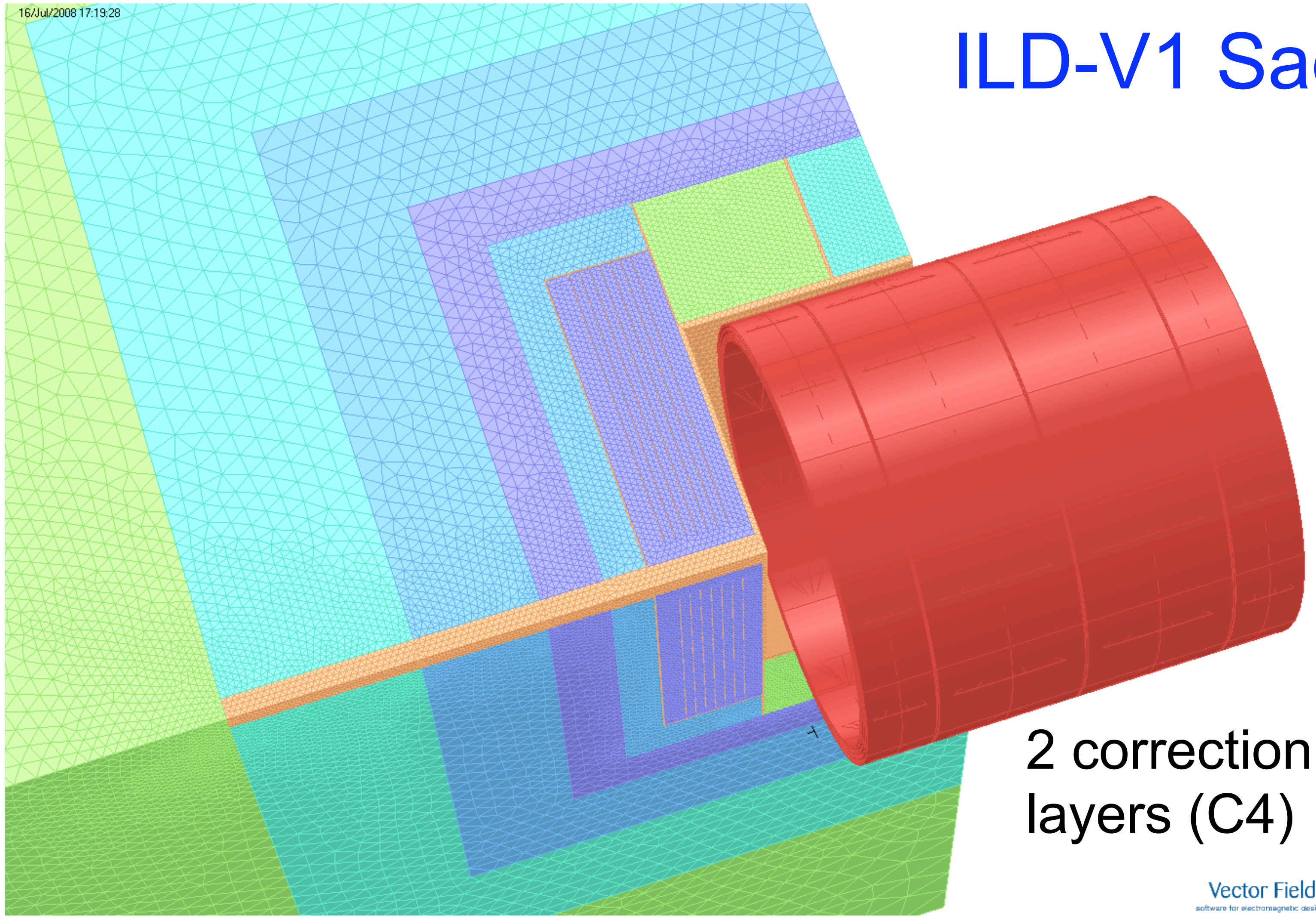
- The total axial force (147 MN) is transferred to the reinforcement through the bonding of the outermost layer. This bonding becomes very critical for the shear strength resistance.

- The axial thermal contraction of the coil, affected by the insulating material, does not match the cylinder thermal contraction, leading to a further increase of the shear stress at the cylinder-winding bond.

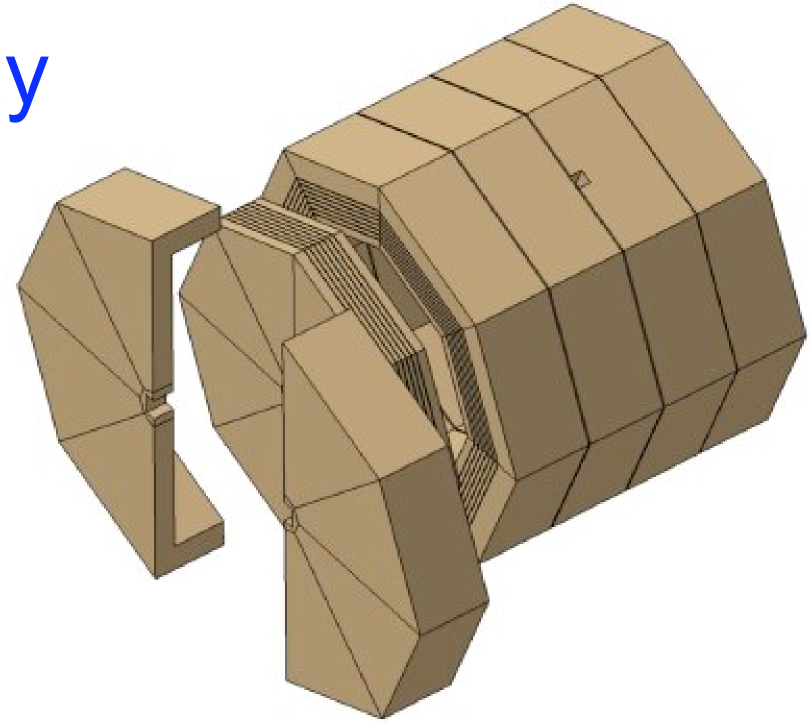


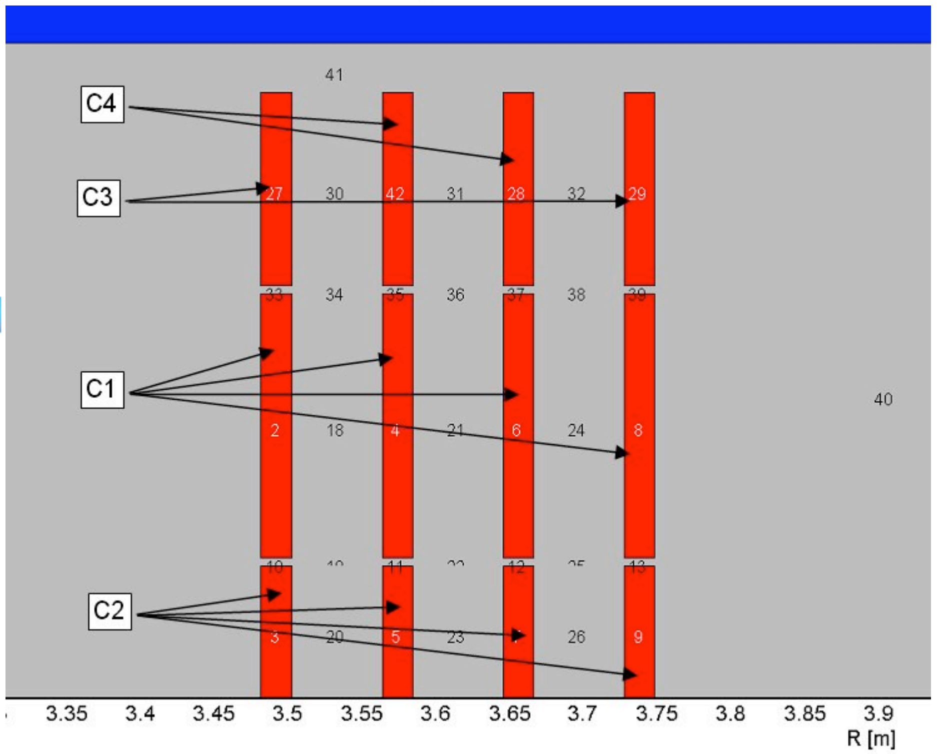
→ As the CMS, Hybrid type is better, but B <5Tesla.

ILD-V1 Saclay



2 correction layers (C4)





Current distribution :		2 correction layers		
12948	12948	12948	12948	12948
32136	12948	12948	12948	32136
32136	12948	12948	12948	32136
12948	12948	12948	12948	12948

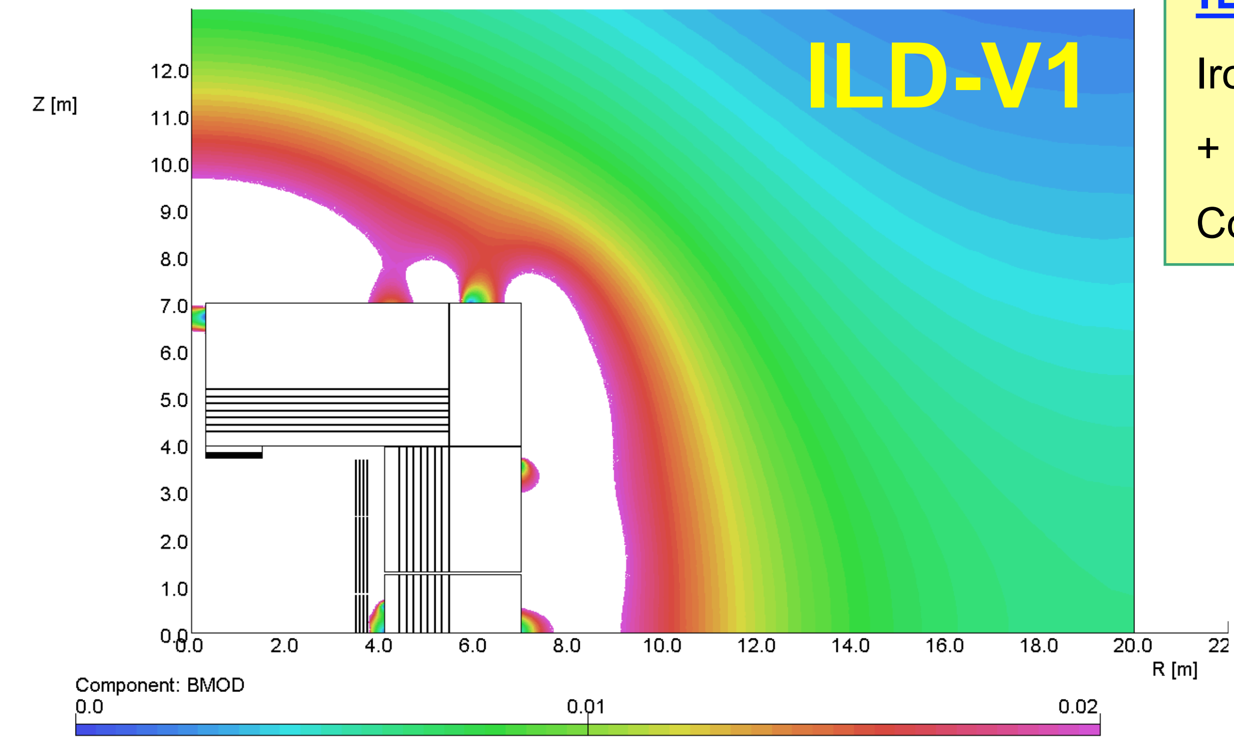
	NI (MA)	J (A/mm²)	N (turns/layer)	I per turn (kA)	I correction (kA)	Length (m)
C1	1.29	40.0	100	12.9	0	1.65
C2	0.65	40.0	50	12.9	0	1.65
C3	0.95	40.0	73	12.9	0	1.21
C4	2.35	93.0	73	32.1	19.2	1.21

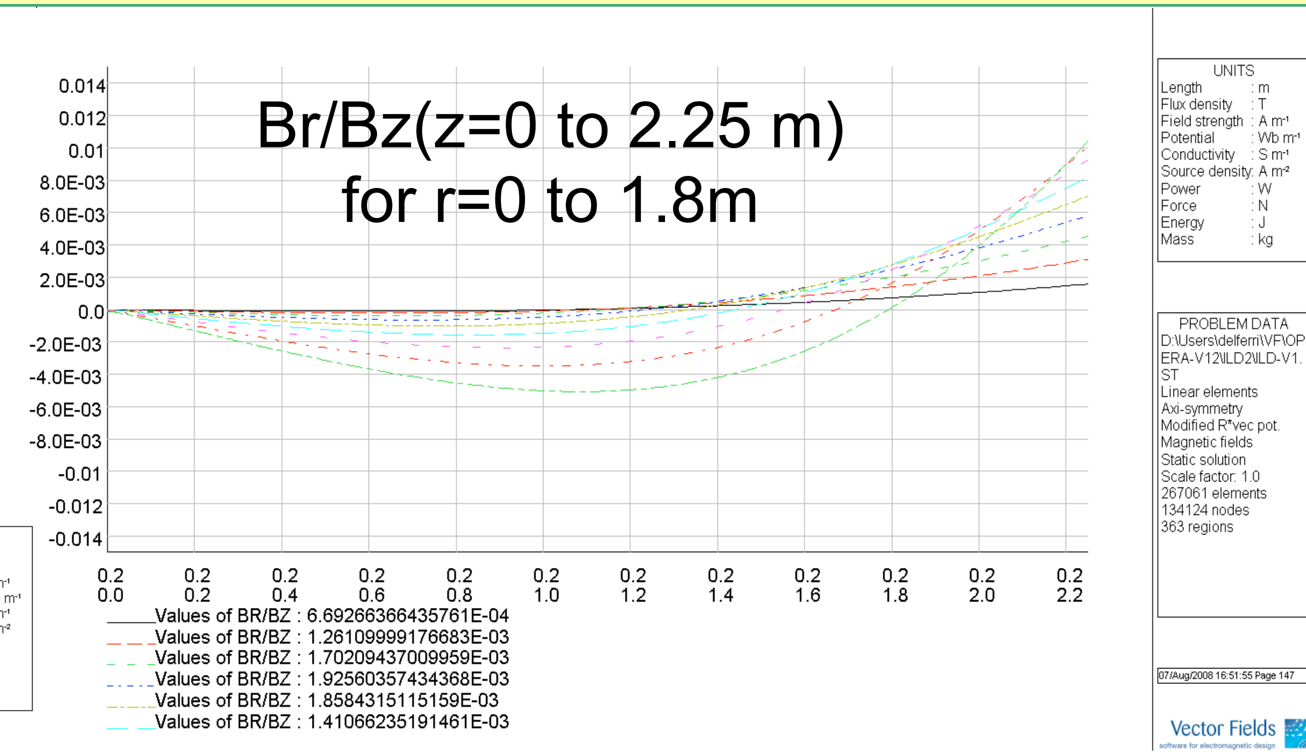
ILD-V1 configuration

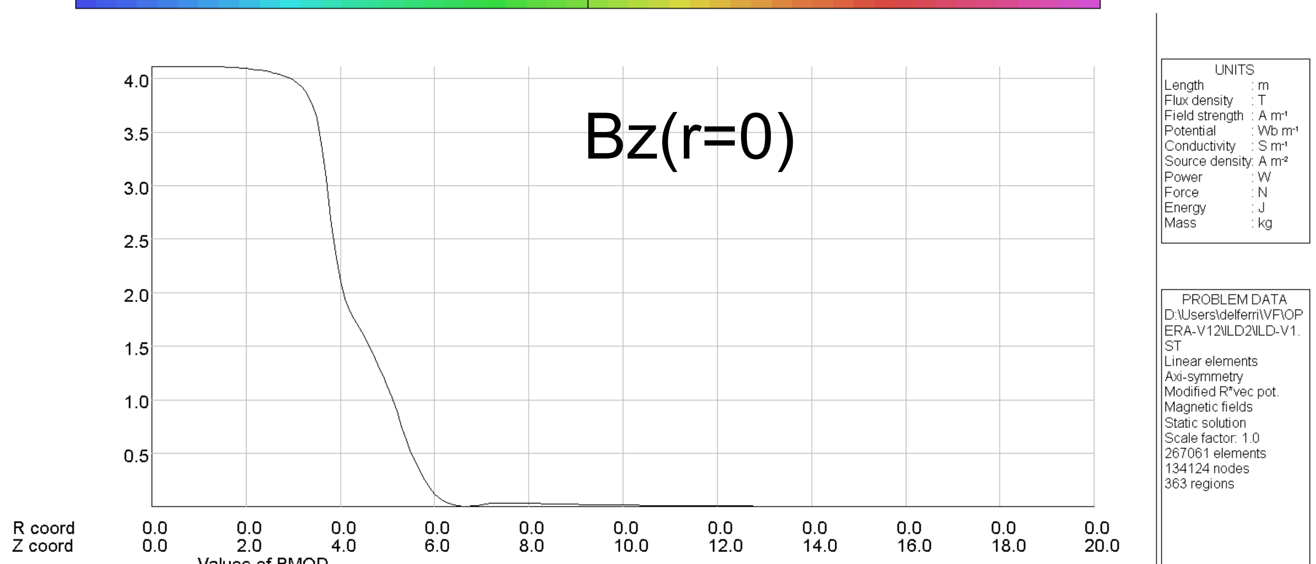
Iron : up to R=7m, up to Z=+/-7m (~3m thickness)

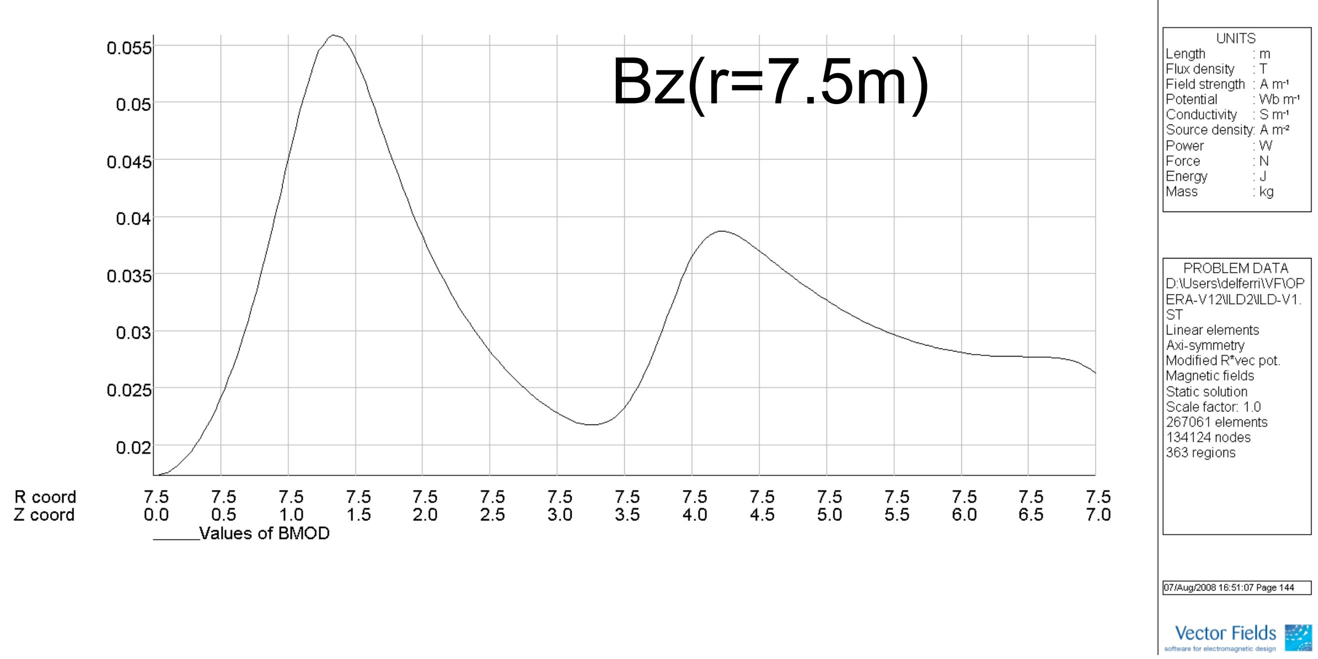
+ 100 mm FSP (Field Shaping Plate)

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

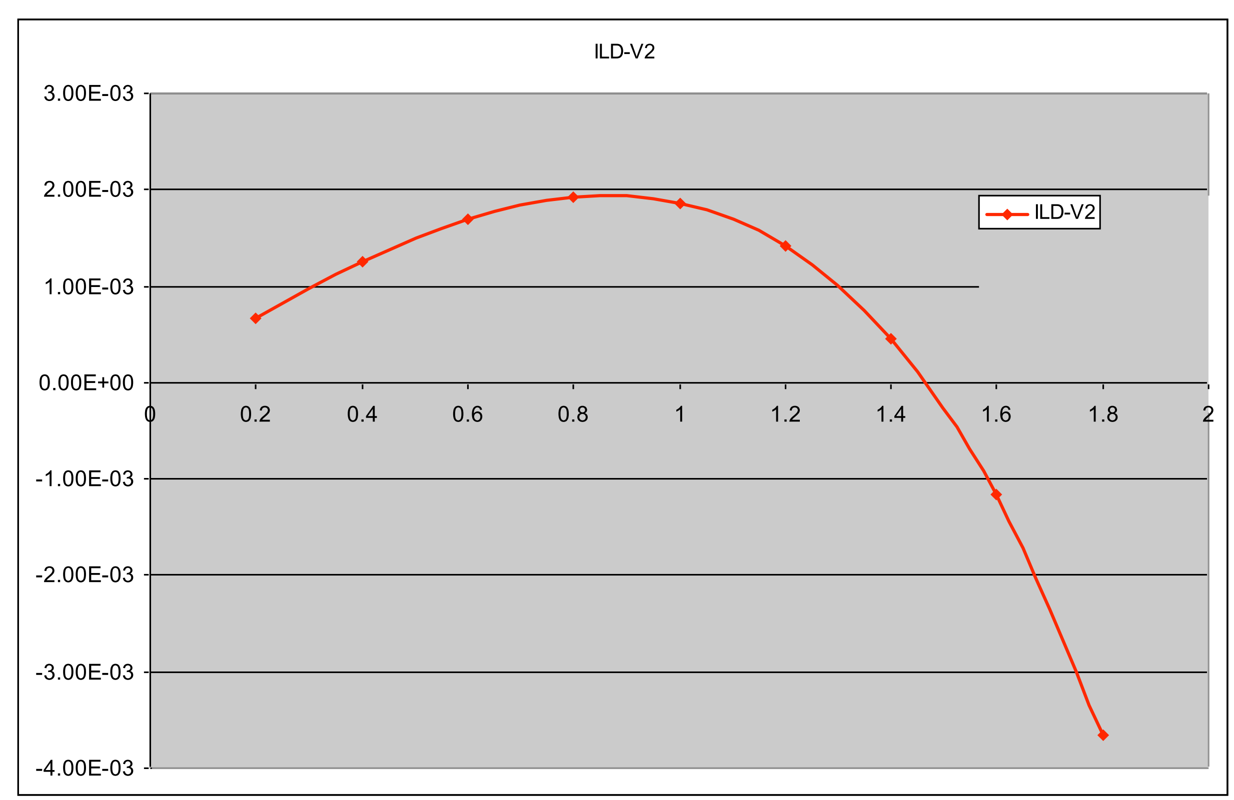








∫(Br/Bz) vs r (z=0 to 2.25 m)

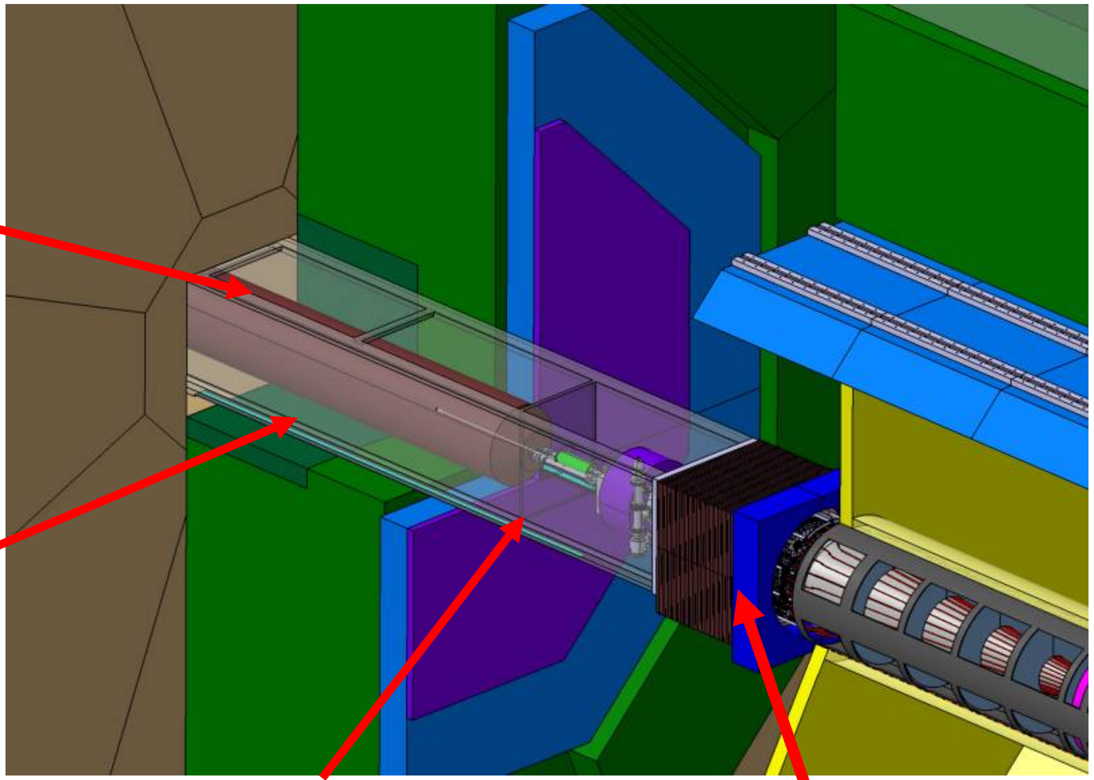


Forward region

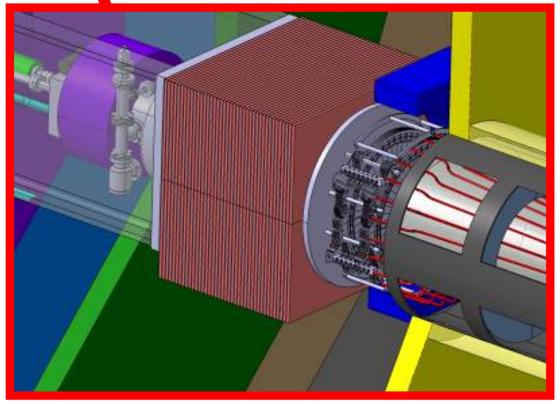
- Description

QD0
(superconducting magnet)

Support tube



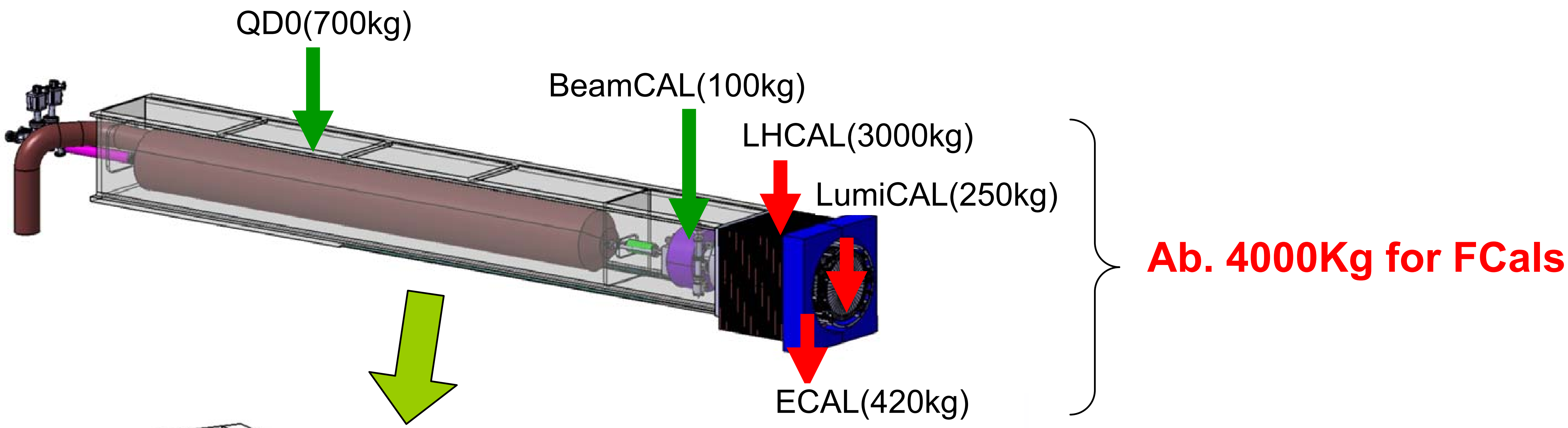
Beam line components

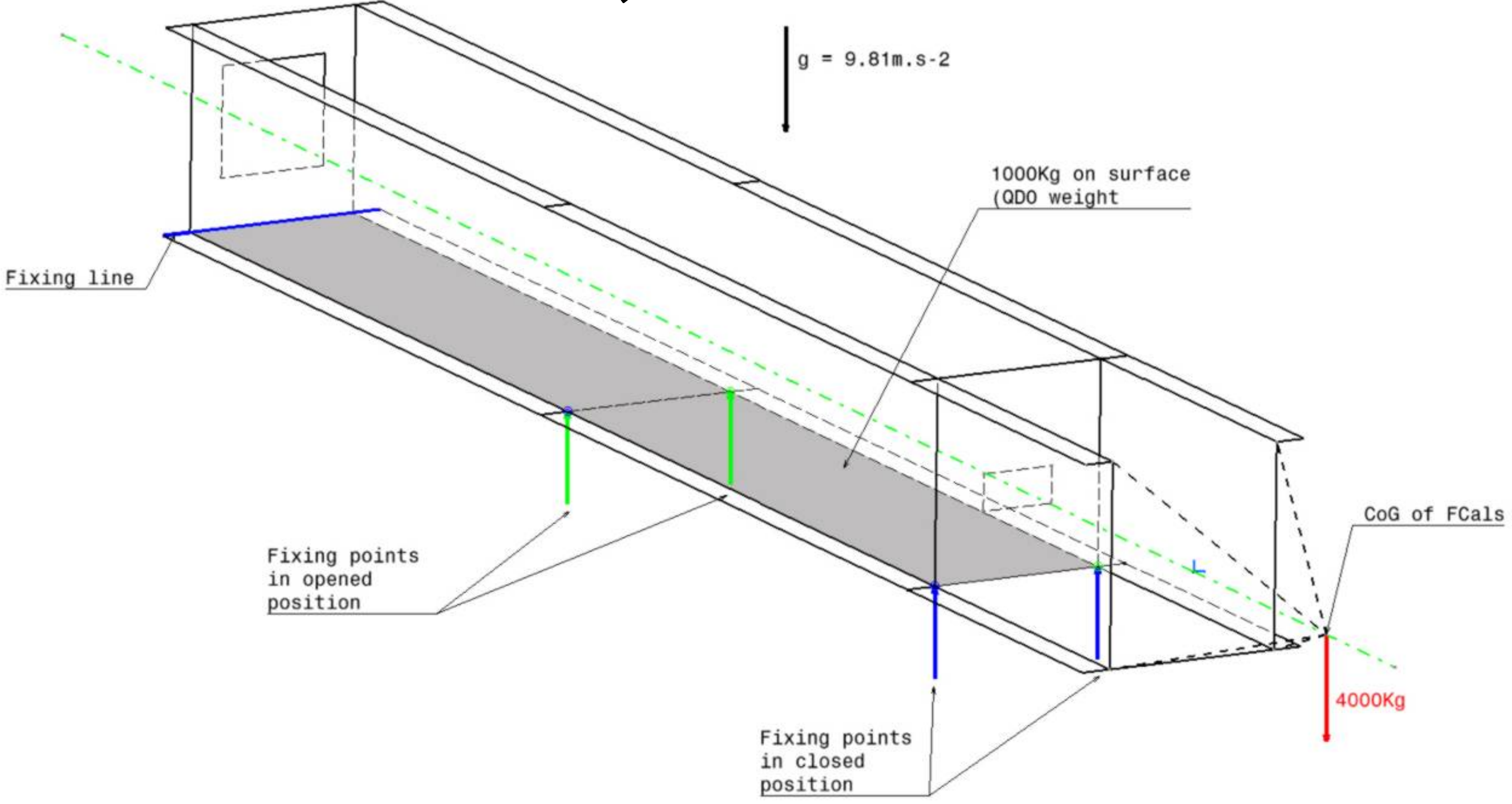


Forward Cals

- Requirements on support tube
  - **Support all the forward components**
  - **Good vibration performance (QD0 stability)**
  - **Allowable amplitude**
    - Few mm in static load
    - About 50nm for ground motion (IR interface document)
  - **Alignment system is needed (in a mm range)**

Model for calculations



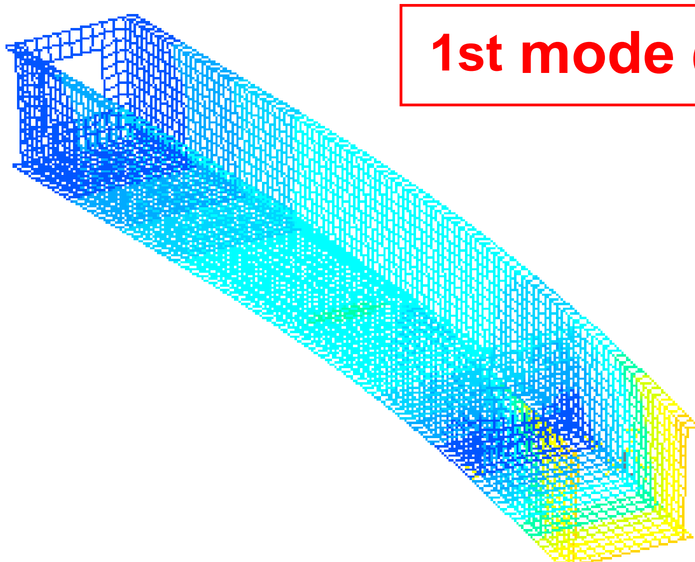


U shape is used for accessing to Forward components
If needed, structure could be reinforced by tie rods or else.

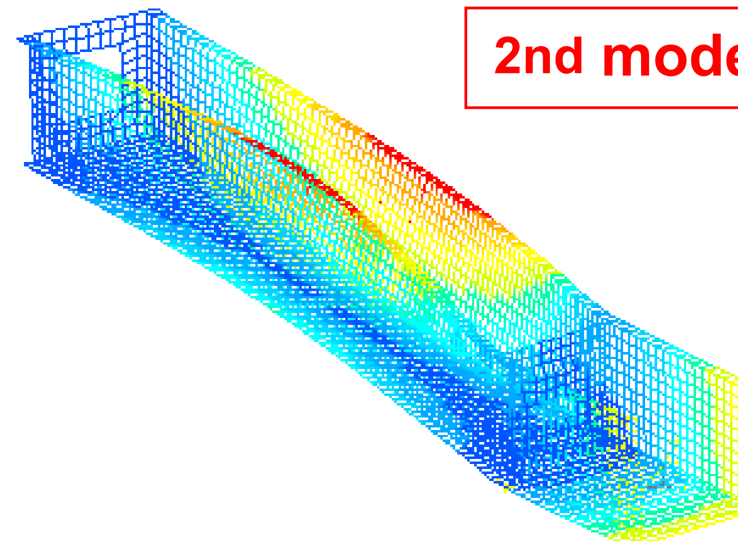
Natural frequencies

- For 50mm thick and Endcap closed

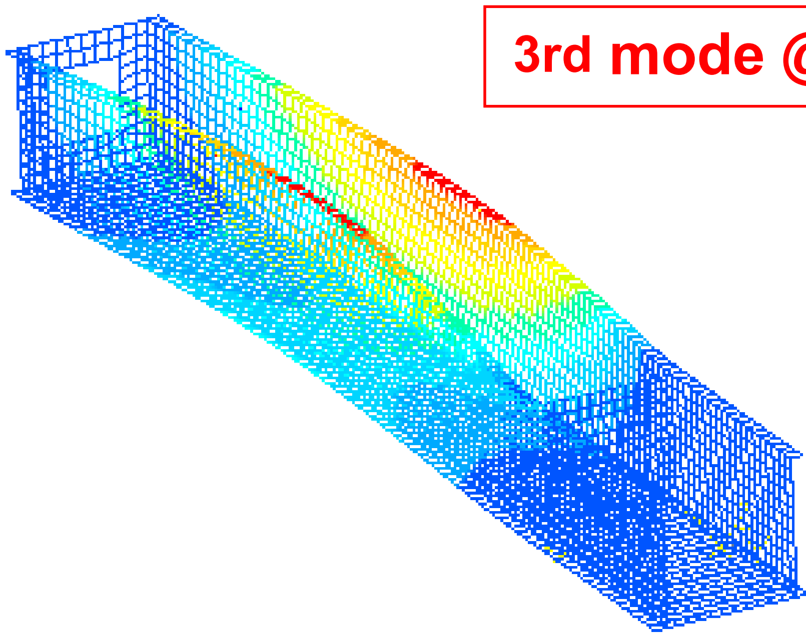
1st mode @ 44Hz



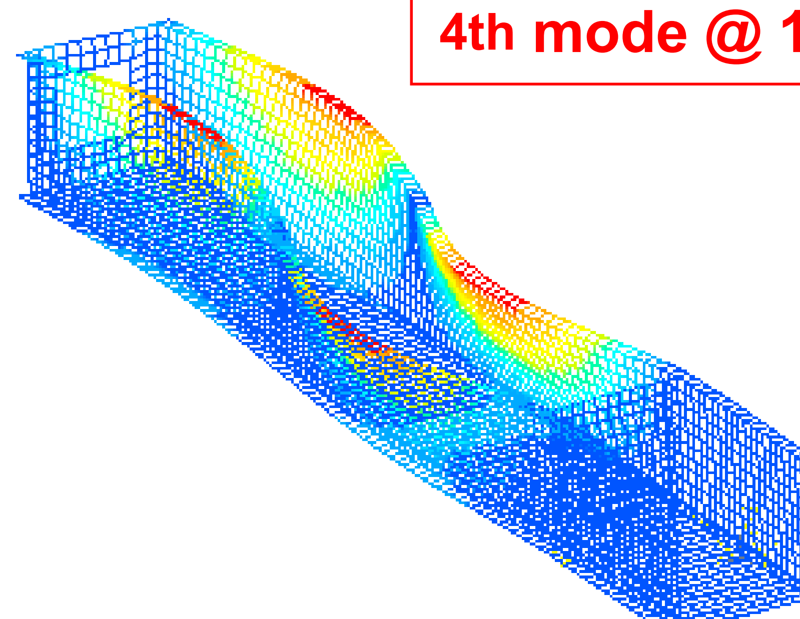
2nd mode @ 60Hz



3rd mode @ 71Hz

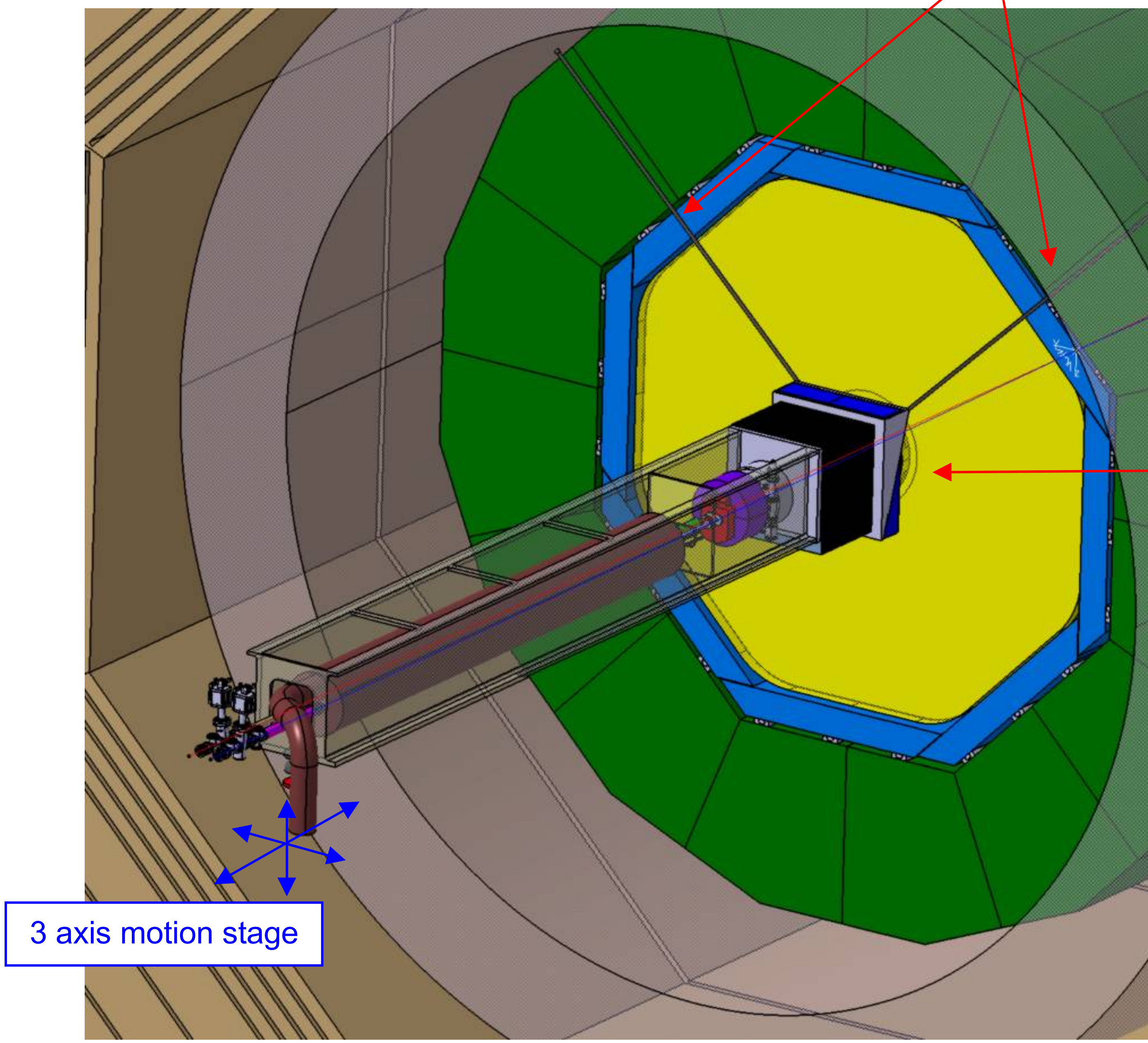


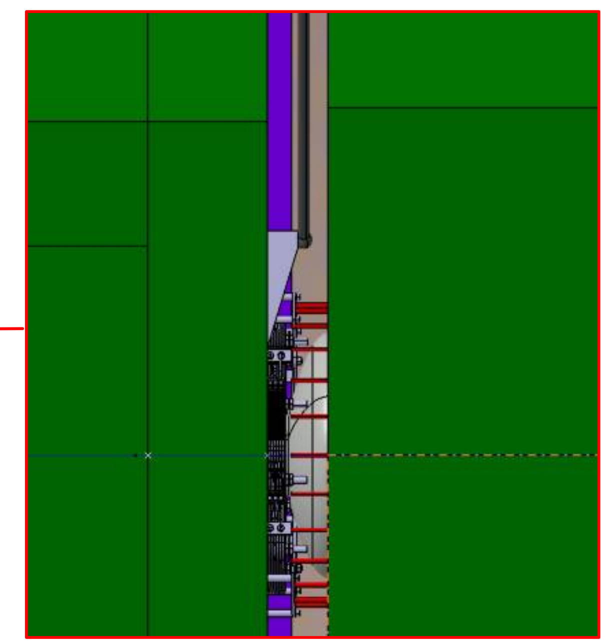
4th mode @ 125Hz



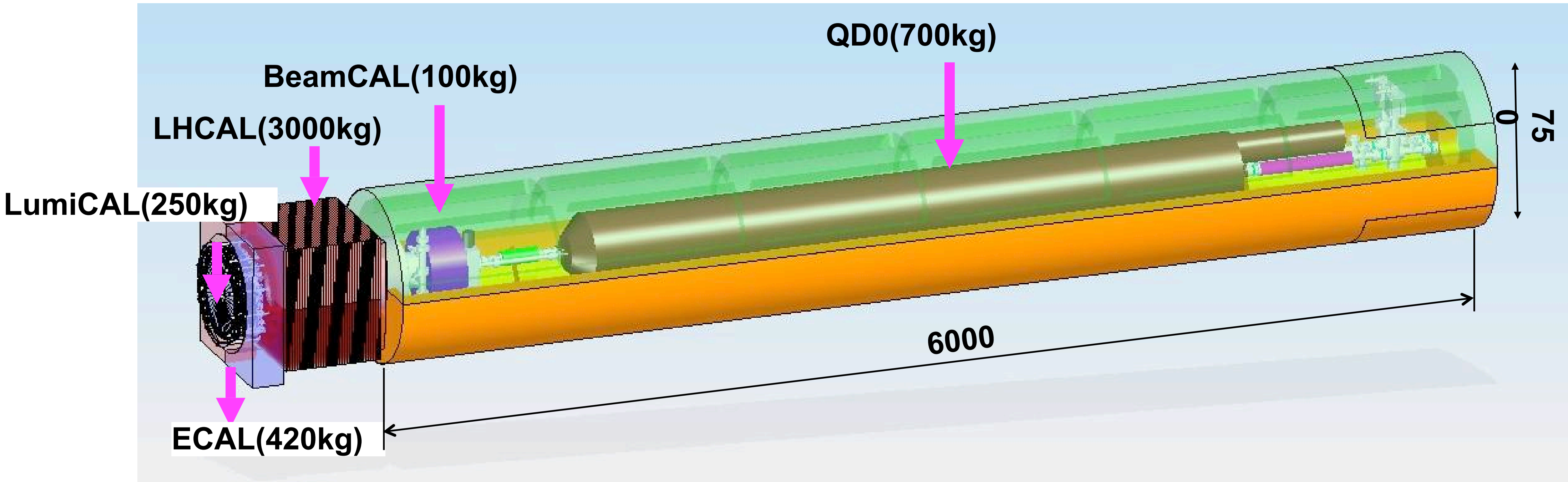
Alignment method

Adjustable tie rods

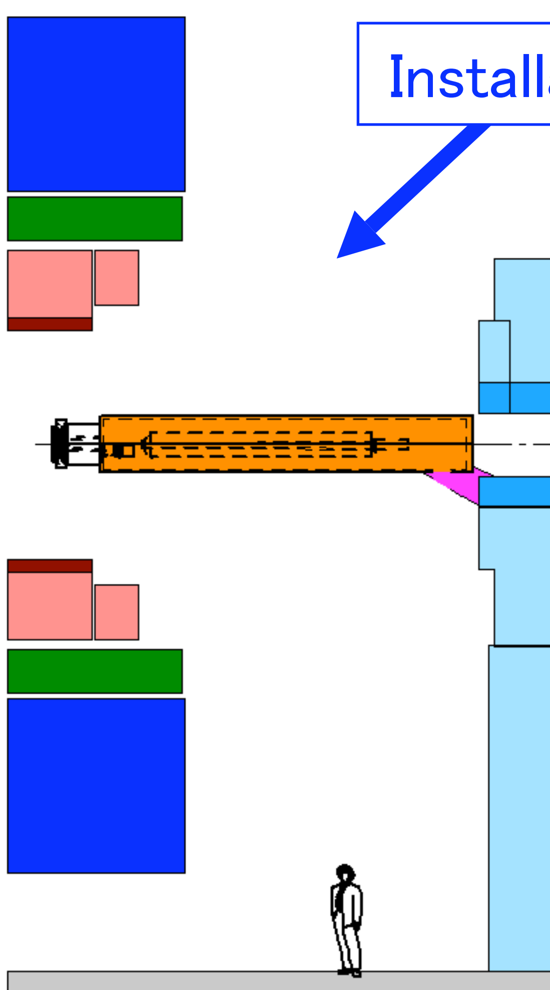




Cylindrical Support Tube



Installation method



H.Yamaoka will present the details at LCWS2008.

Progree since Warsaw, even after Cambridge ?

1. Engineering model of ILD
   3D CAD
   Opening senario