A Few Highlights and Impressions from the 7th ACFA LC Meeting

New Vertex Detector Idea

GLD Kickoff.

Real work on Flux Return/Magnet

Impressions

LCD Meeting 12/09/04
J. Jaros

A new idea of the vertex detector for ILC

Y. Sugimoto

Nov.10. 2004

How to reduce pixel occupancy?

- Read out >20 times per train
  - Column parallel readout
    - CPCCD (LCFI group)
    - MAPS (Strasburg group)
    - >50 MHz readout speed
    - Possible RF pick-up problem
  - Analog registers on pixel (Readout between trains)
    - FAPS (RAL group): CMOS pixel with registers
    - ISIS (LCFI group): Small CCD registers on pixel
    - Complicated design → Mosaic of small segments
    - Possible RF pick-up problem for FAPS
- Use >20 times finer pixels

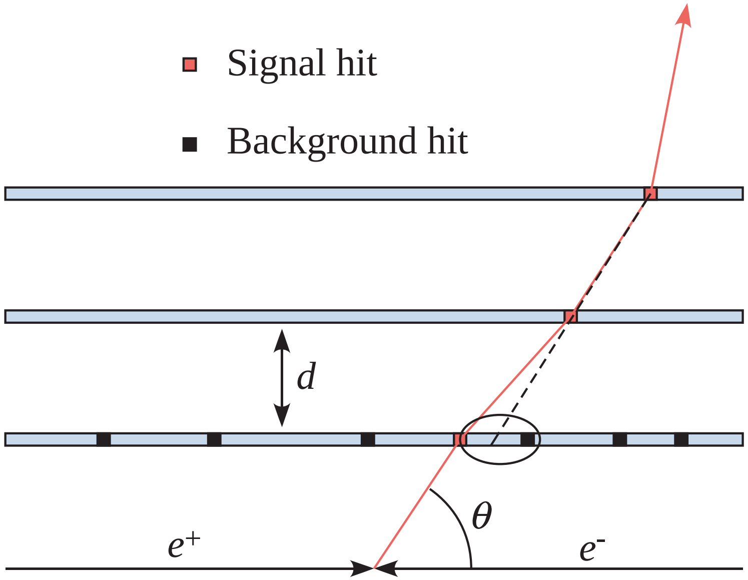
  ➔ A new idea: Fine Pixel CCD

Design concept of FPCCD

- Pixel size: 5μm square
- Accumulate 2820 BX and readout between trains
- Fully depleted to suppress diffusion and reduce hit pixels
- Pixel Occupancy < 0.5% at R=20mm and B=3T
  ➔ Acceptable
- Multi-port readout to reduce readout time and increase radiation immunity
- Operation at low temperature (< -70 C) to suppress dark current accumulated in readout cycle time of 200ms

Challenges of FPCCD

- Tracking efficiency
  - Pixel occupancy ~0.5%, but hit density is ~40/mm^2
  - Large number of background hits may cause tracking inefficiency: mis-identification of signal hit with background hit



For a normal incident track;

$$p_{mis} = 2\pi\sigma R_0^{\ 2}, R_0 = d\theta_0$$

σ : Background hit density

θ_0 : Multiple scattering angle

Angular and momentum dependence;

$$p_{mis} \propto p^{-2} \sin^{-4}\theta$$

Large/Huge Detector Concept

9. Nov. 2004

@7th ACFA LCWS in Taipei

Y. Sugimoto

KEK

Basic design concept

- Performance goal (common to all det. concepts)
  - Vertex Detector: $\delta(IP) \leq 5 \oplus 10 / p \sin^{3/2}\theta$
  - Tracking: $\delta p_t / p_t^2 \leq 5 \times 10^{-5}$
  - Jet energy res.: $\delta E / E \leq 0.3 / \sqrt{E}$

    ➔ Detector optimized for Particle Flow Algorithm (PFA)
- Large/Huge detector concept
  - GLC detector as a starting point
  - Move inner surface of ECAL outwards to optimize for PFA
  - Larger tracker to improve $\delta p_t / p_t^2$
  - Re-consider the optimum sub-detector technologies based on the recent progresses

A possible modification from GLC detector model

- Larger R_{max} (2.0m) of the tracker and R_{in} (2.1m) of ECAL
  - TPC would be a natural solution for such a large tracker
- Keep solenoid radius same:

➔ Somewhat thinner CAL (but still 6λ), but does it matter?

- Use W instead of Pb for ECAL absorber
  - Effective R_m: 25.5mm → 16.2mm (2.5mm W / 2.0mm Gap)
  - Small segmentation by Si pad layers or scintillator-strip layers
- Put EC CAL at larger Z (2.05m→2.8m) ➔ Longer Solenoid
  - Preferable for B-field uniformity if TPC is used
- It is preferable $Z_{pole\text{-}tip} < l^*$ (4.3m?) both for neutron b.g. and QC support (l^* :distance between IP and QC1)

Comparison of parameters

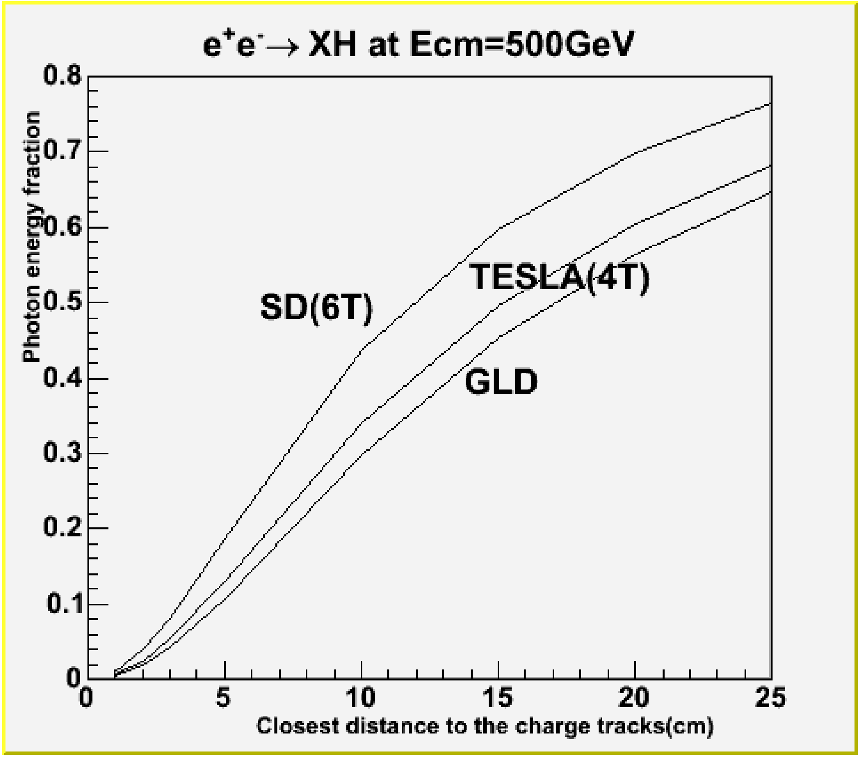
		SiD	TESLA	JLC	GLC	GLD	LD
ECAL	R_{in} (m)	1.27	1.68	2.5	1.6	***2.1***	2.0
	BR_{in}^2	8.1	11.3	12.5	7.7	***13.2***	12.0
	Type	W/Si	W/Si	Pb/Sci	Pb/Sci	**(*W/Sci*)**	Pb/Sci
	R_m^{eff} (mm)	18	24.4	21.3	25.5	***16.2***	21.3
	BR_{in}^2/R_m^{eff}	448	462	588	301	***817***	565
	Z (m)	1.72	2.83	2.9	2.05	***2.8***	3.0
	BZ^2/R_m^{eff}	822	1311	792	494	***1452***	1271
	X_0	21	24	29	27	***27***	29
E+H CAL	λ	5.5	5.2	6.9	7.3	***6.0***	6.9
	t (m)	1.18	1.3	1.5	1.8	***1.4***	1.7

Charged – γ separation

$$F \equiv \frac{\sum_{all\ \ events} E_\gamma (d < d_{cut})}{\sum_{all\ \ events} E_\gamma}$$

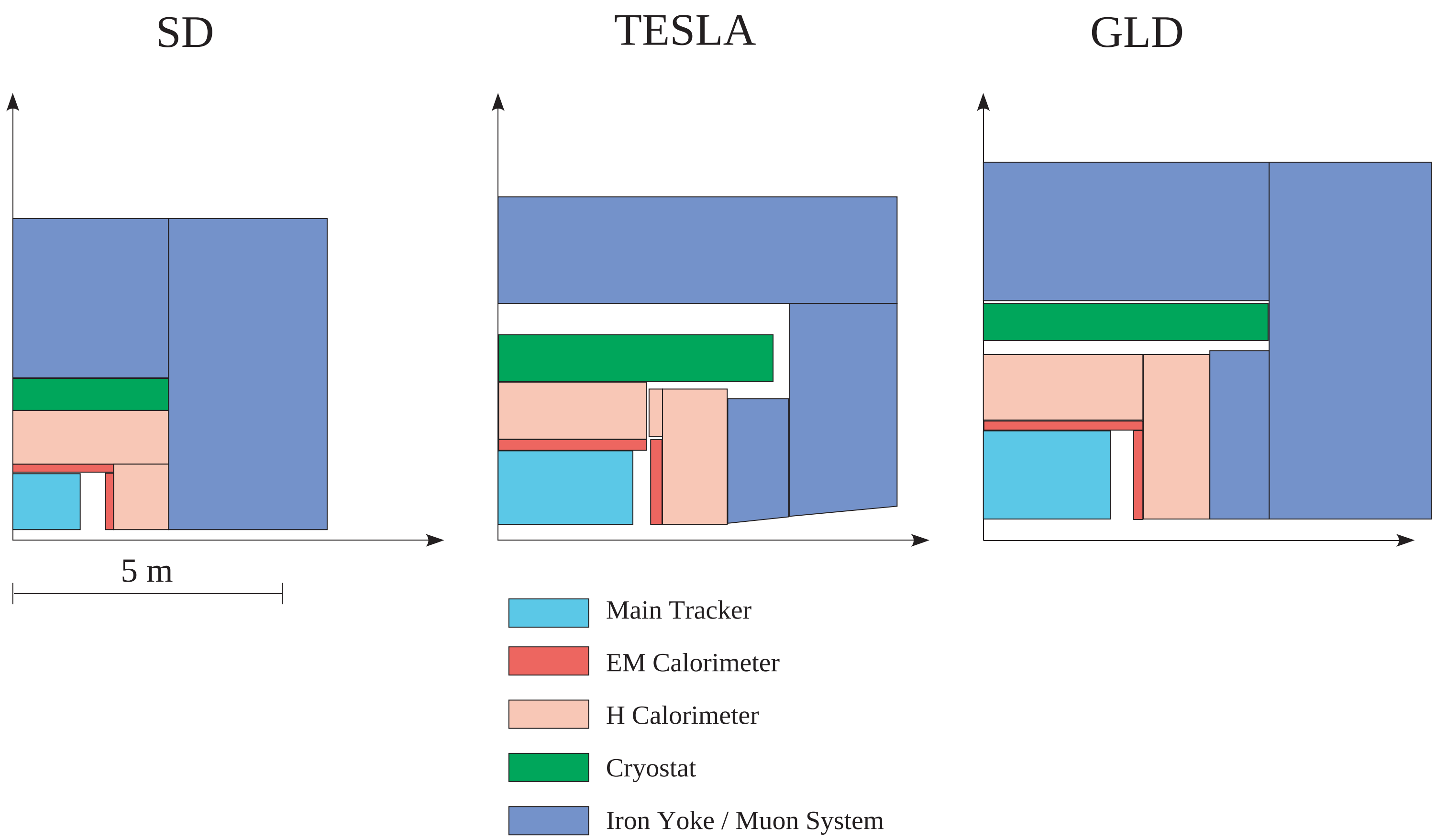
- Simulation by A. Miyamoto
  - Events are generated by Pythia6.2, simulated by **Quick Simulator**
  - Particle positions at the entrance of EM-CAL
  - Advantage of Large/Huge detector is confirmed
  - Inconsistent with J.C.B's result → need more investigation

F



d_{cut}

Global geometry



Merits and demerits of Large/Huge detector

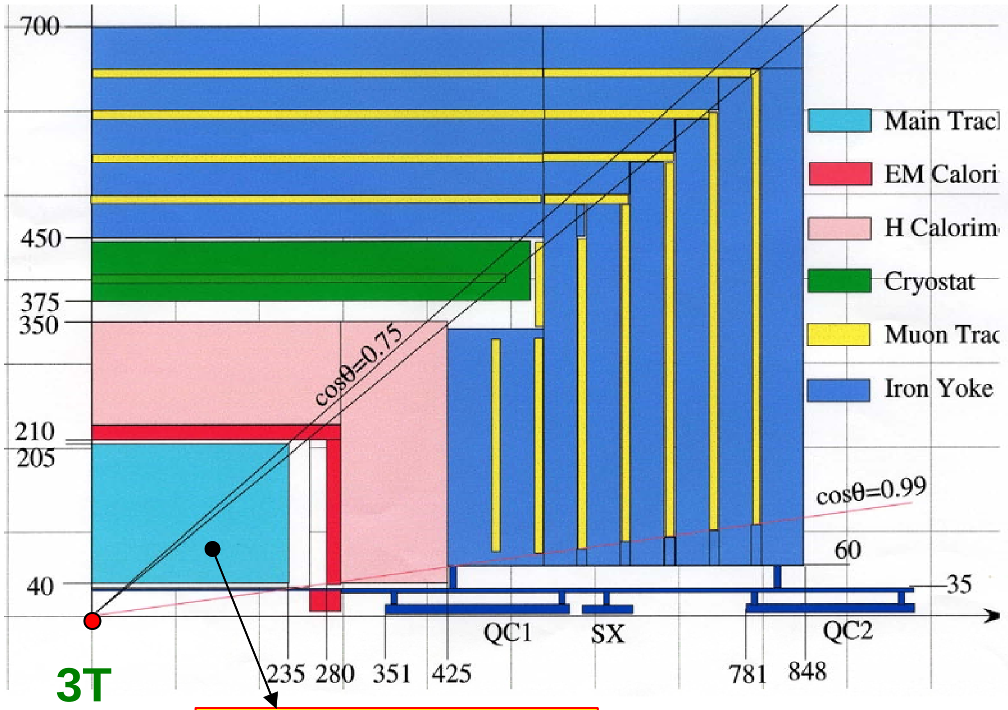
- Merits
  - Advantage for PFA
  - Better p_t and dE/dx resolution for the main tracker
  - Higher efficiency for long lived neutral particles (Ks, Λ, and unknown new particles)
- Demerits
  - Cost ? – but it can be recovered by
    - Lower B field of 3T (Less stored energy)
    - Inexpensive option for ECAL (e.g. scintillator)
  - Vertex resolution for low momentum particles
    - Lower B requires larger R_{min} of VTX because of beam background
    - $\delta(IP) \sim 5 \oplus 10/(p\beta\sin^{3/2}\theta)$ µm is still achievable using wafers of ~50µm thick

Nov. 10, ‘04

Support and magnet coil

KEK Hiroshi Yamaoka

Initial configuration of the iron yoke



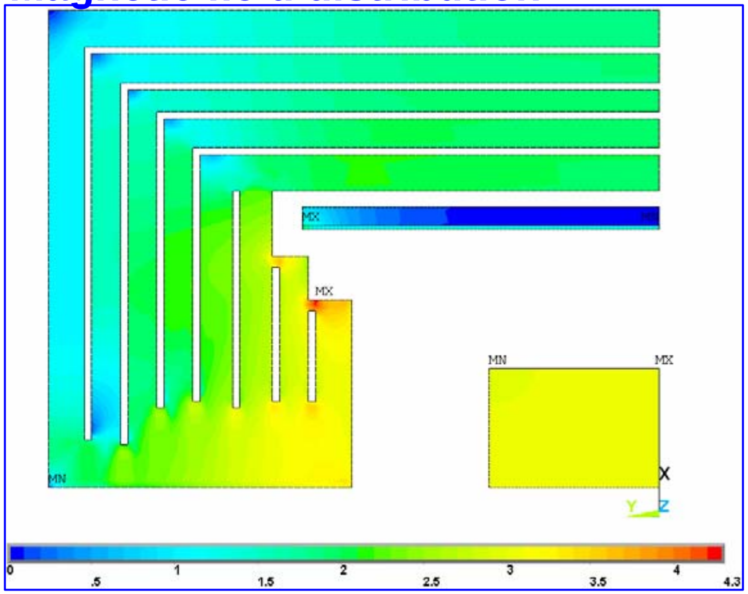
$$\int_0^{Z_{\max}} \frac{Br}{Bz} dz < 2mm$$

$$\int_0^{Z_{\max}} \frac{Br}{Bz} dz = 2.3 - 8mm$$ → **Too large!!**

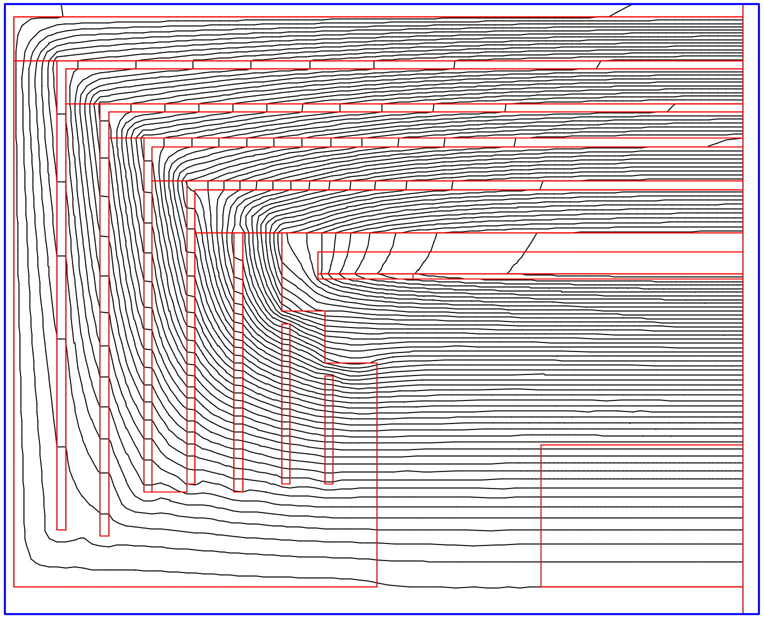
Further amount of iron is necessary.

Iron Yoke configuration is optimized!

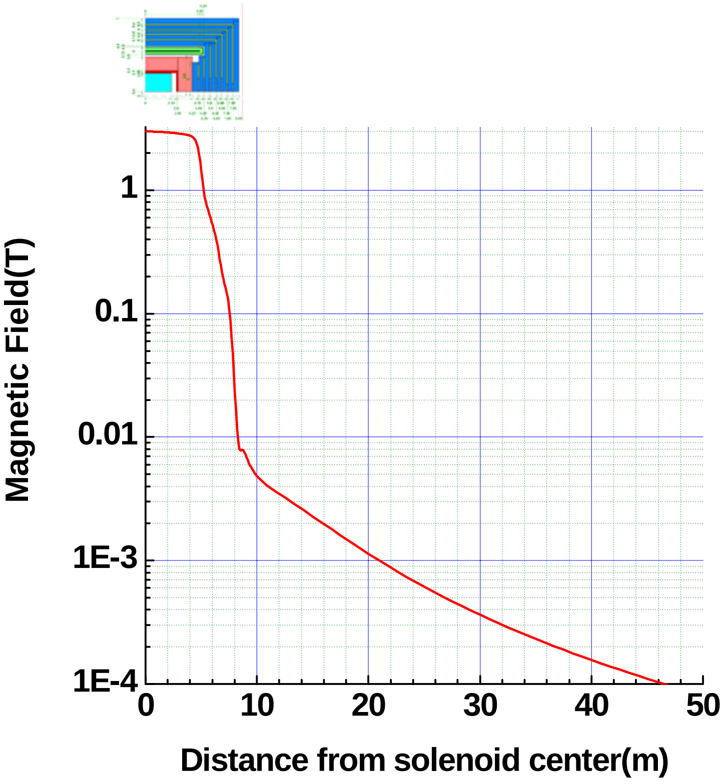
Magnetic field distribution



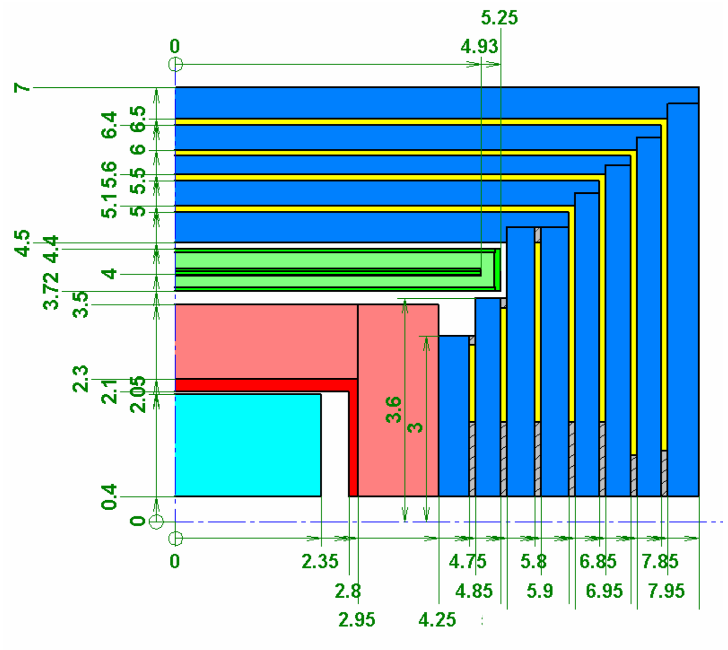
Flux line

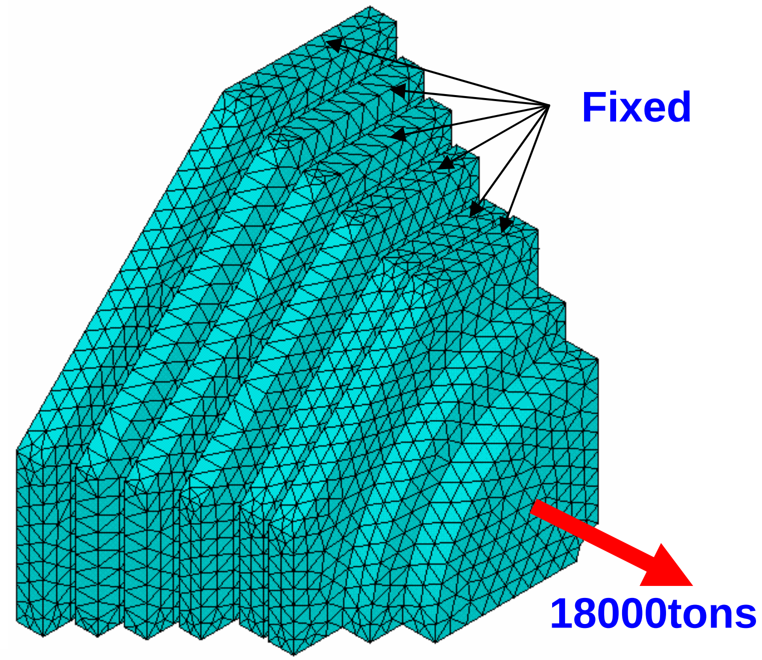


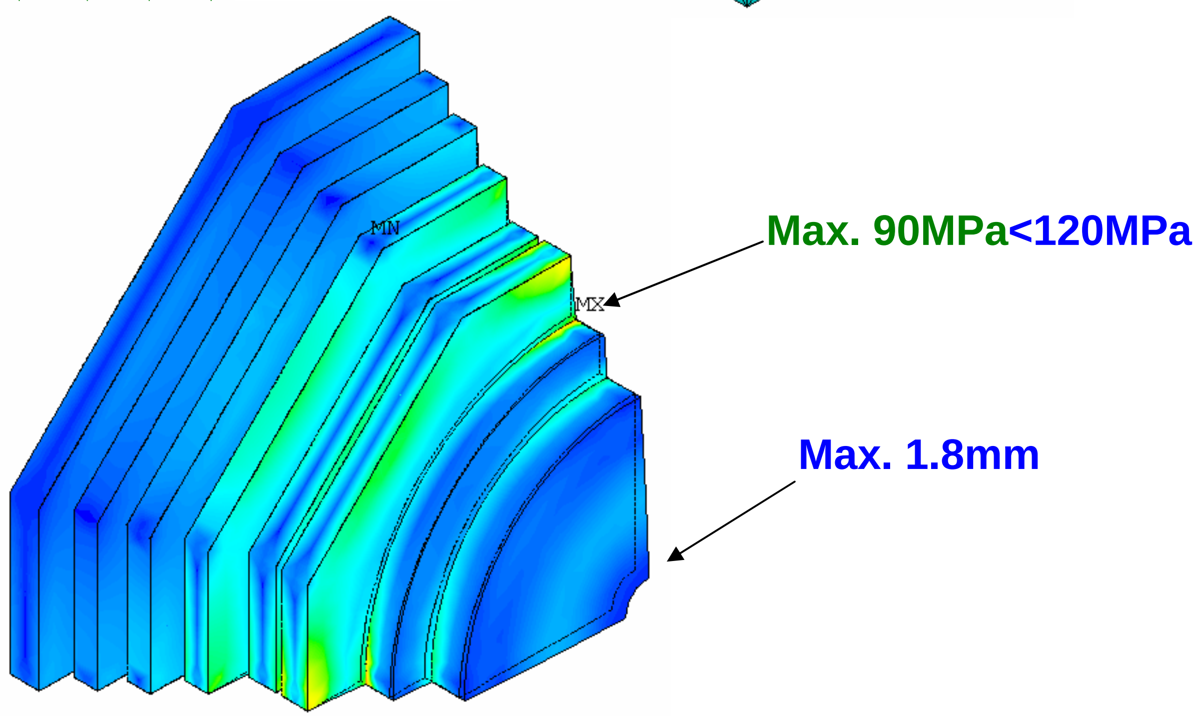
Fringe/Leakage field



Stress/deformation of End Yoke

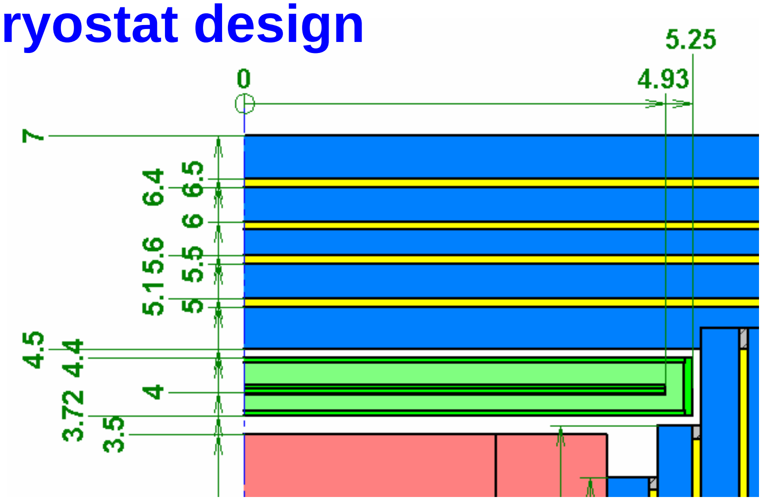






Cryostat design

Oct. 29, '04
KEK H. Yamaoka



Load condition
- Weight of the calorimeter: 2000tons
- Weight of the solenoid : ～140tons
- Vacuum : 0.1MPa

→ **Thickness of**
- Inner vacuum vessel
- End plates

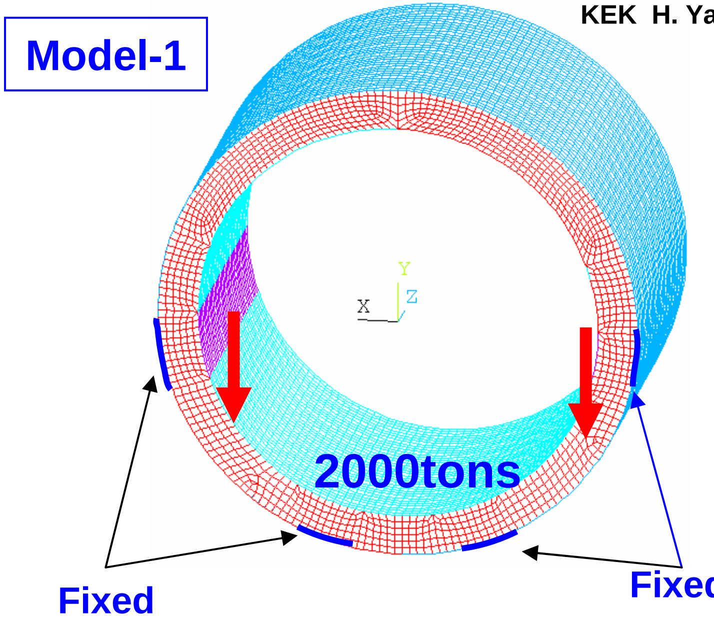
were optimized.

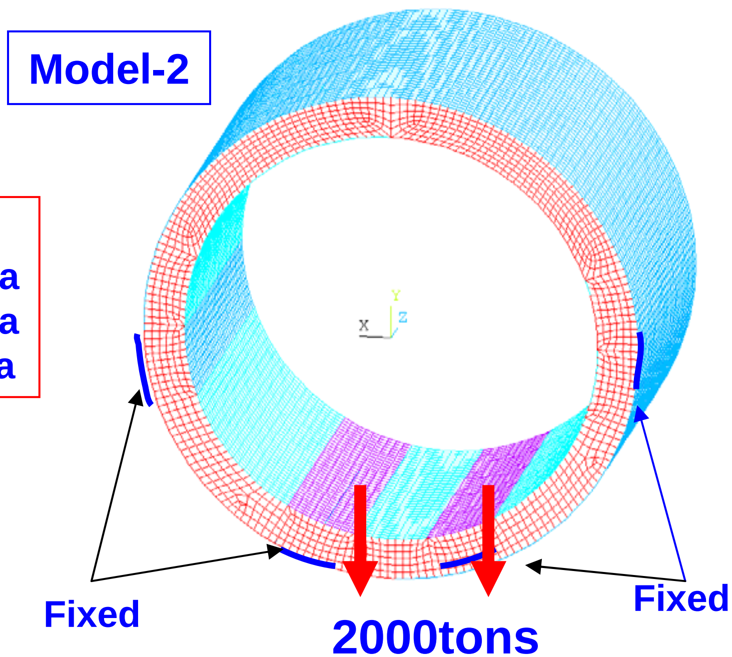
SUS304
σ_t =530MPa
σ_y =210MPa
σ_{allow}=140MPa

- **Outer vac. vessel**
  40mm thick ← t

$$p = \frac{0.855}{\left(1-\mu^2\right)} \cdot \frac{0.75E}{\left(r/t\right)^{\frac{5}{2}} \cdot \left(L/r\right)}$$

p: Buckling pressure
0.1MPa x 2(safety factor)





Some Observations

- Taipei is on the Ring of Fire (R=6.7!)
- ACFA ***wants*** the LC in Asia=Japan.

  Claims lower cost in Asia.
- HEP on upswing in Taiwan. It's supported, growing, with abundant students. Korea too.
- Much Si Detector R&D focused on local fabrication capability, not much on new designs.
- Japan contributes to one and only one LHC detector by funding agency decree. Generalize.
- Si tracking seems popular. Si experts questioned SiD resolution assumption (7um) and systematics of a large system.
- GLD has lots of Si tracking. Advantages (short livetime, no ion feedback, robustness, no T to D) are appreciated.