Brief Introduction of

"Huge" Detector Concept

Towards our common future = Experiments at ILC

3 Sep 2004
ECFA LC Workshop@ Durham

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On behalf of many colleagues

1. What is Huge?
2. Merits of Huge & Challenges/open questions

2004 April-May (After LCWS2004)
Start discussion on the advantages of the 'Huge /Truly Large Detector' concept.

2004 July at Victoria (North America LC Workshop)
Quick presentations of `Huge Detector Concept'

2004 Sep at Durham
This presentation

2004 November 9-12
7th ACFA Linear Collider Workshop on Detector and Physics
Taipei, Taiwan information is on http://hep1.phys.ntu.edu.tw/ACFA7/

We will have a **kick-off meeting** for **Huge Detector Concept Study**.
Please come and join the discussion and actual studies!

We are now very much **open-minded**

Size/experience

Update of philosophy/technologies

Physics Motivations & Experiences

World-wide studies on P-Flow Algorithm

World-wide new detector R&D

Huge Detector Concept

Best optimized for **PFA**

Detailed study has just started…

There are so many open-questions and many challenges

→ **Should be very interesting**

Ideas of Huge detector concept must be developed by global team from the beginning.

We would like to work together with all of you.

Our definition of "Huge" detector

- Moderate strength of magnetic field **(B~2.5-3T)**
- Large inner radius of ECAL **(R>2m)**

It is still smaller than the CMS detector at LHC

Main Motivations:

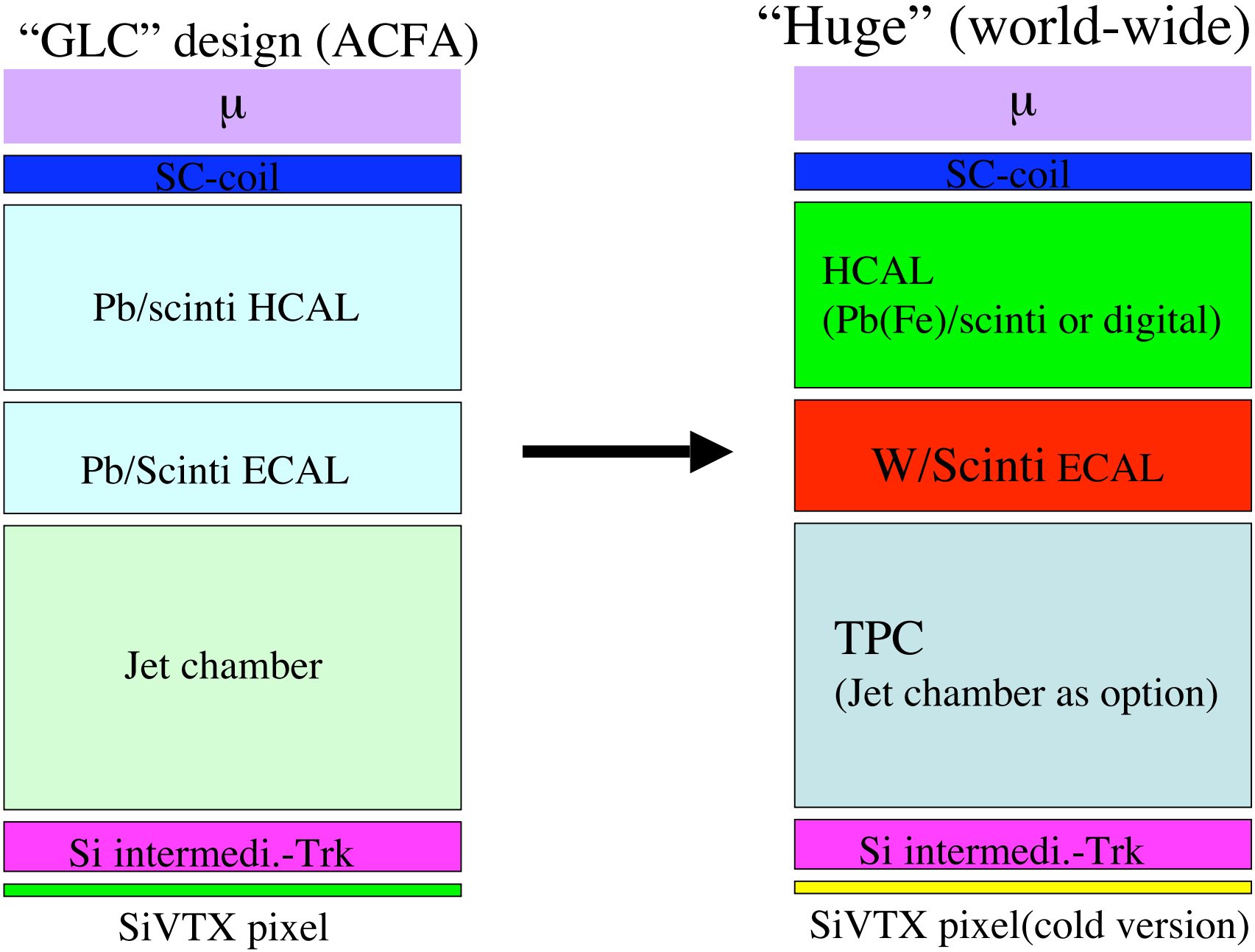
= Good separation of clusters/tracks --> good for PFA

Current rapid movements (in Japan) towards "Huge"

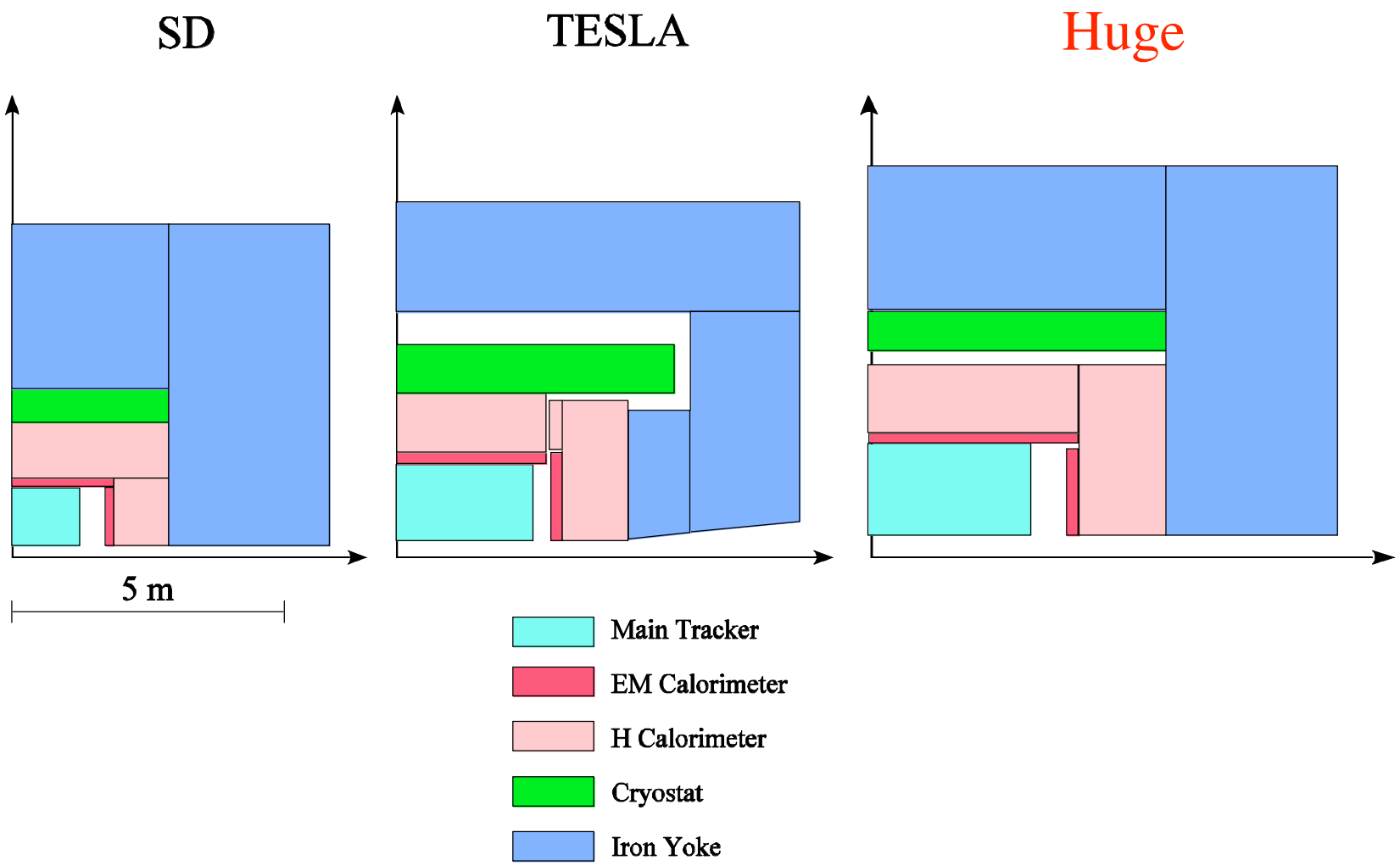
- **Simulation** study: focus on **PFA** and VTXing
- **Calorimetry**:
  Compensation type Pb-Scinti --> **W-Scinti** base ECAL
- Gas tracker
  Jet chamber --> **TPC** (Jet chamber as an option)

Some of the preliminary results of checks will be presented at ACFA workshop

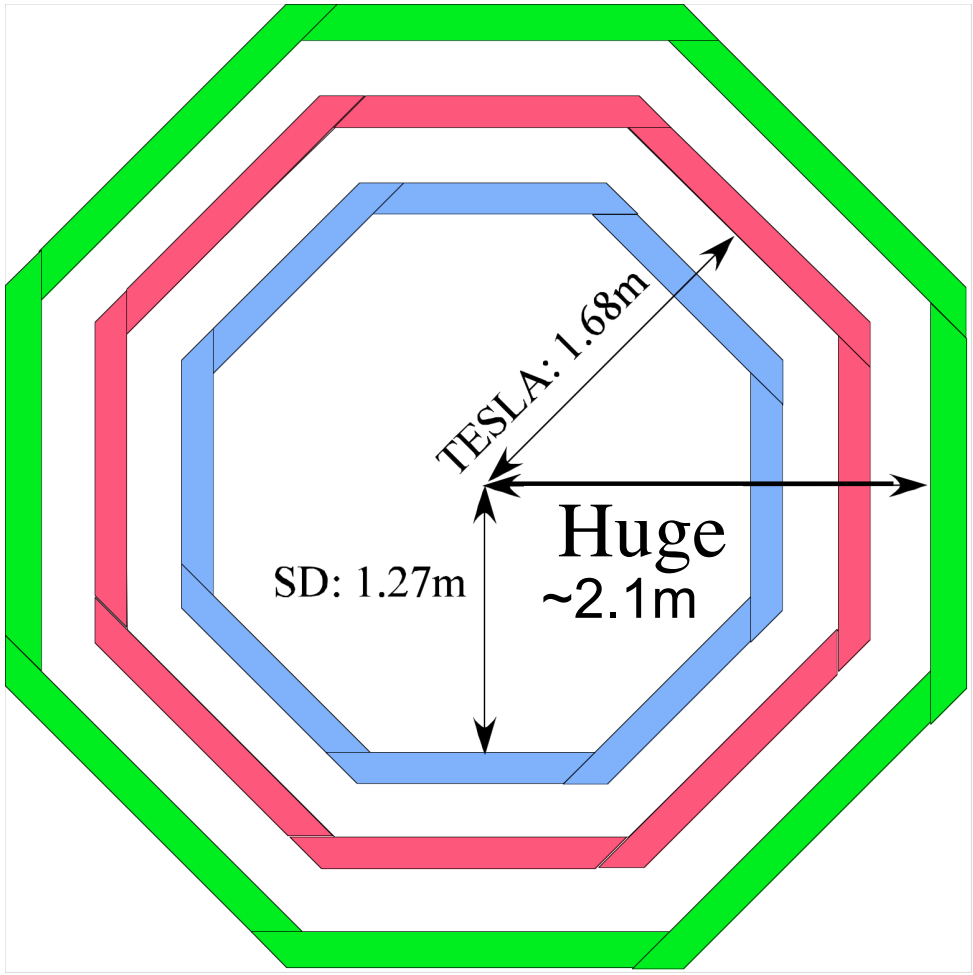
Typical "Huge" models under consideration



General view of "Huge"



Comparison of size of EM CAL surface



- Area of EM CAL (Barrel + Endcap)
  - SD: ~40 m^2 / layer
  - TESLA: ~80 m^2 / layer
  - Huge: ~100 m^2 / layer
  - (GLC: ~130 m^2 /layer)

Merits of Huge Detector

- **Good Jet Energy (Particle) Flow Measurement**
  Good charged track separation in a jet at the inner surface of the calorimeter
  large BL^2

- **Pattern recognition is easier**
  large n with thin material, small number of low momentum curling tracks

- **Good momentum resolution for charged particles**
  large $BL^2\sqrt{n}$

- **Good dE/dx measurement for charged particles**
  large n

- **Smaller relative volume of the dead space**
  small $\Delta V/V$ for constant $\Delta V \propto n$

- **Two track separation, Larger efficiency for Ks and Λ (any long lived)**
  large BL^2 , larger R

- Figure of merit (1) : Main Tracker

$$\delta p_t / p_t^{\,2} = \left(\frac{3.3\sigma}{BL^2}\right)\sqrt{\frac{720}{n+4}}$$

σ : Spatial resolution

B : Magnetic field

L : Tracking length

n : Number of samplings

(The momentum resolution at lower energies is determined by multiple scattering, though)

- Figure of merit (2): Calorimeter

$$\sigma_{jet}^2 = \sigma_{charged}^2 + \sigma_{\gamma}^2 + \sigma_{nutral\ had}^2 + \sigma_{confusion}^2 + \sigma_{threashold}^2$$

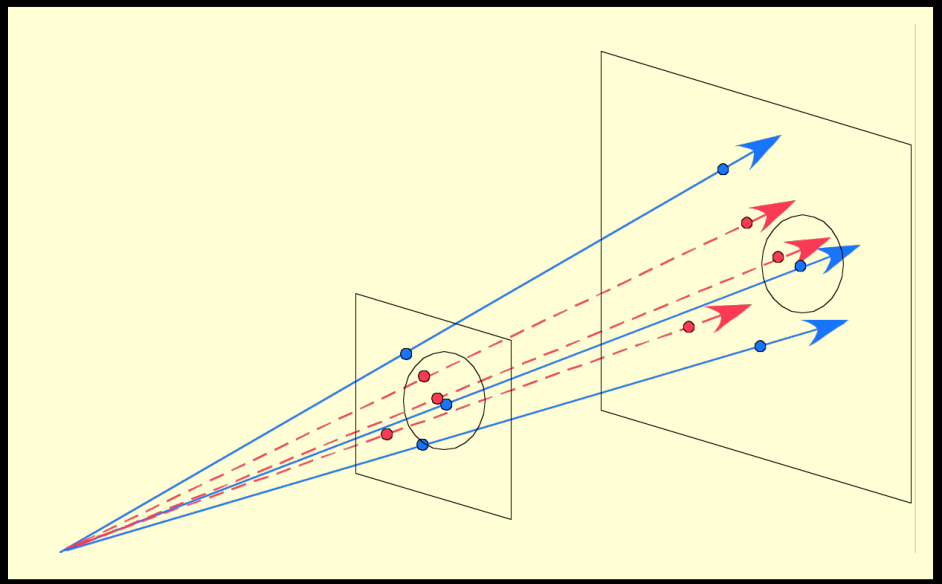
  - Separation of charged particles and γ/nhad is important

(--> H.Videau's talk at LCWS2004)

Separation: $B \times L^2 / R_M$

L : Inner radius (Z) of Barrel (Endcap) ECAL

R_M: (effective) Moliere length



A quick comparison

(Y.Sugimoto)

- tracker

(numbers for `Huge' are all tentative)

		SD	**TESLA**	**Huge**
Solenoid	B(T)	5	4	3
	Rin(m)	2.48	3.0	3.75
	L(m)	5.8	9.2	*8.4*
	E_{st}(GJ)	1.4	2.3	*1.2*
Tracker	R_{min} (m)	0.2	0.36	*0.40*
	R_{max}(m)	1.25	1.62	*2.05*
	s(mm)	7	150	*150*
	N_{sample}	5	200	*220*
	dpt/pt^2	**3.9e-5**	1.5e-4	***1.1e-4***

(Y.Sugimoto)

A quick comparison - ECAL

		SD	TESLA	Huge
ECAL	R_{in}(m)	1.27	1.68	*2.1*
	p_t^{min} (GeV/c)	1.9	2.0	*1.9*
	BR_{in}^2	8.1	11.3	*13.2*
	Type	W/Si	W/Si	*W/Scinti*
	R_M(mm)	18	24.4	*16.2*
	BR_{in}^2/R_M	448	462	*817*
	Z	1.72	2.83	*2.8*
	BZ^2/R_m	822	1311	*1452*
	X_0	21	24	27
Total	λ	5.5	5.2	*6.0*
	t (m)	1.18	1.3	*1.4*

Many basic/essential open questions and challenges

- **How to reduce the cost of ECAL? Which type of ECAL photo-sensor to chose?**
  (Number of channels would be similar to other detector designs, though)
- **HCAL should be inside Magnet? Or can be put outside? How to support the heavy structure?**
- **Silicon Vertex Inner radius** (due to the lower magnetic-field) ? --> need ILC parameters.
  Any essential impact on physics ?
- **Uniformity of the magnet** is fine? (seems to be fine - by Yamaoka's study)
  How about stored energy of magnet? Energy $\propto B^2V$
- **Crossing-angle**? Which forward detector? --> need ILC parameters
- How to mechanically **support central tracking system** including Final-Q ?

…. …. ….

⇒Many challenges and open questions:
Need detailed studies. Very good for new Participants!

Summary

- We will accelerate efforts towards the truly global ILC(International linear collider) project and experiments there.
- Based on the past (regional) studies and new ideas given by World-wide groups, and aiming to design a LC detector best optimized for "Particle Flow Algorithm", we are now thinking of "Huge (Truly large)" Detector Concept.
- Detailed studies have just started.

  A global efforts are needed and we are looking for many equal footing partners in the world.

- There are a lot of essential open questions and challenges, which would attract many physicists, especially who have not directly participated in the LC working groups.
- *A kick-off meeting will be held in Taipei in Nov. 2004.*

  Please join the discussion!