Status of ILD

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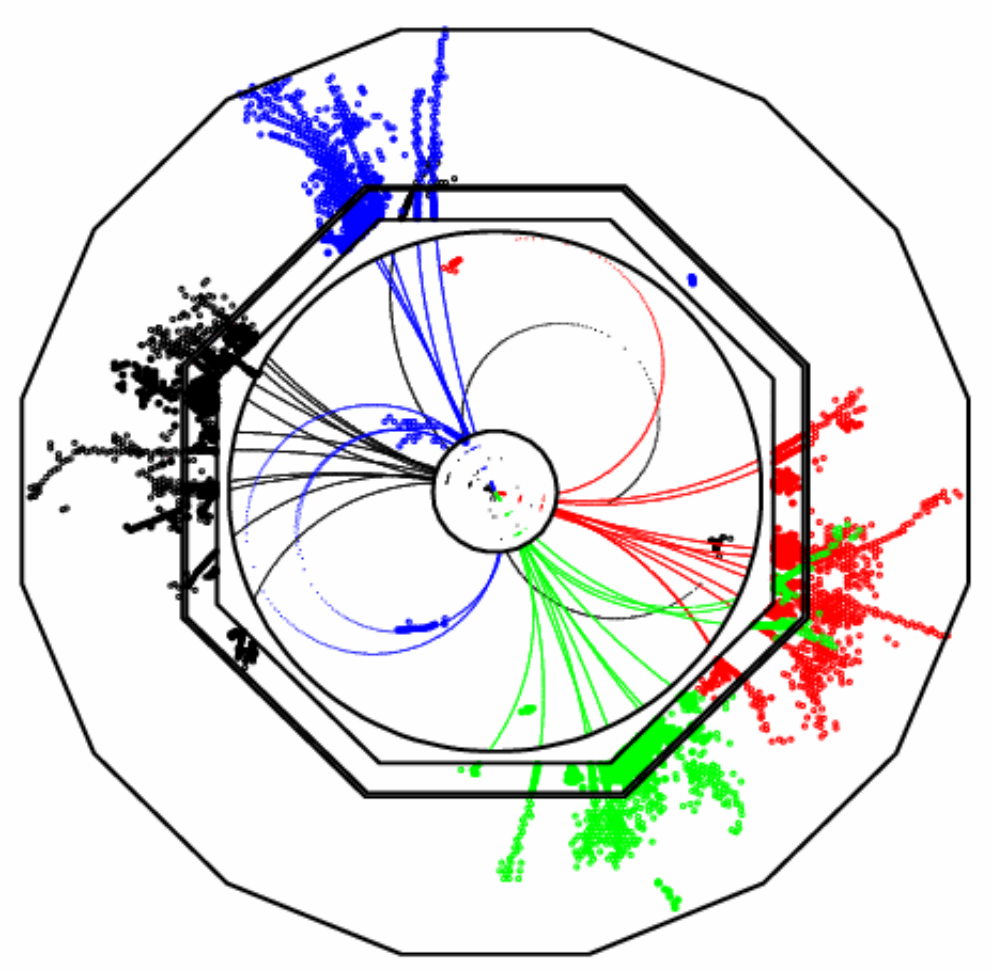


This talk:

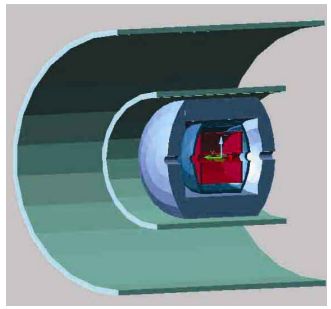
1. ILD
2. LDC → ILD ← GLD
3. ILD Optimisation Overview
4. Simulation Progress
5. Software Progress
6. What next ?

❶ The ILD Concept

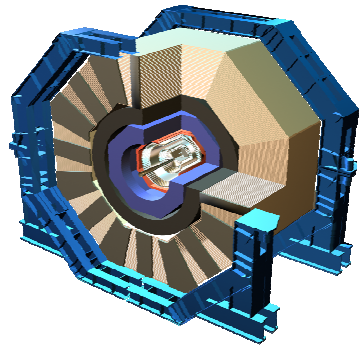
ILC Detector Concepts:

- ★ Until recently ILC Detector Design work centred around 4 detector "concepts"
- ★ 3 of these concepts "optimised" for PFA Calorimetry SiD, LDC, GLD
- ★ ILD formed from GLD and LDC; work towards joint detector concept

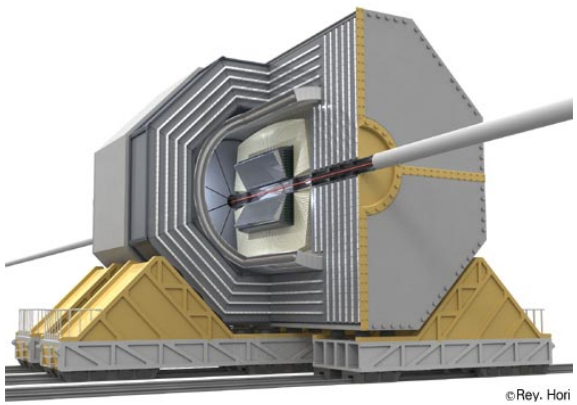
"4th"



SiD : Silicon Detector

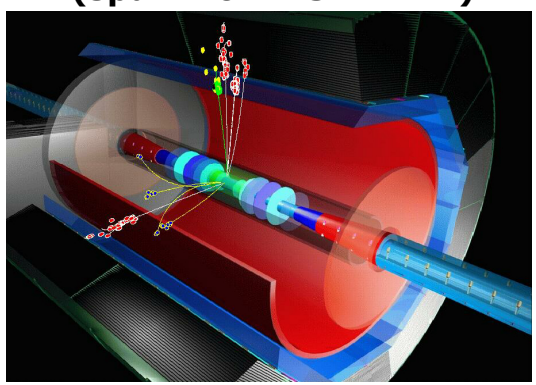


GLD : Global Large Detector



⊕

LDC : Large Detector Concept
(spawn of TESLA TDR)



= ILD

ILD Concept Organisation

- ★ For the LoI phase: fairly lightweight ILD "managerial" structure
- ★ Only in place until LoI is out of the door (will then re-evaluate)
- ★ Some recent developments
- ★ Geared towards optimising detector on basis of physics (not just average of LDC and GLD)

ILD Steering Group:

Ties Behnke Henri Videau	Yasuhiro Sugimoto Hitoshi Yamamoto	Dean Karlen Graham Wilson

Working Groups:

Detector Optimisation:	MDI/Integration:	Costing:
Mark Thomson Tamaki Yoshioka	Karsten Buesser Toshiaki Tauchi	Akihiro Maki Henri Videau

Detector Contacts: connect to "horizontal" R&D projects+… (list being defined)

TPC	VTX	ECAL	HCAL	SiLC	DAQ	Software

From EoI to LoI

- ILD recently submitted Expression of Interest (EoI) to write a Letter of Intent (LoI) to develop a Conceptual Design for an ILC Detector
- The EoI was carefully worded:
  "The list of institutions that have worked on, are working on, or expressed interest in working on the ILD concept study is given below."
- Approximately 150 institutes worldwide signed this
- Good spread across the globe : China (5), France (8), Germany (15), India (6), Italy (11), Japan (27), Korea (10), Poland (8), Russia (8), Spain (10), US (TBC), +…
- 10 from UK : Birmingham, Bristol, Cambridge, Edinburgh, Glasgow, Liverpool, Manchester, RAL/STFC, Royal Holloway, UCL

Current Work towards LoI (March 31st 2009):

- Emphasis on:
  - demonstrating ILD can meet ILC physics/detector requirements
  - defining an optimised ILD baseline (by September 2008)
  - all based on full simulation/full reconstruction physics studies

❷ LDC → ILD ← GLD

★ How will GLD/LDC evolve into ILD ?

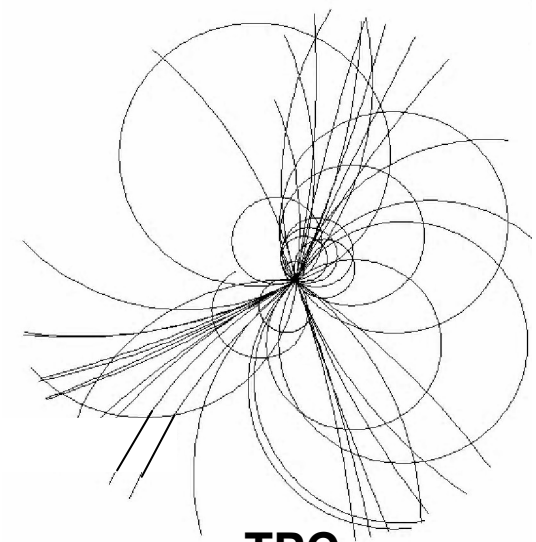
GLD/LDC have common features:

- ★ Both are Large Detector concepts, "Large" tracking volume
  - for particle separation
- ★ Both have TPC
  - for pattern recognition in dense track environment
- ★ Both have high granularity ECAL/HCAL
  - for Particle Flow Calorimetry

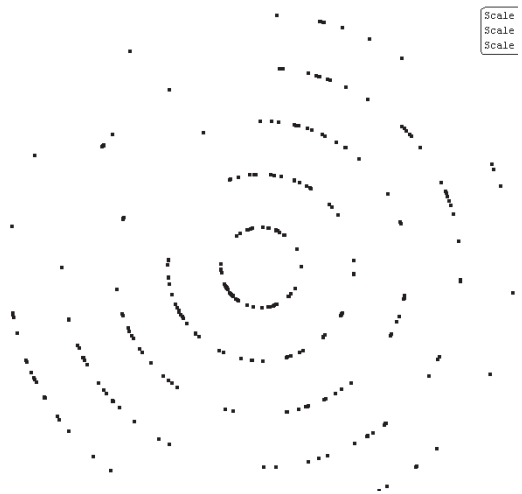
	LDC		GLD	ILD ?
Tracker	TPC		TPC	TPC
R =	1.6 m		2.1 m	1.5–2.0 m ?
B =	4 T		3 T	3–4 T
ECAL	SiW		Pb/Scint	SiW or Pb/Scint
HCAL	Steel	RPC / Scint	Pb/Scint	yes

Goal of ILD Optimisation Study

Design Issues : why a TPC ?



TPC



Silicon Tracker

★ Large number of samples vs. “few” very well measured points

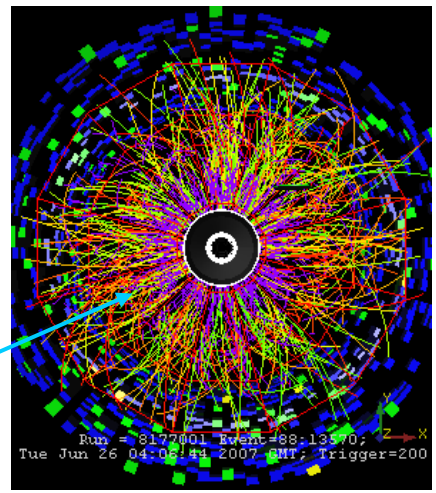
★ From point of view of momentum reconstruction both can deliver required momentum resolution

So why a TPC ?

★ Good pattern recognition capability even in a dense track environment

- This is important for particle flow
  - – need high efficiency reconstruction of “loopers” and “kinks”

★Tried and test technology (ALEPH, DELPHI, STAR,…)



ILD Calorimetry: LDC vs GLD

ILD designed for particle flow:

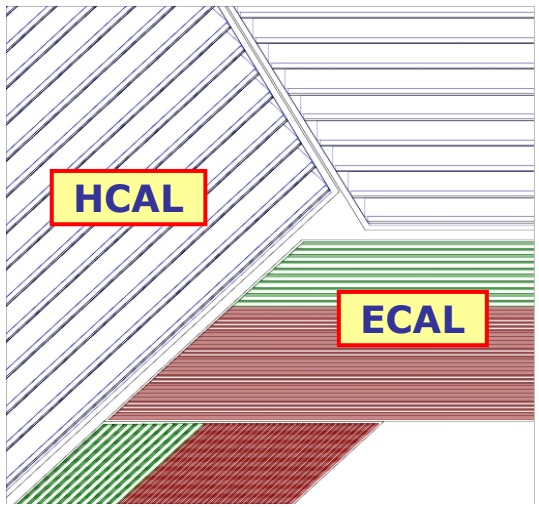
- ★ECAL and HCAL inside coil
- ★Very high segmentation (transverse and longitudinal)

ILD ECAL

Two options…

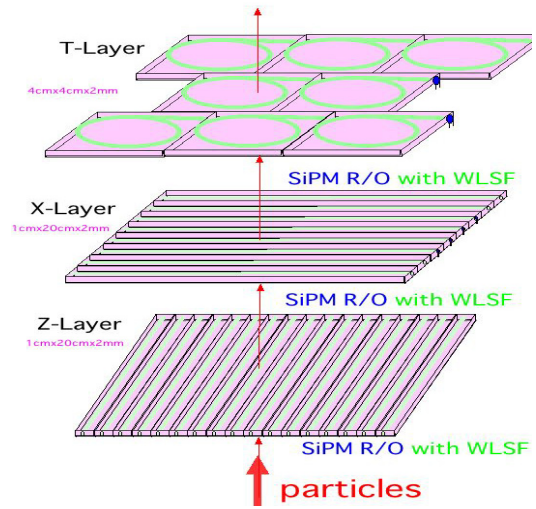
★**CALICE-style SiW calorimeter:**

- Lateral segmentation: ~1cm^2 ~ $R_{Moliere}$
- Longitudinal segmentation: 30 layers
- Typical resolution: $\sigma_E/E = 0.15/\sqrt{E(GeV)}$



★**GLD-style Scint-W calorimeter:**

- Achieve effective ~1cm^2 segmentation using strip/tile arrangement
- Strips : 1cm x 20cm x 2mm
- Tiles : 4cm x 4cm x 2mm



ILD HCal

Again Highly Segmented – for Particle Flow

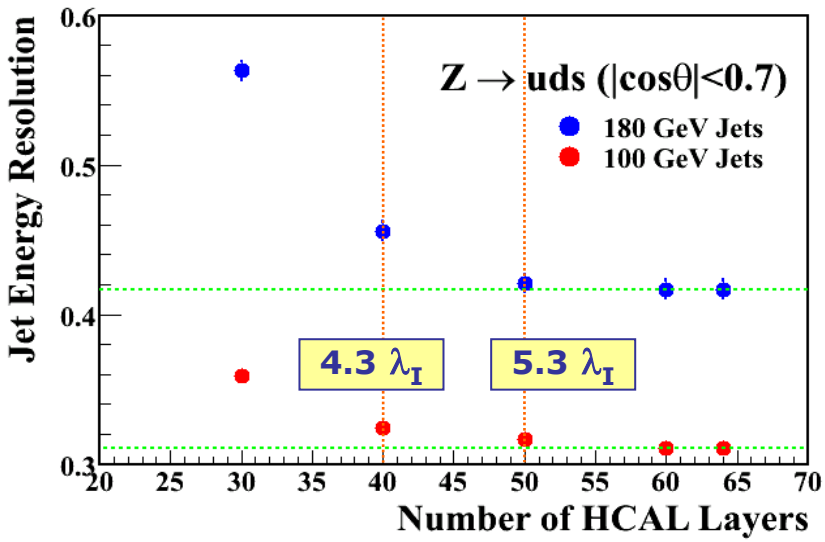
- **Longitudinal: ~40 samples**

Two main options:

- **Tile HCAL (Analogue readout)**
- **Steel/Scintillator sandwich**
  or Pb/Scintillator sandwich
- **Segmentation ~ 3x3 cm2**

- **Digital HCAL**
- **Segmentation**
- **RPCs, wire chambers, GEMS…**

★ **Optimisation studies needed**



★ **Many open questions ⇨ detector optimisation**

❸ ILD Detector Optimisation

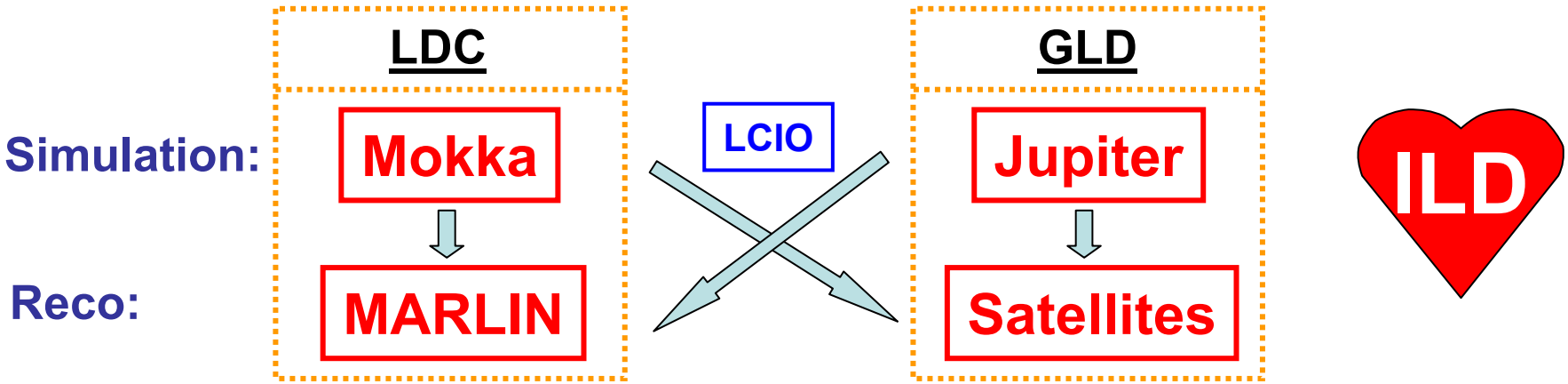
- ★ This is currently the major effort in ILD
- ★ Weekly phone meetings (Wednesday 1300 UK)
  - well attended and very interesting meetings
  - significant contributions from UK
  - progress is rapid !
- ★ This is a non-trivial effort:
  - Detailed detector simulation: sub-detector models handed over to detector R&D groups – very positive move.
  - Full reconstruction code exists (Vertexing, Tracking, PFA): sophistication at level of LEP experiment reconstruction ! (much borrowed from LEP)
  - About to generate fully simulated/reconstructed SM background samples on GRID (aiming for sample of similar size to that used by LEP experiments)

In the next slides will try and give a feel of on-going optimisation work

Optimisation Studies : How ?

★ Currently GLD and LDC use different G4 simulations/ reconstruction frameworks (this is not ideal but it is what we have got)

★ Connected by common data format



★ Given the timescale, perform ILD detector studies in context of both GLD and LDC

★ Study physics performance dependence by changing global parameters
e.g Radius, field

★ Compare GLD and LDC – provide some cross check of conclusions

★ Also many interesting sub-detector questions to be addressed,
e.g. impact of dead material

LDC'/GLD' Common Parameters

★ **Have defined** (and will simulate) a common point: LDC' and GLD' : a larger version of LDC and a smaller version of GLD ⟹ direct point of comparison

Sub-Detector	Parameter	GLD	LDC	GLD'	LDC'
TPC	R_{inner} (m)	0.45	0.30	0.45	0.30
	R_{outer} (m)	2.00	1.58	1.80	1.80
	Z_{max} (m)*	2.50	2.16	2.35	2.35
Barrel ECAL	R_{inner} (m)**	2.10	1.60	1.82	1.82
	Material	Sci/W	Si/W	Sci/W	Si/W
Barrel HCAL	Material	Sci/W	Sci/Fe	Sci/Fe	Sci/Fe
Endcap ECAL	Z_{min} (m)***	2.80	2.30	2.55	2.55
Solenoid	B-field	3.0	4.0	3.50	3.50
VTX	Inner Layer (mm)	20	16	16	15

START GENERATION WITH LDC'/GLD'

THEN WITH LDC/GLD

THEN MAXI-LDC/J4LDCGLD

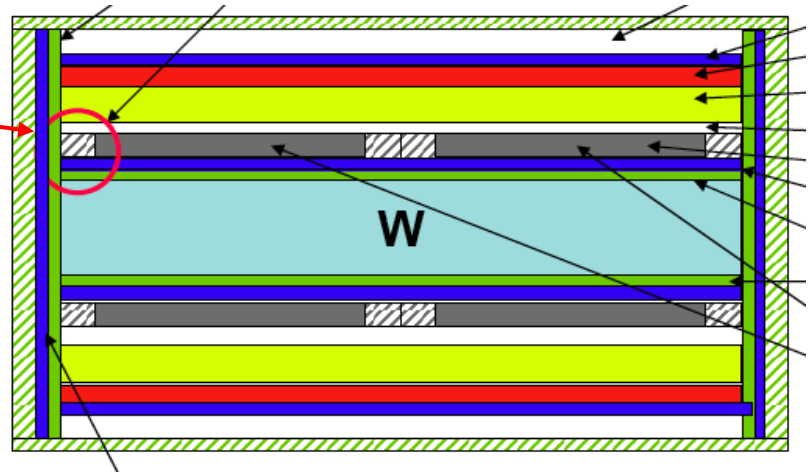
First 3 Points in detector space to guide ILD design

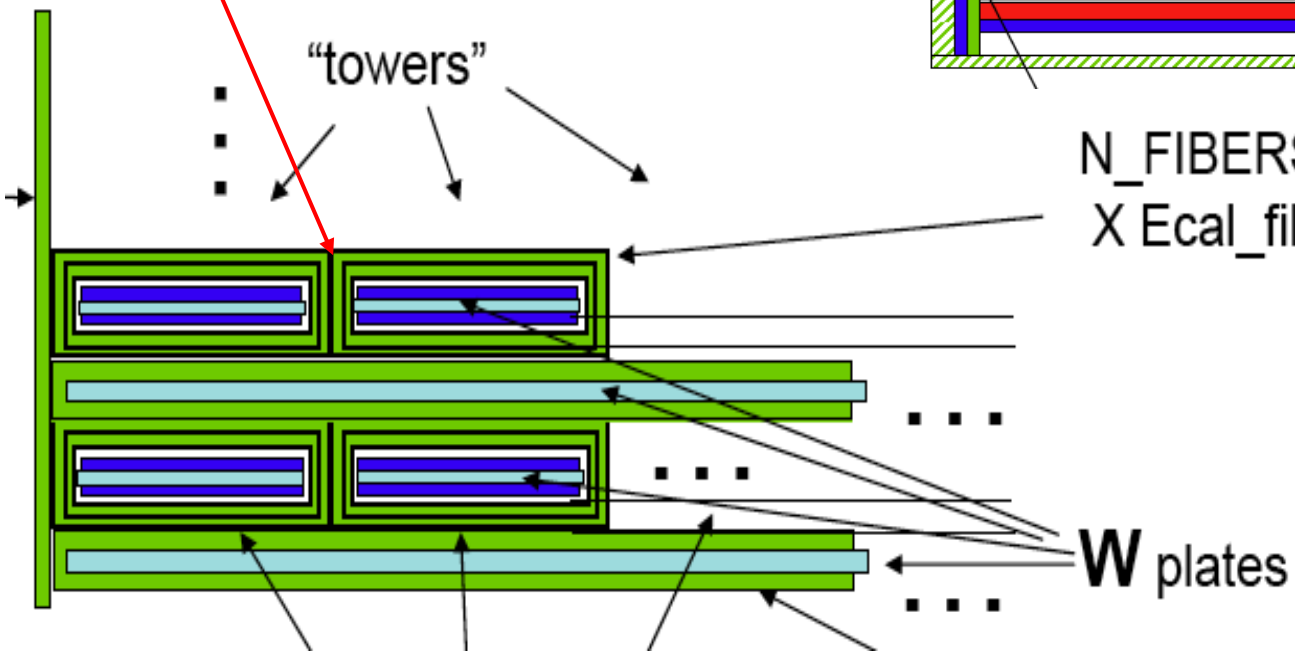
❹ Simulation Progress

- During the last two months – a lot of progress in defining new LDC detector models (LDC, and LDC') and GLD models
- Changes to G4 models for most sub-detector drivers !
  - More realism (good/bad)
  - More flexibility
- LDC Detector models finalised 3.5 hours ago.
- Philosophy:
  - driven by needs of global detector optimisation
  - but also want to make as useful as possible for sub-detector groups (VTX, HCAL, Si-tracking) provided does not impact the main aim

e.g Ecal

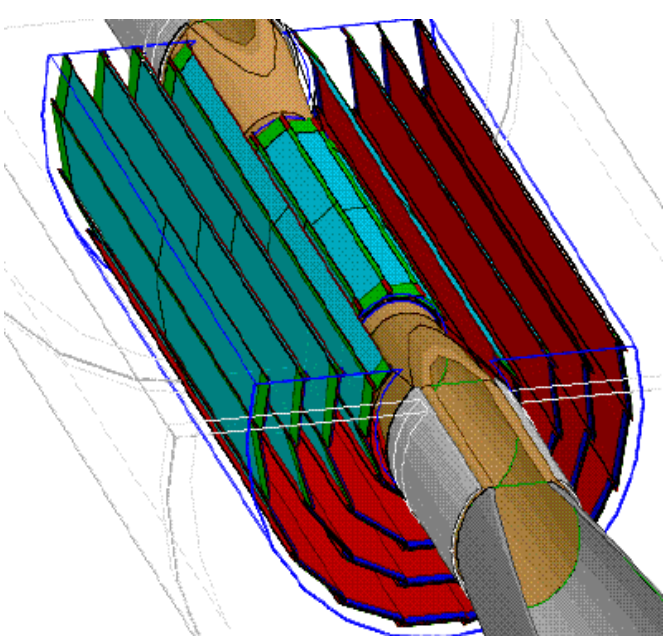
- Detailed, "first order engineering level" description
- Larger dead areas
  - edge of wafers
  - inter-alveolar gaps

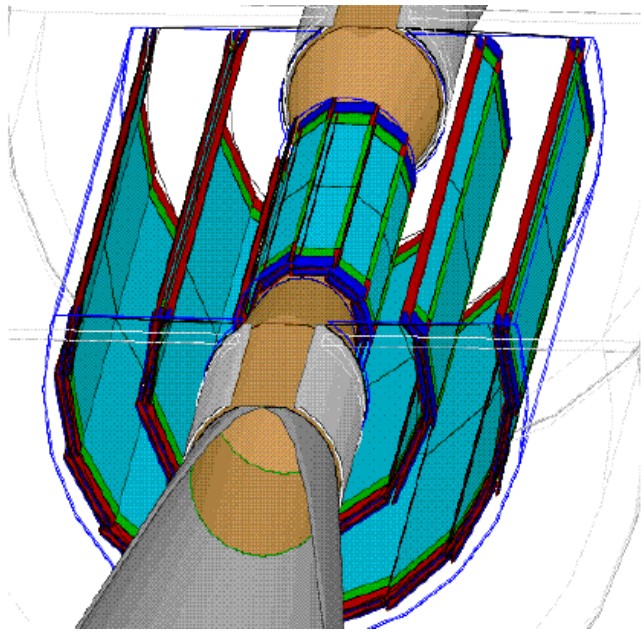




e.g. Improved Vertex Models

- ★ Two new drivers
- ★ LDC-like geometry and GLD-like geometry
- ★ Flexible for VTX optimisation studies
- ★ Models driven by VTX community (a very positive move)

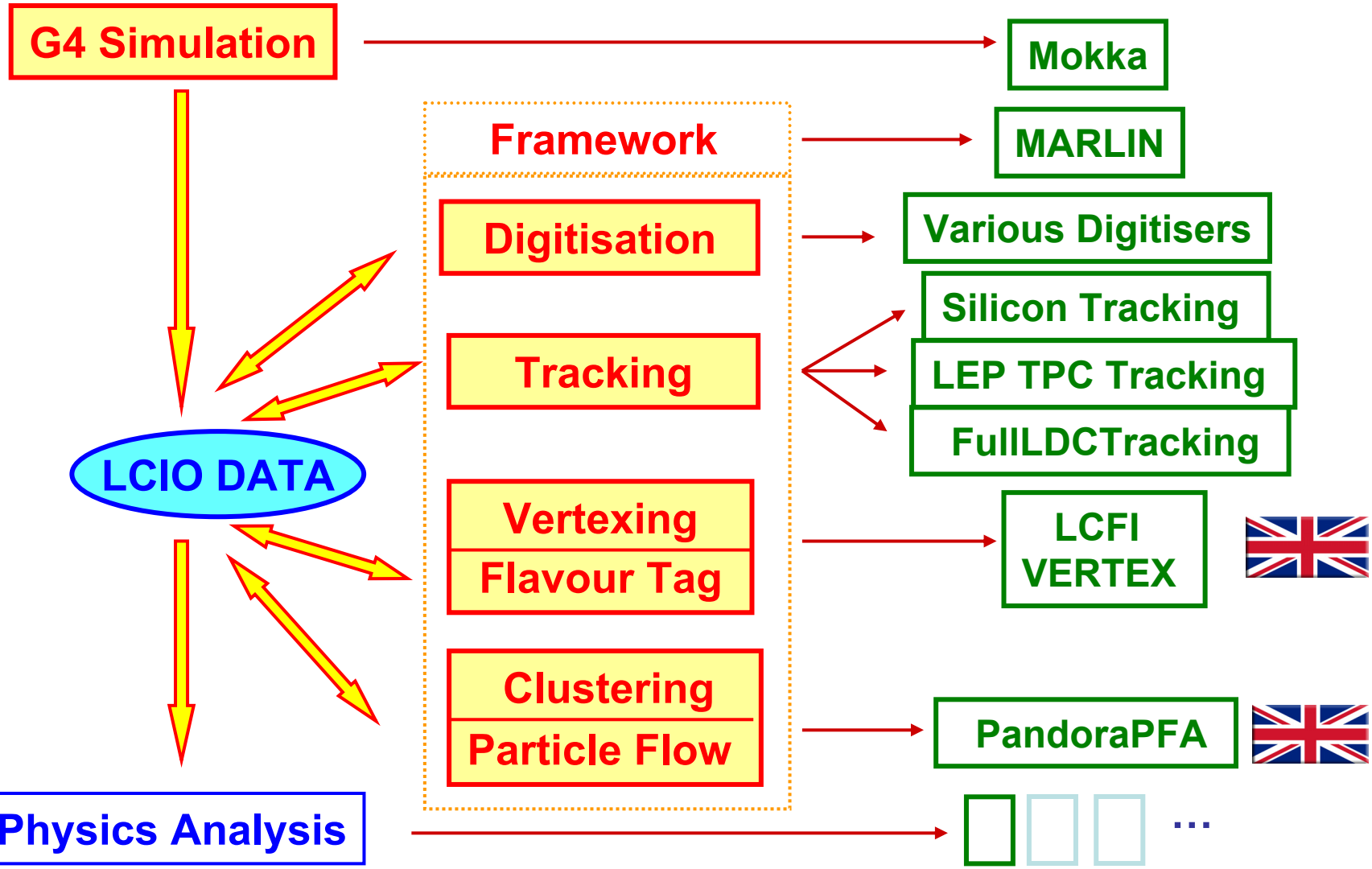




- ★ Sensor active area and response for different technologies can be implemented at digitiser stage
- ★ Powerful tool for optimisation of both global detector and sub-detector
- ★ Vital UK contributions in validating these models.

❺ Software Progress (LDC side)

It all exists, and it works ! To get to this point has been non-trivial

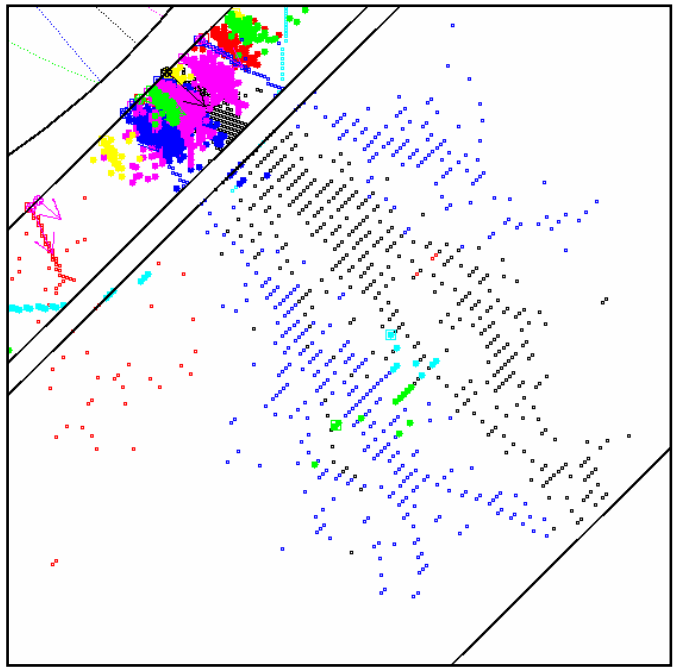


e.g. Current LDC PFA Performance

★ **Validated using full reconstruction chain, e.g.**

PandoraPFA v02-01 + FullLDCTracking

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	0.235	3.5 %
100 GeV	0.306	3.1 %
180 GeV	0.427	3.2 %
250 GeV	0.565	3.6 %



★ **For 45 GeV jets, performance now equivalent to**

23 % / √E

- **unprecedented calorimetric performance ! (MC)**
- **this is not the end…**

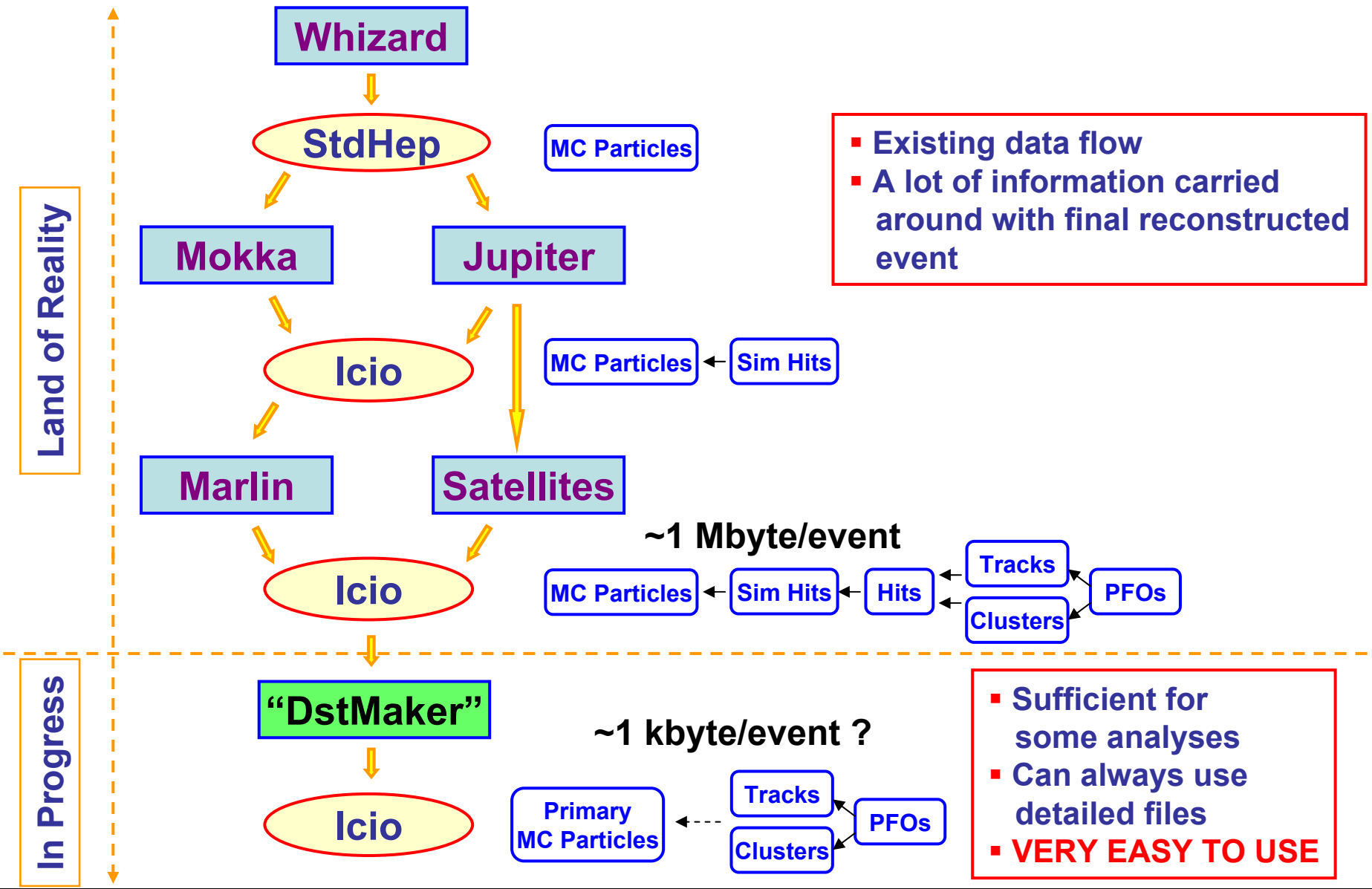
[Applications to other LCs ?]

★ **We know that ILD can reach ILC calorimetry goal !**

★ **This + Vertexing + Tracking will be important input LoI**

★ **Can now move to physics studies, how best to do this ?**

Input to Physics analysis



- Existing data flow
- A lot of information carried around with final reconstructed event

- Sufficient for some analyses
- Can always use detailed files
- VERY EASY TO USE

❻ What next ?

What next for ILD ?

- Flood the GRID with Monte Carlo !
- Aim for first physics-based optimisation for **September ILD meeting** (in UK?)
- For LoI convincingly demonstrate ILD as viable ILC detector

What next for the UK ?

- Current funding situation is not ideal…
- But, things are moving forward and the UK needs to remain involved.
- Already having a big impact through PFA and vertexing + … !
- People can also contribute to physics studies. ILD strategy is to make this as easy as possible:
  - will provide complete reconstructed MC samples
  - hopefully even at DST level
- Ideal starting point for graduate students (+ undergraduate projects)

And finally…

- ★ The next 9 months will define ILD
- ★ We will see very rapid progress
- ★ In ***n*** years time, we may be building something not unlike-ILD…
- ★ The run upto the LoI will be an exciting time