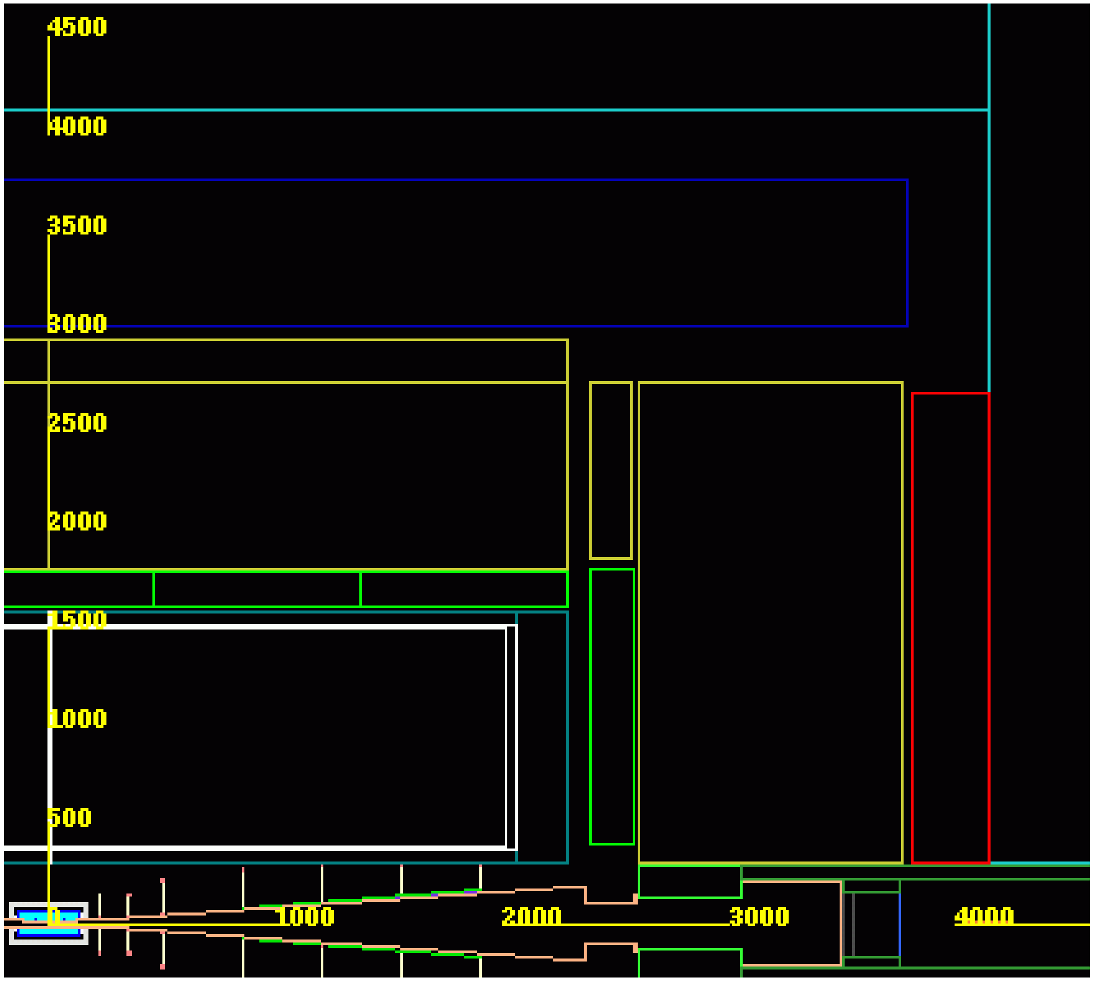
# LDC in Mokka

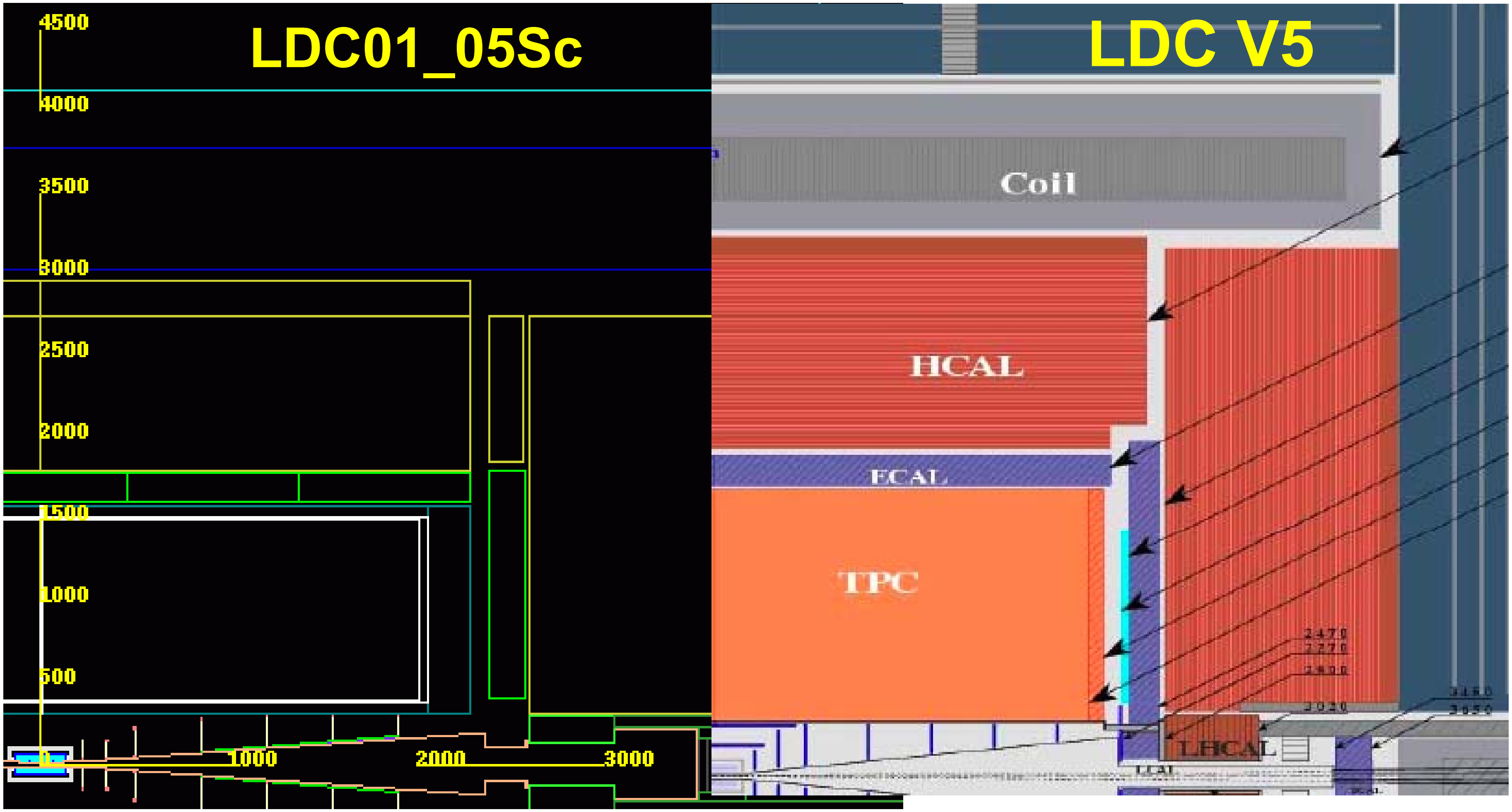
**Mark Thomson**
**University of Cambridge**



# Overview

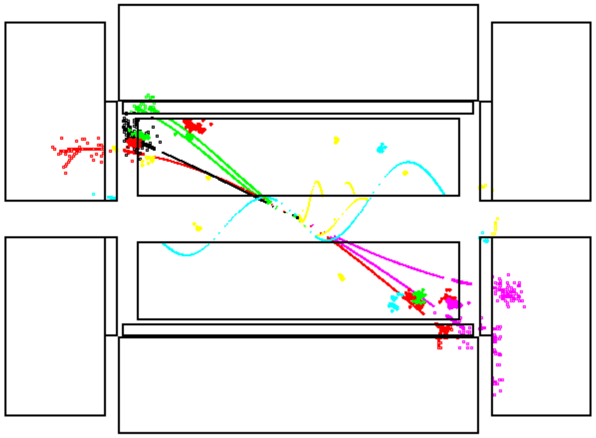
- During the last two months – a lot of progress in defining new LDC detector models (LDC, and LDC')
- Changes to most sub-detector drivers !
  - More realism (good/bad)
  - More flexibility
- Set the deadline for finalising sub-detector drivers for this coming Monday
- At Wednesday's optimisation phone meeting – will fix (?) model for mass GRID-based generation
- At that stage, will only make changes to fix bugs rather than improve the model
  - motivated by need to start production
- 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

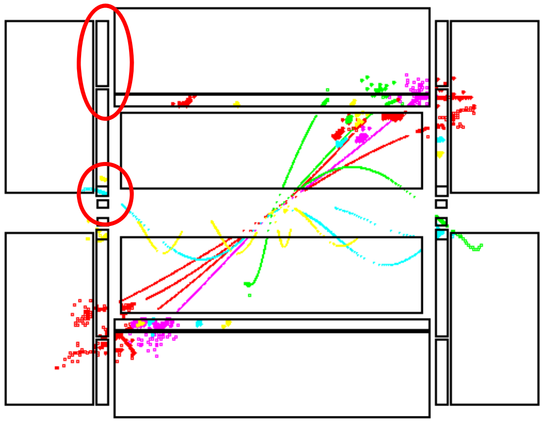
# LDC detector in Mokka



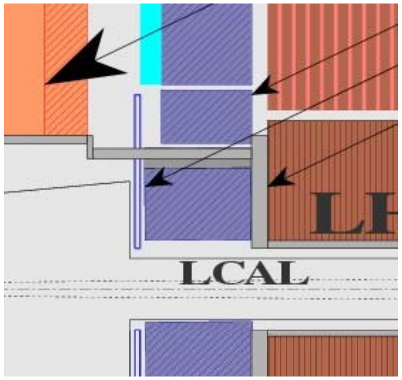

- Close to, but not exactly the same as, proposed LDC model
- Here, will concentrate on main changes

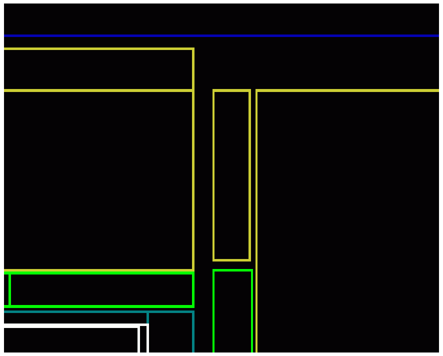
# Plugging the gaps





- **LCAL (B. Pawlik) : 48 sectors in phi – enough for PFA ?**
- **ECAL Plug (P. Mora) : between ECAL and LCAL**
- **HCAL Ring (P. Mora) : coverage**

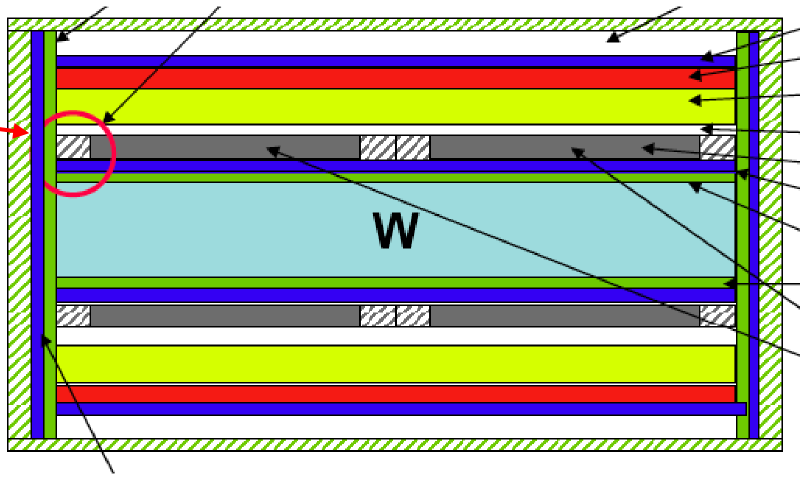


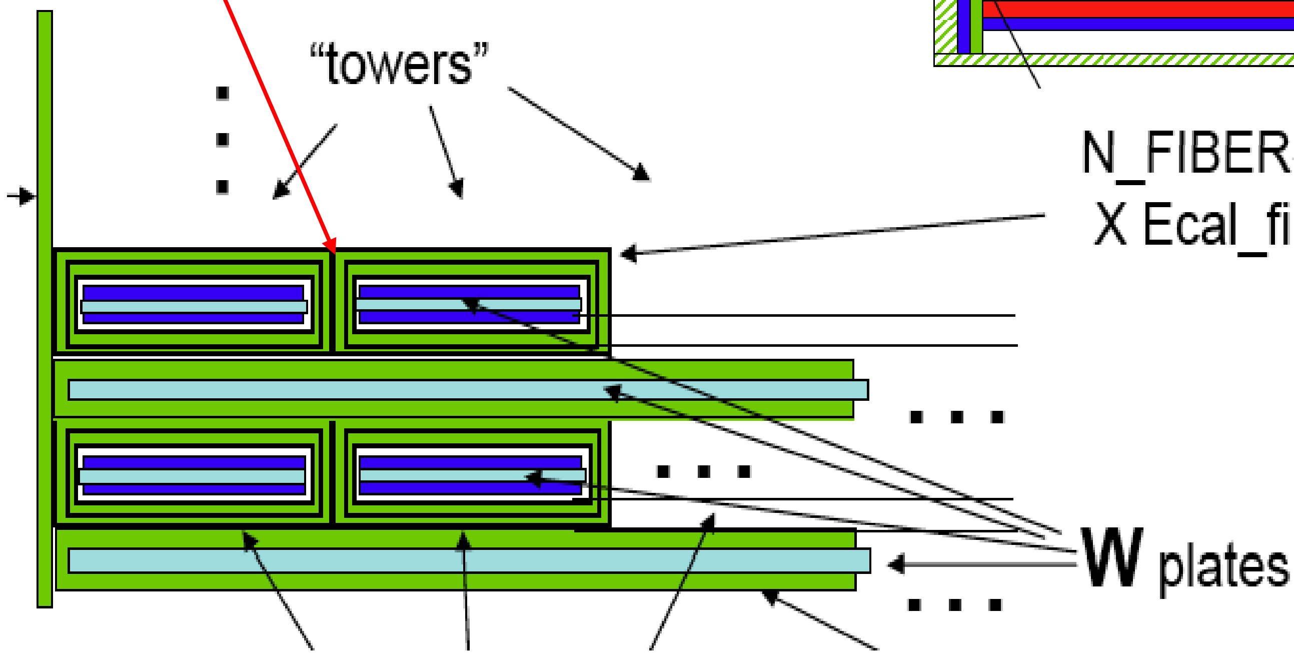



★ **Still no LHCAL**

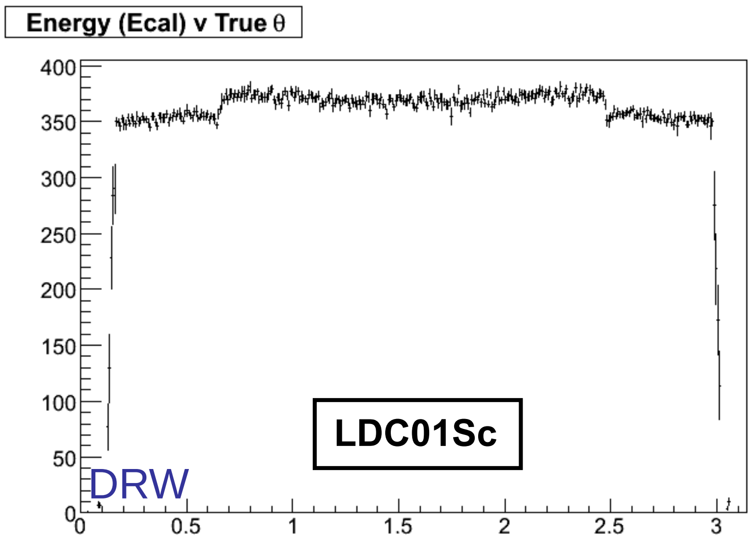
# Improved Ecal in Mokka (P.Mora)

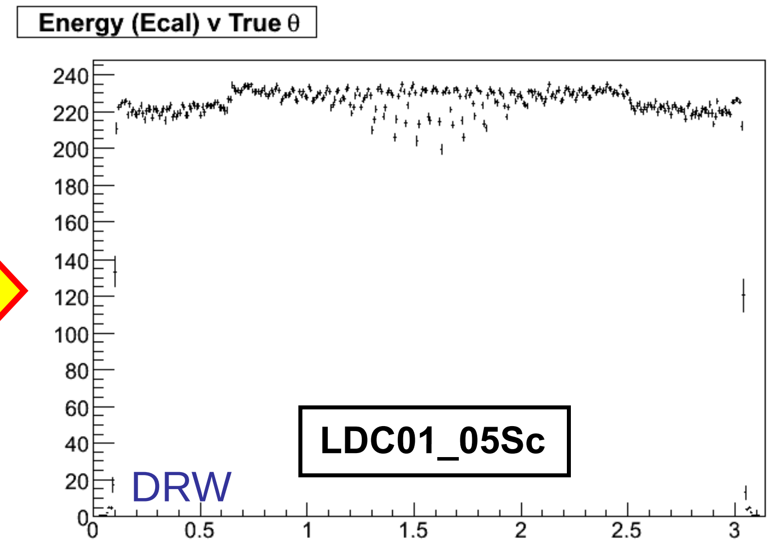
- Detailed, "first order engineering level" description
- Larger dead areas
  - edge of wafers
  - inter-alveolar gaps



# Impacts "performance"




★ Can ***estimate*** **contributions to PFA performance** **(45 GeV jets)**

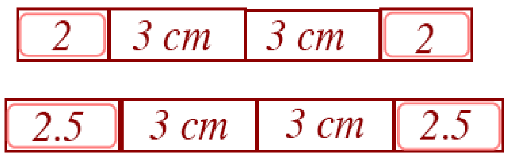
$$\sigma_E = \alpha\sqrt{E}$$

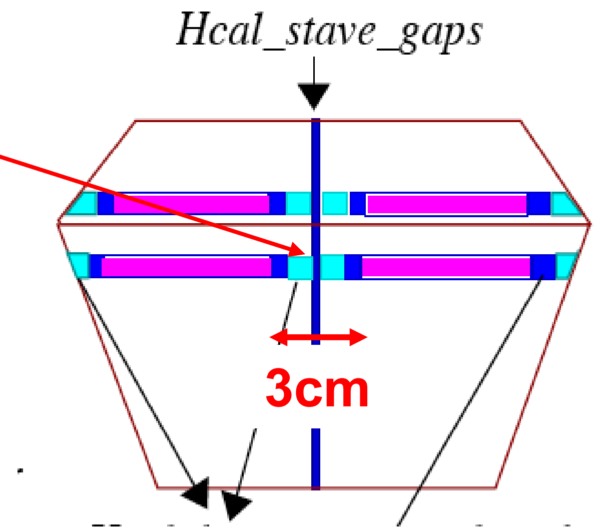
| α | ECAL | HCAL | Confusion | Other | Total |
|---|---|---|---|---|---|
| LDC00Sc | 0.07 | 0.17 | 0.11 | 0.09 | 0.235 |
| LDC01_05Sc | 0.14 | 0.17 | 0.12 | 0.09 | 0.267 |

- ★ **Effect will be reduced somewhat in current (smaller gaps than LDC01_05Sc)**
- ★ **BUT raw ECAL resolution will be degraded**
  - ★ **and PFA performance degraded**
- ★ **Will need to correct for effects of gaps in software !**
- ★ **This is a significant complication – is this what we want ?**

# Improved HCAL (A. Lucacci)

- ★ Increased realism/more flexibility
- ★ Introduced additional caps in middle of module
  - ♦ not small ~ 3cm
  - ♦ “gaps” line up and point to IP
- ★ Also introduced realistic scintillator tiling



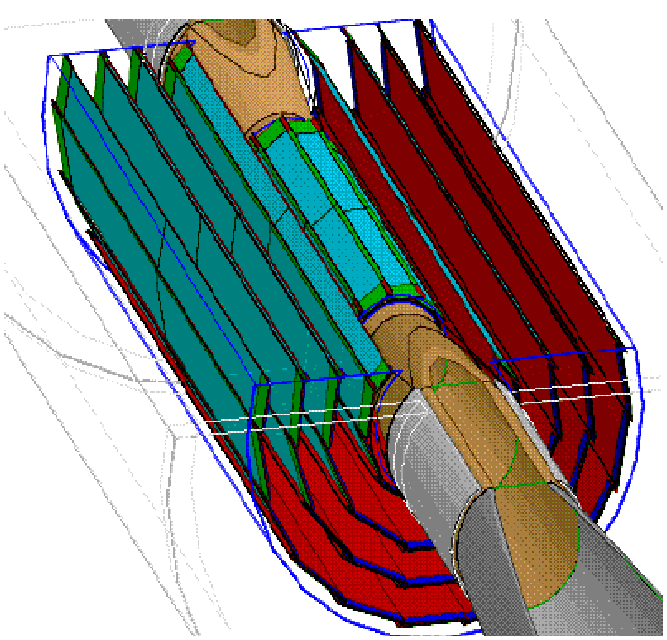



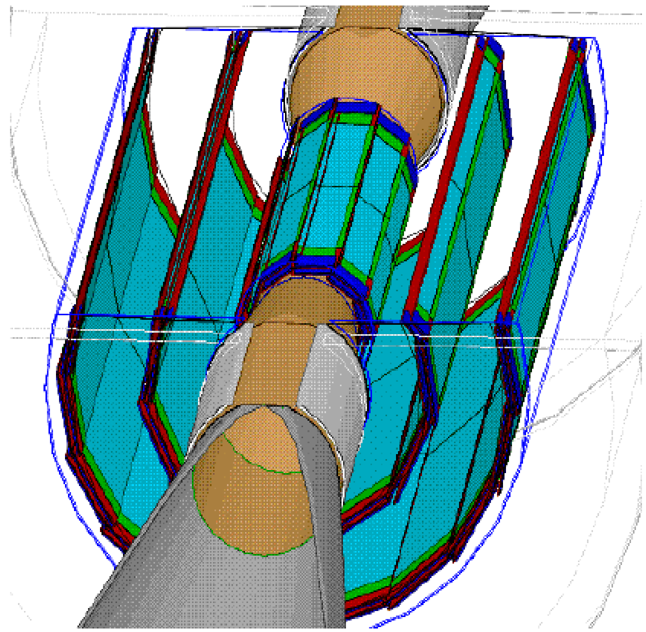

**Comments/Questions:**

- ★ Impact of large gaps on PFA is not known
  - ♦ could affect clustering
- ★ Gaps may be realistic, but very much doubt we would design a real HCAL with this pointing gap geometry
- ★ Suggest reducing gaps to ~1cm for mass generation
- ★ In parallel, study impact on PFA
- ★ Win-win approach:
  - ♦ if 3cm gaps don’t matter, performance with 1cm gaps is ~same
  - ♦ if they do matter, need to revisit design, but global study not affected

# Improved VTX (D. Grandjean)

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





**Comments/Questions:**

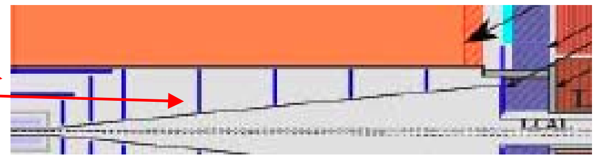
- ★ Mass generation with LDC-like geometry
- ★ NOT yet validated with tracking/LCFI Vertex reconstruction code !
  - ♦ but being studied (Lynch) – report at next optimisation meeting
- ★ Fallback solution – revert to old model…

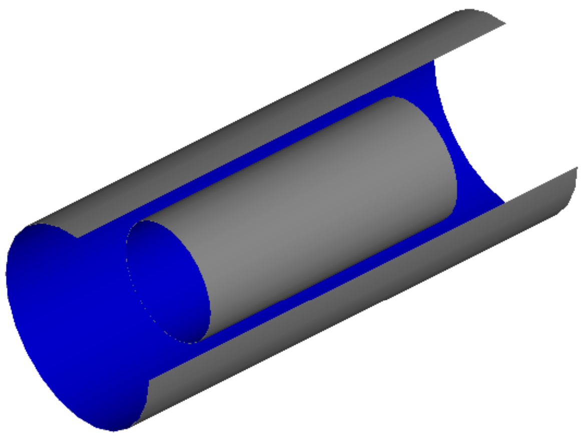
# Silicon Tracking (V. Saveliev)

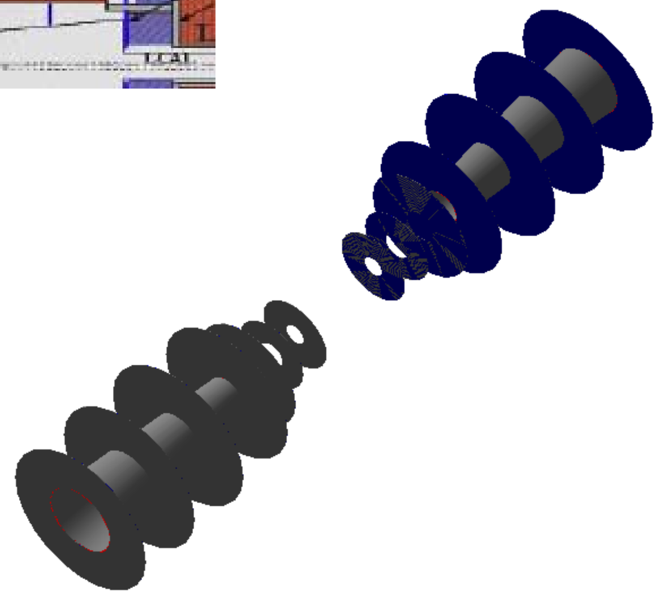
★ **All new drivers from SiLC**

**Inner Tracking**

★ **SIT**
★ **FTD**







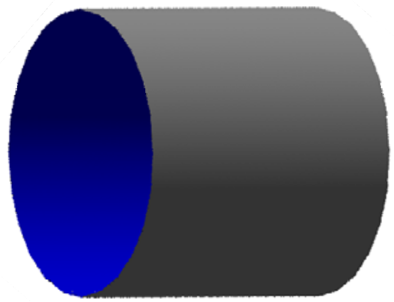
**Comments/Questions:**

★ **“Hard-coded” non-scalable drivers – need scalable drivers v. soon**
★ **Exists for LDC model but not yet for LDC’ (in progress)**
★ **This will be a problem if not ready in time…**
★ **Tracking software being validated (Raspereza)**
★ **Fallback solution – use old drivers ?**

# Silicon Tracking cont

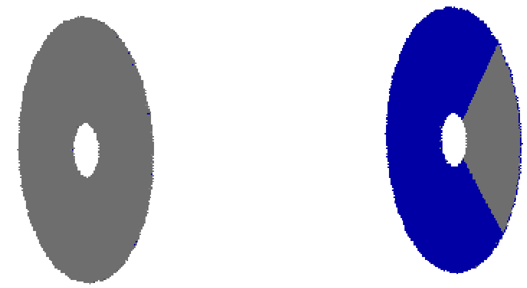
**Outer Tracking**

★ **SET** : between TPC and ECAL barrel



Silicon + carbon support
2 XUV layers × 0.65 % $X_0$

★ **ETD** : behind TPC end-planes



Silicon – carbon sandwich
3 XUV layers × 0.65 % $X_0$

**Comments/Questions:**

★ "Hard-coded" non-scalable drivers – need scalable drivers v. soon
★ May cause problems with ECAL driver
★ Are the SET/ETD part of the initial "baseline" ?
★ Tracking software does not (yet) use ETD or SET:
  - Inclusion increases lever arm for track–calorimeter extrapolation
  - How thick are these models ?
  - At this stage inclusion can only degrade detector performance
  - Balanced by potential use for SiLC tracking studies
★ Fallback solution – do not include

# Decision Time…

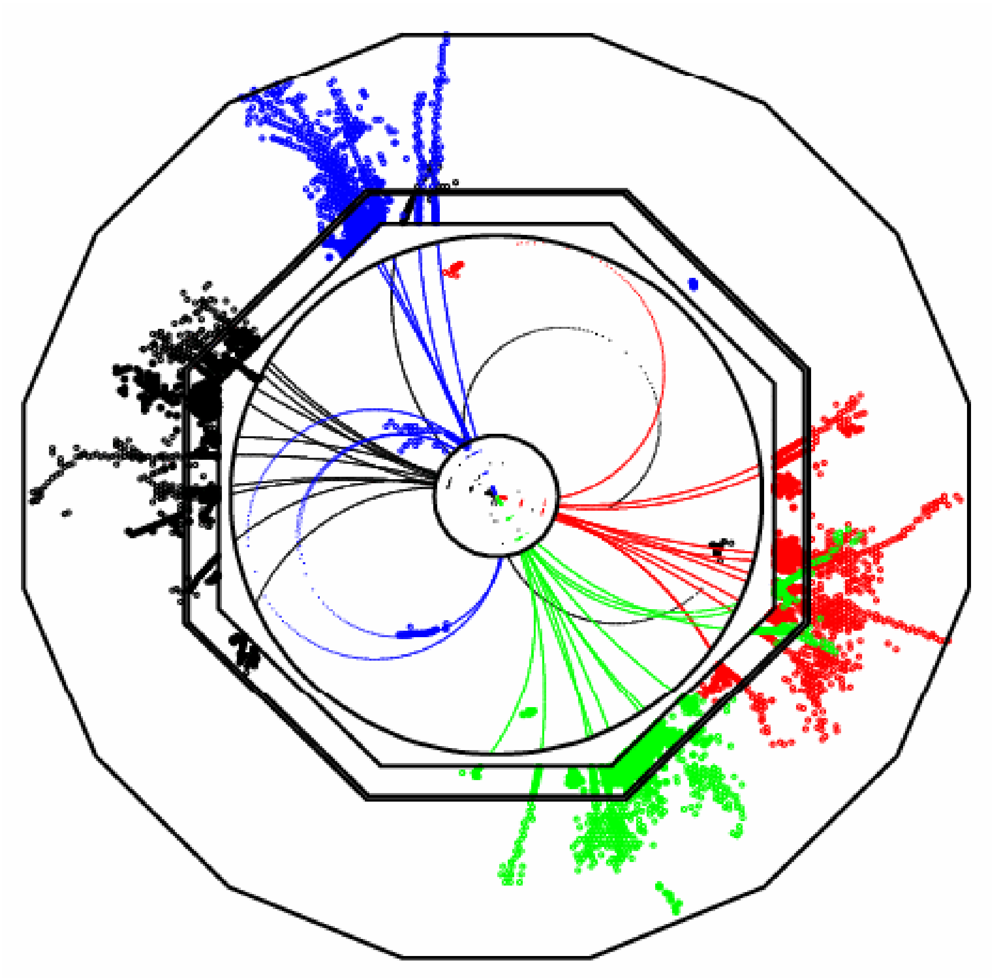
★ **Want to finalise model for mass generation <u>very soon</u>**

**<u>Some concerns:</u>**

- ★ **HCAL model : ready in time ?**
- ★ **SET/ETD : will degrade track-cluster matching**
  - **could be particularly damaging in endcap**
  - **once included in the tracking this may not be an issue**
  - **but this won't happen on timescale of first optimisation**

# ILD Detector Optimisation

**Mark Thomson**
**University of Cambridge**



**Overview:**

❶ **Towards ILD ?**
❷ **Detector Optimisation**
❸ **Optimisation Strategy**
**How ?**
**What ?**
**Subdetectors**
**When ?**
❹ **Summary**

# ❶ 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**

**But also significant differences:**

| | 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 | | Scint | SiW or Scint |
| HCAL | Steel | RPC / Scint | Scint | yes |

**First Goal of ILD Optimisation Study** (R and B)

# ❷ Detector Optimisation Study

## Charge of Detector Optimisation Working Group:

"Investigate the dependence of the physics performance of the ILD detector on basic parameters such as the TPC radius and B-field. On the basis of these studies and the understanding of any differences observed the WG, will make recommendations for the optimal choice of parameters for the ILD detector. It is the responsibility of the WG convenors to organize this work, while the steering board will assist them in executing the charge."

## Initial Goal (pre-December 2007):

- First results from detector optimisation studies by May 2008 .

## New Goal (for discussion):

- LoI timescales have been extended by 6 months
- As a consequence LDC have spent more time refining simulation
- But want to make first ILD baseline ~end of Summer 2008
- Want for first results from detector optimisation studies on this timescale

- Whatever happens this is not the end of the story !
- Optimisation/Physics studies will continue through 2010/2012

## in the first stage aim to:

- Convincingly demonstrate the ILD can meet ILC physics requirements
- Justifiable set of detector parameters optimised on scientific grounds
- GLD & LDC ➞ ILD

# ❸ Optimisation Strategy

**Basic Idea:**

- Detector parameters optimised for physics performance
- Studies as realistic as possible:
  - Study signal + all SM background Monte Carlo
  - Ideally include machine and underlying event backgrounds
- Use full detector simulation and reconstruction
  the tools now exist for both LDC and GLD
- Aim to parameterize "performance" vs. $R_{TPC}$, B, etc…
- THEN use cost model to optimize

(hard)

★ This is an ambitious goal !
★ Need to be realistic about what can be done by end Summer 2008
★ Need to collaborate effectively
★ Plans will evolve with experience…

**Questions:**

- For LoI-study what parameters are we optimising ?
- In practice, how we will do this ?
- In detail, on what timescale do things need to happen ?
- What are the open questions ?

# Optimisation Strategy : What ?

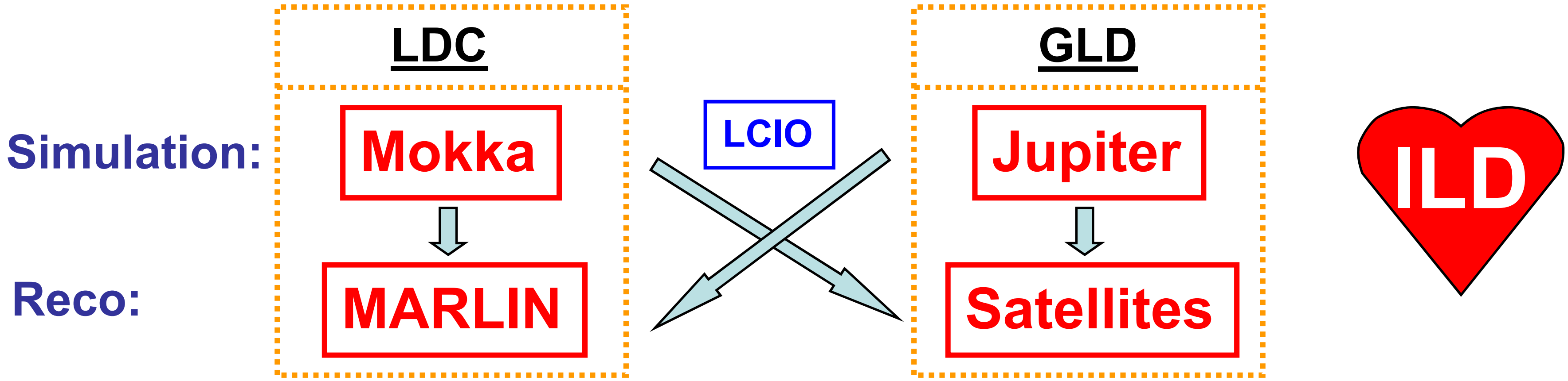
**Optimisation priorities**

- ★ Study parameter space "between" LDC and GLD
- ★ To study the full matrix of detector parameter space (R, B, L, …) would prove very time consuming – be realistic
- ★ Initially concentrate on main parameters (R and B)
  - will need to do this to exercise full reconstruction chain
- ★ Enough to start to define ILD
- ★ But also want to investigate impact of sub-detector design

# 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 timescale, decided to perform ILD detector studies in context of both GLD and LDC

★ Study physics performance dependence by changing parameters of GLD and LDC – provide some cross check of conclusions

★ Can directly compare results using common LCIO data format…

# LDC'/GLD' Common Parameters

★ 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 | 18 | 18 |

**PROPOSE TO START GENERATION WITH LDC'**

# Event Samples

## Signal samples

★ Relatively small samples – resources to study multiple models should not be a big problem…

## Background

★ On LDC-side propose to generate "full" ~50 $fb^{-1}$ SM sample(s)

★ Requires significant resources (see Frank's talk)

~50 CPU-years !!!

★ No idea how long this will take on GRID… only experience will tell

★ But it is clear we will not be able to do this for multiple detector models

## How to handle this?

★ Exact strategy will depend on experience

★ Worse case

- generate single large SM background sample and use for all variations of detector models (ugly)
- in this way understand main backgrounds for physics channels
- + generate main backgrounds with multiple detector models
- would be complicated – will require coordination…

★ Better case

- full SM sample with LDC and LDC',… what about $\sqrt{s}$ = 230 GeV ?

# Detector models/Signal Samples

**Signal samples: what models do we generate/and in what order ?**

- ❶ LDC' ⟶ agreed
- ❷ LDC
- ❸ LDC – GLD sized

(❷, ❸: ?) — (❶–❸: 3 Points in B, R)

Then what ? Can probably defer this discussion for now… the above will take 1/x of a Jovian year (x>1)

**Signal samples: generation/reconstruction, where ?**

- Want to compare different models
- Need to ensure that all samples are generated in comparable manner
- Many pitfalls
  - gluon radiation
  - fragmentation
  - generator settings
- Need to ensure all samples reconstructed correctly with appropriate configuration files, again there are pitfalls:
  - calibration
  - appropriate steering

⇒ **All files Generated/Reconstructed centrally : GRID** ?

# GLD ↔ LDC

★ So far concentrated on LDC plans

**What about GLD studies ?** (see Akiya's talk)

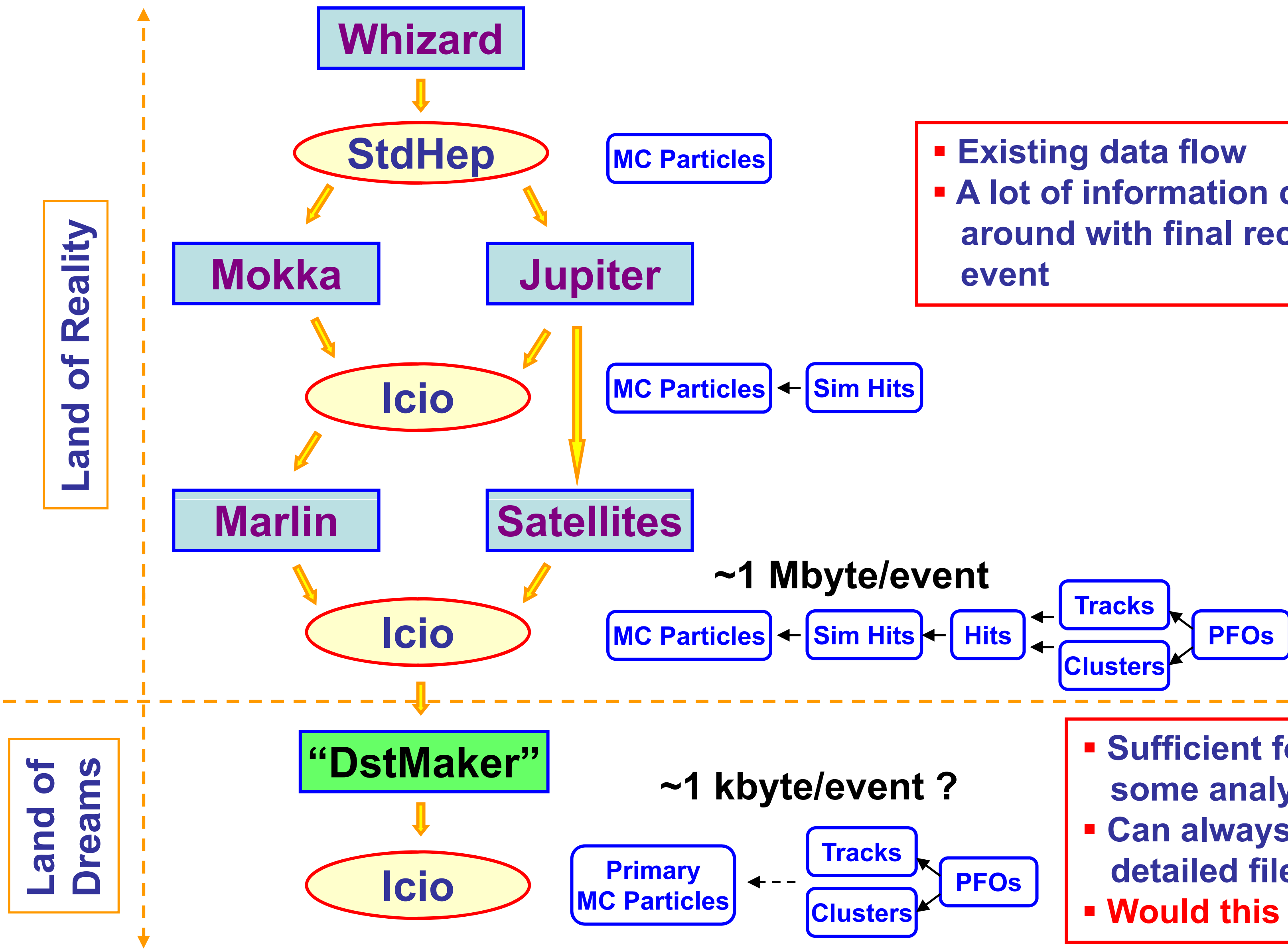
- Insufficient resources for mass generation of SM background
- But, a lot of analyses being developed
- How do we connect this to the LDC studies
- Possible approach: use LDC studies to identify important backgrounds for a particular study and just simulate these…

**What detector models ?**

❶ GLD'
❷ GLD
❸ J4LDC – LDC sized GLD

} 3 Points in B, R
Matched to 3 initial points in LDC study ?

# 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
- Would this be useful ?

# Optimisation Strategy : Sub-detectors

★ Initial studies will concentrate on global parameters, i.e. B, R
★ These are major cost drivers
★ But also want to investigate important aspects of sub-detectors

★ Generating a full set of SM/signal samples with even one detector model will be non-trivial
★ Will not be possible to generate full SM sets for many models
★ Sub-detector groups need to come up with a wish-list:
- What detector parameters need to be studied ?
- Minimal set of samples to be used (i.e. important signal)
- Limited resources
  - need to be realistic in what can be achieved

★ Need alternative sub-detector models in Mokka/Jupiter
  - follow the lead of the Vertex community
★ Has to be responsibility of detector groups
- e.g. Marcel's suggestion of heavy tracker

# Backgrounds

★ **Backgrounds:**
- **Ultimately: must include "beam" backgrounds (beam + $\gamma\gamma$) in physics analysis at some level**
- **Initially: develop analyses without "beam" backgrounds**
- **In parallel: develop tools for including backgrounds – file merging etc, walk before running…**

**What is needed for the LoI ?**

- **??? Demonstrate TPC Patrec with background ???**
- **??? Impact of background on PFA performance ???**
- **??? ... ???**

**What's missing**

- **Timing in simulation and reconstruction**

# Timescales : can we do this ?

| Task | "Deadline" | Status |
|---|---|---|
| Final version of Letter of Intent | Mar 09 | |
| Refine results and LoI performance section | Jan 09 | |
| First draft of LoI physics performance section | Nov 08 | |
| Define ILD Baseline Parameters ! | Sep 08 | |
| Physics Optimisation Results | June 08 | |
| Start of mass reconstruction of physics samples | Apr 08 | |
| Validation of reconstruction software | 1st Apr 08 | Started |
| Start of mass generation of physics samples | 15st Mar 08 | |
| Preliminary results for TILC 08 (Sendai) | Mar 08 | GLD started |
| Status reports of Physics Studies ILD mtg. (Zeuthen) | Jan 08 | |
| GLD'/LDC' in Mokka/Jupiter | 1st Dec 07 | Done |
| Define GLD'/LDC' | 15th Nov 07 | Done |
| Check Mokka/Jupiter LCIO compatibility | 15th Nov 07 | |
| LDC baseline in Mokka | 15th Nov 07 | Done |
| GLD baseline in Jupiter | 15th Nov 07 | Done |
| Define LDC v5 baseline parameters | | Done |
| Define GLD baseline parameters | | Done |
| Start Developing physics analysis | ASAP | In progress |

**STRAWMAN TIMELINE**

1 year

**Production**

# ❹ Summary

- There is a lot of ground to cover in the next months
- Need to demonstrate ILD can deliver the required physics performance and determine "optimal" detector parameters
- "sub-detector community" becoming integrated into the simulation/physics studies – good news !
- Given the timescale we cannot expect to do everything in this first phase (we are not in the EDR phase yet)
- Important not to be overly ambitious – if by ~Sept 2008 we have well-justified choice of the detector's size and B-field based on physics we should view this as a success
- Hope for more, e.g. improved understanding of sub-detector design on physics performance c.f. sub-detector performance