Physics/Optimisation Planning

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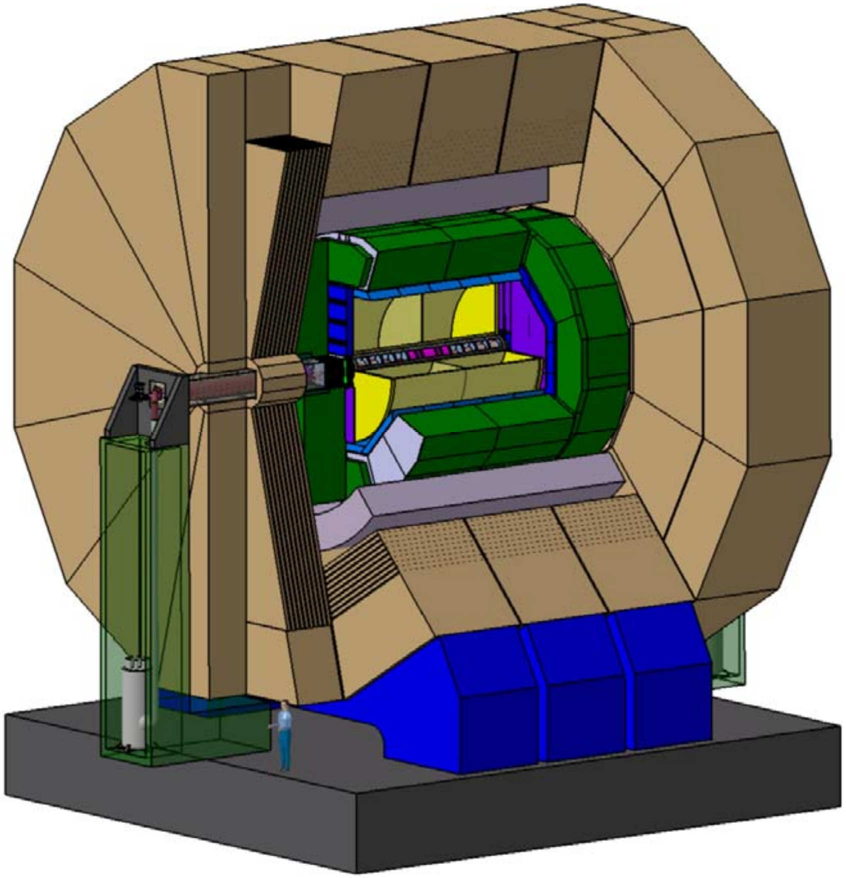


This talk:

❶ LoI loose ends
❷ New physics studies?
❸ What next...

➊ LoI → TDR

- ★ **From birth of ILD to LoI took ~1.5 years**

  IDAG: "At the LOI stage the progress of the Collaboration in realizing their detector concept is impressive and the path is clear for ILD to make continued progress"
- ★ **We have 2½ – 3 years to produce the TDR**
- ★ **Need to start to define our path forward**
- ★ **From physics/optimisation perspective want to identify main tasks**

In the next few slides, try to start this discussion…

❷ Simulation

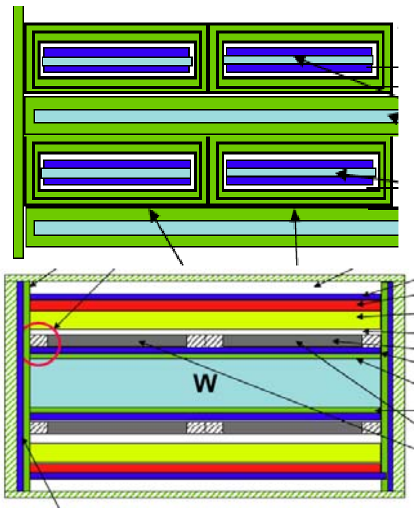
Guideline for the Plan of the detector groups

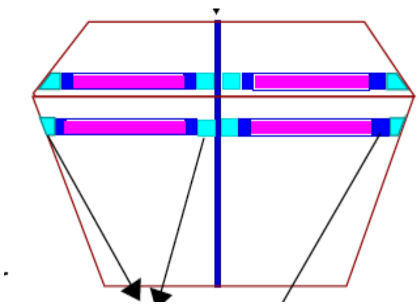
4. Develop a realistic simulation model of the baseline design, including faults and limitations

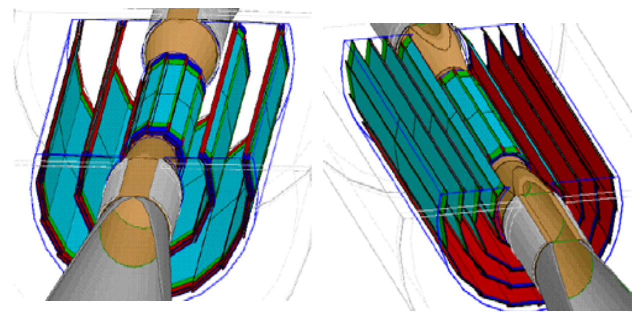
★ **What does this mean for ILD ?**

- Many sub-detectors already in pretty good shape

ECAL **HCAL** **VTX**



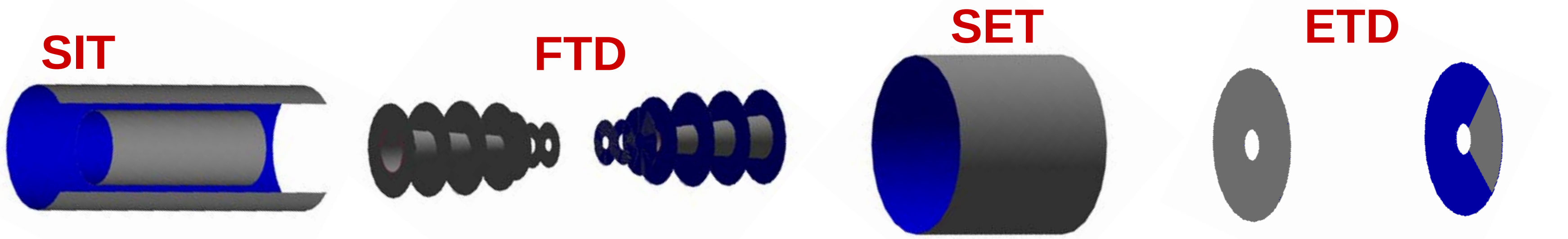




- Probably already sufficient level of detail. A few details…
  - non-uniformity across HCAL tiles ?
- Need to include dead cells (digitisation) ?

Simulation: areas needing work

★ **Silicon tracking**



- Current models are not as detailed as ECAL/HCAL/VTX
- Do we need to model strips ?
- Need support structures

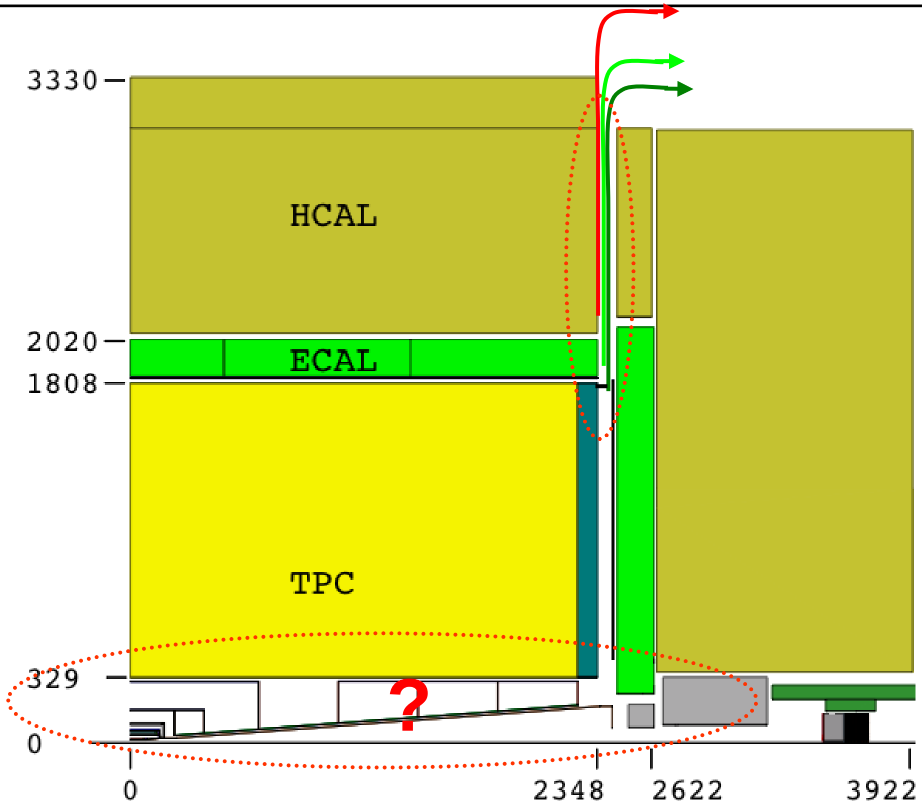
★ **Forward region (LCAL, LHCAL, BCAL, Masks, Beampipe)**

- work needed on detail design
- support structures
- LHCAL, LCAL, BCAL need more detail ("idealised")
- Potentially important for background

★ **TPC:** not clear, depends on design of endplane

Simulation: areas needing work…

★ **Services and cables**
- data out
- power, (cooling?) in



★ **Layout / material budget needs to be defined**
- This could start soon – report/define baseline for Paris mtg.?
- Don't want to simulate individual cables (makes little sense)
- Could define cable volumes with estimated average density

Simulation: Strawman proposal

★ **Aim to satisfy most of:**

4. Develop a realistic simulation model of the baseline design, including faults and limitations

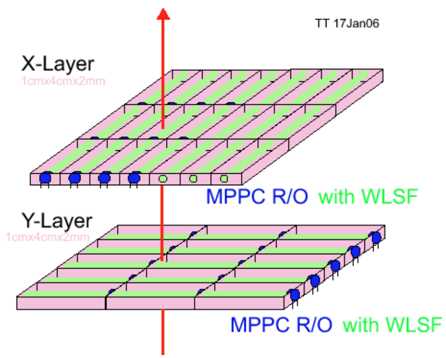
in the next 6 months.

- **Plausible timescale**
- **We are starting from a strong position**
- **But, requires real work focussed in a few key areas**

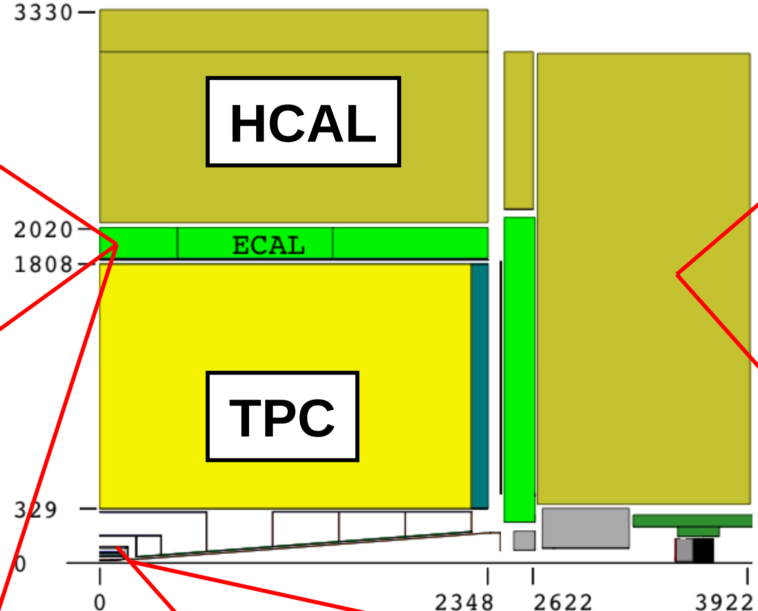
❸ Options

ECAL

- ★ SiW: 5×5 mm^2
- ★ ScintW: strips



- ★ MAPS: digital

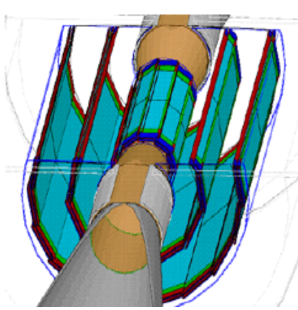


HCAL

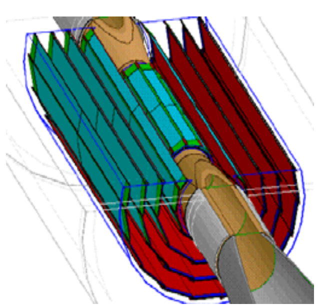
- ★ Steel Scint.
  Analogue
  3×3 cm^2 tiles
- ★ Steel RPC
  (Semi-)digital
  1×1 cm^2

Vertex Detector

- ★ 3 Double Layers



- ★ 5 Single Layers



Guideline for the Plan of the detector groups

2. Define a feasible baseline design

(Options may also be considered. But one of them should be proven to be feasible.)

- ★ **Need to be in position to evaluate options**
  - **Essential to include in Mokka as soon as possible**
    - ♦ **integration into reconstruction is non-trivial**
  - **Should have comparable level of detail to reference detectors**
- ★ **What ?**
  - **Scintillator strip ECAL**
    - ♦ **Here the reconstruction is a significant task**
  - **MAPs ECAL**
    - ♦ **Again the reconstruction is a significant task**
  - **Semi-digital HCAL**
    - ♦ **Essential to implement in current HCAL geometry and in “Videau” layout [will help evaluate performance]**

❹ Backgrounds

Guideline for the Plan of the detector groups

8. Simulate and analyze some reactions at 1 TeV, including realistic higher energy backgrounds demonstrating the detector performance.

★ **Heroic efforts for the LoI !**

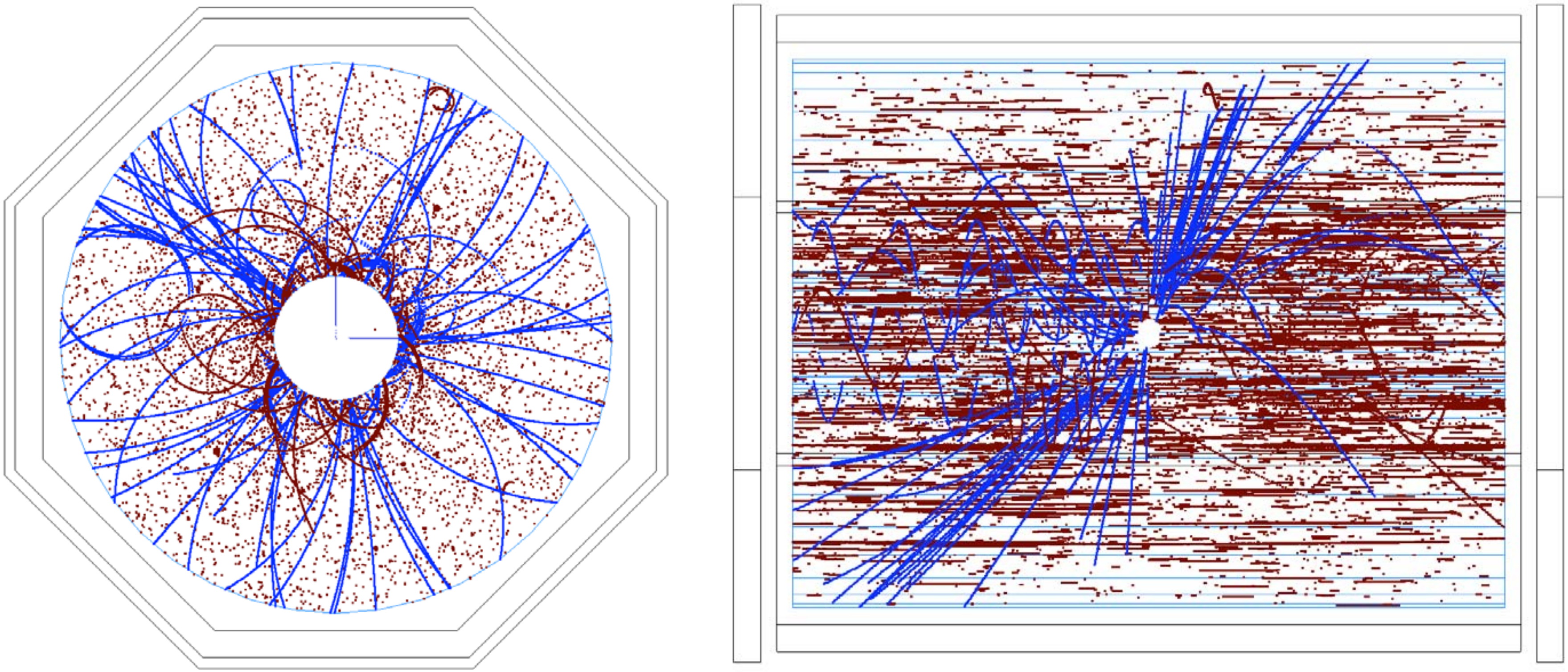
- **But incomplete…**
- **Not fully integrated into a physics analysis**

So what was done for LoI ?

TPC Background

- ★ Large fraction of hits from low energy electrons/positrons from photon conversions
- ★ Form tight helices, “micro-curlers”, along length of TPC
- ★ Background concentrated on relatively few TPC readout pads
- ★ Developed PatRec software to identify and remove “micro-curlers”

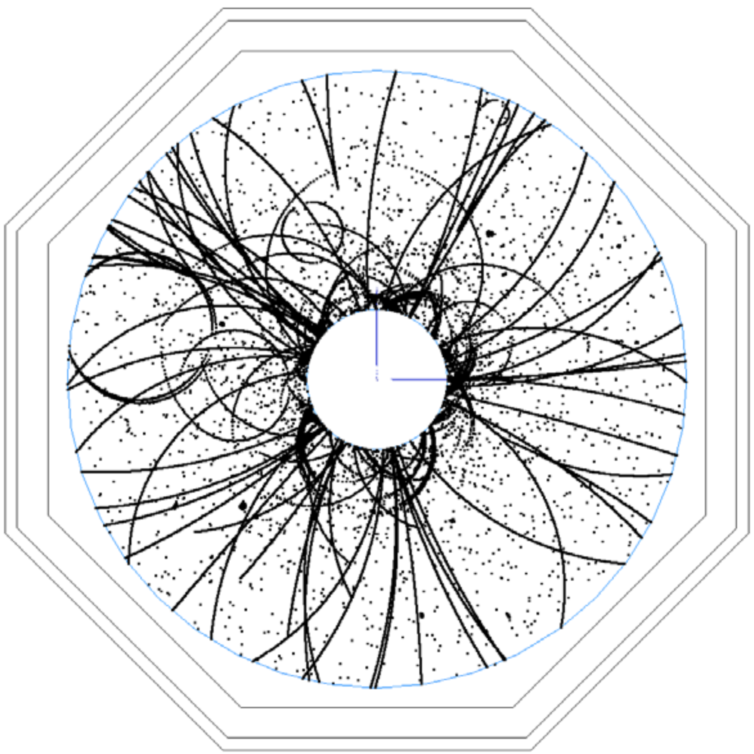
150 BXs of pair background

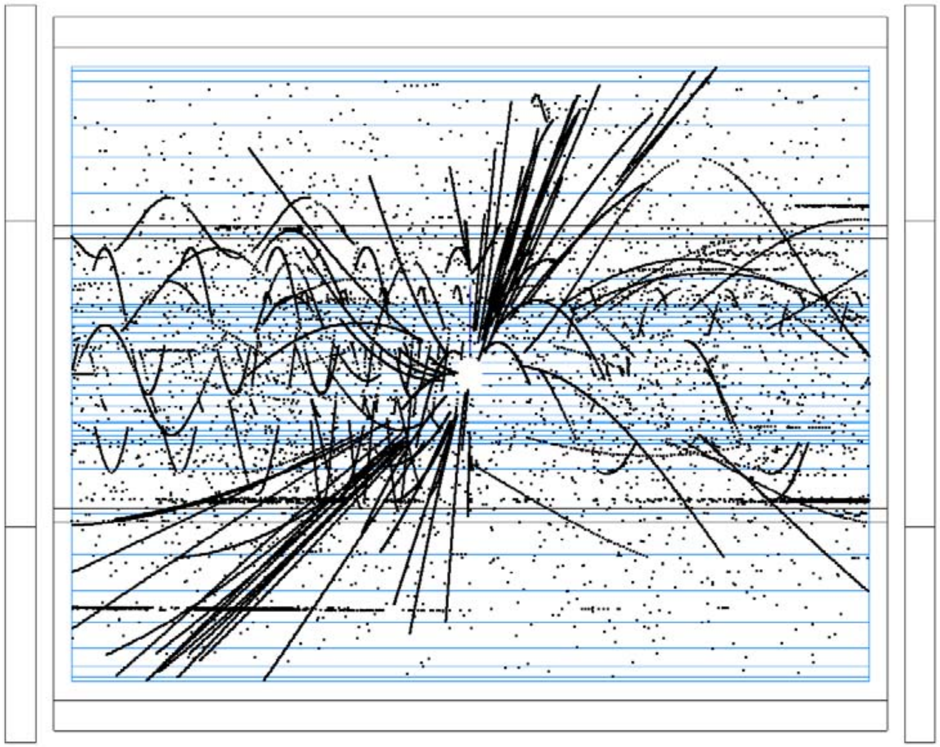


★ **Effective removal of large fraction of background hits**

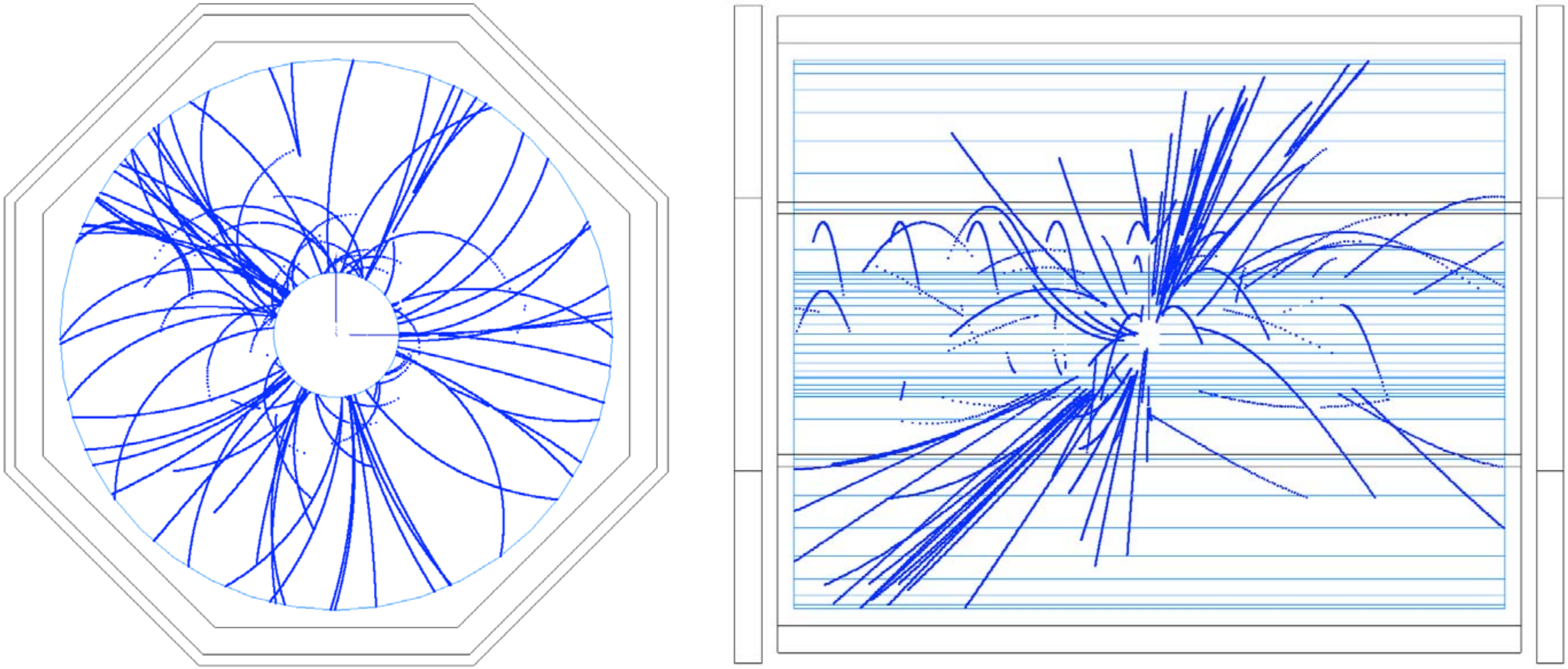
	Top (p_T>1 GeV)	Background
Raw hits	~8,600	~265,000
After	~8,500	~3,000

★ **By eye – clear that this should be no problem for PatRec**





- ★ Superimpose 150 BXs TPC background on $e^+e^- \rightarrow t\bar{t} \rightarrow 6$ jets
- ★ For 100 events, **NO loss in track-finding efficiency observed**
- ★ Similar story for 3x nominal background
- ★ A **clear demonstration of the robustness of TPC tracking**



Background: VTX

★ Background in VTX detector complicated by assumptions for Si pixel integration time
★ IF one assumes single BX tagging capability then background is not an issue
★ For ILD studies "conservatively" assumed 30 μs / 125 μs integration times for VTX layers (0,1) and (2,3,4,5) respectively
★ Therefore VTX integrates over 83/333 BXs
★ Superimpose on fully-hadronic top-pair events at 500 GeV

⇨ 200,000 background hits per event !

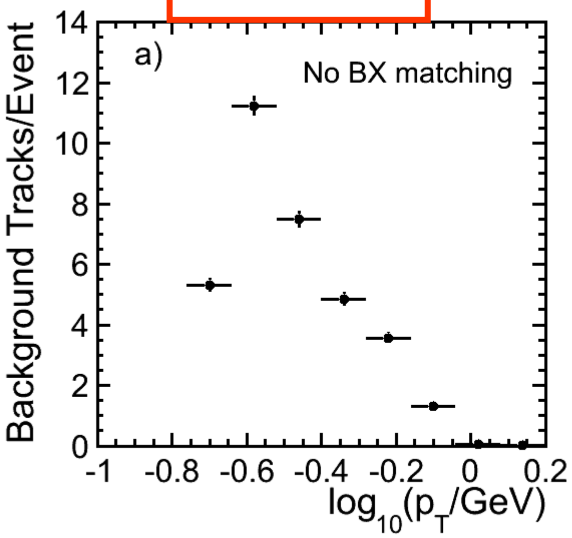
★ Also consider finite cluster size of background hits (~10 pixels)
★ Significantly increases occupancy

layer	Occ.
0	3.3 %
1	1.9 %
2	0.4 %
3	0.3 %
4	0.08 %
5	0.06 %

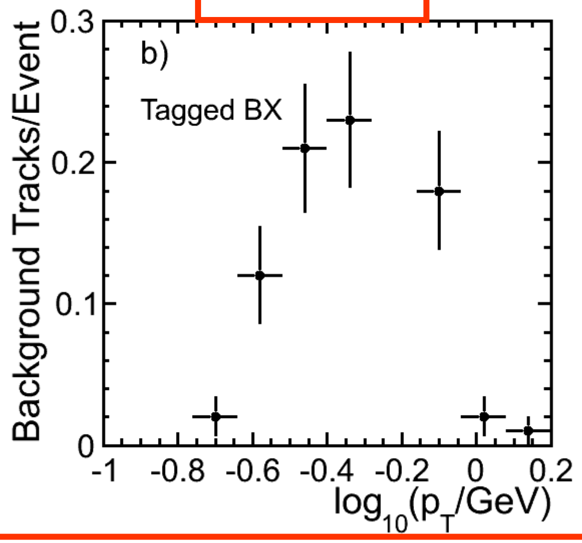
Background: VTX - fake tracks

- ★ Combinatorics produce fake "ghost" tracks
- ★ In addition to some real electron/positron background tracks
- ★ Large combinatoric background challenges pattern recognition
- ★ Reconfigured current algorithm (not ideal)
- ★ From 83/333 BXs overlayed on $e^+e^- \rightarrow t\bar{t} \rightarrow 6\ \mathrm{jets}$: reconstruct ~34 "ghost" tracks/event (~1/3 are genuine)
- ★ Rejected by requiring at least 1 SIT hit or >10 TPC associated hits

34/event



1/event



Left with ~0.5 GeV per event (mixture of real tracks/combinatorics)

Scorecard…

- ★ TPC studies look pretty solid
- ★ The VTX studies assumed integration times of
  83/333 BXs (31/125 μs) – what is really needed ?
- ★ To get background level down to acceptable level assumed single BX-tagging capability in SIT and in TPC
- ★ No account for SIT strip structure/ghosts
- ★ No background studies in FTD
- ★ Occupancies in inner layers are high for nominal ILC background i.e. 2-3 %
- ★ With assumed integration times, safety factor not great, i.e. for 10 x current background probably lose inner layers

Issue of time-stamping in ILD needs more consideration

- ★ Potentially large impact on:
  - timing requirements for VTX and SIT
  - design of SIT
  - FTD; as currently designed may not cope with ILC background!

What needs to be done…

- ★ **Ideally aim to incorporate background into analyses as the default**
  - **Beam background**
  - **Two-photon background**

- ★ **To do this requires:**
  - **New tracking code !**
    - **TPC patrec (old f77 code) needs replacing**
    - **SiliconTracking not optimised for background**
  - **Proper simulation/reconstruction of silicon strip detector**
    - **Need to account for stereo strip layers in SIT/FTD (currently, artificially combine into "point")**
    - **Reconstruction code for FTD – combinatorics potentially large**
  - **New digitisation code?**
    - **Treatment (possibly parametric) of clusters in pixel detectors**
  - **Definition of two photon samples**
  - **More realistic treatment of BX tagging in reconstruction**
  - **Realistic plan how to implement into analyses (speed issues)**

What needs to be done <u>now</u>

- **But, should not underestimate the amount of work !**
  - This is a major under-taking
  - But it is potentially important
  - It will also take time, certainly >1 year…

- **Define a coherent plan of work**
  - We did this at Tsukuba – and it worked
  - Again this could be an aim for the Paris

❺ Physics

Guideline for the Plan of the detector groups

7. Simulate and analyze benchmark reactions, which can be updated

Main issues to consider

- ★ Still loose ends to tie up (e.g. include new qqcc analysis in LoI)
  - 30 % →15 % stat. error on BR(H→cc)
- ★ ZHH final state
  - ILC Golden measurement Higgs trilinear coupling
  - Current studies suggest very little sensitivity !
  - Need to improve reconstruction of b-jet energy ?
  - This a major analysis/reconstruction effort – but IMPORTANT
  - Set up "task force" to consider possible improvements?
- ★ How to approach the "Peskin" physics questions
  - For 500 GeV physics could start now
  - For 1 TeV could generate "main SM backgrounds" with current detector model (e.g. 4f and 6f) + some signals
    - important to keep the physics analysis effort moving forward
    - can't leave this for 12-18 months…

New beam parameters

- ★ Need to make a preliminary assessment of impact of new beam parameters
- ★ Should aim to provide input early in 2010
- ★ Need to consider carefully what to study:
  - Higgs recoil mass at 250 GeV
  - Quantify loss going from 250 GeV to 500 GeV
  - …

What needs to be done <u>now</u>

- ★ **Define a coherent plan of work…**
  - **Aim for the Paris meeting**
  - **In meantime, start preparing for limited 1 TeV production (first need Whizard stdhep files…)**

❻ Summary

Main Priorities (i.e. all essential for TDR)

- Define more realistic Si-tracking in Mokka
- Cables/Services in Mokka
- Options in Mokka: Scint-ECAL, MAPs-ECAL, Semi-digi. HCAL
- Modify/develop reconstruction for options to evaluate performance
- New tracking code (TPC, SIT + VTX, FTD)
  - replace f77 TPC patrec
  - proper treatment of strip detectors
  - dedicated forward tracking code
- Develop plan for treatment of background
  - identification of tasks/names…
- ZHH !
- Develop a plan for continued physics analysis
  - I would favour limited 1 TeV production soon
  - Not too soon to start…
- … (What have I missed)

Over to Frank…