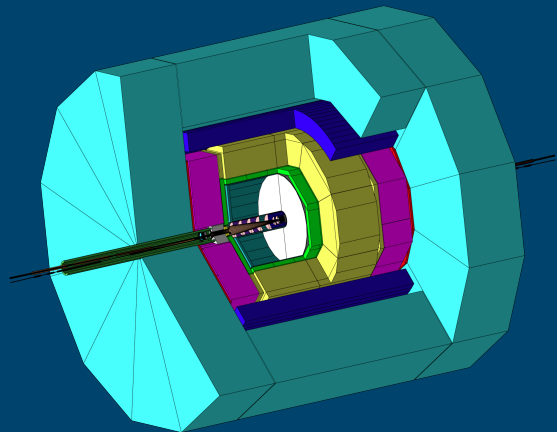


HEPHY

Institut für Hochenergiephysik

Forward Tracking at ILD

(ideas and questions by the Vienna Group)

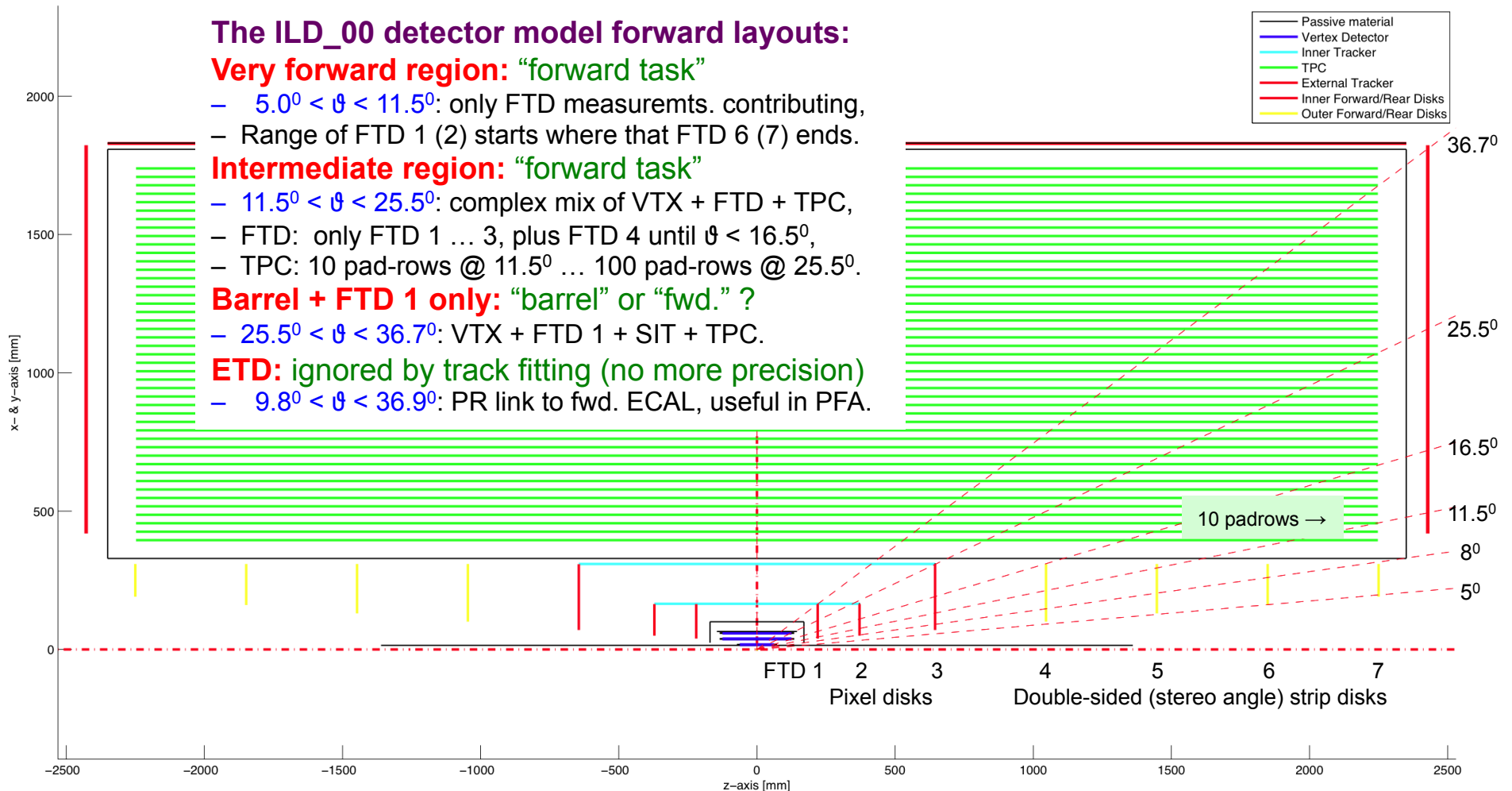


Winfried A. Mitaroff

ILD Software Web Meeting

2 February 2011

Differences in ILD_01 layout ?



Forward tracking sub-tasks

1. FTD geometry description,
 2. FTD drivers in Mokka,
 3. FTD digitizations in Marlin,
 4. **FTD stand-alone track search**
(very fwd. and intermediate regions, $5^\circ < \vartheta < 25.5^\circ$),
 5. **TPC-supported track search**
(optional in intermediate region, $11.5^\circ < \vartheta < 25.5^\circ$),
 6. **DAF-based final hit associations,**
 7. **Precision forward track fit.**
- Region $25.5^\circ < \vartheta < 36.7^\circ$ is “mostly barrel” (VTX, SIT, TPC) with only one FTD 1 \Rightarrow barrel or fwd. task ?

Open questions of the design

- The **user API** should be common for barrel and forward tracks.
- However, the **implementation** is suggested to be separate and complimentary for the barrel and the forward regions:
 - Optimal track search algorithms will differ for barrel and fwd.,
 - Internal track representations may differ (e.g. $1/p_T$ vs. $1/P$),
 - Coordinated independence of the two programming teams.
- A small **MarlinReco** control processor for the required top-level steering “barrel vs. fwd. calls”, transparent to the user.
- Coordination is enhanced by a common skeleton toolkit (**GenFit** or **KalTest**), and a pool of **utility classes** and **libraries**.
- Both implementations will rely on common **interfaces**, e.g. for
 - Using available results from a previous **track search in TPC**,
 - Persistency by the new **LCIO** data model, augmented for GSF,
 - Interfacing to the new **GEAR** geometry toolkit (A. Münnich, CERN).
- **Clear separation of generic vs. detector-dependent functionality.**

How to share responsibilities

Discussions at the ILD Software WS (DESY, July '10) and thereafter.
Consent on sharing of tasks for the new ILD tracking:

- **DESY Hamburg:**
 - Overall coordination and all barrel tracking: work has started.
- **Spain (Santander, Valencia) and HEPHY Vienna:**
 - All forward tracking, with the sub-tasks
 - (1,2) FTD geometry description, drivers in Mokka: Spain,
 - (3) FTD digitizations: Spain with contributions by Prague,
 - (4) FTD stand-alone fwd. track search: Spain and Vienna,
 - (5) TPC-supported fwd. track search: Vienna,
 - (6,7) DAF-based fits, precision track fit: Vienna.

Active work in Vienna to start after the AIDA kick-off (March/April '11).

Manpower & funding in Vienna

- **Commitment:**

- Expect a **PhD student** in his/her first year, to work full-time on sub-tasks 4 - 7 from April 2011 for about 1 year;
- Follow-up study of **background radiation in the forward region**, starting in spring 2012 (part-time with SiLC work);
- Supervision by Winni M., backed by Rudi Frühwirth.

- **AIDA Proposal:**

- **Within EU's fp7**. Time frame is 2011-14, approved April 2010, **Kick-off Meeting 16-18 Feb. 2011 at CERN**. 9 Work Packages.
- WP 2 **“Common Software Tools”** (F. Gaede, P. Mato) includes
- Task 2 of 2: **“Reconstruction Toolkits for HEP”**, Sub-task 1 of 4: **“Tracking Toolkit”** – DESY, Santander, Valencia, Vienna.
- Rely on 1/3 refunding for 3+ student-years, and travelling costs.

Backup slides

(presented at IWLC '10, Geneva, 18 - 22 Oct. 2010)

What is the “forward region” ?

- **Very forward region**
 - $5^\circ < \vartheta < 11.5^\circ$: only FTD measurements contributing,
 - Range of FTD 1 (2) starts where that FTD 6 (7) ends.
- **Intermediate region**
 - $11.5^\circ < \vartheta < 25.5^\circ$: complex mix of VTX + FTD + TPC,
 - FTD: only FTD 1 ... 3, plus FTD 4 until $\vartheta < 16.5^\circ$,
 - TPC: 10 pad-rows @ 11.5° ... 100 pad-rows @ 25.5° .
- **Barrel + FTD 1 only**
 - $25.5^\circ < \vartheta < 36.7^\circ$: VTX + FTD 1 + SIT + TPC.
- **ETD: $9.8^\circ < \vartheta < 36.9^\circ$**
 - Ignored by track fitting: cannot contribute to precision,
 - Useful for PFA (pattern recognition link to fwd. ECAL).

Fwd. track search strategies

- **Stand-alone in FTD:**
 - This is the only possible strategy in the very forward region,
 - Various algorithms exist – which to choose needs careful study,
 - For small ϑ , hits from **beamstrahlung-induced background** may cause further problems (we need a reliable estimate),
 - Layout for optimized track resolution (e.g. strip orientation and stereo angle) not necessarily optimal for track search.
- **Combined TPC–FTD:**
 - This may be an optional strategy for the intermediate region:
 - Inward extrapolation of tracks found by local PR in the TPC, FTD hits tested against and associated to them,
 - **Timing problems** hopefully solved by “time stamps”.
- **Soft hit association:**
 - Hits may be shared among tracks, and the final association relegated to track reconstruction based on the DAF.

Forward track reconstruction

- **Algorithms used:**

- Based on the Kalman Filter, with robustification by the adaptive Deterministic Annealing Filter (DAF):
- (1) Testing and updating the track hypothesis (hit associations) by identifying and removing “outliers”, and resolving ambiguous associations from the track search,
- (2) Performing a precision track fit.

- **Special features:**

- Flexible track propagation in the complex intermediate region,
- Energy loss of electrons modeled by the Gaussian Sum Filter (GSF) \Rightarrow requires extension of the LCIO data model,
- Magnetic field distortions by the “anti-DiD” taken into account (small “Billoir corrections” on helices, or Runge-Kutta).