Detailed simulation of Silicon tracking system for Linear Collider

International Workshop on Linear Colliders 2010
(ECFA-CLIC-ILC Joint Meeting)

Frederic Kapusta presenting on behalf of
Alexandre Charpy
& Konstantin Androsov

LPNHE - Paris

Silicon Tracking System
SiLC Goal

Goals of the SiLC (Silicon Tracking for Linear Collider) collaboration

- Optimisation studies of the geometry of the silicon trackers
- Access to different sensors and electronics technology
- Develop a tool to facilitate the optimisation studies
- Provide drivers for ILD concept and CLIC detectors

Main ideas

- Generate different kind of geometry very easily (number of silicon layers, false/true double-sided, technology …) → dynamic aspect
- Possibility to introduce mis-alignment studies according a mechanical structure
- Materiel budget effects induce by the supports and the cabling
- Could be used in different framework

Silicon Tracking System
Code history

History

- Developing a silicon tracker through ILCRoot framework (2008)
  First integration in the 4th concept
- Switch to Mokka framework (end of 2009) for a more detailed description of the ILD concept

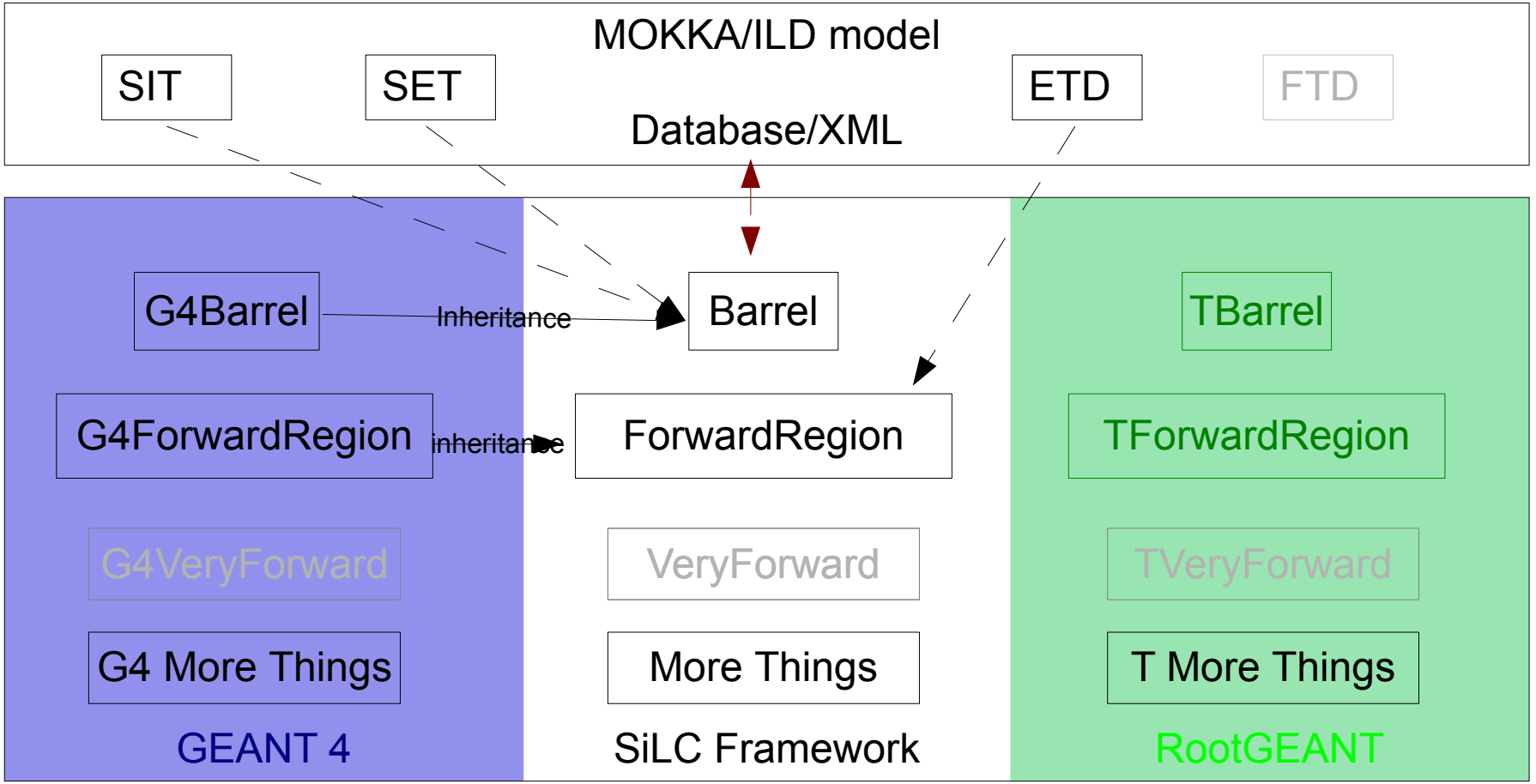
- Re-design the design pattern in 2010 (more flexibility for CLIC study):
  - Integration in different framework
  - More flexibility = fewest fixed parameters
    → creation of sub-detector families
    → sub-detectors configuration
    → cross setup
  - Different input

Availlable for ILD_01 release
Actually in MOKKA trunk version

Silicon Tracking System
Code description

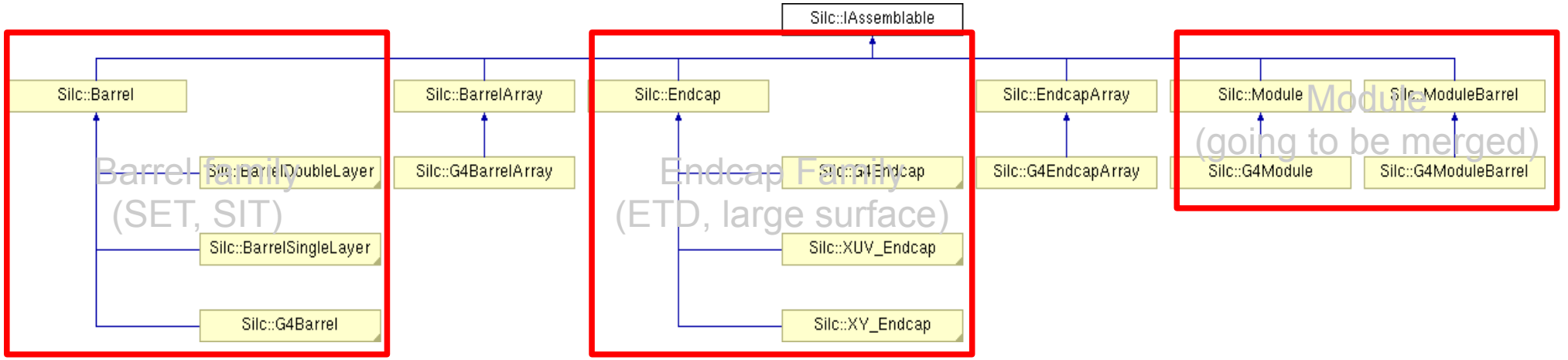
RootGeant and Geant 4 (ideas and plans)

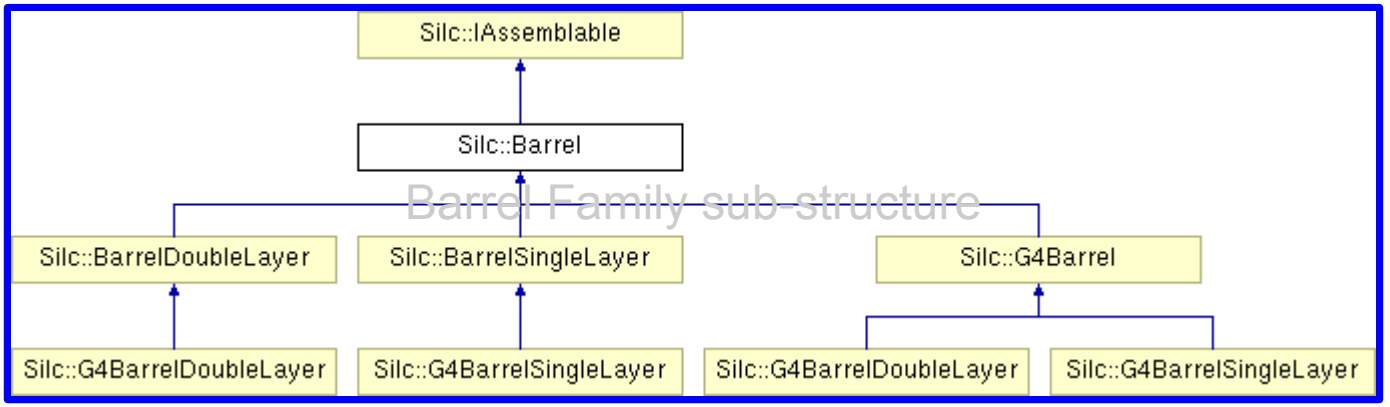
→ build independent classes
→ can be extended
→ connect it to the geometry builder according the framework
→ possibilities to merge the concepts (example: use database and use Root Framework)



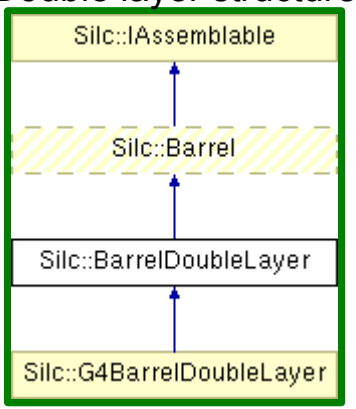
Silicon Tracking System

Design Pattern – UML class diagram



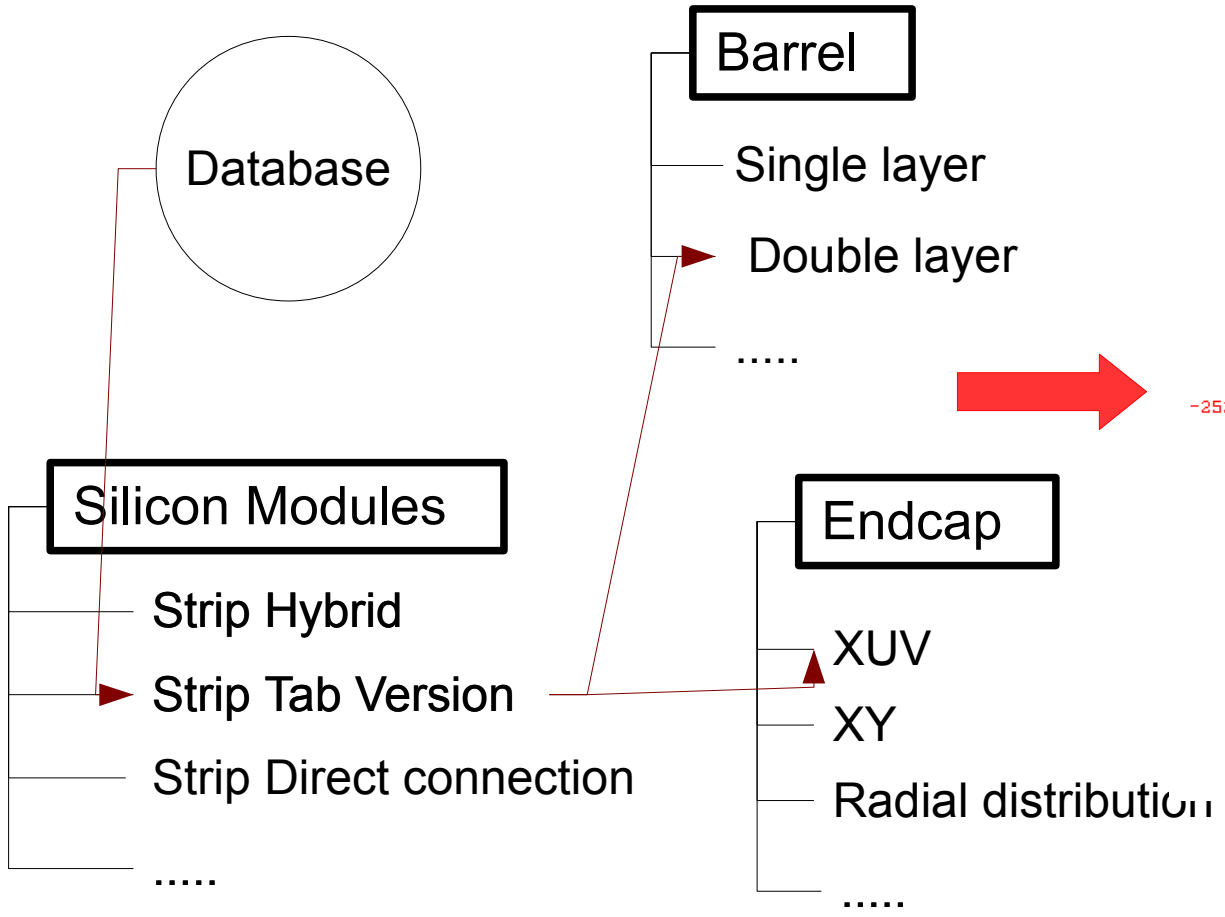


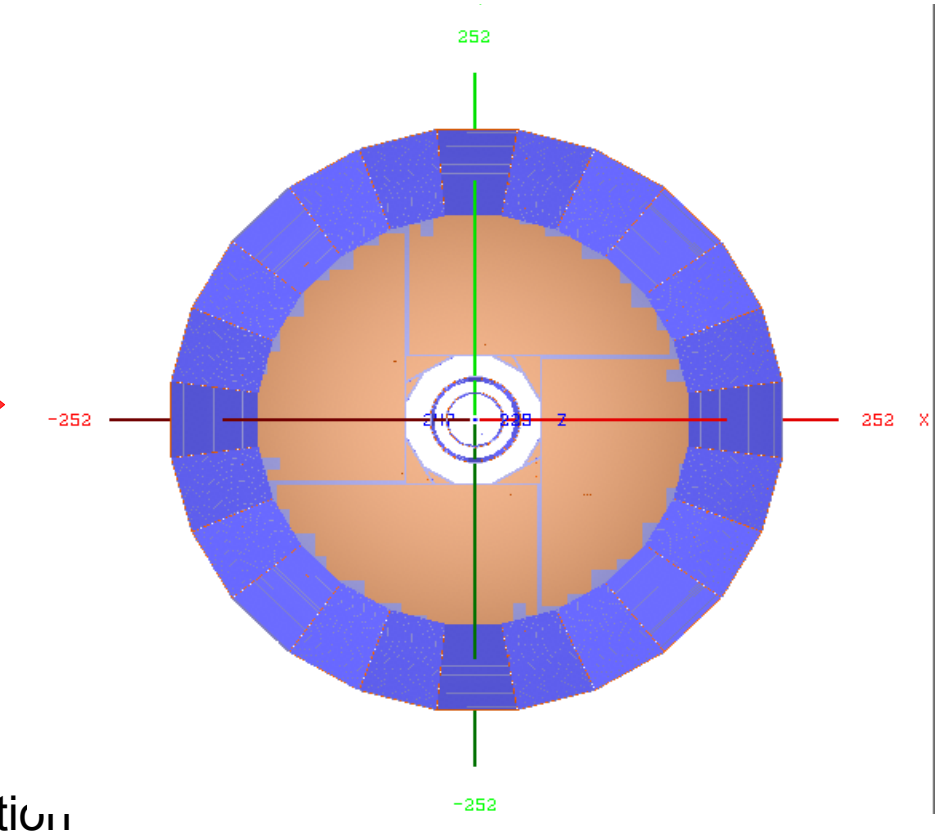
One cylinder
Double layer structure



Silicon Tracking System
Interest of this complex structure

- Build the detectors from basic elements → LEGO game (pick up all the element requested by the user, checking the consistency and build the sub-detectors) = we add more flexibility





Silicon Tracking System
Geometry builder – hierarchy with ILD example

- All “family” are built into a common hierarchy (generic name)
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  - the super-module (ex: quadrant for ETD, face in the barrel region)
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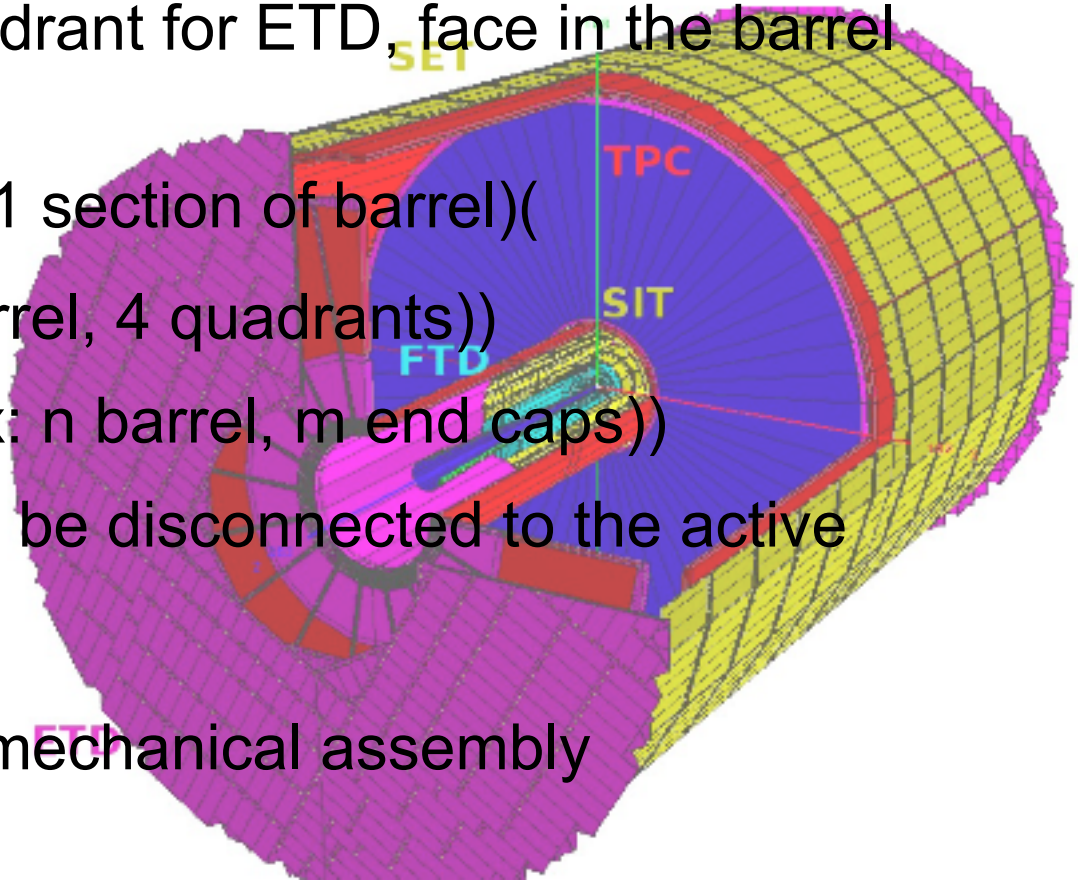
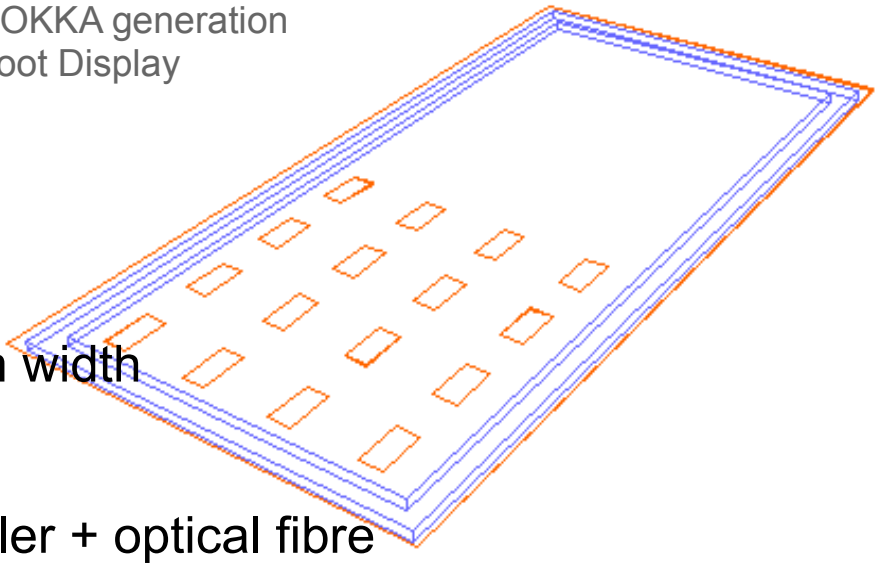


Example of Application
ILD Concept

Silicon Tracking System

ILD Silicon Module Detector

Silicon module (1*2 sensors)
MOKKA generation
Root Display



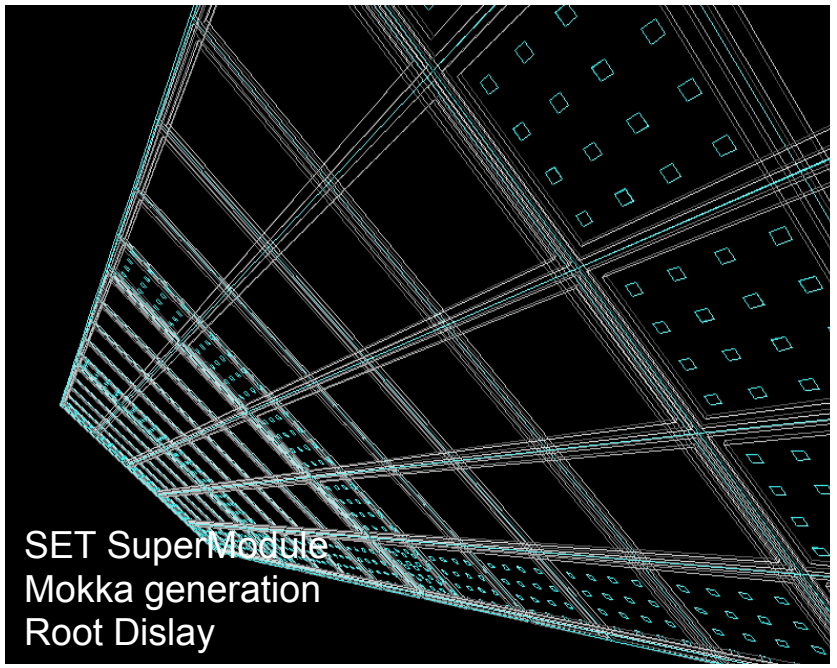
- Baseline
  - 100.12*100.12*200 mm^2*μm
  - Strip technology
  - 50μm pitch (~2048 channels), 12;5μm width
  - Edgeless
  - Chips on board: SiTr130-128+ controller + optical fibre

  → A silicon module consists into n chained silicon sensors

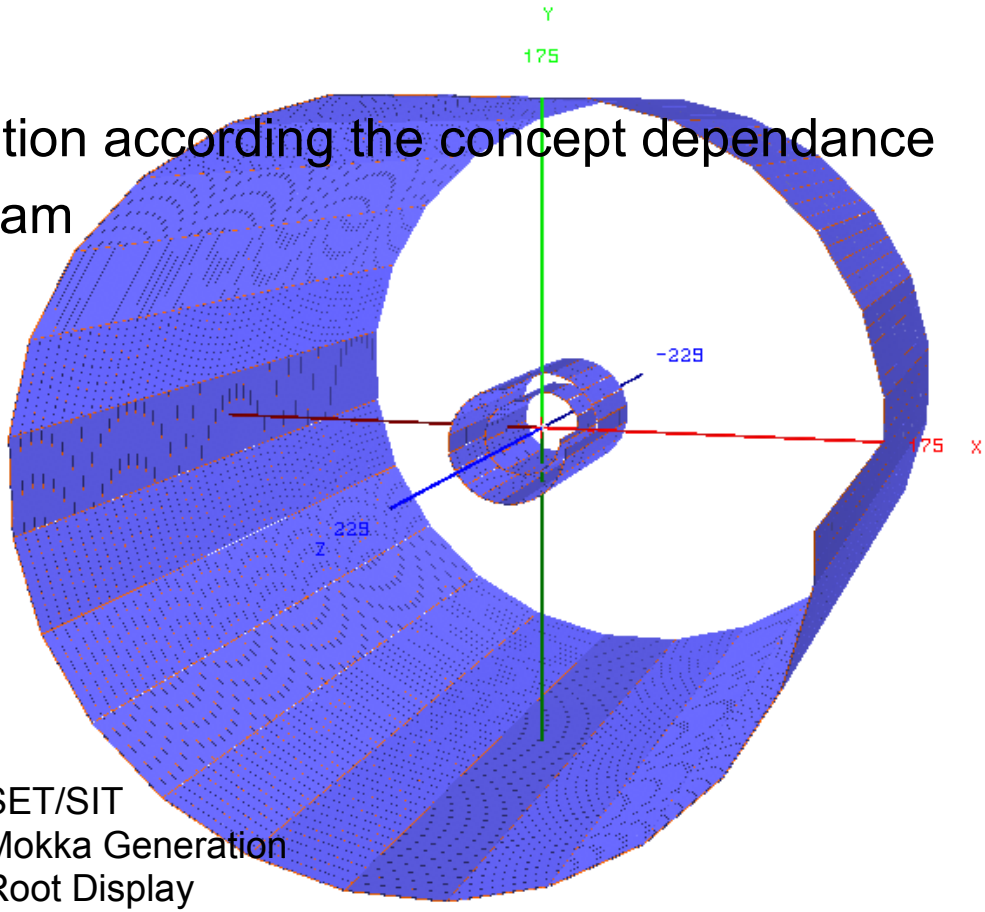
- GEANT 4 description
  - Module size: 1*n sensors+50 μm gap
  - The module segmentation and the sensors misalignment (rotation+shift) are included in the digitisation process
  - Chip+controller included
  - Support: graphite

Silicon Tracking System
ILD SIT/SET

- Geant 4 description:
  - Using the edgeless properties
  - false double sided strip detectors
  - Gaps: 50 micron gap between modules, Super Module, Detection Element
  - Support:
    - SET → partially defined/fixation according the concept dependance
    - SIT → waiting integration team



SET SuperModule
Mokka generation
Root Dislay



SET/SIT
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Silicon Tracking System
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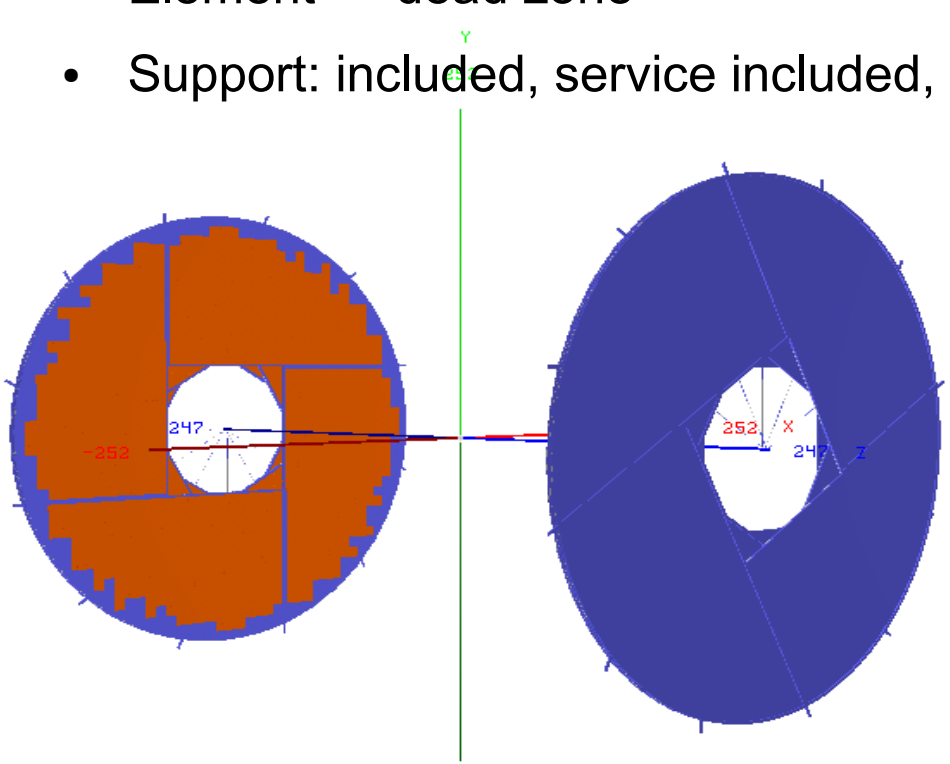
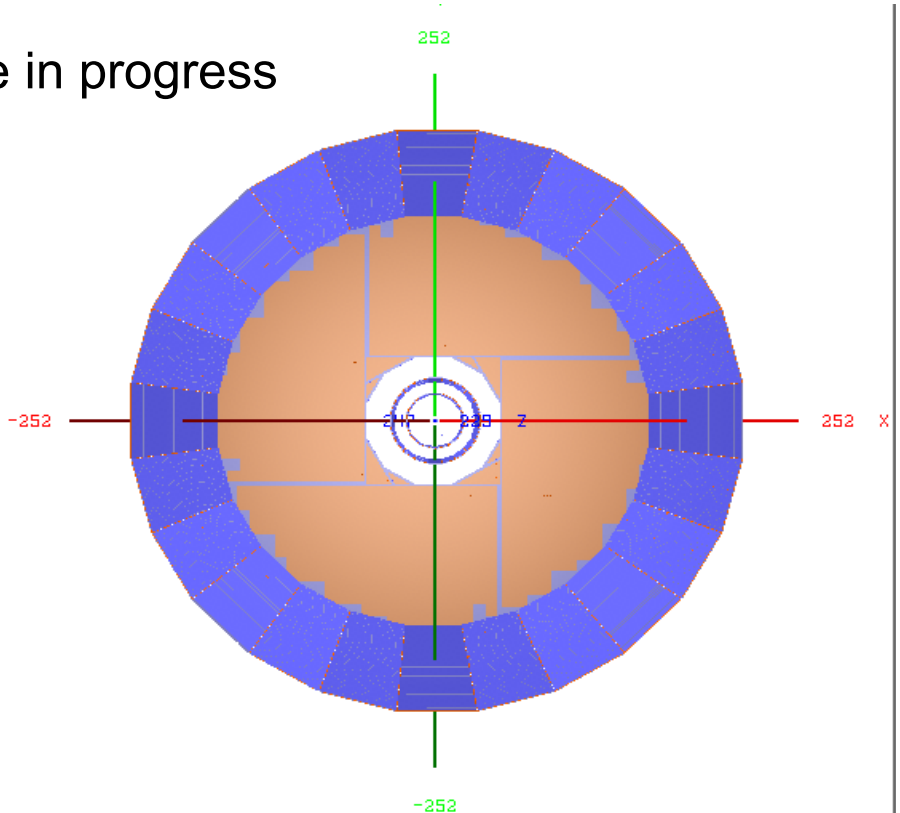




Silicon Tracking System

Overlapping

Overlapping in the Silicon tracking components:

- checked through Root within 10 μm
- according the present status of the development

→ SIT, SET, ETD : ok

Overlapping with other detectors:

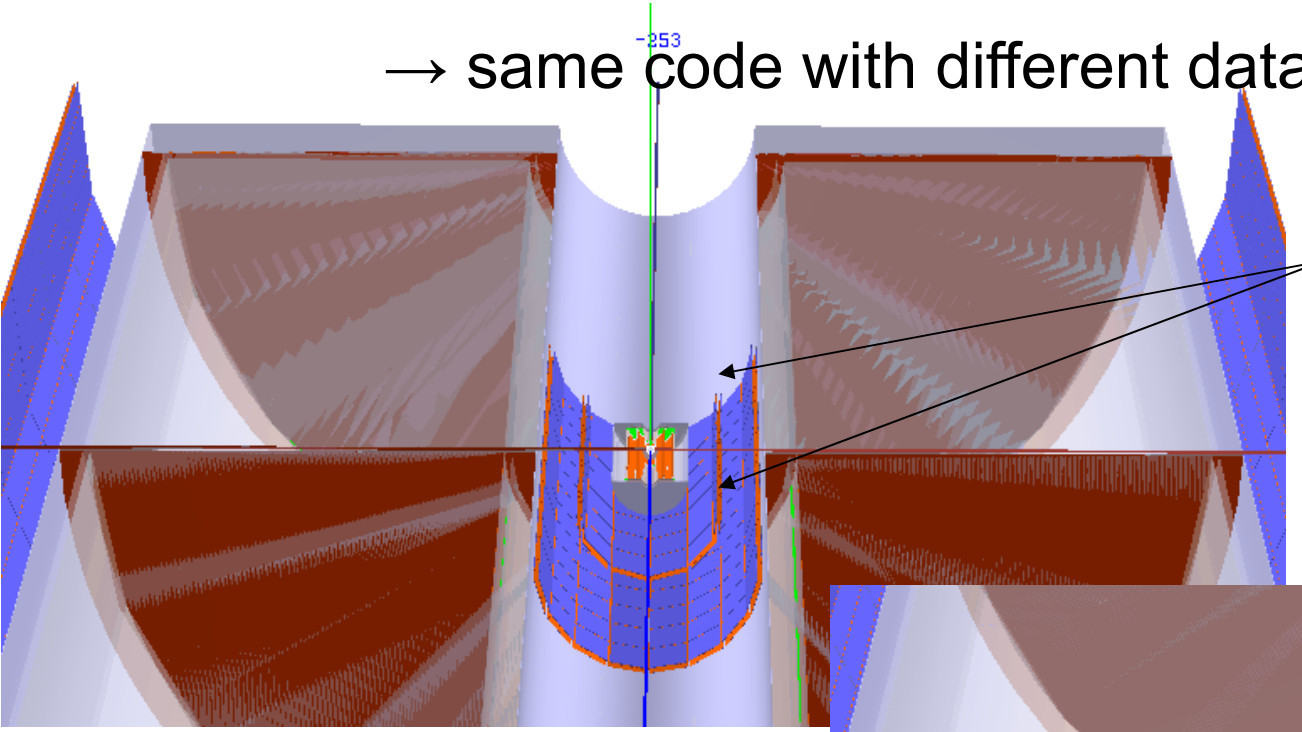
- SET/TPC → under discussion with the TPC and MOKKA team (priority of the sub-detectors builder, re-scaling, “who depend of who”, support structure
- SIT/FTD → fixed
- ETD/ECAL/TPC → under investigation (the place holder is not defined actually – see C.Clerc)

Silicon Tracking System

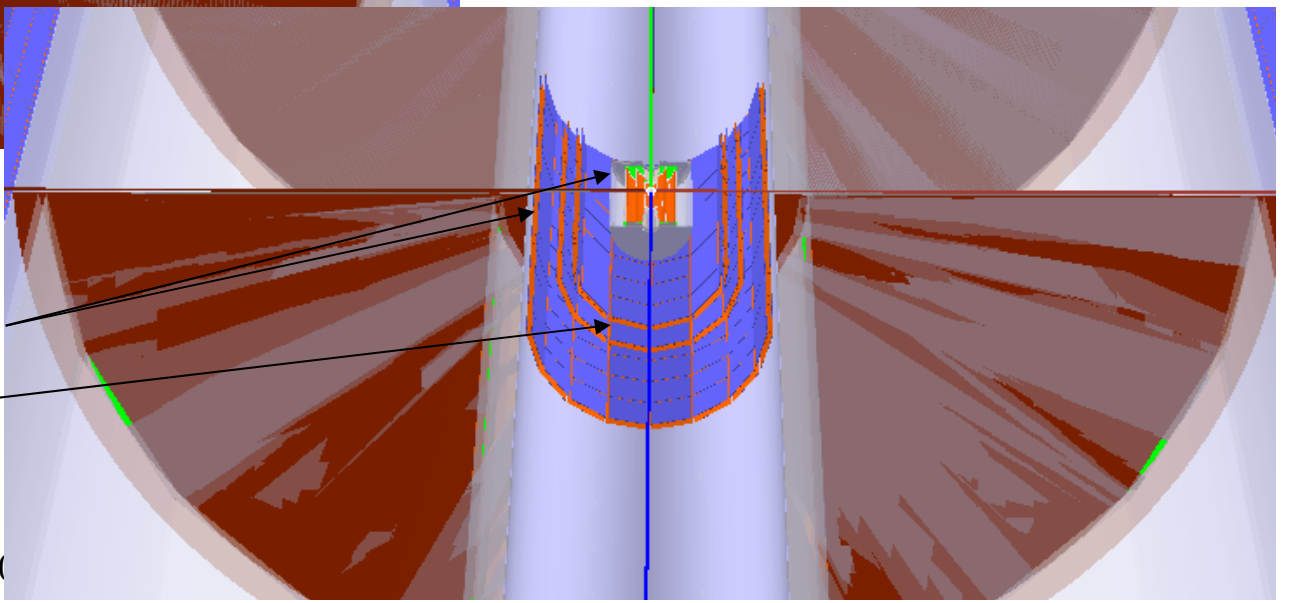
Easy customisation

- Modification of the number of silicon barrels in the internal part of ILD

→ same code with different database input



SIT (baseline):
2 double « false double » layers

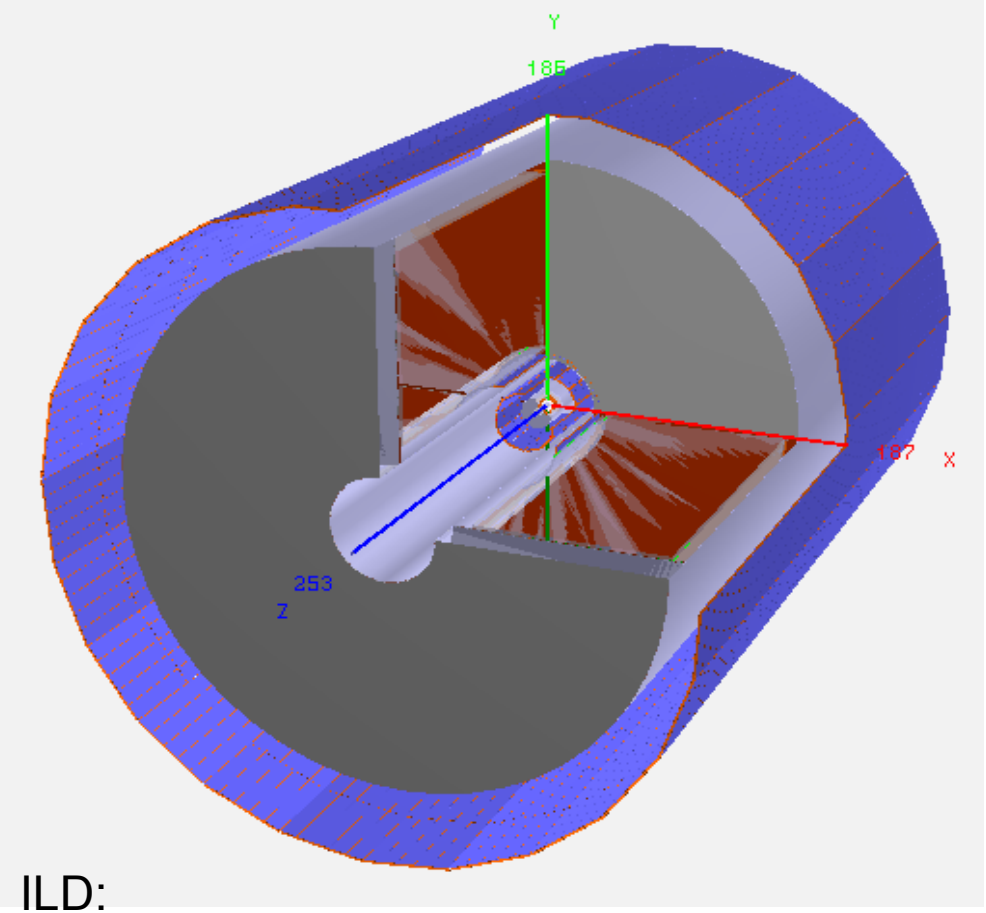


SIT (alternative concept):
2 double « false double » layers
+1 single or double layer

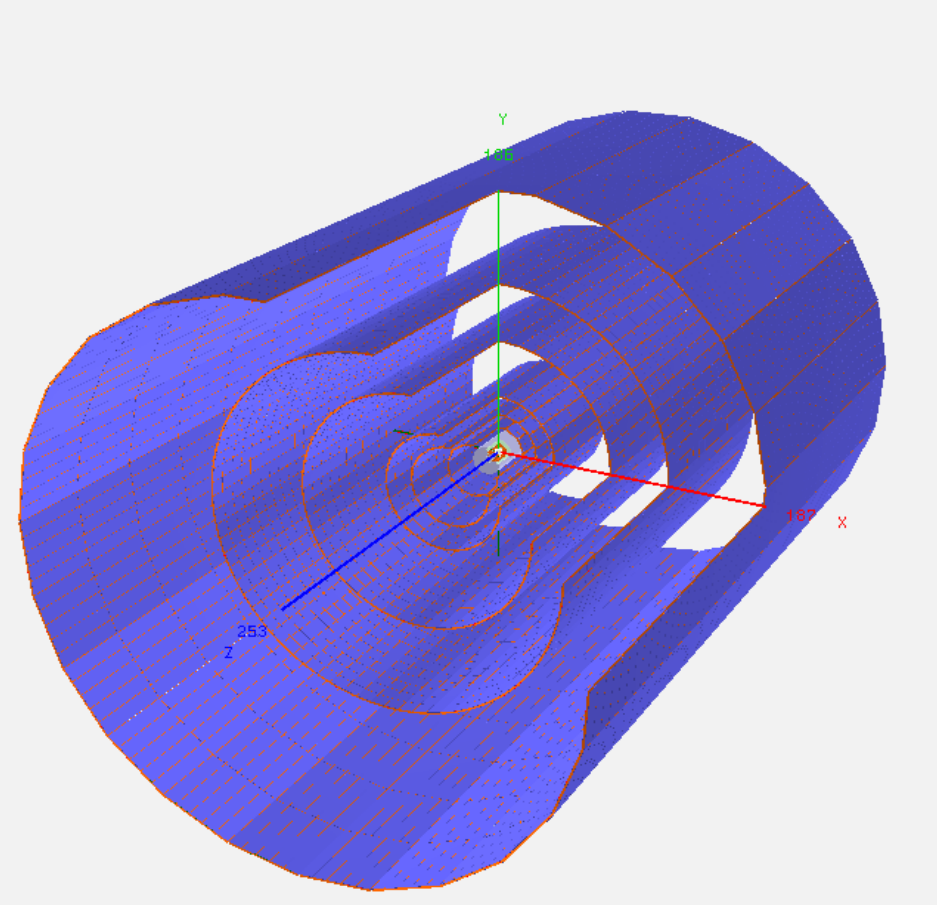
Silicon Tracking System

Not only ILD – CLIC studies

Full Silicon tracker: free to choose the shape and the sensor technologies for each layer :)



ILD:
VXD+SIT+SET+ETD+TPC



VXD+7couches silicium

Silicon Tracking System

Other Features

- Flexible parameters
  - Sensors and module sizes
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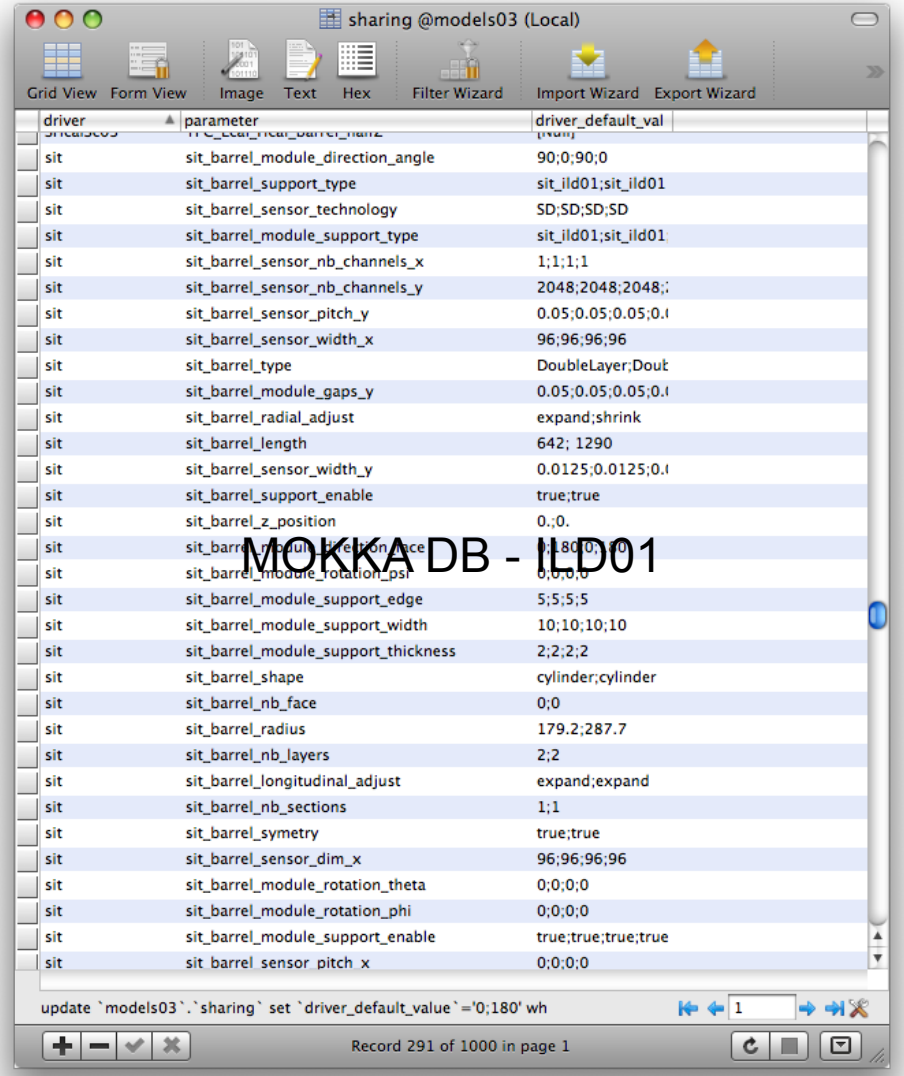
  - Sub-detector dimension and shape
  - Number of sub-detectors, of layers etc ...



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New User are really Welcome
We need feedback

Thanks for your attention …

And to the speaker ^^

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Mémo:
General SiLC goal => R&D for new technology of Silicon Tracking system
- R&D senseurs silicium
- R&D Front-End Electronic

Physics Goals:
- optimisation of the silicon tracker sub-detectors (momentum, tagging etc...)
=> need a tools to create easily new geometry configuration without writing long piece of code
=> completion fast/slow simulation easier
=> provide code and configuration for detector concept (ILD, ex4th, CLIC …)

SiLC develop a code in this purpose with these main ideas .....

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History of this task
- start in 2008 with ILCRoot (for 4th concept – see if we can use this framework rapidly – it was true :)) (from AliRoot-> meaning natural transition to learn about linear collider)
- in 2009, drivers incomplete for ILD → decide to transfer the code into GEANT 4/ MOKKA – transition
- CliC consideration => give a more flexibility => meaning independence (as much as possible) to the framwork (G4, RootGeant), dynamics parameters – philosiphie: “forbid” the fixed parameters

Silicon Tracking System

Code description

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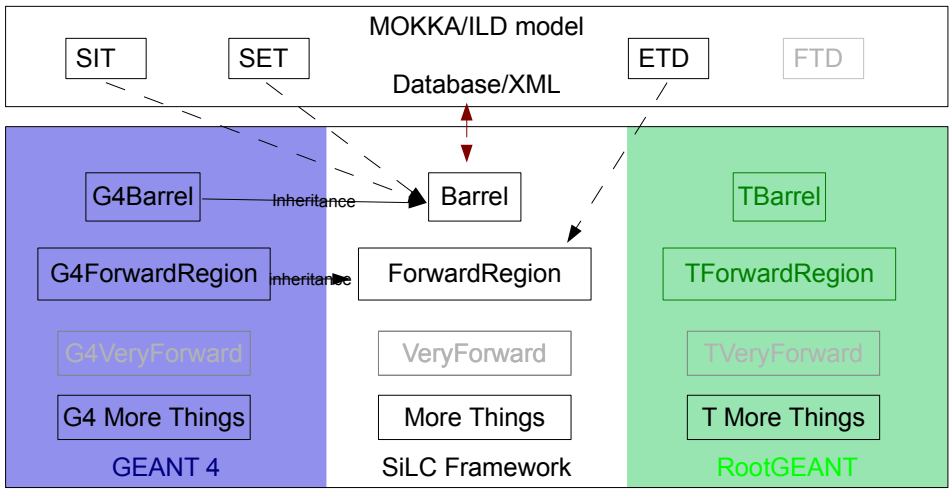
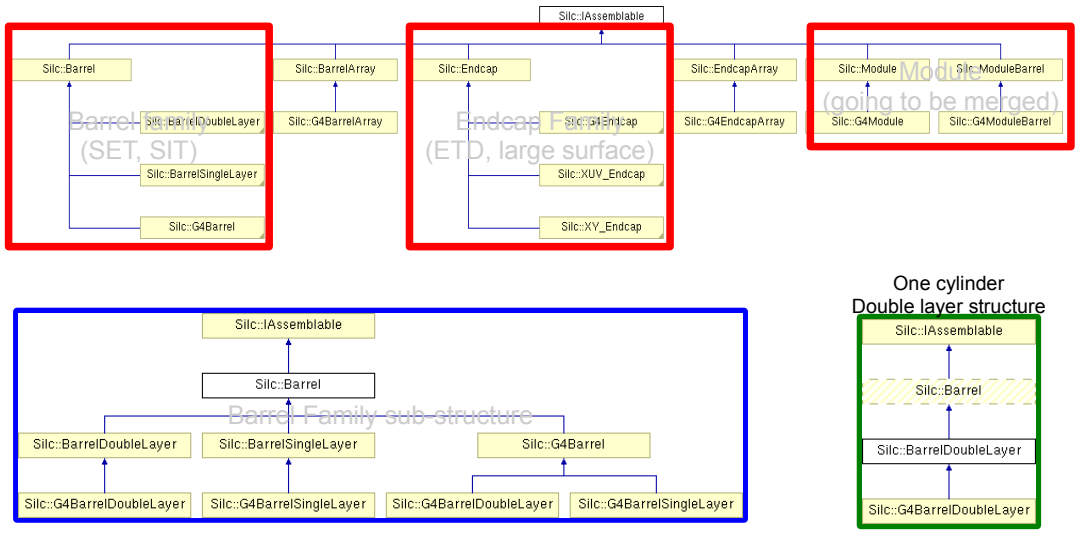


In this purpose:
(vertical lecture)
- starting point MOKKA DB or XML
- drivers calls
- use “independent” class to create and check the consistency of the configuration
- call the geometry class for the geometry builder

(horizontal lecture)
- Creation of family of sub-detectors accroding their surface and the physics region (barrel, forward, very forward etc …)
- could add more family very easily → because template for the construction

Silicon Tracking System

Design Pattern – UML class diagram



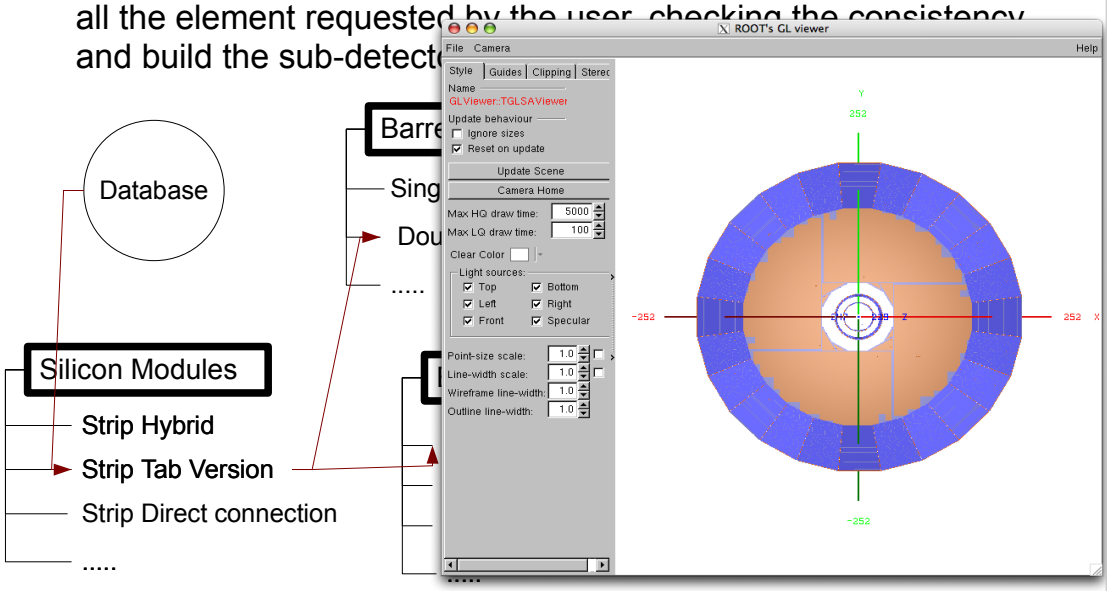
UML diagram: flexibility and modularity mean code abstraction and more complicated to write one class for the geometry (ex ETD00, ETD01 .... now it is the same code for every version).

- red line: “family” → Barrel with SET/SIT for ILD concept
- each configration are store in a table of container => each barrel, endcap etc or store inside → persitency of the configuration and Geant object and ease to get back all information (example: volume position, gear etc …)
- in blue: structure of one family: example: single of double layer structure for one “barrel”
- in green: inheritance of one object (ex: G4barrelXX inherit of BarrelXX inherit of virtal class Barrel inherit of Iassemble object

Silicon Tracking System

Interest of this complex structure

- Build the detectors from basic elements → LEGO game (pick up all the element requested by the user, checking the consistency and build the sub-detect



Why more flexibility:

- instead of to store one drivers for one sub-detectors configuration, we propose a knd of lego game or “cooking”.
- from the DataBase we enter the ingredient we wish:
  - I want a full silicon tracker → automatic generation
  - I want ans envelop of silicon composed of one 8-Pgon barrel, with one XUV encaps both equiiped with active edge sensor with tab configuration (layer of silicon sensor – Kapton – electonics)
  - the drivers pick up all the class needed to build this configurarion

Silicon Tracking System

Geometry builder – hierarchy with ILD example

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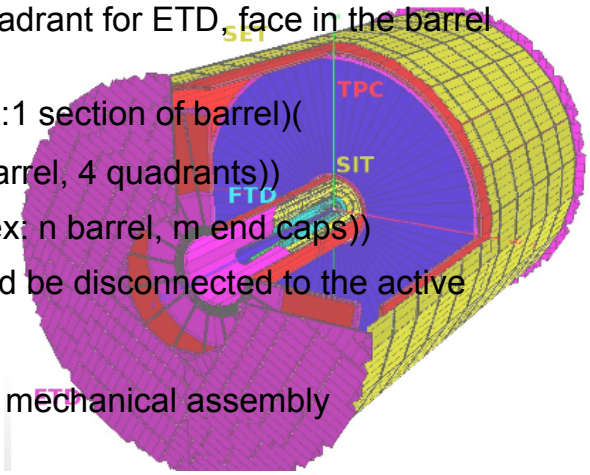


To offer this modularity we need a predefined structure:
→ here are enumerate of a subdetectors is build → 5 steps
→ the independancy of the support, cabling etc …

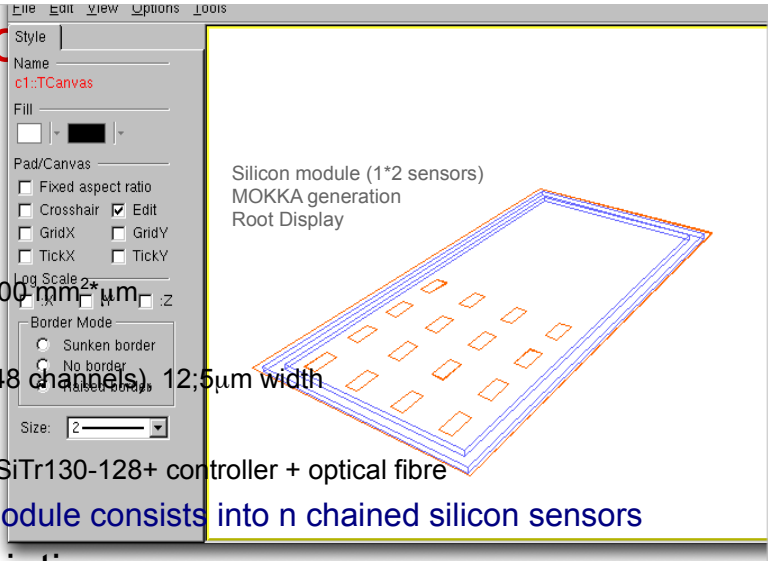
There is example according the ILD concept..

Example of Application
ILD Concept

Now application for ILD concept

Silicon

ILD



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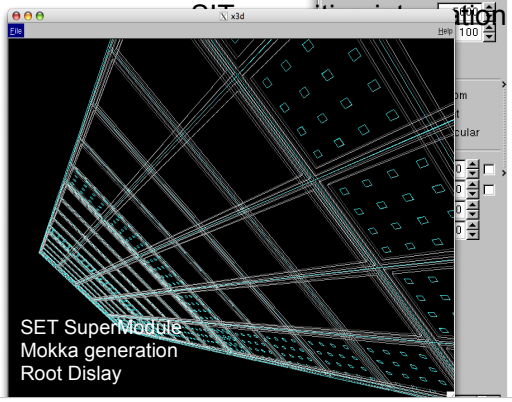

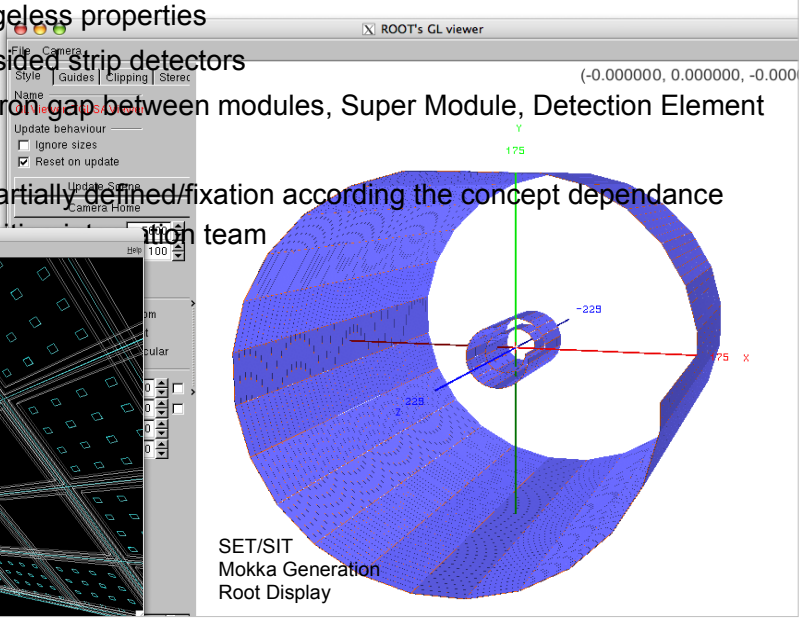

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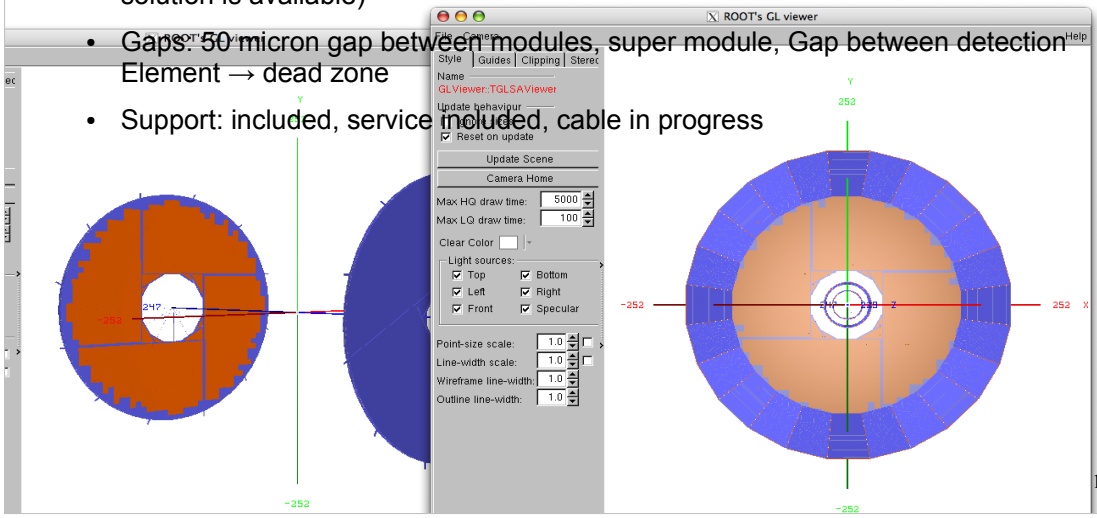

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Parameterisation

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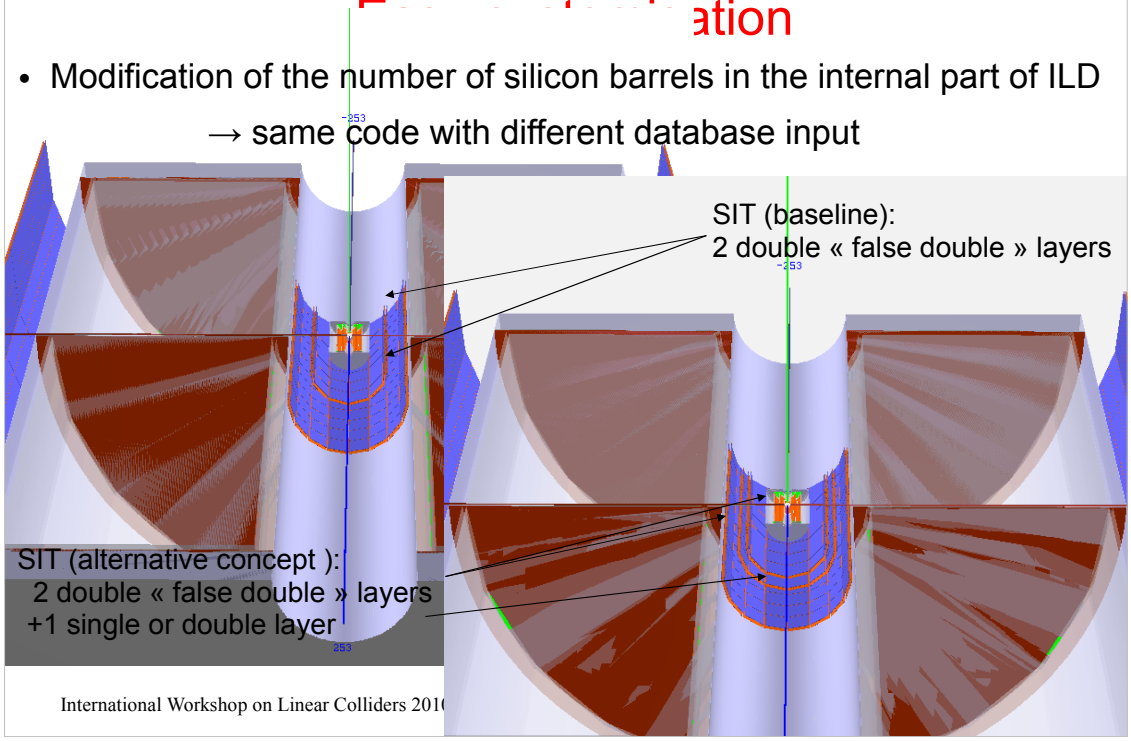

Silicon Tracking System

Not only ILD – CLIC studies

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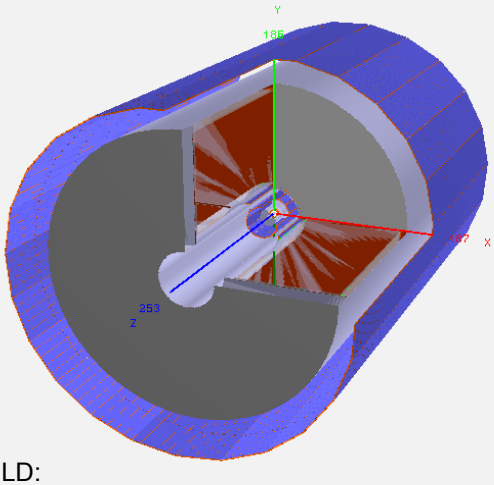

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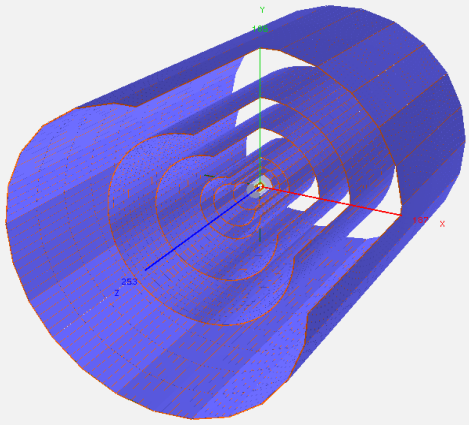

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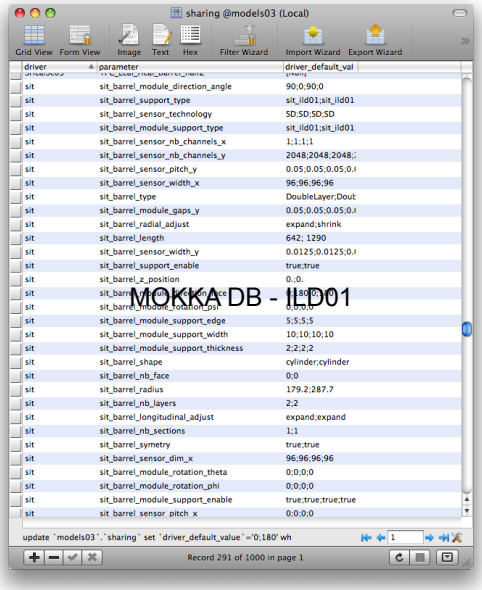

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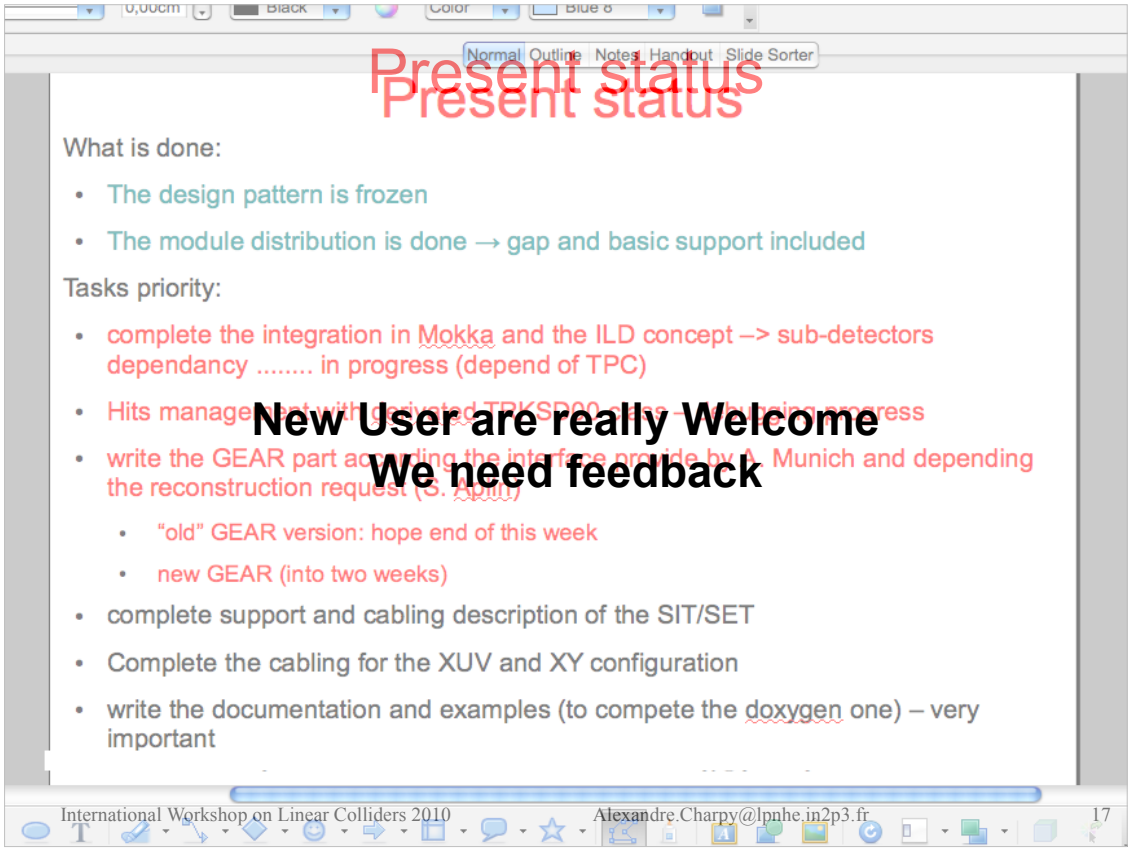
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Thanks for your attention …

And to the speaker ^^