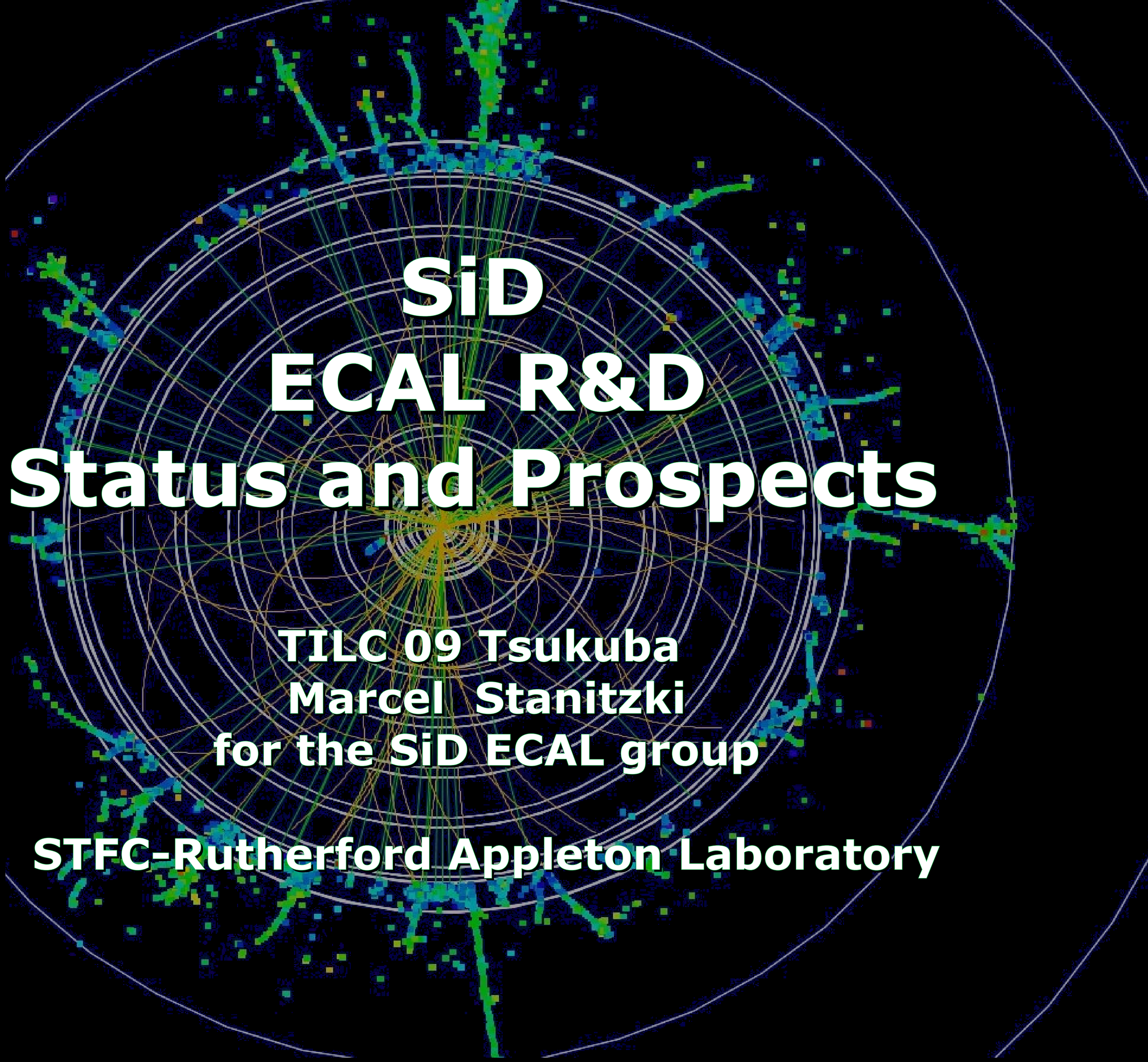

SiD ECAL R&D Status and Prospects

TILC 09 Tsukuba

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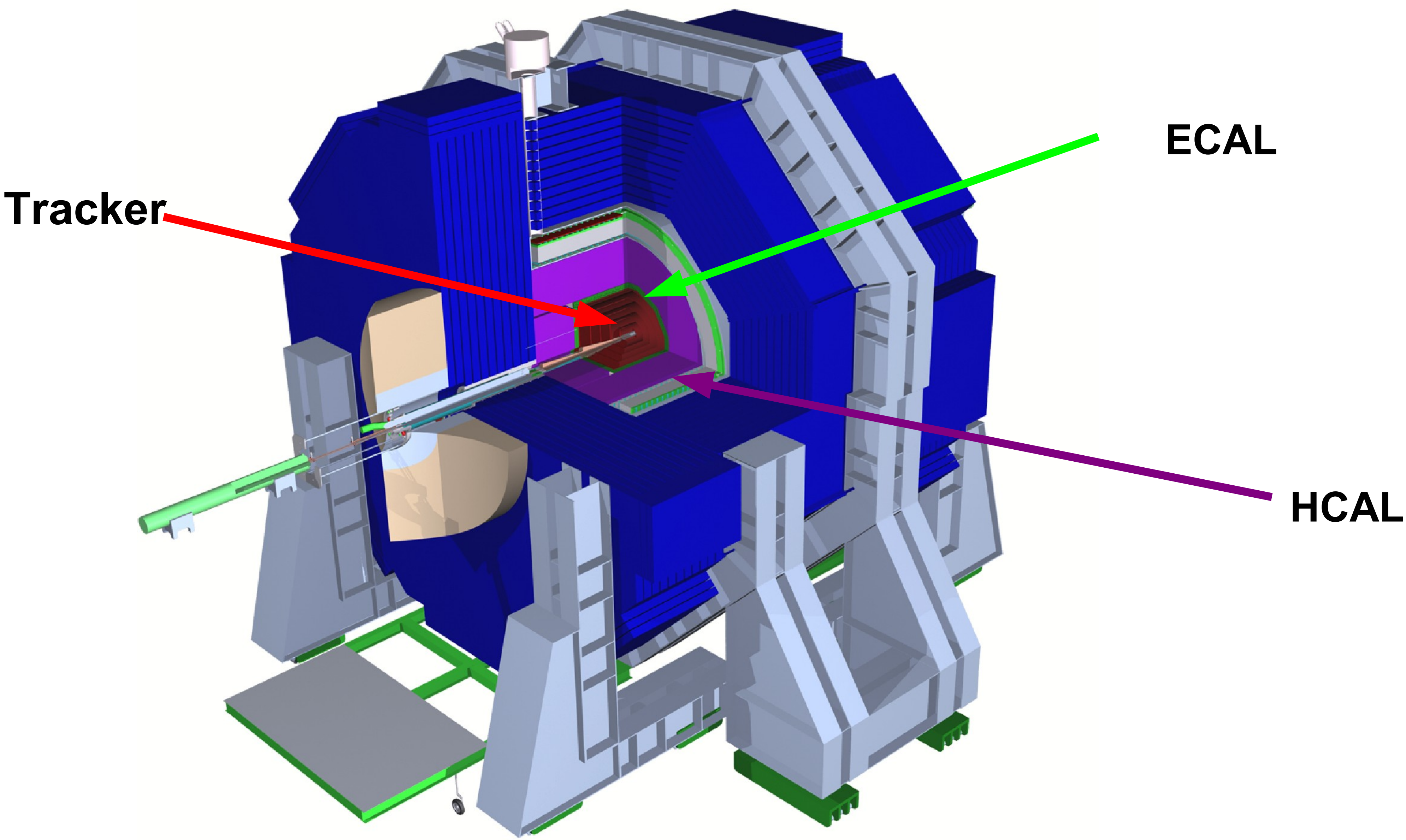
for the SiD ECAL group

STFC-Rutherford Appleton Laboratory

Introduction

- The SiD Calorimetry System is build around the Particle Flow paradigm
  - High granularity
  - Located inside the solenoid
  - Well integrated with Tracking
- The ECAL is designed as ***Imaging ECAL***
- Si+W Sampling calorimeter
  - Good energy resolution
  - Compact
  - Segmentation smaller than $r_{Moliere}$

The ECAL and SiD



ECAL Overview

- Dimensions
  - Inner radius of ECAL barrel 1.27 m
  - Maximum z of barrel 1.7 m
- Layers
  - 20 layers 0.64 X_0 + 10 layers 1.3 X_0
- EM energy resolution 17%/√E
- Readout gap 1.25 mm
- Effective Moliere radius 14 mm

Two ECAL options

Si+W

Common Mechanical Design

Traditional Silicon Diodes

- HEP-style silicon
- 13 mm^2 hexagons
- Analog readout
- KPiX readout chip
- ***Baseline Option***

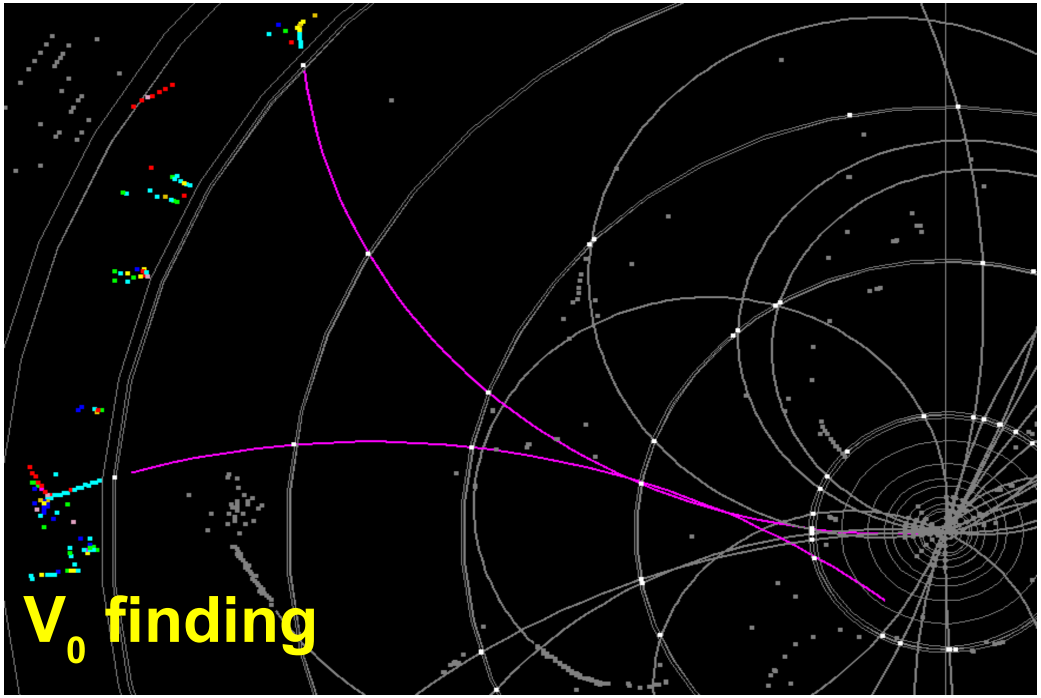
TeraPixel Option

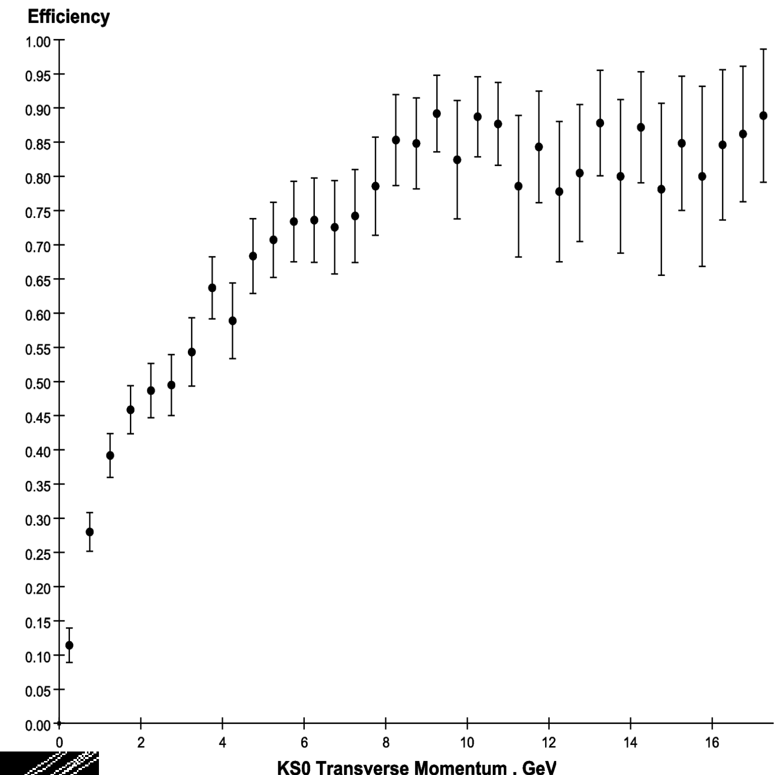
- CMOS MAPS
- 50 x 50 µm pixel size
- Digital readout
- readout integrated in pixel
- ***Alternate Option***

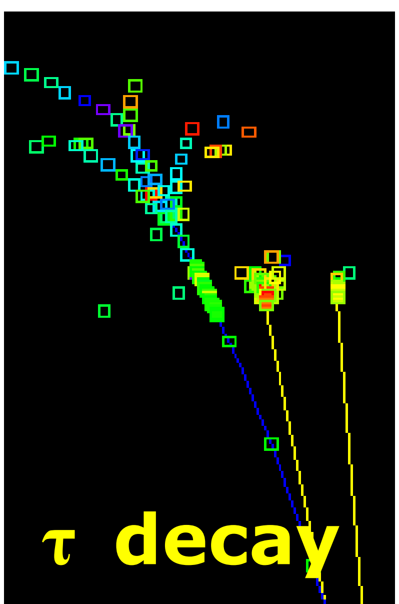
Option overview

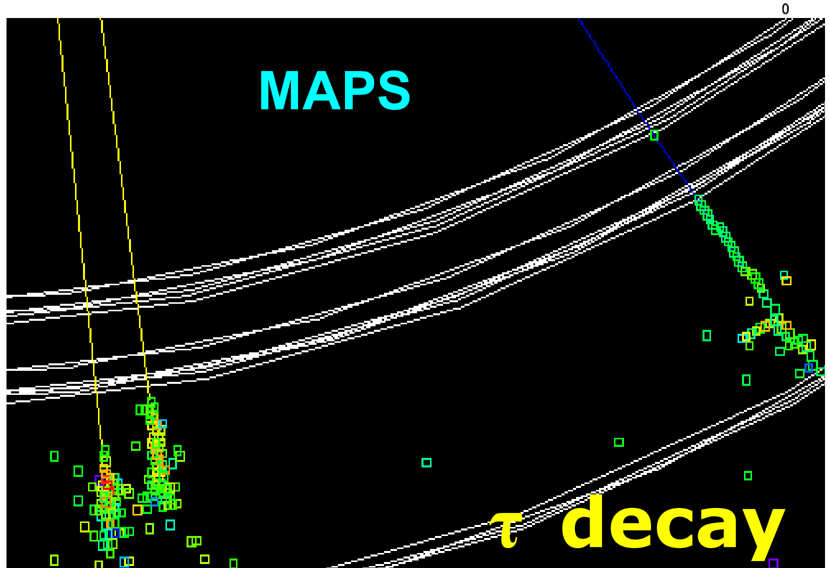
	Baseline Option	MAPS Option
Pixel Size	13 mm^2	50x50 µm
Pixels per silicon sensor	1024	1,000,000
Channels per KPiX chip	1024	-
Pixel dynamic range requirement	0.1 to 2500 MIPs	1 MIP (digital)
Heat Load Requirement/Sensor	<=20 mW	<=20 mW

Physics Capabilities



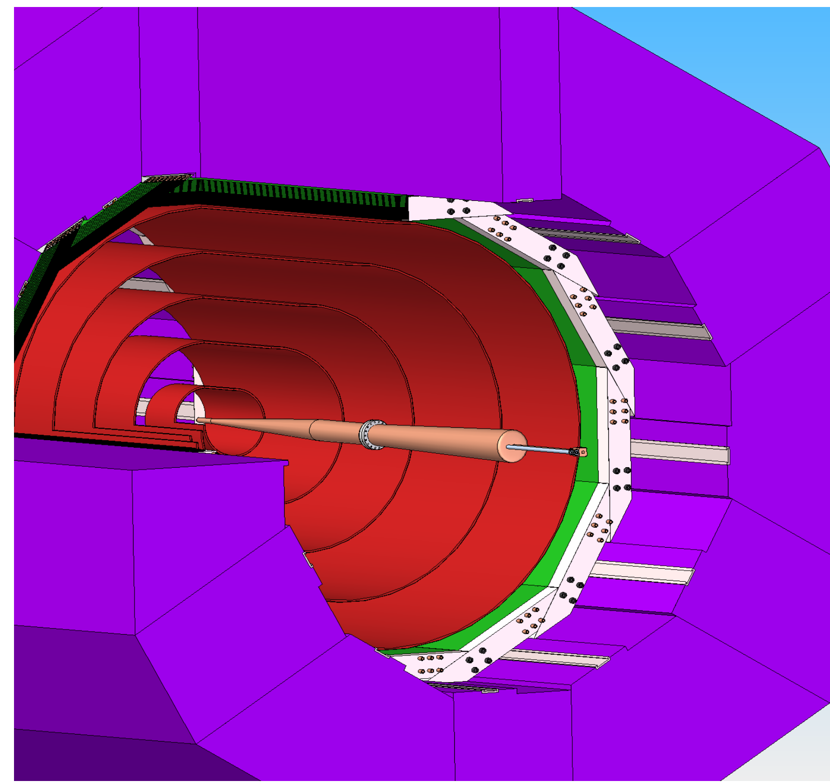




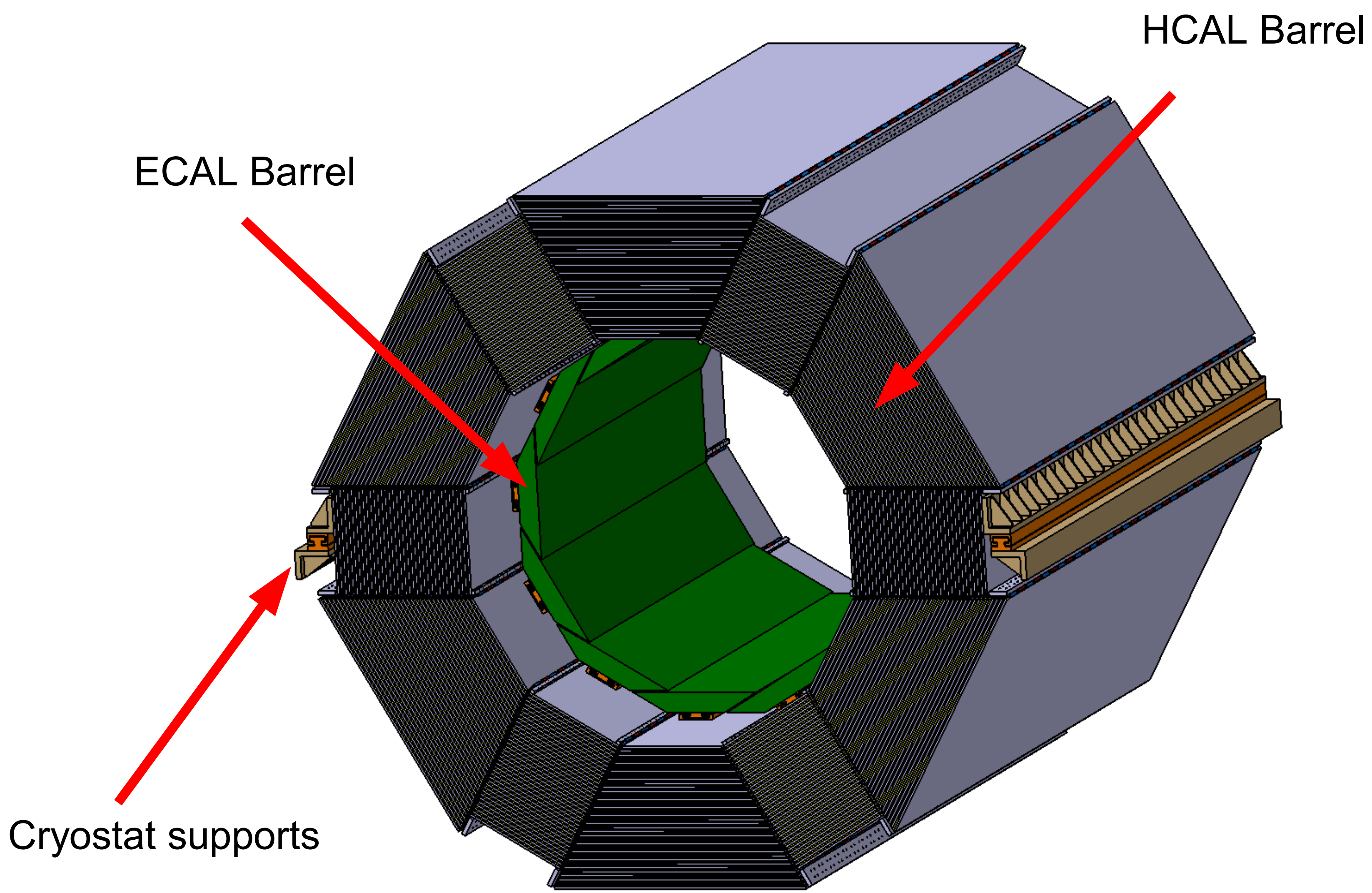


ECAL Mechanics

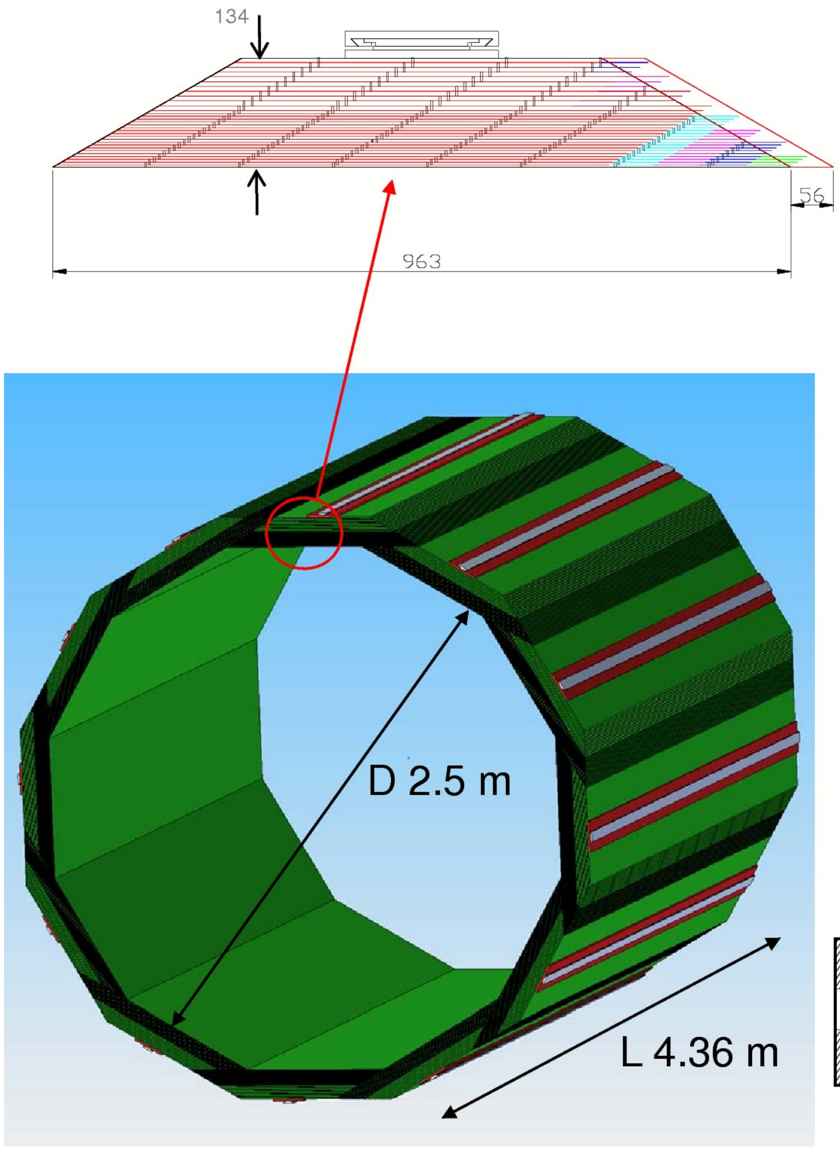
- ECAL barrel has a sound mechanical design already
  - 12 individual wedges
  - fixed with rails to HCAL
  - stacks of tungsten
- tungsten plates
  - max 1 x 1 m requires interleaving
  - interconnects done using "screw and insert" technology

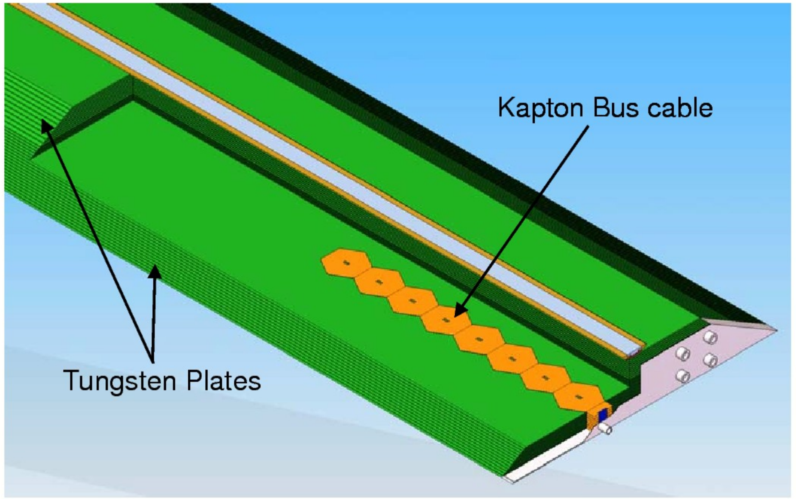


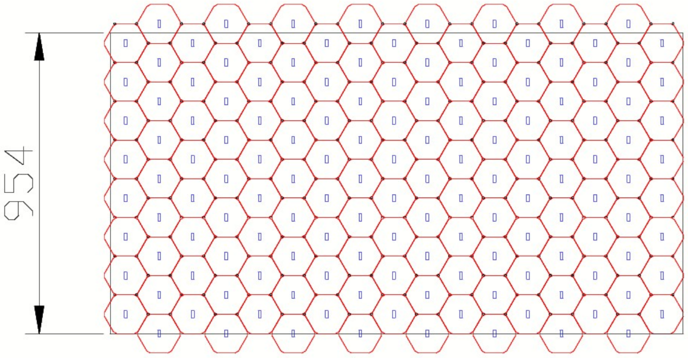
ECAL and HCAL



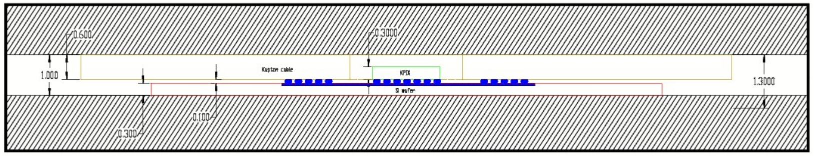
In detail





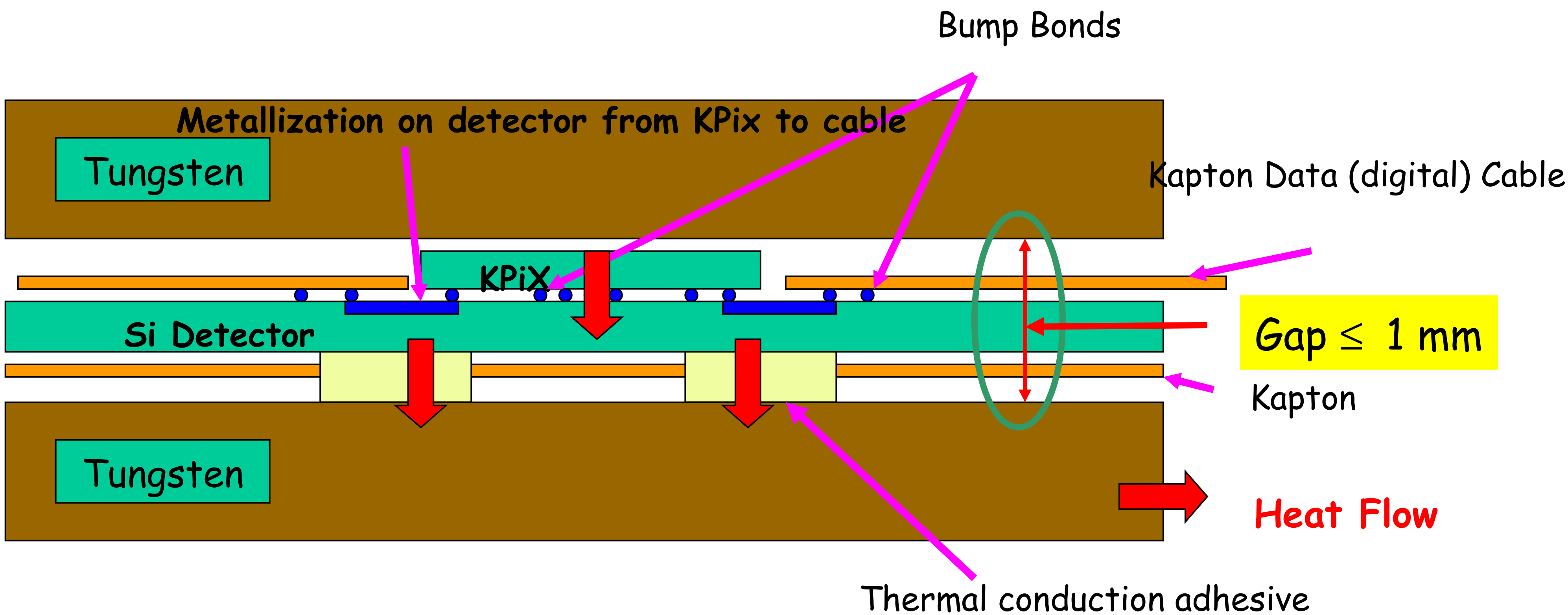


Hexagon sensors arrangement

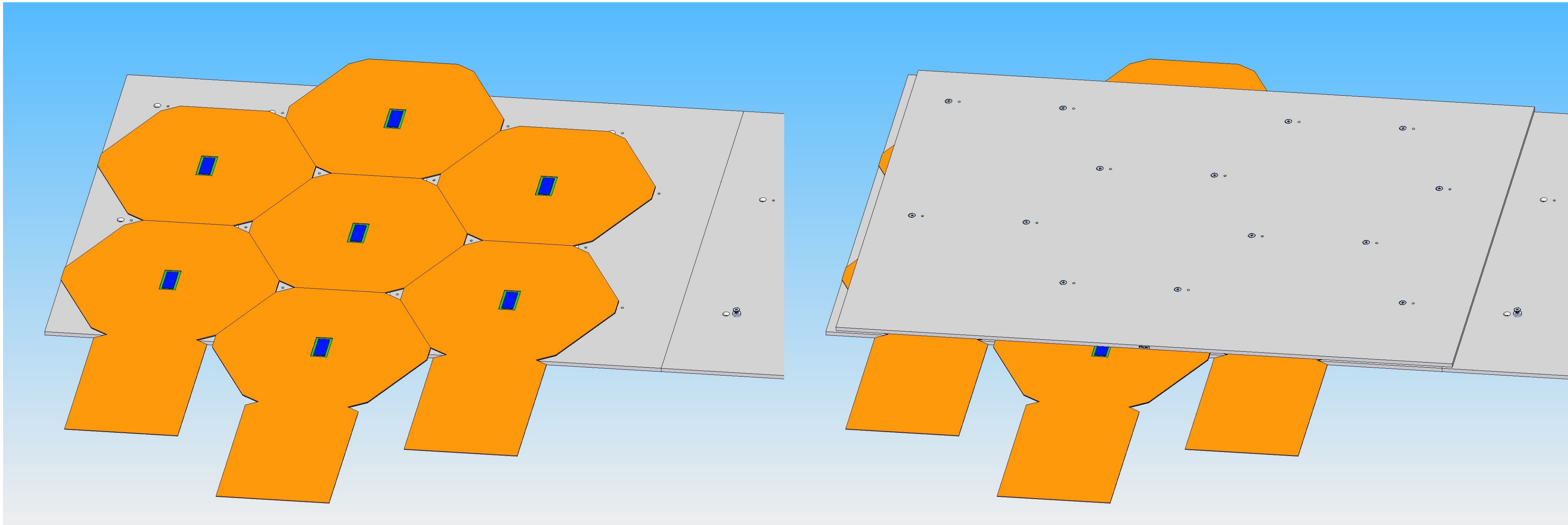


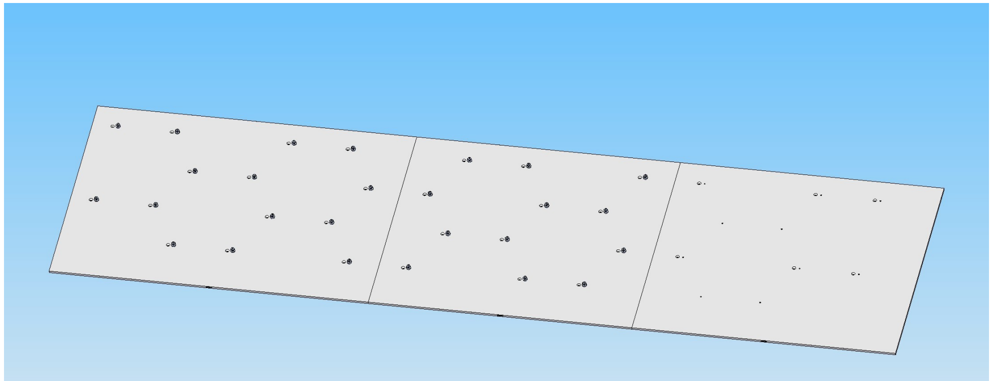
detector module between tungsten plates

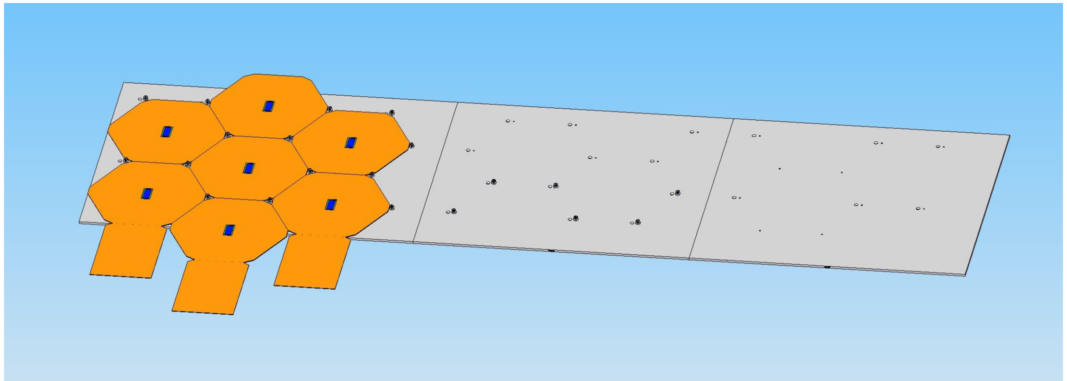
The readout gap



Assembly

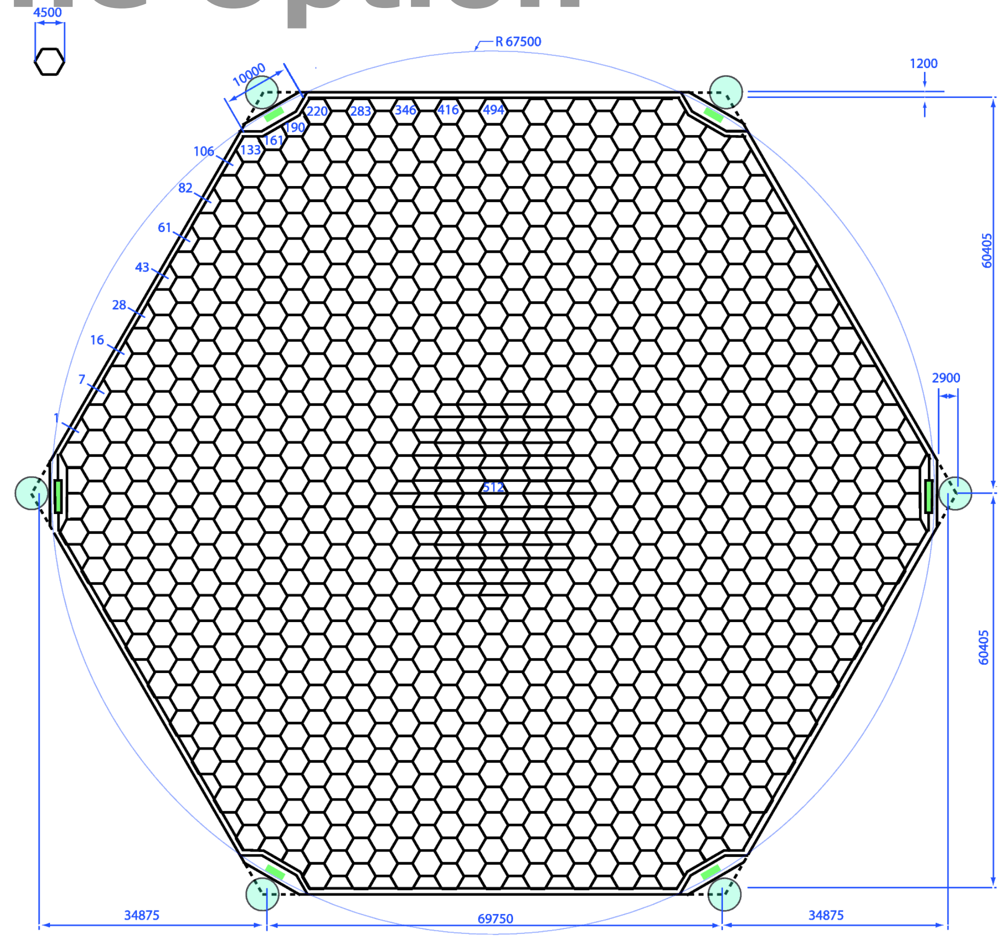






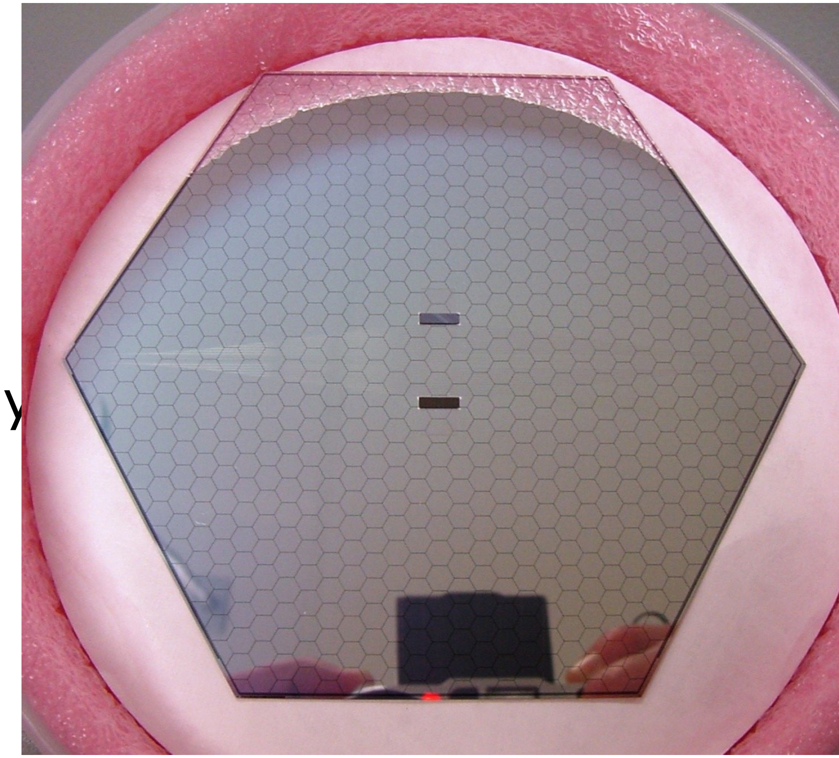
Baseline Option

- Using High-res silicon sensors
  - second version obtained
  - testing has begun
  - will be used for testbeam
  - KPix bump-bonded to wafer
- Exploring new bump-bonding options
  - avoids needing a Ti-W treatment



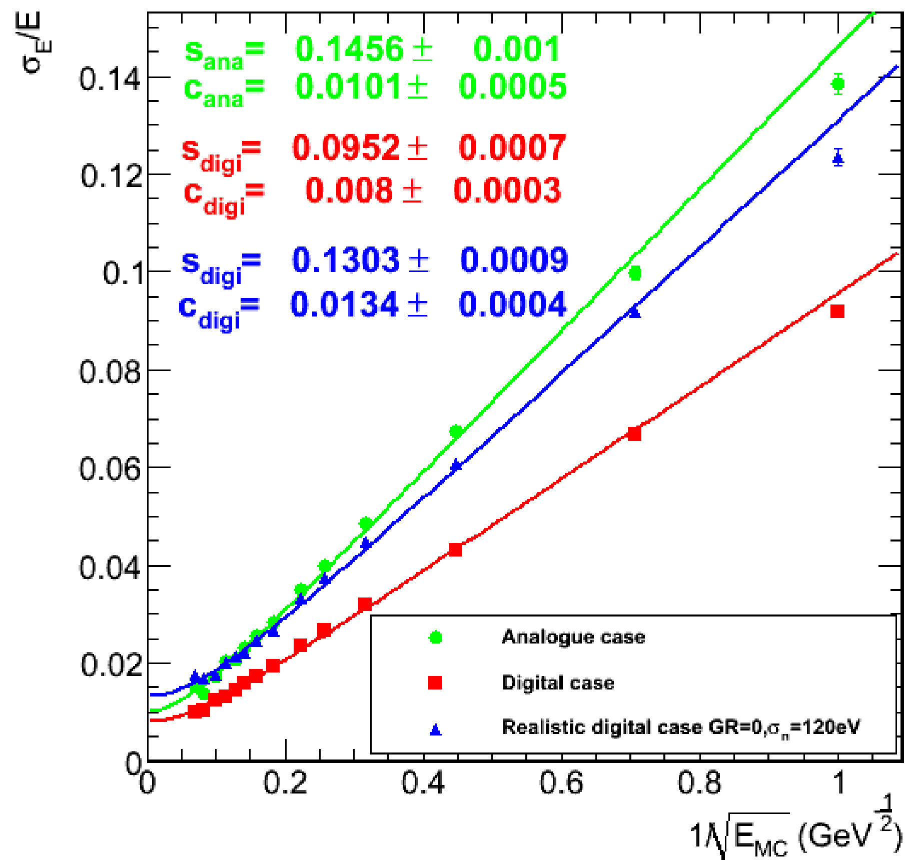
KPiX

- 1024 channels
  - KPiX 7 has 64 channels
  - 256 channel version is on the way
- bump-bondable
- 13 bit ADC and Dynamic Gain selection
- 0.25 micron CMOS
- ~ 20 mW/channel
- KPiX als planned for
  - Tracker/HCAL/Muon chambers



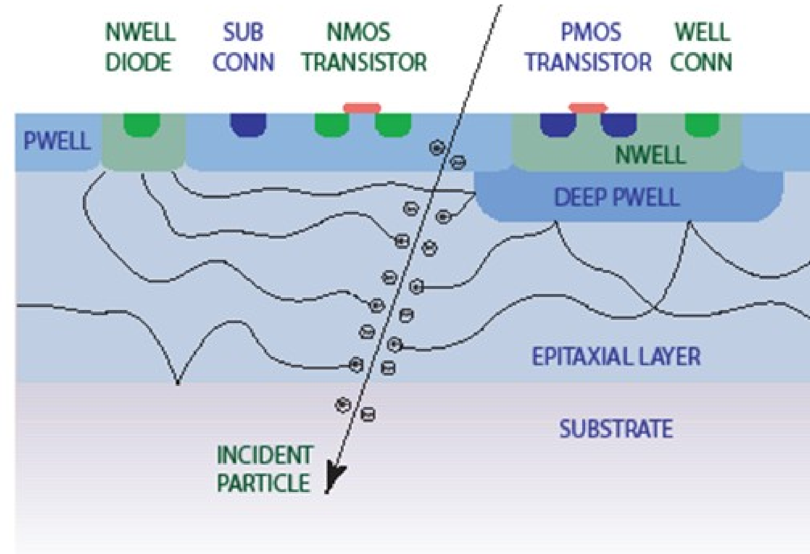
DIGITAL MAPS Option

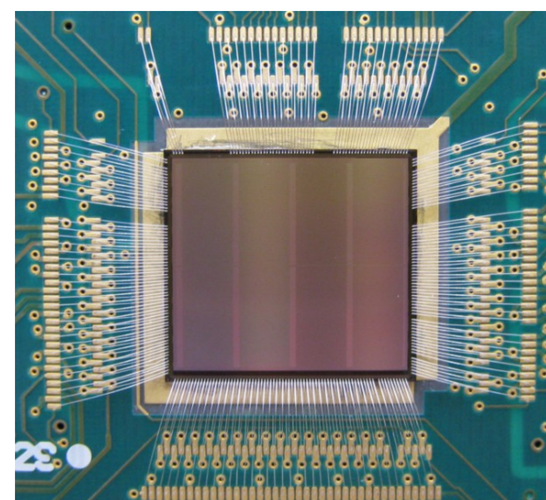
- A digital SiW ECAL has theoretically a much higher resolution
- Realistic simulation
  - 35% increase in error
- Due to
  - Noise hits
  - Dead area
  - Charge diffusion
  - Particles crossing pixels boundaries and sharing pixels



The TPAC sensors

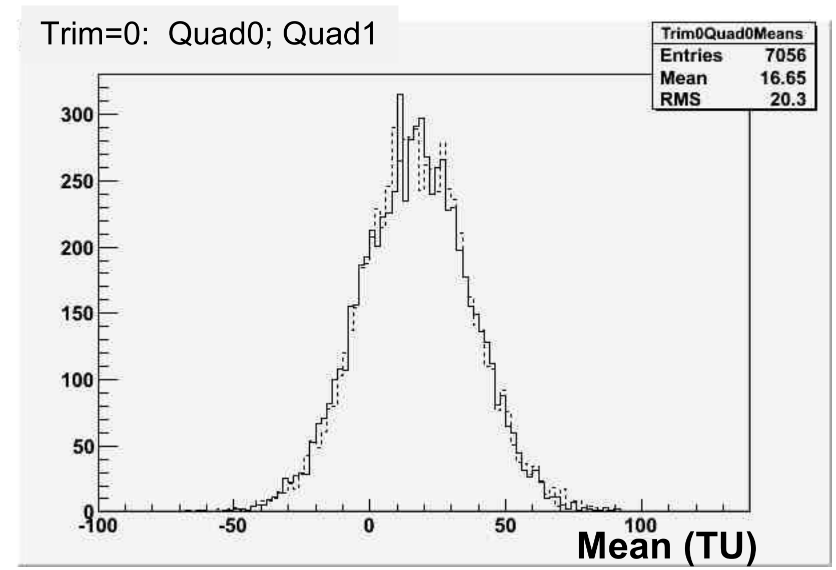
- TPAC series of chips
  - MAPS-based
  - deep p-implant
- Electronics in each pixel
  - amplifier
  - comparator
  - trim registers
  - mask register

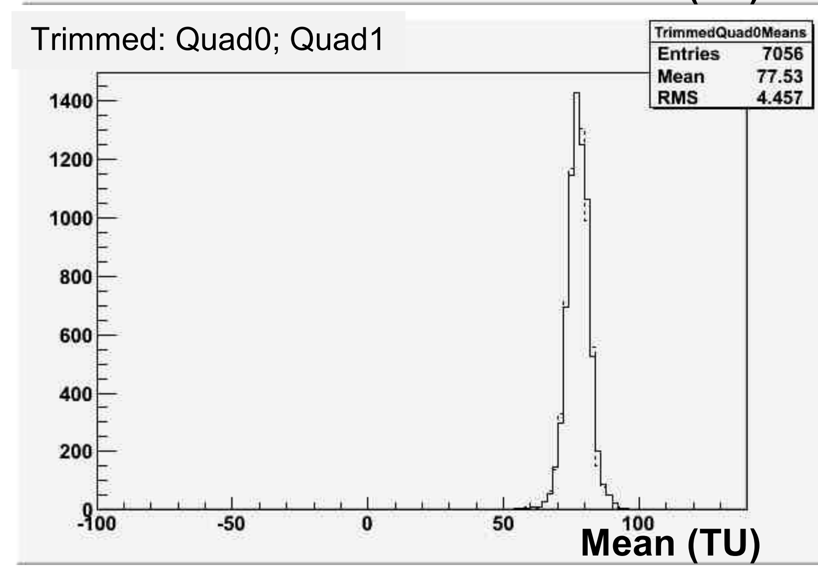




Current Status

- testing of TPAC 1.1
  - Only one pixel variant (instead of 4 on TPAC 1.0)
  - 6 bit trims
  - minor fixes
- Also further exploring deep p-well implants
  - TCAD simulations
  - rad-hardness



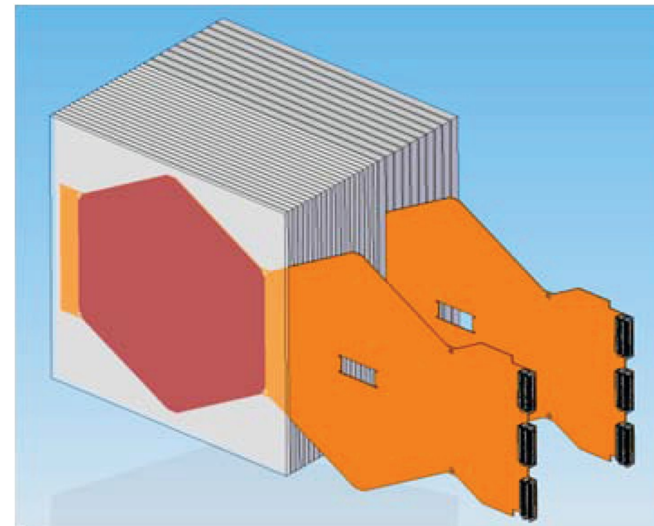


Alignment and Calibration

- For calibration
  - Silicon is considered stable over time
  - Gain differences in the electronics
  - Have dedicated calibration circuits per channel
  - main issue is sheer number of channel
- For mechanical alignment
  - optical Alignment during assembly < 1 mm
  - positioning of modules known to ~ 100 μm
  - we expect this to be sufficient for the ECAL
- Can further improve this with cosmics & beam data

Future Plans

- For both options the aim is to produce a stack
- For the baseline
  - 30 layers with KPix
  - requires 1024 channel KPix
  - 30720 channel
  - Using steel to mechanical concept
- The MAPS option plans
  - 16 layers
  - 64 million channels
- Both plan to be done 2012



R&D

- 1024 channel KPiX
  - 256 channel well under way
  - expect 1024 version next year
- MAPS
  - make a large sensor (~ 5 x5 cm)
  - planned for 2011
- Physics studies
  - Dedicated π^0 finder
  - clustering optimization

Summary

- SiD ECAL is well advanced
- Mechanics well defined
  - common for both options
- Both option plan beam tests
  - before 2012
- Exploring physics capabilities
  - What can we really do with such a great device
- Thanks to M. Oriunno, R. Frey, Andy White for comments and contributions