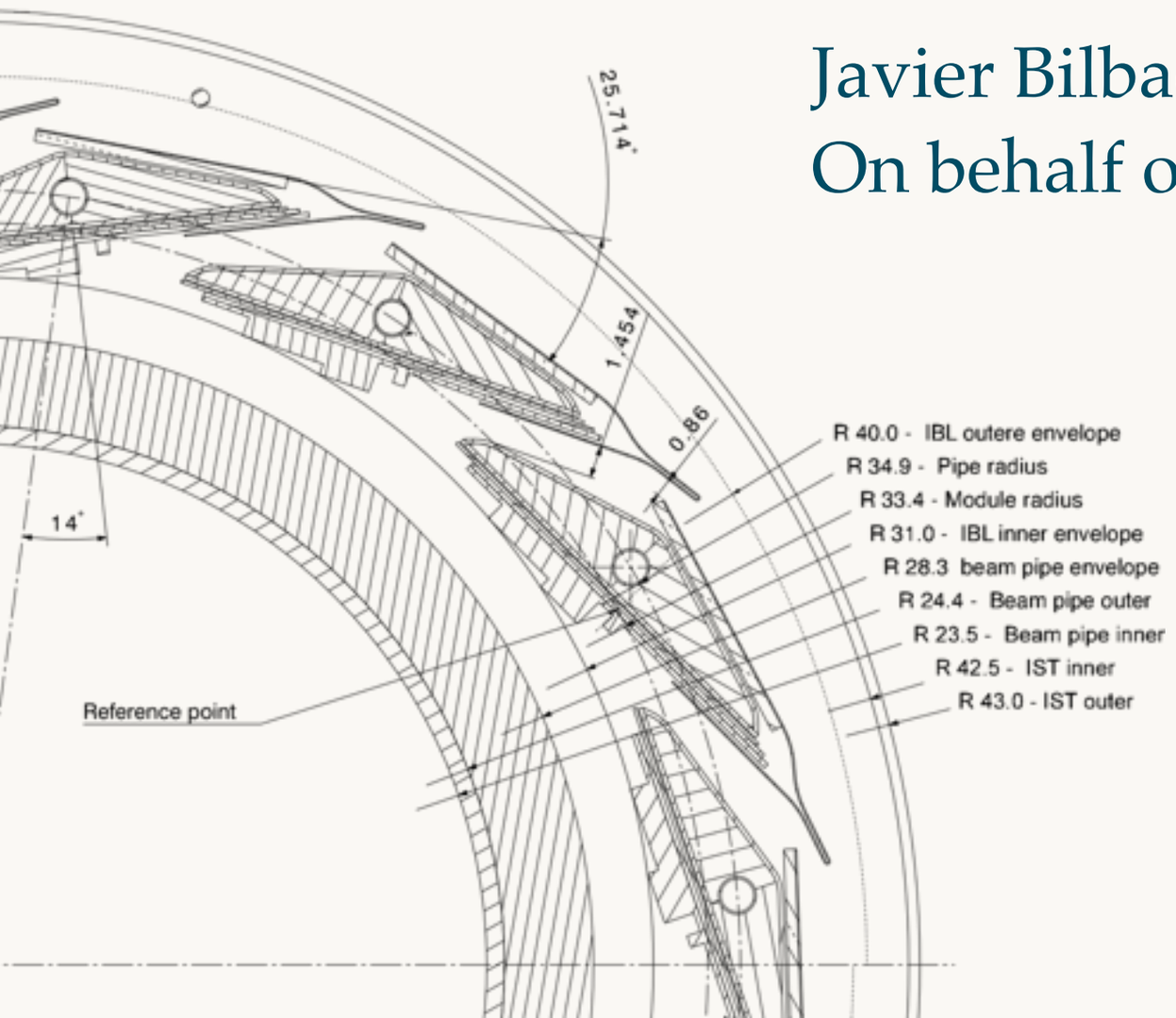
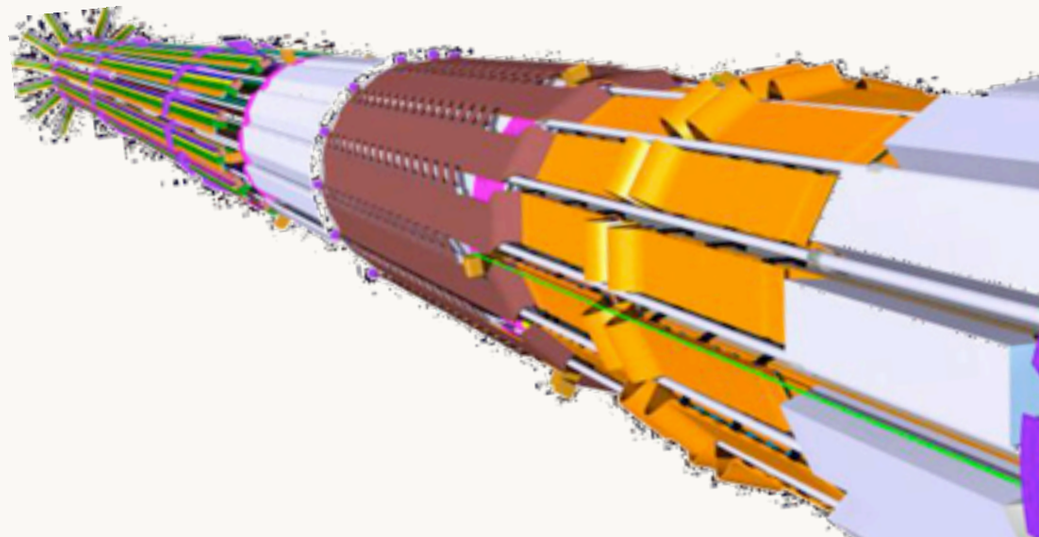
UNIVERSITÉ DE GENÈVE

The ATLAS Insertable B-Layer (IBL) Project

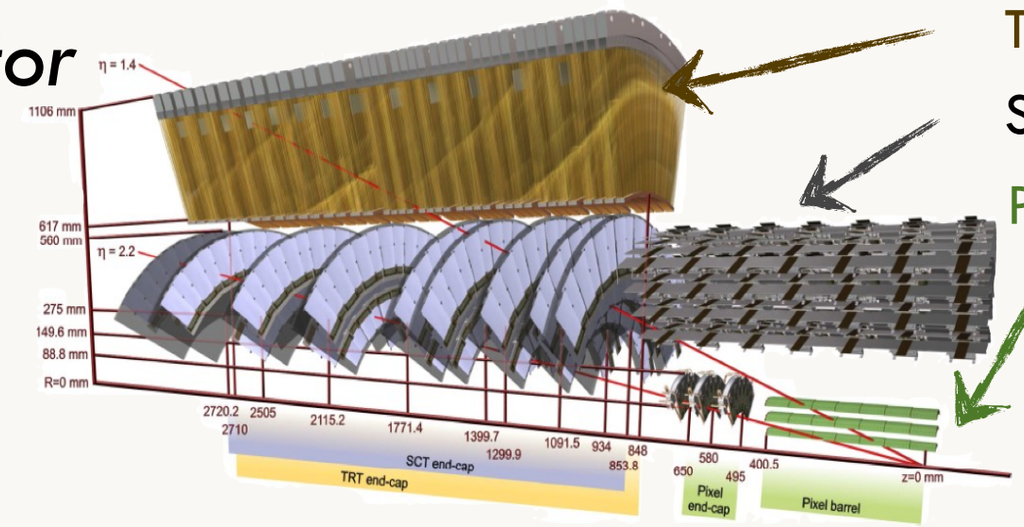
Javier Bilbao
On behalf of the ATLAS IBL collaboration





The IBL in the current ATLAS

Actual Inner detector



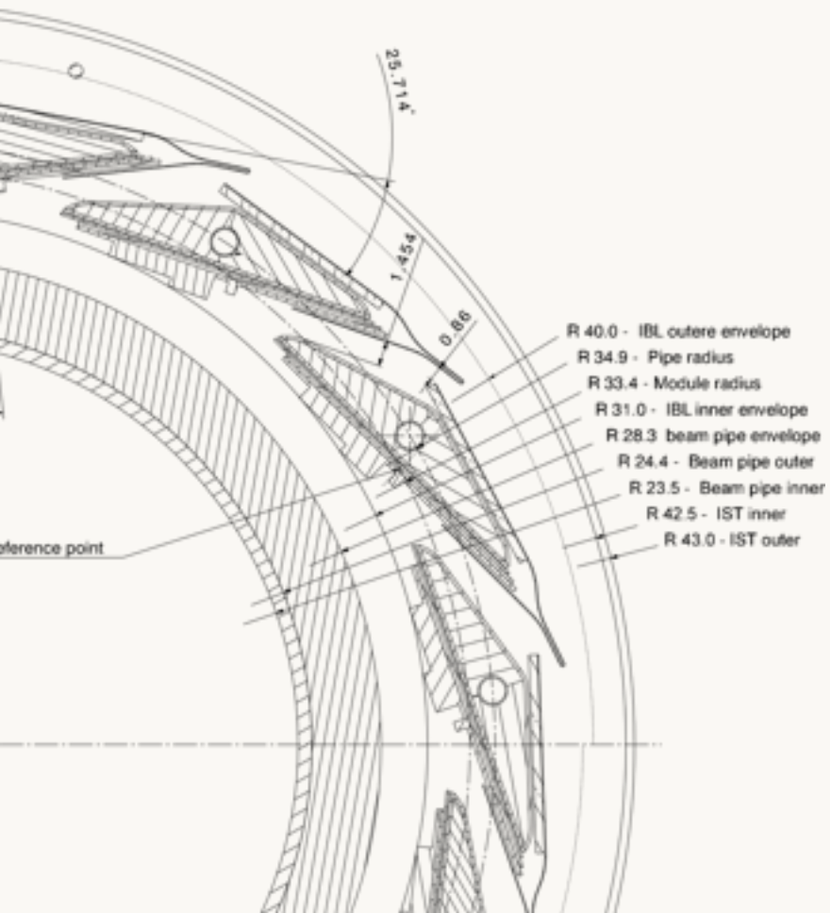
Transition radiation Tracker

Semiconductor Tracker

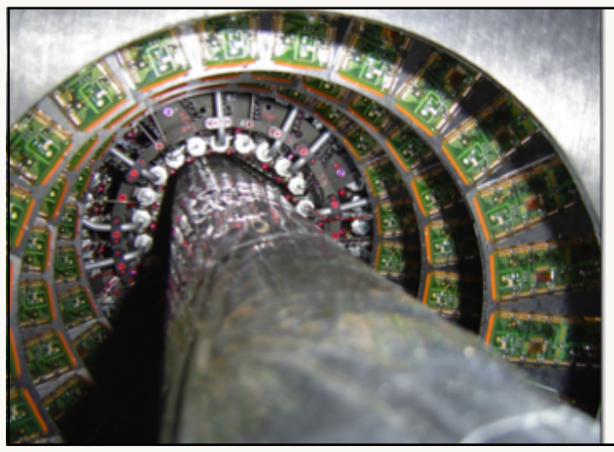
Pixel Detector

in 2013

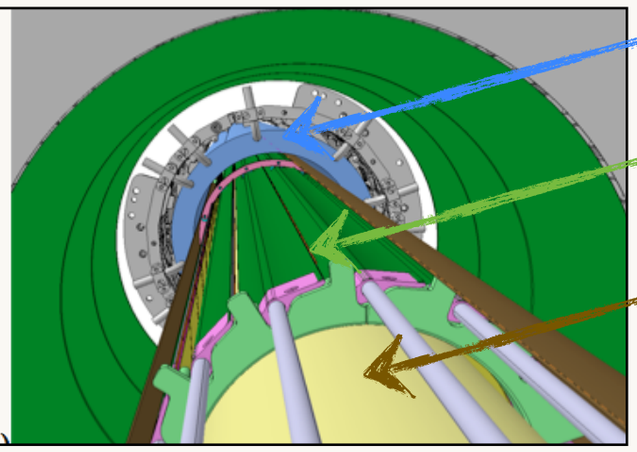
Upgrade the current Pixel detector with a new inner 4° layer with finer segmentation



Actual Detector



IBL & pixel



1° Pixel layer

IBL staves

New beam pipe

Installation:

i) Beam-pipe extracted

ii) IBL Support Tube inserted

iii) IBL with smaller Beam Pipe (23.5 mm) inserted in the IST

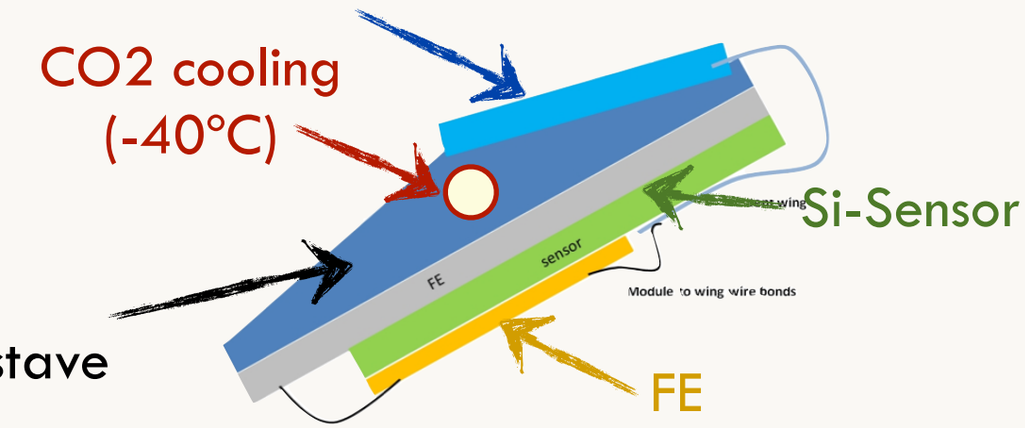
Insertable B Layer

The IBL stave

ATLAS → Inner Detector → Pixel

- *Composed of 14 staves*
- *60 cm of active length (Z) or η coverage of 2.5*
- *Average radius of 34mm with a 9mm envelop*
- *Hermeticity ensure with an overlap of 1.8° between staves*

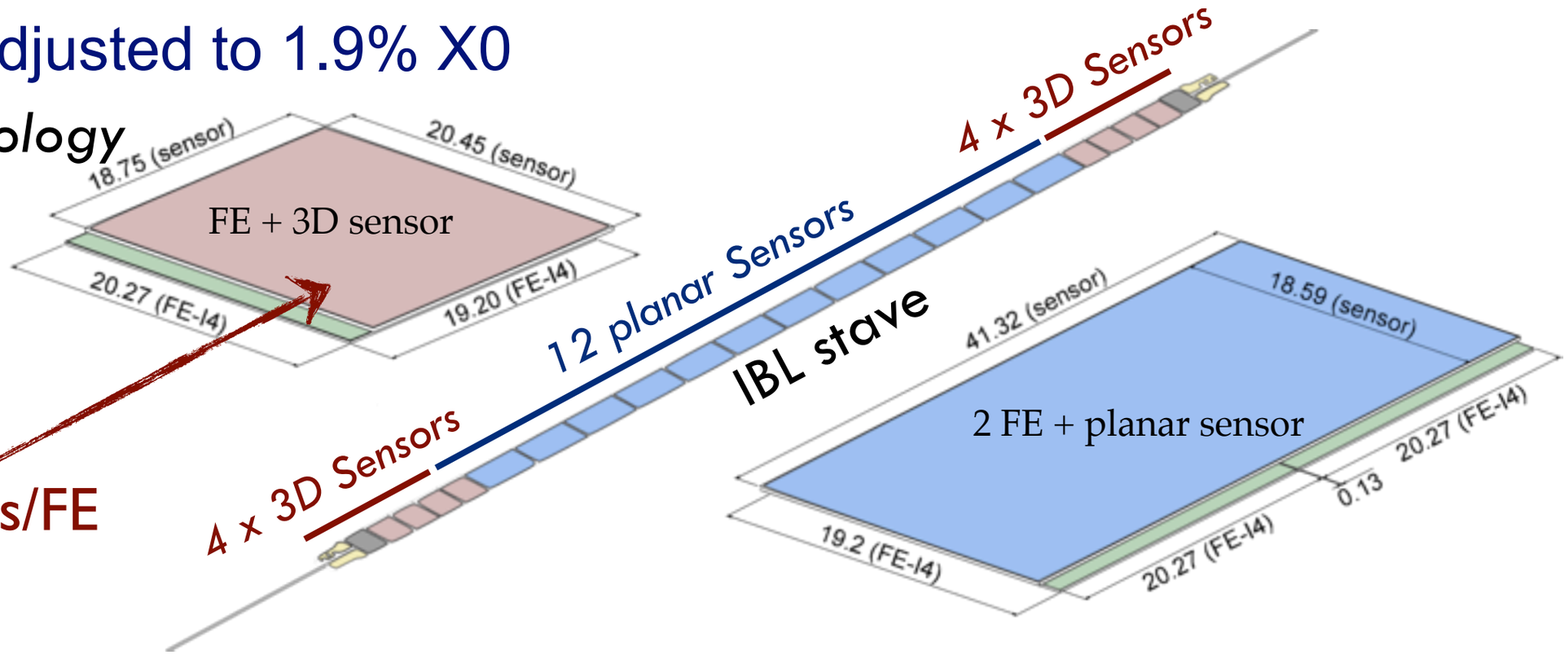
Stave flex - half stave read-out



IBL material adjusted to 1.9% X0

- *2 sensor technology*
- *New FE-I4*

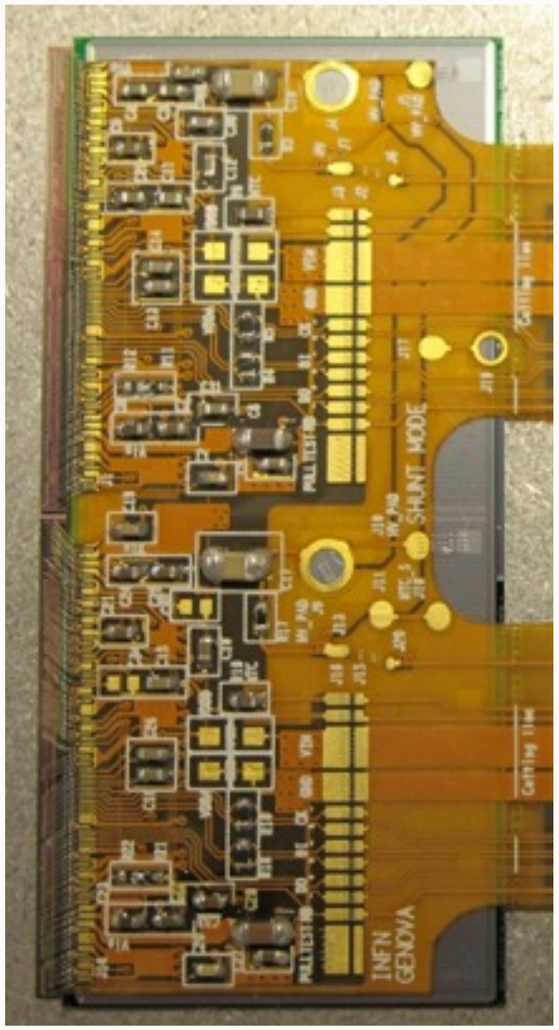
~30 000 pixels/FE

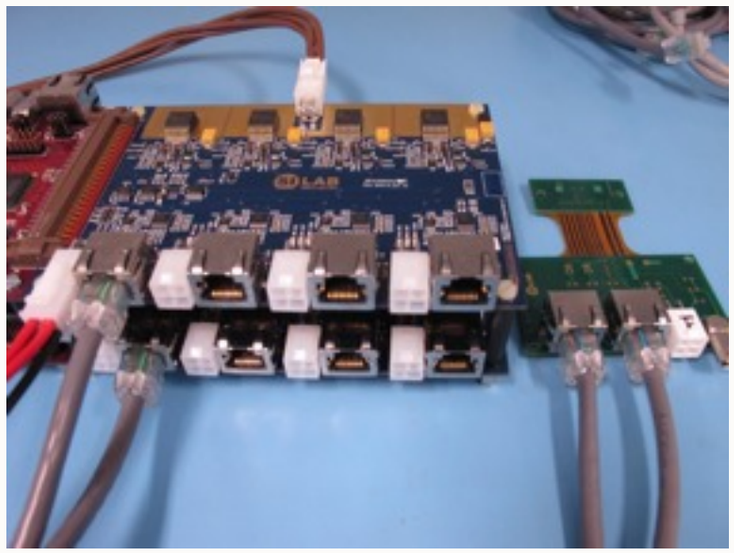


Stave @ UniGE

- Module reception test
- Stave Loading
- Metrology & envelope
- Stave QA

Module electrical RT





Stave @ UniGE

- Module reception test
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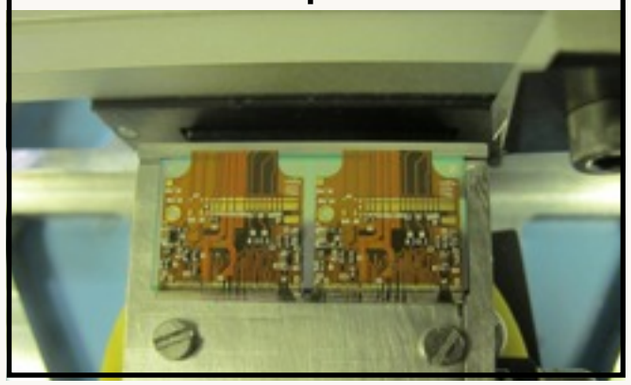
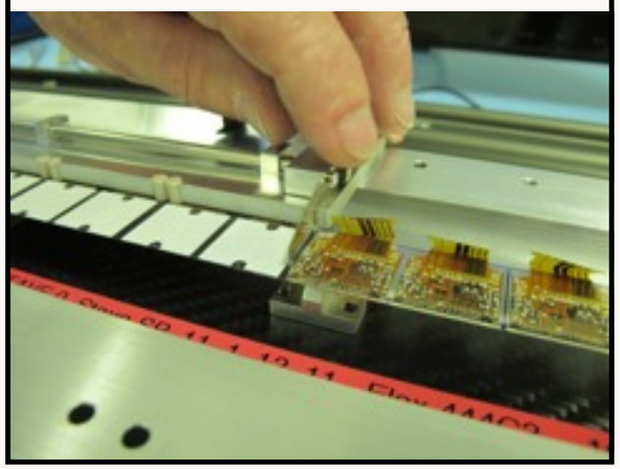
- Stave QA

Th. grasse + glue

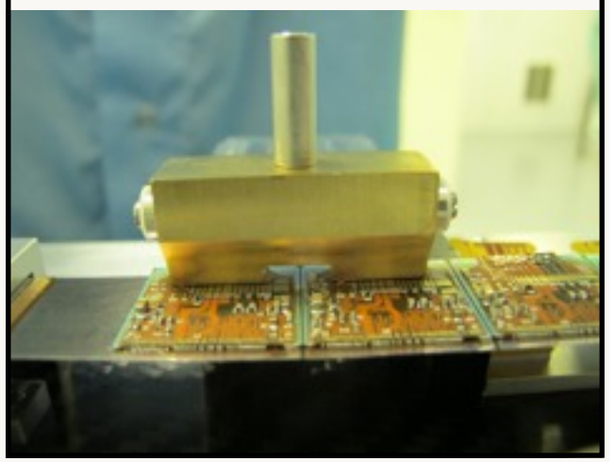
Module Preparation



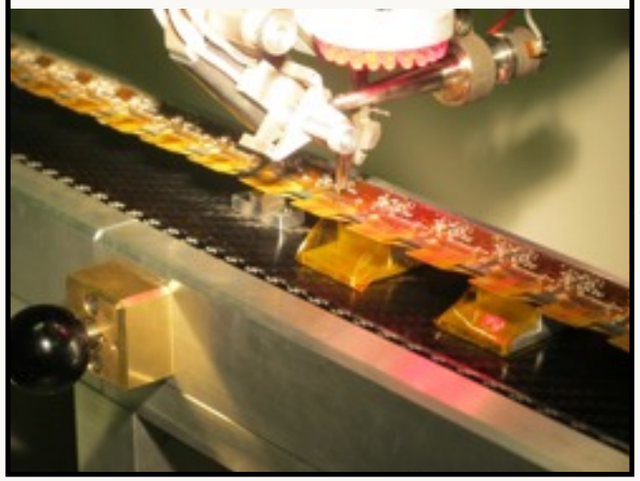
Module loading

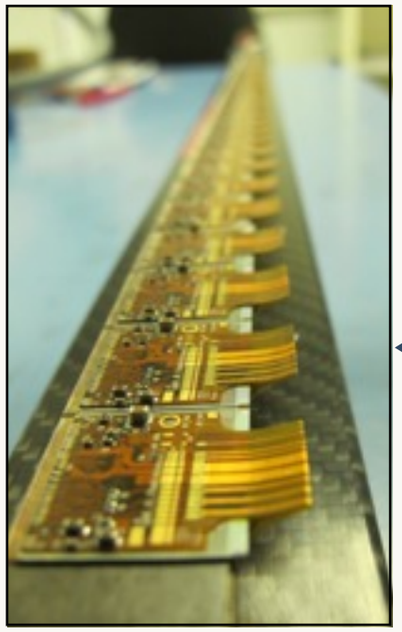


Wing Gluing



Stave Wirebondind

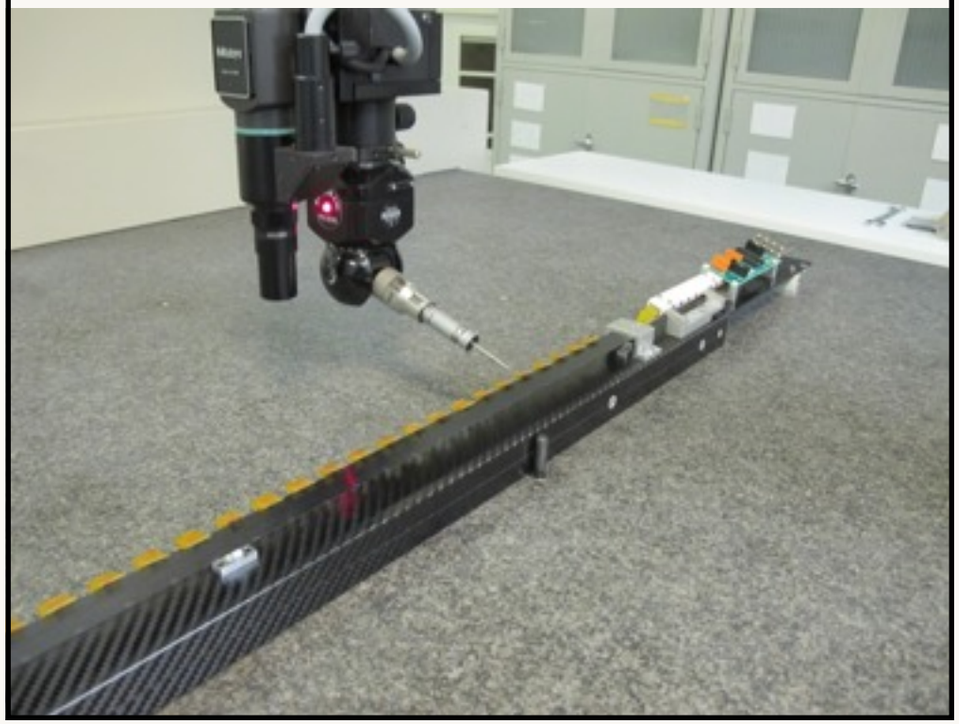


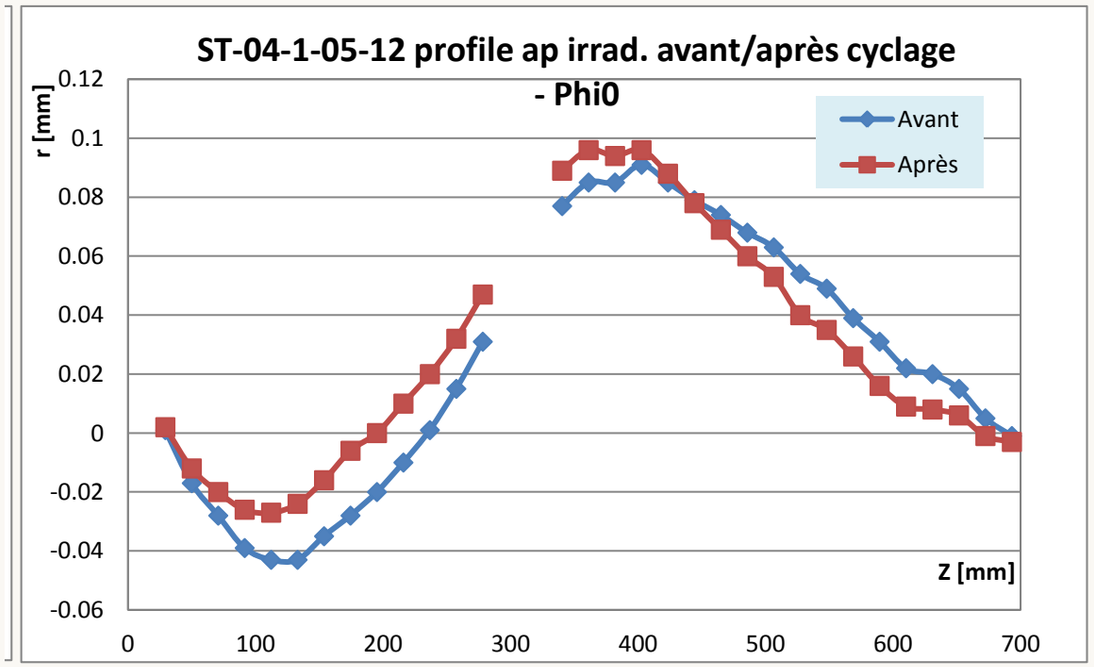


Stave @ UniGE

- Module reception test
- Stave Loading
- Metrology & envelope
- Stave QA

Stave metrology

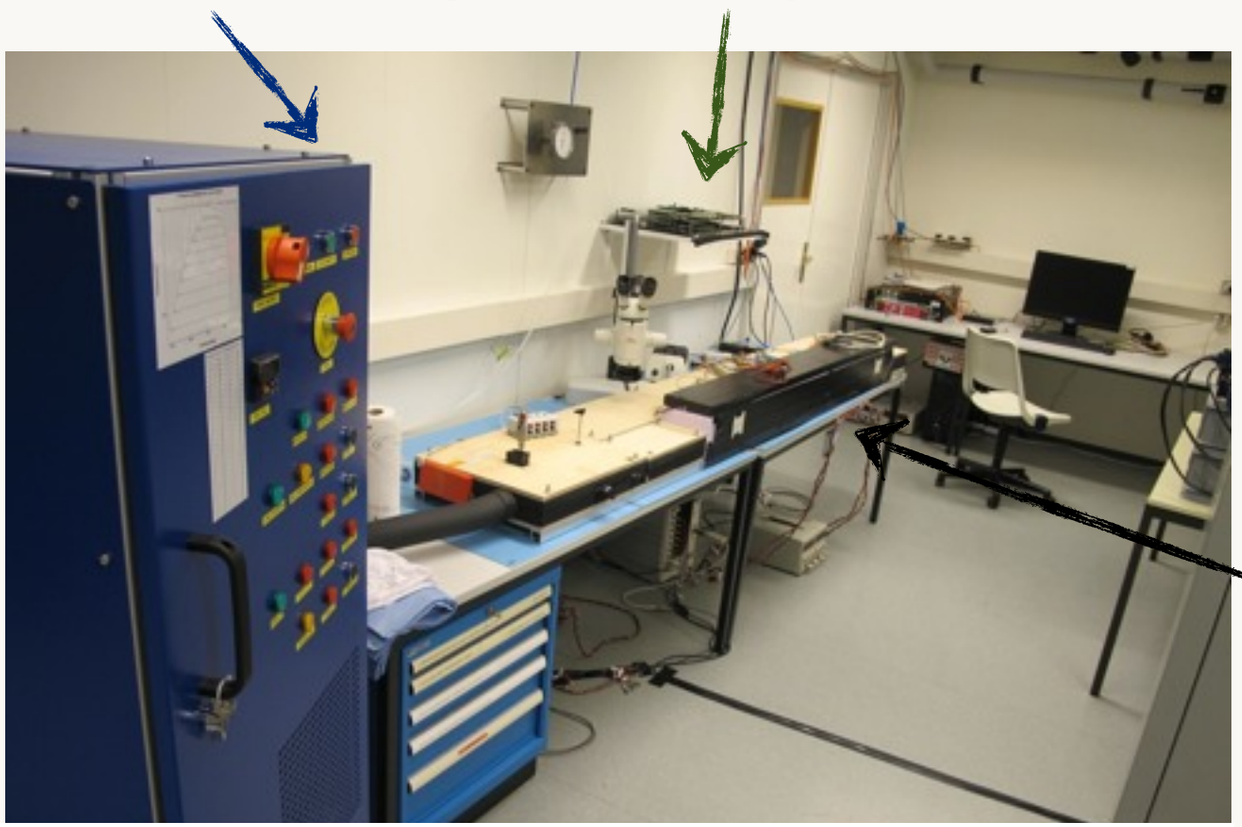


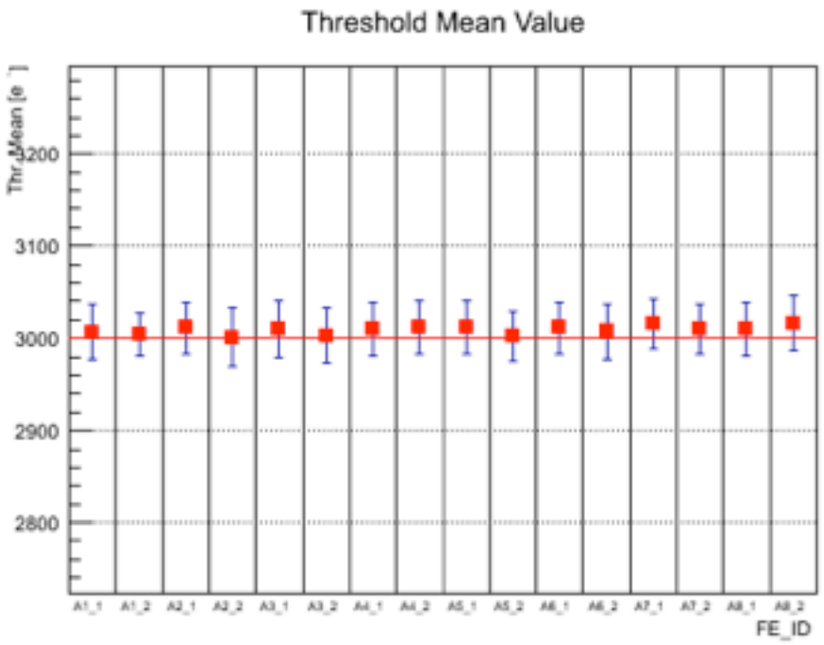


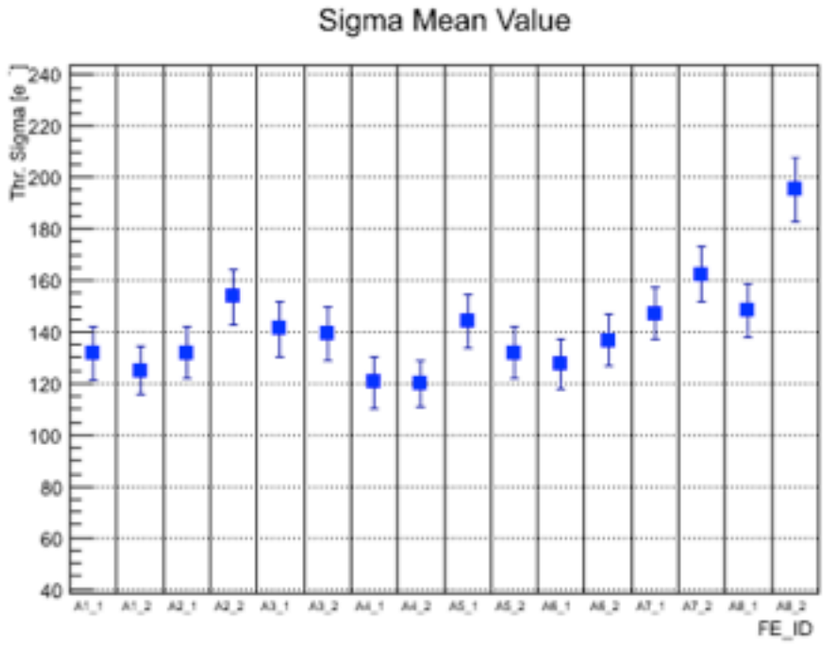
Stave envelope precision 100 um
Stave stability 40 um

Stave @ UniGE

- Module reception test
- Stave Loading
- Metrology & envelope
- Stave QA

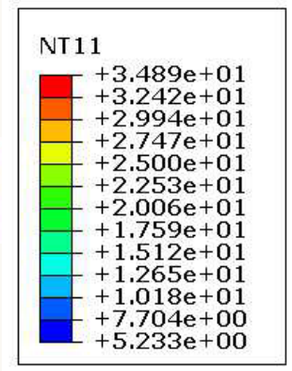




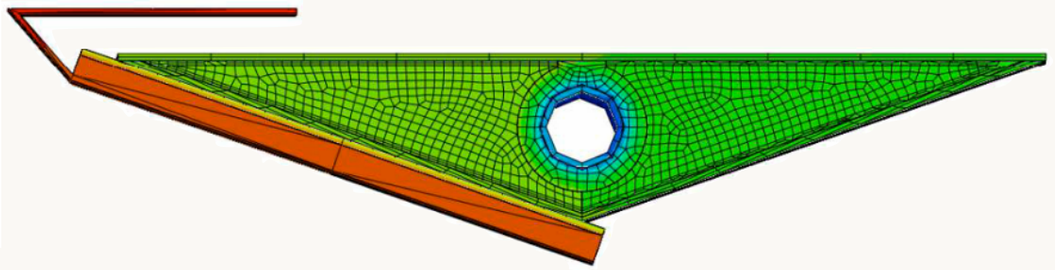


130 e Noise

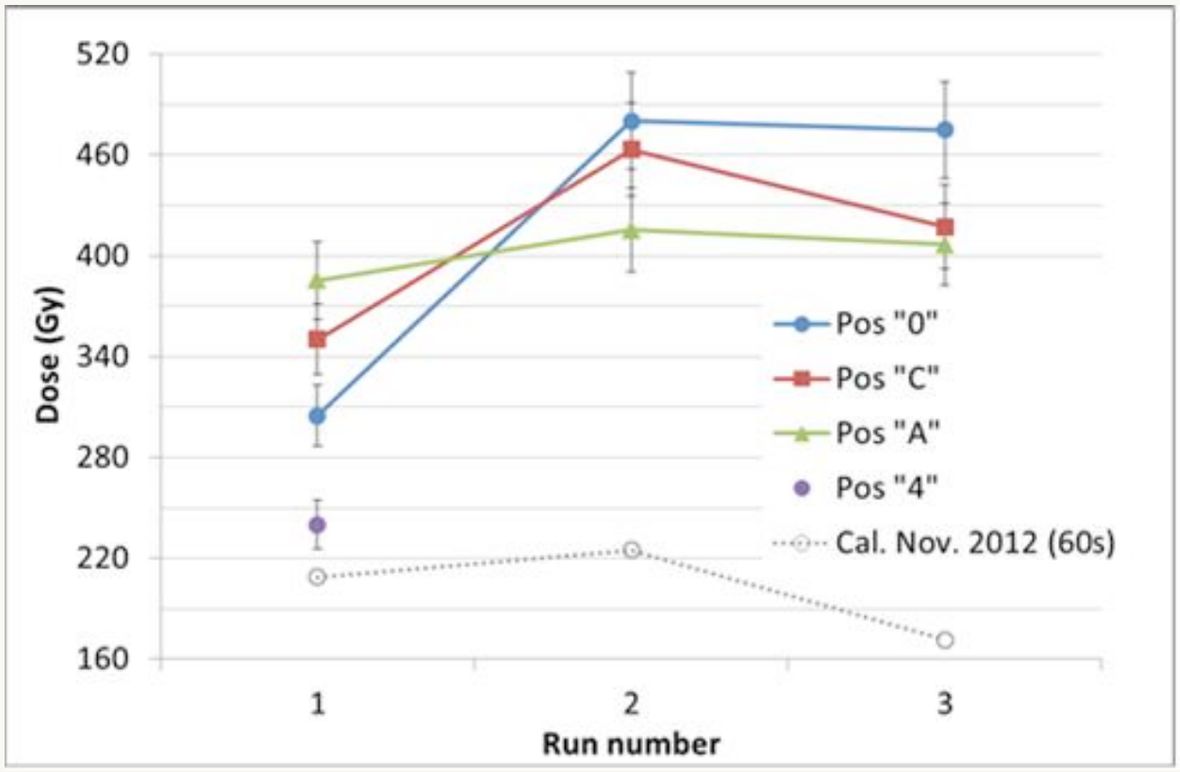
Stave irradiation



- Thermal calculation



Dosimetry results for first 3 runs



340 + 8 x 450 = 3,9 MGy

Thanks!

Back up slides...

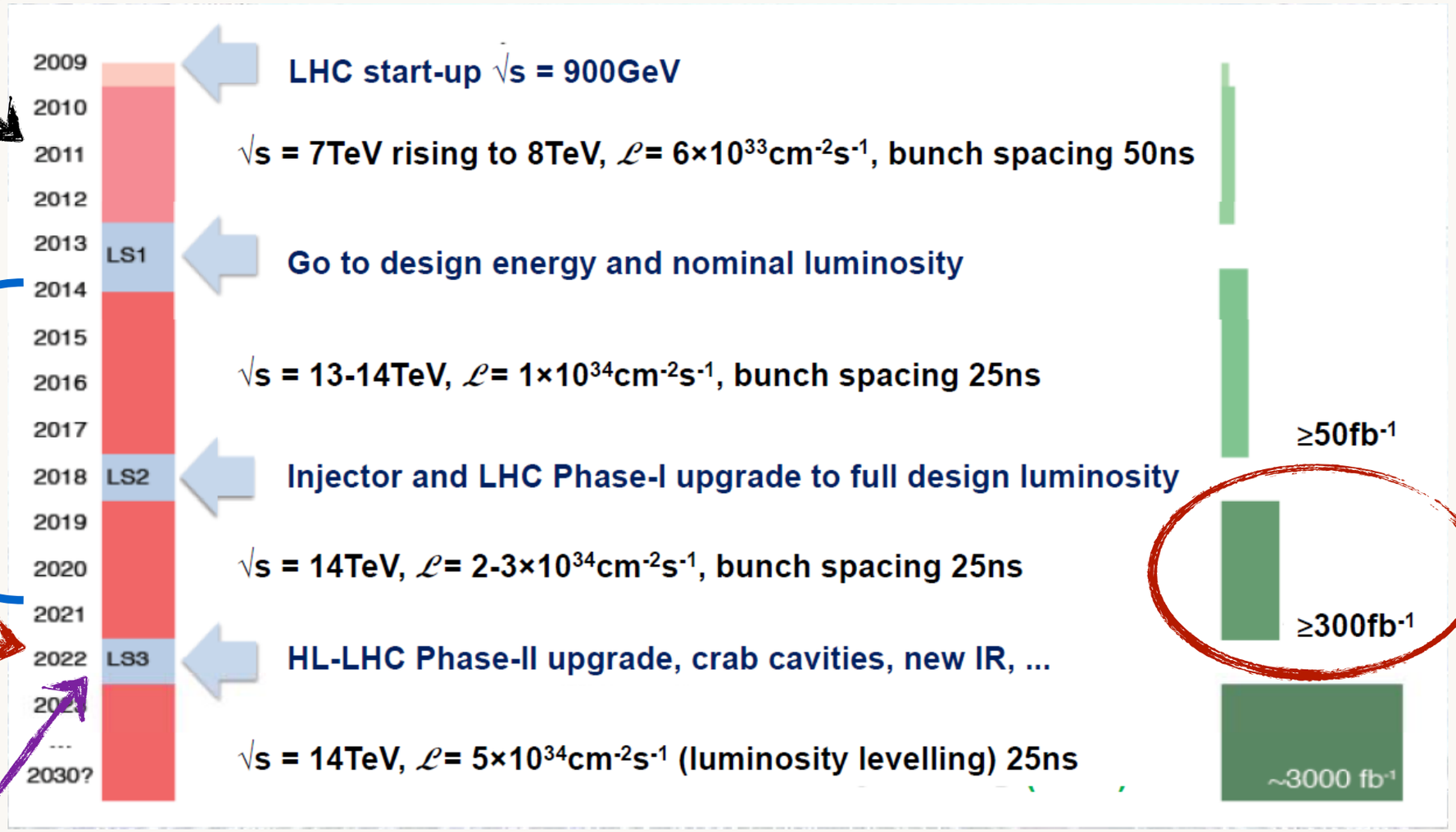
ATLAS and LHC program

Operating since 2009 with an integrated luminosity ~30 fb^{-1}

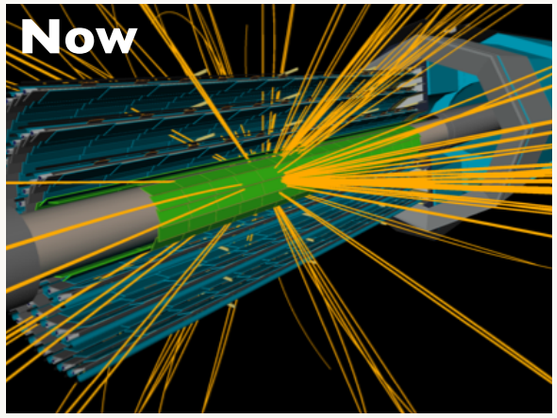
LHC upgrade: higher Luminosity and Energy

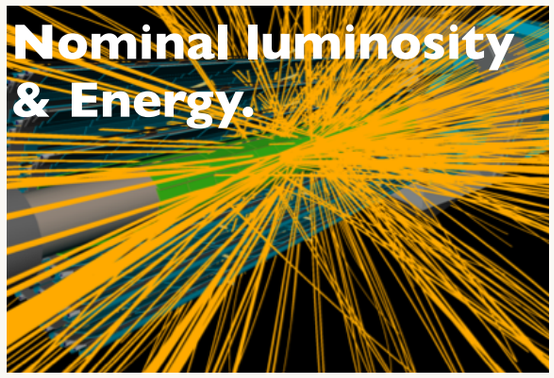
More than 300 fb^{-1} and 8-12 years of time life + Luminosity effects

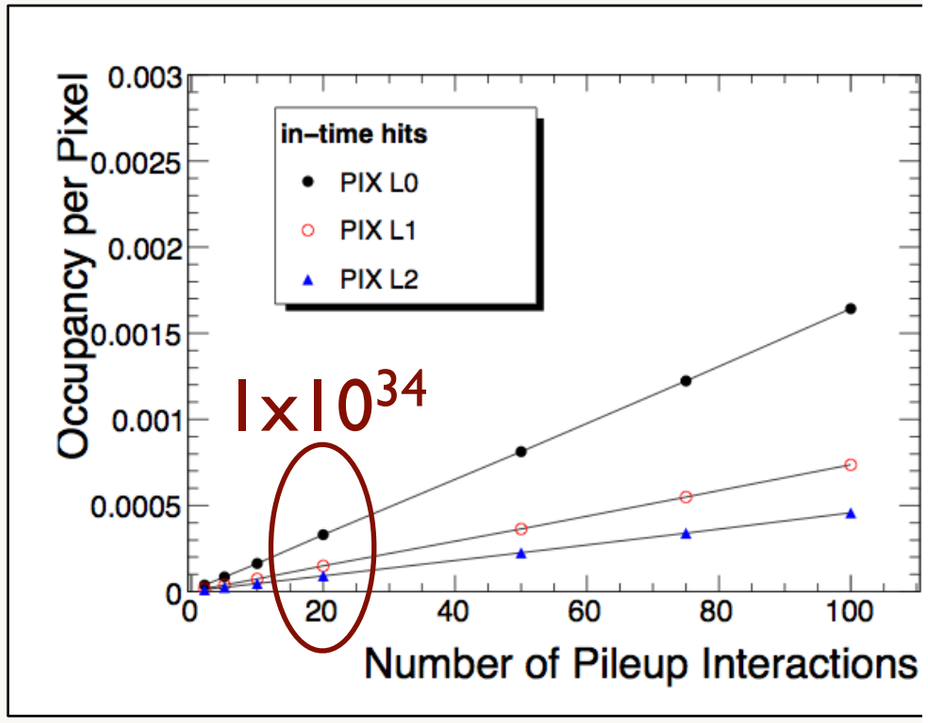
Complete new ATLAS tracker pixels and strip detectors

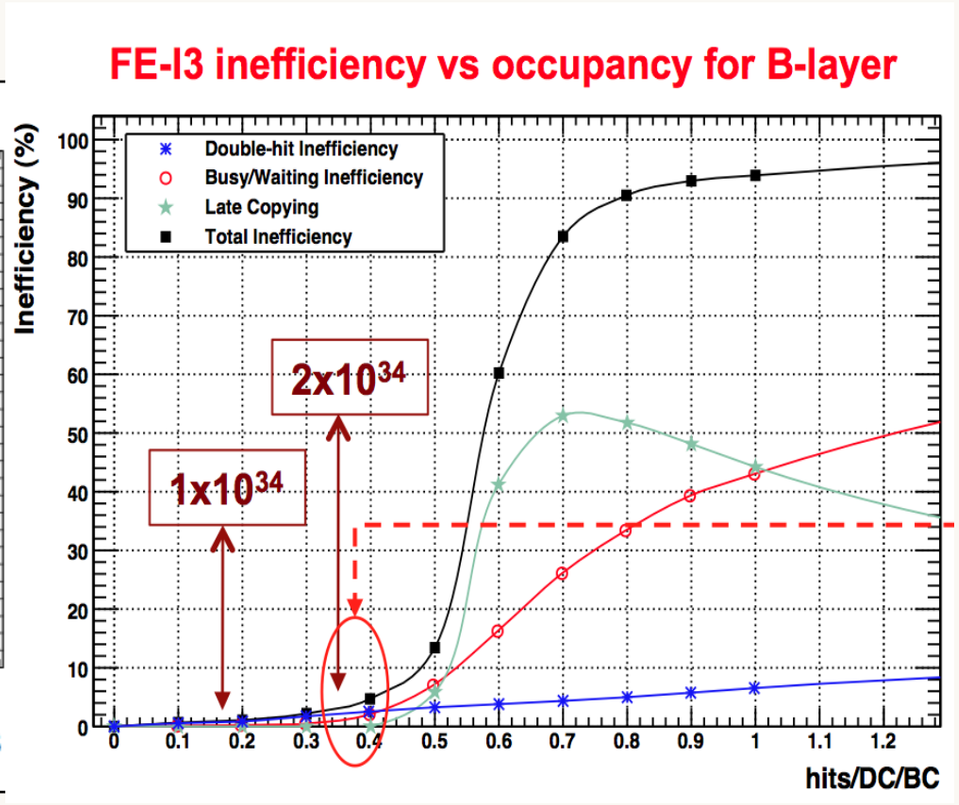


LHC program & Implication







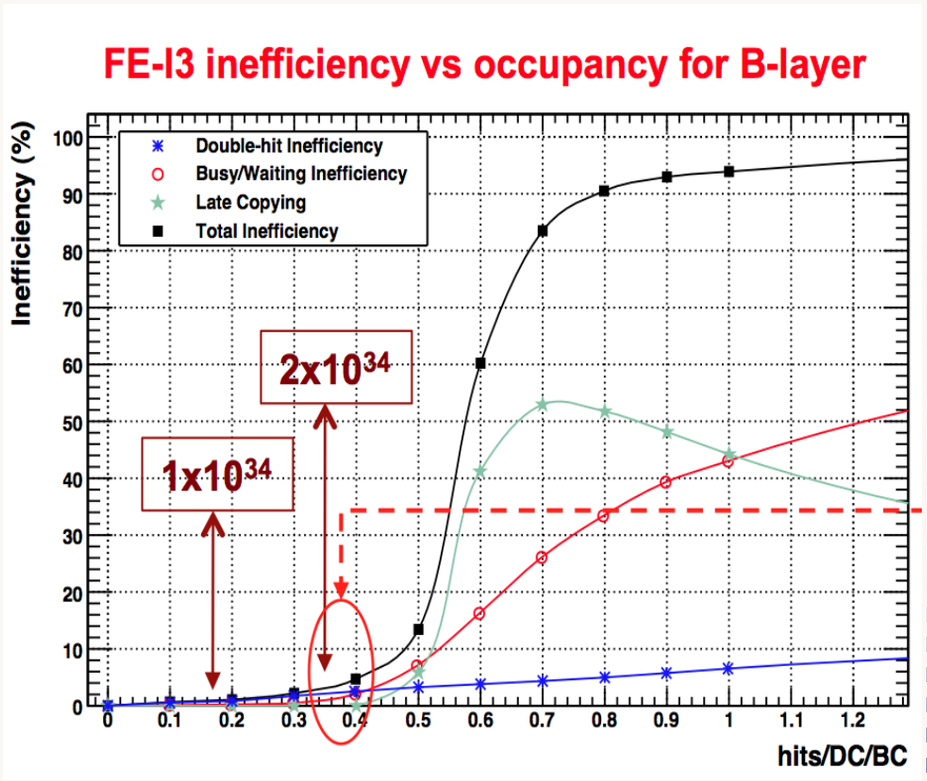


Status of the current pixel detector:

Affected System (failure classes)	No. of parts in the system	No of part fail / % of dead pixels	
		Whole Pixel	B-layer only
Pixel	80 363 520	161 k / 0.20 %	15 k / 0.11 %
Front-end	27 904	42 / 0.15 %	9 / 0.20 %
Module	1 744	40 / 2.29 %	6 / 2.10 %
Opto-board	272	1 / 0.37 %	- / 0.00 %
Cooling loop (high leak)	88	(3) / 0.00 %	(0) / 0.00 %
Total dead pixels		**3.01 %**	**2.41 %**

Need a first update to operate the detector during 3-4 more years to compensate the degradation

IBL read out: new FE-I4



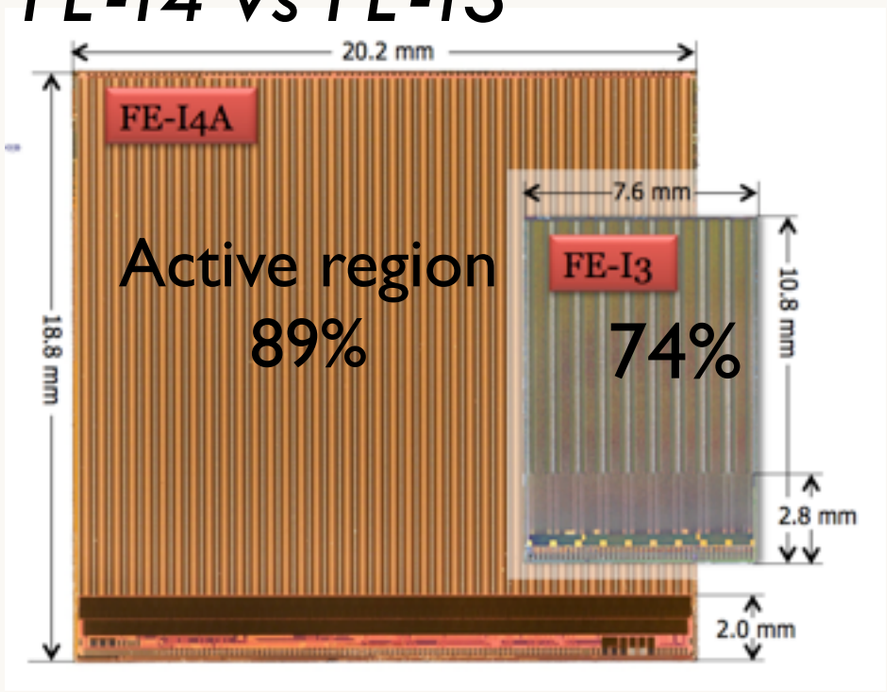
Needs

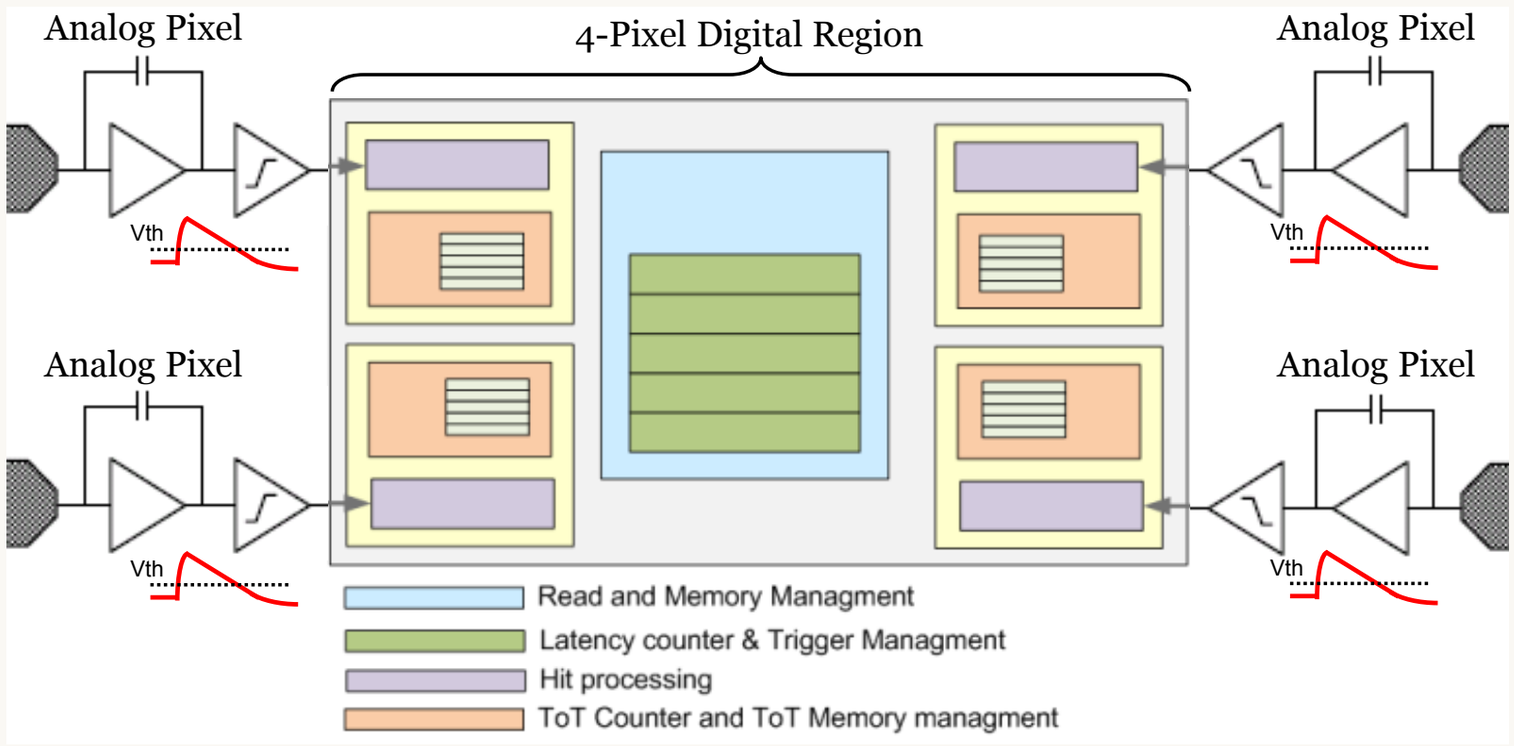
Pixel size: 50x250 µm
336x80(rows x cols)
Threshold: < 4000 e^-
Dispersion: ~100 e^-
Noise: < 300 e^-

Specifications

- 150 nm thickness
- 130 µm technology
- Charge resolution/TOT: 4 bits
- Analog preampfification
- Power consumption: 200mW/cm^2
- Increase read out speed: 160 Mb/s

FE-I4 vs FE-I3

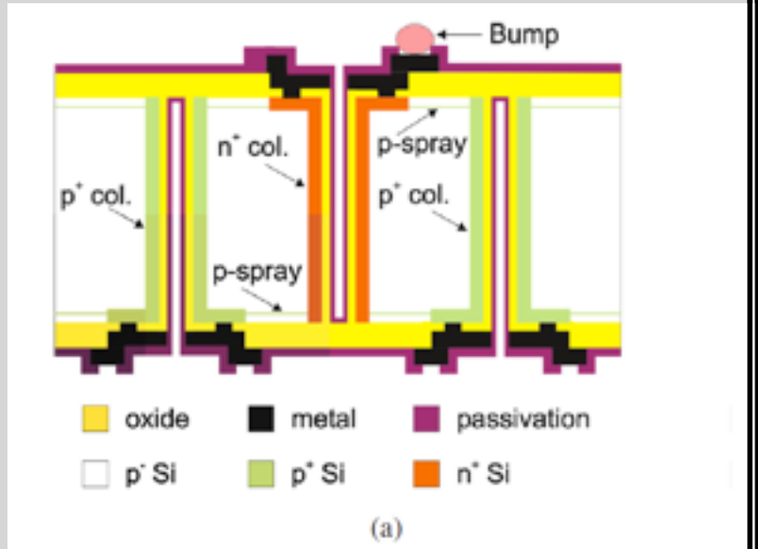


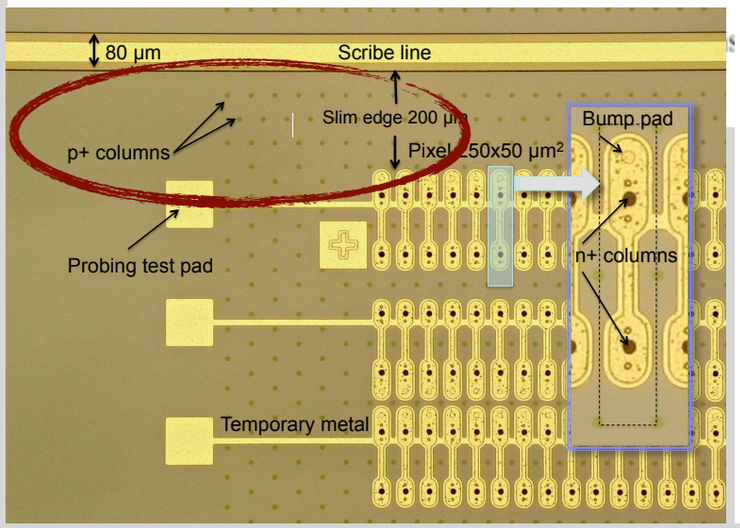


3D Sensor

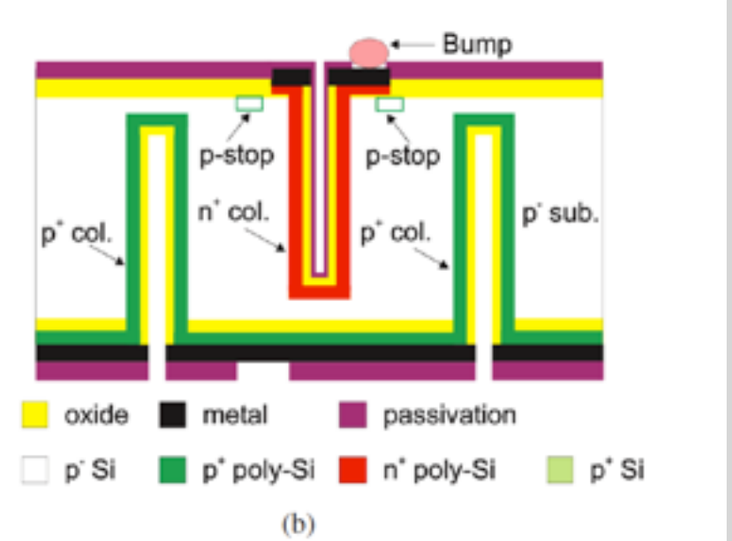
- 230um thick 3D n in p-type sensors
- Low operational bias Voltage: 20V (Close anode and cathodes)
- Slim edge 200 um, minimizing inactive region

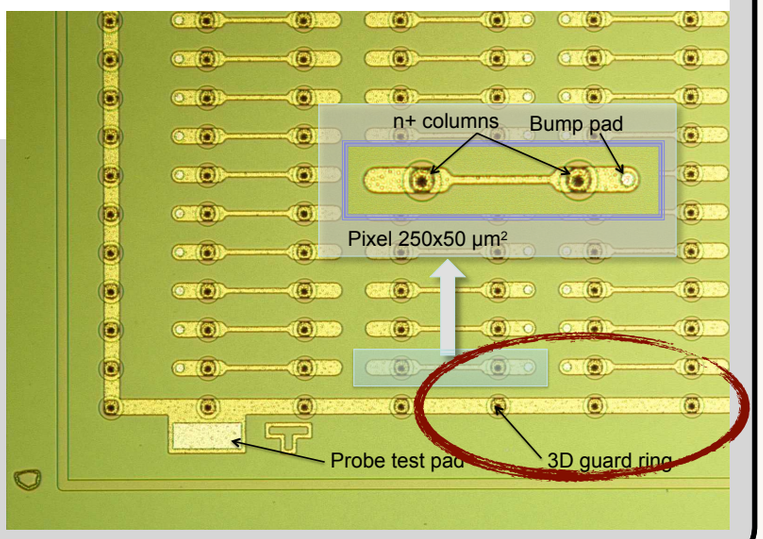
FBK



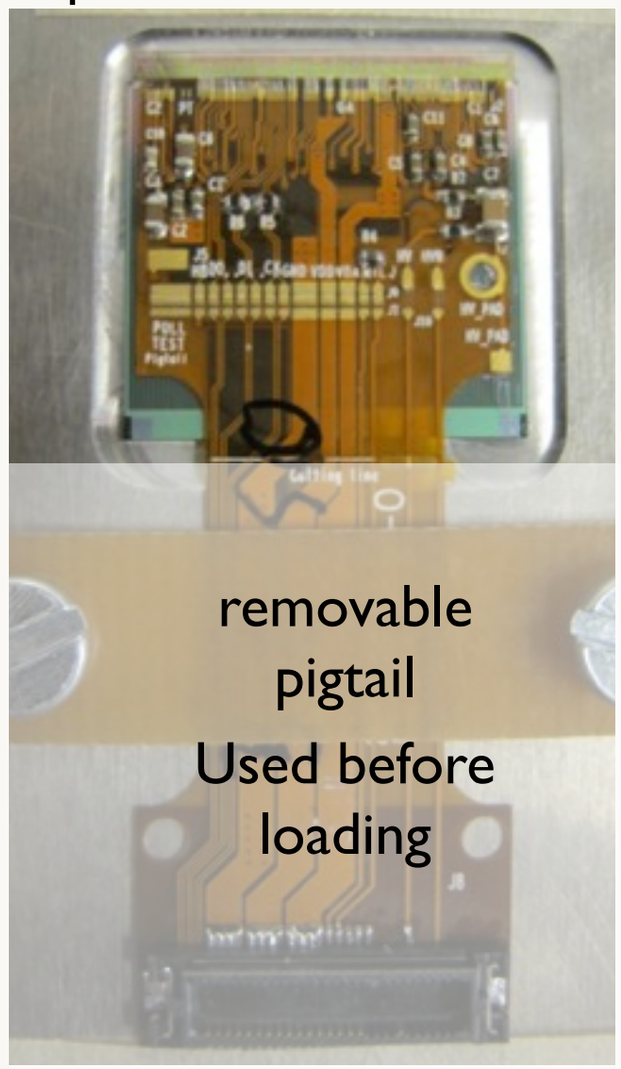


CNM



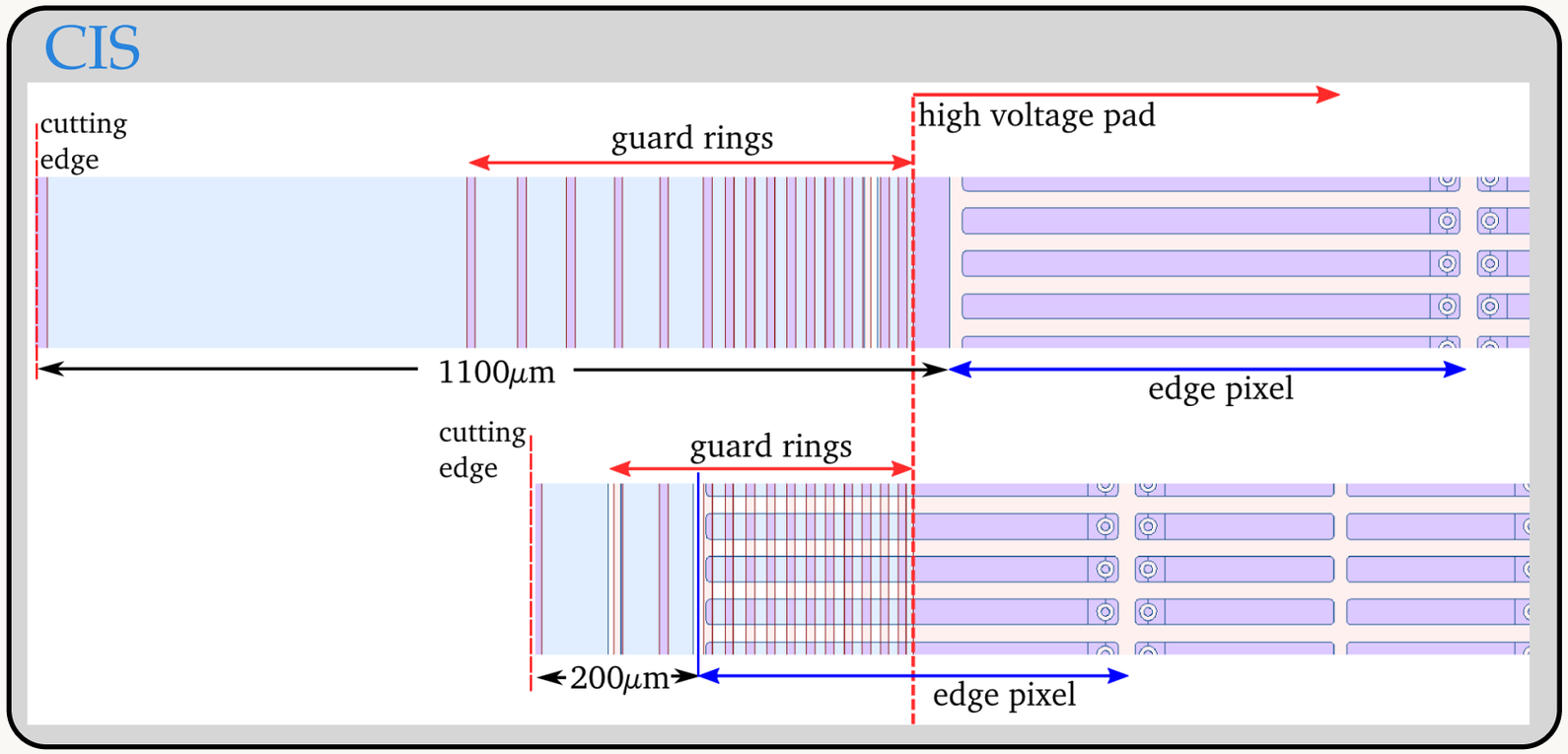


Operational module



Planar Sensor

- 200um thick n+ in n-type sensors
- Higher operational bias Voltage
- Slim edge: Shifted guard rings (13) underneath active pixels
- Border pixels larger : 500 um (border efficiency)



Outer area has been prove to remain active for 200 um thick detector Vb=-60 .
Improved after type inversion