



ATLAS SILICON DETECTOR PERFORMANCES

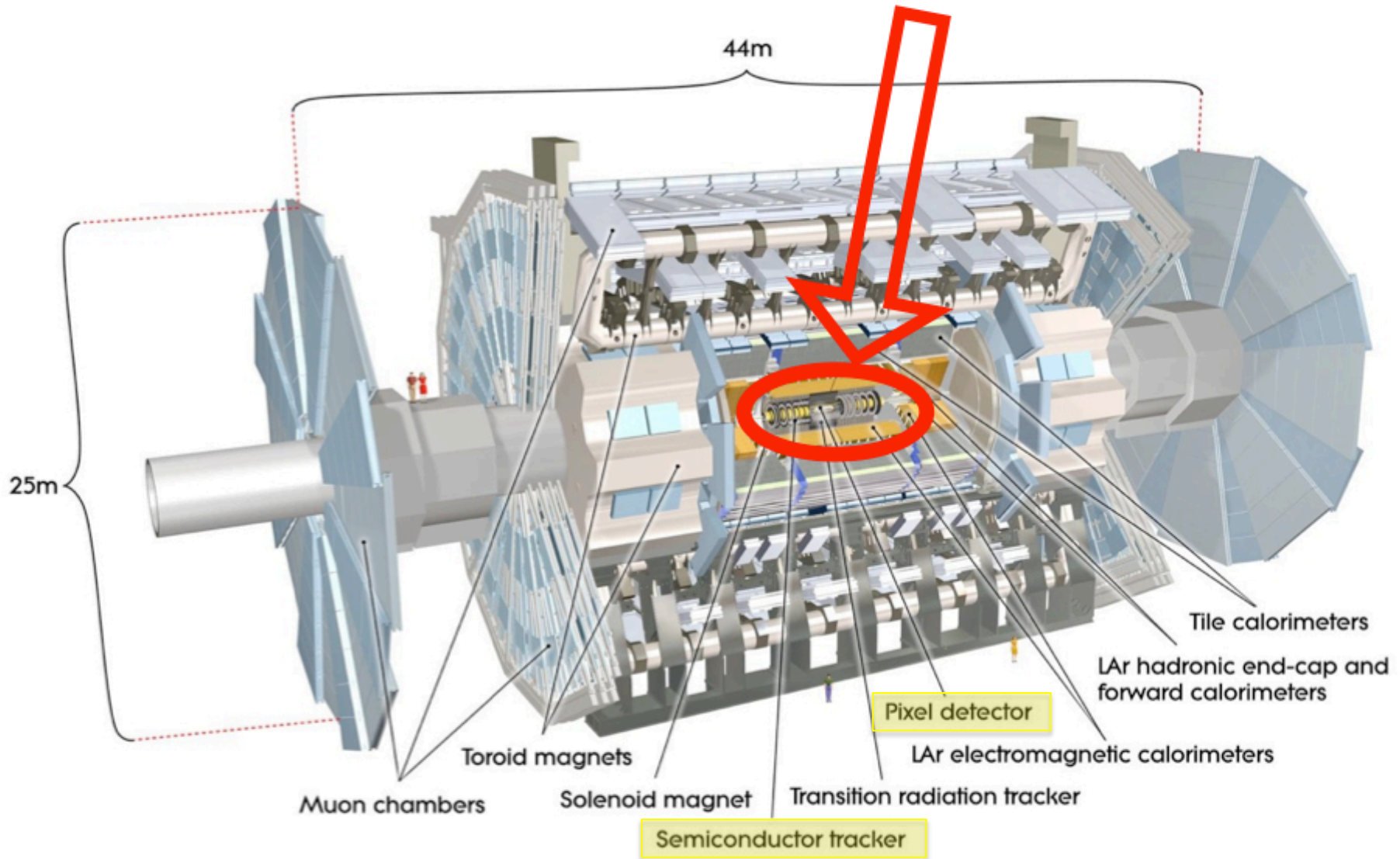
Saverio D'Auria, University of Glasgow for the Atlas collaboration

**6TH "TRENTO" WORKSHOP ON
ADVANCED SILICON RADIATION DETECTORS**

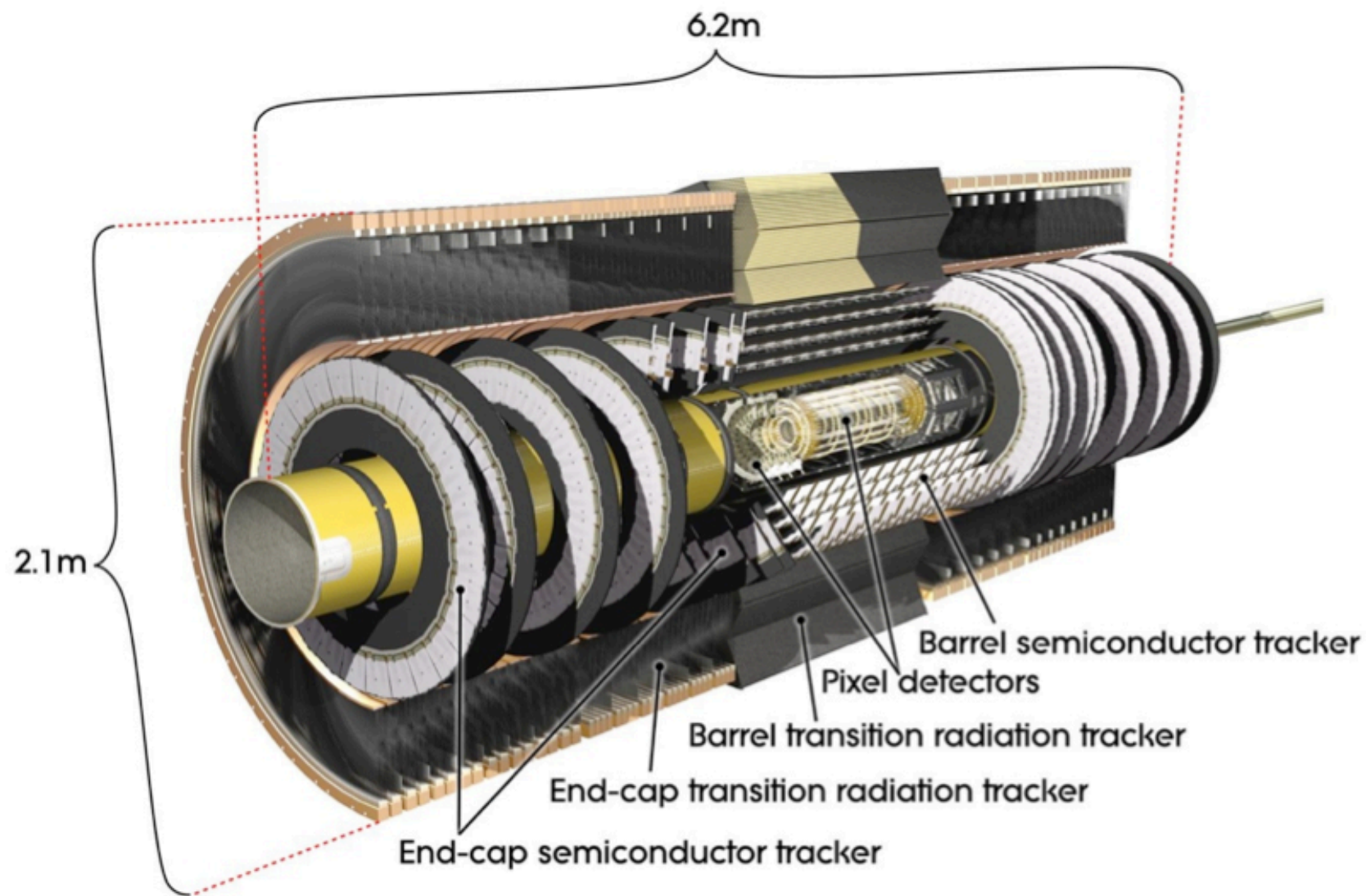
Trento, March 2nd 2011 Fondazione Bruno Kesser

Tracking in ATLAS

Tracking detector



Tracking in ATLAS



Atlas Tracker

TRT Transition radiation Tracker
gas operated straw

Semi Conductor Tracker

(SCT) strips

61 m² of Silicon, single sided,
back-to-back

6.3 x 10⁶ readout channels

1 barrel: 4 layers, 2112 modules

2 endcaps: 9 disks, 998 modules

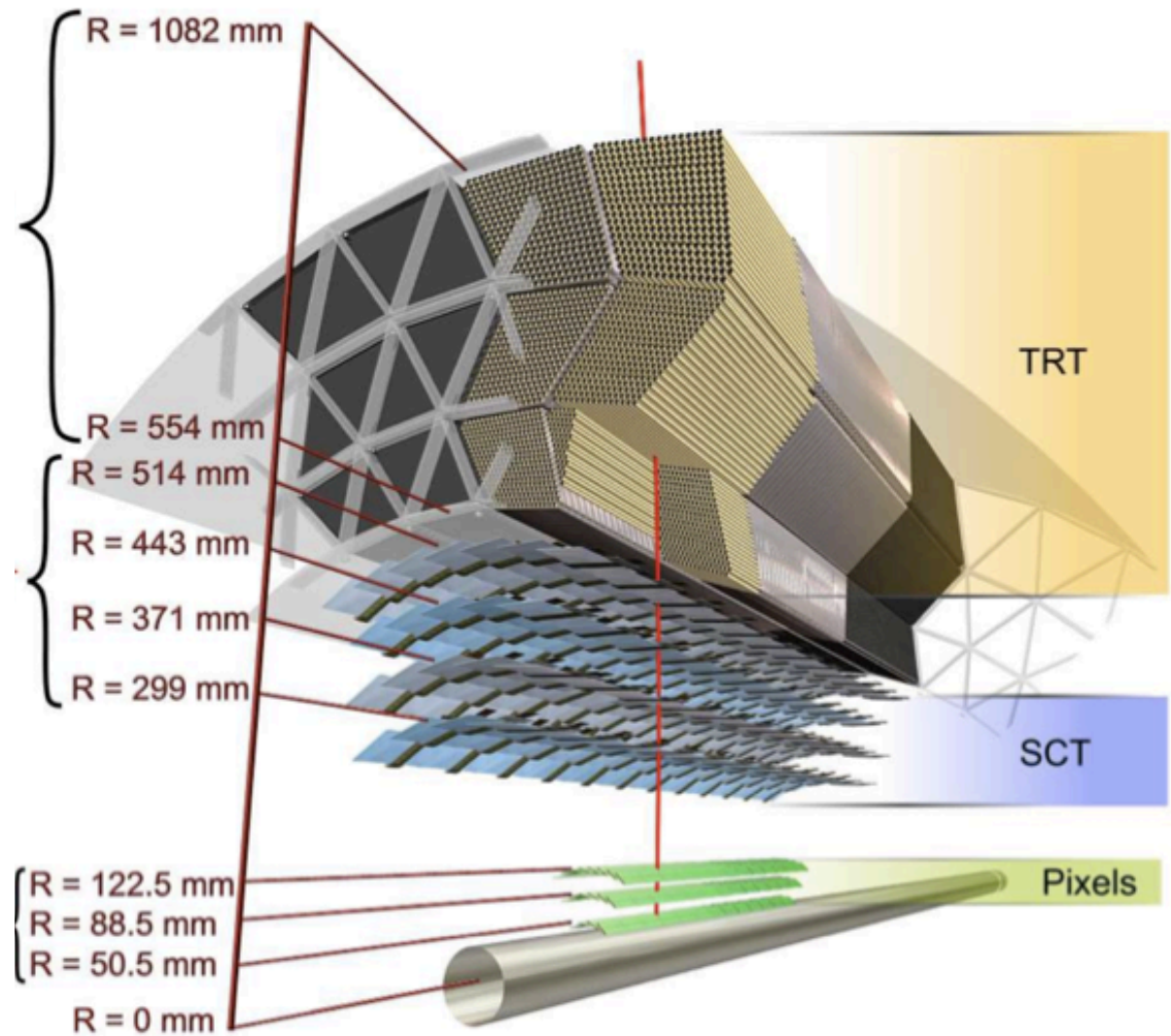
Pixels

1.8 m² of flip-chip Silicon

1744 modules 82 MegaPixels

1 barrel: 3 layers, 1456 modules

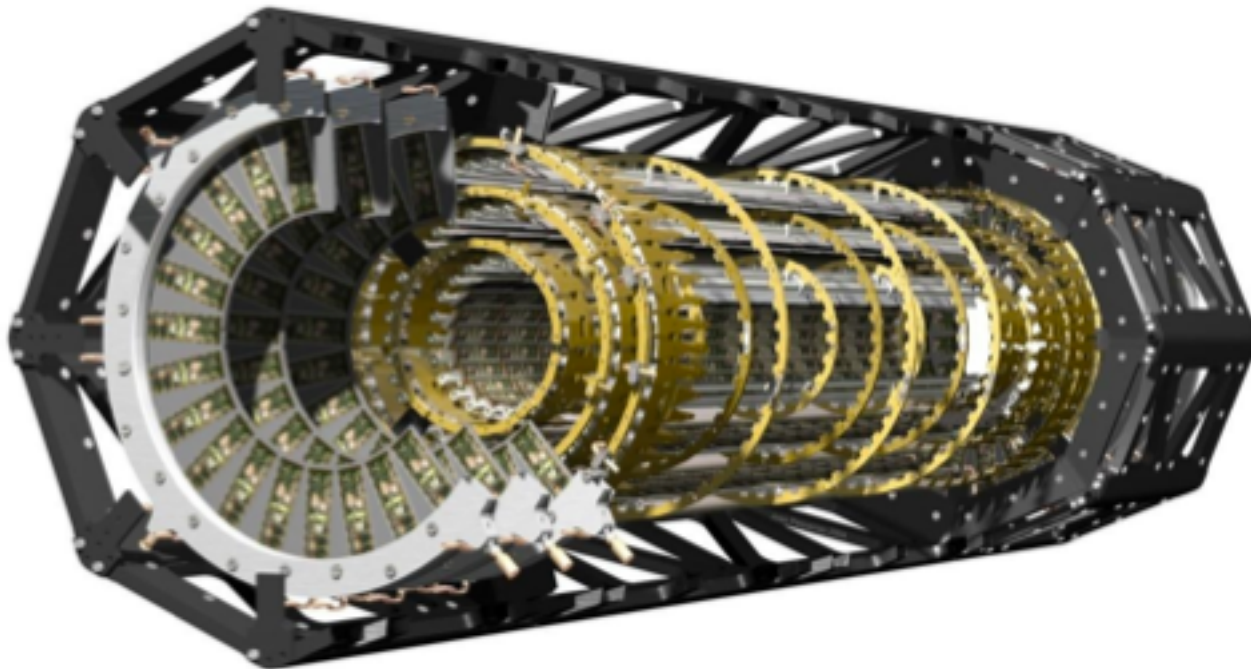
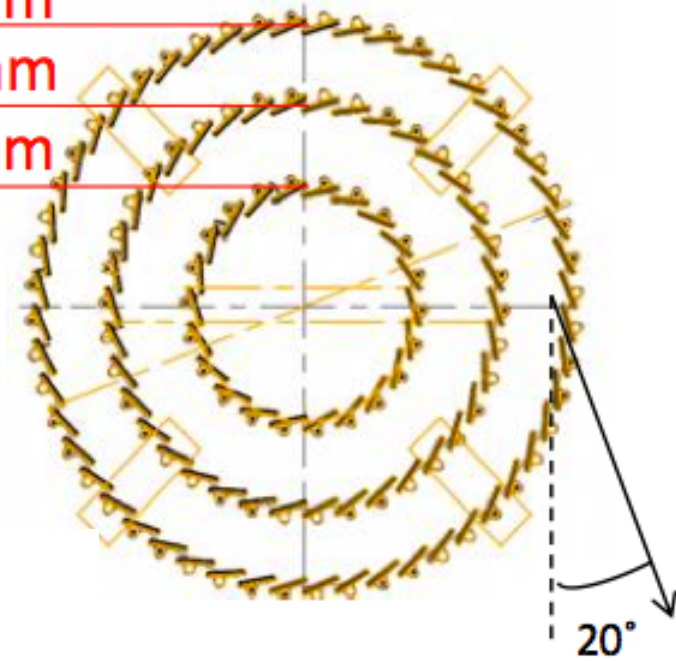
2 endcaps: 3 disks, 144 modules



Atlas Pixels

L2 122.5 mm
L1 88.5 mm
B 50.5 mm

Low mass carbon composite support structure,
minimize detector interaction length
15 kW power removed with
evaporative cooling using C_3F_8



Modules are tilted
to compensate for the
Lorentz angle

Atlas Silicon μ strip sensors (SCT)

4 shapes (barrel + 3 wedges)

Mainly $\langle 111 \rangle$ n -type silicon, 285 μm thick

16 μm wide p^+ strip implant,

80 μm strip pitch (barrel)

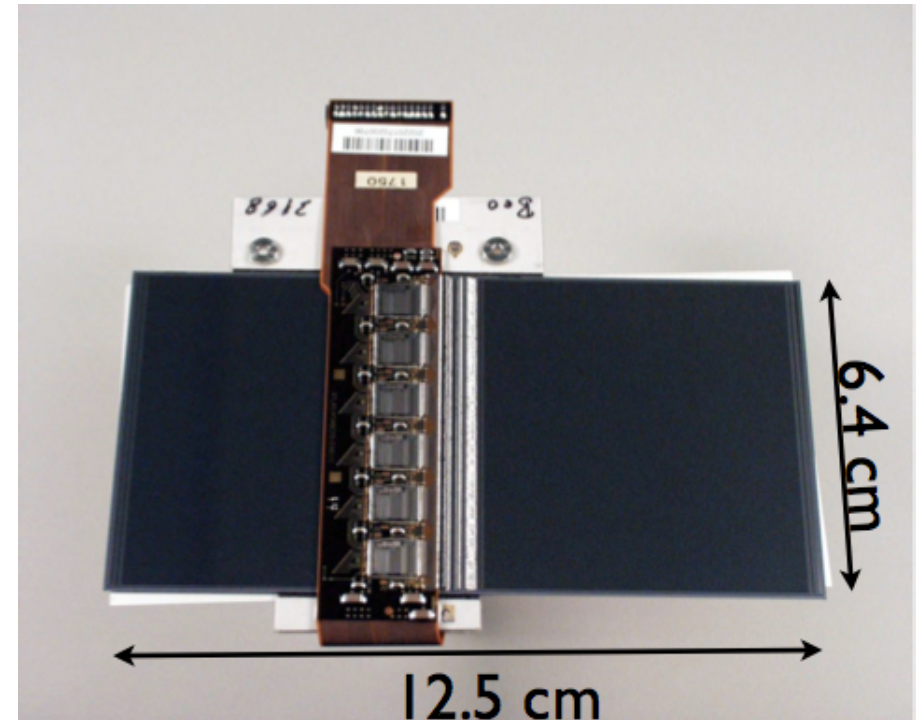
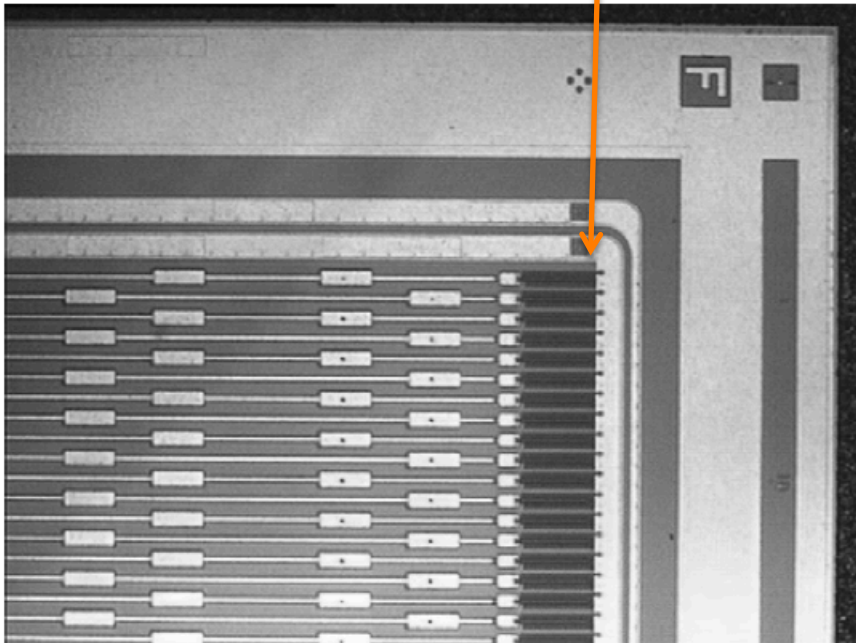
22 μm wide metal strip (barrel)

Reach-through protection: 10 μm gap

Polysilicon bias resistors, 1.25 $\text{M}\Omega$

Passivation on strip side only

Uniform back contact

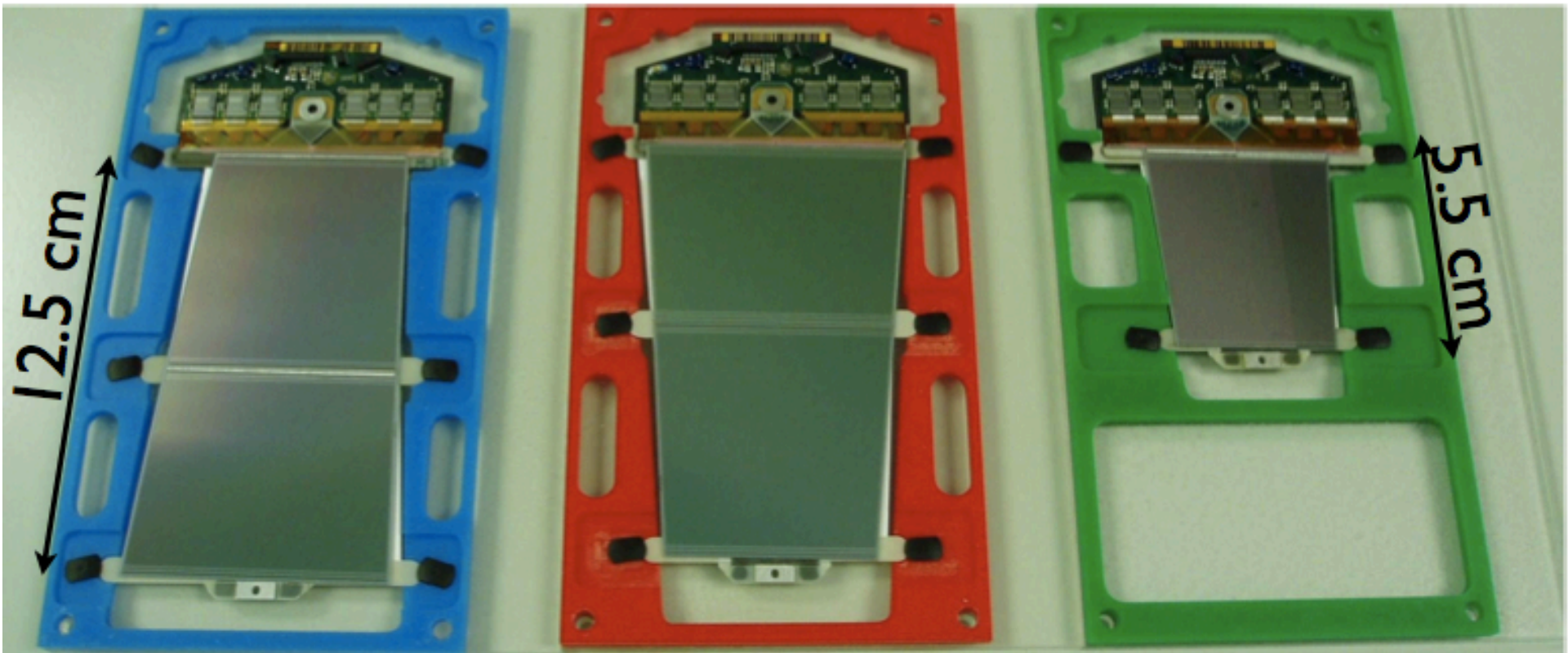


Module: back-to-back sensor pair,
stereo angle 40 mrad.

12 ASIC "ABCD" readout chips on
Cu/Polyimide flexicircuit

Tilt angle 11 deg for Lorentz angle

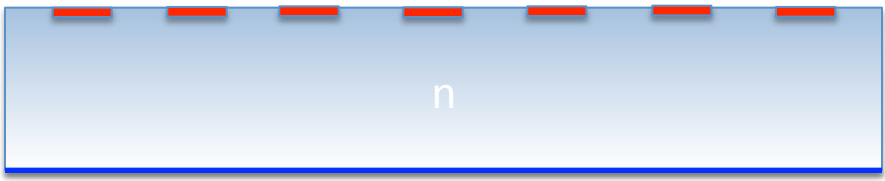
ATLAS SCT end cap modules



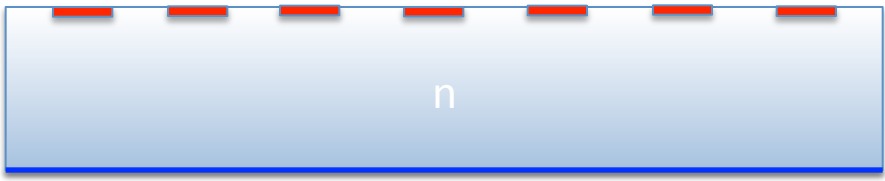
Outer

Middle

Inner



Before inversion



After radiation-induced type inversion

Atlas Pixel module

Sensor:

oxygenated float zone

250 μm thick n -type silicon

Pixel $n+$ contact, 50 x 400 μm

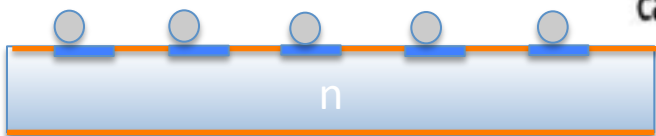
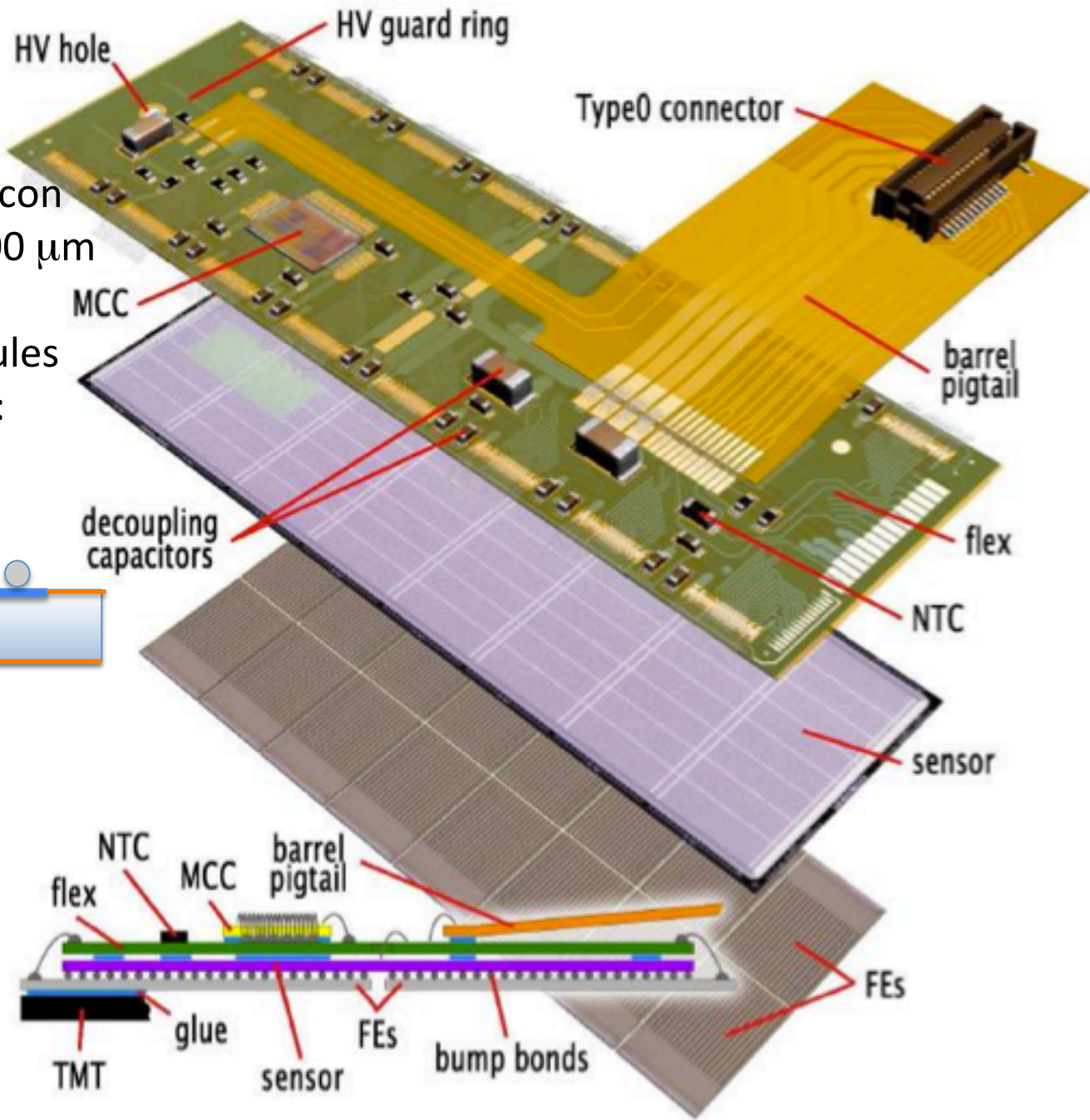
p -spray separation.

All identical shape modules

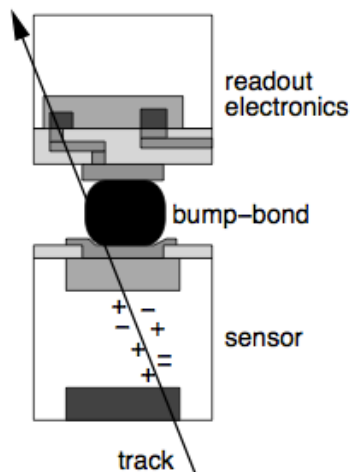
Flip-chip bump bonding:

46% SnPb by IZM

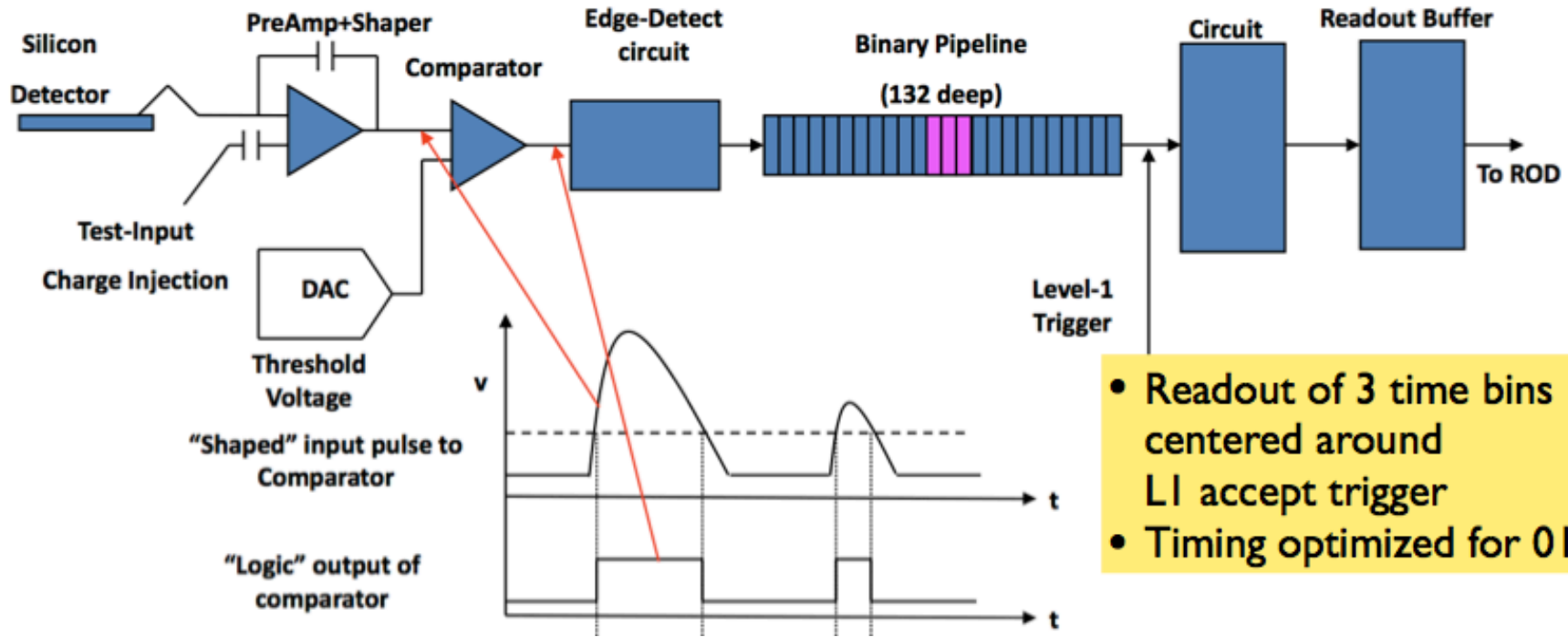
54% In by AMS



Before inversion



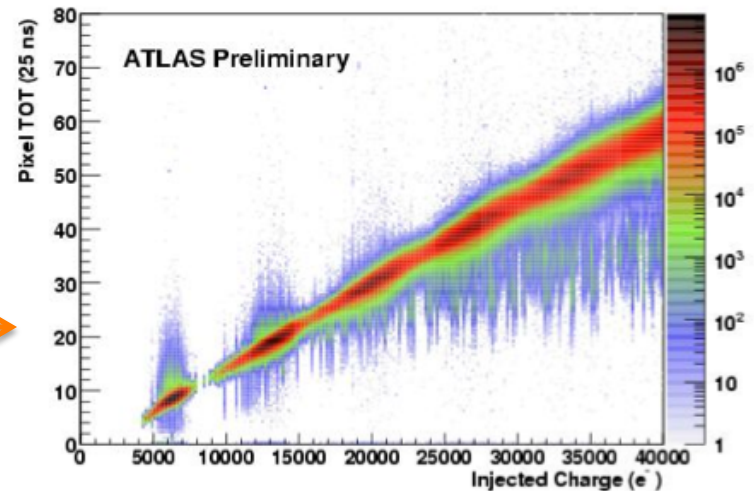
Atlas Silicon strips read-out schema



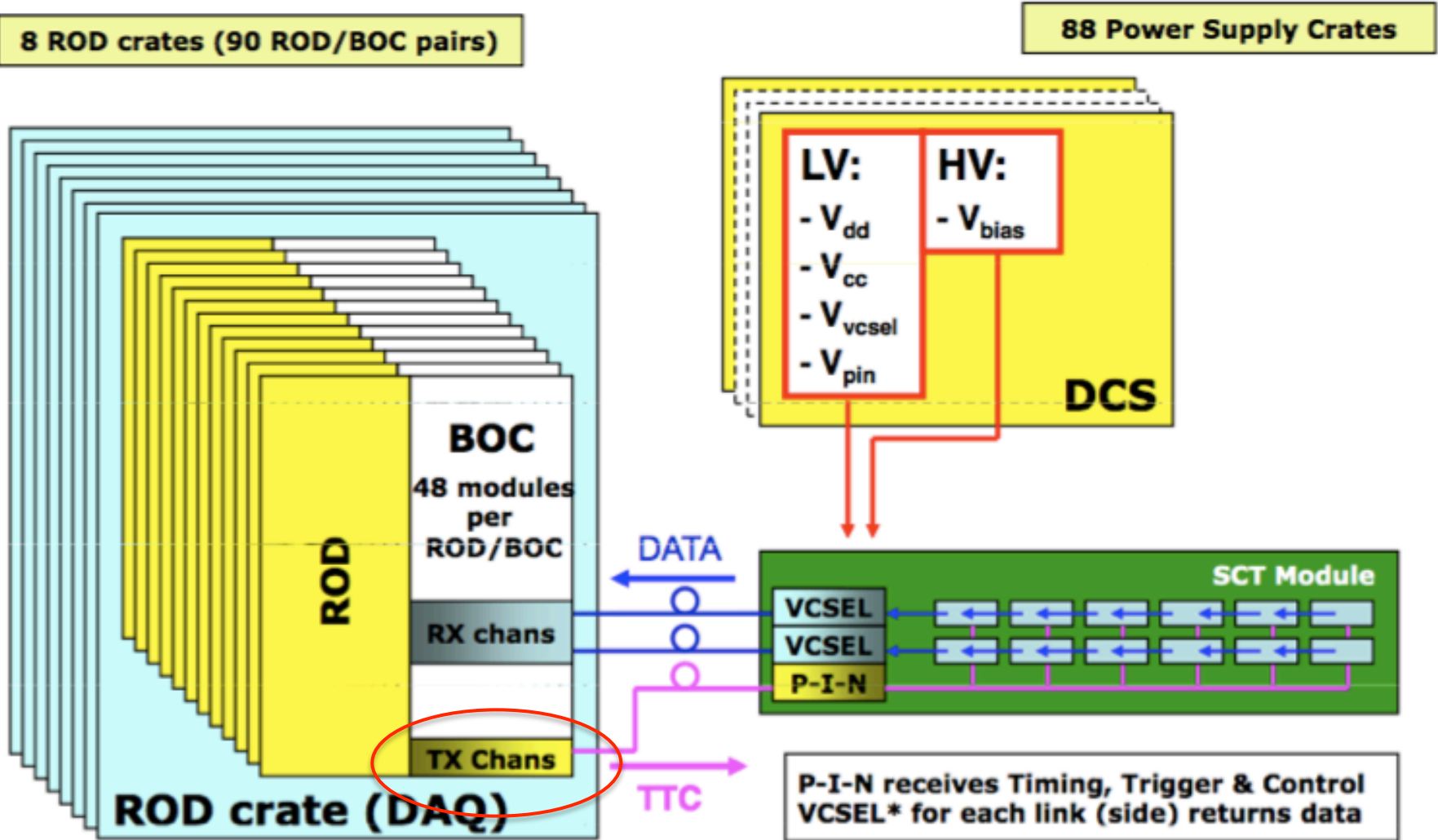
- Readout of 3 time bins centered around LI accept trigger
- Timing optimized for 0IX

SCT Fast shaping 20 ns peaking time.
50 ns double hit resolution for 3.5 fC signals

Pixel longer shaping: can use Time Over Threshold to encode pulse height measurement

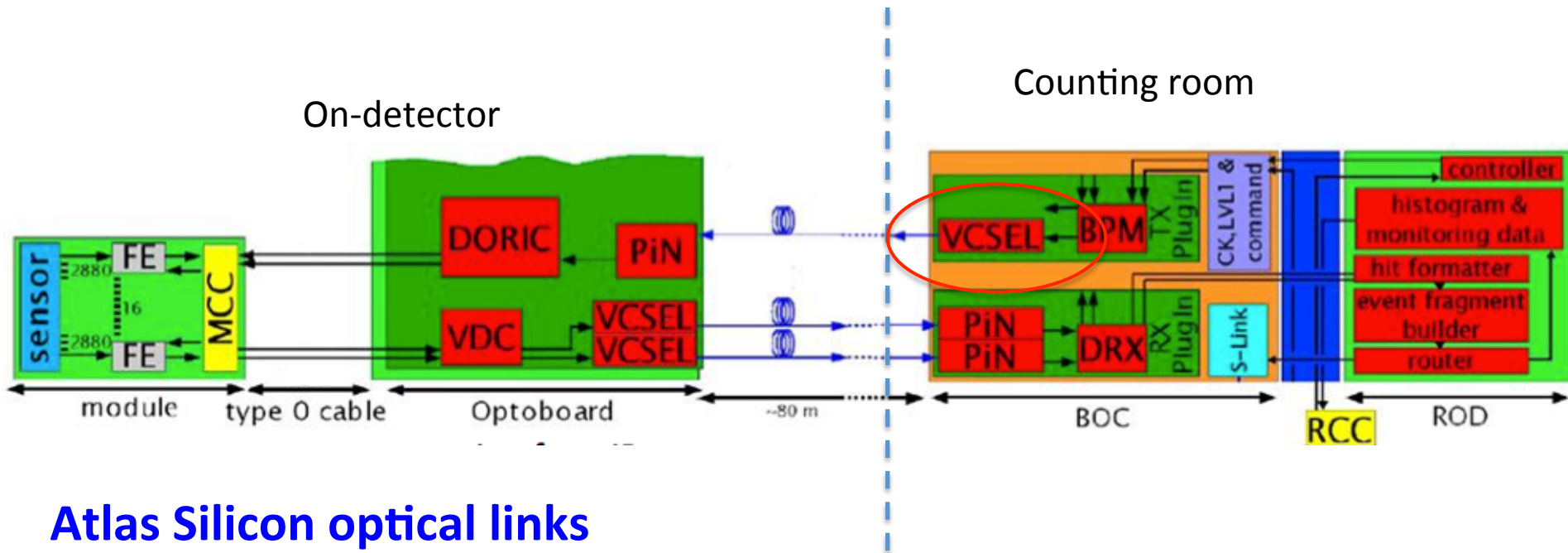


Atlas Silicon strips read-out schema



* VCSEL=Vertical Cavity Surface Emitting Laser

Atlas Pixels read-out schema



Atlas Silicon optical links

Vcsel failure rate $\sim 2/\text{day}$

SCT can use redundancy scheme most of times.

Pixes need to replace TX

Present explanation: humidity in environment.

Non-sealed plug-in package. Only affect vcsel on VME boards

On-detector vcsel may have different failure (and longer lifetime)

New vendor for vcsel, same package, as temporary solution.

New plugin design by mid 2011, sealed package

Atlas SCT operations

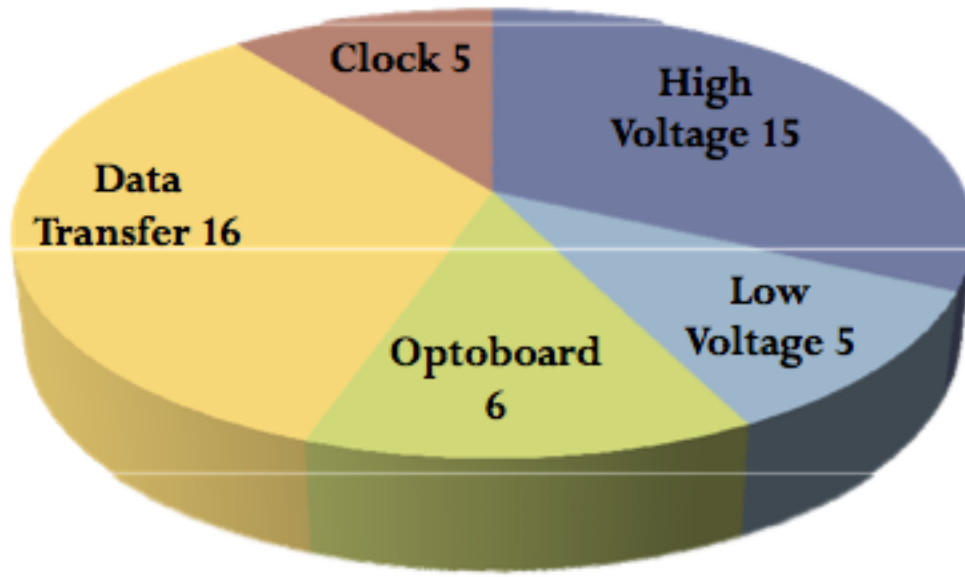
Disabled Readout Components	Endcap A	Barrel	Endcap C	SCT	Fraction (%)
Disabled Modules	5	10	15	30	0.73
Disabled Chips	5	24	4	33	0.07
Masked Strips	3,364	3,681	3,628	10,673	0.17
Total Disabled Detector Region					0.97

	Endcap A	Barrel	Endcap C	SCT	Fraction (%)
Total	5	10	15	30	0.73
Fraction (%)	0.5	0.2	1.5	0.7	
Cooling	0	0	13	13	0.32
LV	0	6	1	7	0.17
HV	4	1	1	6	0.15
Readout	1	3	0	4	0.10

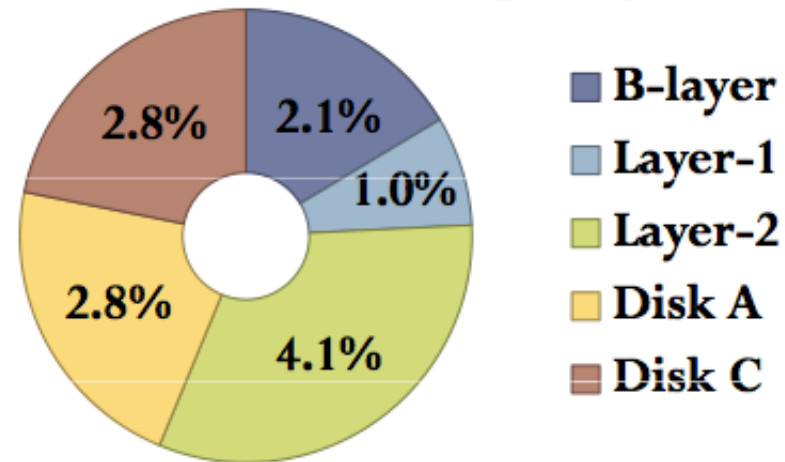
Atlas Pixel operations

47 modules are disabled from DAQ : 2.7% of total
44 single chips disabled

Disabled Modules by Failure Type

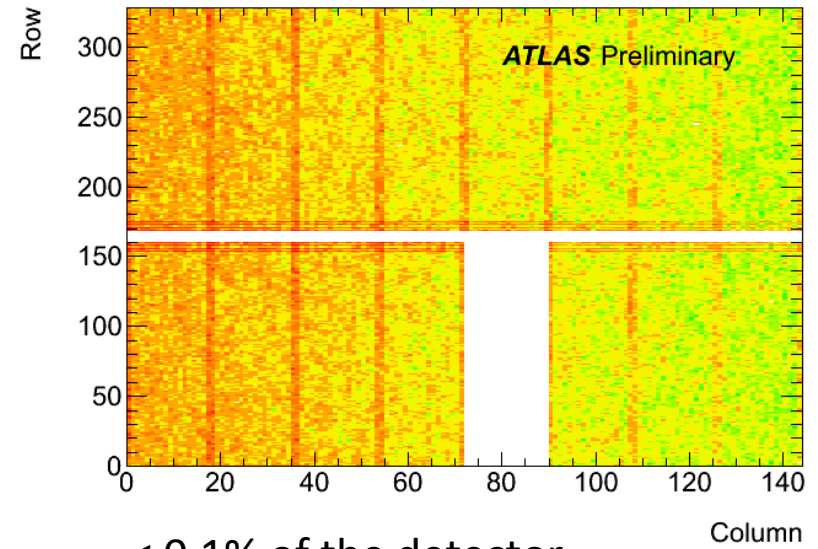
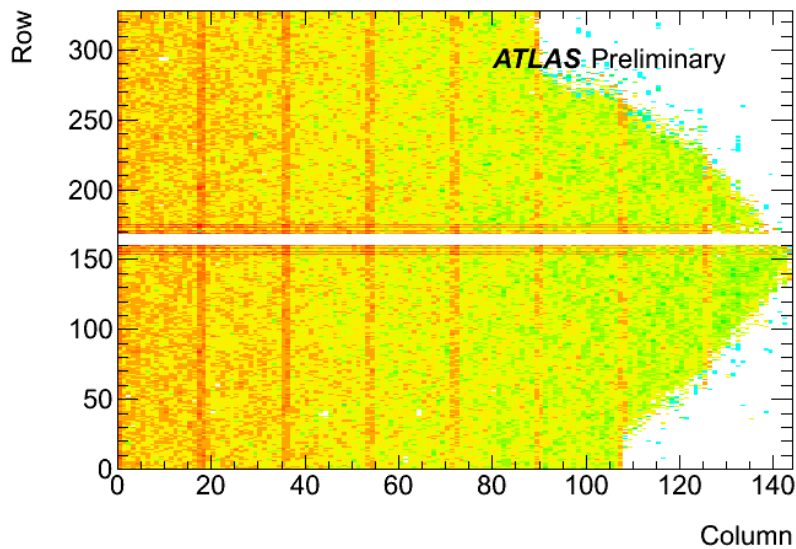


Inactive fraction per layer

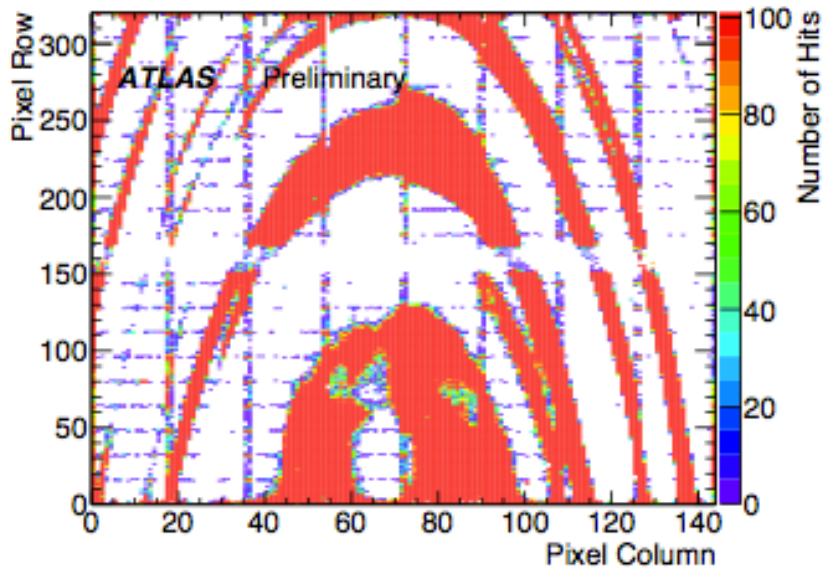


Atlas Pixel performance

Some modules show disconnected bump bonds and disabled single chips

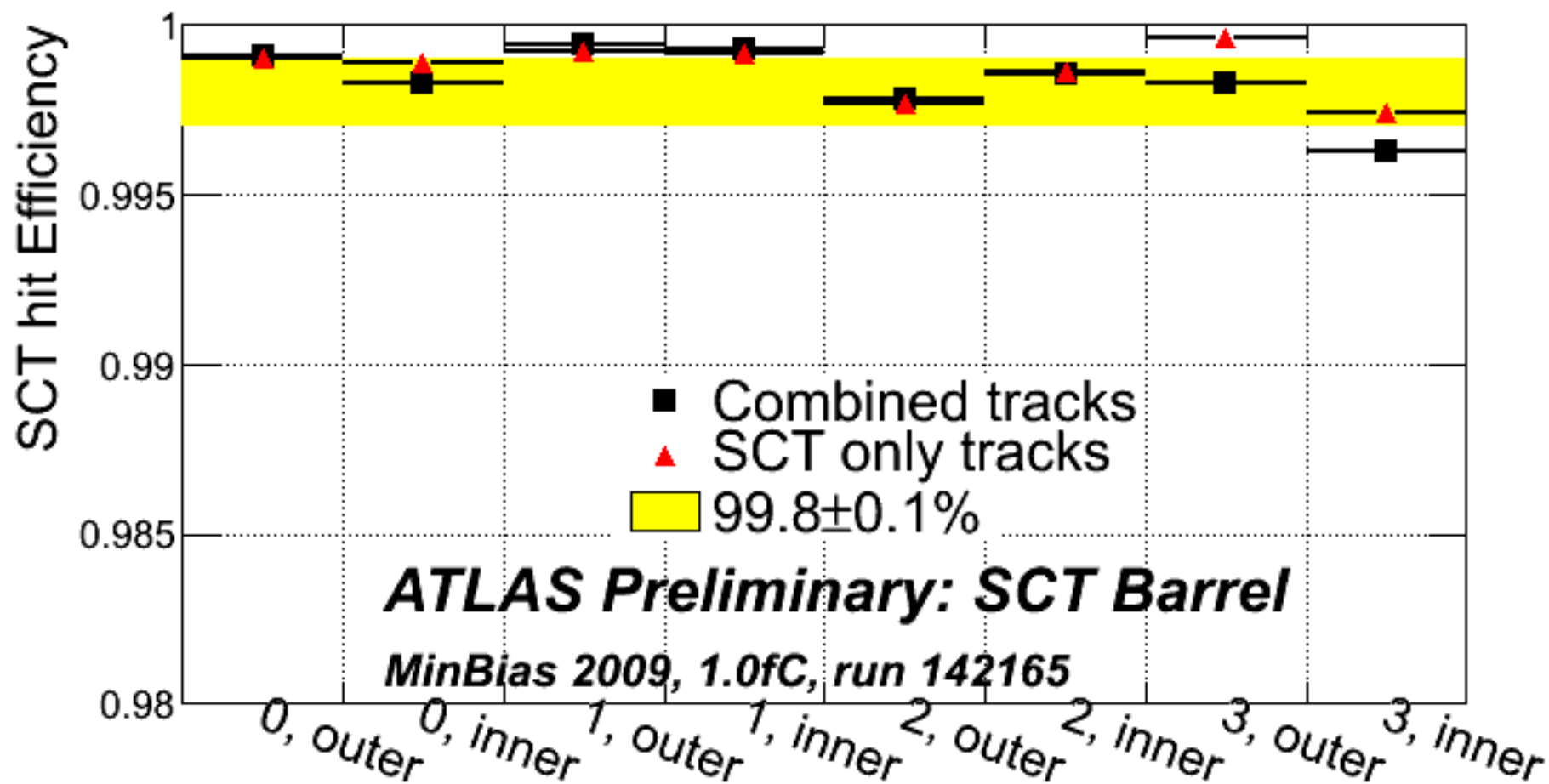


< 0.1% of the detector



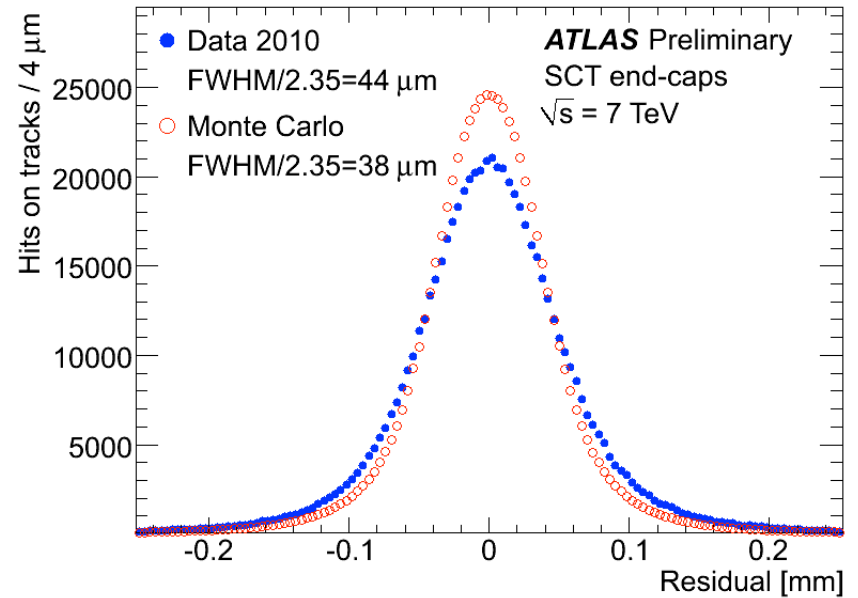
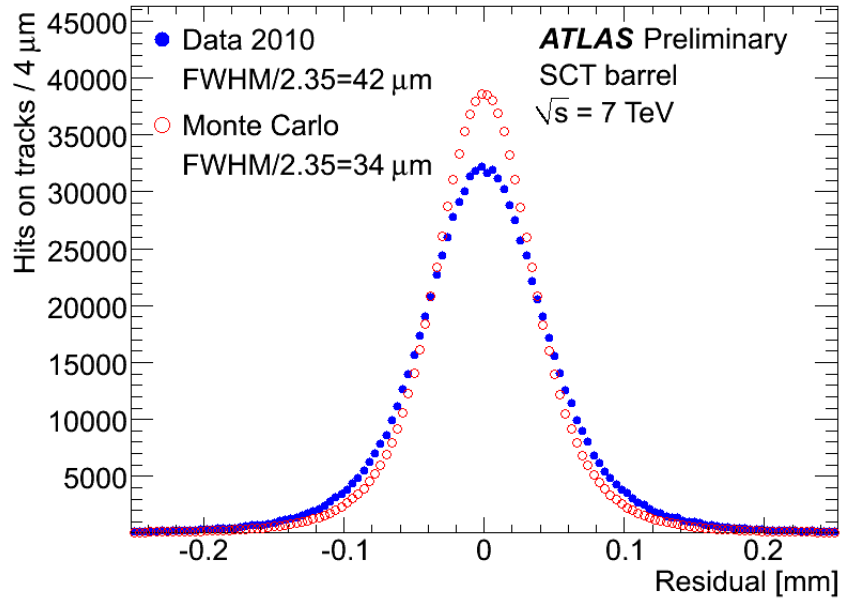
Mapping of local variation of resistivity obtained from cross-talk measurements at Vbias just below depletion voltage

Atlas SCT performances



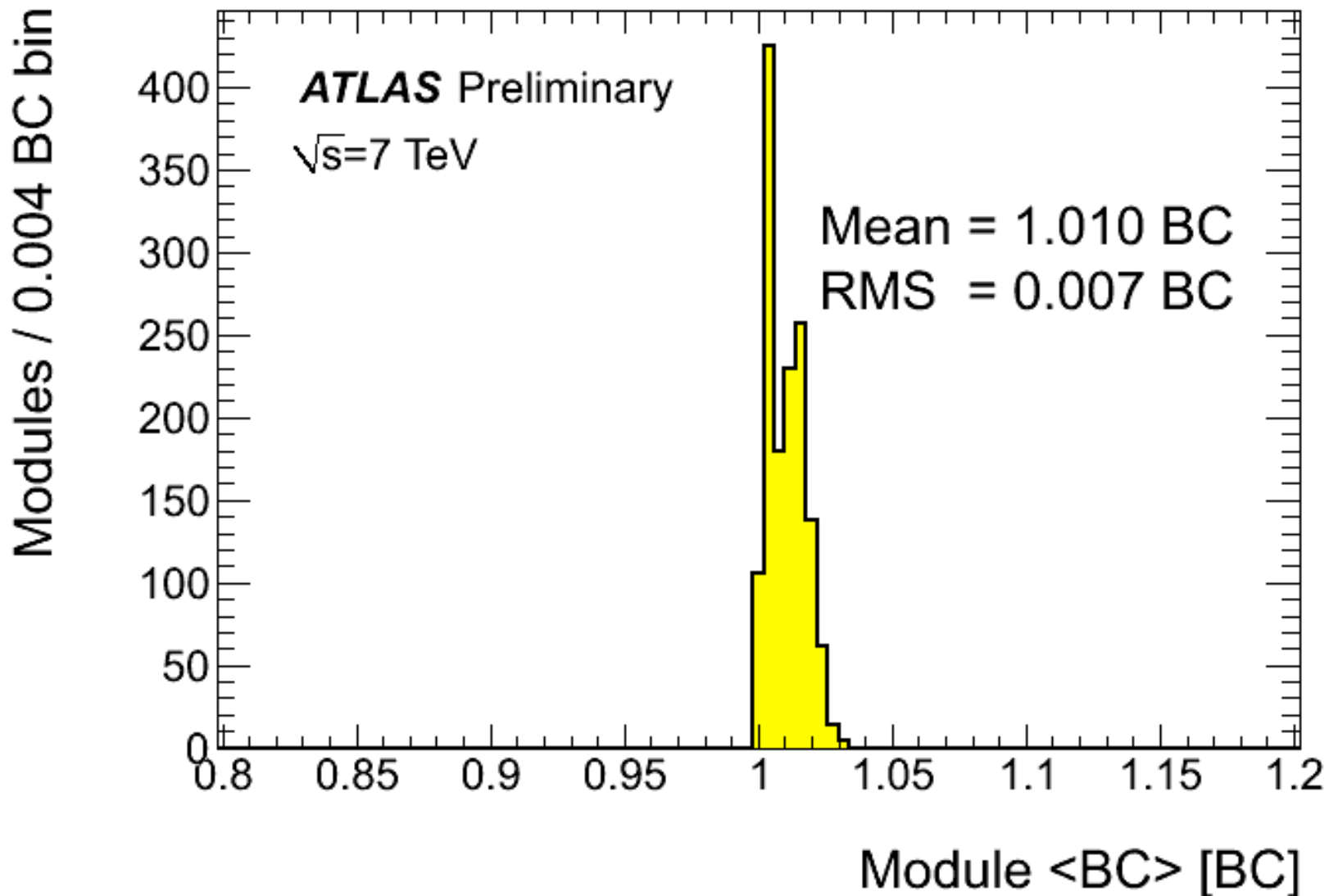
Atlas SCT performance

Hit resolution for Barrel and end-caps, w.r.t. Monte Carlo



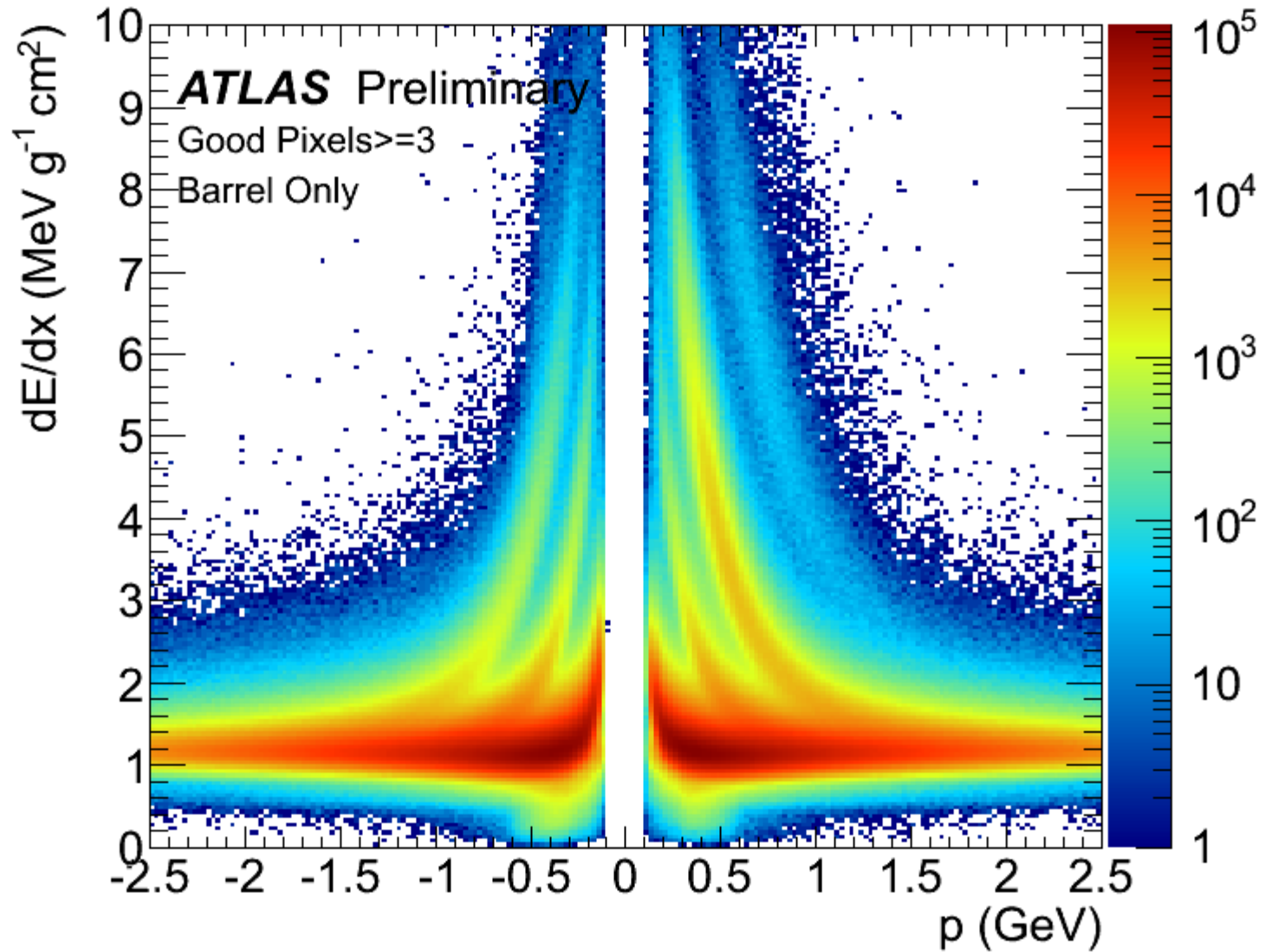
Atlas Pixel performance

Time-in of modules: dispersion of the response to high charge signal
0.007 bunch crossing (25 ns)



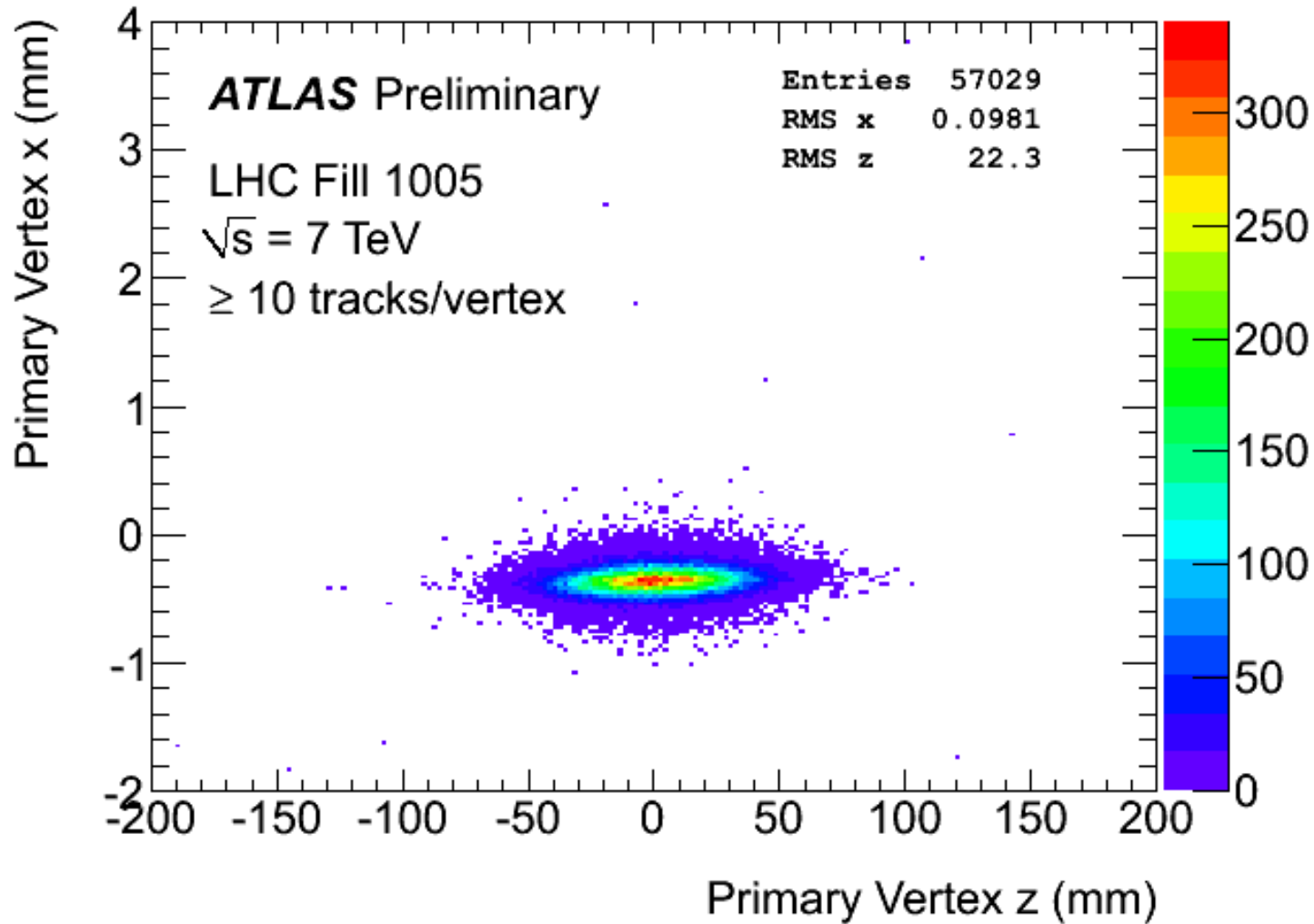
Atlas Pixel performance

Use of pulse height ToT to measure dE/dx and particle identification



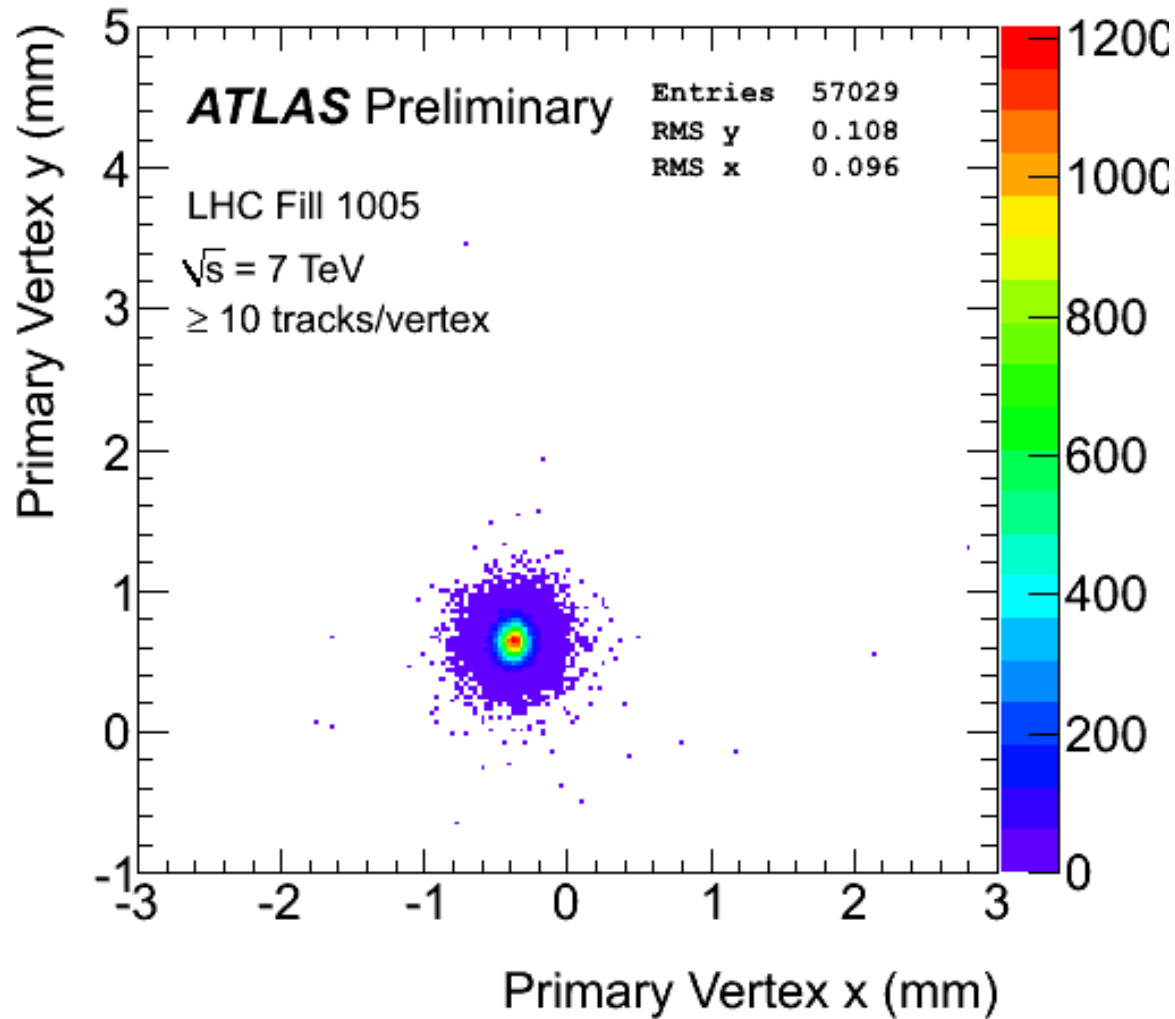
Atlas Combined tracking performance

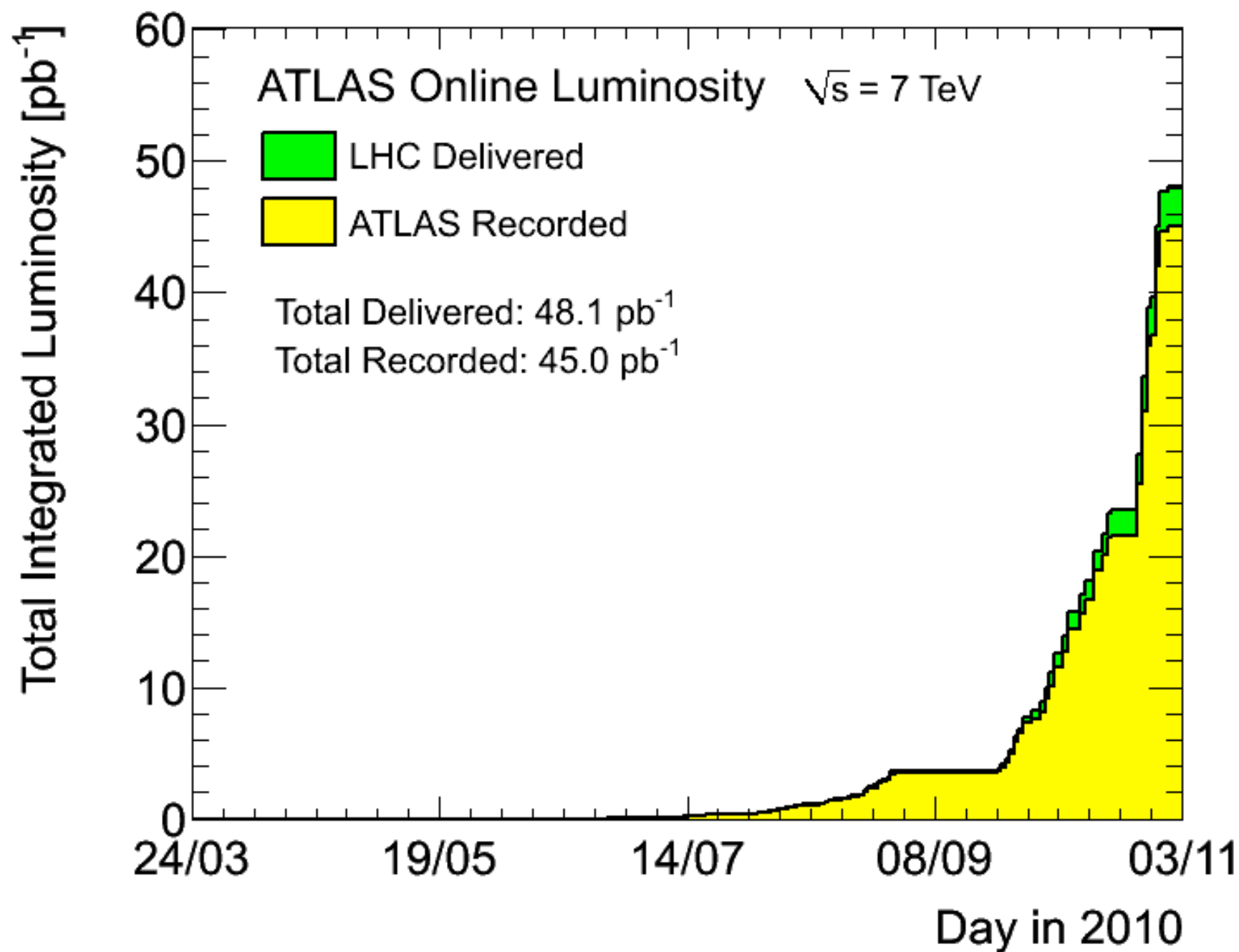
Collision region in x-z plane



Atlas Combined tracking performance

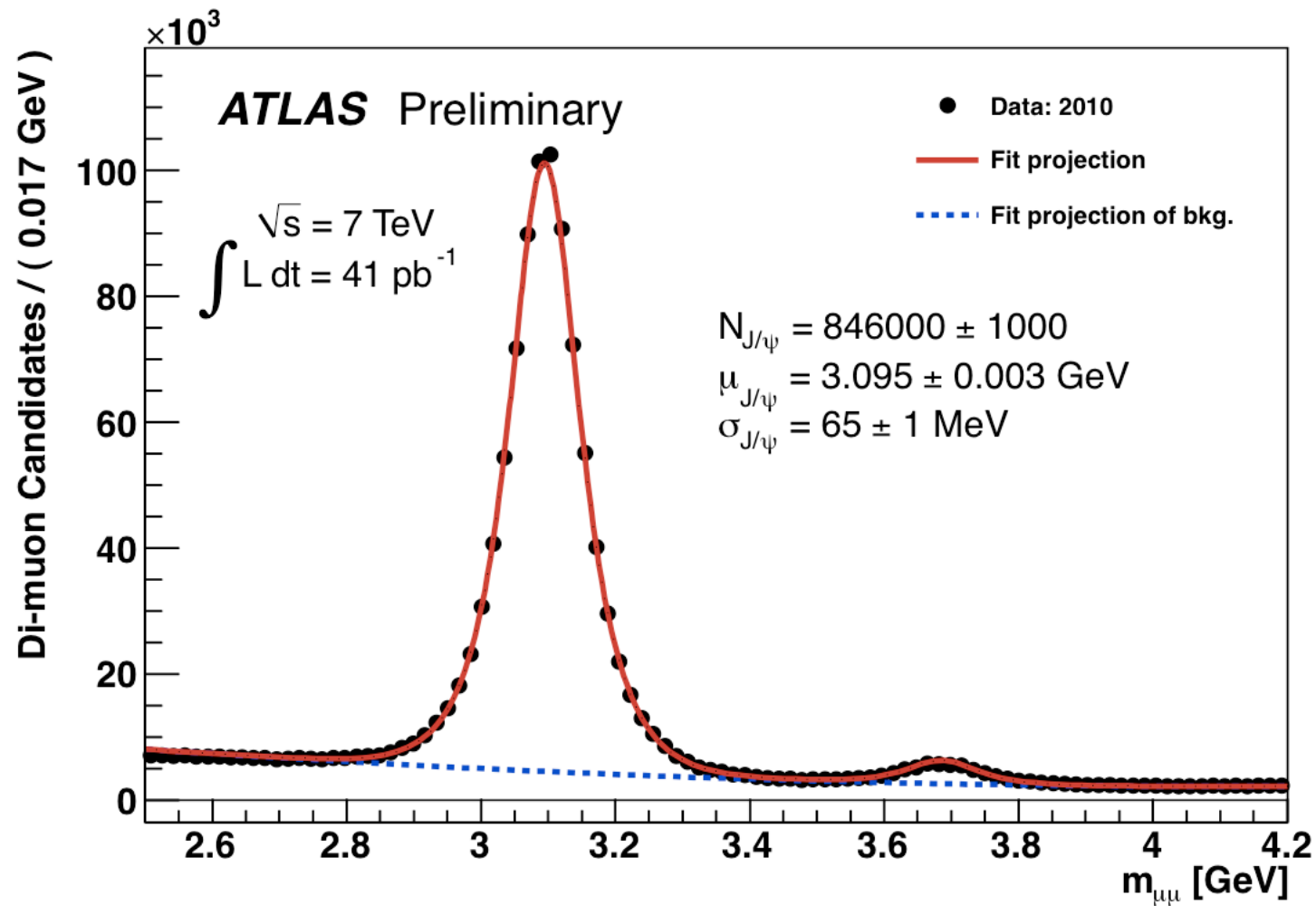
Collision region in transverse plane





Atlas Physics

Di-muon invariant mass



Conclusions

Atlas Silicon detectors have been taking data efficiently in 2010
Time-in, alignment, calibration well established.

All digital readout, but using ToT-encoded dE/dx in physics analyses
(Minor) operational issues: vcsel failures

Looking forward to more data taking in 2011
(the year of the Higgs discovery ?)

Atlas Pixel readout

