ATLAS Pixel
Operational experience

B. Di Girolamo
CERN

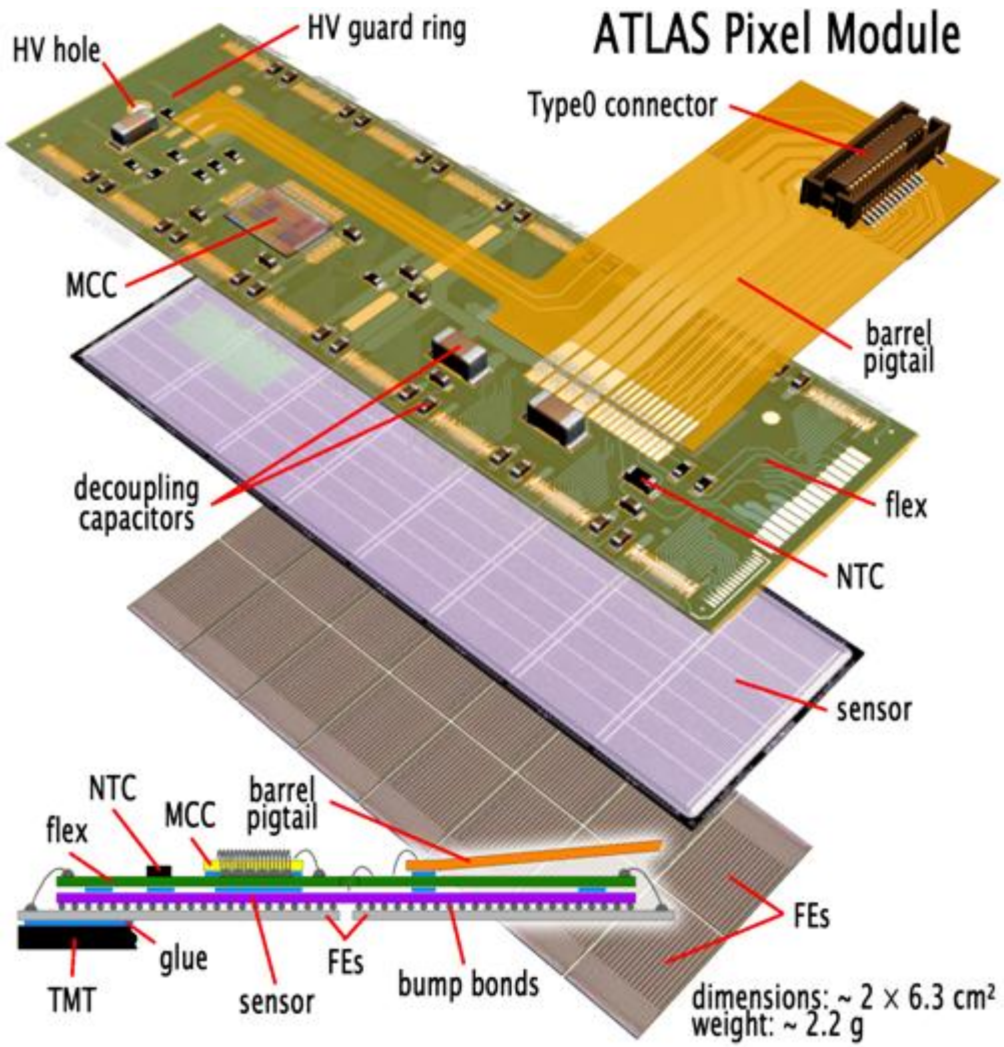
2011: a quite good year

- We closed 2011 with less operational issues
  - However we did have an increase in failures
    - Last year I gave you a 97.3% as available detector, unfortunately today we have 95.8%
    - A number of modules stopped sending data: main problem the optoelectronics
    - More later
- We didn't suffer anymore from beam background effects
  - LHC improvements and more robust handling at our back-end electronics level

2011: a quite good year

- However, correlated to the increased luminosity we started to see "SEU" effects
  - Double quotes because these are at the level of the chip (a.k.a. MCC) performing event building at the module level and managing trigger and commands
    - If SEU happens there we loose the data output and we can't have a flag saying "Yes that was it"
    - However symptoms are clear, correlation with occupancy is clear, it even happens randomly in outer layers: what else would you call it?
  - Not a big problem: we can just reconfigure the module and get going again

The Pixel module



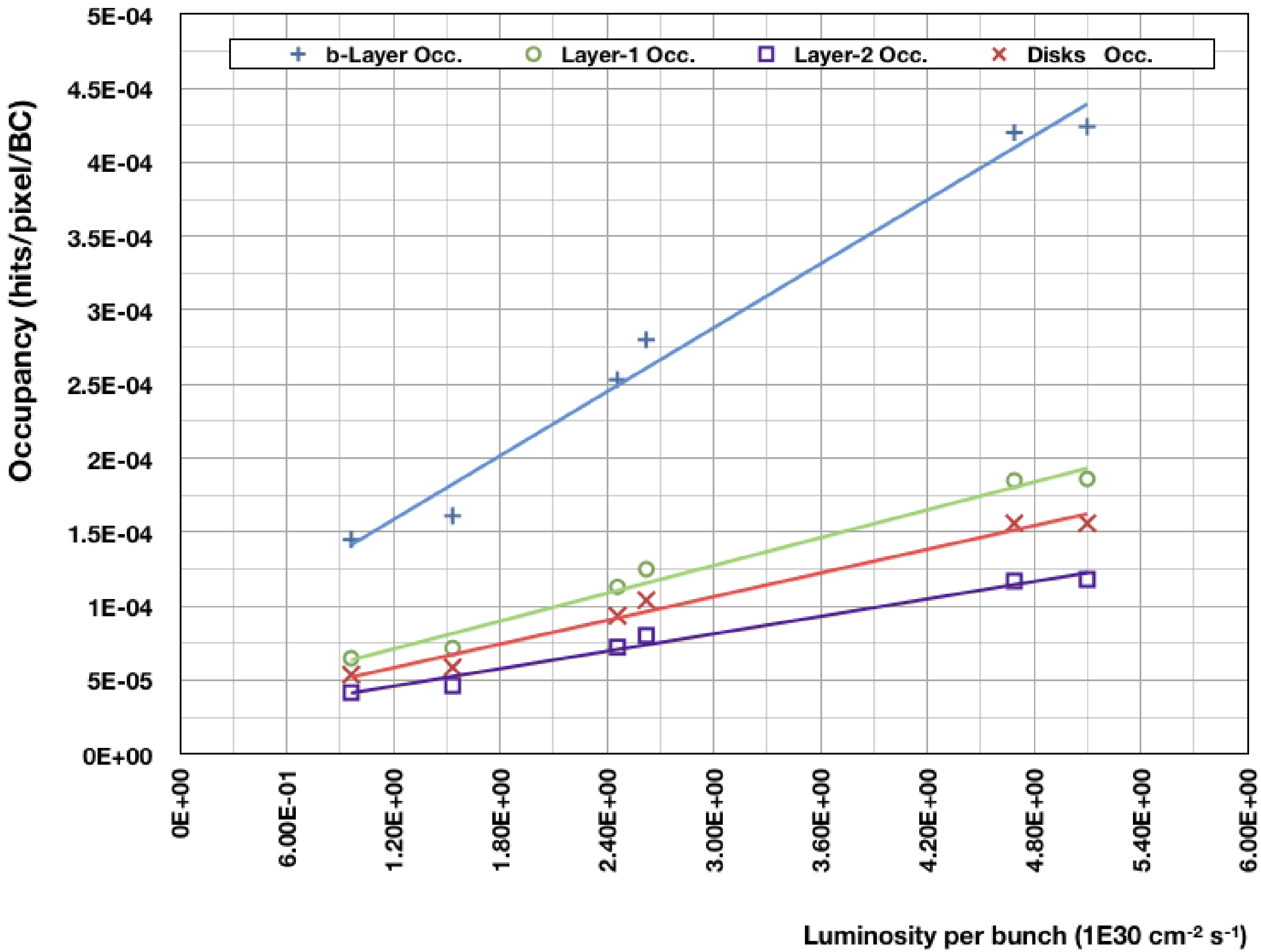
2011: a good year

- Up to now we observe a rate between 0.5 to 1 module/hour
- The recovery last year was done manually
  - Order of seconds: busy, reconfigure, resume
- We now have a new back-end electronics firmware that will allow to recover in milliseconds without the need of asserting the busy

2011: a good year

- We didn't observe so far SEU effects at the front-end chip level
- We have a triple redundant logic and SEUs are flagged in the data stream if any

A quick look to occupancy



A quick look to occupancy

Slopes of occupancy and ratios			
radius (mm)	Slope	Ratio to Layer2	Speed (MHz)
50.5	7.20E-05	3.21	160
88.5	3.36E-05	1.50	80
122.5	2.24E-05	1.00	40
disks	2.64E-05	1.18	80

Ratios between layers in Barrel

- The outermost layer was expected to have 4 times less occupancy than the innermost layer
  - Instead only 3.2 times less: 20% more occupancy than expected
- The middle layer is within expectations
- Overall around a factor 2 higher occupancy when extrapolated to L = 1E34 cm^{-2} s^{-1}
- Making extrapolations to 2021 and up to 3 times the design luminosity

Where are our limits

- The innermost layer, provided some lower resolution in charge, can go up to ~ 3E34
- The outer layer due to the higher than expected occupancy, will need more back-end electronics in counting rooms and can go up to 3E34
- The middle layer would have limitations when approaching 2E34 at the FE chip level
  - You could then use the same "trick" as for the innermost layer, but…
  - The next limitation kicks in: we saturate the links between the MCC and the back-end electronics
    - It does not scale with occupancy because of the header and trailer information that become a problem with a readout at 80 MHz instead of 160 MHz and that limits the middle layer to be ok up to 2E34
  - but with some services upgrade can go beyond 3E34
- We are inserting a 4^{th} layer in 2013/14 and no readout limitations (new FE chip)

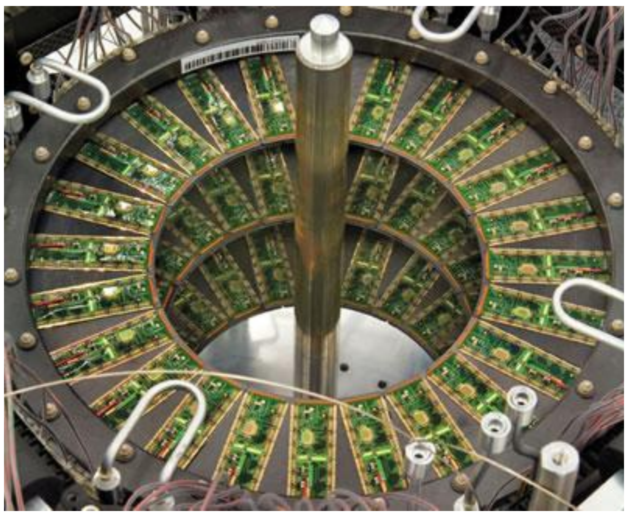
Service repair and upgrade

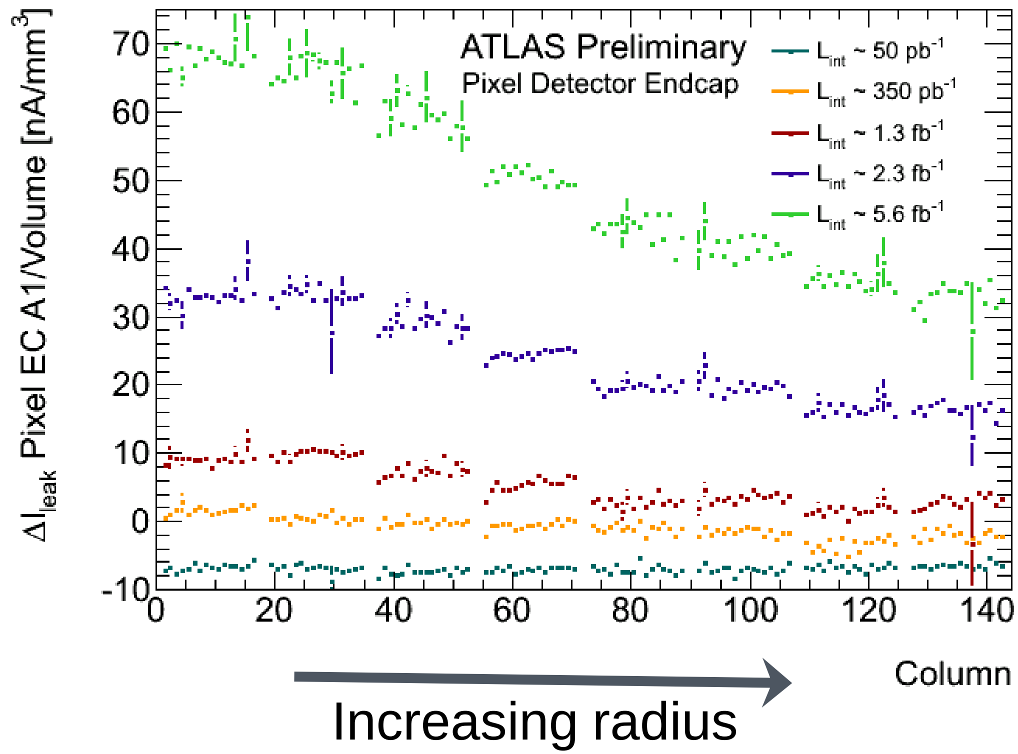
- We started a production of new services to fix the optoelectronics problems
- We upgraded these new services to allow the higher speed of operations for the middle barrel layer
- Discussions ongoing about the deployment

2011: the year of rad damage signs

- Last year we didn't observe yet effects of radiation damage
- Yesterday we got a nice overview of the effects in pixels and strips
- Effects at the FE level? Not really manifest so far
  - Tiny variations in thresholds are cleared when we tune the threshold for the smallest dispersion
  - Some understanding effects seen in Disks

- An example of an inhomogeneous leakage current distribution from the per pixel scan: end-cap disk modules oriented in R direction, (R column #).
  - Clear radial dependence of the leakage current.
  - Observe steps in increase related to FE chip; investigations ongoing.





What else?

- Very important the automatic switch-on of the detector
  - The shifter would have only to watch when it happens
- Prototype ready
  - It looks at BCM (beam monitors) occupancies
  - LHC conditions and luminosity, if all good:
  - Then switches on Disks, look at occupancy
  - If good: switch in sequence the rest, each time checking
- Switch off already automatized

Shifts and e-log

- We reduced our shift crew: 1 shifter looks at the entire Inner Detector (Pixel, SCT and TRT)
- Up to now, until the switch on will be automatized, the run coordinator switches on the Pixel
- We managed to have an improvement of the e-log with appending capabilities.

All that required few fixes

- Reduction of tools available to the shifter
  - Less handles, less errors
- More meaningful plots
  - Not as advanced as ALICE, but on that path
- More experts around
  - Difficult as experts flow rate is low in input, high in output

Online cooling loops leak measurements

Motivations :

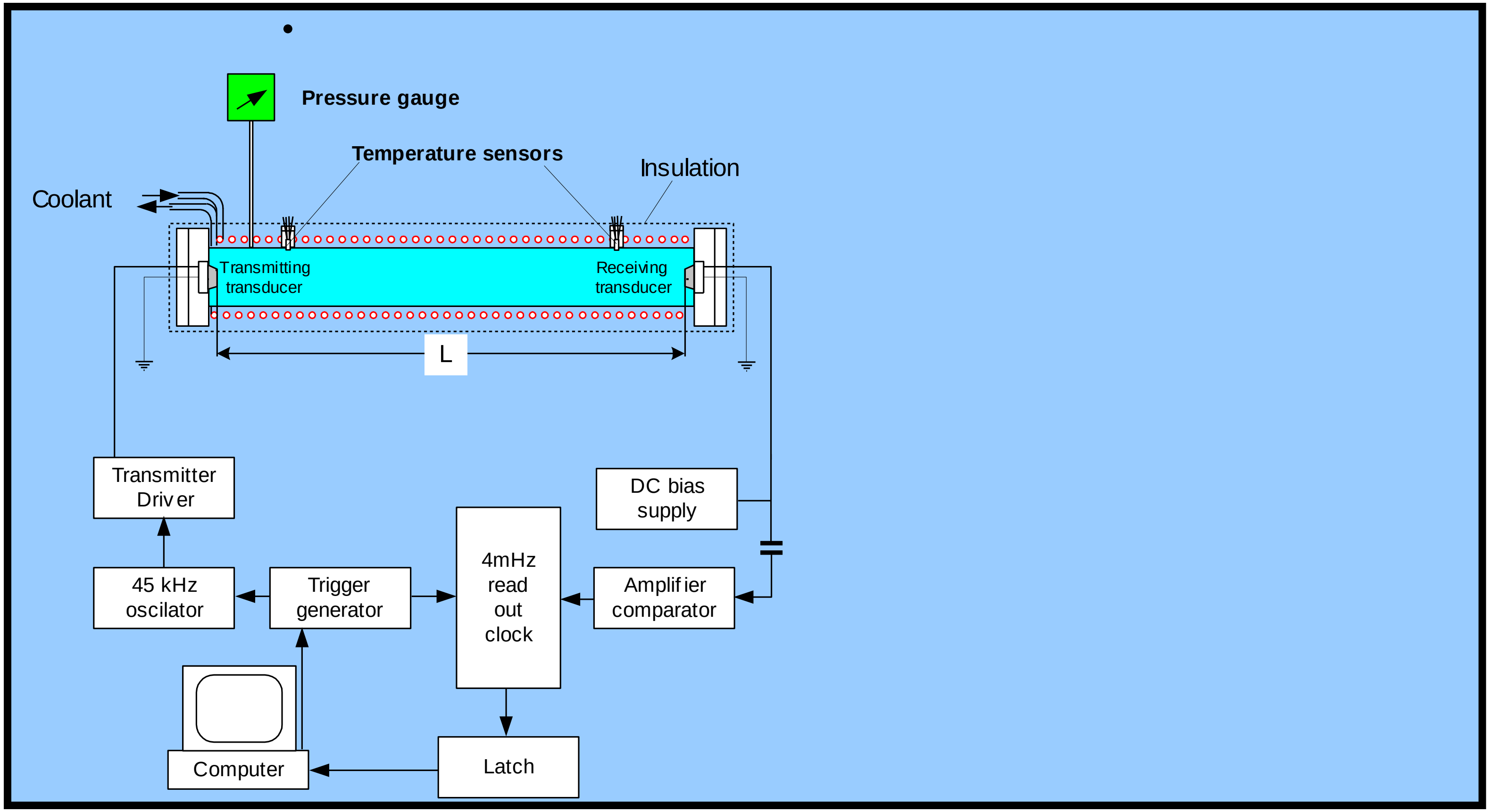
• leaks might depend on operation conditions (temperature, pressure, liquid/gas phase etc), so it is complementary to standard high gas pressure tests

• separate leaks inside pixel volume (danger of corrosion by HF) from leaks outside pixel volume

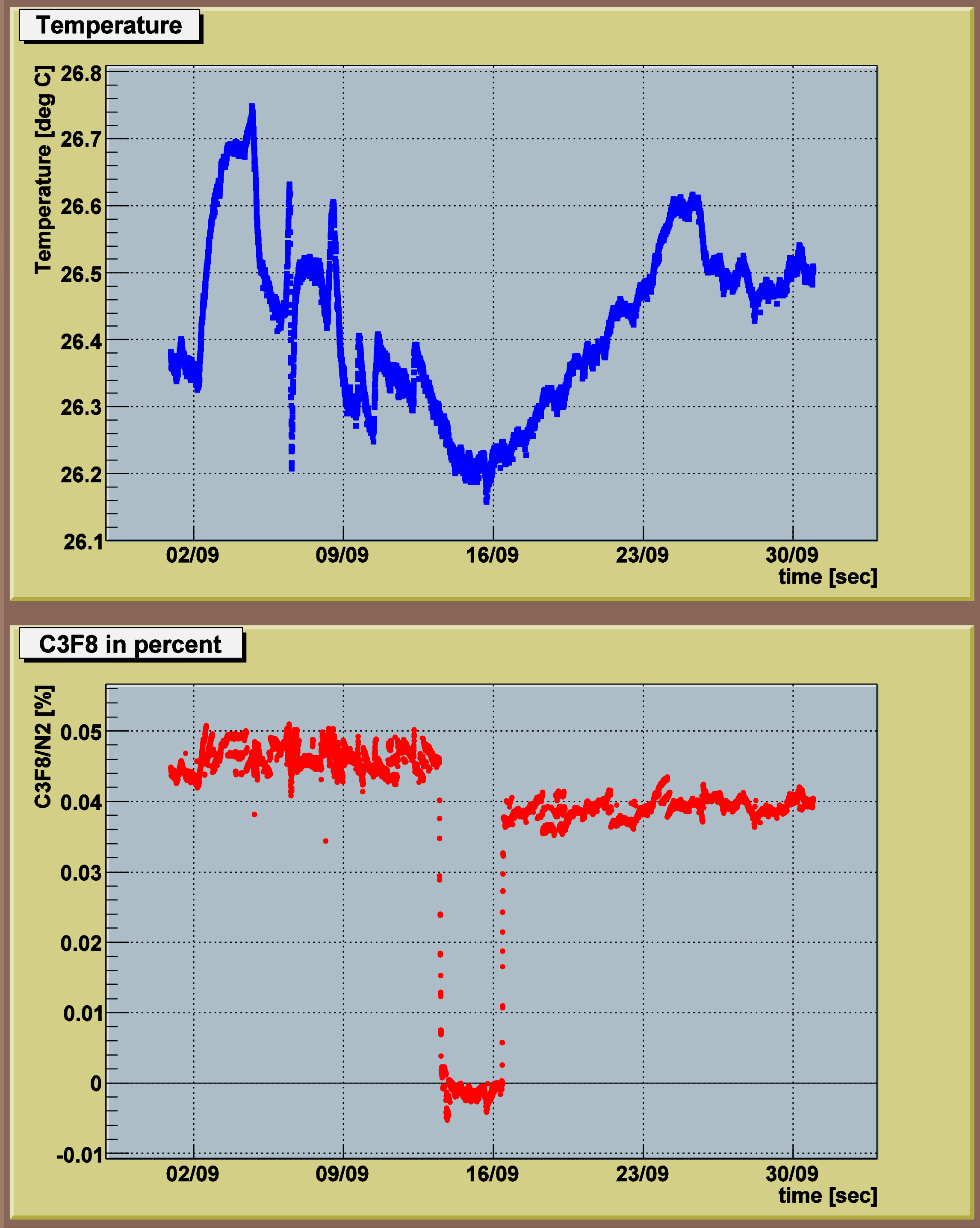
• monitor total leaks permanently on the long periods

Contributions : operation-shifts (Greg, Sasha, Laurent, Nicolas), PVSS sonar (Martin), pixel (Iskander, Kerstin), cooling (Koichi, Olivier)

Pixel exhaust sonar

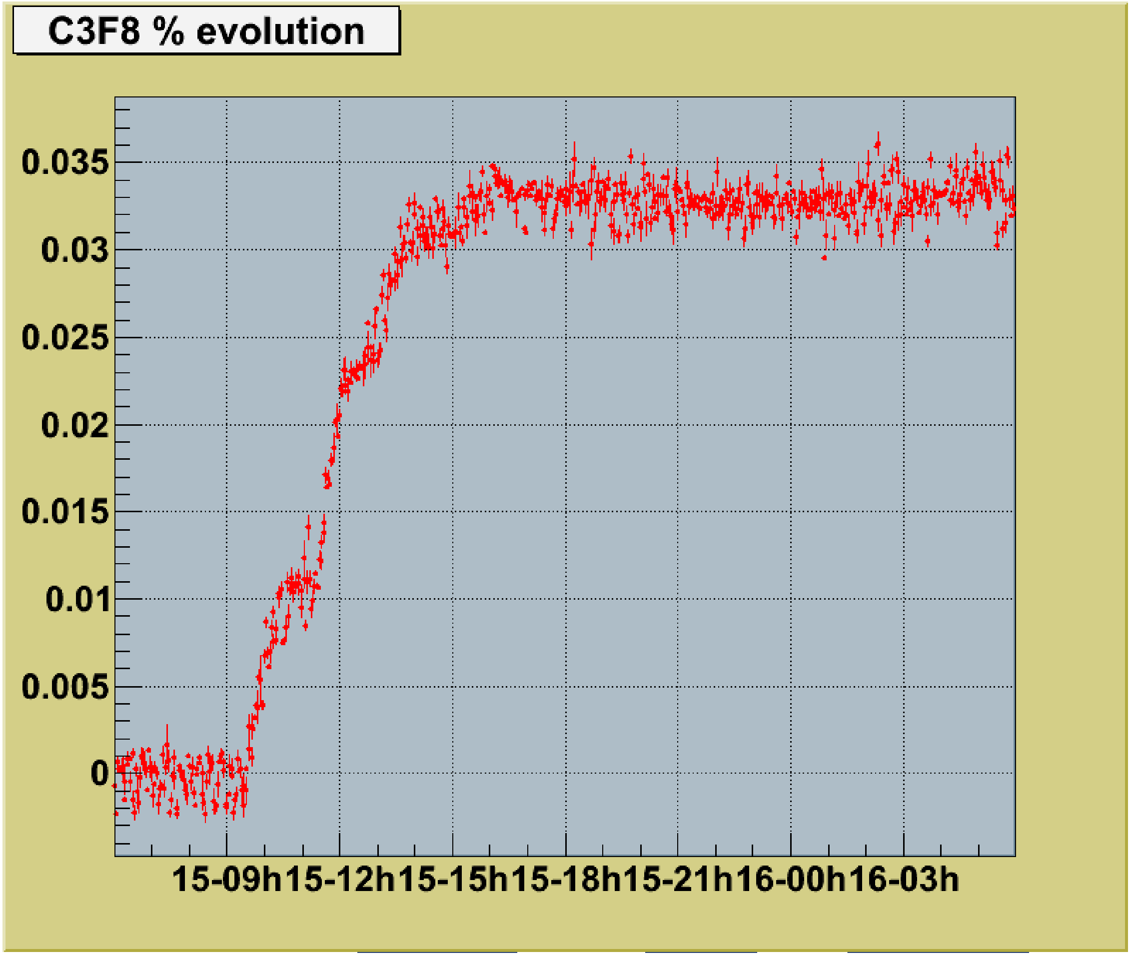


…easurement of the …3F8 during normal …xel operation



- Zero level calibration with flux of pure N2
- Warning: Absolute scale to be repeated with Ecotec3000, as 40-50 % differences were seen in earlier measurements

Longer term 16-20 January 2012



Cooling leaks

- We monitor continuously
- Not worrying at all so far
  - We did irradiations with 1% C_3F_8 contamination in N_2 container with “module” inside
  - No signs of damages
  - We will repeat with higher concentration of C_3F_8 and higher humidity (in ATLAS we have 0)