Mini TPC at Saclay : update

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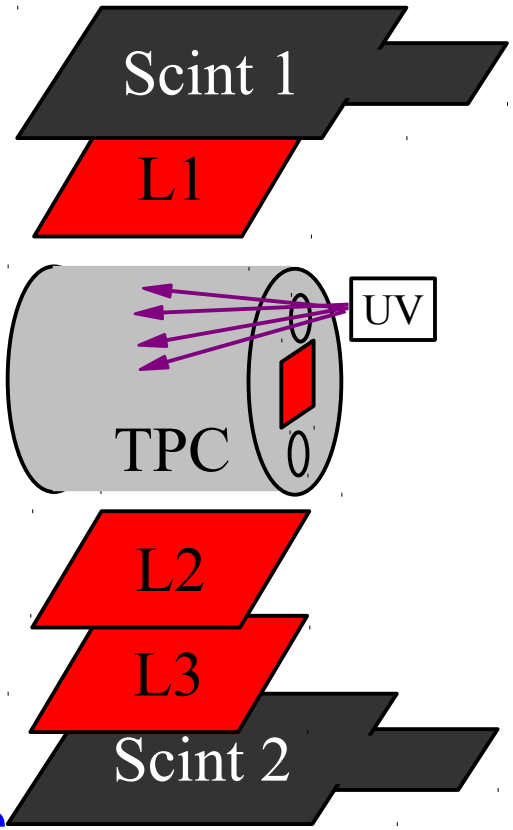
Outline

- Introduction/Reminder
- Recent events
  - Alignment
  - Gas

Mini-TPC project

Goal: test TPC tracking performance in the presence of space charge to check/tune simulation of space charge effect

- Recycle existing chamber present at Saclay
- Use micromegas resistive module as TPC pads
  - Existing detector+electronics (AFTER)+DAQ developed for T2K and ILD R&D
  - New TPC end-plate to plug the micromegas device
- Transparent windows to send UV-rays through the chamber
  - UV rays yield photo-electrons at the cathod level
  - Photo-electrons drift toward micromegas
  - Micromegas amplification yields ion back-flow in drift space
- Measure tracking performance with cosmic muons
  - Trigger with 2 scintillators
  - Use 3 large area micromegas chambers as hodoscope.

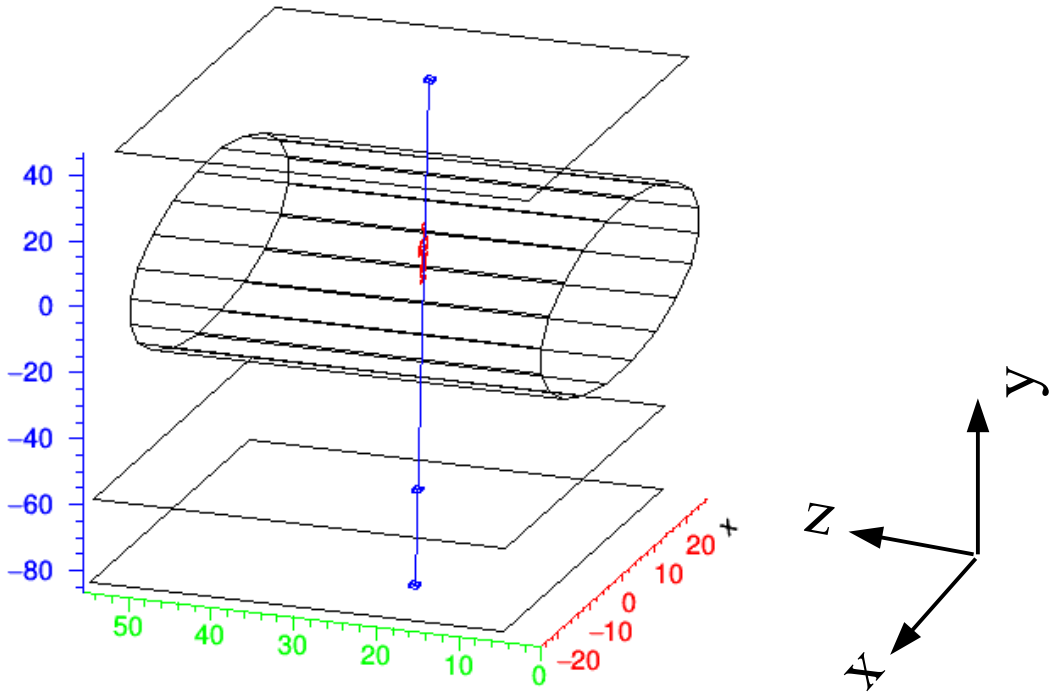


TPC+Multigen data

- Start steady data acquisition in January 2017
  - Required amount of data for a proper tracking performance study was not known
  - Goal to collect as much data as possible in steady state
    - Typical trigger rate ~ 1 Hz
    - Typical rate for good events in 3 Multigen and TPC volume ~ 0.3 Hz
- Data acquisition in 2017 - 2018
  - Use 95% Argon + 5% Isobutane
  - TPC Mesh at -430 V (128 µm GAP)
    TPC Drift -10 kV / 48 cm → ~200 V/cm
  - Multigen (v1) anod at +480 V
- Issues to be solved before turning UV on
  - Quality:
    - Large e- capture rate in TPC
    - Sometimes poor S/B in multigen
    - Track resolution not as good as expected
      - need to improve tracking
  - Stability
    - Gain in TPC not stable in time
    - S/B in multigen not stable in time
    - Track resolution varying with time

Alignment procedure

- Quick fit
  - Define track from 2 hits from outermost Multigen (Layer 1 and 3)
  - Compute residuals for the hits in TPC and MG Layer 2
  - Fit (z,x,y) of 3 Multigens
  - Fit 3 rotations relative to (X,Y,Z) axes for TPC
  - Fit drift velocity

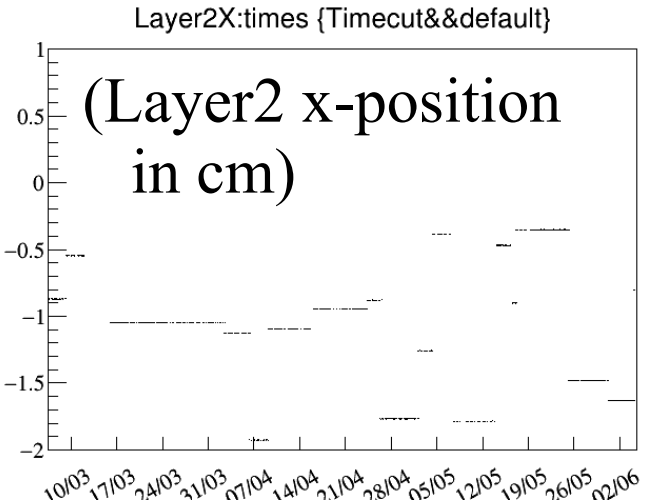


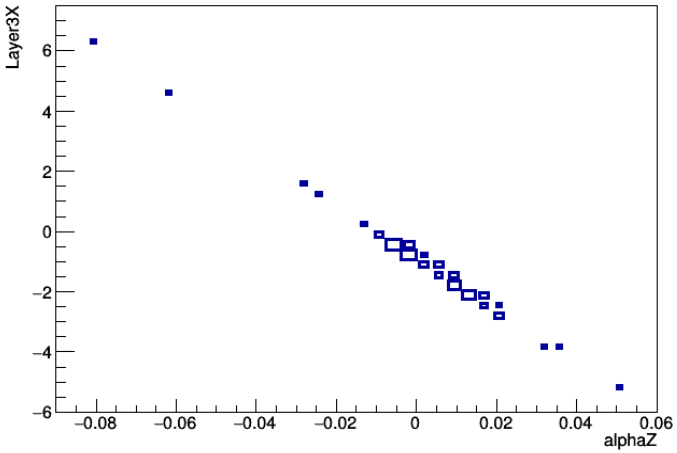
Alignment issue

Alignment constants are computed regularly

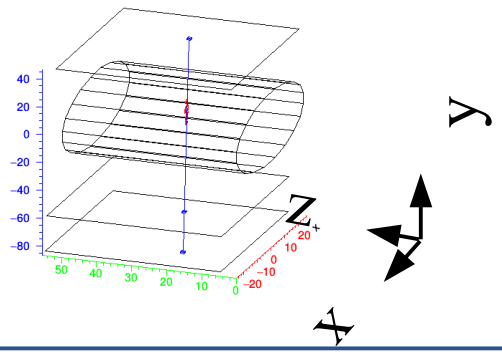
- They should be equal over a short period as we don't move the detectors
- They are not

- Reason for instability
  - Evidence of degeneracy in fit outputs:
    Not enough sensitivity to disentangle a rotation of TPC from a translation of Multigen ?
  - Note: this does not track resolution
  - This is a problem when you compare an absolute (x,y,z) coordinate between different runs (eg for Tomography)
- Recent attempt to improve:
  - Fixed two rotations (around z-axis and x-axis)





Layer3x- vs rotation around Z-axis, in different runs

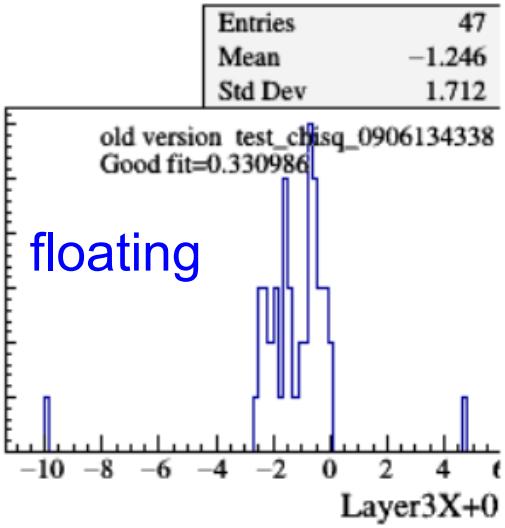


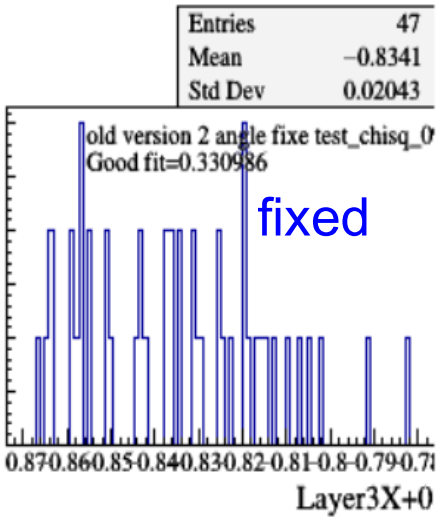
Alignment resolution

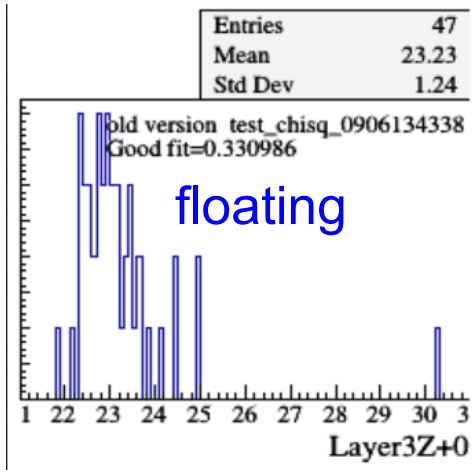
- Use several runs from April data:
- Recompute alignment for every files ~ 1 hr of data taking (~5k trigger)
  - alignment constant (in cm) with floating vs 2 fixed angles

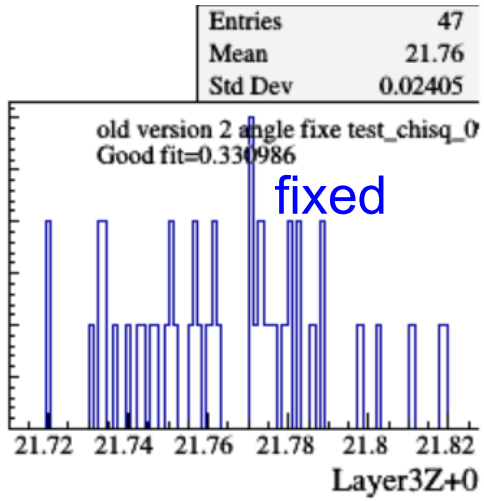
With 2 fixed angles:

- Improve spread from 1.7 cm to ~ 0.2 mm for Layer-3 X-position
- Improve spread from 1.2 cm to 0.2 mm for Layer 3 Z-position
- Also remove tails



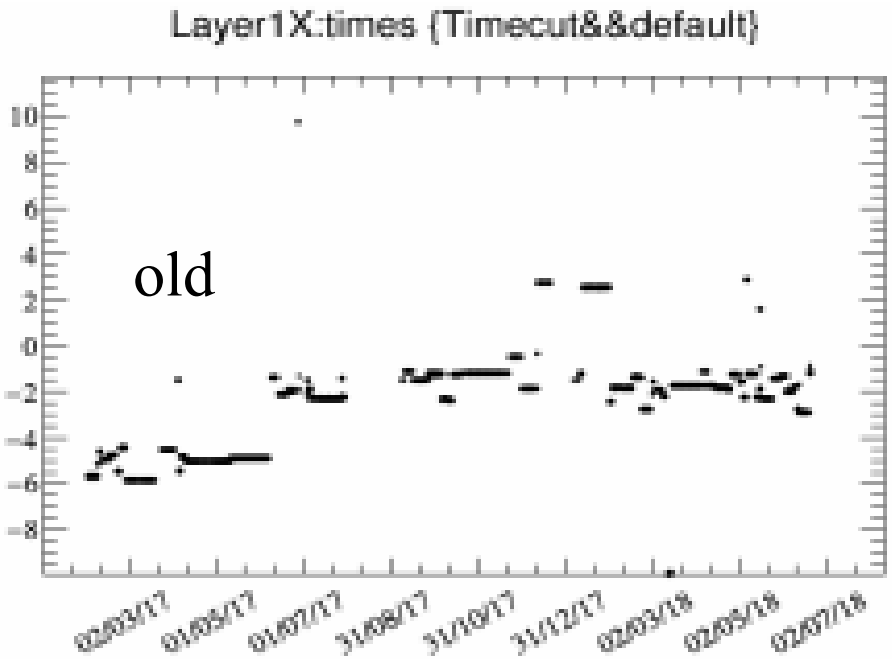


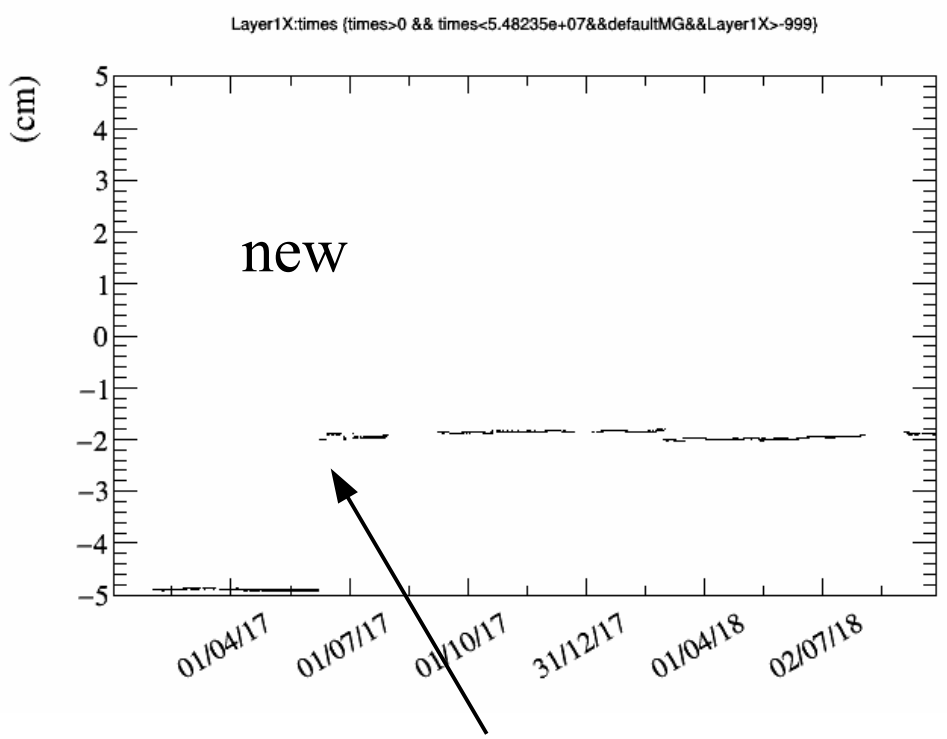




Switched to new alignment procedure

- Reprocessed data with new alignement procedure = fixing 2 angles.
- See the expected stability eg for Layer 1, X-position

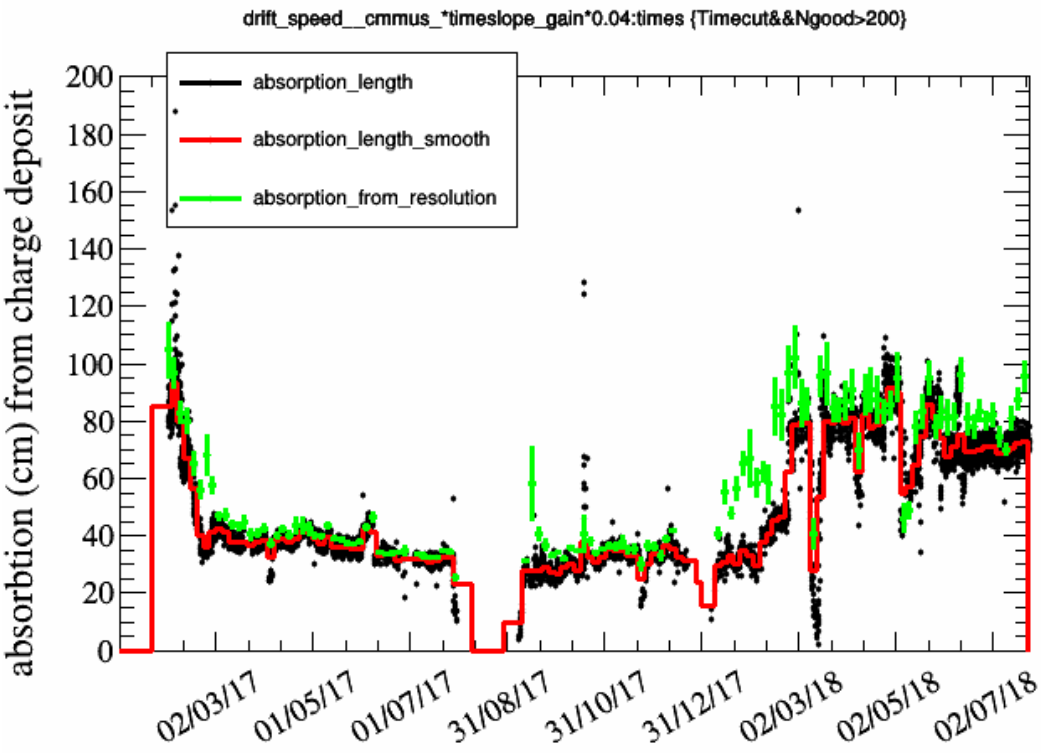




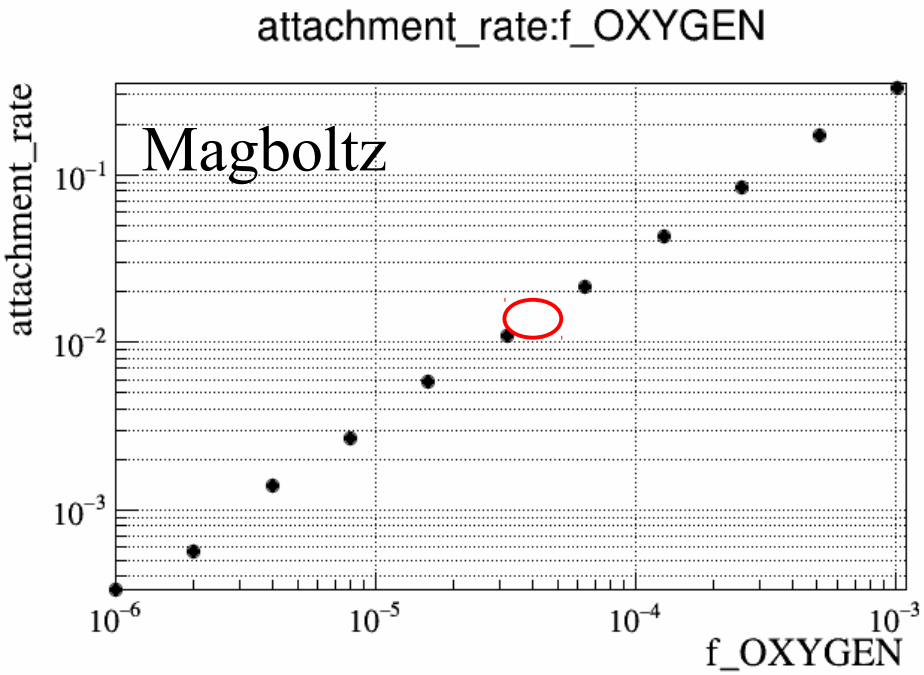
When TPC bench moved in the current room

Issue with gas

- Too large absorption in gas (electron capture) affecting resolution.
- Presumably O2 outgasing or leakage.
  - Suspected something wrong in gas.
  - In July, changed 10 m of gas pipe. Was nylon, now aluminum coated pipe.
  - No visible change. Now suspect a leakage in some pipe connector, or O2 in the Argon bottle



green: e- capture determined from resolution vs z
red e- capture determined from charge vs z

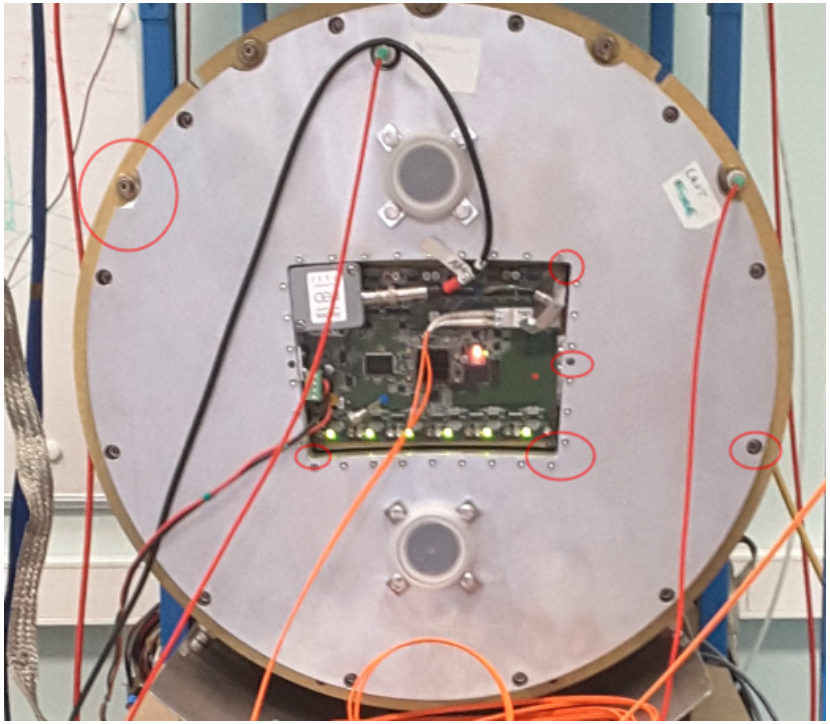


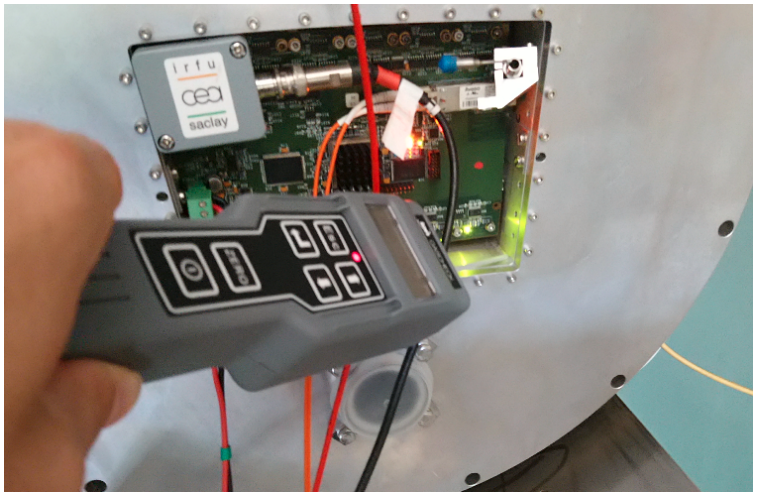
Attachment ~ 1/80 cm-1 ↔ f_{O2} ~ 3E-5

This is expected from atmosphere due to a leak of ~ 1.5 ml/hr

Test with a gas sniffer

- Use a gas sniffer to detect any Argon leakage
- Several leaking zones have been spotted where Oxygen may flow in





- Need to open in clean room to fixed the most important leak
- This should happen in a few weeks, as there are some plans to change the module with a new prototype (designed to get 100% of the 1728 channels responsive)

Summary

- Detector alignment improved
  - There were too many degrees of freedom
  - Things are stable now
- Data quality
  - Gas quality:
    - Evidence for leakage in TPC
    - TPC need to be fixed.

Support