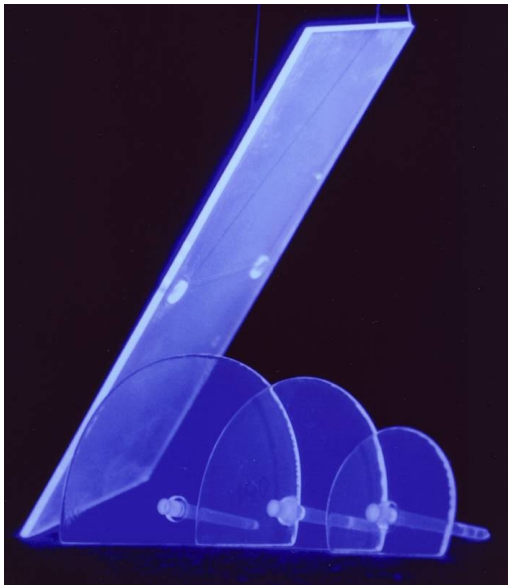
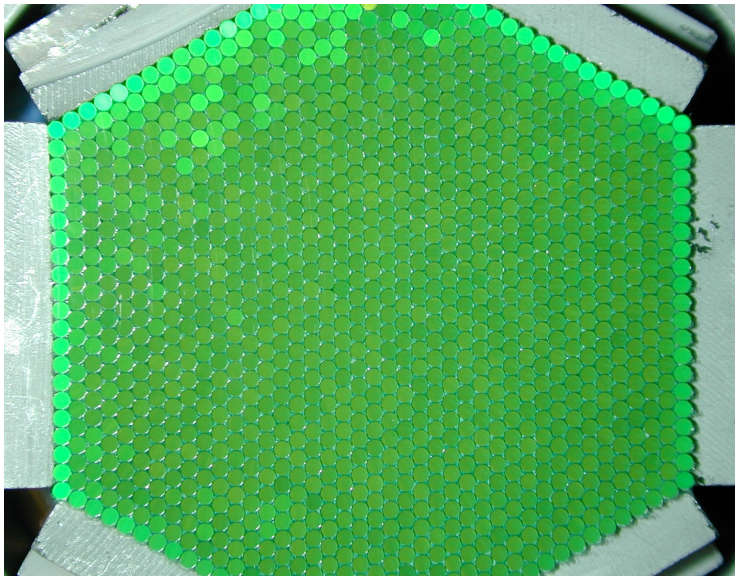
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

LOMaC

Laboratory of optics and scintillating materials





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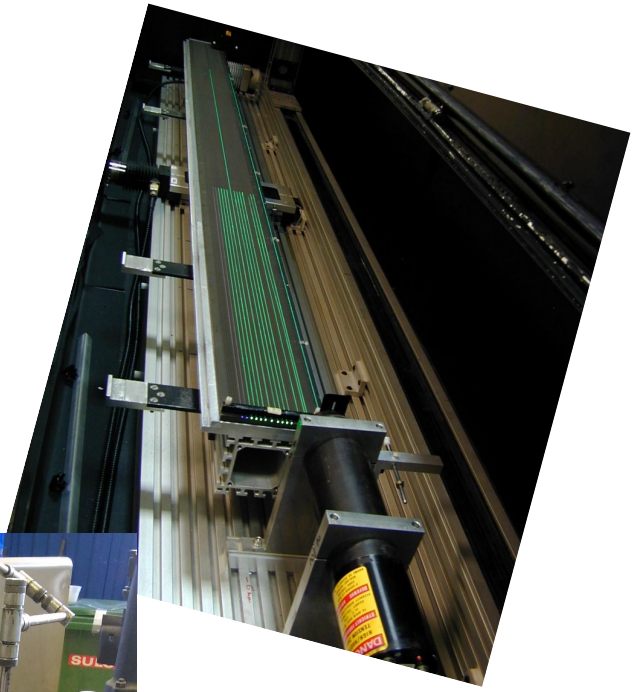
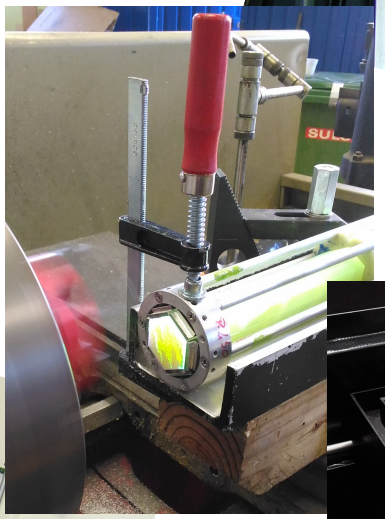
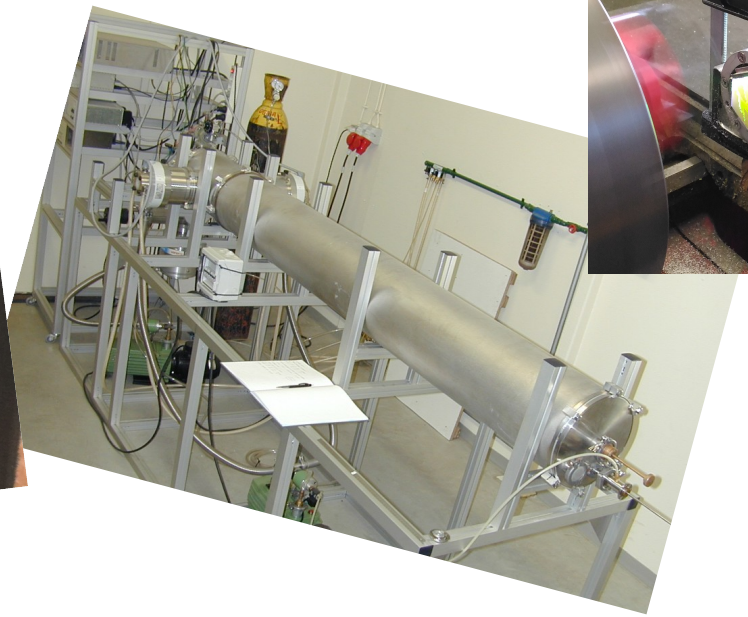
FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

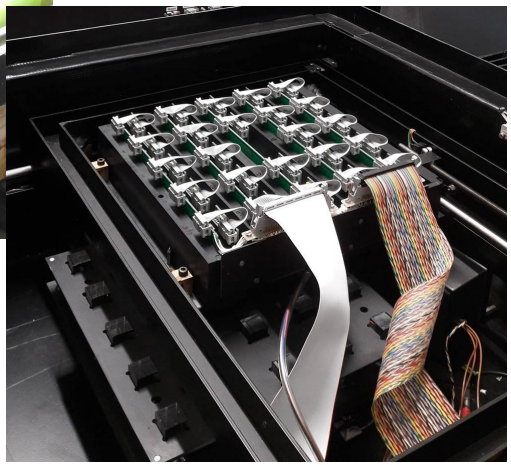
LOMaC facilities

- What instruments do we have in the laboratory?
  - Dedicated test benches
    - Optical characterization of Optical fibers (Fibrometer)
    - Optical characterization of Scintillators (Tilemeter)
    - PMTs characterization
  - Sputtering setup for top aluminization of fibers
  - Oven for accelerated natural ageing
  - Milling machine (to be repaired/replaced)
  - Lathe machine (recommended maintenance)





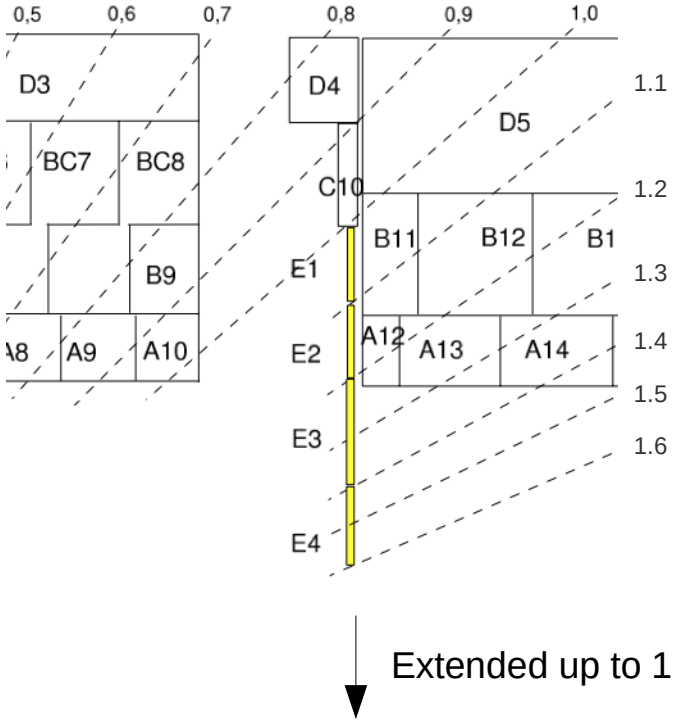




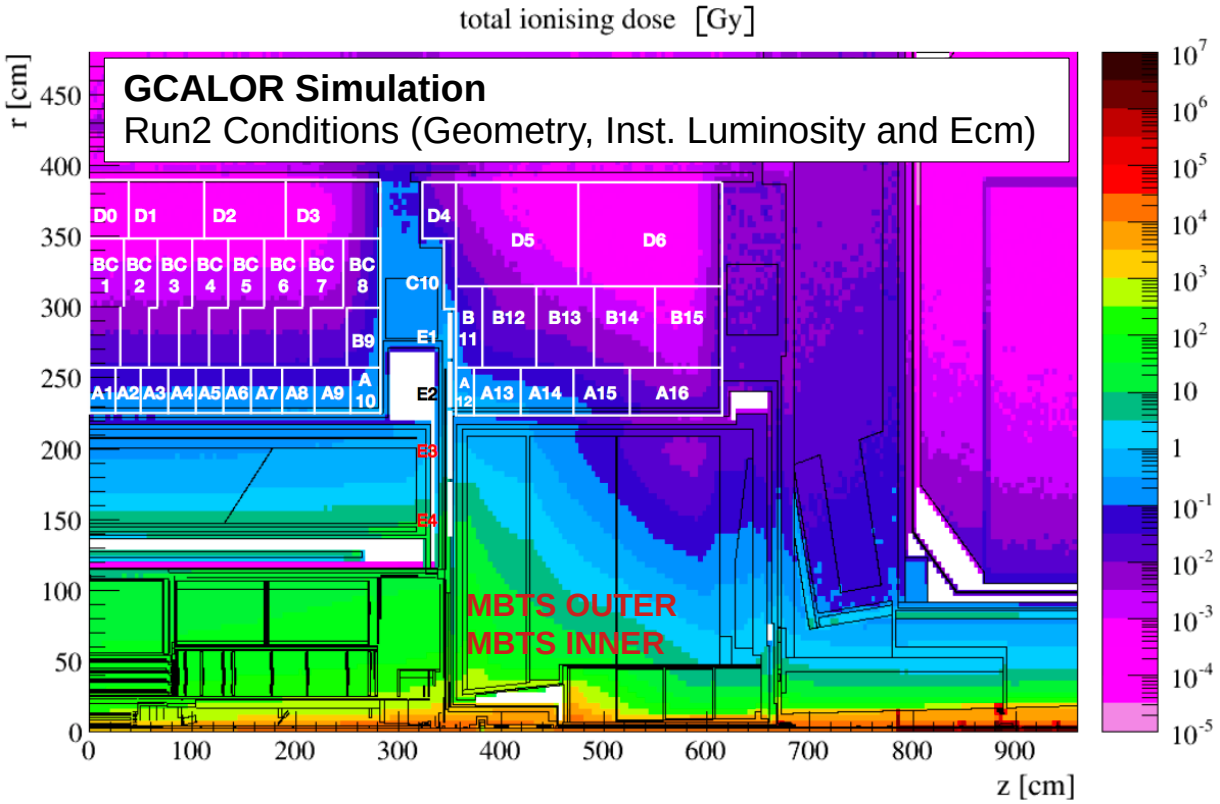
LOMaC activities

- Relocation of instruments:
  - @LIP
    - Tilemeter, Mono-fibrometer, PMT test bench
    - Sputtering machine → to install at room 120
  - @FCUL
    - Fibrometer
- Fibers for TileCal Phase I Upgrade
  - Gap+Crack counters
  - MBTS (Minimum bias trigger scintillators) counters
- Setup PMT test bench
- Scintillators for future detectors (Exploratory)
- Collaboration with other groups
  - Dosimetry
  - Nuc-Ria
- Education and Outreach

Optics Upgrade



Extended up to 1.72



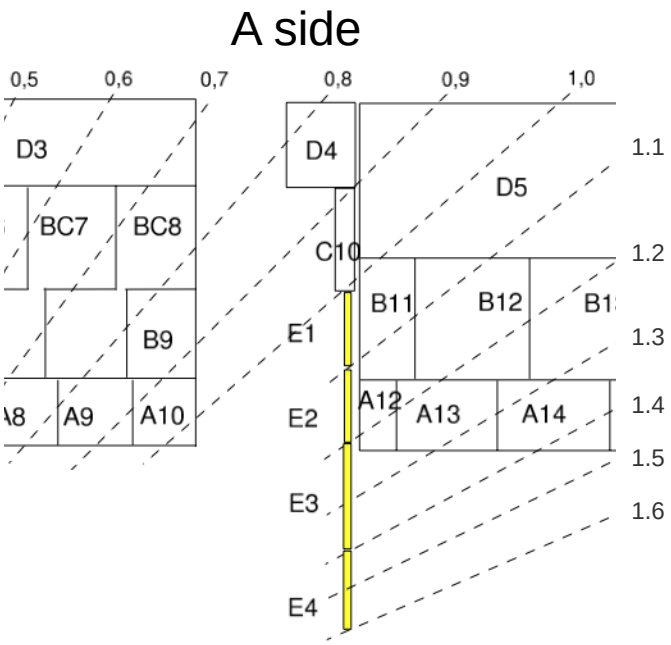
E scintillation counters and **MBTS** scintillation counters accessible and replacement scheduled in ATLAS Upgrade calendar: LIP/ATLAS responsible for the preparation of the optical fibers.

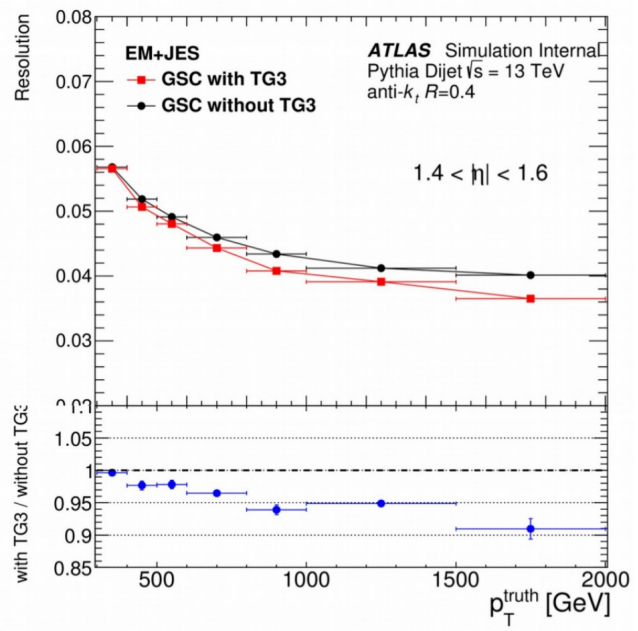
PMTs replacement for A cells (800 units) during LS3

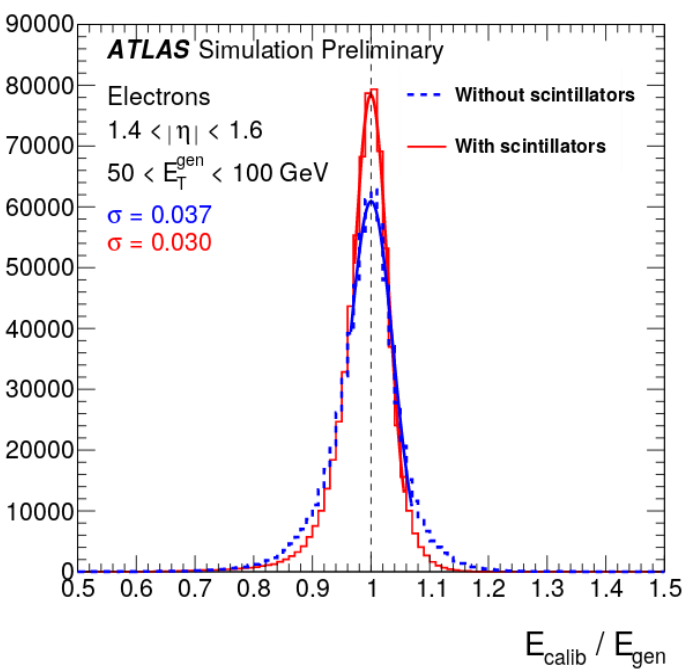
Revision of ALL PMT status prior to HL-LHC during LS3

Gap/Crack counters

- Motivation
  - e/gamma and jet energy reconstruction, Fake Jets Rejection

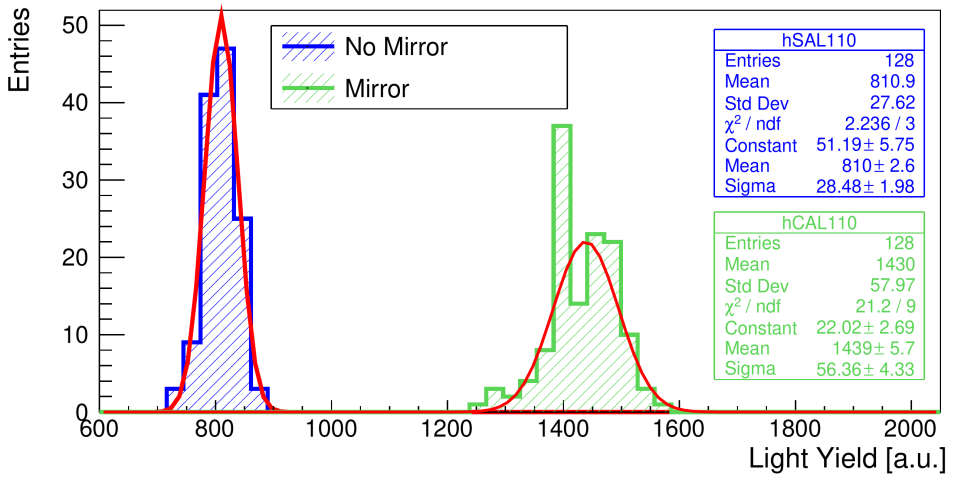






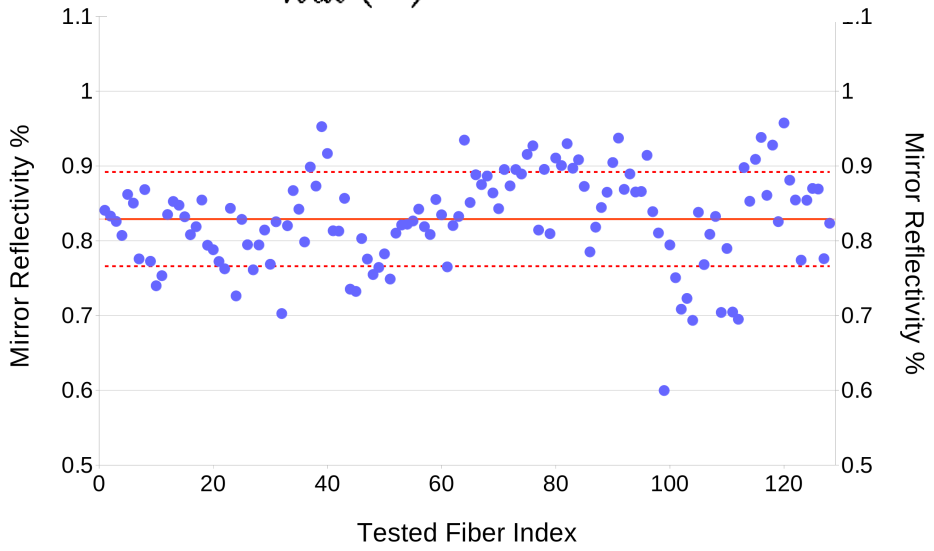
- GAP-CRACK scintillators and fibers
  - (2019-2020) Same type of scintillators and fibers
  - (2025-2026) Radiation Hard scintillators and fibers, and PMTs

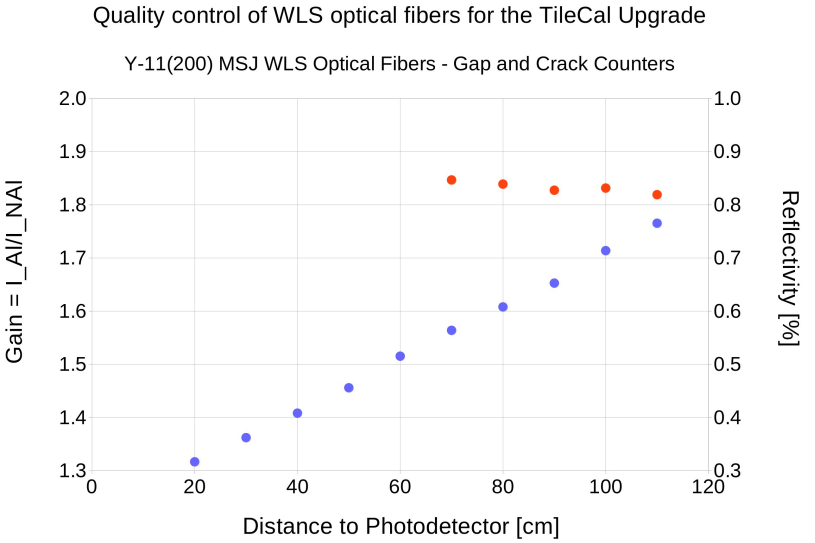
Fibers preparation: Gap/Crack



- About 2500 WLS Y-11 fibers prepared
- Close to mirror (~10 cm):
  - LY RMS : **3.8%** (Non-AL) **4.7%** (AL)
  - <Gain> : **1.77 +- 3.23%**
  - Reflectivity : **82% +- 8.5%**

$$R = [\frac{I_{al}(x)}{I_{nal}(x)} - 1] \cdot e^{[2 \cdot \frac{L-x}{latt_{long}}]}$$

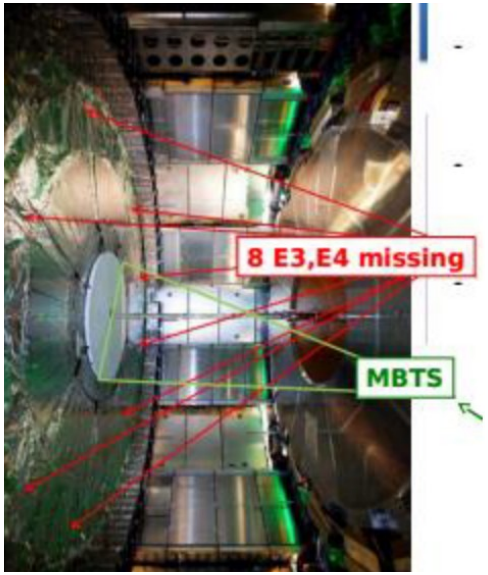


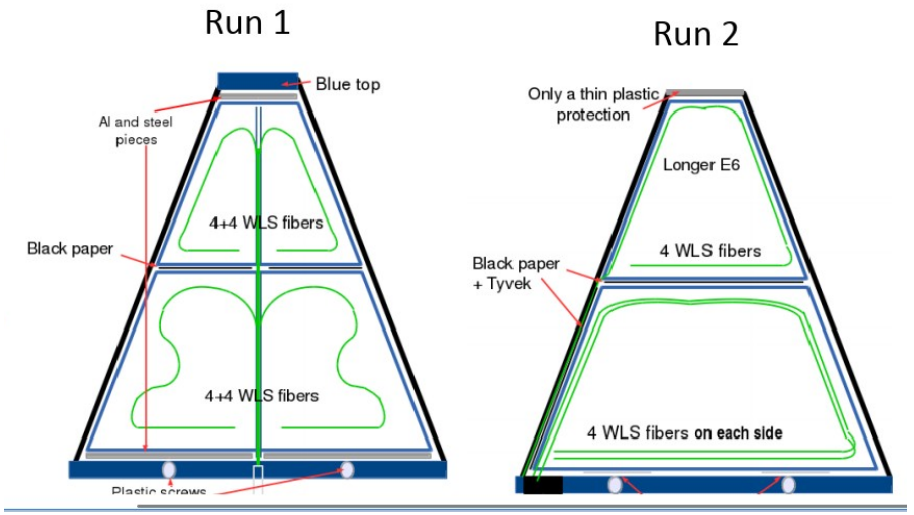


MBTS

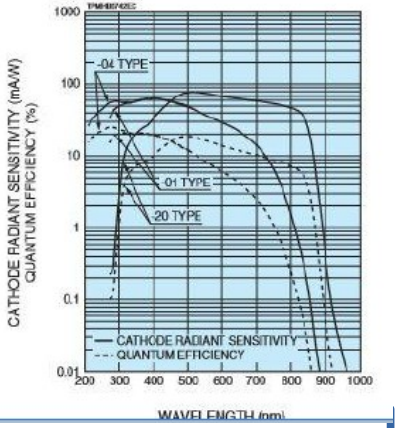
- Trigger: Low luminosity runs (→ ALFA detector), vdM scans, Heavy Ion program

- After Run 1 readout configuration updated increasing light collection
- During run 2 response goes down to 1%/10% (inner/outer)





16 wedges in each side of the Extended Barrels



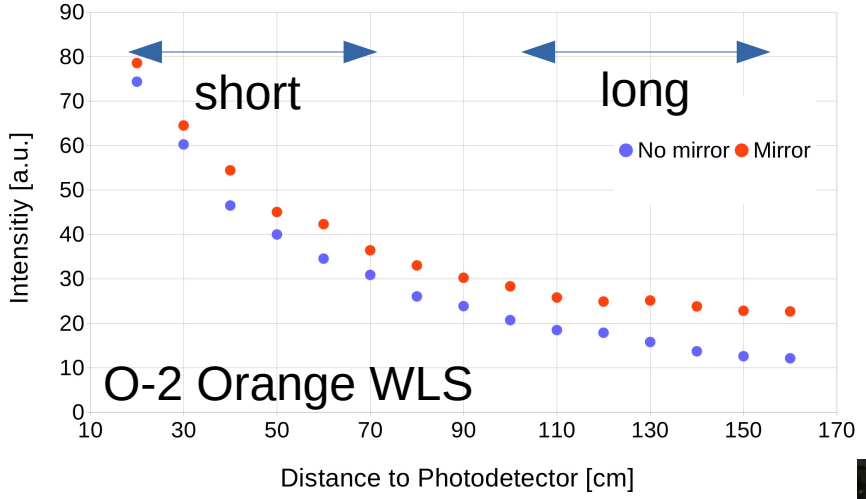
- After Run 2 **BLUE**/**GREEN** scintillator in **OUTER**/**INNER** counters
  - **PS + PTP + POPOP → PS + PTP (paraterphenyl) + BBQ (Benzimidazo-Benzisochinolin-7-on)**
  - **WLS Y-11 fibers WLS O-2 fibers**
  - **INNER NEW** PMT Hamamatsu (R7600-20 ERMA) with new 3-in-1 card/HV divider.
  - **OUTER NEW** PMT Hamamatsu (R11187) with improved performance

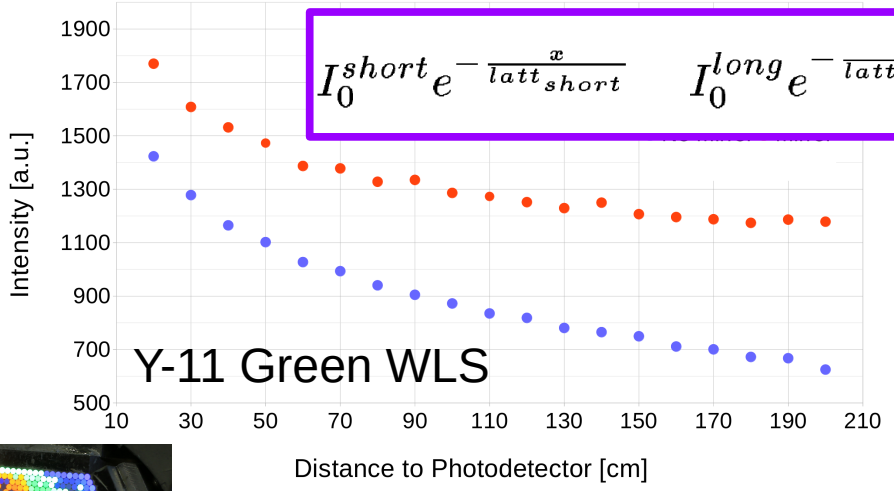
Fibers preparation: MBTS

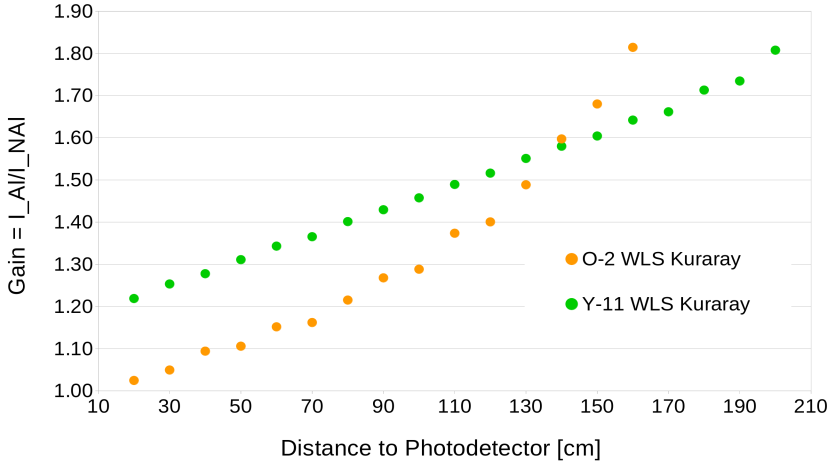
- We had a total of ~300 fibers of each color Y-11 MSJ and O-2 MSJ
- 10 % (~32) were used in quality control for each color

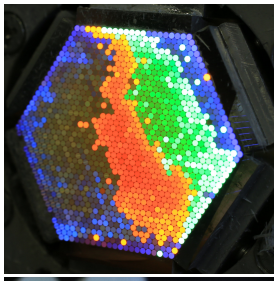
O-2
Lat$_{short}$ 65+-2 cm (Mirror) 56+-1 cm (NO Mirror)
Lat$_{long}$ 223+-26 cm (Mirror) 105+-3 cm (NO Mirror)

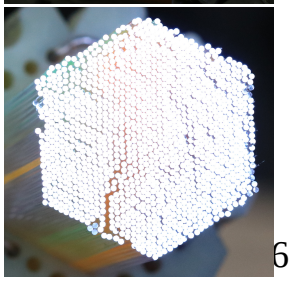
Y11
Lat$_{short}$ 203+-9 cm (Mirror) 144+-6 cm (NO Mirror)
Lat$_{long}$ 981+-104 cm (Mirror) 365+-15 cm (NO Mirror)











$$R = [\frac{I_{al}(x)}{I_{nal}(x)} - 1] \cdot e^{[2 \cdot \frac{L-x}{latt_{long}}]}$$

- Reflectivity (16 fibers)
  - **R = 78 +- 6%** **Y-11 Green**
  - **R = 82 +- 10%** **O-2 Orange**

PMTs Test Bench

- Joining the Tilecal effort of QC of PMTs in Upgrade Phase 2.
  - Tilecal will buy ~1000 new PMTs to replace most damaged ones
  - requalify on the fly some PMTs during the LS3.
  - Participating institutes: Bratislava, CERN, LIP, Pisa
- Strategy for assembly and upgrade of the testbenches discussed in a meeting at Lisbon
- LIP PMT testbench currently is the only one (almost) operational and will be used as guide for the other setups
- Continuation of tests, maintenance and recovery envisaged for next couple of years

Fibers, Scintillators and PMTs for the ATLAS Upgrade

ATLAS Upgrade (2019-2020) for Run3

- 2018: concluded fiber preparation fot Gap+Crack counters
- 2019: additional request to prepare fibers for MBTS also concluded
- Current status: Gap/Crack and MBTS instalation concluded in 2019
- Pit closing in March **2021**

ATLAS Upgrade (2025-2026) for HL-LHC

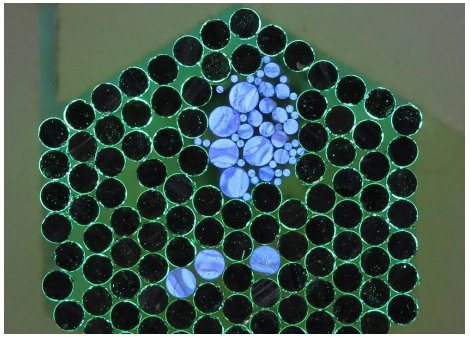
- **Current option** goes to replacement of Scintillators, fibers and PMTs
- Need to be optically characterized (individually and assembled) and evaluate radiation hardness
- **Characterization and rad hard studies of new** scintillators, WLS fibers, and PMTs

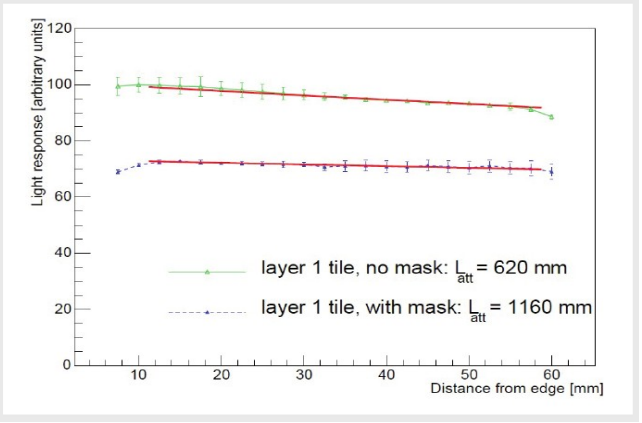
Natural Aging studies revision

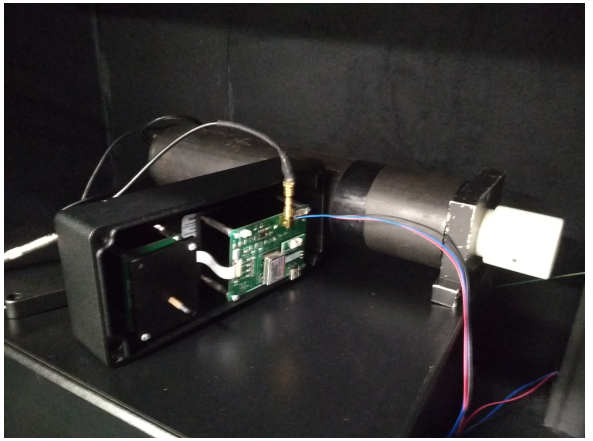
- Past data has been reviewed
- New set of measurements were done
- Plan is to continue with this measurements this year
  - Using the current used set of fibers coming from TileCal construction
  - Add new fibers from the upgrades produced in the last couple of years

Future Prospects

- Applications to Dosimetry:
  - Preparation of table to characterize ribbons of fibers
  - Proton beam monitoring, small volumes dosimeter
  - Participation in submitted project FCT/UTA Call
- Particle Tracking:
  - Tracking of particles for R^3B → Beatriz Pereira poster
  - Participation in projects in this next call PTDC Call
- Scintillators and fibers for future detectors
  - **Exploratory** studies continued at LOMaC
    - Start by the simplest and with available material
    - Measure basic characteristics response, uniformity for top aluminized optical fibers, tiles and their combinations; Radiation hardness; Input to HCAL/FCC simulation
  - SiPMs assembled and preliminary measurements done

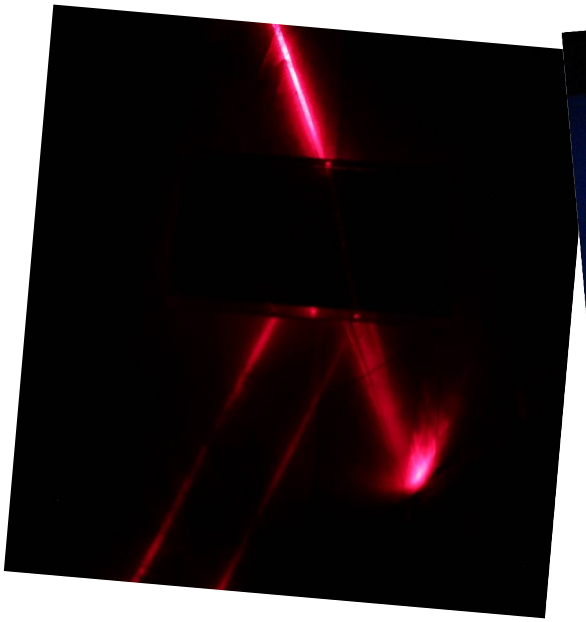


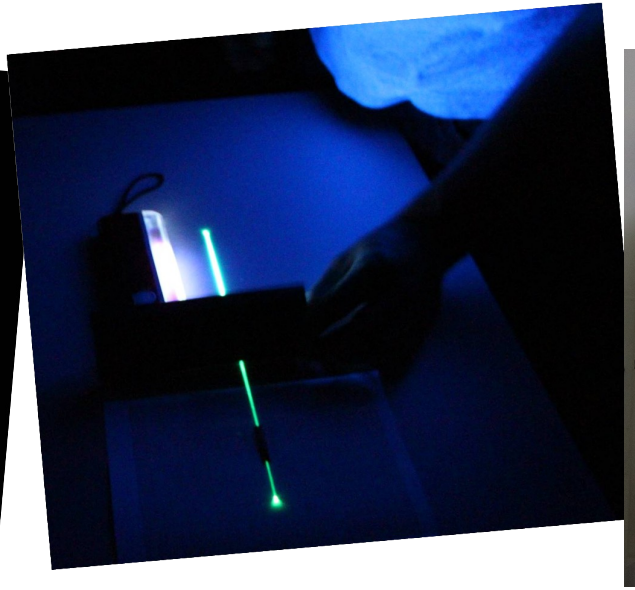




Outreach and education

- Summer Schools for MSc students
- Curricular Internships
- Visits from schools
- Peddy-paper
- ‘Ocupação científica de jovens nas férias’
- Introduce concepts of scintillation and optical fibers detectors to FCUL graduation students





Summary

- LOMaC installation
  - Partially assembled at LIP in ground floor
  - Fibrometer still at FCUL
- Optical components preparation
  - Preparation of fibers for the ATLAS Upgrade Phase-I
  - Exploratory studies for the hadronic calorimeter FCC
  - Natural aging reviewed
- ATLAS Upgrades near future work at LOMaC:
  - fibers, scintillators and PMTs
- Participation in other projects envisaged: Dosimetry and Nuc-Ria groups
- Outreach activities are a pleasant and repeated practice on the year by year work at LOMaC