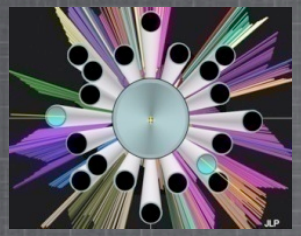


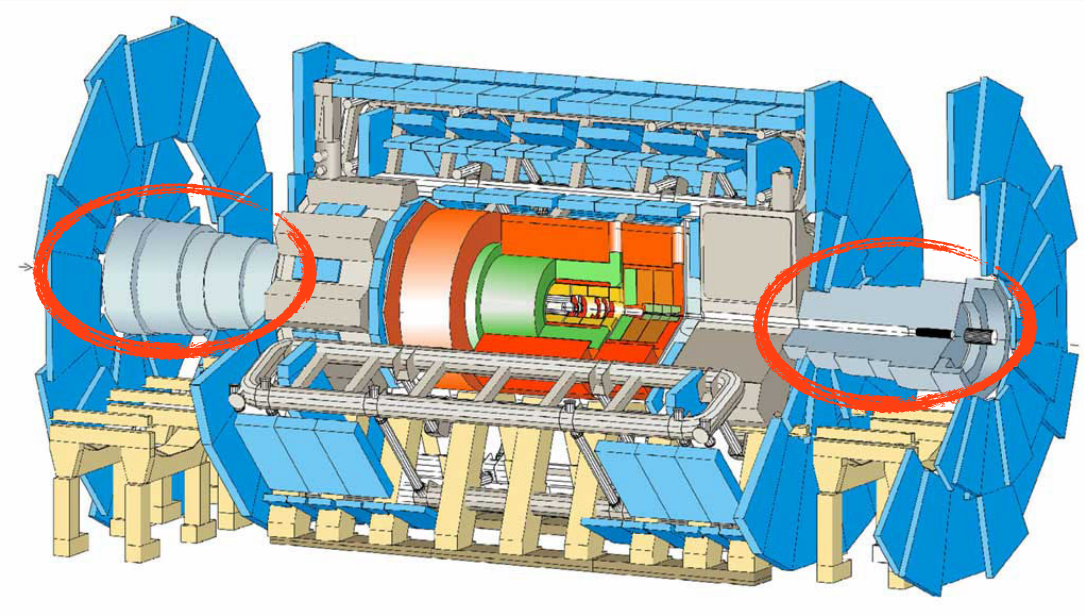
LUCID IN ATLAS
DIFF2010

JACOB GROTH-JENSEN

concept and design
electronics
results from first data

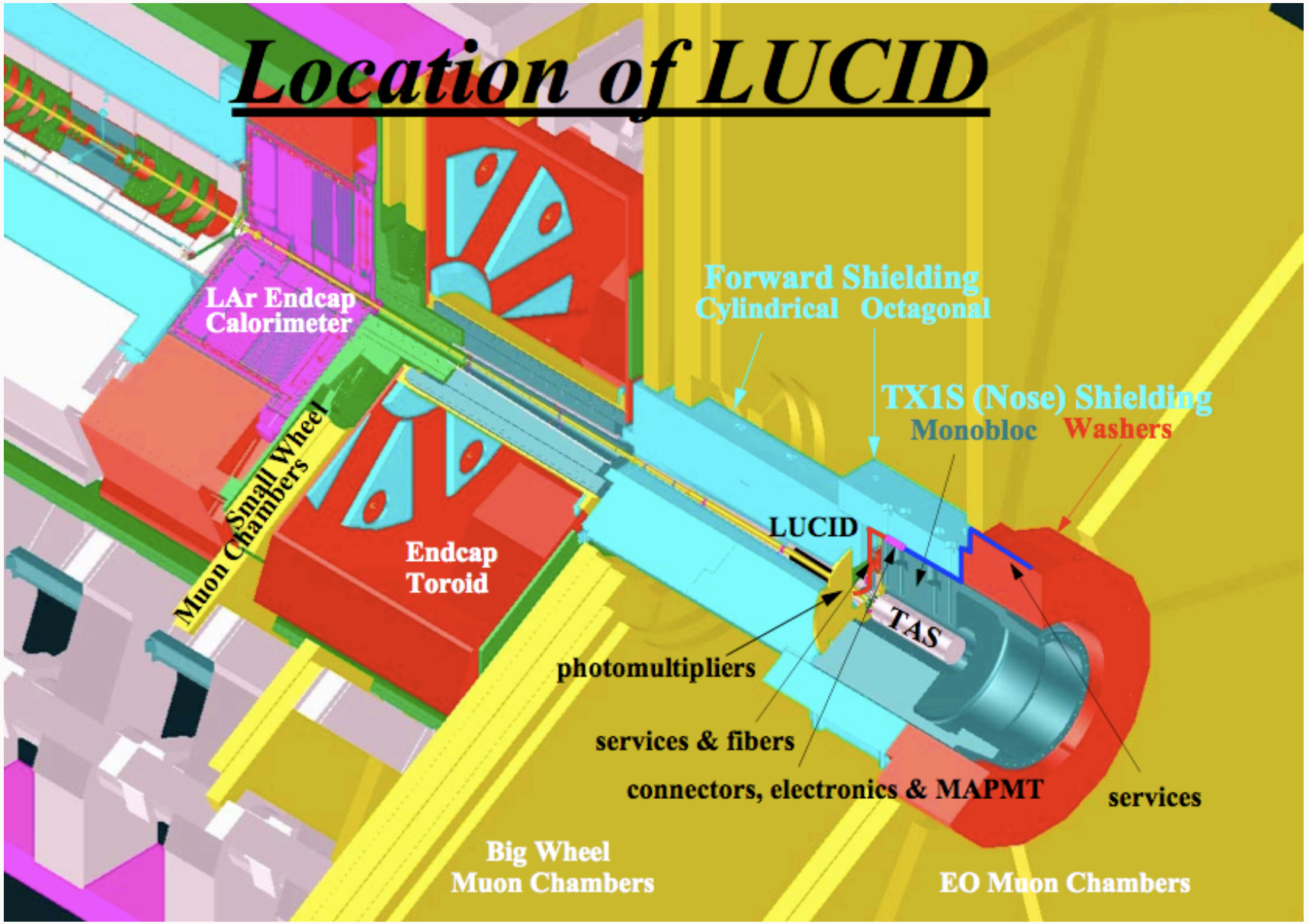
LUCID IN ATLAS

LUCID: LUminosity Cherenkov Integrating Detector



Two symmetrical detectors around the beam pipe, located at 17 m from the IP

- Measure the LHC luminosity by counting charge particle tracks
  - Need absolute normalization (machine parameters, physics...)
- Trigger capability
  - Minimum bias
  - Forward and diffractive physics

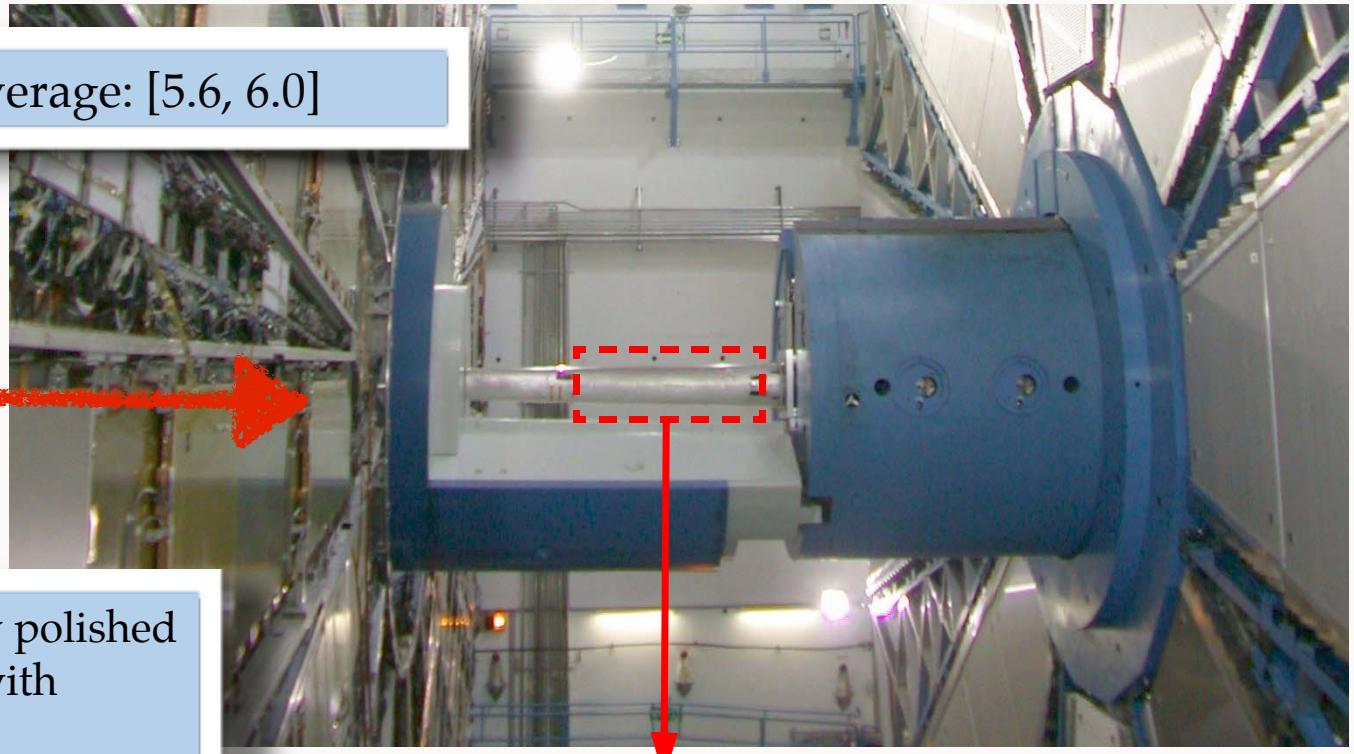


Expected dose: 7 Mrad/year @ highest luminosity (10^{34} $cm^{-2}s^{-1}$)

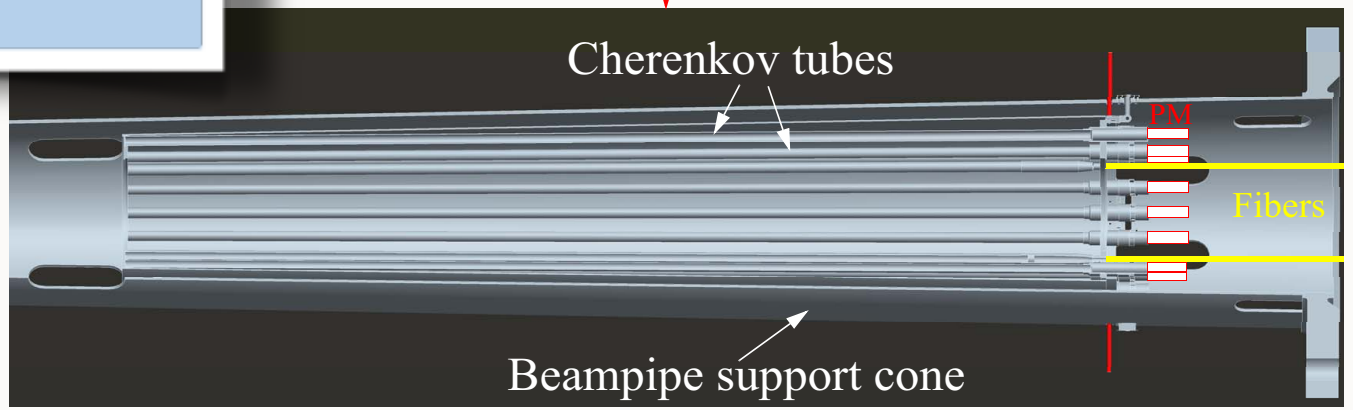
DETECTOR LOCATION

|η| coverage: [5.6, 6.0]

IP



- Array of 20 mechanically polished Aluminum tubes filled with Cherenkov gas (C_4F_{10})
- C_4F_{10} pressure at 1.1 bar



DETECTOR PRINCIPLE

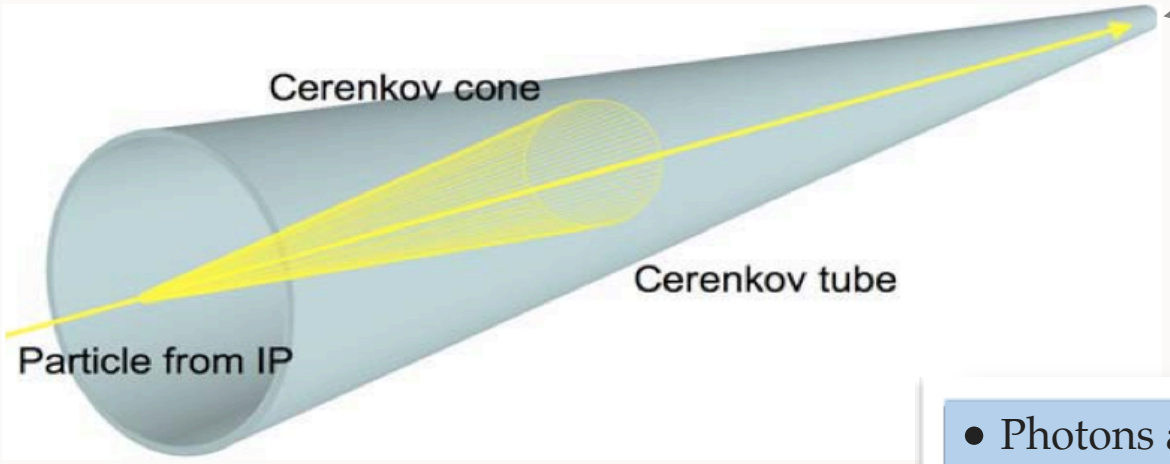
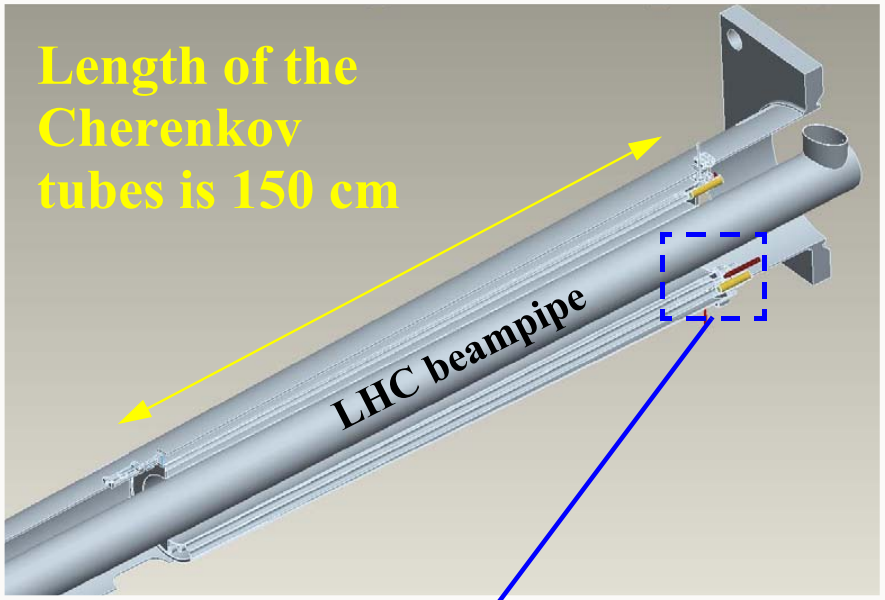


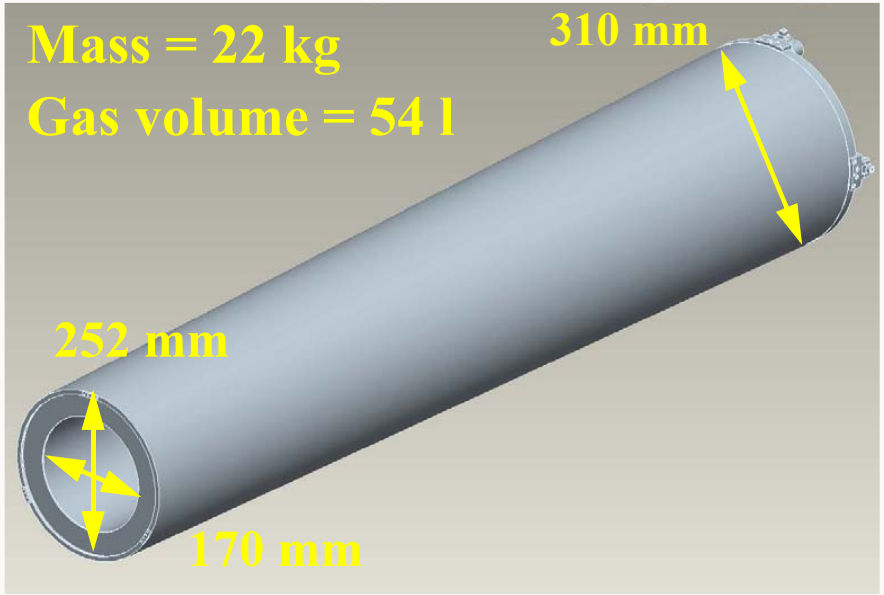
Photo-multiplier tubes (PMT) read-out

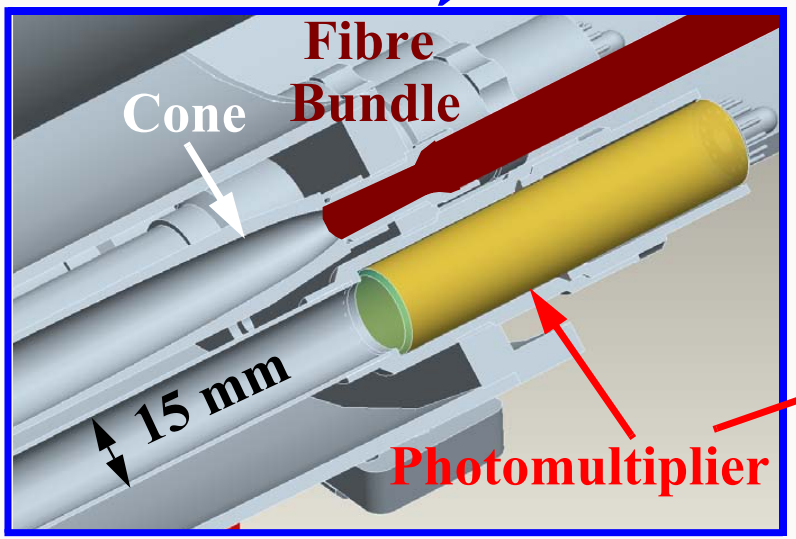
- Photons are emitted at 3°
- On the average 3 reflections inside the tube
- Further radiation of photons inside the PMT window

- Background suppression:
  - Cherenkov threshold: in the gas (10 MeV for e- and 2.8 GeV for π)
  - Tubes are pointing to the pp interaction region.
- The fast response (few ns) allows for single bunch crossing detection.

DETECTOR DESIGN





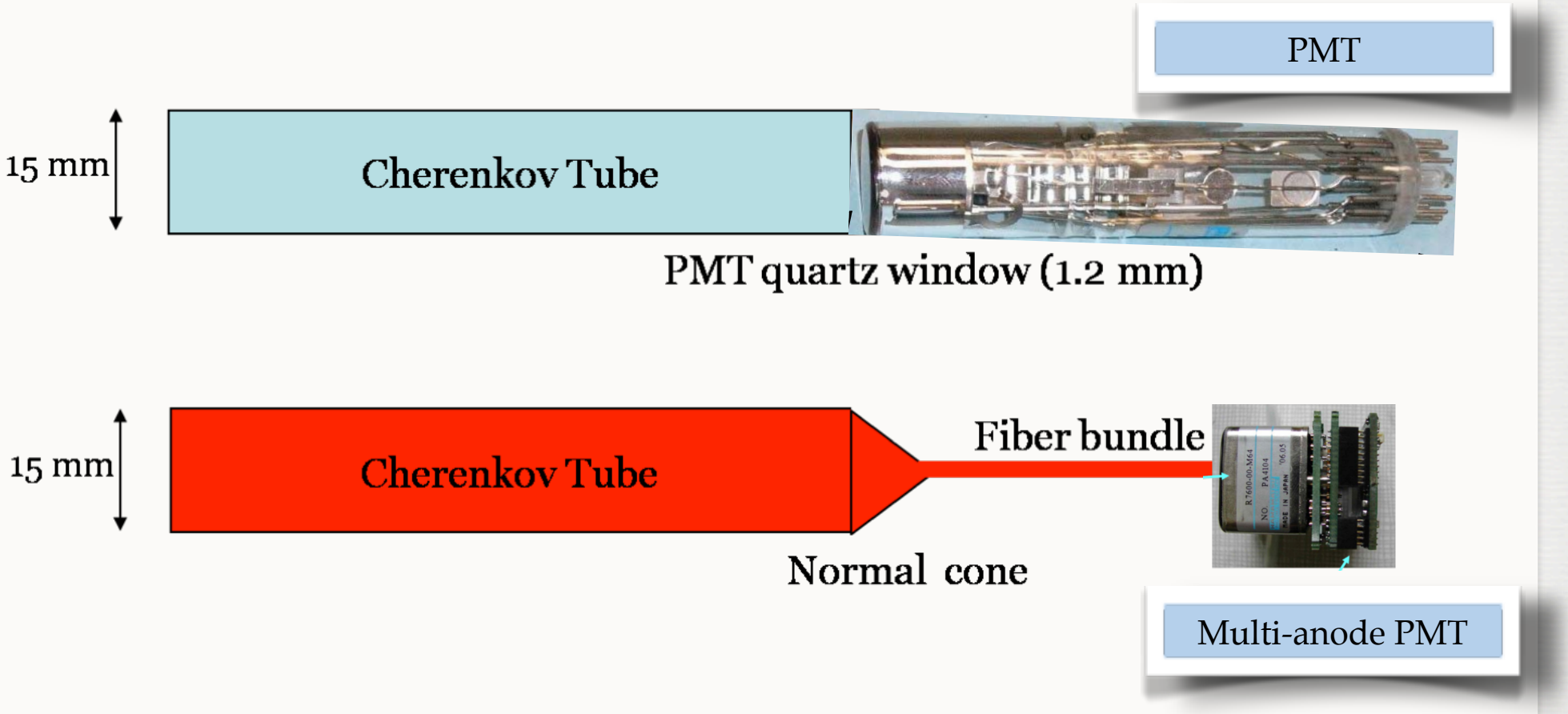


Hamamatsu R762

The quartz window thickness is 0.8 mm

LUCID READ-OUT

2×16 tubes are directly coupled to PMT.
PMT's must be radiation hard.



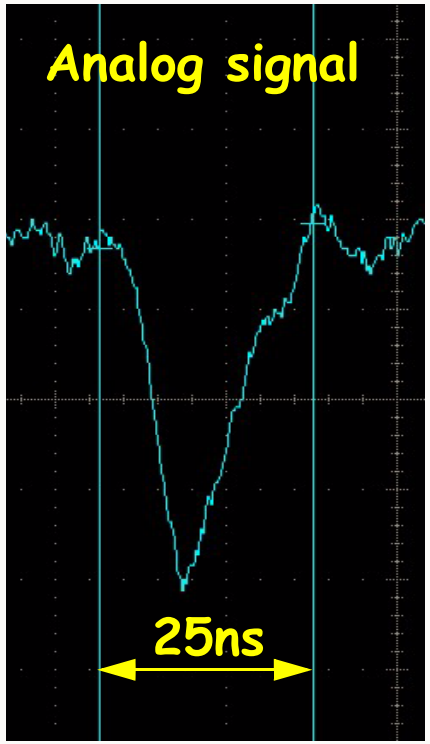
2×4 tubes are coupled to multi-anode PMT via optical quartz fibers.
Better for high luminosity runs (MAPMT not exposed to high radiation doses).

TIME RESOLUTION

The response of an ATLAS luminosity monitor must be :

1. Stable over a large dynamic range (from 10^{27} to 10^{34} $cm^{-2}s^{-1}$)
2. Stable in time and radiation hard (next slides)
3. A fast detector response (order of nanoseconds) allowing monitoring of individual bunches.

- The nominal LHC bunch spacing is 25 ns
- A typical signal in LUCID is at the order of a few ns.
- With this time resolution LUCID will be able to separate individual bunches and provide a luminosity measurement for the individual 2808 bunches in the LHC



RADIATION HARDNESS

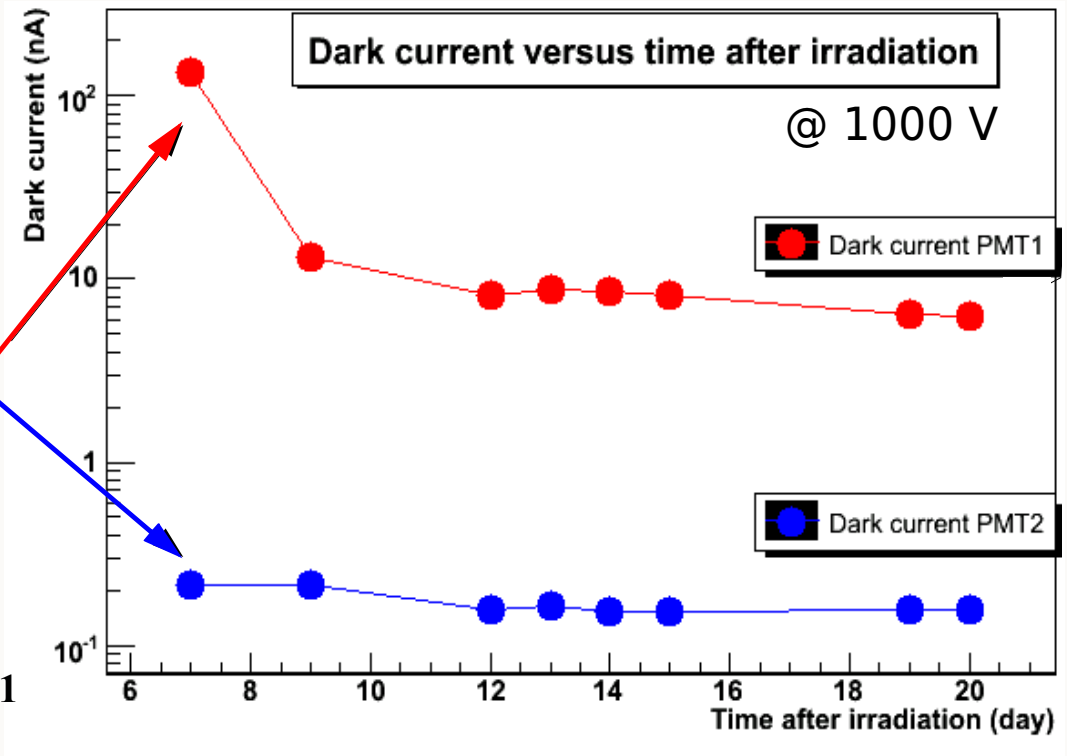
- Because of the very forward position of LUCID radiation hardness of the readout electronics is a key issue.
- A Hamamatsu R762 photomultiplier has been irradiated with a ^{60}Co source and the dark current and gain has been studied.

PMT 2: No irradiation

PMT 1: 20 MRad in 18 hours

Equivalent to 15 years at $2x10^{33}$ $cm^{-2}s^{-1}$

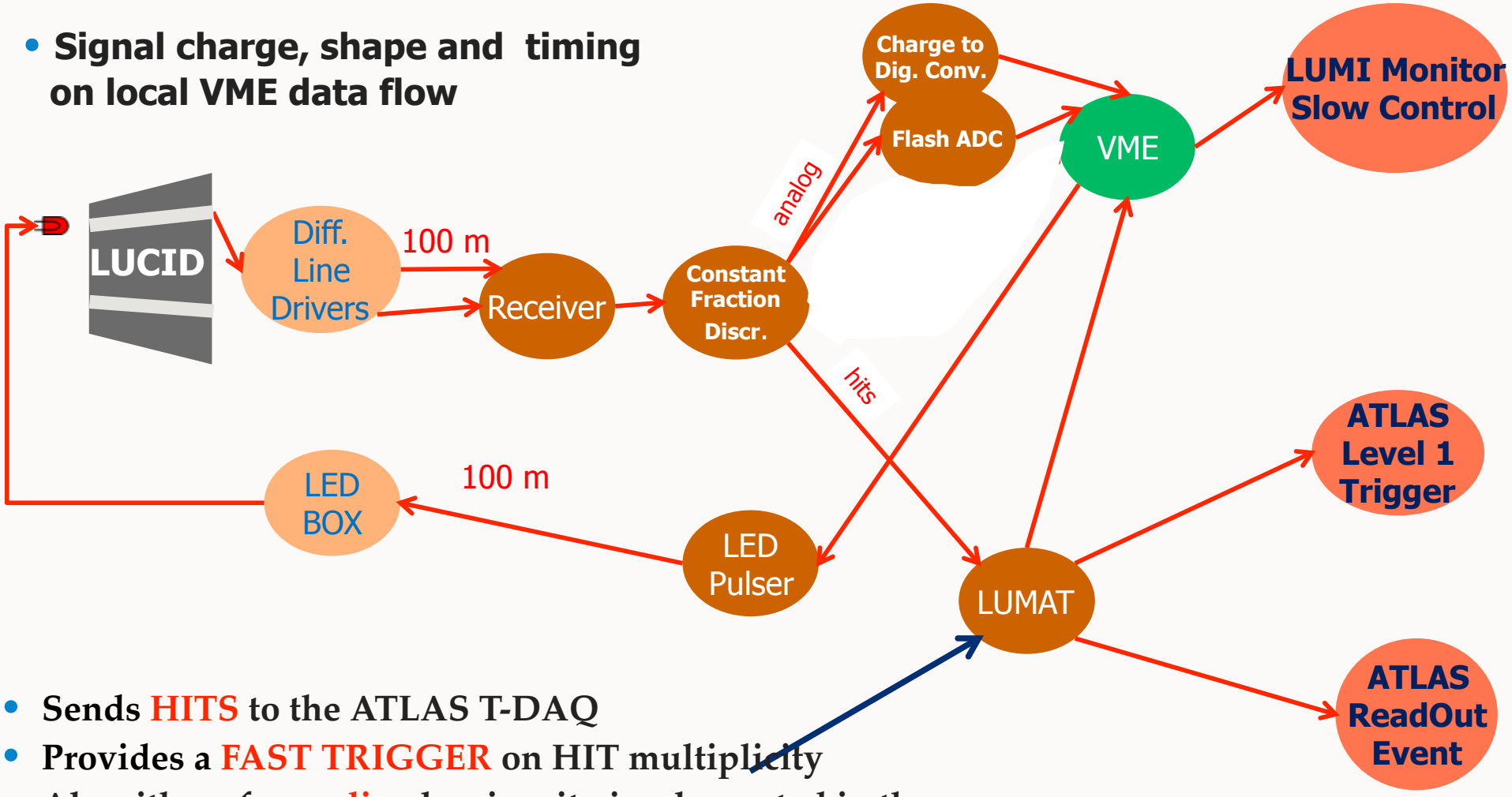
Equivalent to 3 years at $1x10^{34}$ $cm^{-2}s^{-1}$



The increase of the dark current is not a concern for the PMT lifetime !

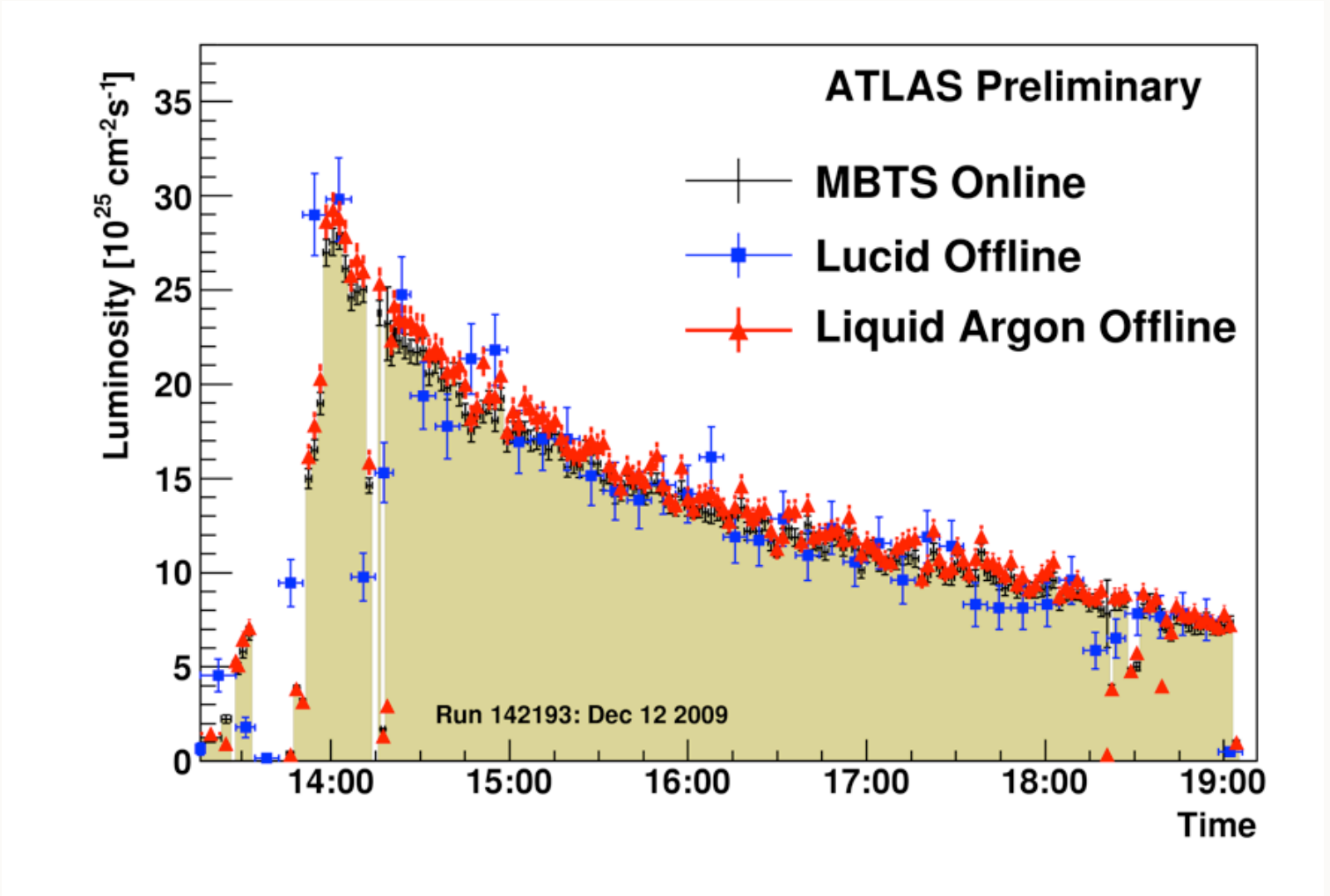
READ-OUT DATAFLOW

- **Signal charge, shape and timing on local VME data flow**



- **Sends HITS to the ATLAS T-DAQ**
- **Provides a FAST TRIGGER on HIT multiplicity**
- **Algorithms for on-line luminosity implemented in the LUMinosity And Trigger monitor card**
- **TIME and AMPLITUDE analysis on signals off-line**

INST. LUMINOSITY



Minimum Bias Trigger Scintillators : Array 16+16 scintillators, placed symmetrically to the IP, covering $2.1 < \eta < 3.8$

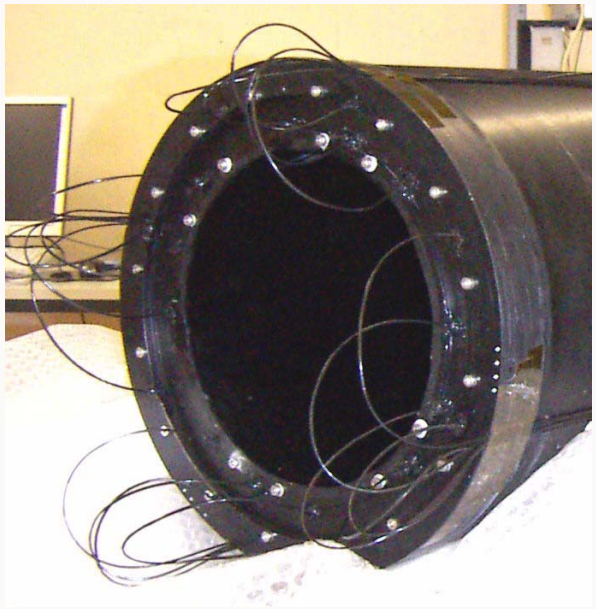
Liquid Argon : Electromagnetic & Hadronic calorimeter covering the region $|\eta| < 4.9$

SUMMARY

- The LUCID detector is designed to be :
  - Radiation hard
  - Provide a fast response
- .. and LUCID will provide ATLAS with:
  - Luminosity monitor on-line/off-line
  - Luminosity by Bunch Crossing and Integrated
- Analysis of first data has begun and the first results looks promising

BACK-UP SLIDES

CALIBRATION SYSTEM



The detector is calibrated by injecting LED light via optical fibers.