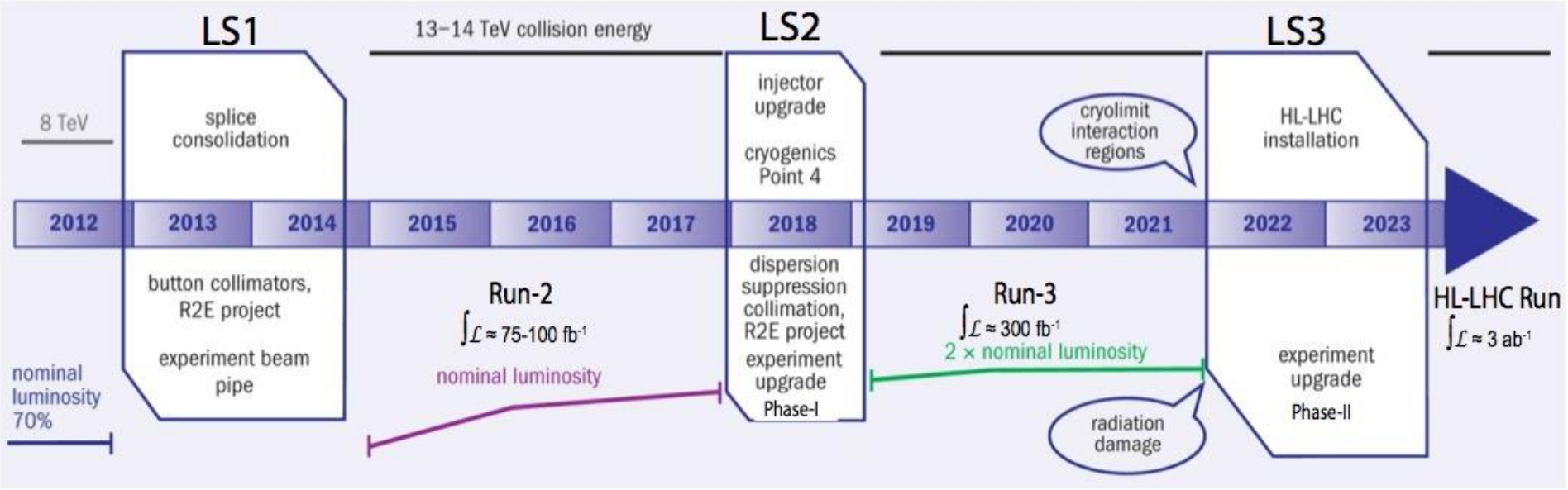
# *ATLAS : detector upgrades*

Remi Lafaye for the ATLAS LAPP group

# LHC planning & ATLAS upgrades

3 long shutdown foreseen:



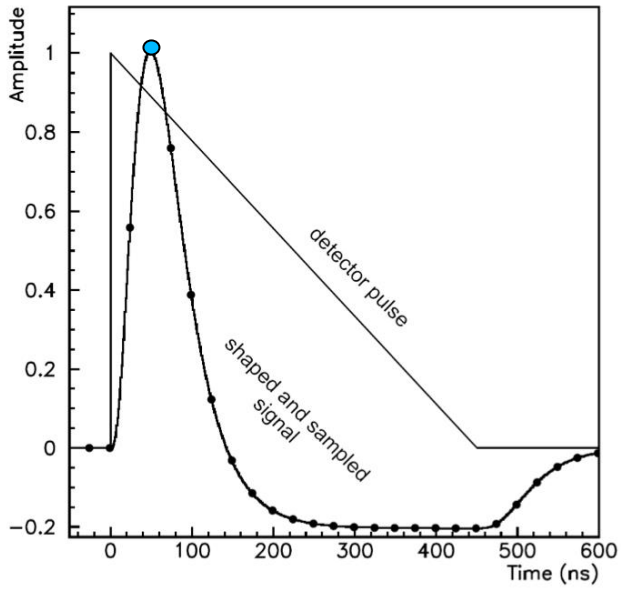

**LAPP:**

Hardware themes:
1. LAr calorimeter
2. Pixel tracker

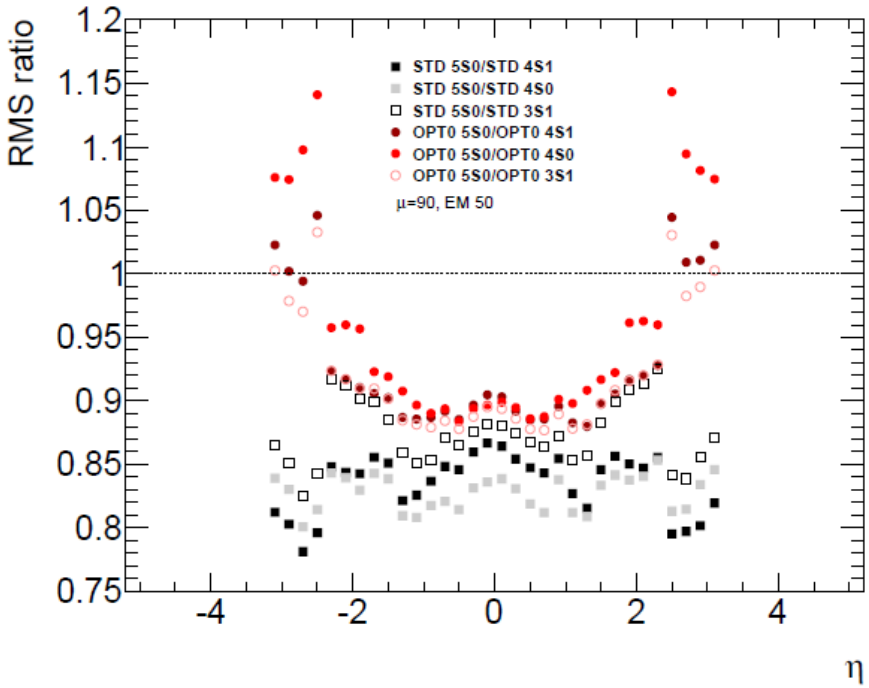
| | | |
|---|---|---|
| LAr readout optimisation & IBL installation | LAr level 1 trigger upgrade | Replace tracker<br>LAr readout for 40 MHz |

# LS1 upgrade at LAPP: LAr

- After LS1: higher trigger rate
  - Level 1 trigger rate goes from ~60 to 100kHz
  - Pileup goes from μ~25 (at 25 ns bunch crossing) to up to 80 (at 50 ns bc)
  - Critical for Inner Detector




- Liquid Argon Calorimeter:
  - Optimise calibration procedure
  - Avoid bandwidth limitation in LAr readout for 100 kHz data taking
  - ⇒ Reduce from 5 samples to 4 samples
  - ⇒ Shown to increase noise by 20% max (worst case scenario at 50 ns bc, μ=90)



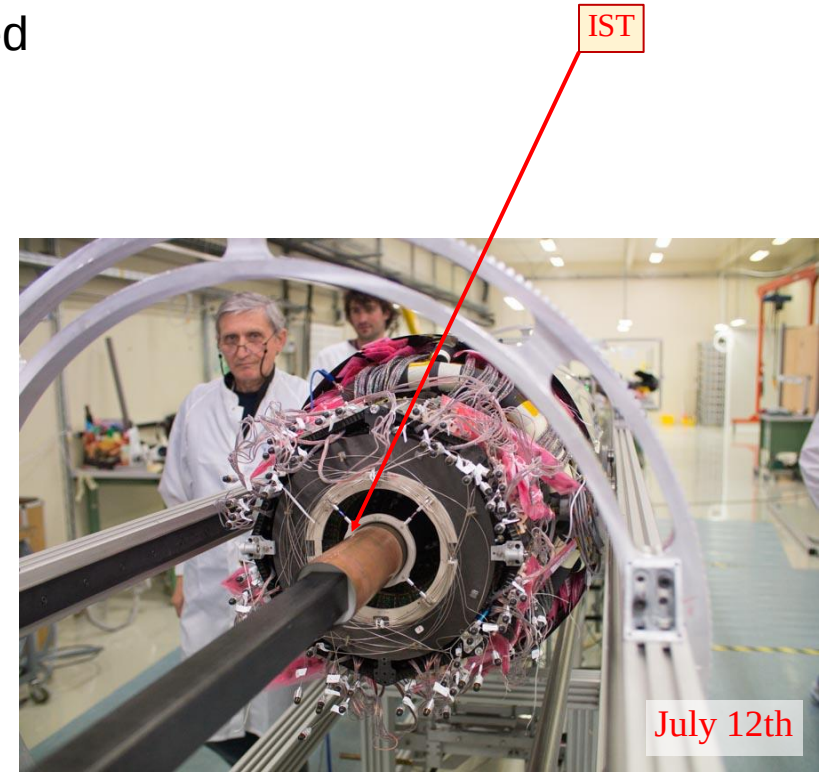
# LS1 upgrade at LAPP: IBL

IBL: Insertable B-Layer

= Additional radiation hard pixel detector closer to the interaction point

- Pixel detector was brought on surface in April 2013
- Consolidation: 99% of channels OK (95% before)
- Inner Support Tube (IST) for IBL was inserted

- Pixel should be back in cavern: December 2013 or January 2014
- IBL to be inserted in March 2014



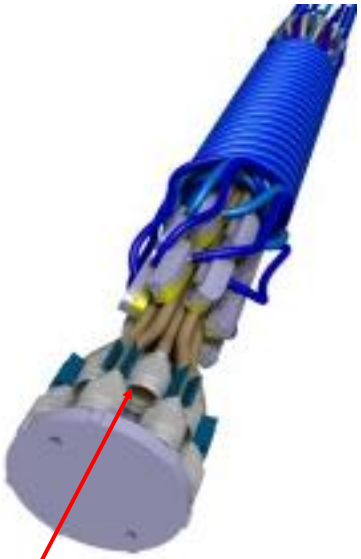
# LS1 upgrade at LAPP: IBL

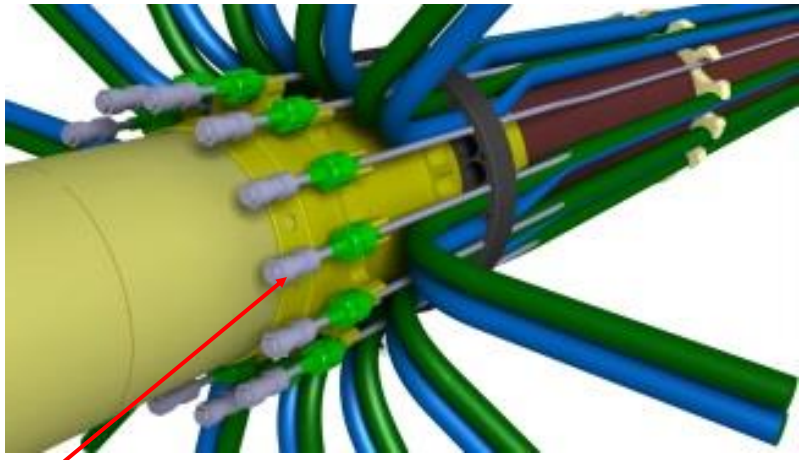
LAPP responsible for services and integration

*J. Ballansat, P. Baudin, P.Y. David, P. Delebecque, S. Elles, N. Massol, T. Rambure, T. Yildizkaya*

Main problem: insert IBL in between support tube and beam pipe, 56-83 mm

From one side, all services wrapped in



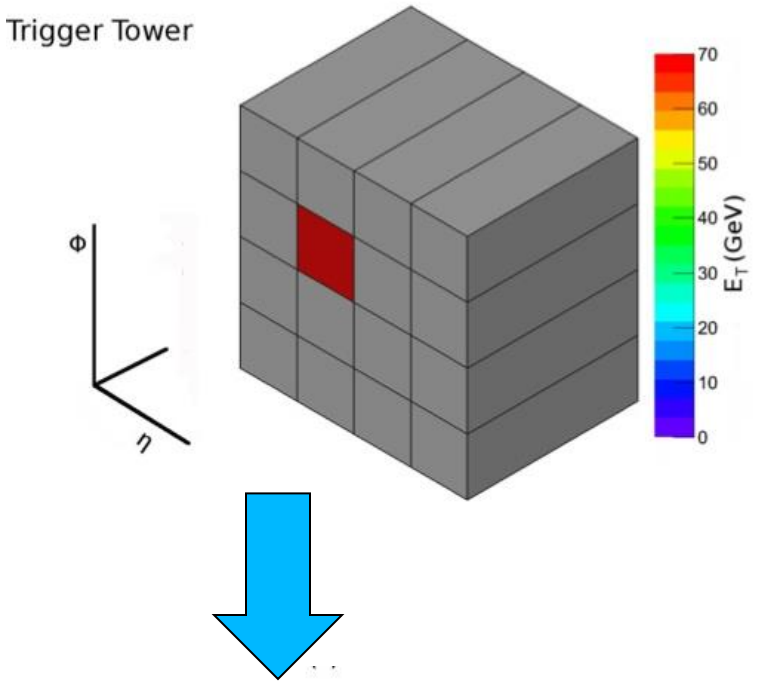


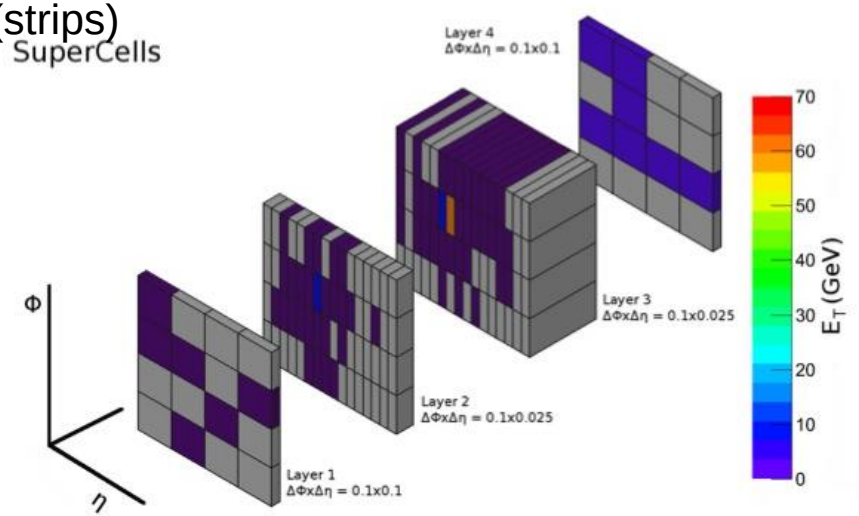
- Cooling titanium connectors developed at LAPP: sphere on cone
- Axon electric connectors 68 pins in a tiny format

# LS2 upgrade at LAPP: LAr

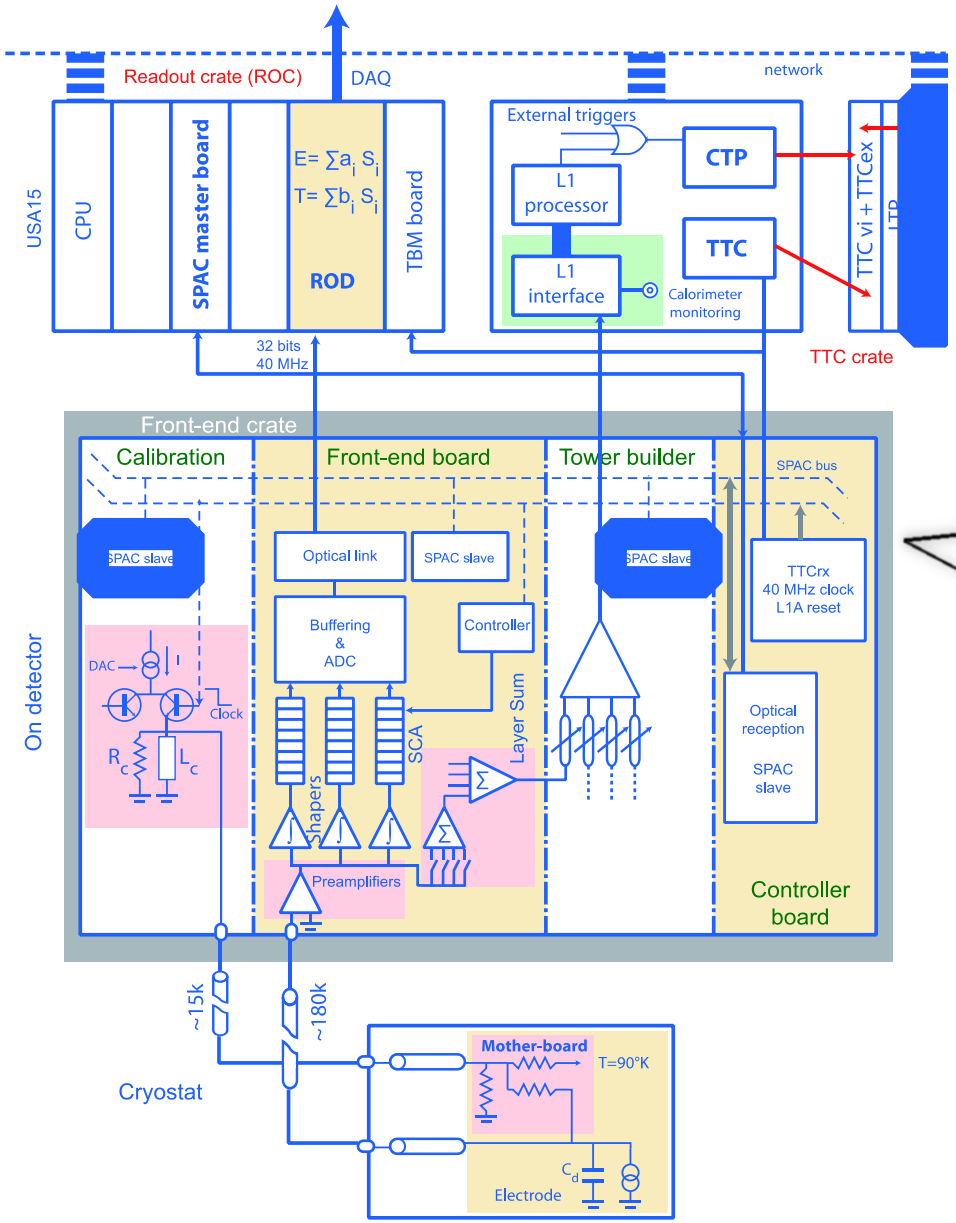
- Trigger rate still limited to 100 kHz
  - Electromagnetic L1 trigger are dominated by jet-background
  - Just increasing the threshold means acceptance loss
  - Needs to improve jet-rejection
- Move from Trigger Towers to Supercells
  - Increase granularity from 0.1x0.1 to 0.1x0.025 in strips and middle layers
  - Keep information per layer
  - Change quantization from 1 GeV to 32 MeV (strips) and 125 MeV (middle)
- Processing done by AMC boards in development at LAPP

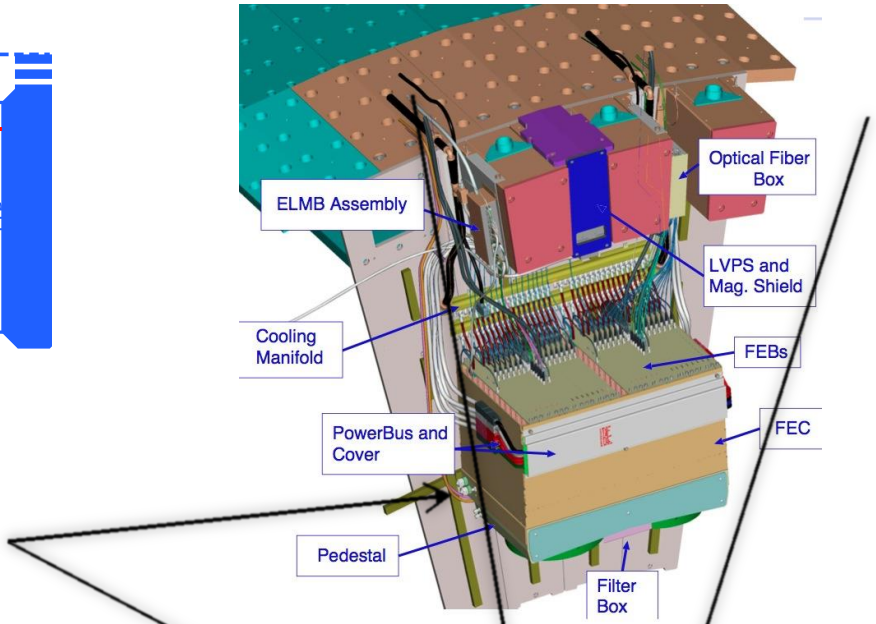
  *AMC=Advanced Mezzanine Card*



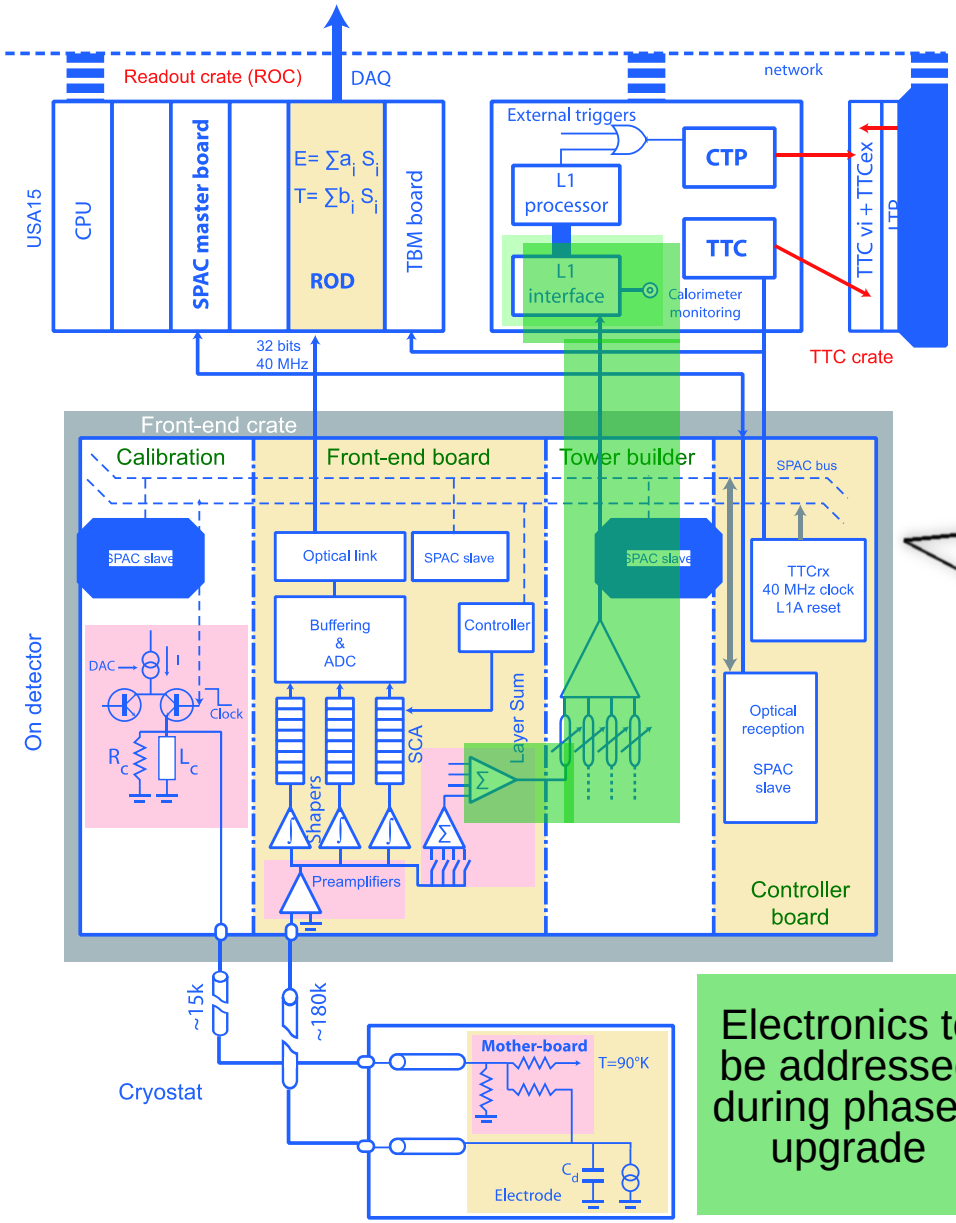



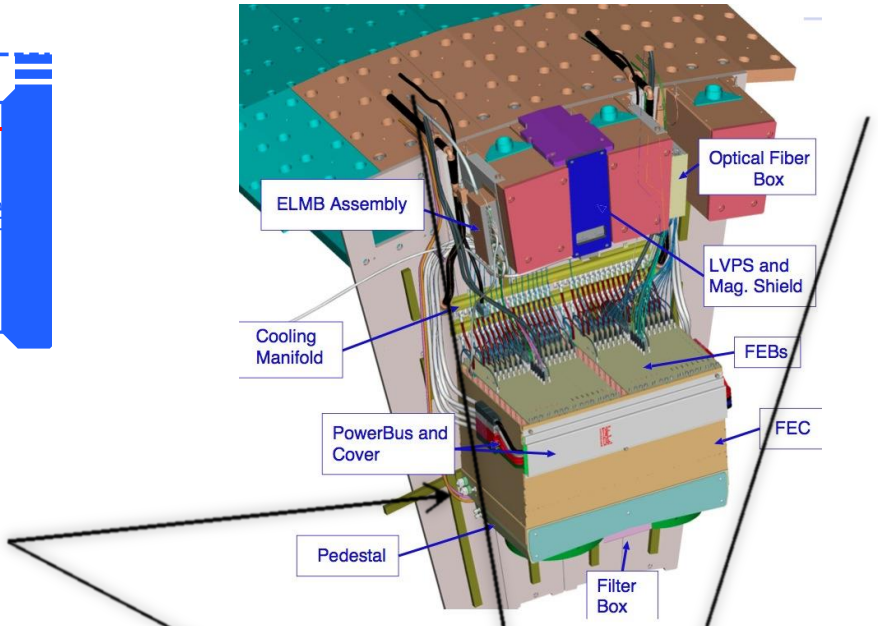
# LAr System before LS2



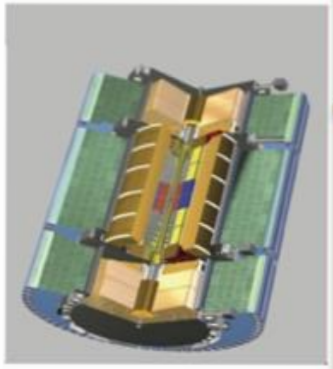

# LAr System after LS2




Electronics to be addressed during phase-I upgrade

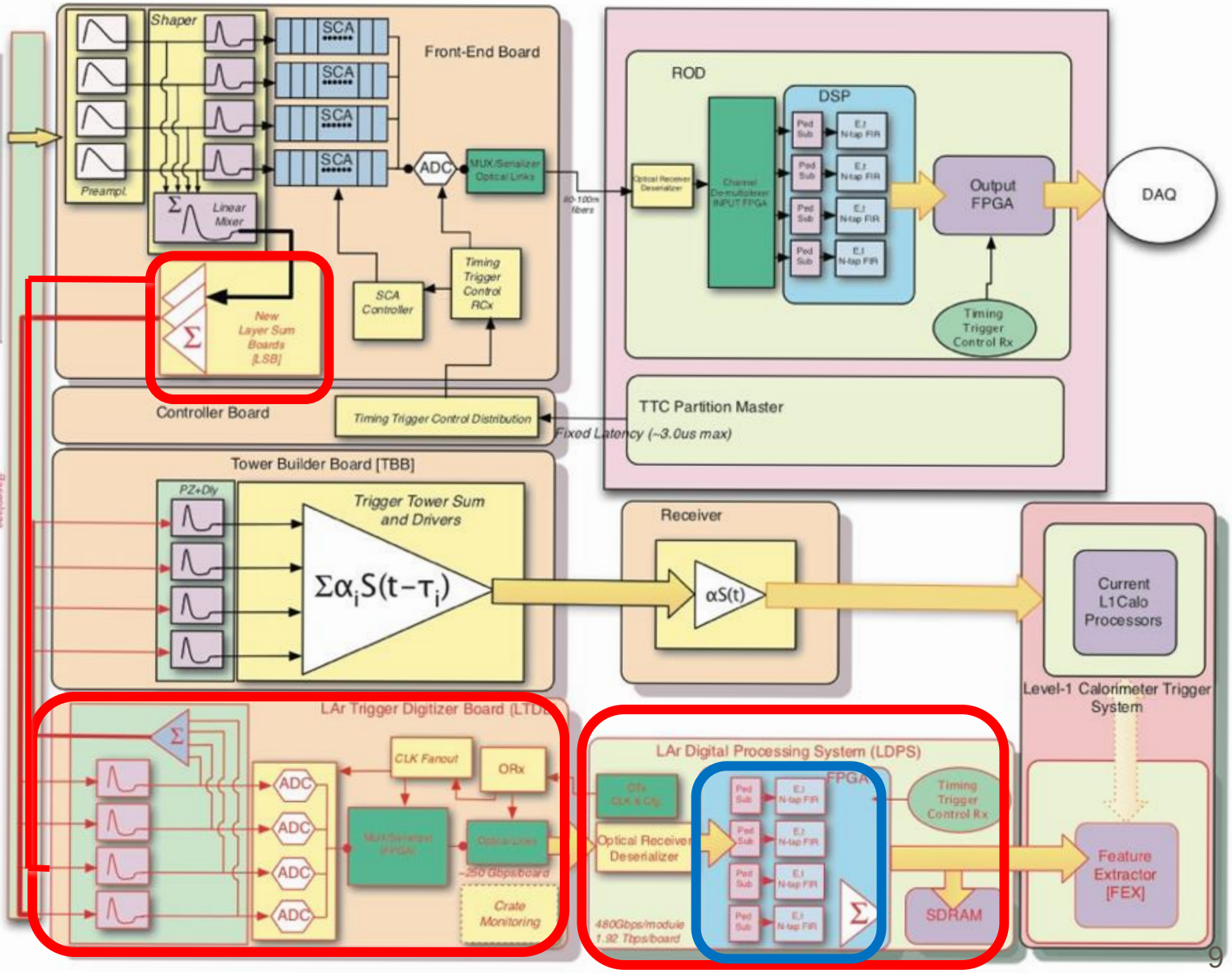
# LAr Readout system for LS2



**New or modified components in red**

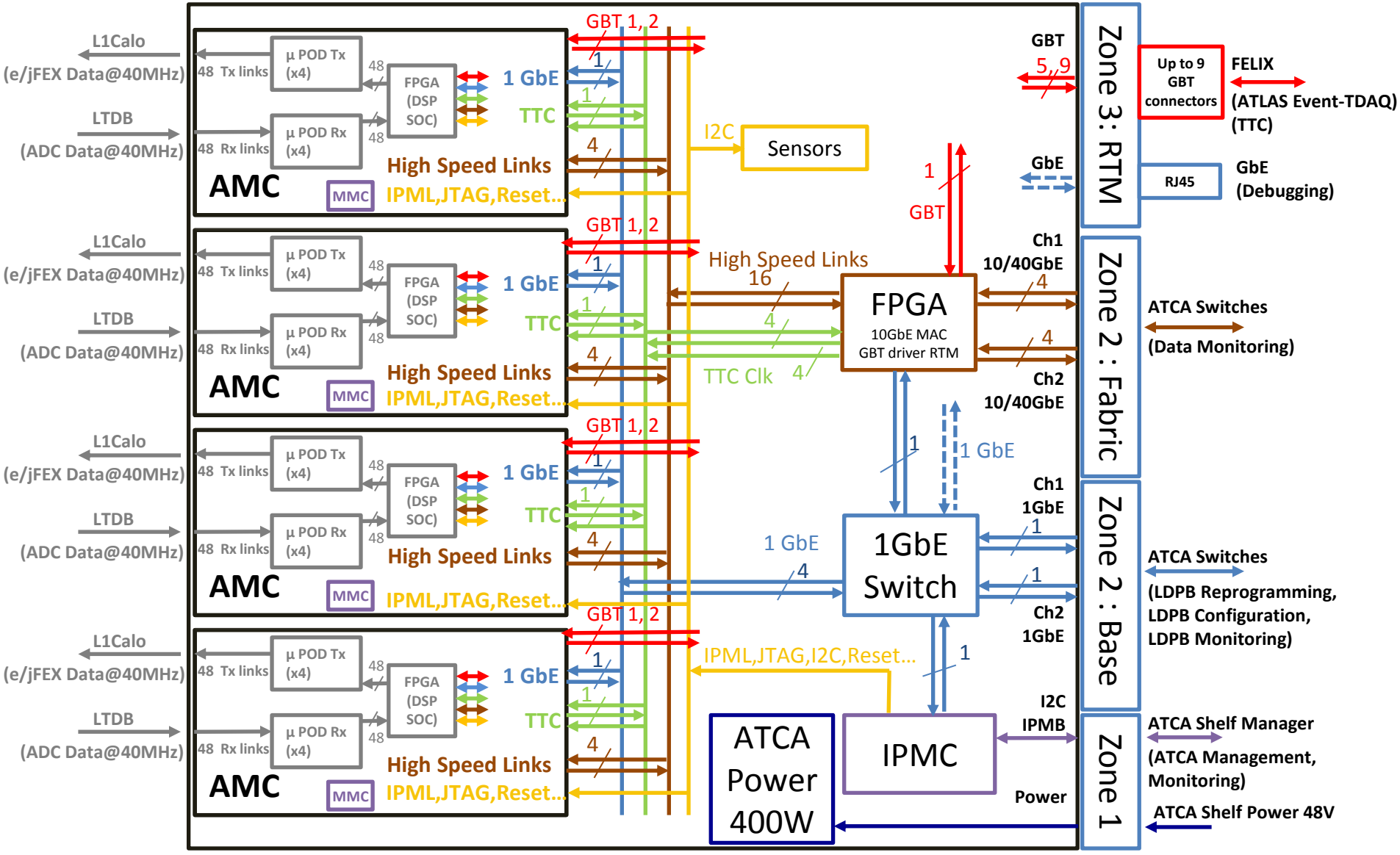
**Proposed phase I upgrade fully compatible with plans for phase II upgrade**

**LAPP responsible for AMC PU on ATCA boards**



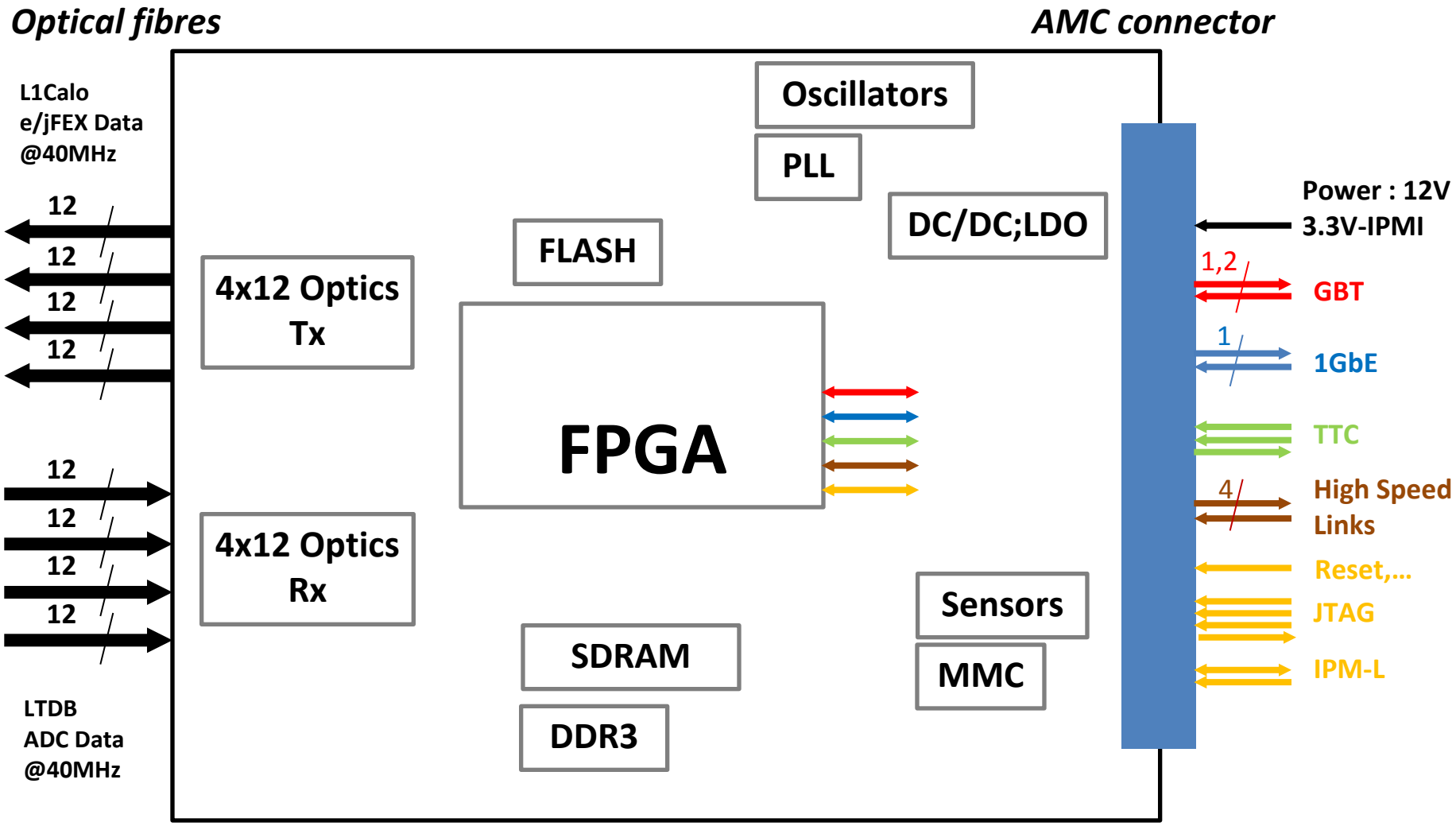
# LAr - ATCA board

*ATCA=Advanced Technologies Communication Architecture*



# LAr- AMC mezzanine board

*AMC=Advanced Mezzanine Card*




**First prototype in 2014**

# LAr- LS2 upgrade

ATCA prototype with 3 FPGA

- ATCA prototype & IPMC control board
- AMC mezzanine board in development
- Data processing in VHDL

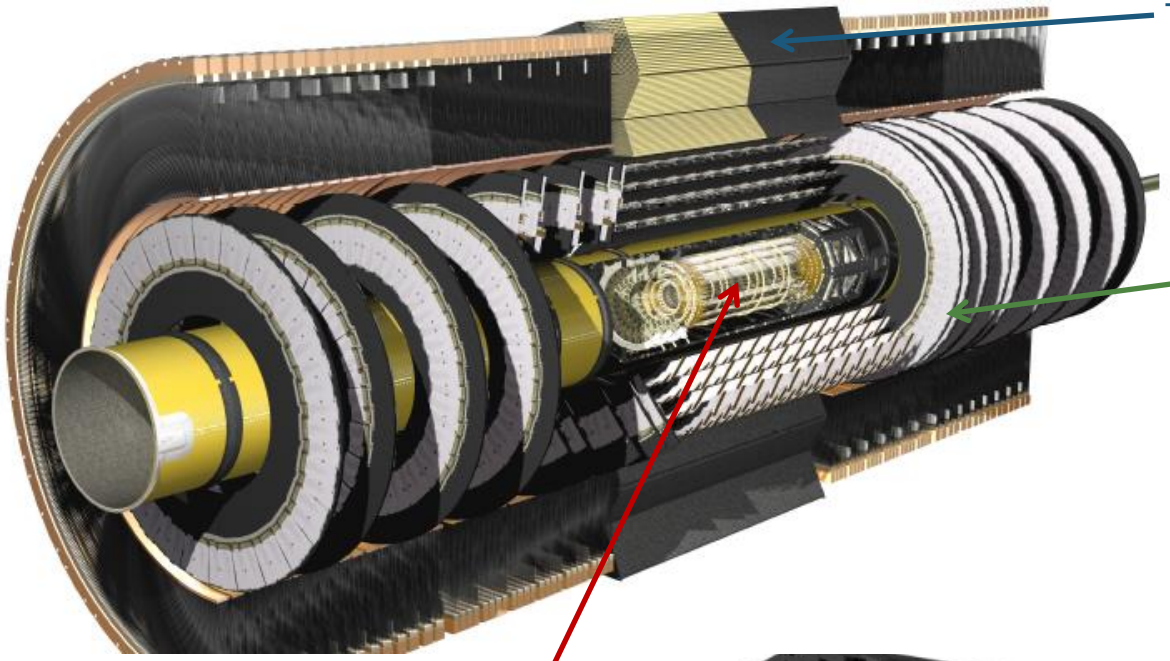
*Equipe d'électronique : Sébastien Cap, Nicolas Dumont-Dayot, Nicolas Letendre, Guy Perrot*

- IPMC code
- Online software

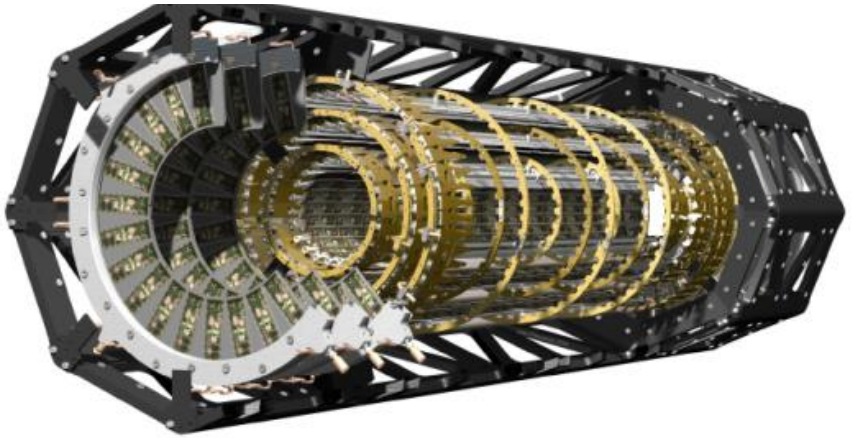
*Equipe informatique : Alain Bazan, Fatih Bellachia, Jasmin Fragnaud*

# LS3 upgrade at LAPP: Pixels

During LS3 the full Inner Detector needs to be replaced




Pixel detector designed for 300 $fb^{-1}$



Integrated radiation level at design limit

Technologically limited because of occupancy

# LS3 upgrade at LAPP: New Pixels

New Pixel detector options are currently under study

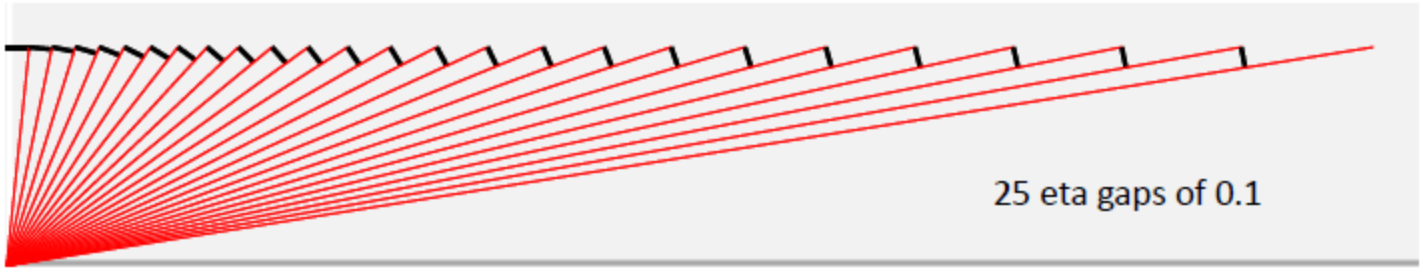
Goal: same tracking performance at High Lumi than at LHC start

$\Rightarrow$ Increase granularity

With a possibility for a forward extension from $|\eta|<2.5$ to 4.0

Ideally:

- All sensors should be perpendicular to the tracks to minimize material
- Constant track density per sensor (constant in $\eta$ at LHC)

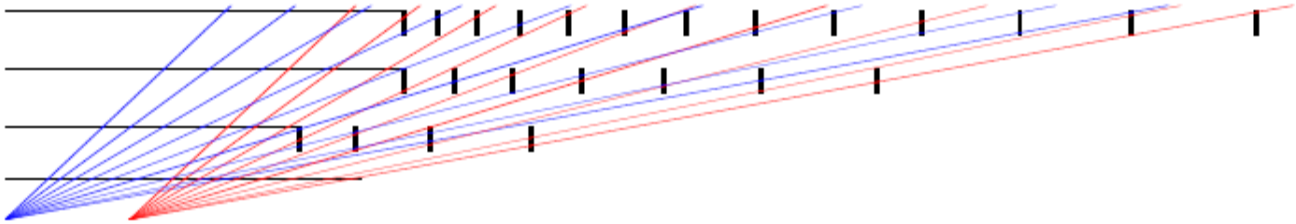



But hard to fit mechanical support, electrical connections, cooling, …

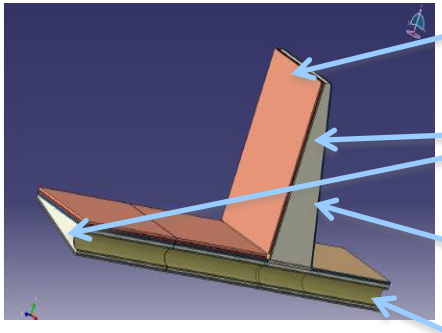
# LS3 upgrade at LAPP: Alpine Pixels

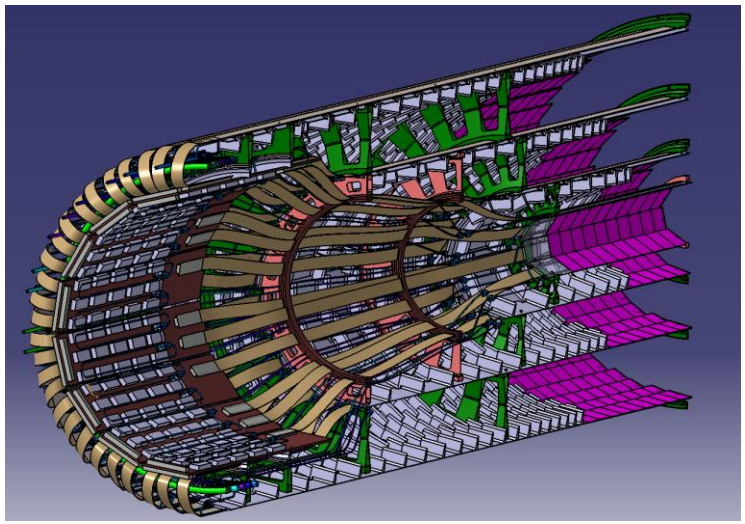
## LAPP design proposal: Alpine design

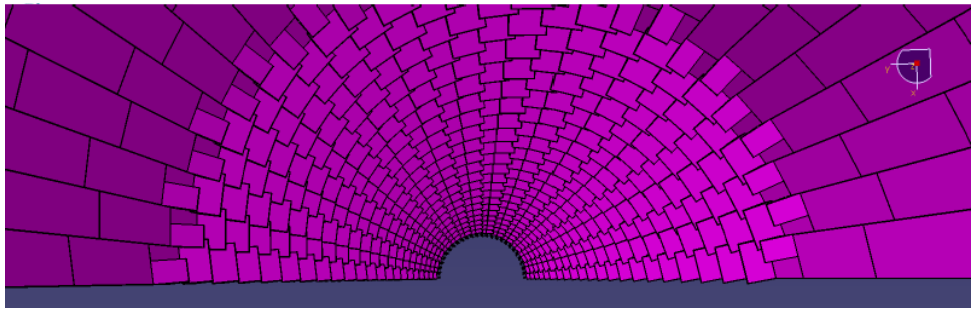
*J. Ballansat, P. Baudin, P.Y. David, P. Delebecque, S. Elles, N. Geffroy, N. Massol, J.M. Nappa, T. Rambure, T. Yildizkaya*



Barrel: Strips, like standard design
Endcaps:
« Alpine » sensors





Sensor surface divided by 2 w.r.t baseline design

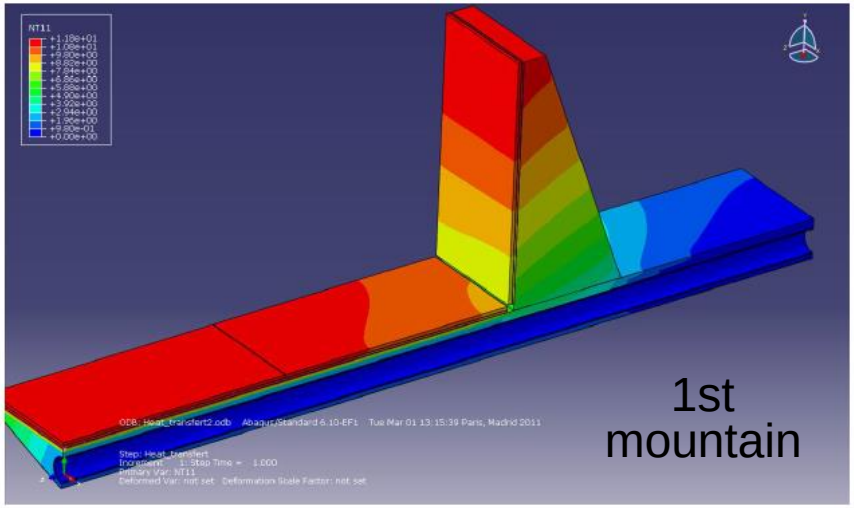
LAPP team will show proof of concept

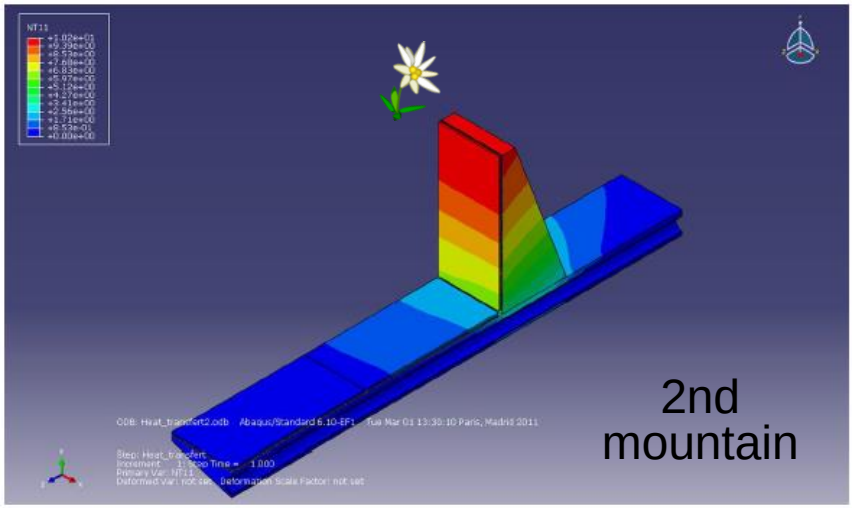
# LS3 upgrade at LAPP: Alpine Pixels

First stave prototype tested at LAPP

Promising cooling performance

Results very close to simulation (±1°C)

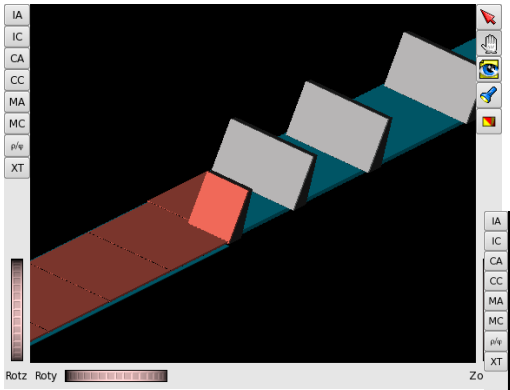


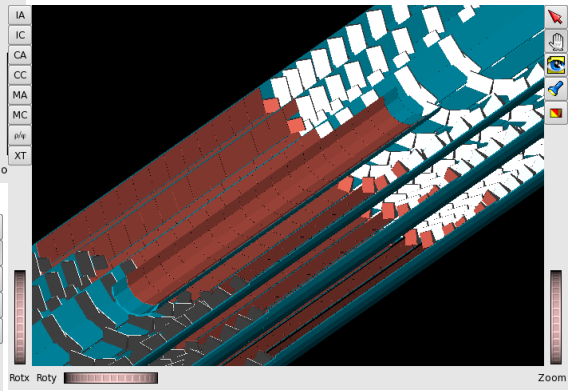



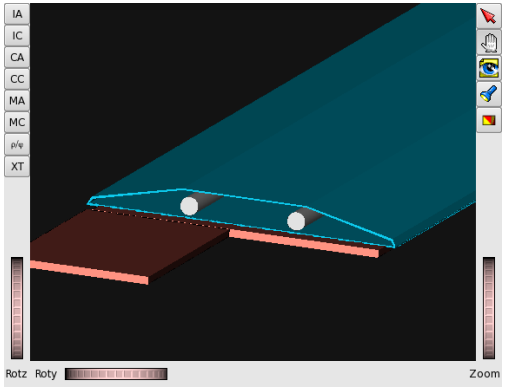
# LS3 upgrade at LAPP: Pixels Simulation

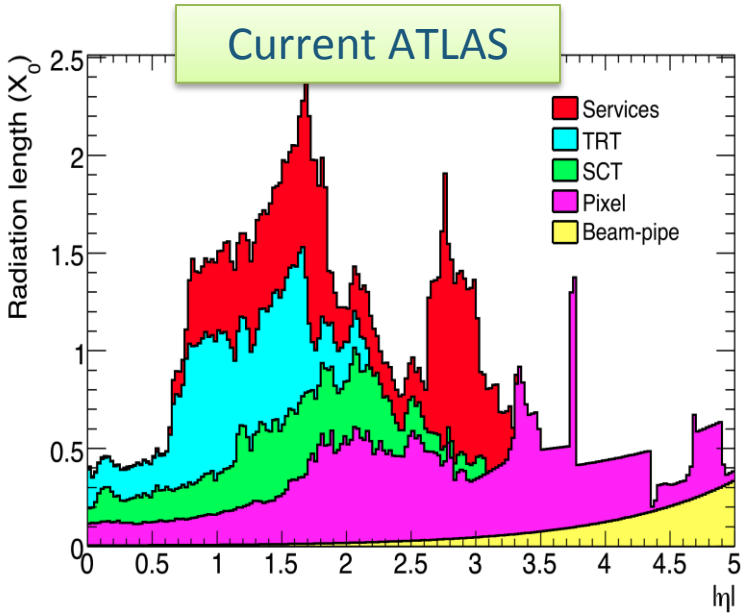
Baseline & Alpine design + Forward tracker in full simulation, *by Sabine Elles*

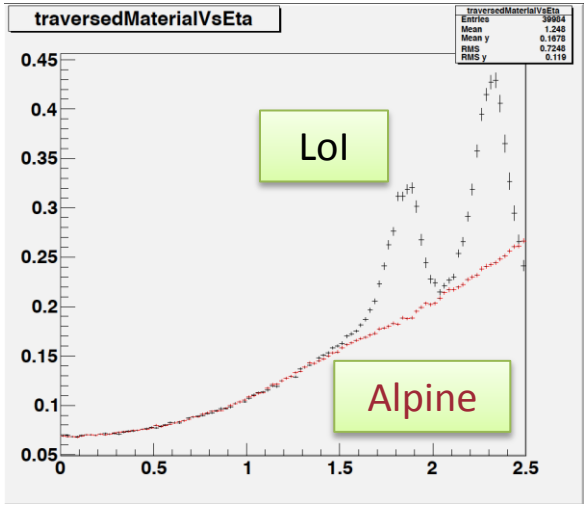
Alpine tracking algorithm not in simulation yet



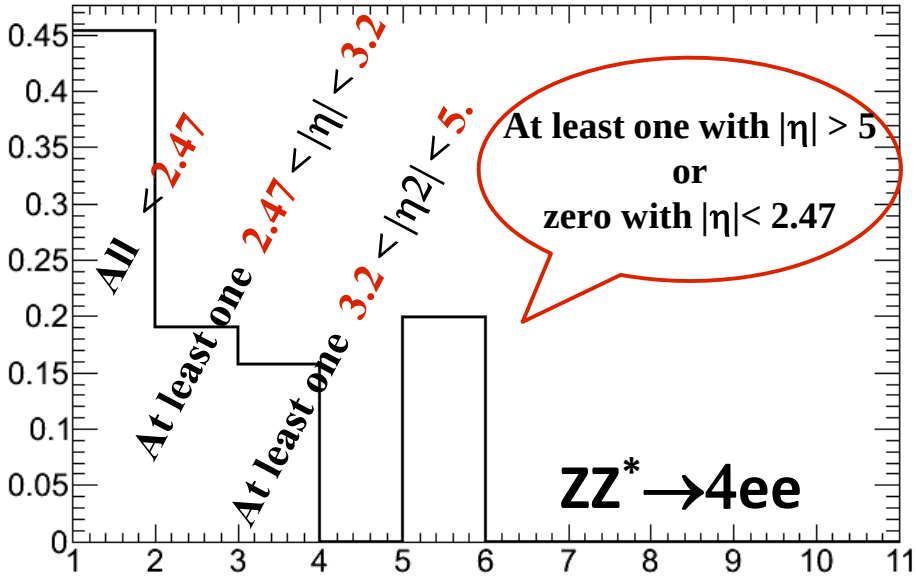
# LS3 upgrade at LAPP: Forward Pixels

Physics cases for a Forward Pixel detector ($|\eta|<4.0$)

- Diboson: expect non-negligible gain in acceptance
- $Z \rightarrow ee$ production & Higgs couplings (4e, $\gamma\gamma$, VBF)

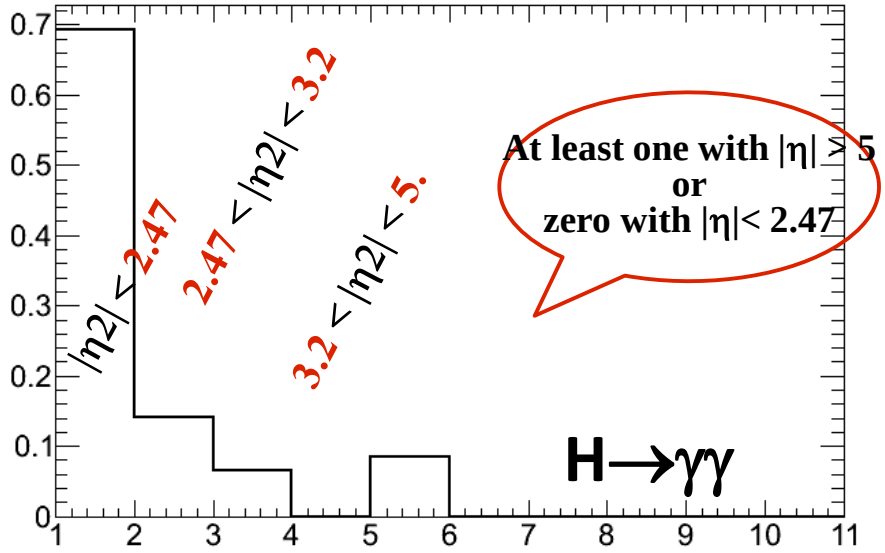
**$WW^* \rightarrow e\nu e\nu$:** 56% → 80%

**$ZZ^* \rightarrow 4ee$:** 45% → 80%




**$Z \rightarrow ee$:** 46% → 72%

**$H \rightarrow \gamma\gamma$:** 70% → 92%



# Prospects

Pixel detector:

- Build 2 new stave prototypes to scale for mechanical tests
- Test sensors on prototypes
- 1m60 flex in development
- Alpine tracking algorithm to be implemented in ATLAS full simulation
- Physics performances for Forward Pixel detector

⇒ 2016 TDR for Pixel Upgrade

⇒ Installation during LS3 (2022)

LAr calorimeter:

- Prototype of the AMC mezzanine board for 2014
- Online code to be developed
- LAr supercells trigger algorithms to be developed

⇒ Installation for LS2 (2018)

⇒ More optimization foreseen for LS3

Upgrade LAr readout for 40 MHz (2022)

Still interesting work for newcomers, within these two projects