Possible activities in Pisa for the TileCal phase-II upgrade

F. Scuri – INFN Pisa

ATLAS-Pisa meeting, April 12, 2013

Outlook:

- Recalling the problems seen with high anode currents in the "hot" cells of the Tile Cal detector.
- Extrapolation of the PMT anode current budget to higher luminosities.
- Proposed solutions: new gain in the "3 in 1" FE cards, new HV active dividers.
- Possible contributions from Pisa.



Where are the problems with increasing LHC luminosity / energy ?

- Linearity loss of the PMT response at high PMT anode currents (O(μA))

<u>and</u>

• saturation of the signal integrating section of the "3 in 1" FE card (I >= 2μ A).

in the "hot" sectors of the MBST wheel and of the extended barrel





Measured anode currents in the extended barrel cells in Minumum Bias (MB) events

Anode current is proportional to the luminosity at fixed c.m. energy (7 GeV)

This figure is assumed to make extrapolations to higher luminosities



Extrapolation to $L = 1 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, c.m. E = 13 TeV

cell	E1	E2	E3	E4	A13
μA	1.6	3.0	<~E4	8.0	0.8

Measured anode currents in the gap wheel in MB evts

• Ratios E_i /A13 = 2->10

Assumed to be also valid athigher energy and luminosity;

extrapolations verified at 8 TeV for $E_1/A13$ and $E_2/A13$

• Absolute rates at Vs = 7 TeV: $I_{A13} / L \approx 6 \text{ nA} / 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ $I_{E4} / L \approx 60 \text{ nA} / 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$

estimated ~ 30% increase
of the pp x-section from 7 to
13 TeV c.m. energy

• E4 MB currents saturating in the last 2012 runs ($^{2}\mu A @ L > 3 \ 10^{33}$)

E4 in 2015 = A13 at sLHC!!

One example from Federico: run 203719 (~5*10^33 laser events in the gap seen from all MBTS



compare the spikes in this plot (for example around 16 : 15) a splikes in luminosity on slide 8.

Proposed improvements

- a) Change the amplification of the "3 in 1" board for the trigger signal sum.
- b) Change the present "passive" voltage dividers of the PMTs with "active dividers" (prototypes available, 2 new divider samples sent to Pisa)

Short term plans:

- Goal is the installation of 256 read-out channels (PMT active dividers + new FE cards) in the EB (crack/gap) cells during the 2013-2014 shutdown (LS1); to be decided if and how many MBTS will be kept; 256 is the number of allocated channels for MBTS and/or E type cells
- Radiation hardness tests (Argonne, Clermont-Ferrand?) of dividers and new electronics required
- Extensive tests for qualifying the operation (gain stability) of dividers and FE electronics (Argonne, Clermont-Ferrand, Pisa ??)
- First test results required soon, installation starting in a few weeks / months



"3 in 1" Front-End card



"3 in 1"Front-End card: shaping, amplification and integration



HV (active) dividers

F.Vazeille presentation Jan 2013: https://indico.cern.ch/getFile.py/access?contribId=18&resId=1&materialId=slides&confId=229066





The voltage on the 3 last dynodes is kept constant at almost any anode current I_A ; a variable current flows in the transistors whose V_{CE} voltage is kept at constant value by the resistor chain; diodes are used to protect against accidental BE reverse bias

Comparison of passive and active HV dividers



(tests made in C-F, Jan. 2010) Anode-dynode_8 voltage vs anode current



50

0

100

Anode current [µA]

After Long Shutdown 1 : plans

Production and certification

F. Vezeille, Tile Week, Feb. 1, 2013

• Number of Dividers ?

4 LB Demonstrators: 4 × 32 (PMTs) = 128 Gap/Crack : 8 (PMTs) × 64 (Modules) ×2 (EB) = 1024 10% spares for Gap/Crack: 102 Radiation tests : 66 Already produced : 74 **350 already**

350 already ordered (G.Usai)

\Rightarrow Total of 1250 Dividers.

Making: already submitted to several Cies

 → Request of production delays and cost estimates of the 3 parts:
 PCB, component procurement and implementation, cable connexion.
 ⇒ Final delivery: milestone November 2013.

Certification

by Clermont-Ferrand in about 2 weeks. (they said ...)

Atlas-Pisa lab arrangement for testing HV dividers



Almost all pieces required for PMT divider characterization are available in the Atlas-PI lab, but some preliminary work required before tests begin:

- Resume operation of DAQ (PMT analog out digitization and data storage)
- Check the HV system
- Check the optics for laser pulse distribution; is the laser head (440 nm) adequate? (laser calibration in Tilecal is made at 532 nm)

Project for the phase II up-grade: change HV dividers and "3 in 1" cards in all expected "hot" cells (A1 – A16)



Total number of A cells to be equipped with the new devices:

N_{A cells} =15 x 2 x 64 = 1920

Unit cost for HV active dividers: 17 Euro \rightarrow Total cost = 30 – 35 KEuro

Some personal remarks

• New contributions to the qualification, purchase and mass test of the HV active dividers and of the new FE cards are mandatory for keeping the TileCal detector operating till the sLHC era, especially in a context where the groups (Clermont-Ferrand, Univ. Chicago, Argonne) having proposed and designed the devices seem to have not enough man-power or will to complete the project ...

• For the dividers test, we have almost what needed in the Atlas-Pisa lab; however a non negligible effort is required to resume operation of DAQ and HV supply.

• First tests are quite urgent, they should be done before the installation in the LS1.

At the moment, only V. Cavasinni, T. Del Prete and F. Scuri have expressed some interest; to guarantee continuity till 2022, at least one more "younger" collaborator is required;
F. Scuri mainly busy in the "Laser II" project and in the calibration analysis, at least till completion of the Laser II system installation (2014).

• The cost of the participation (some KEuro for consumables and participation to the orders) should not have a "terrific" impact on funding request to INFN, problem is that we are the only section interested in TilaCal activities ...

• Last but not least: contributions to the divider characterization will become more interesting if the readout would include the new FE cards and if we plan to participate to the parameter optimization of the devices; this case some support from the Pisa electronics pool is required

Back-up

Comparison of passive and active HV dividers



GAP-99-015 Passive and Active PMT Biasing Networks II

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