

Istituto Nazionale di Fisica Nucleare Sezione di Padova

Analysis status of LST1 Real Data



Rubén López-Coto - INFN Padova F2F INFN meeting - Padova - 18/11/19

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LST Status

- Inaugurated in October 2018
 - Under commissioning since then.
 - Drive (October 2018 May 2019)
 - Optics (October 2018 June 2019)
 - Camera (October 2018 Today)
- Data taking has been held due to commissioning, currently many usable runs of:
 - Calibration
 - Pedestal
 - Some cosmic events
 - Even some joint MAGIC+LST observations





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Computing facilities

- NFS Disk: 3.4 PB
- 2000 CPU cores
- Slurm Batch system

IT cluster in la Palma

Access:

- Join the ctan-onsite-it group
- Secure IP activated
- 700 GB in /fefs/aswg/workspace

Data backup: see L. Zangrando's talk this afternoon



LST Analysis repo

cta-Istchain (<u>https://github.com/cta-observatory/cta-Istchain</u>): side repository to develop LST-related tools for analysis which uses ctapipe as a dependency

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To read LST real data you also need protozfitsreader and the plug-in ctapipe_io_lst

- **io**: input/output rutines
- data: real data routines
- reco: Currently full pipeline from DL0 -> DL2, single-telescope energy, direction reconstruction and γ/h separation.
- **calib**: low and high level routines.
- **pointing**: corrections related to pointing.
- **magic-lst**: tools (readers...) to analyze MAGIC+LST data.
- visualization and other tools included as well.
- mc/spectra: calculate single-telescope sensitivity weighting events.

Simulations

Short Summary of the Production

Y. Ohtani

- primary : gamma (PS), gamma-diffuse, electron, proton
- zenith angle = 20 [deg]
- spectral index = -2

- injection : South/North half and half
- site : La Palma
- reuse of shower : 10 times for one job

| | gamma (PS) offset = 0.0 [deg] | gamma-diffuse | electron | proton |
|------------------|----------------------------------|----------------------------------|----------------------------------|--|
| Energy Range | 5 [GeV] – 50 [TeV] | 5 [GeV] – 50 [TeV] | 5 [GeV] – 50 [TeV] | 10 [GeV] - 100 [TeV] |
| Viewcone | 0 [deg] | 10 [deg] | 10 [deg] | 15 [deg] |
| Core Range | 1000 [m] | 1000 [m] | 1000 [m] | 2500 [m] |
| Input Events | South : 3.0e7 North : 3.0e7 | South : 5.0e8 North : 5.0e8 | South : 6.0e8 North : 6.0e8 | South : 5.0e9 North : 5.0e9 |
| Triggered Events | South : 1.08e6 North : 9.60e5 | South : 1.22e6 North : 1.11e6 | South : 1.18e6 North : 1.04e6 | South : 8.28e5 North : ongoing |
| Number of cores | 100 x 2 [cores] | 1000 x 2 [cores] | 1000 x 2 [cores] | 5000 x 2 [cores] |

Low level calibration



- We use a DRS4-based readout that needs to be corrected
 - Readout Corrections currently applied at software level:
 - Subtract pedestal (baseline) of each of the 4096 capacitors¹⁰⁴
 - Dependence of the baseline on the time elapsed since the last reading of the given DRS4 coll
 - Interpolate spikes A & B.
 - They will be directly implemented in the Event Builder (EvB3)
 - Everything implemented and under validation Rubén López-Coto - 18/11/19







High level Calibration



- Flatdield dataset taken with interleaved pedestals
- ADC values before and after flat fielding
- Gain standard deviation after flat-fielding is ~2%
- See talk by Franca in this session

High level Calibration



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Cross-calibration using MAGIC

- S. Micanovic, F. Di Pierro, A. Berti, I. Vovk, M. Huetten, D. Green, L. Saha, A. Moralejo and many others...
 - (see **F. Di Pierro's** talk later in the session)
- Time tagging of the same events will allow us to identify them in both systems.
- This is an invaluable cross-calibration and validation of the full LST performance -> It will allow for a direct comparison of energy and direction estimation and gamma-hadron separation.
- Current analysis uses simtelarray + MARS
 - Moving to ctapipe analysis
- Events can also be combined for a hybrid analysis



Muons

- Size: 4490 phe
- Width: 0.18 deg
- Radius 1.19 deg
- Impact parameter 4.2 m
- (For muon tagging, see afterwards the talk of L. di Venere)



40

Charge [phe]

10



Absolute optical throughput

Very preliminary



Online Event Display

 Developed by E. Lyard, recently installed in the IT cluster (tcs07) in La Palma



Offline Event Display

- ctapipe-event-viewer
- Small modifications to make it work with LST real data



Crab campaign

- Starting today, the Crab is visible under favorable zenith angles for the next couple of weeks
- We will be performing a campaign performing data taking in real conditions to:
 - Test drive, optics, and camera
 - Test data taking procedure (pedestal and calibration runs + data taking run with readout corrections).
 - If successful, test online analysis, full analysis chain to spot weak/missing points and hopefully...



Conclusion & Prospects

Run: 442 / Event: 159214







- LST real data analysis is ongoing.
- Little sky data available because of ongoing commissioning. Needed to use calibration runs with cosmic events.
- Most of the tools already there, some features and fine tuning still ongoing.
- First shower results shown here. Calibration and HV settings need to be fine-tuned to get the best performance.
- Starting first campaign to take real data *today*