LST of CTA in the Infra-Tech

Discussions are ongoing with the LST groups, ET, SKA, KM3NeT…

A **not exhaustive** list of topics has come out. With a core participation of groups involved in first line and companies working with them from ESFRI RI and other infrastructures in APP that require similar items would constitute an efficient project where EC money is used to substantially advance RI in APP.

For the LST project this least is very appealing and 2 examples are provided.

1) **Efficient computing and algorithms at Tier0 level**
    1. Artificial Intelligence algorithm for filtering and reconstruction at L0
    2. High efficiency and low carbon solutions (GPUs, FPGA, ..)
    3. Low latency alerts
    4. Long term preservation of massive data

2) **Material Surfaces**
    a. Coatings
    b. Mechanical substrates for mirror
    c. optical elements

3) **Monitoring, sensing and actuation**

a. Monitoring and/or sensing

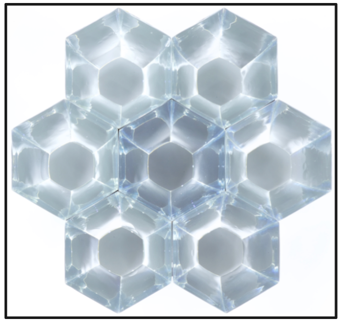
b. Control and actuation

c. Adaptive systems and compensation

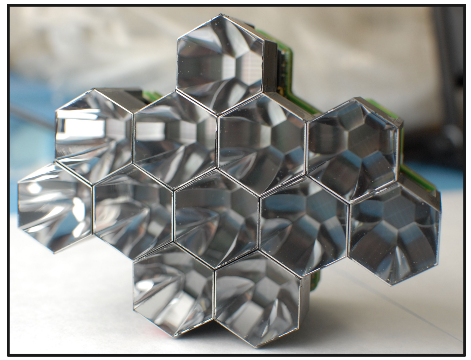
4) **Photo-sensing and electronics**
    a. Sensors
    b. Associated Electronics

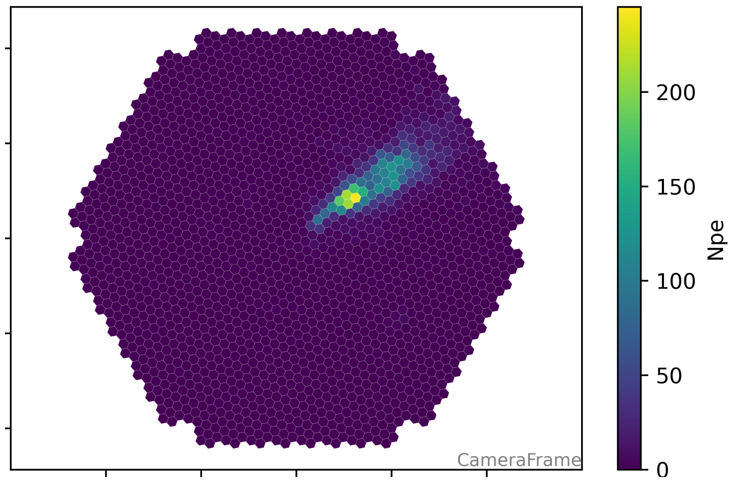
Examples from LST: Advancing photodetection in the gamma-ray field

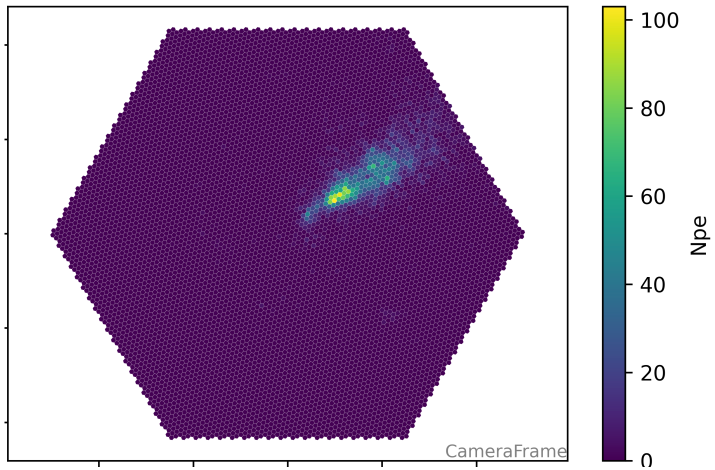
- Small size telescopes (4m diameter) of CTA successfully adopted SiPM thanks to their robustness against light, mass-producibility, cost, …
- An Advanced SiPM camera for large size telescopes (23 m diameter) is being planned for future LSTs to:
  - outperform the existing camera over the entire energy range
  - be upgradable/ reprogrammable
- Many challenges to tackle:
  - **Power consumption**
  - **Data throughput**
  - **GHz full digital redout**
  - **Cost**



LST PMT camera **(0.1°)**



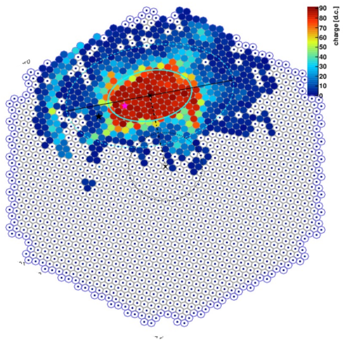




AI in gamma-ray astrophysics

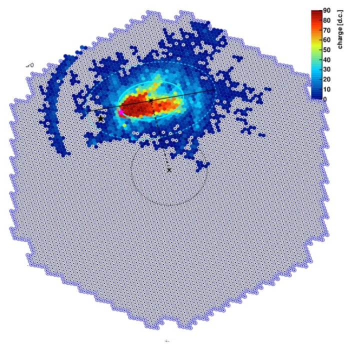
- Main problematic is to improve classical image analysis:
  - Image classification (gamma/hadron separation)
  - Energy and arrival direction reconstruction
  - ➢ CNNs are very good for extracting image features and are commonly used for these tasks
- An advanced camera with SiPM-based pixels, smaller than current PMT ones, canexploit CNN based algorithms to pin down details of images

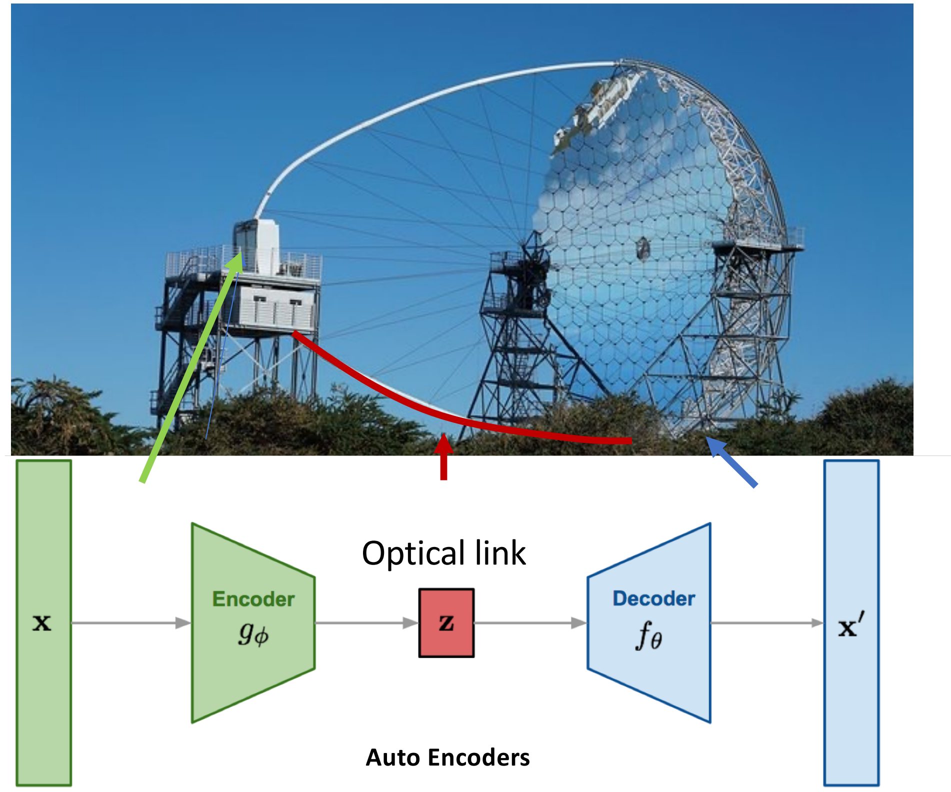
PMT camera
(1855 x 0.1° pixel)



Decrease pixel size to increase feature extractions capabilities

Advanced SiPM camera
(7420 x 0.05° pixel)





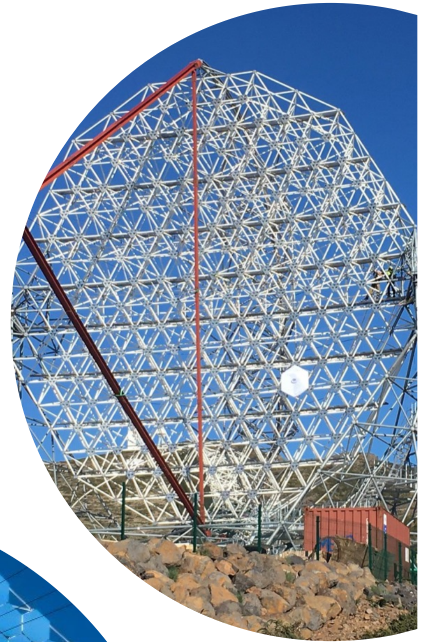
Cherenkov camera
Raw image

DAQ servers
Decoded image

- On-going activities:
  - On-line trigger algorithms based on CNNs for better random noise reduction and larger bandwith;
  - Data volume reduction through photon stream extraction in wavefrom using 1D CNN in real time;
  - Compress data (factor 100-400) yet maintaining key features for physics analysis using auto encoders.

Material surfaces, adaptative systems, …

1) Long Life Mirror Coating: coatings of 5 layers are done for the current mirror facets. By increasing layers to 7, probably we can extend the lifetime from 10-20 yrs to 20-40 years, and also cut out/suppress the photons of longer wavelength to reduce the contribution from background light for SiPM. Prototyping of these advanced mirrors in the industry.



2) Study of the structure with Dynamical Finite Element Analysis to stand for earthquakes in Chile and prototyping

3) modern mirror actuators

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