Status of Himalyan Gamma Ray Observatory (HiGRO)

(VHE Gamma-ray Astronomy in India)

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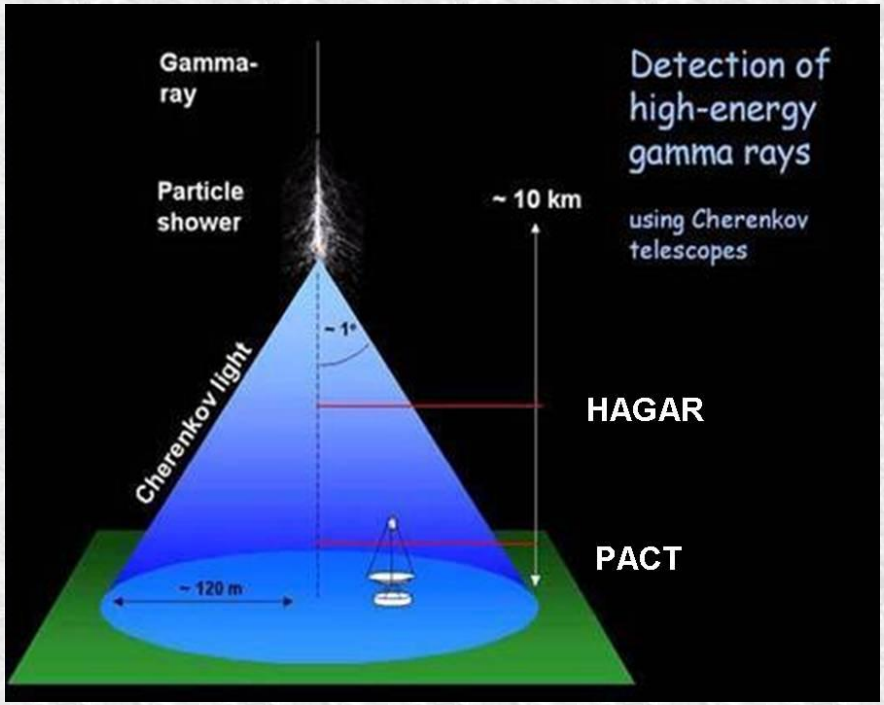
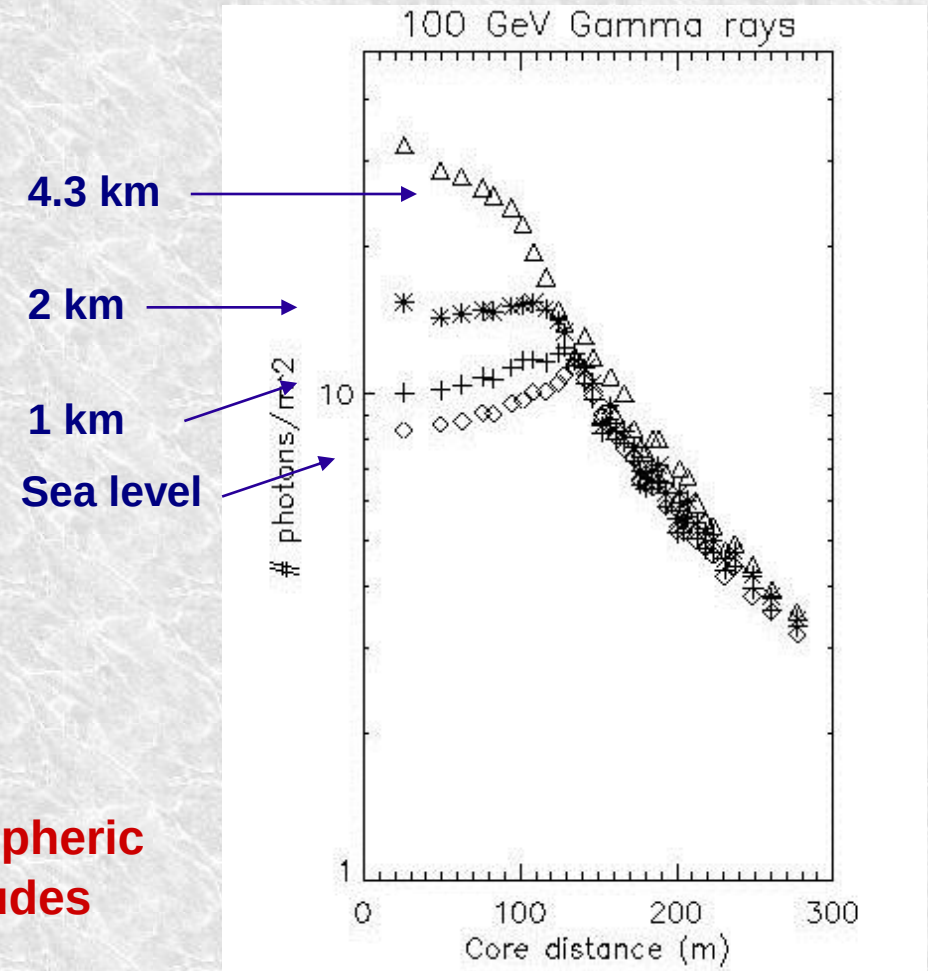
Himalayan Gamma Ray Observatory, HiGRO @ Hanle

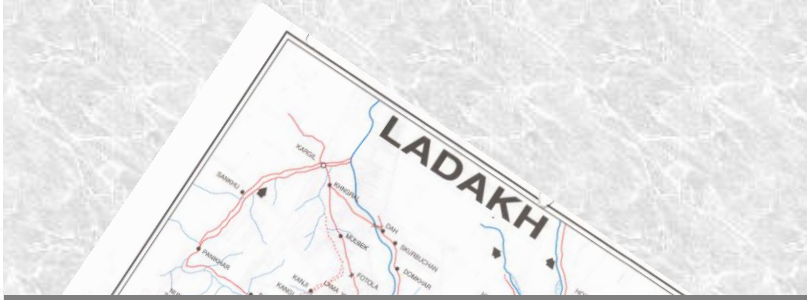
- **Hanle: a high altitude location in Himalayas**
- **Cost effective way of reducing energy threshold of atmospheric Cherenkov telescope**

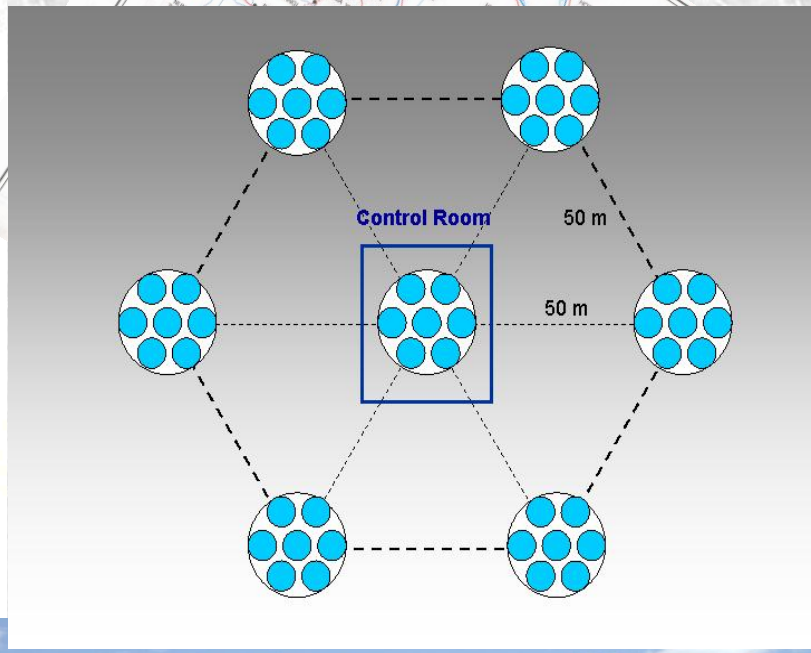


Lateral distribution from simulations



Higher Cherenkov photon density and less atmospheric attenuation of Cherenkov photons at higher altitudes



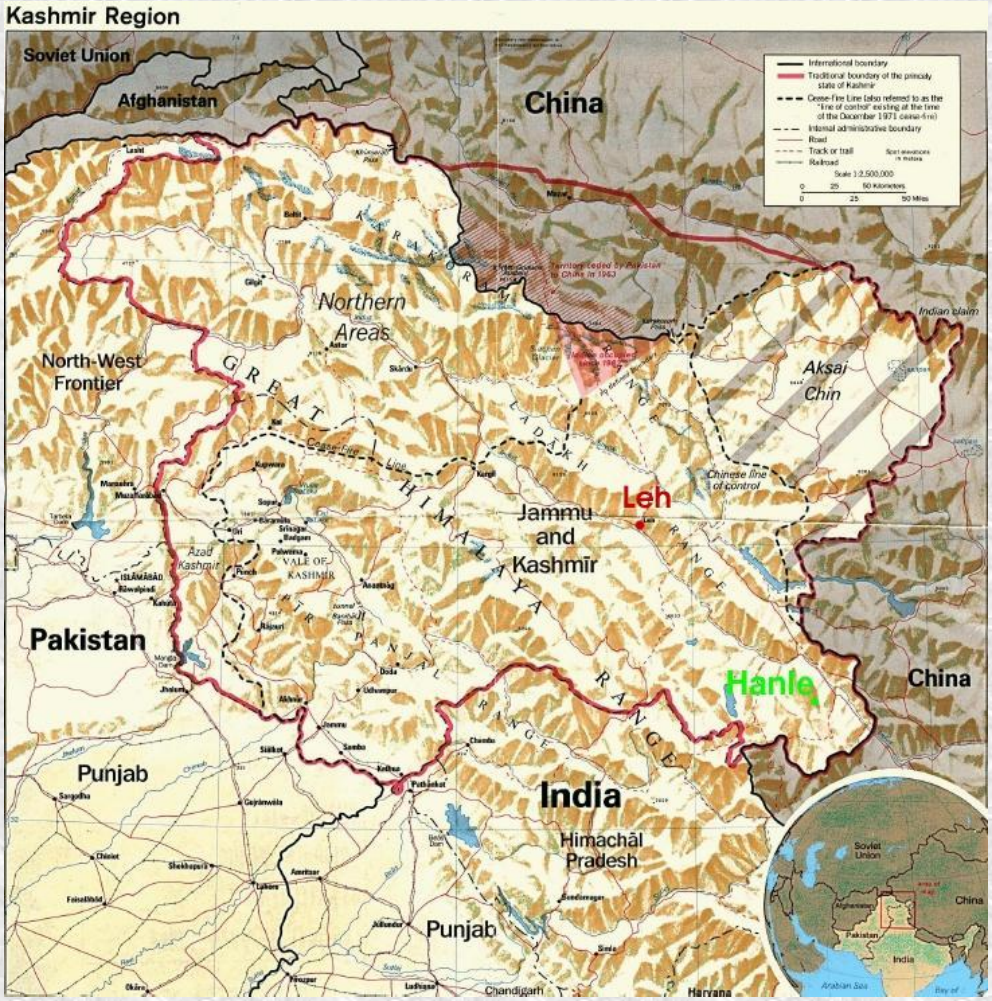


Latitude: 32° 46´ 46˝ N
Longitude : 78° 57´ 51˝ E
Altitude : 4270 m

Himalayan Gamma Ray Observatory (HiGRO)

Collaboration between BARC, IIA, TIFR and SINP

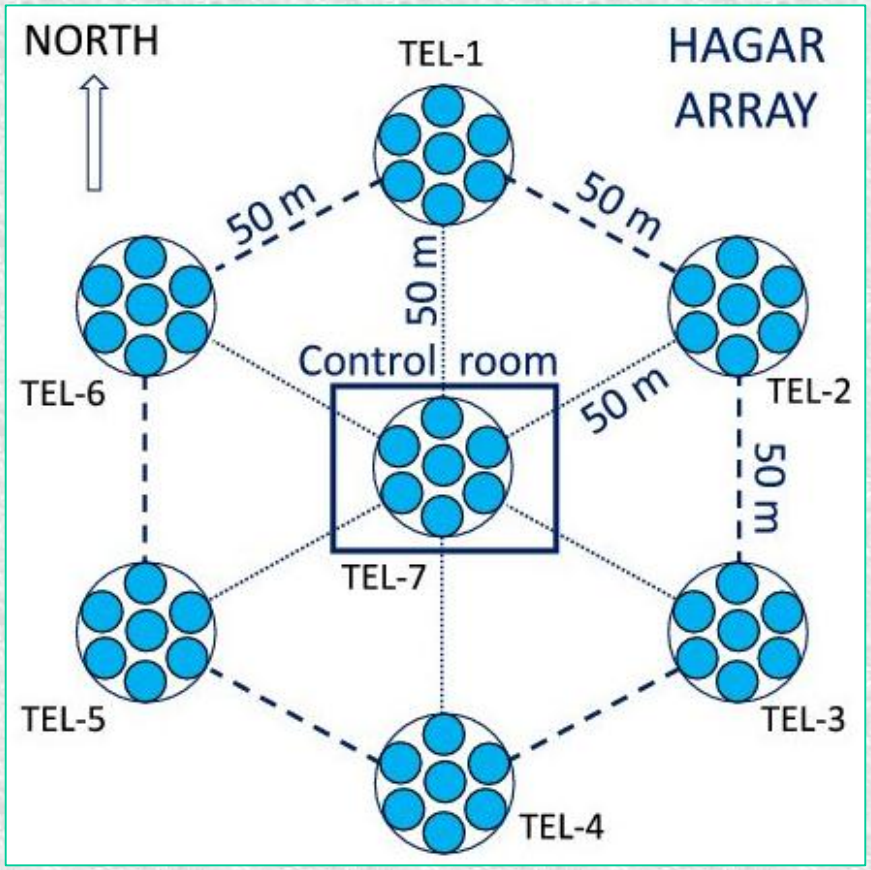
- **Located at Hanle in Himalayas**
  (Lat: 32^0 46' 46" N; Long: 78^0 57' 51" E; and Altitude : 4270 m
- **Located at the base camp of Indian Astronomical Observatory**
- **260 spectroscopic nights/year**



- **Phase 1 : HAGAR (non-imaging)**
  (array of 7 small telescopes)
- **Phase 2 : MACE (Imaging)**
  (21m diameter single telescope)

High Altitude GAmma Ray (HAGAR) Telescope Array

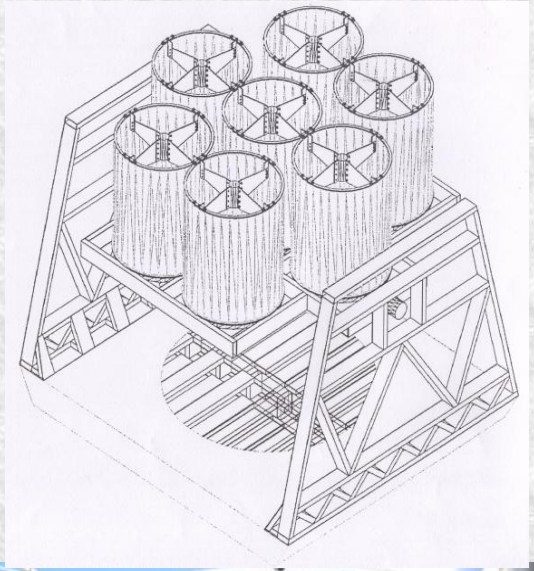
- **An array of 7 telescopes based on wavefront sampling technique**
- **Arrival time of Cherenkov shower front recorded at various locations in Cherenkov pool using distributed array of telescopes**
- **Completely indigenously designed and assembled**
  Civil and mechanical : IIA, Optics and DAQ : TIFR

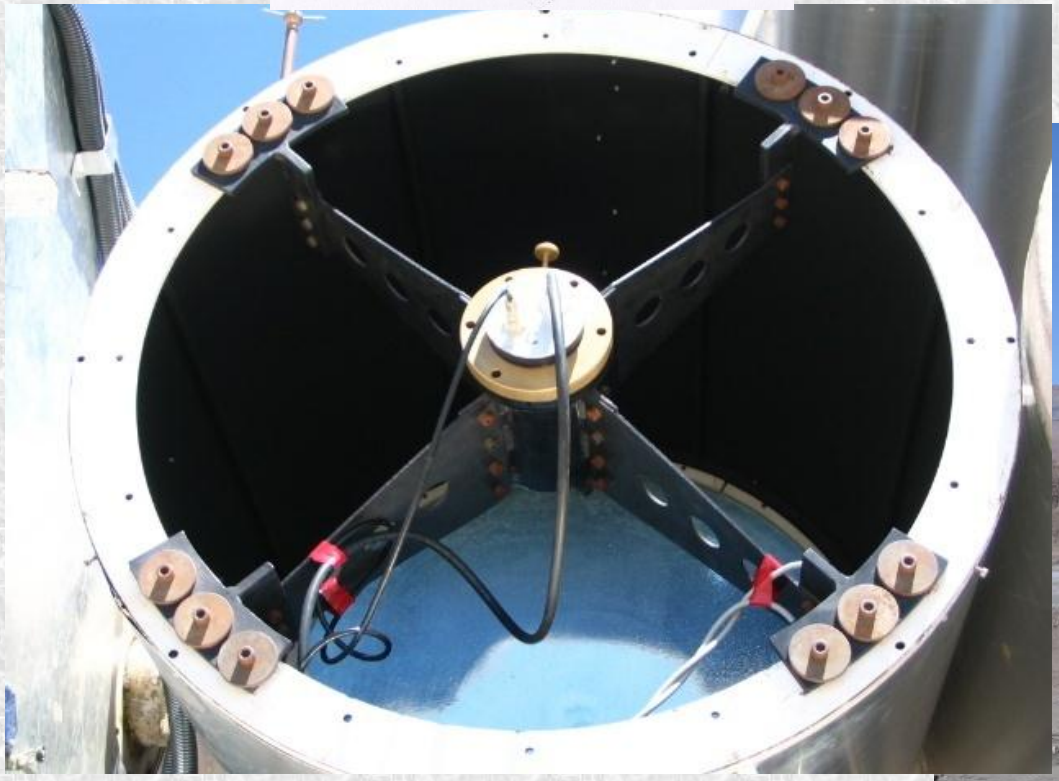


- **7 telescopes, each with 7para-axially mounted glass parabolic mirrors of diameter 0.9 m**
- **f/D ~ 1**
  Field of view : 3^0 FWHM
- **Photonis UV sensitive phototube (XP2268B) at the focus of each mirror**

2005

First HAGAR Telescope at Hanle

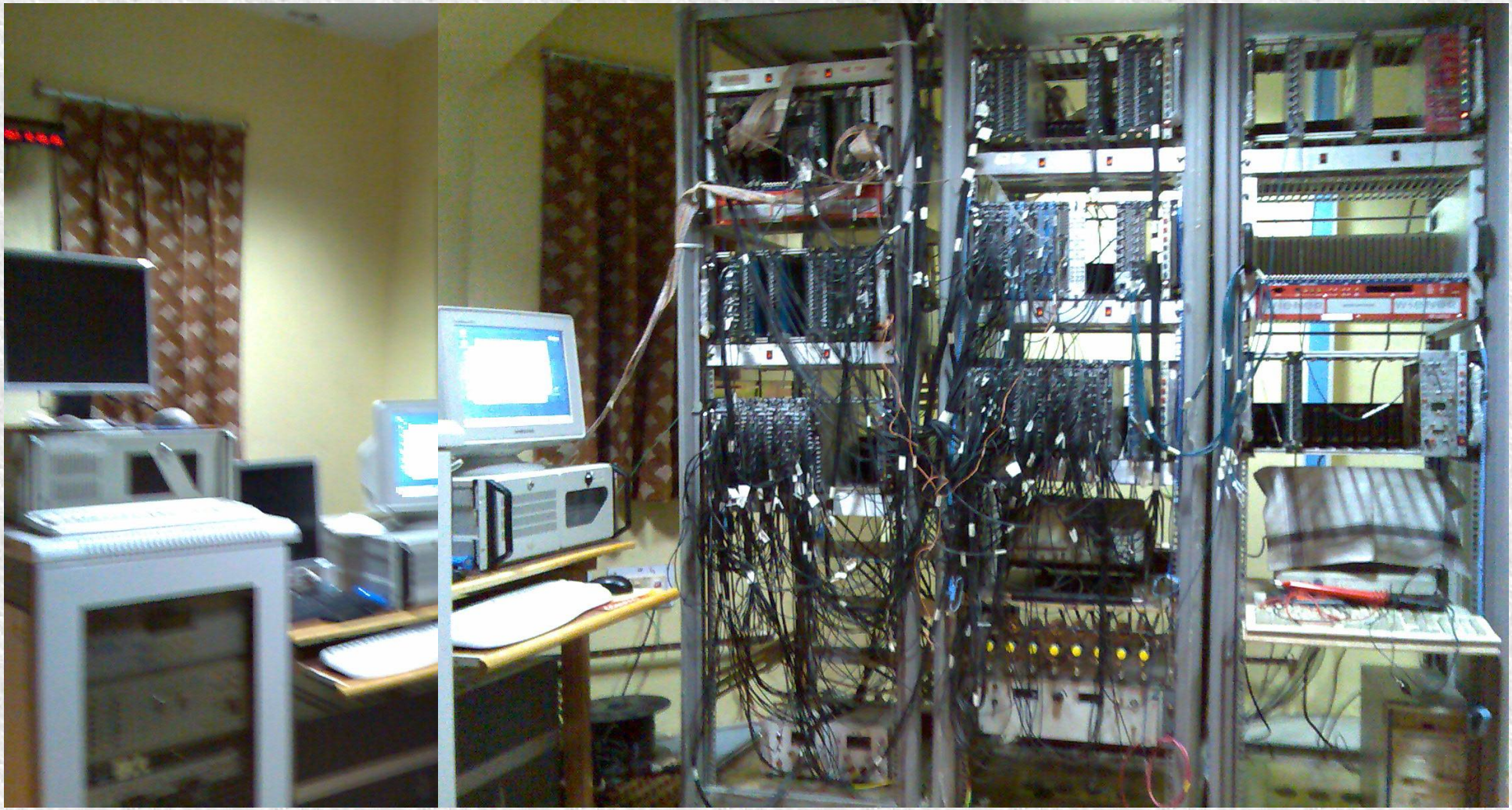




HAGAR Telscope Array

Installation during 2005-2008
IIA & TIFR
Fabricated at Bangalore by IIA
Optical system + DAQ by TIFR

Data Acquisition and Telescope Control System



CAMAC based => VME based + 8 ch Acqiris Digitiser

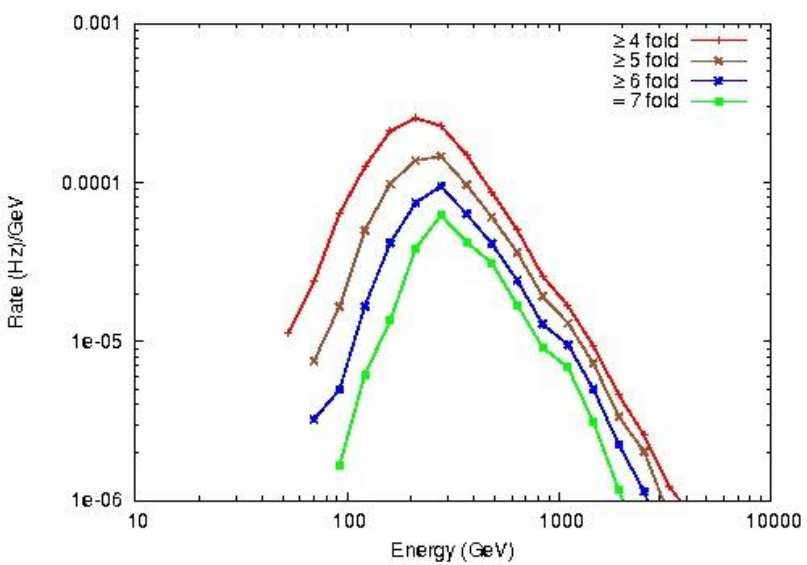
Performance Parameters of HAGAR

1. Trigger threshold : 17.5 photo-electrons/telescope

2. Trigger rate : Protons 9.2 Hz, α particles 3.7 Hz, Electrons 0.11 Hz
Total trigger rate ~ 13.0 Hz

3. Energy threshold :

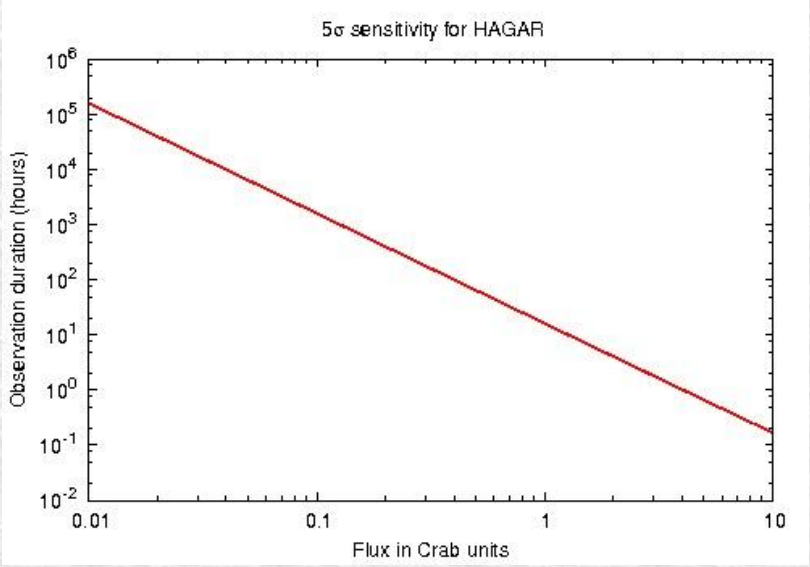
208 GeV for vertical showers
For ≥4 telescopes triggering



4. Expected gamma ray rate from Crab like sources = 6.3/min

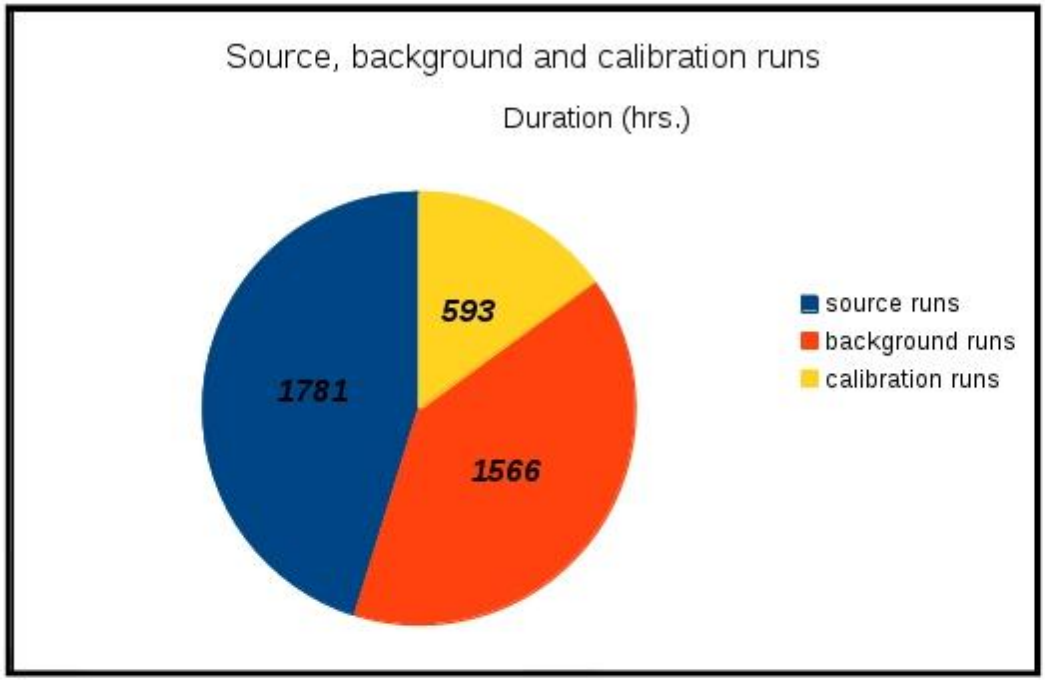
5. Collection area = 3.2 × 10^4 m^2

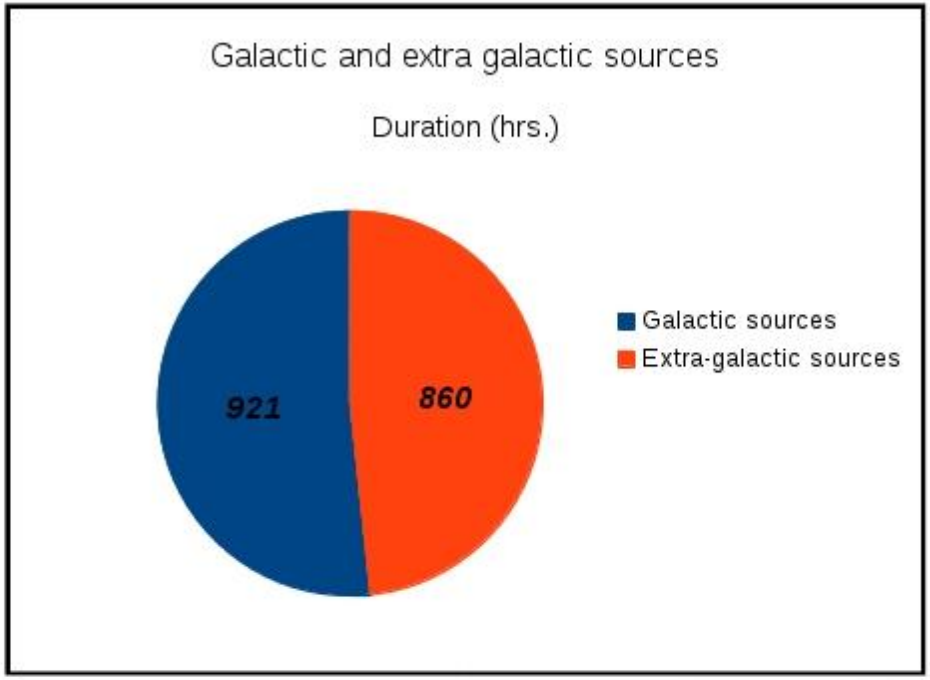
6. Sensitivity :
1.2σ/√(hour) for Crab like sources

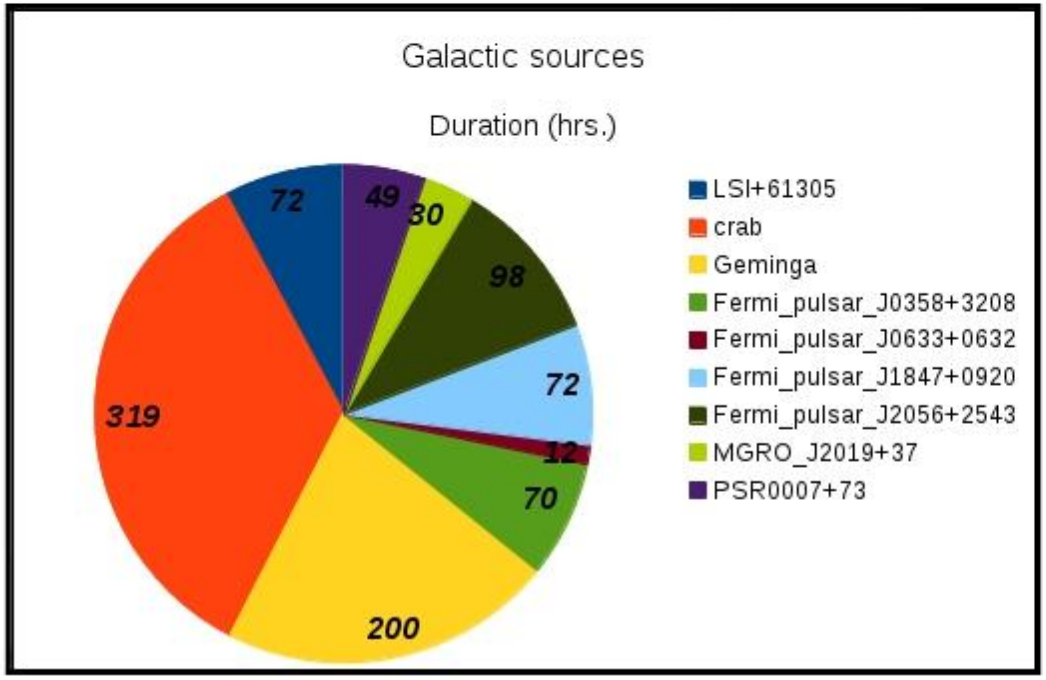


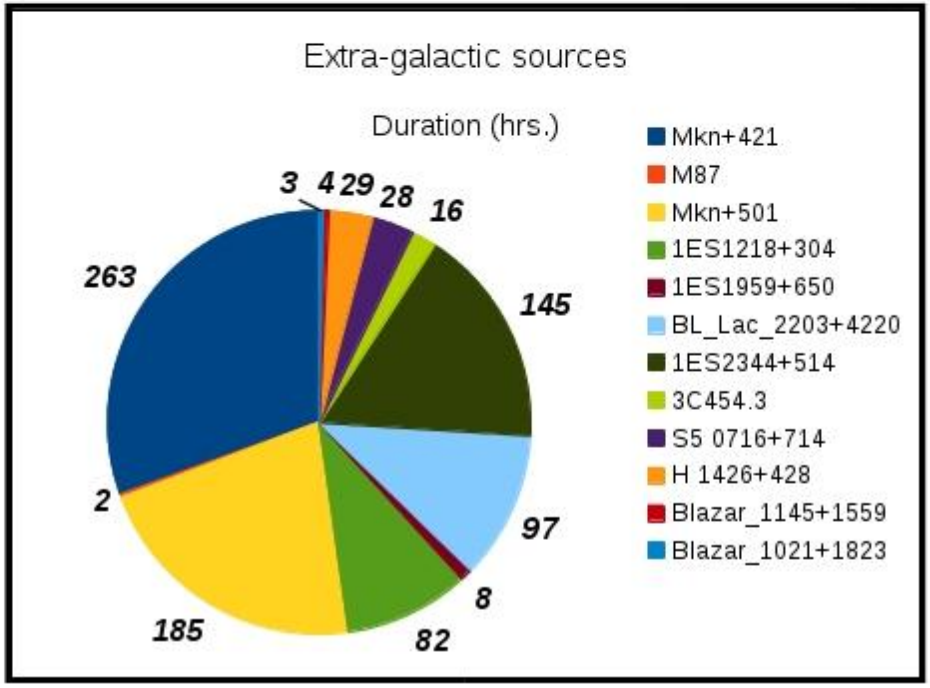
L. Saha et al. , Astroparticle Physics
Vol. 42, p. 33-40, 2013

HAGAR observation log (OCT-2008 to MAR-2015)



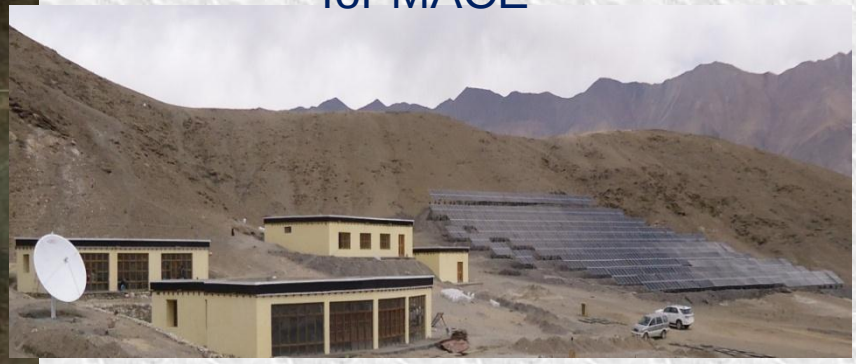






at Hanle site

240 KW Solar Power Plant
for MACE



Subsystems of the MACE telescope

Mechanical Structure (150T)

Mirror Panels (1564/4)

Mirror Alignment System

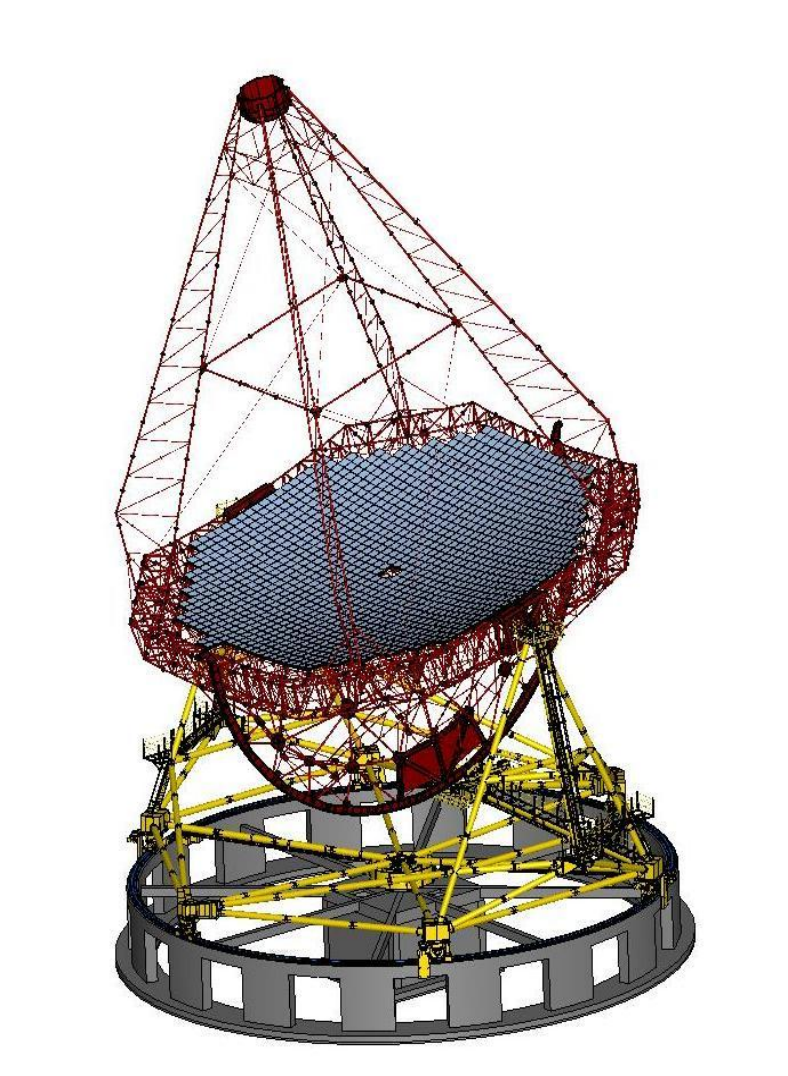
Bull Gear & Drive System

Modular Camera Electronics

Instrumentation Shelters

Data Connectivity

Data Archive

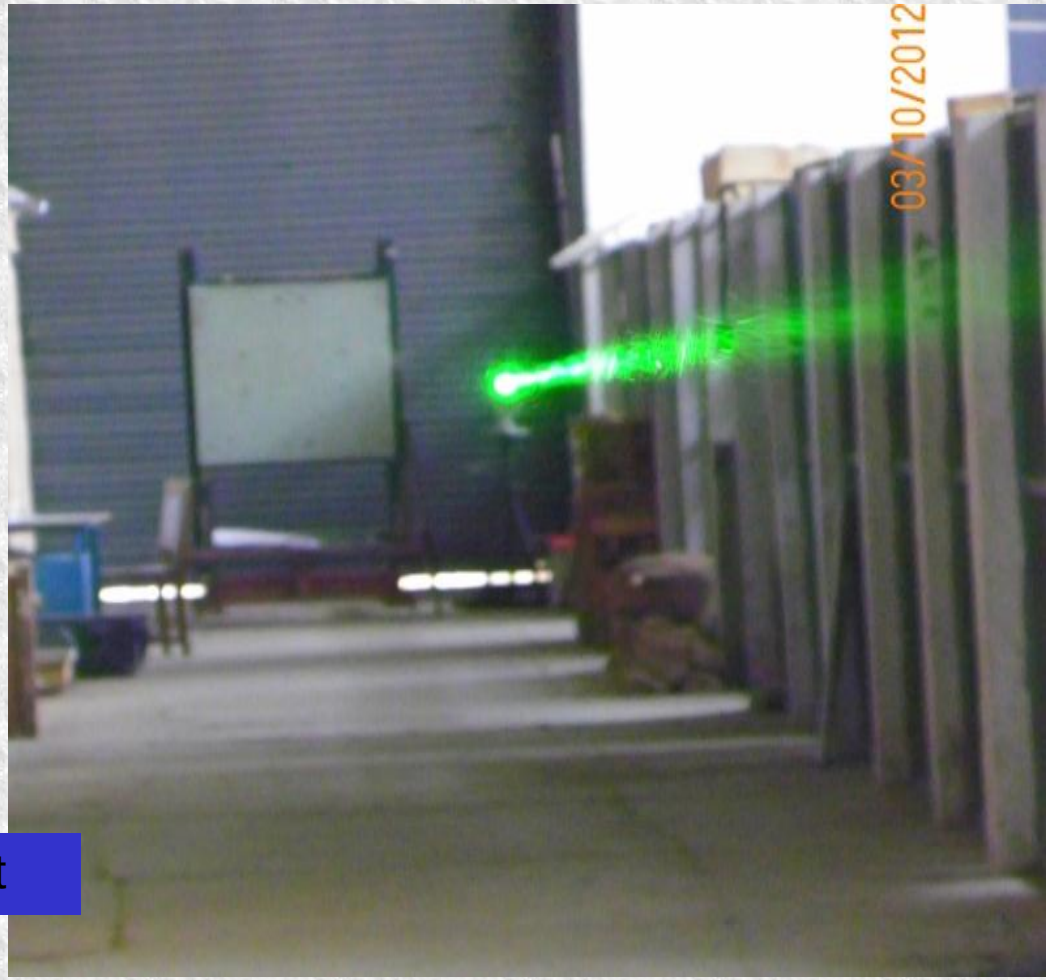


R. Koul et al. NSGRA-2013

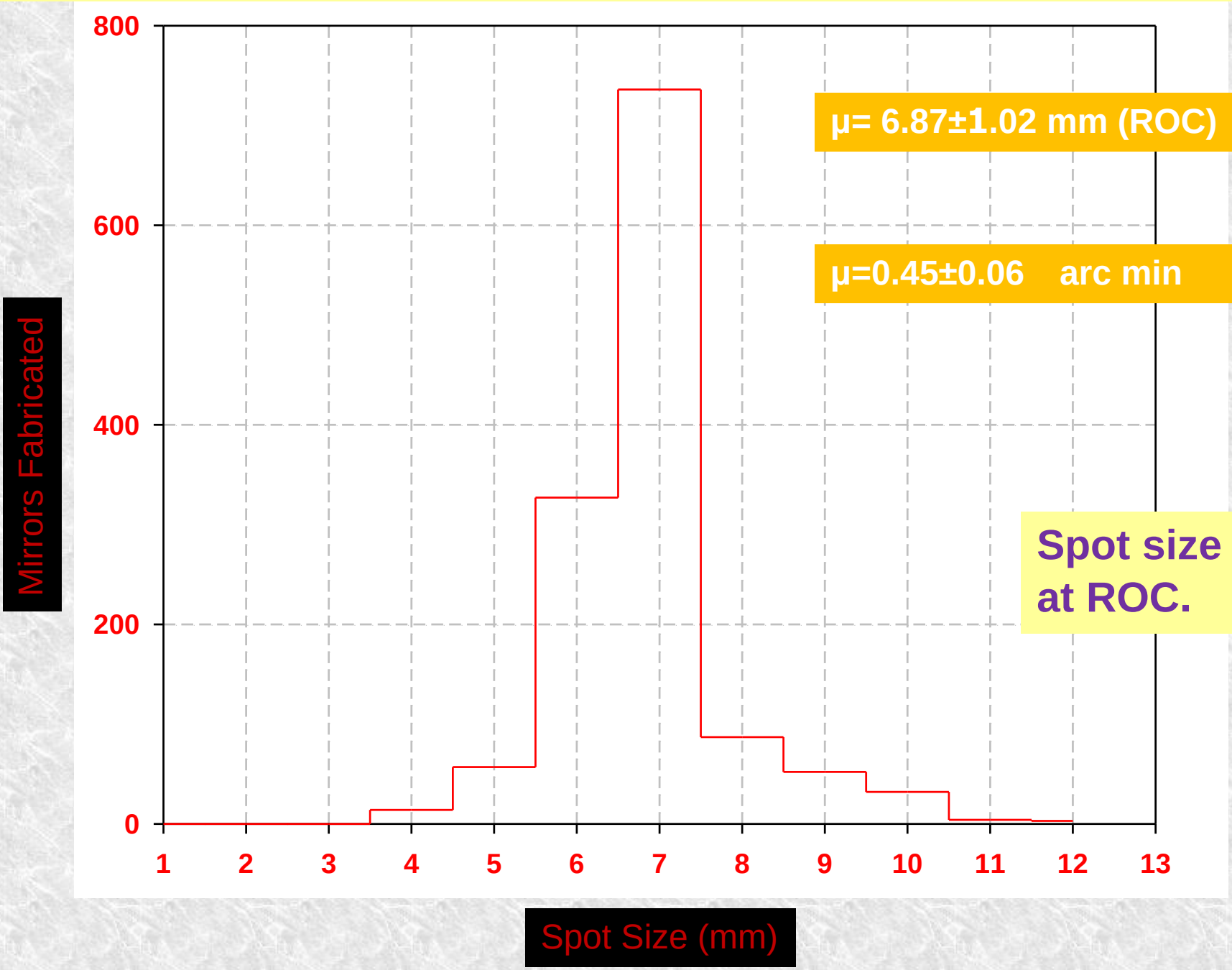
4 Aligned mirrors on Panel

Panel re-arrangement

Laser & Screen



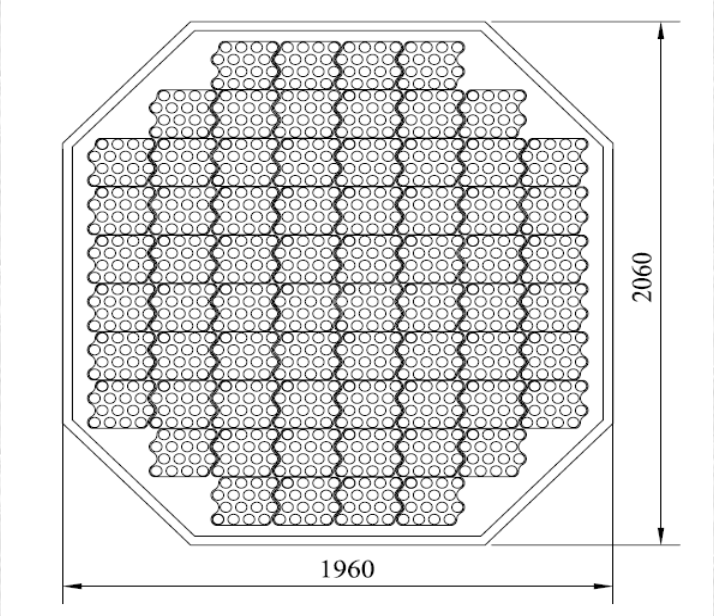
Spot-size distribution status after (**1310 mirrors**)

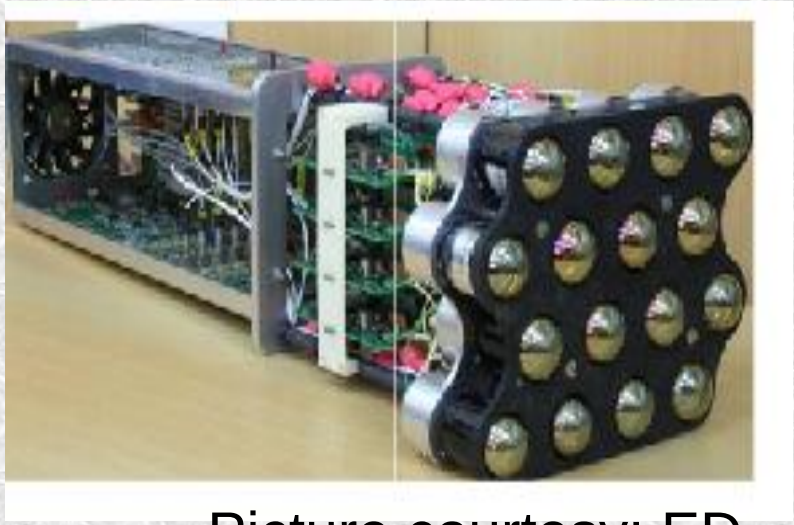


Spot size for D_{80} at ROC.

MACE Camera

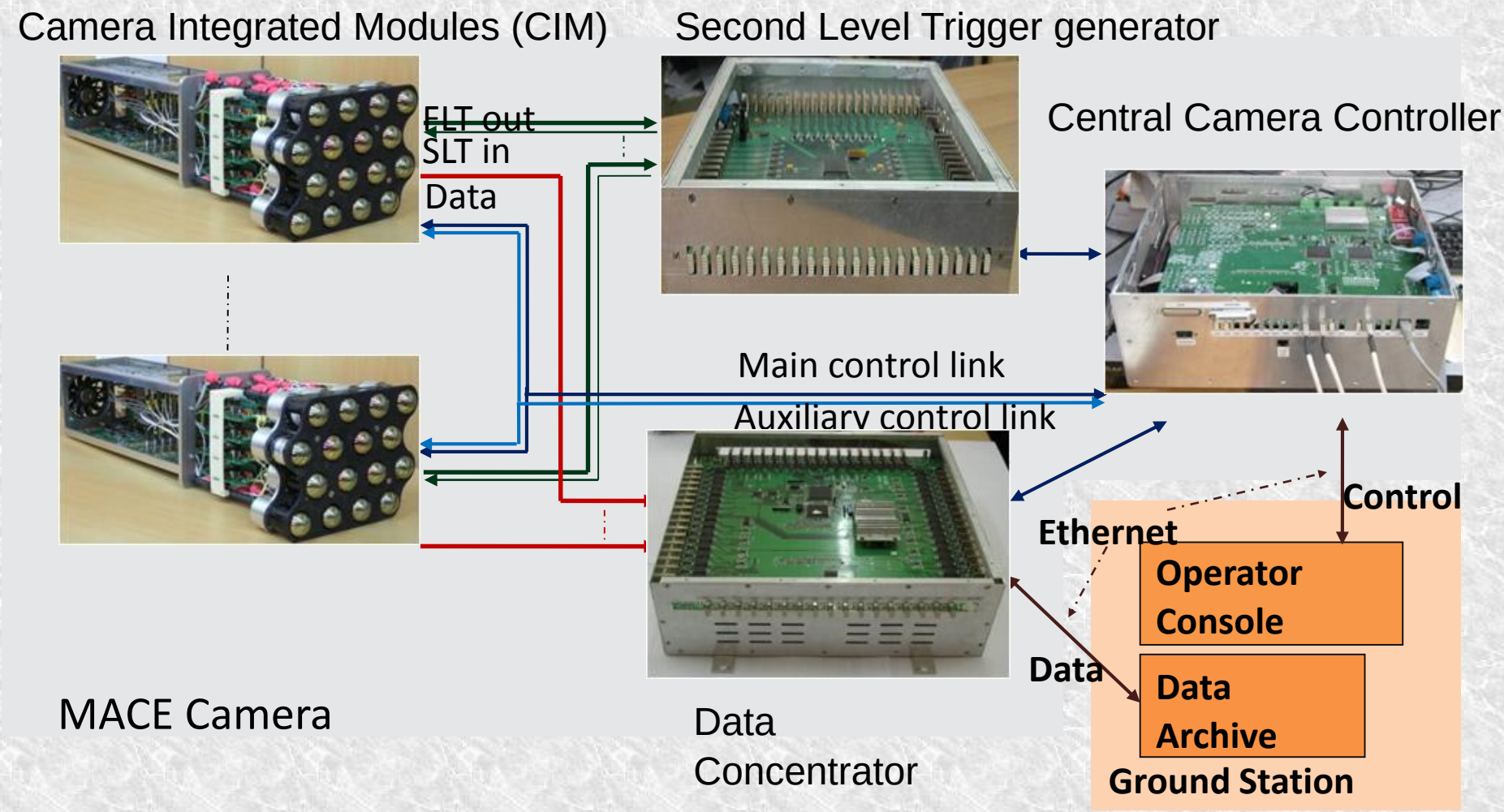
- 1088 PMTs (ETE 9117 WSB) with a uniform pixel resolution 0.125 deg.
- 16 PMTs are arranged in a Camera Integrated Module (CIM).
- PMTs are powered by Voltage Divider Network (VDN) .
- The socket, VDN and a pre-amplifier assembly is housed in a metallic enclosure.
- Programmable HV required for PMT gain matching is mounted close to PMT tubes.



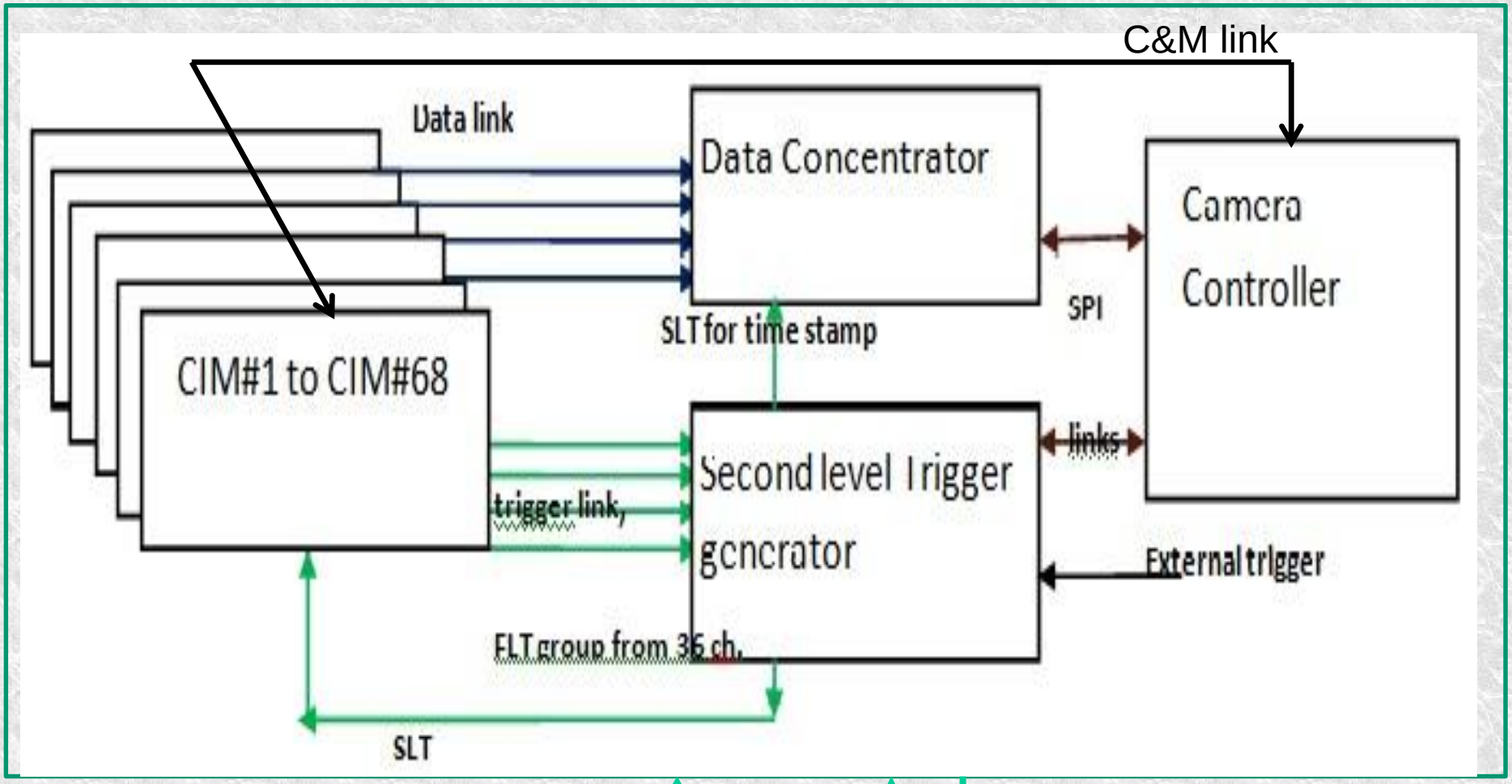


Picture courtesy: ED

Status: Integration of fully assembled 4 CIM modules with DC, CCC, SLTG, Console, Data Archive, Master Clock is completed. Performance evaluation in progress



Overall architecture
Block diagram of camera electronics



Data link

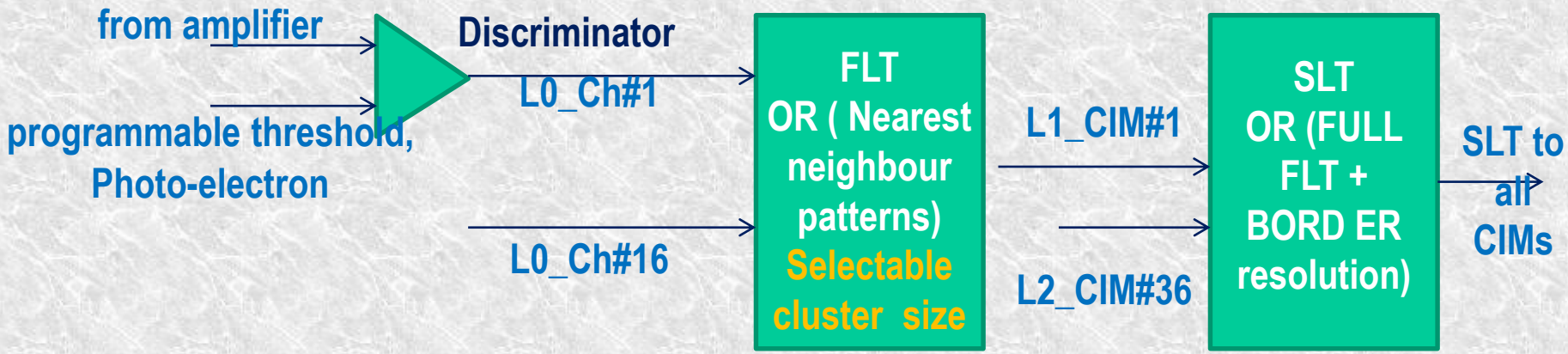
To ground station

C&M link

IRIG-B time code

Entire electronics on camera,
only power and communication cables to camera from ground station

Trigger generation, **MACE** telescope – two stage, two phase pattern based coincidence



First Level Trigger -

- effective coincidence window ~ 5-6 ns
- pe threshold ~ 3-5 photo-electrons
- Selectable tight cluster pattern of 3 to 6 pixels
- Nearest neighbour FULL trigger and partial border triggers,
- Border strength - STRONG, MEDIUM, WEAK

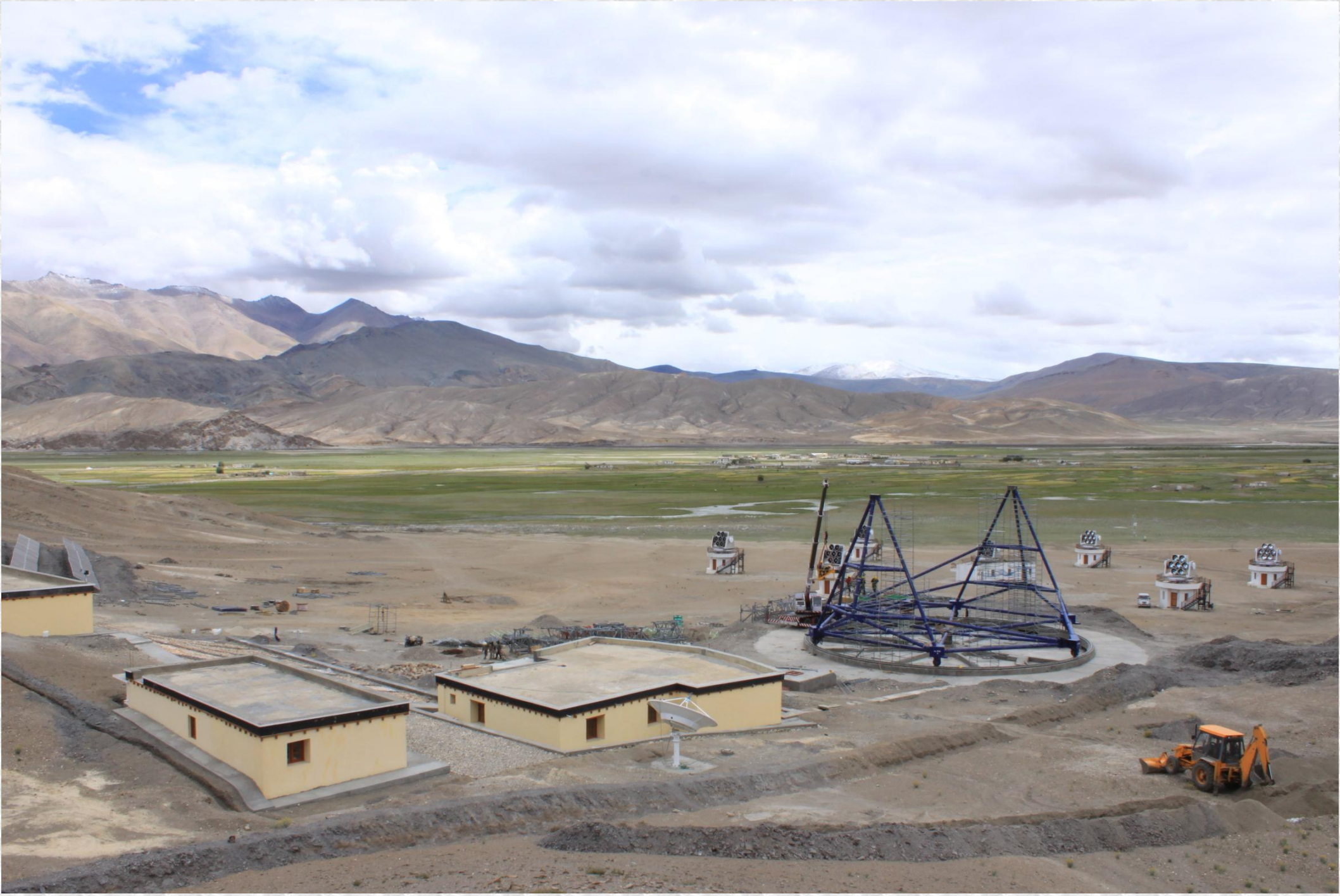
Lower power, lower volume. Allows to compensate for PMT transit time variation with respect to high voltage bias

Assembly status at central India in 2013

Transportation requirements (size < 5mx3m)

21m MACE PROOF ASSEMBLY PROGRESS AT AP&SD/ECIL ON 15.05.2014

At Hanle (Ladakh) site



At Hanle (Ladakh) site

Revised time-line

Review of Telescope Structure assemby: completed on June11-12, 2014

Alignment & Drive tests: from 15 June 2014

Dismantling of structure : 1 July 2014

Transportation to Hanle : 1 Aug 2014

start Installation at Hanle: 1 Sept 2014

finish Installation: by mid 2016

proposed one more similar unit for stereoscopic observations

Thanks