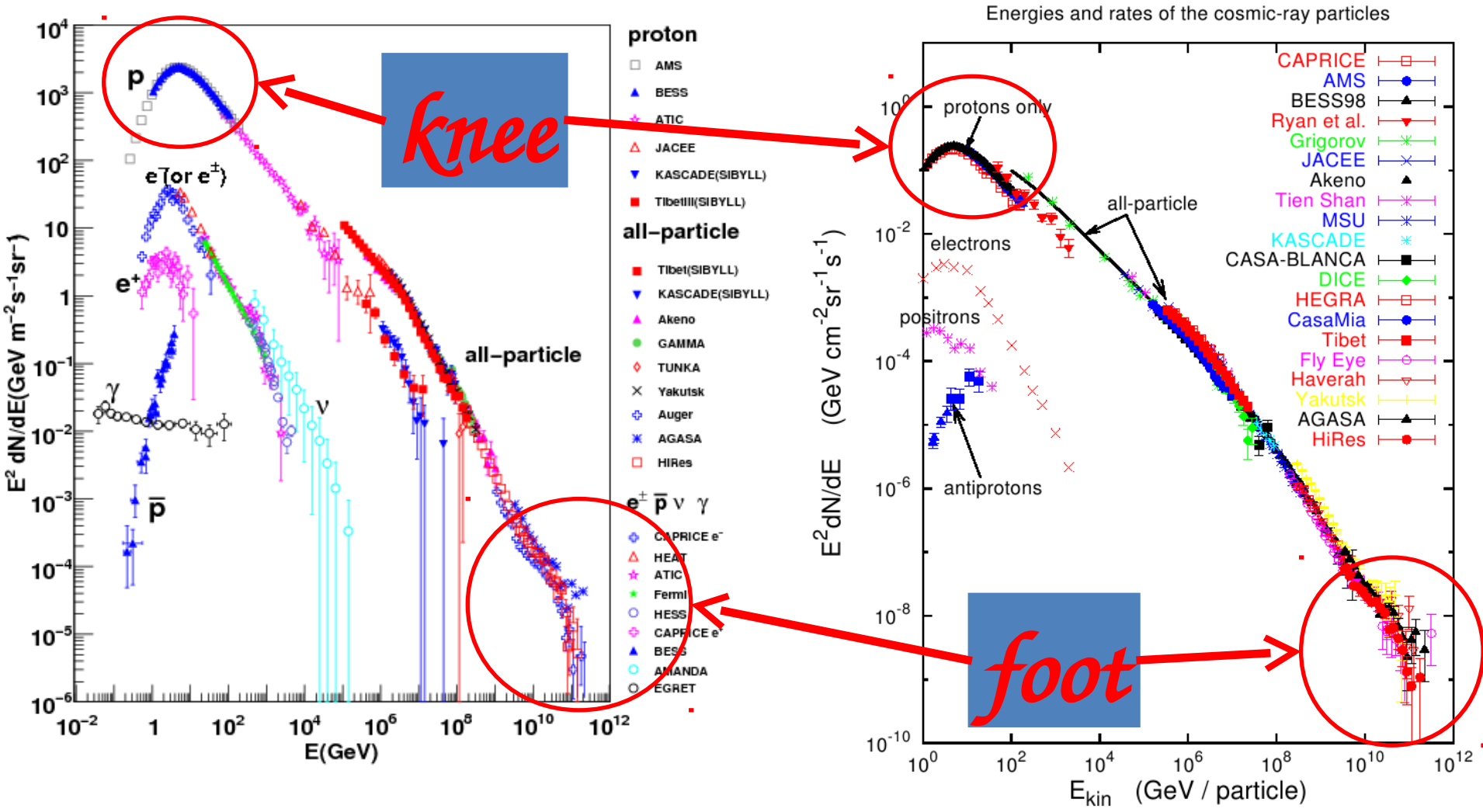
IACT for the TAIGA experiment

Hybrid detector for the PeVatrons searching

Yaroslav Sagan on behalf of the **TAIGA** Collaboration

Cosmic rays energy spectrum



Aims of the TAIGA collaboration

Experimental challenges of TAIGA

In γ-ray astronomy:

- Search for galactic PeVatrons
- VHE spectra of few known sources & absorption on CMB
- Diffuse emission, galactic plane, local supercluster

In cosmic rays:

- Spectrum and mass composition for E ~ 10^{14} – 10^{18} e

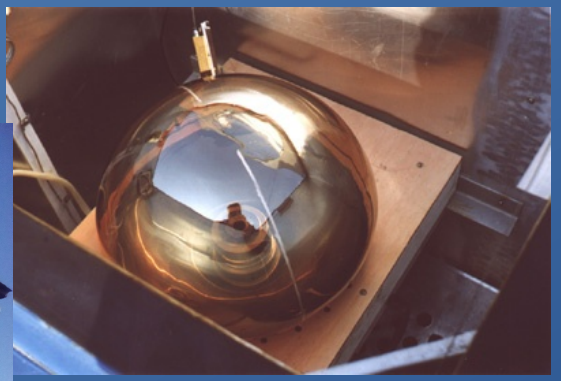
In particle physics:

- Study of possible Lorentz invariance violation
- Axion/photon possible conversion
- Pp cross-section measurement, ...

51° 48' 35" N
103° 04' 02" E
675 m a.s.l.

Detectors and telescopes of the TAIGA experiment:

- Tunka-133;
- Tunka-REX;
- Tunka-Grande;
- HiScore;
- Muon detectors;
- One of the “Master” telescopes;
- **IACT**

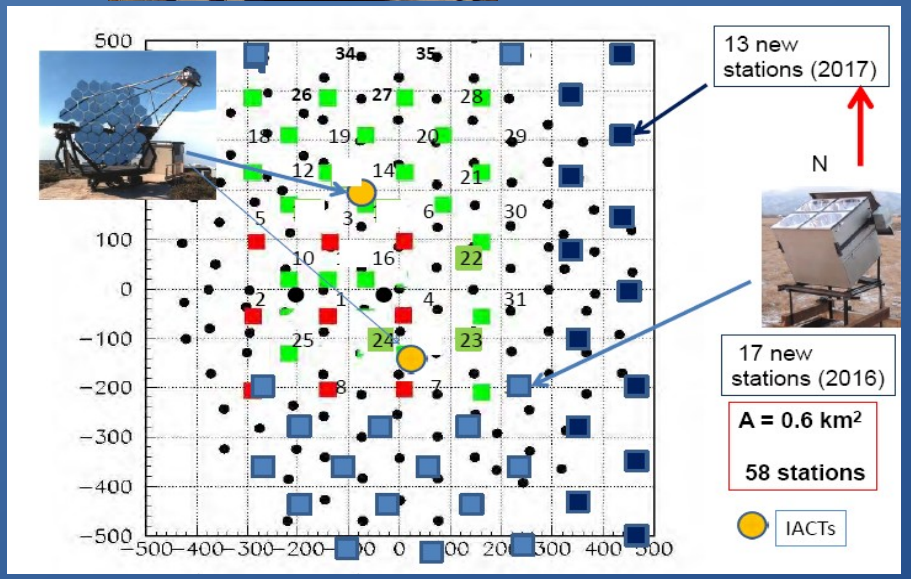


Idea of the TAIGA Hybrid Detector

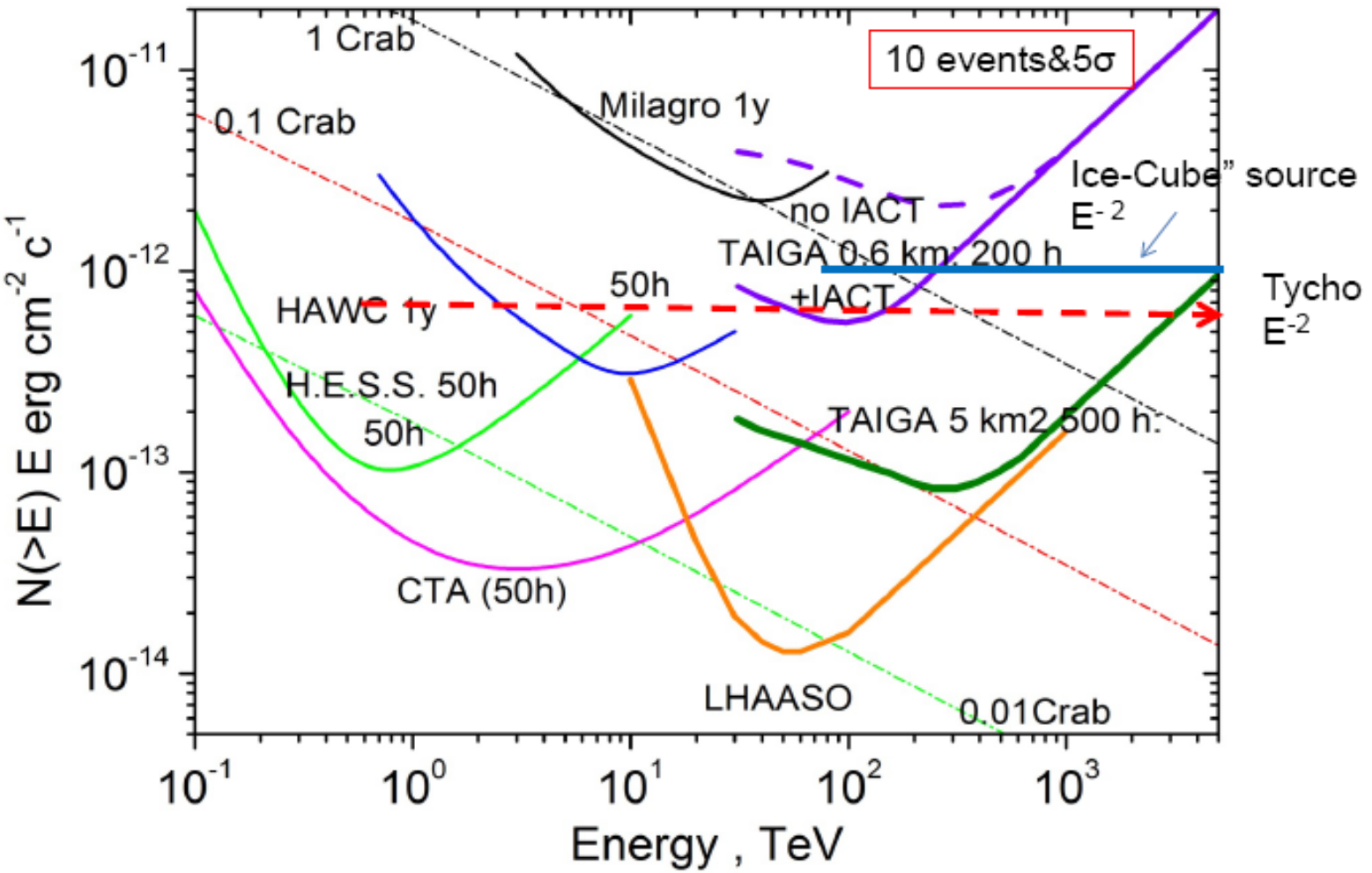
- 500 wide angle optical stations on the 5 km² area, energy threshold 30 TeV

- up to 16 IACTs (10 m² mirrors)

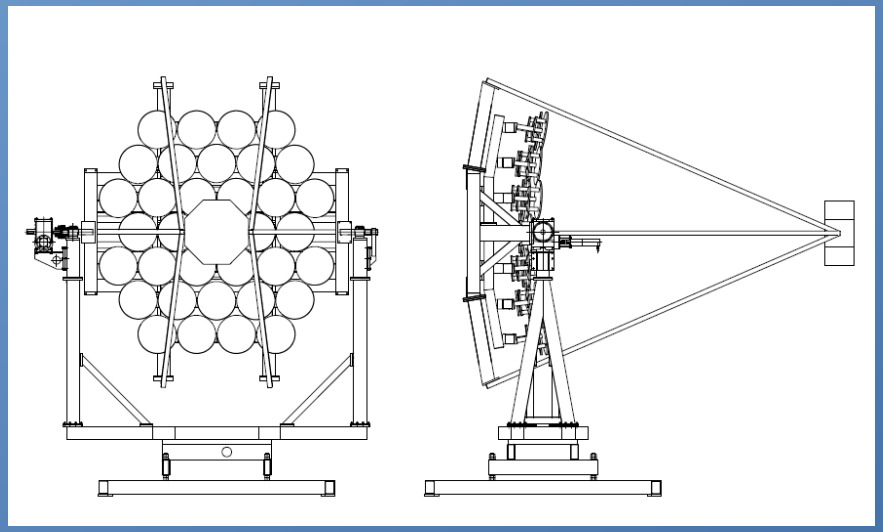
- Muon detectors with total area 2.0 10^3 m²

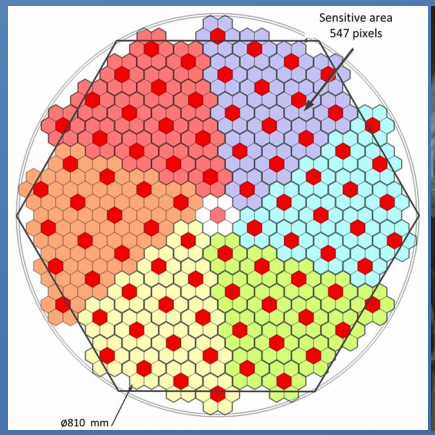


Integral sensitivity to local sources



Basic characteristics of the IACT





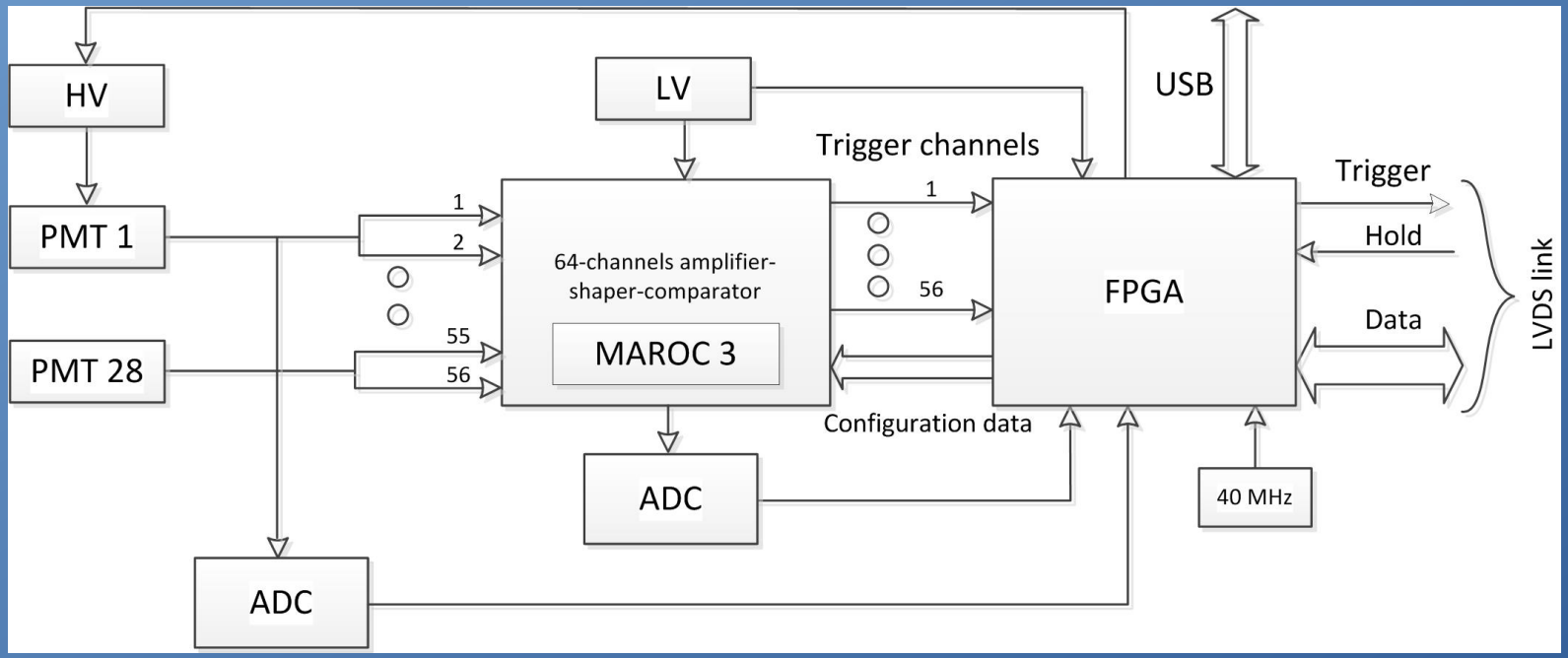
Mirror:

- Davies-Cotton optic type
- Focal length: 4750 mm
- 34 spherical mirror segments
- Diameter of each segment: 60 cm
- Diameter of the mirror: 4.3 m

Camera:

- 547 hexagonal-shaped pixels
- PMT XP1911: window of DIA 15 mm
- Winston cone: 30 mm input size, 15 mm output
- FOV of single pixel: 0.36°
- Full FOV: 9.72°

Data accumulation



Left:
MAROC3 board

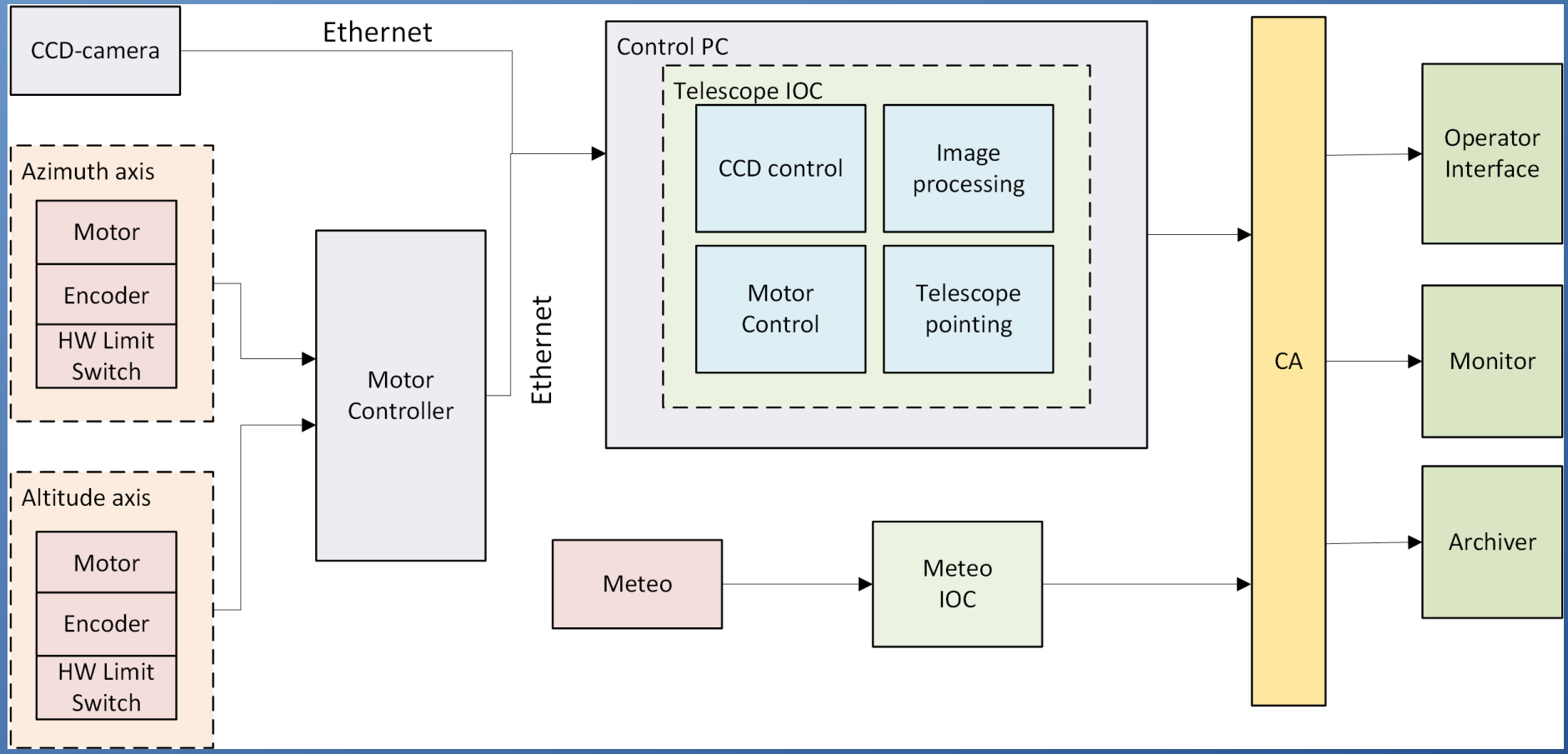
Right:
Assembled cluster

Mirrors fabrication in JINR

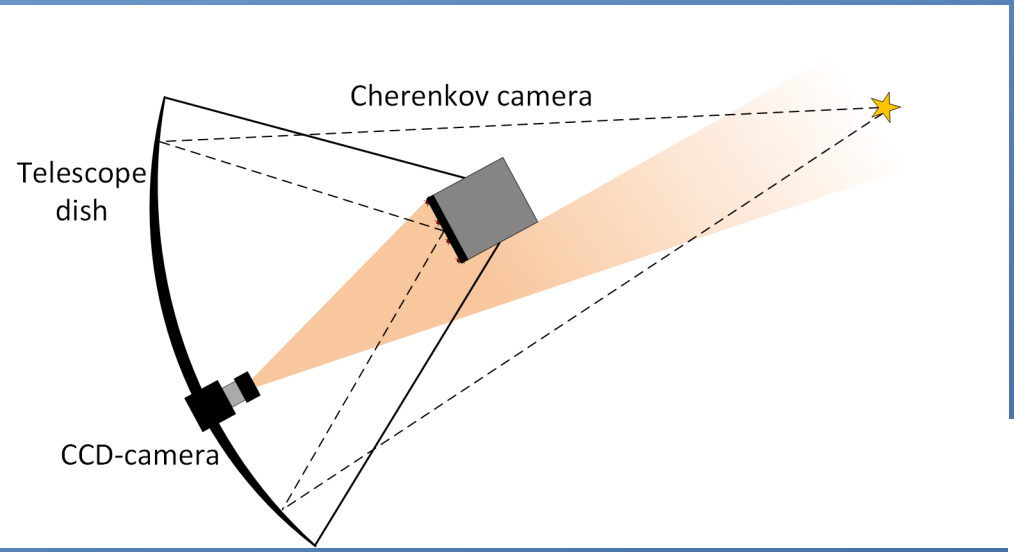
Assembling of the second IACT

Assembling in the Tunka valley: July-August, 2018

IACT control and pointing system

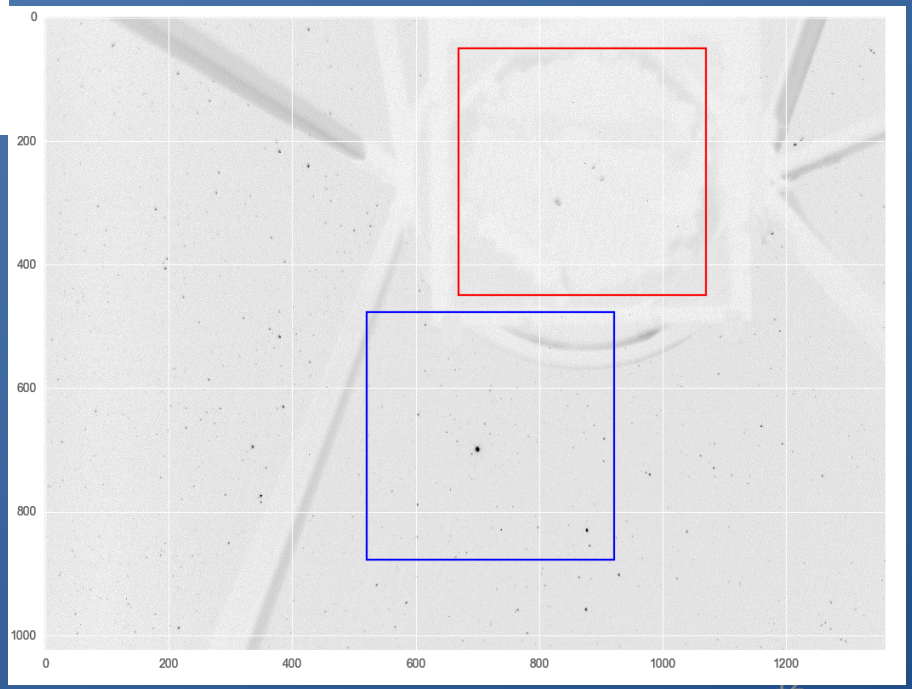


IACT Pointing system

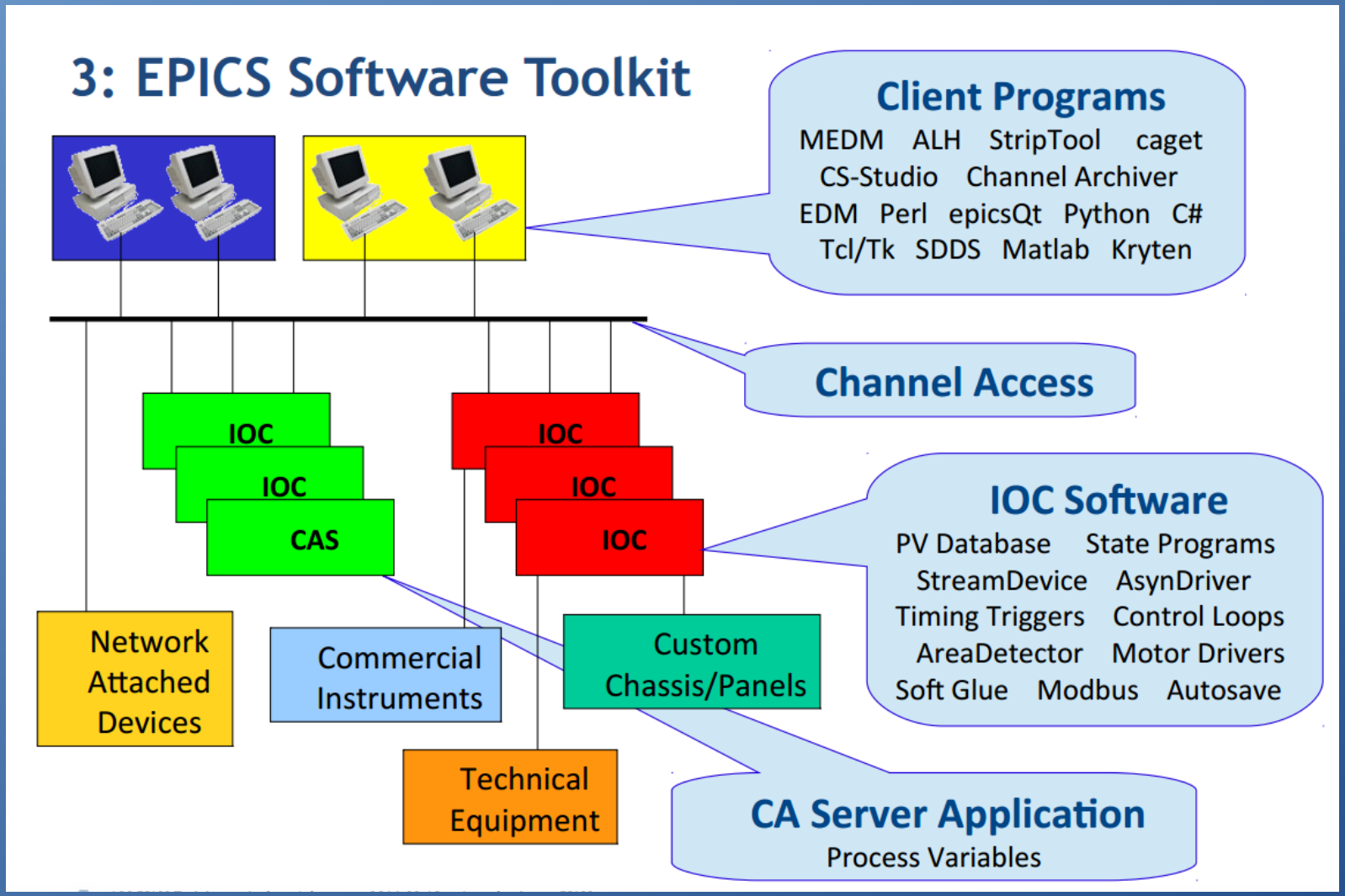


- CCD-camera FoV is ~20x30 [deg]
- Angular resolution is ~0.023 [deg]

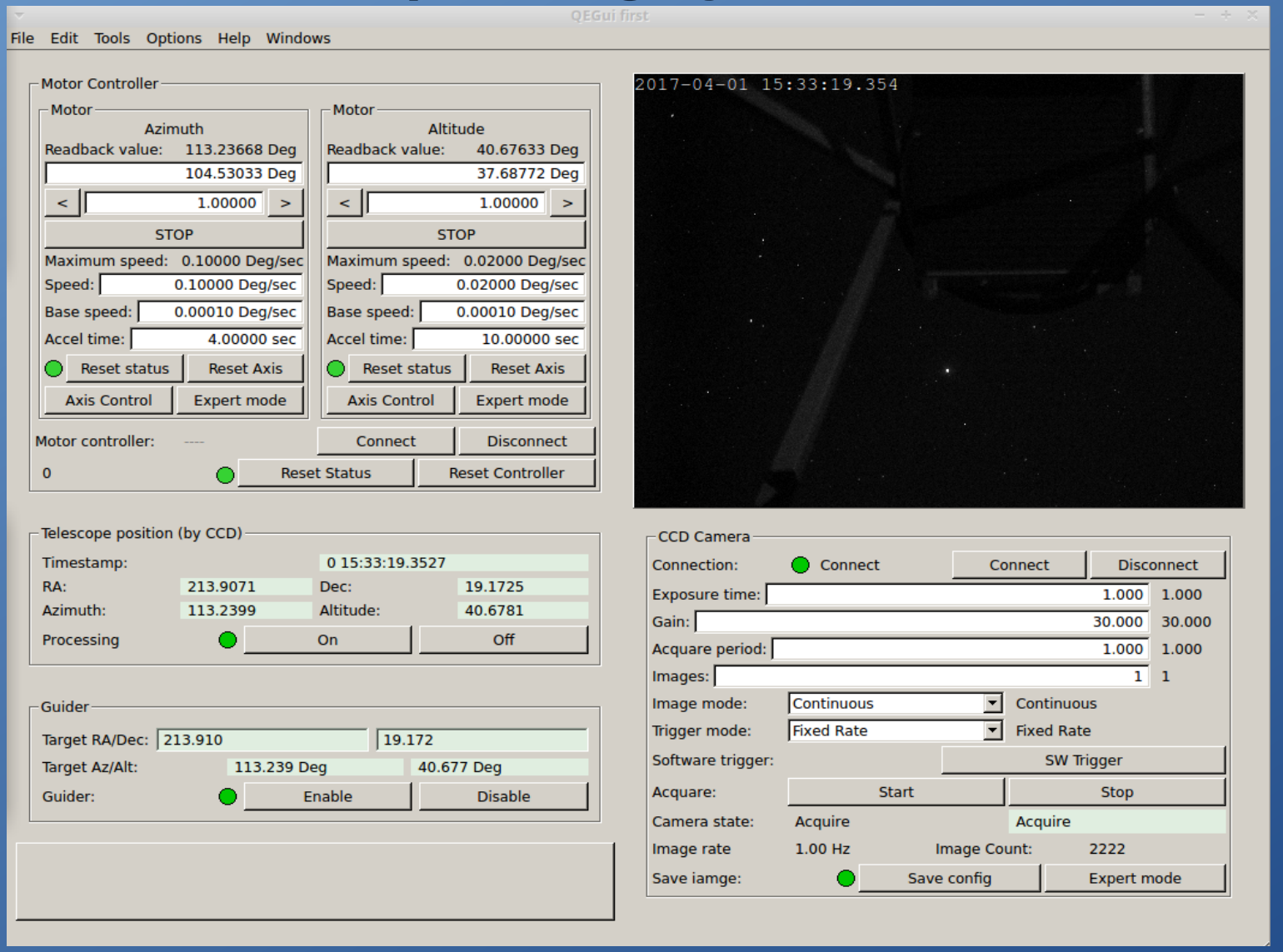
- CCD-camera position allows us capturing both the Cherenkov camera and the observed source



EPICS architecture (control system)



GUI for the online monitoring of IACT control and pointing system



IACT DATA 2016-17 (statistics):

IACT worked: 31 days (35 RUNs)

Total time of work: 145,17 h (522551,98 sec)

Total number of the events: 547 034 865

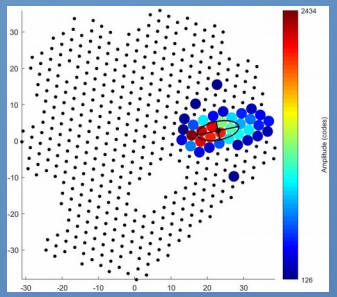
IACT + HiSCORE DATA 2016-17 (statistics):

IACT worked: 15 days (17 RUNs)

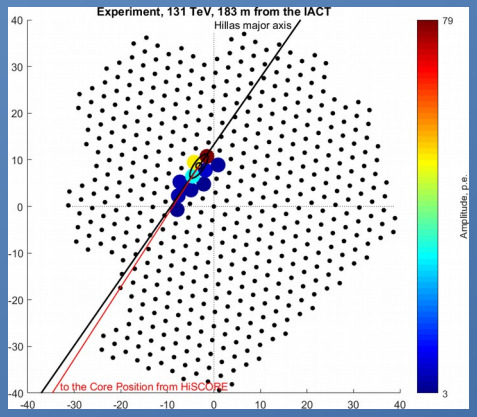
Total time of work: 79,67 h

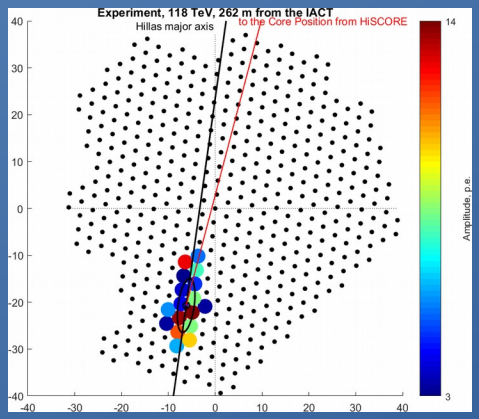
Total number of the joint events: 60 067

Examples of events*



Example of the experimental event together with the Hillas ellipse and major and minor axis





Two examples of the joint experimental events with the Hillas ellipses. The shower axis determined by HiScore is projected onto the camera (red line). The image major axis (Hillas formalism, black line) is in a good agreement

*** E. Postnikov at al., PoS (ICRC2017) 756**

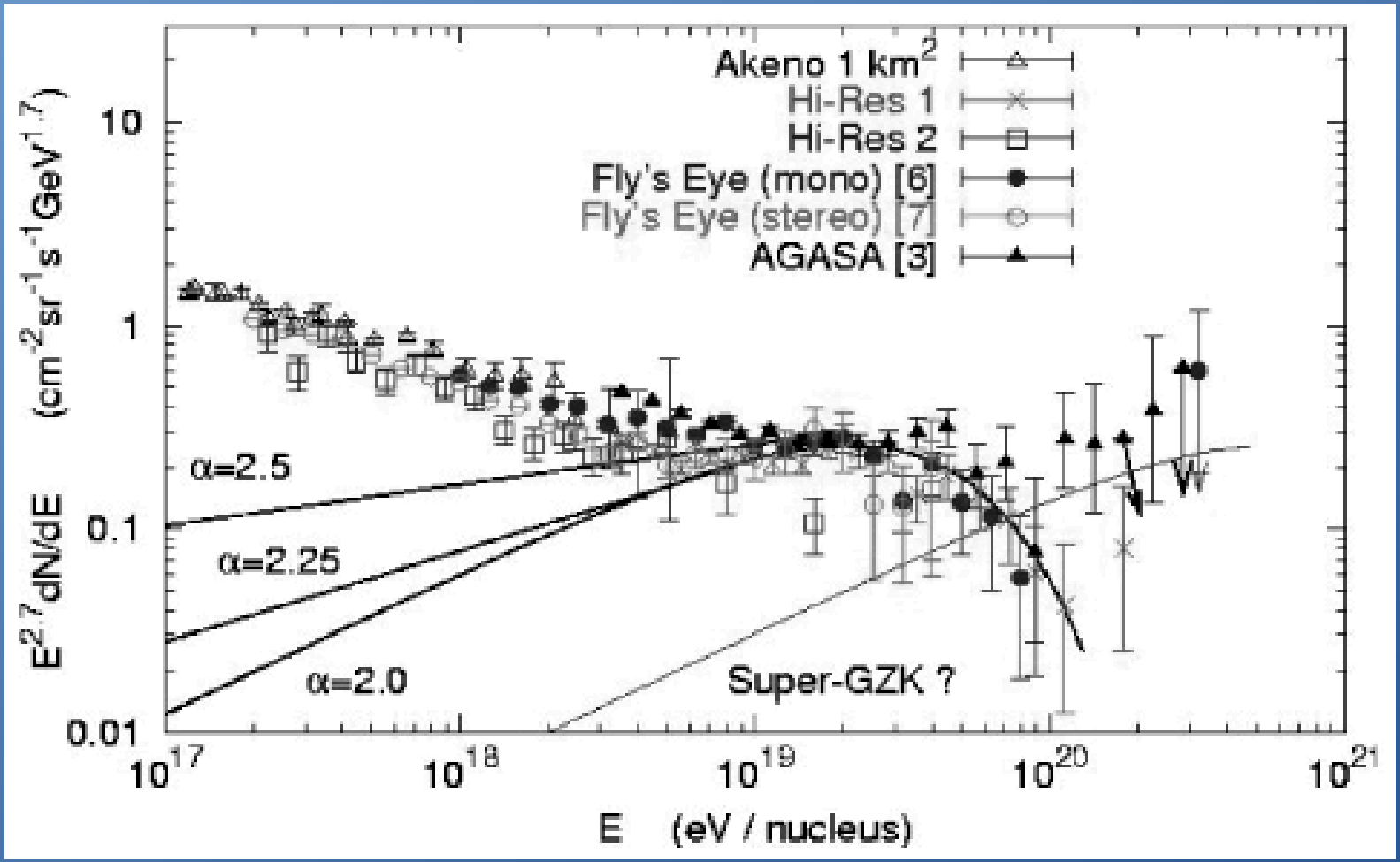
Conclusions

- **Imaging Atmospheric Cherenkov Telescope was developed at LNP JINR and produced at JINR workshop;**
- **The IACT mirrors fabrication process was developed at JINR;**
- **IACT was installed in the Tunka valley, assembled and commissioned, the second is planned to be installed this summer;**
- **The main control, pointing and data accumulation systems were developed and successfully tested;**
- **Principles of collaborative work of HiScore and IACT, and also mechanisms of cleaning and calibration were developed;**
- **Test events statistics, sufficient for checking out the algorithms for cleaning and calibration was obtained;**
- **The first experimental events have been processed and they have a good agreement with the Hillas formalism for the UHECR candidates.**

The official page of the project:

https://taiga-experiment.info/taiga-iact


Сверхновая SN 1987 ~ 10^{51}эрг
E_1
u_1
Ускоренные частицы
$V = -u_1 + u_2$
E_2
Ударная волна
Межзвездное магнитное поле


Akeno 1 km^2
Hi-Res 1
Hi-Res 2
Fly's Eye (mono) [6]
Fly's Eye (stereo) [7]
AGASA [3]
α=2.5
α=2.25
α=2.0
Super-GZK ?
$E^{2.7}$dN/dE (cm^{-2}sr^{-1}s^{-1}GeV$^{1.7}$)
E (eV / nucleus)
10
1
0.1
0.01
10^{17}
10^{18}
10^{19}
10^{20}
10^{21}