Astrophysical investigation in TAIGA experiment (project continuation)

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HIGH ENERGY GAMMA-RAY ASTRONOMY

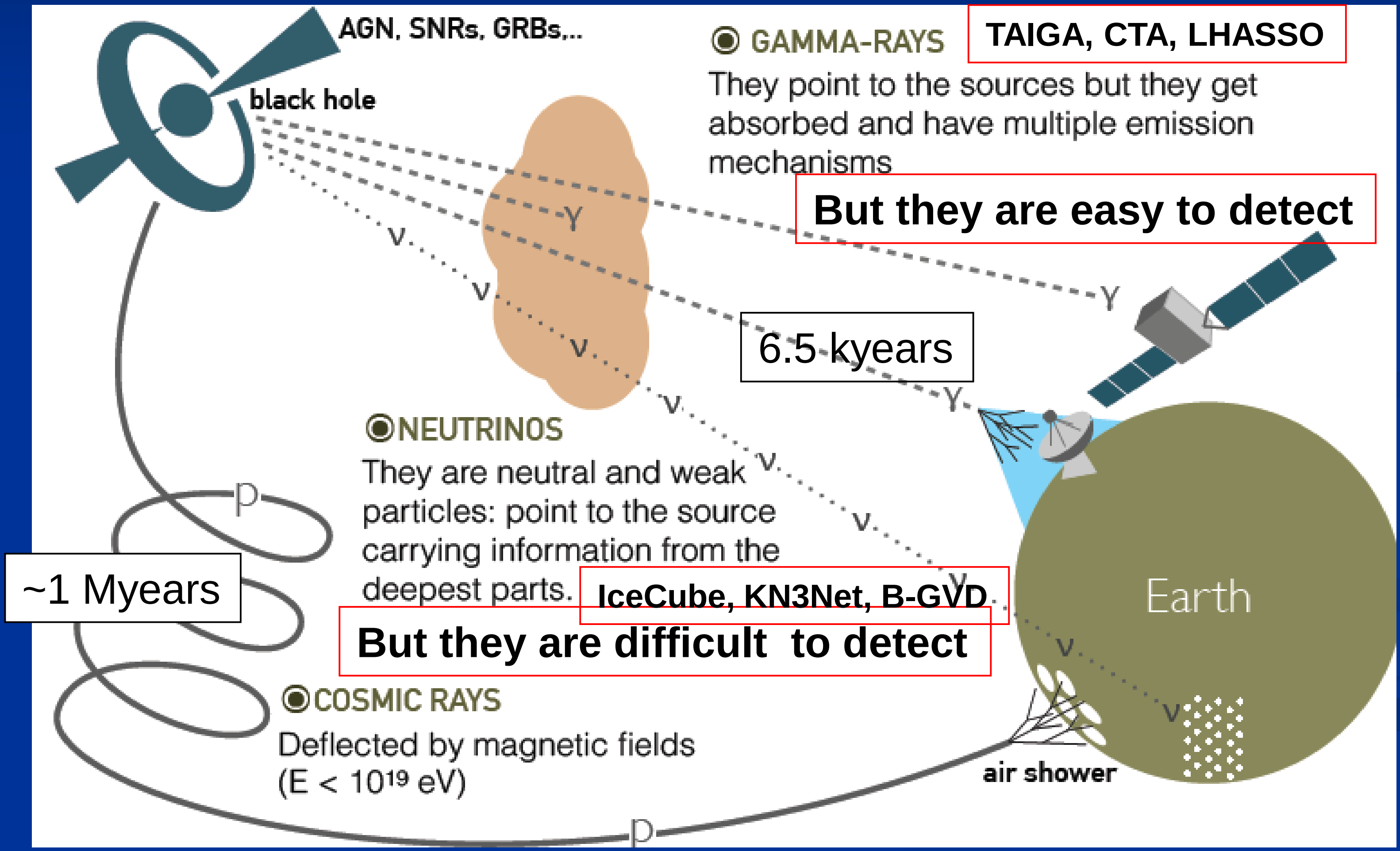
- Sources and methods of investigations. Multimessenger astronomy.

PROJECT TAIGA CONTINUATION

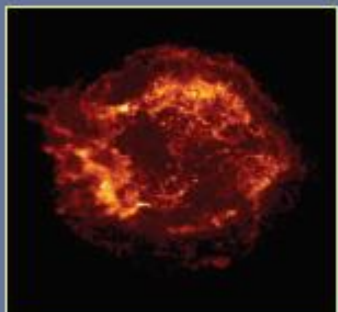
- TAIGA detector. Preliminary results.
- Future detectors
- TAIGA project continuation

Why gamma-ray astronomy?

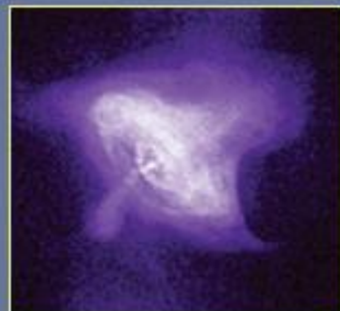
To understand how **Cosmic Accelerators work** we need to detect cosmic rays, gamma – rays and neutrinos



Physics objectives

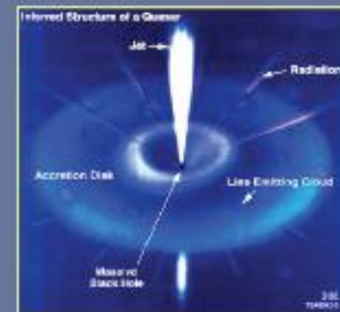


SNRs



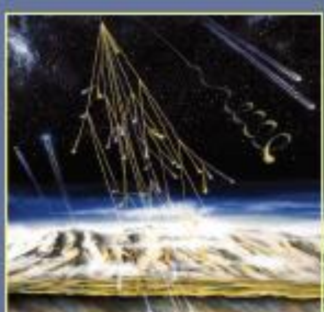
Pulsars
and PWNe

Micro quasars
X-ray binaries



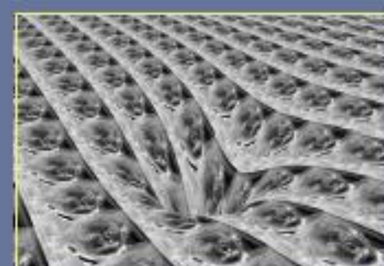
AGNs

GRBs

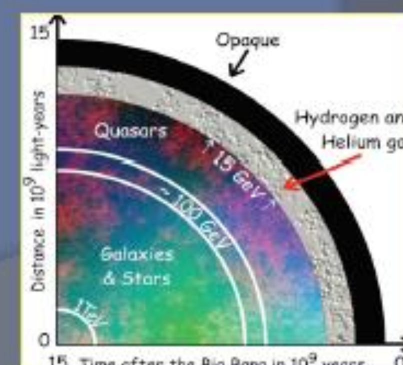


Origin of
cosmic rays

Dark matter

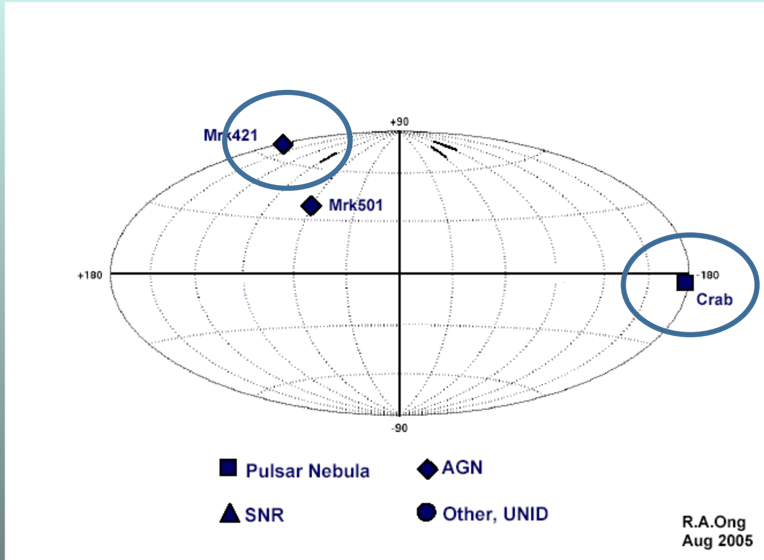


Space-time
& relativity



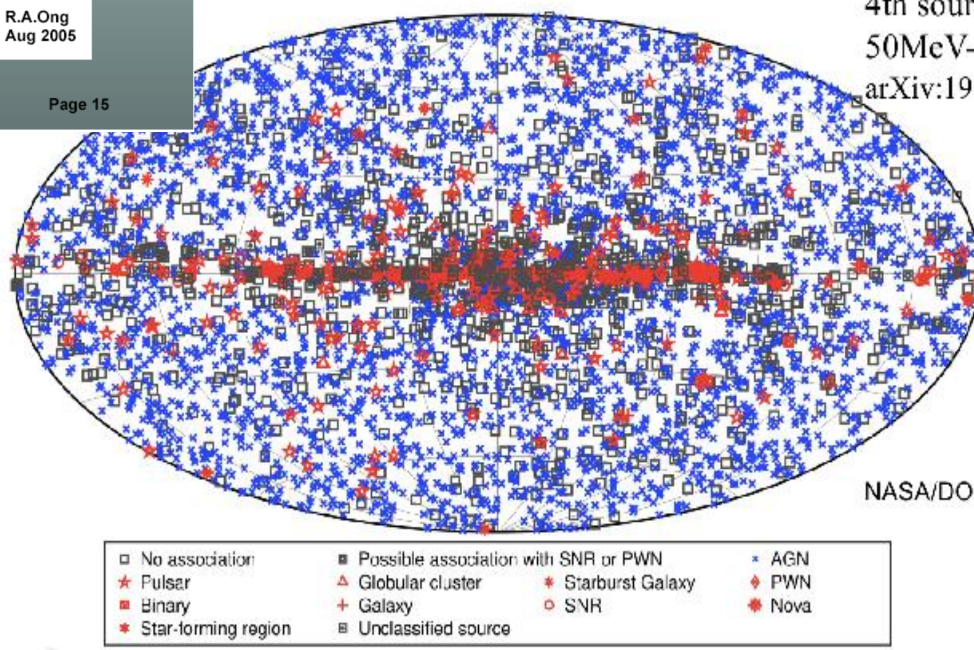
Cosmology

The VHE Sky - 1995



Fermi-LAT γ-ray sky

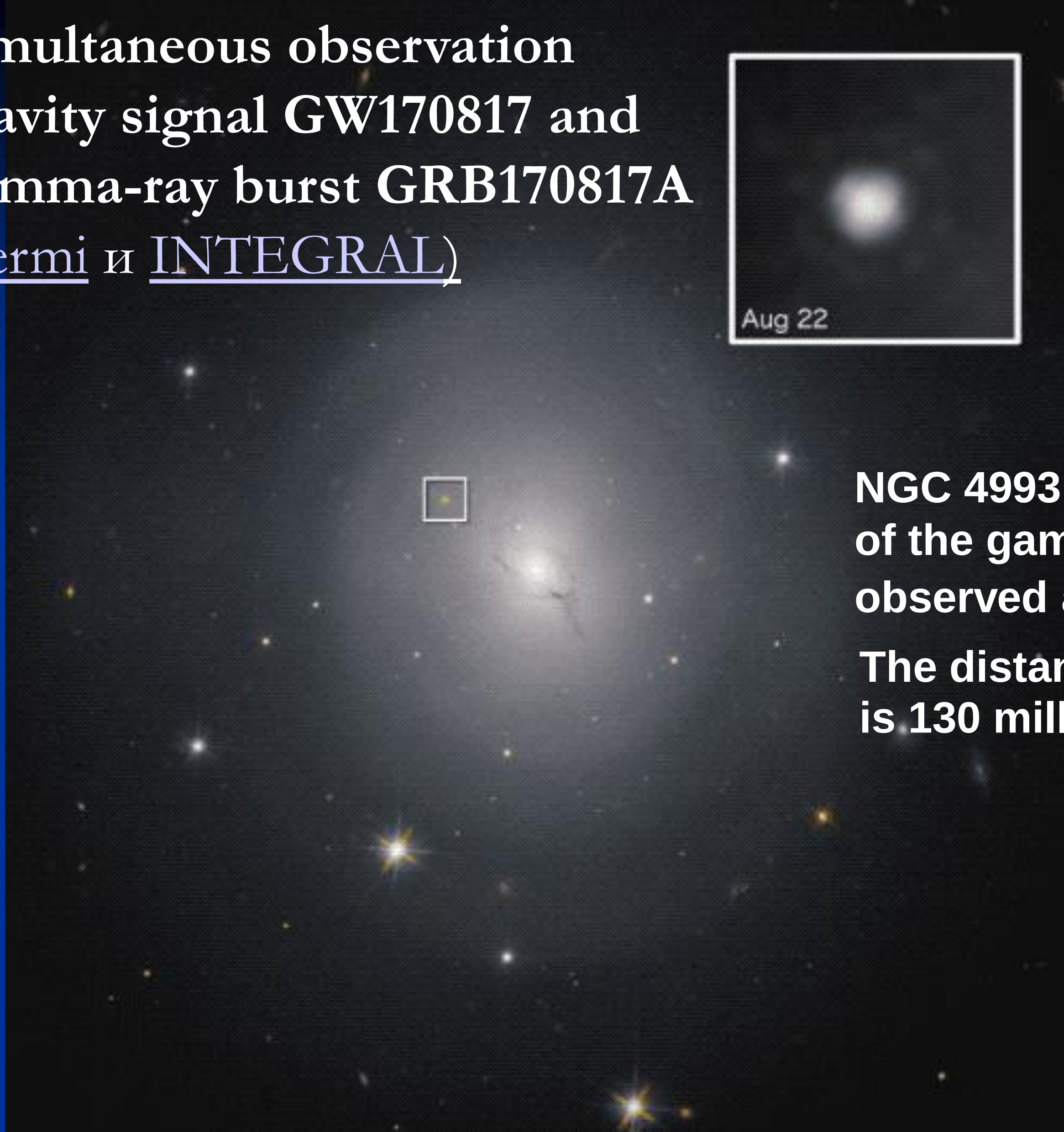
4th source catalog
50MeV-1TeV (8 yrs)
arXiv:1902.10045_v3



NASA/DOE/Fermi-LAT

- > 5000 sources > 100 MeV
- > 1550 sources above 10 GeV (3FHL) Fermi-LAT Collab., ApJS, 232 (2017)

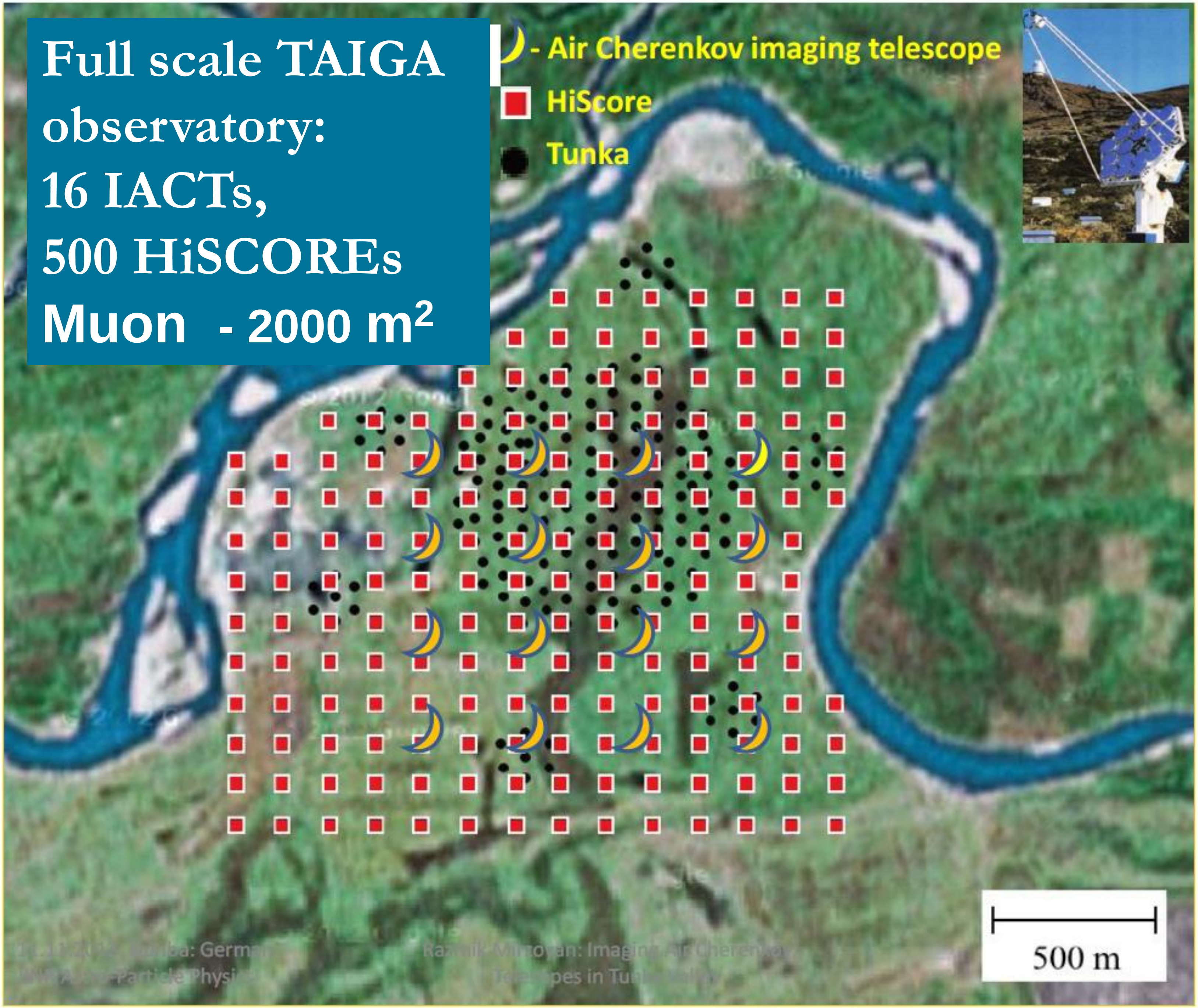
Simultaneous observation gravity signal GW170817 and gamma-ray burst GRB170817A (Fermi и INTEGRAL)



NGC 4993 and the optical afterglow of the gamma-ray burst (inset) observed atHubble space telescope

The distance to the source is 130 million light years

TAIGA EXPERIMENT


Full scale TAIGA observatory:
16 IACTs,
500 HiSCOREs
Muon - 2000 m²
- Air Cherenkov imaging telescope
HiScore
Tunka
500 m

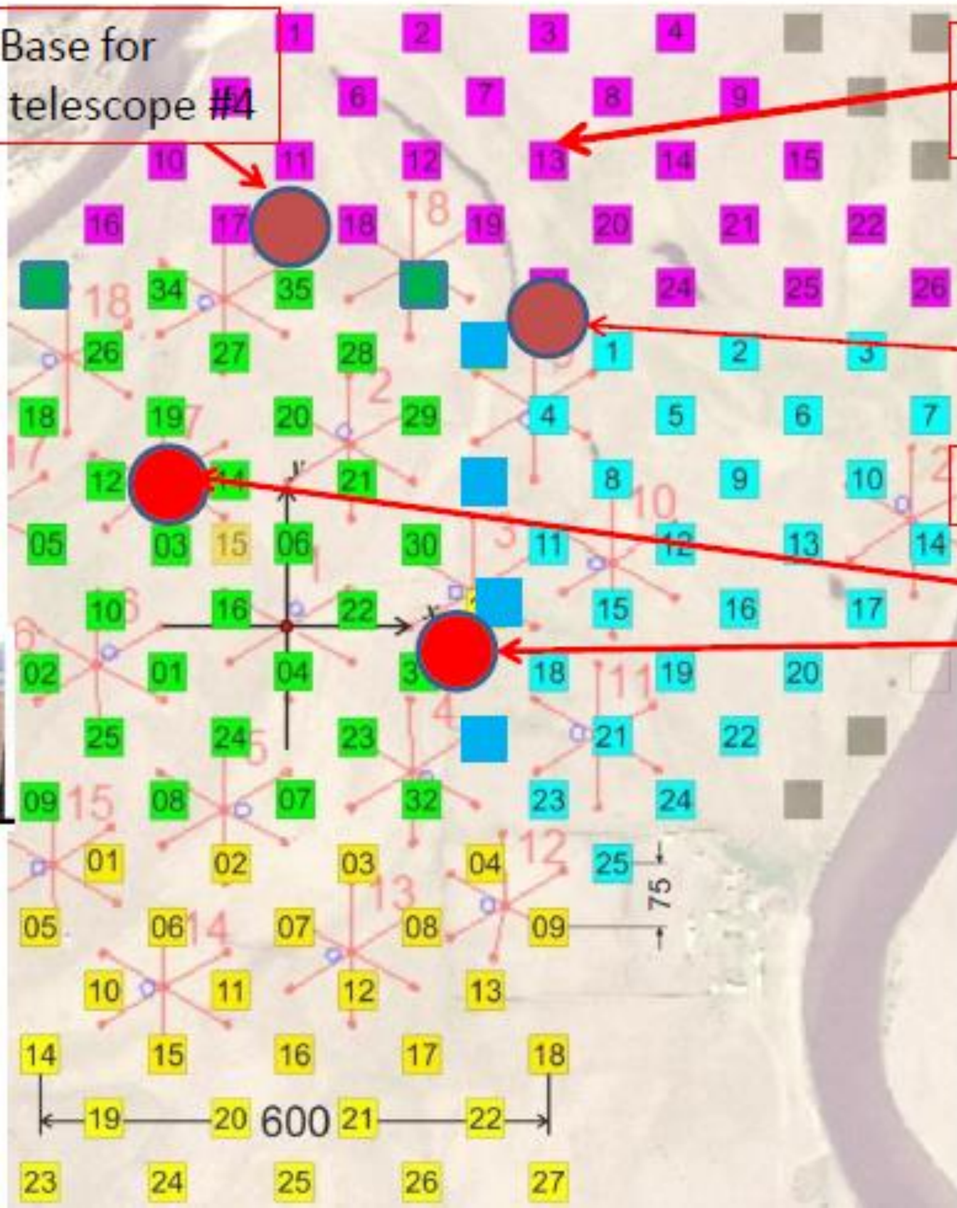
TAIGA EXPERIMENT 2020

N

Base for telescope #4

Cluster #4(30 station autumn 2020)

Cluster#1



Telescope #3 autumn 2020

Cluster #2

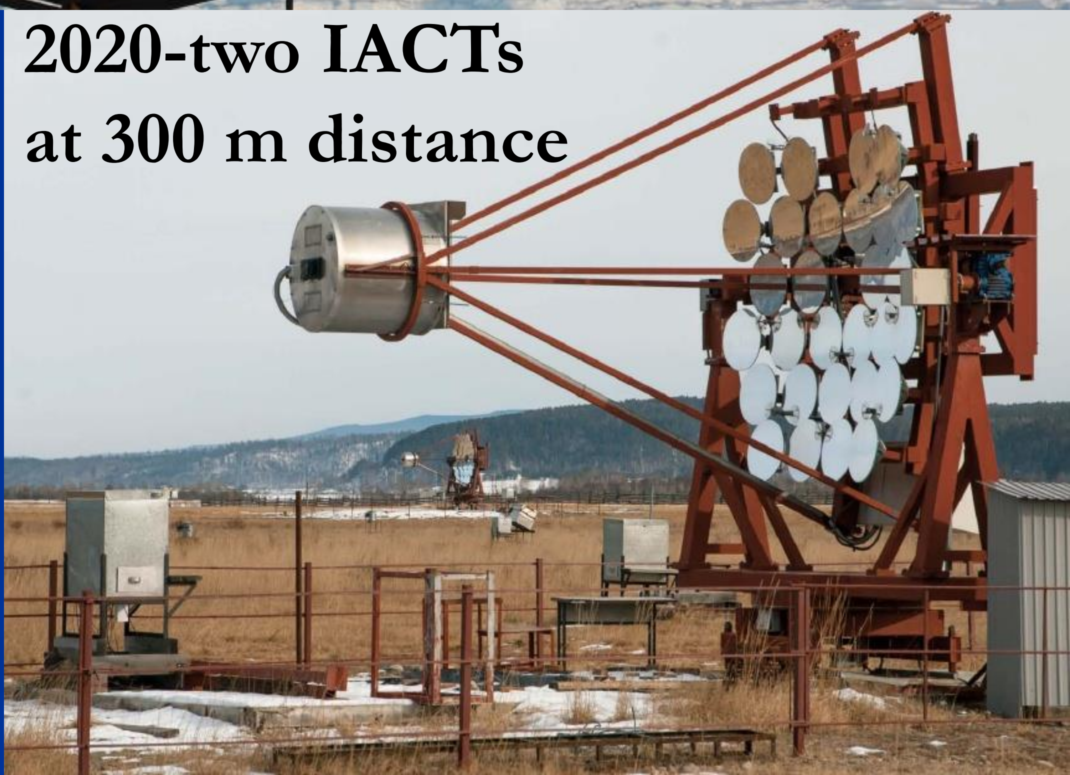
IACT#2
20/01

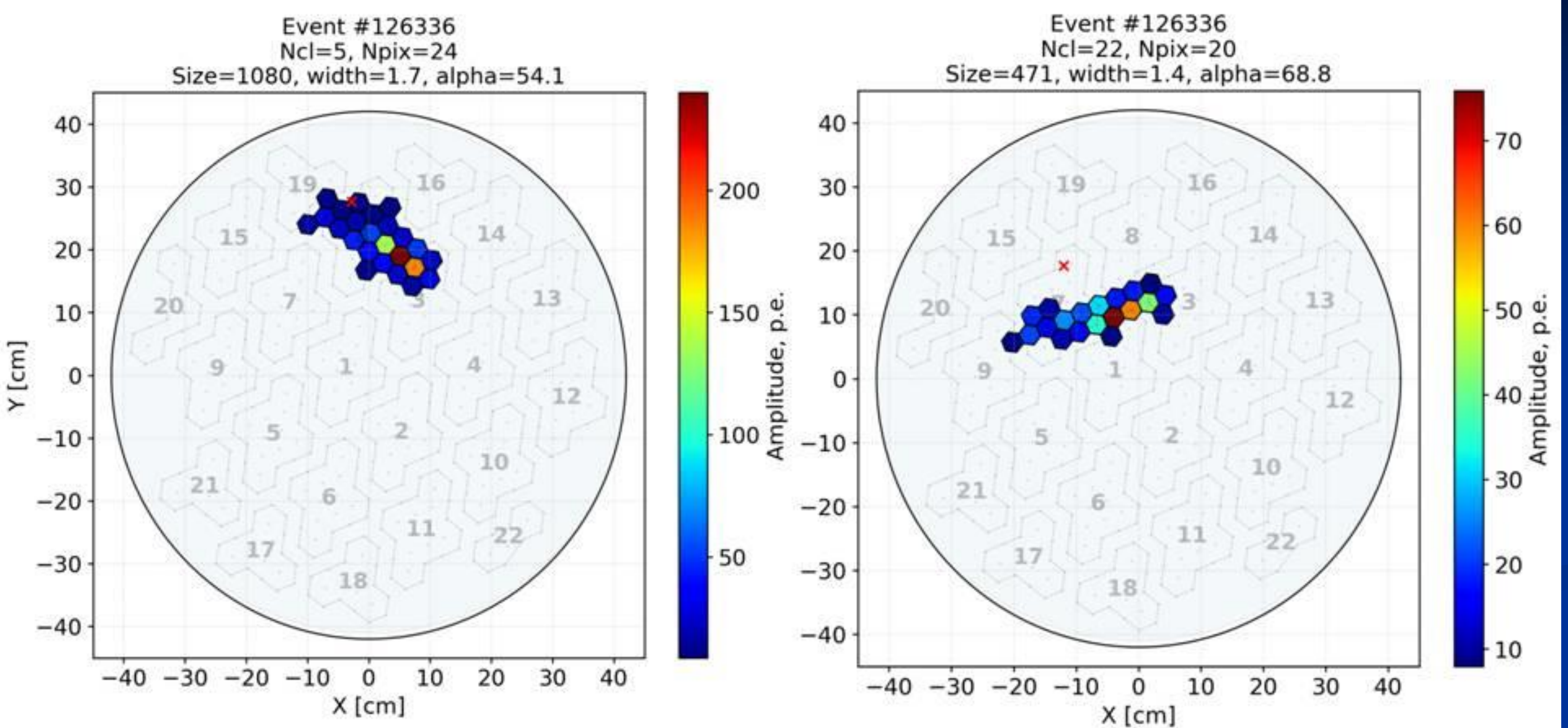
Main IACT parameters;

Spherical shape of 34 mirror modules with Ø 60 cm and with a total mirror area of 9.6 m^2;
Viewing angle ± 4.86°;
Turn around the horizontal axis (θ angle) -10 + 95°;
Turn around the vertical axis (φ angle) 0-410°;
The angular accuracy is 0.01°;
Driving and positioning system – remote with the possibility of computer control;
The rotation speed is ~ 2 deg/sec;

The camera with diameter of ~ 95 represents the matrix of PMTs with FE and DAQ electronics. The weight of the camera is ~ 200 kg and it is fixed at a focal length of 475±1 cm from the dish. Operating conditions – temperature: минус 40 to plus 30°C and high humidity

2020-two IACTs at 300 m distance



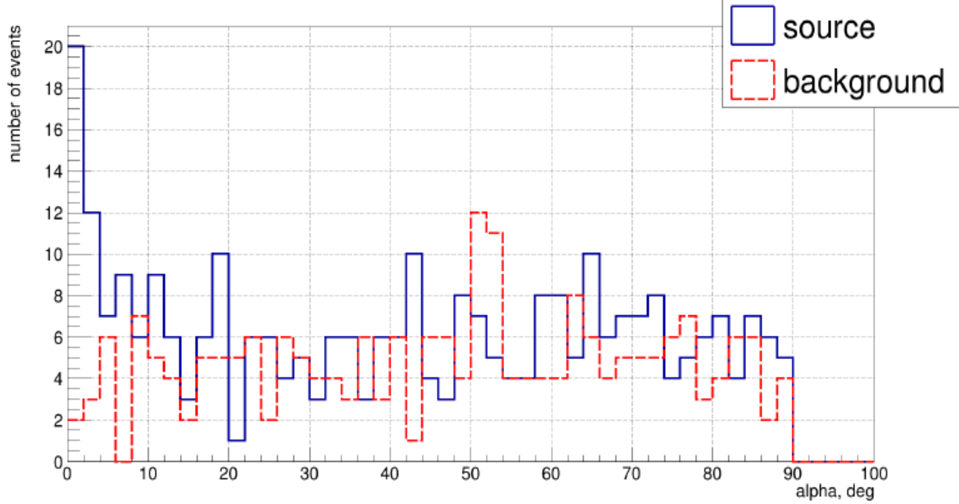


Size = 1080 pe, Width = 0.20 °

Size = 471 pe, Width = 0.17°

An example of EAS event that was measured by two TAIGA-IACTs

Data analysis 2019-2020

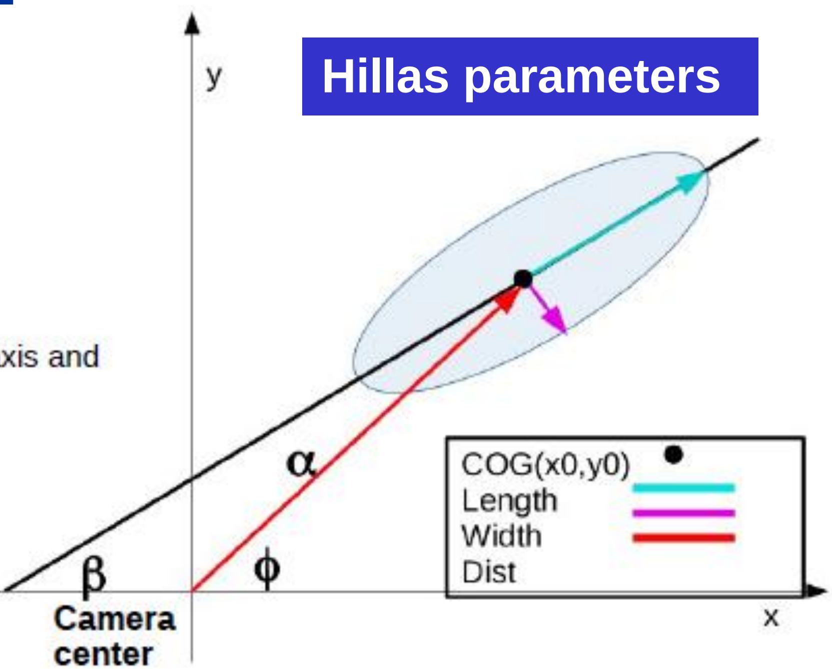


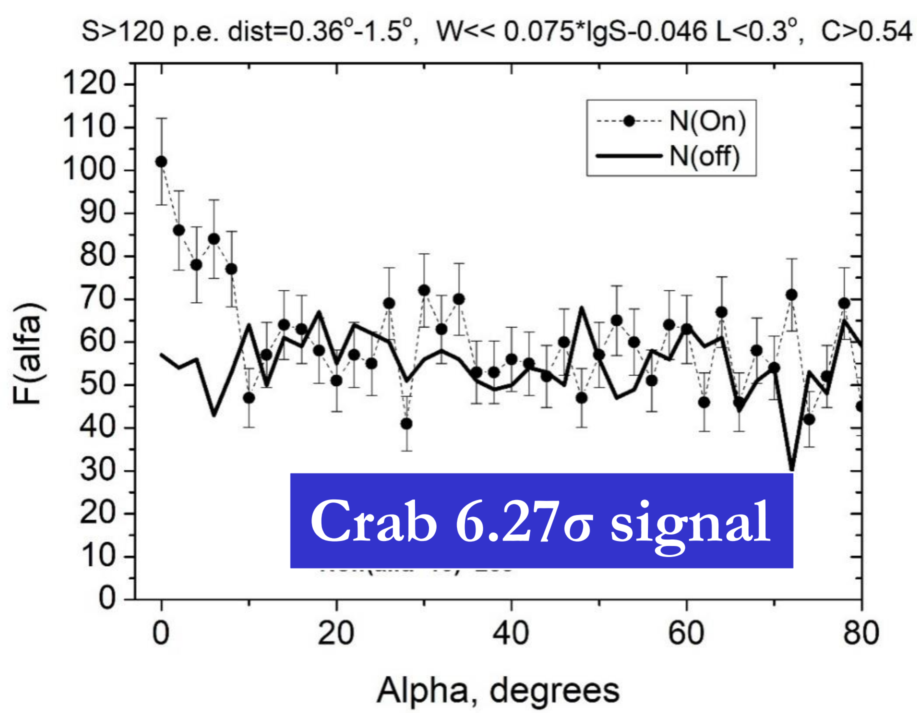
60 h

Mrk-421 5σ signal

Alfa < 8 , Size>170 p.e : Non = 48, Noff =11. Nexc =37

Significance (Li&Ma) =5.00





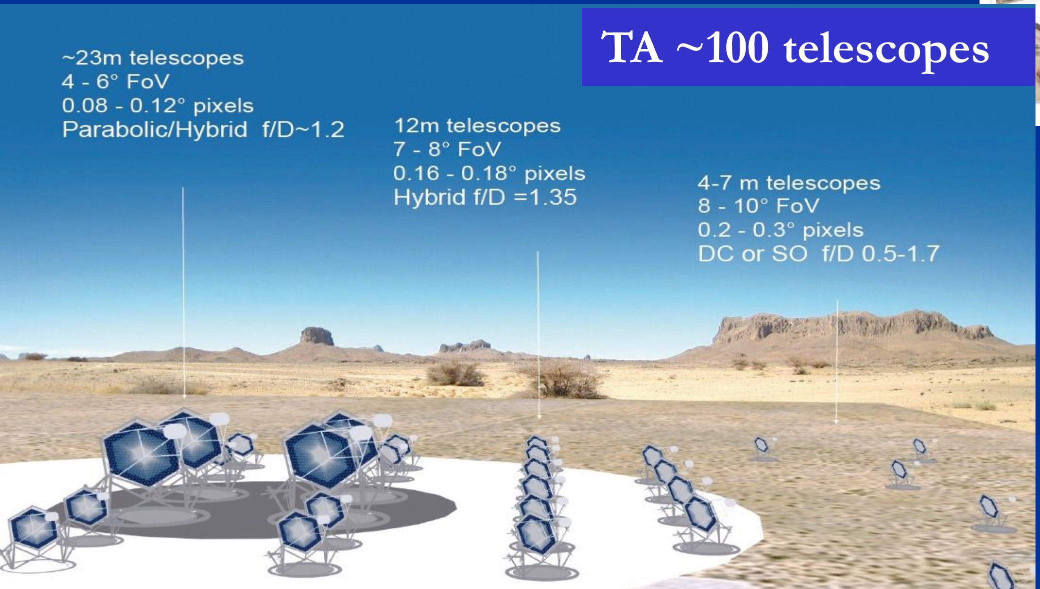
JINR activity – production, tests and delivery 4th IACT R&D and fabrication of the mirror facets for IACTs

3rd IACT commission and tests in JINR

Foundation of 4th IACT in Tunka

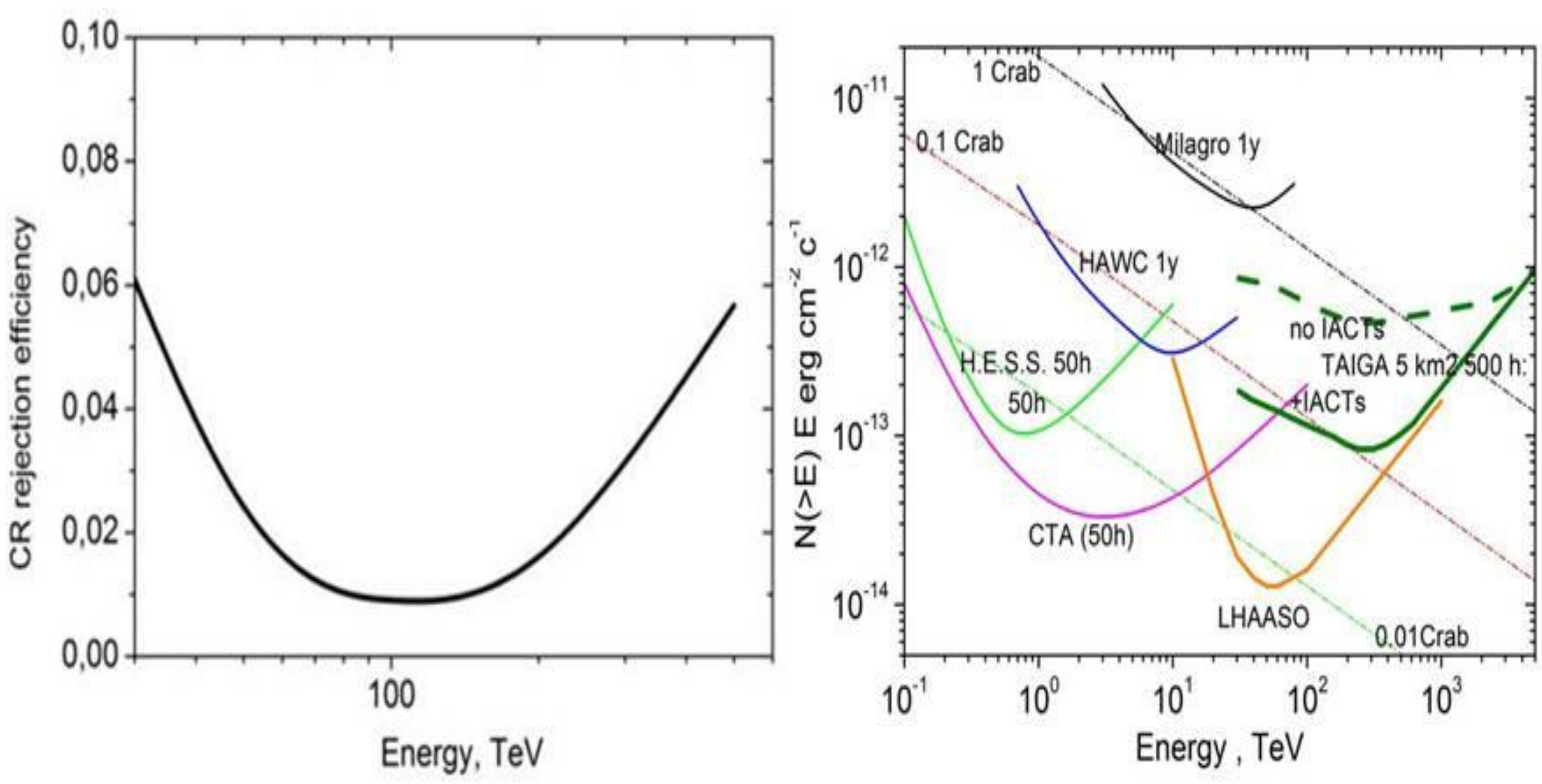
Energy spectrum of gamma: ~ E^{-2}. For Multi-Tev Gamma – ray astronomy we need array with area more than 1 km^2

FUTURE DETECTORS



TA ~100 telescopes

LHAASO Tibet 4400 m a.s.l.
1 sq.km,
~10000 different detectors



Left: Cosmic rays rejection efficiency. Right: Integral sensitivity for point sources for a 5 km^2 observatory. The dashed line marks the sensitivity without IACTs.

Expenditure for project (k$)

Astrophysical investigation in TAIGA experiment

Expense items	Total	2021	2022	2023
Direct expenditure				
1.LNP Design bureau (hours)	1000	800	100	100
2.LNP Workshop (hours)	1400	800	300	300
3.NPO “Atom” (hours)	30	30		
4.Materials	60	40	10	10
5.Equipment	60	40	10	10
6.Research work (contracts)	15	5	5	5
7.Business trips, including:				
- to states outsides rouble zone	30	10	10	10
- to states insides rouble zone	24	8	8	8
Total direct expenditure	**189.0**	**103**	**43**	**43**
RSF grant, Мруб	**12**	**6**	**6**	**-**

Conclusion

- Mechanics of three IACTs have been designed, produced in JINR and delivered to Tunka astrophysical center at 2016-2020

Plans for 2021-2023:

- 4th IACT fabrication and tests equipped with Dubna's focusing mirror facets - 2020-2021 (Kirichkov, LT, Borodin, Skrypnik, Pan, Grinyuk, Sagan)

- 4th IACT delivery and commission at Tunka (LT, Borodin, Pan)

- Dubna's group activity - 2020-2023

  in MC simulation (Grinyuk, Satyshev, Lavrova, Pan)

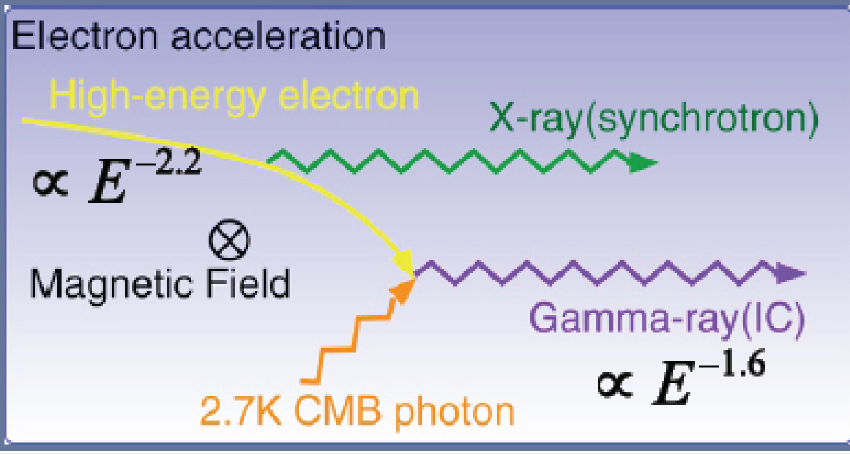
  in data taken at Tunka area (Sagan, Pan)

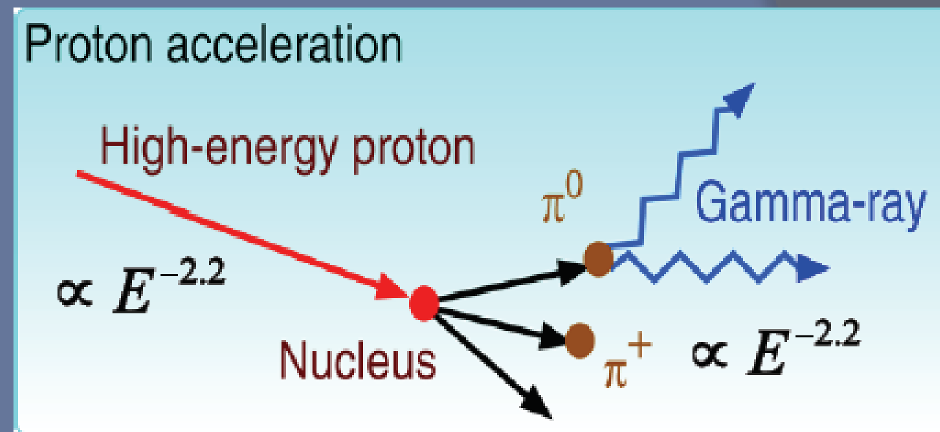
  in physical analysis (LT, Grinyuk, Satyshev, Lavrova, Pan, Grebenyuk)

- full scale TAIGA project preparation (LT, Borodin, Grinyuk)

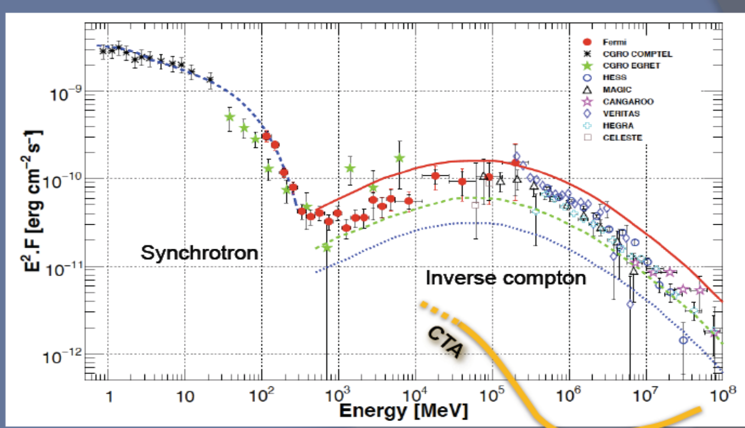
THANK YOU

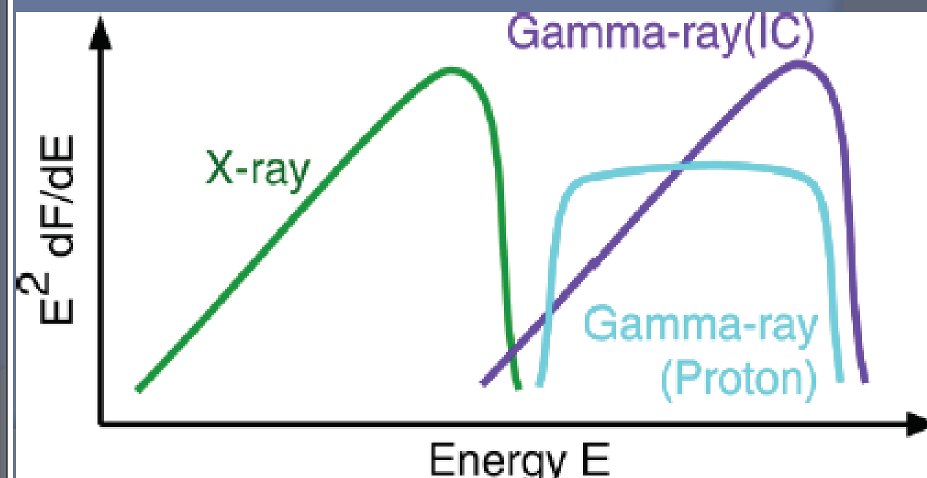
HIGH ENERGY GAMMA RAYS SOURCES

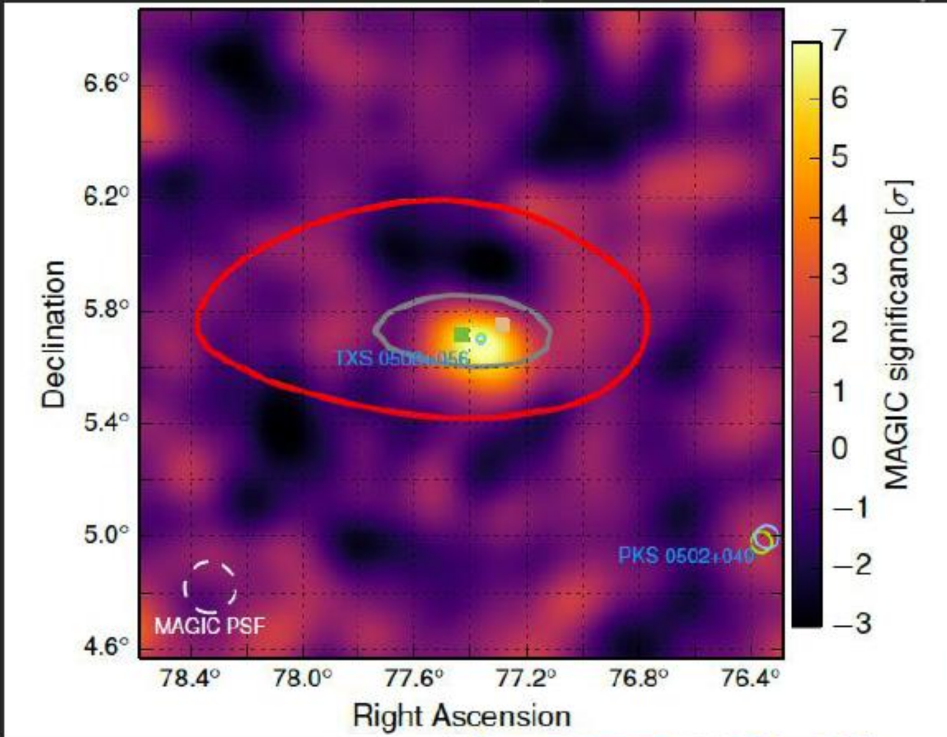




Crab Nebula







IceCube 170922

Z=0.34 distance ~1.7 Gpc

E_ν ~ 290 TeV

Fermi
detects a flaring blazar within 0.06°

MAGIC
detects emission of > 100 GeV gammas

Корреляция на уровне 3σ