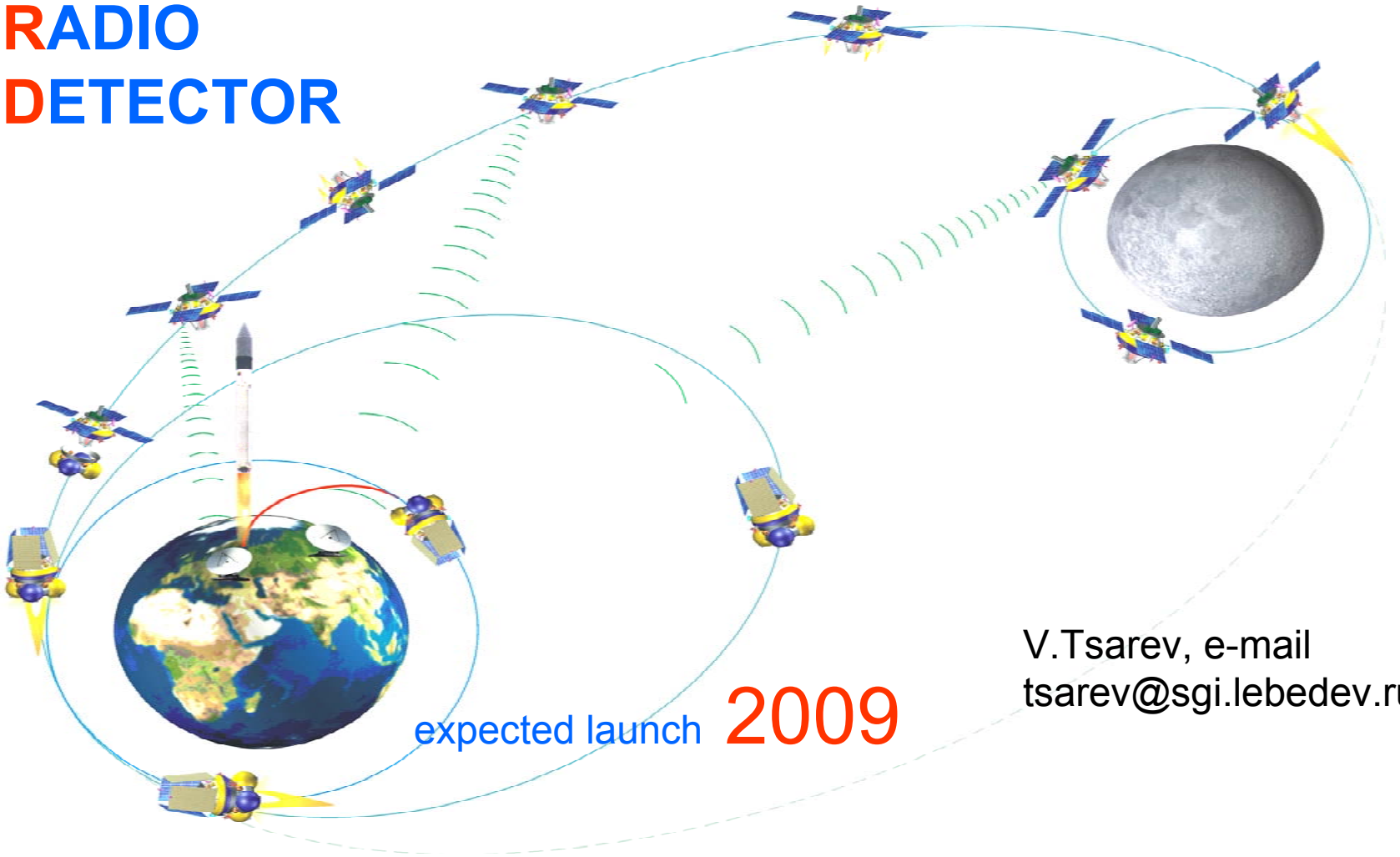
Detection of Ultrahigh-Energy Cosmic Rays and neutrinos by Radio Method

LUNAR ORBITAL RADIO DETECTOR

LPI, Lavochkin Association, MSU, JINR, ISP (Sweden)



expected launch 2009

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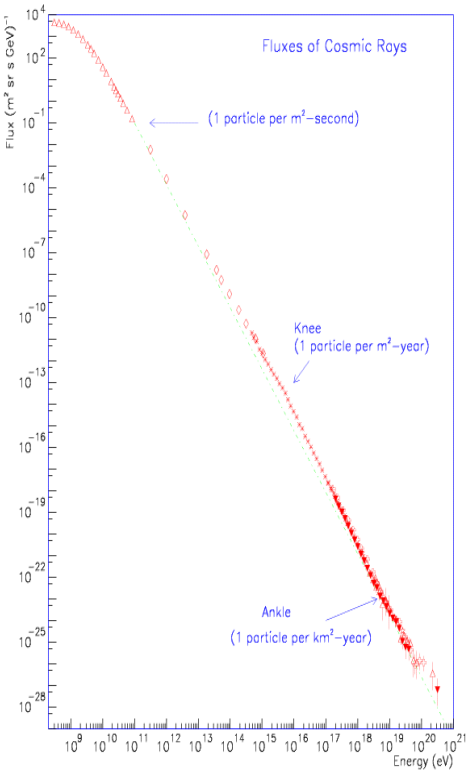
Scientific goals

1. Detection of UHECR & UHEN
2. Study of
   - lunar EM environment
   - lunar seismicity
   - space plasma

ULTRAHIGH-ENERGY CR AND NEUTRINOS

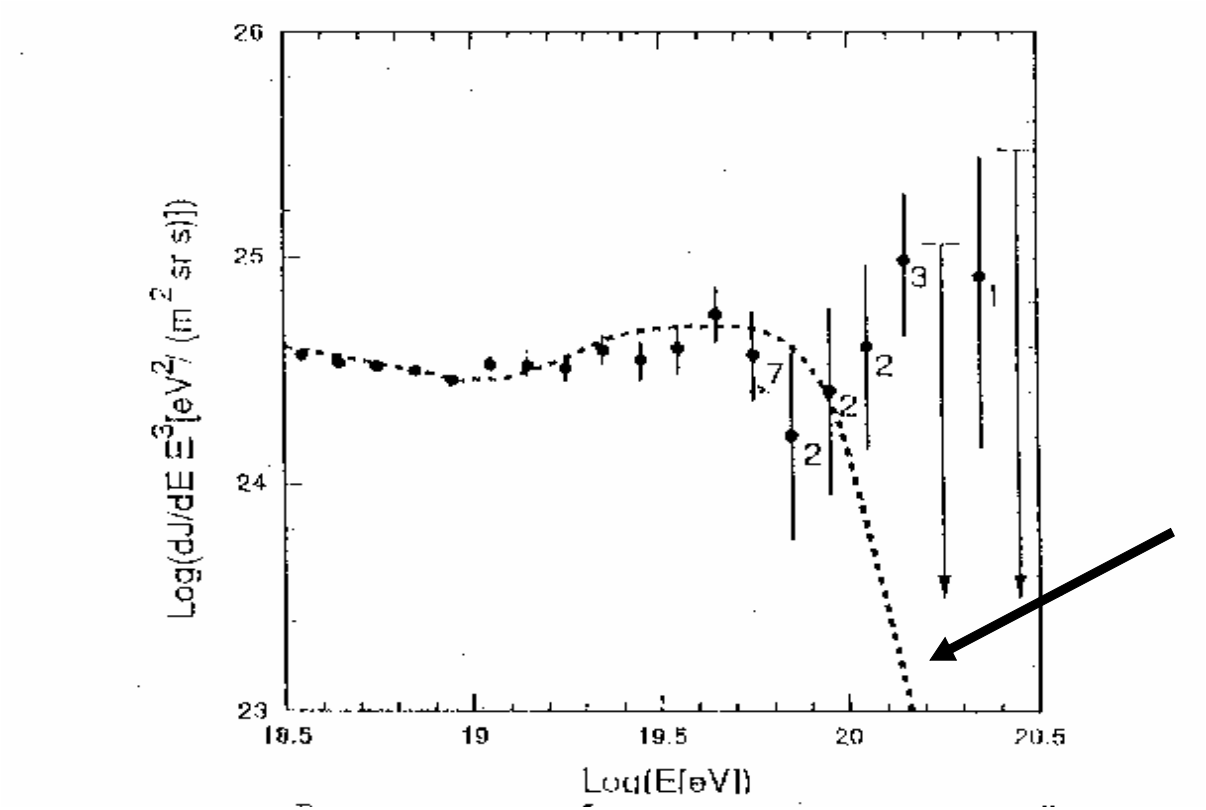


- **What are the highest particle energies in nature?**
- **What their sources?**

- **Many generations of CR detectors**
- **To-date ~ 20 events with $E \geq 10^{20}$ eV (UHECR)**

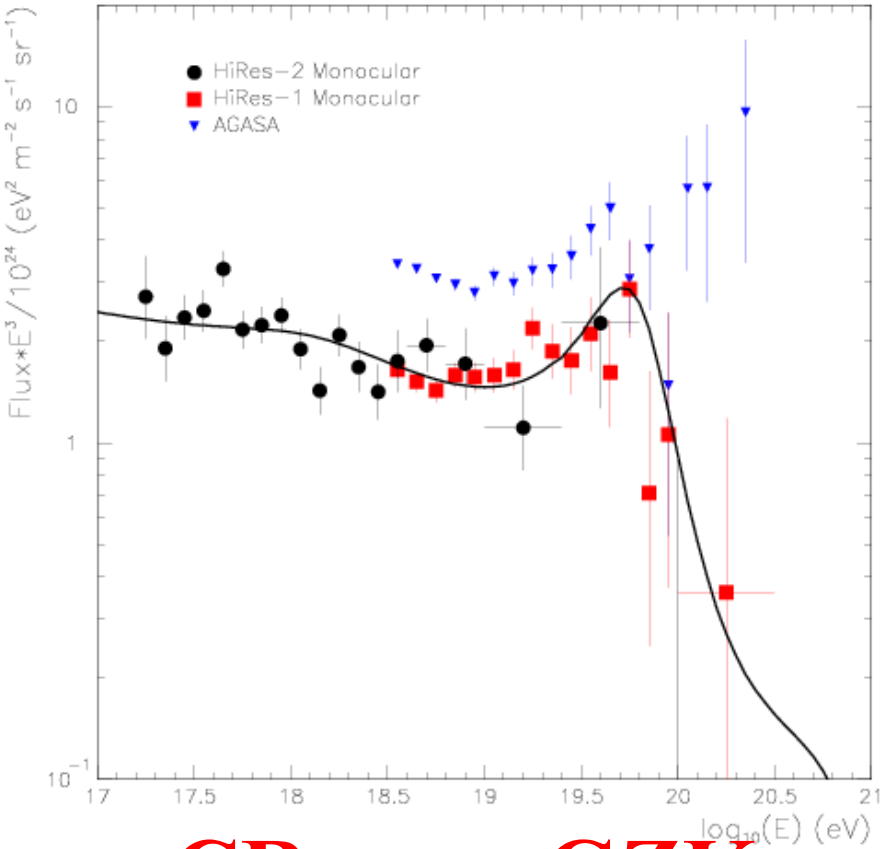
Nature? Sources?

"They should not exist"! ⇐ GZK cutoff caused by interaction with the MCBG

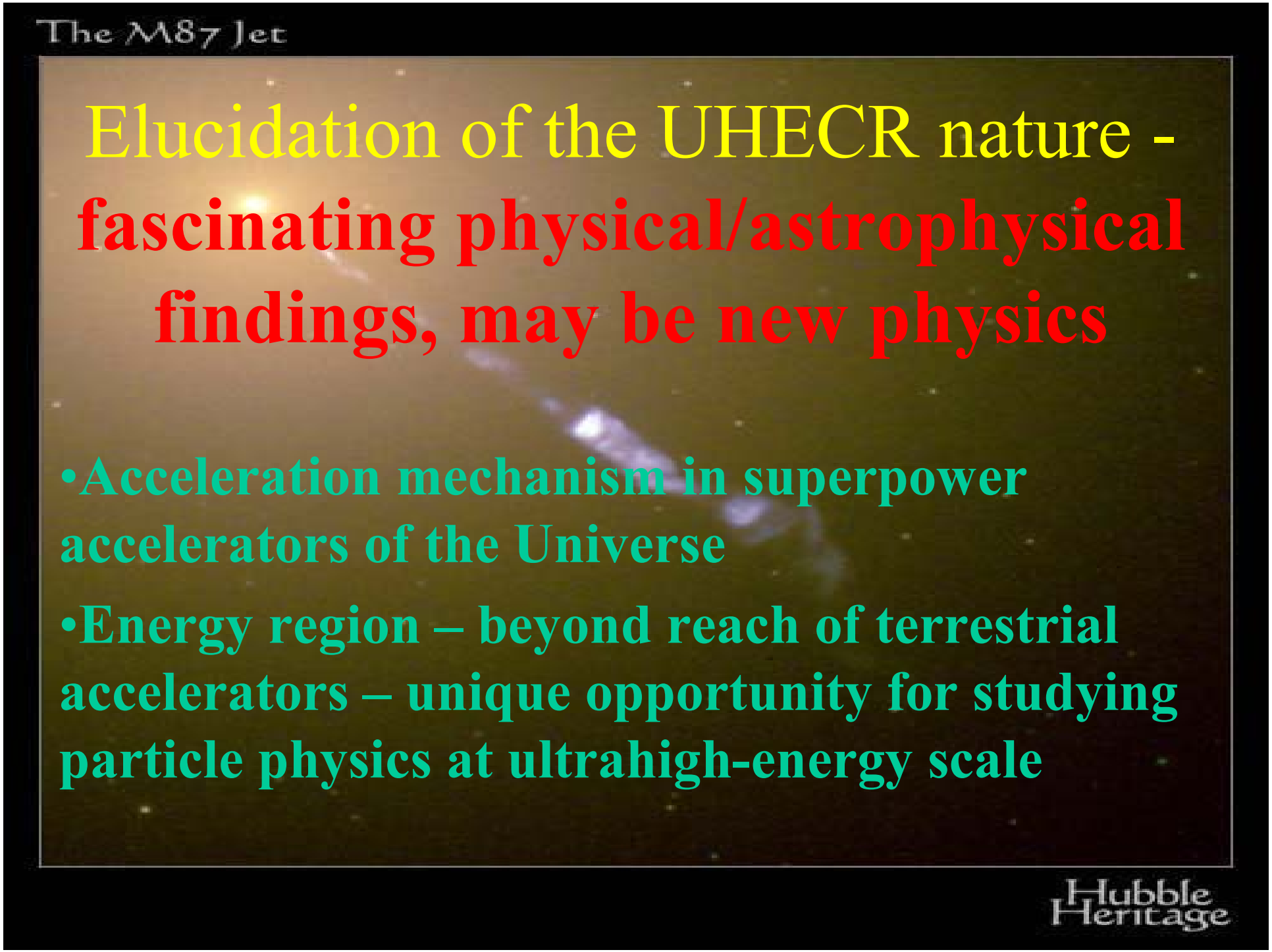


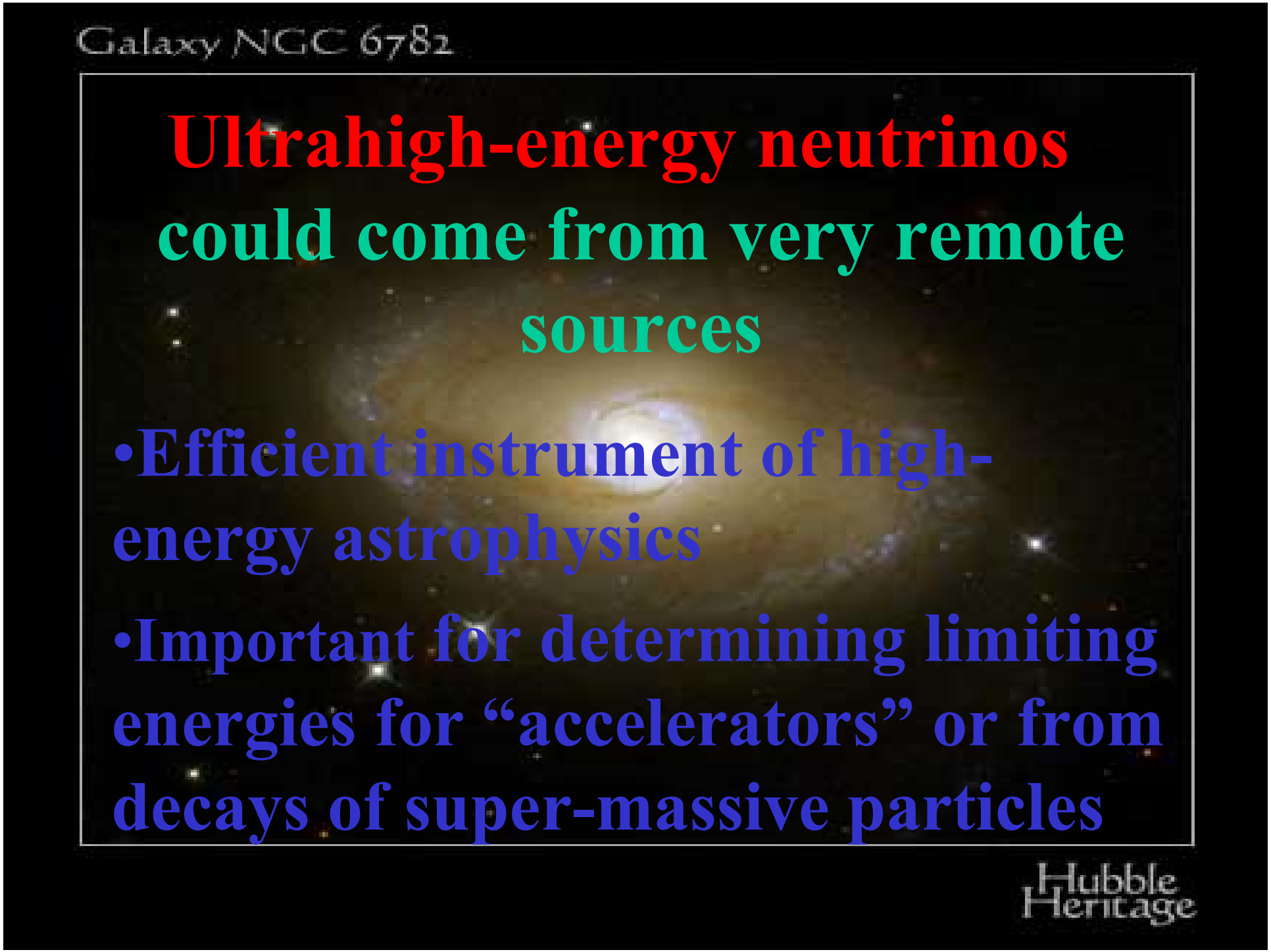
GZK cutoff

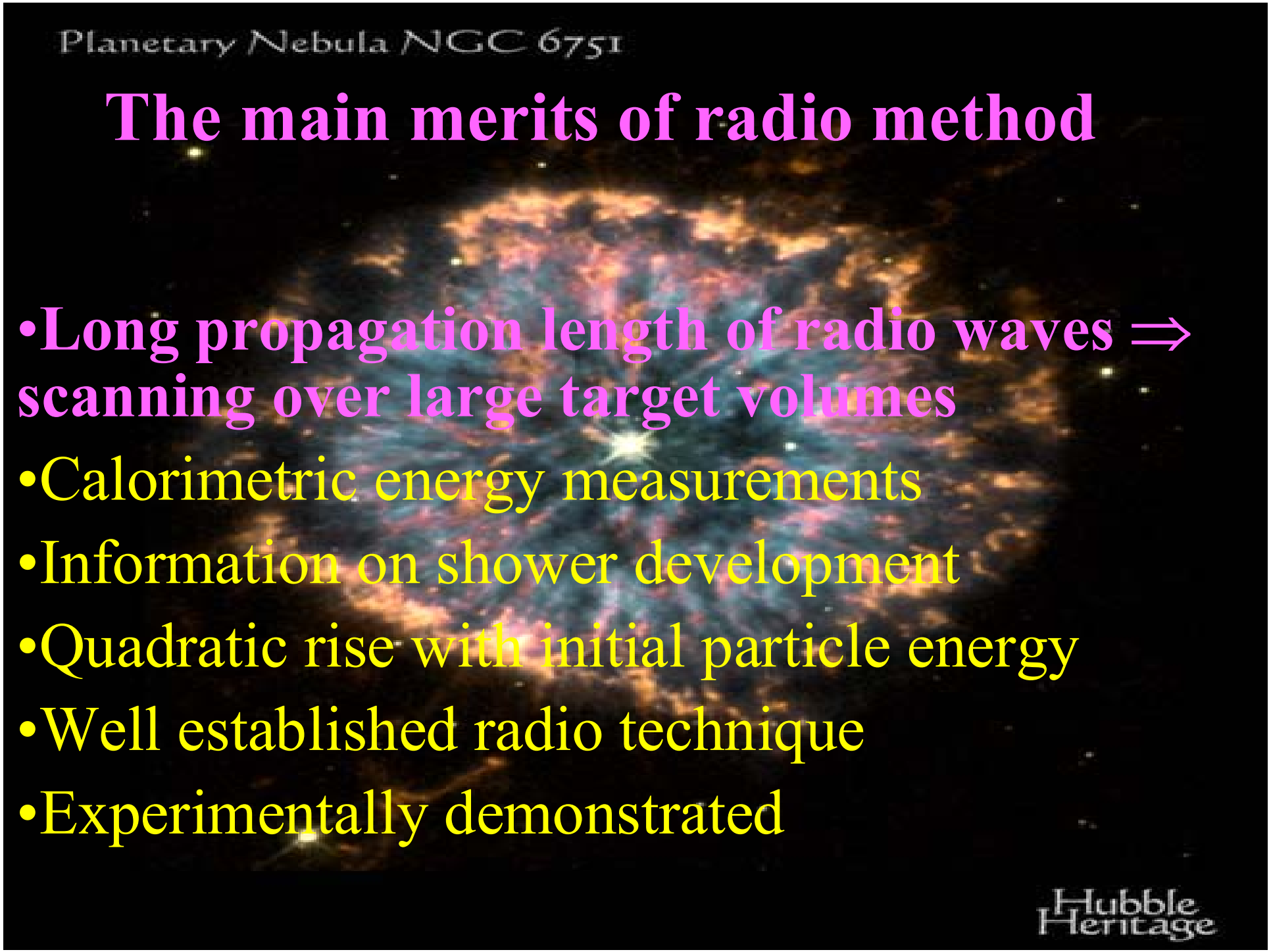
Preliminary data from HiRes



New data on CR near GZK are needed!


The M87 Jet
Elucidation of the UHECR nature - fascinating physical/astrophysical findings, may be new physics
•Acceleration mechanism in superpower accelerators of the Universe
•Energy region – beyond reach of terrestrial accelerators – unique opportunity for studying particle physics at ultrahigh-energy scale
Hubble Heritage

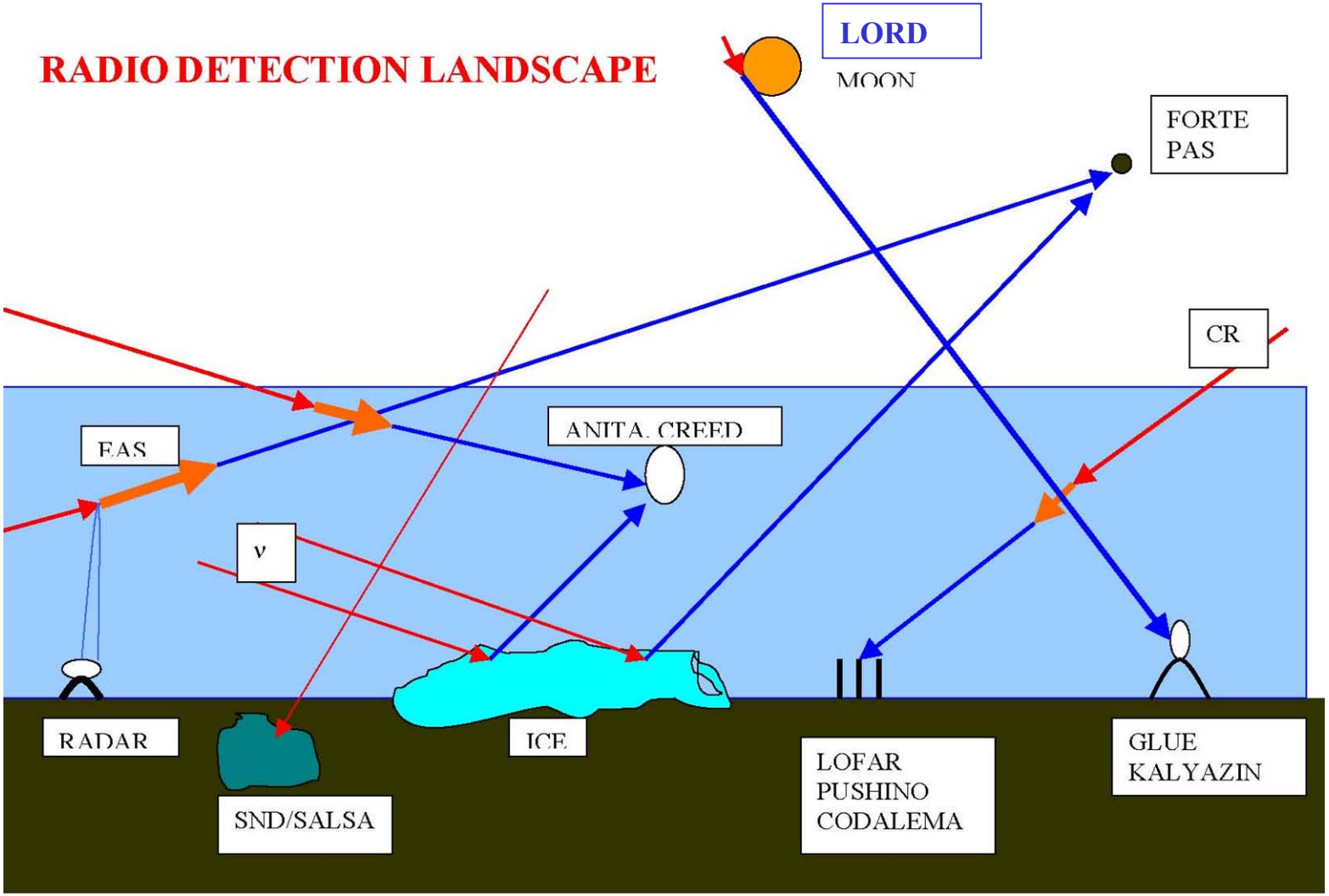

Galaxy NGC 6782
Ultrahigh-energy neutrinos could come from very remote sources
•Efficient instrument of high-energy astrophysics
•Important for determining limiting energies for “accelerators” or from decays of super-massive particles
Hubble Heritage



The main merits of radio method

- **Long propagation length of radio waves ⇒ scanning over large target volumes**
- Calorimetric energy measurements
- Information on shower development
- Quadratic rise with initial particle energy
- Well established radio technique
- Experimentally demonstrated

Current initiatives on UHECR and UHEN radio detection – about dozen of experiments or proposals



Why the Moon as a target?

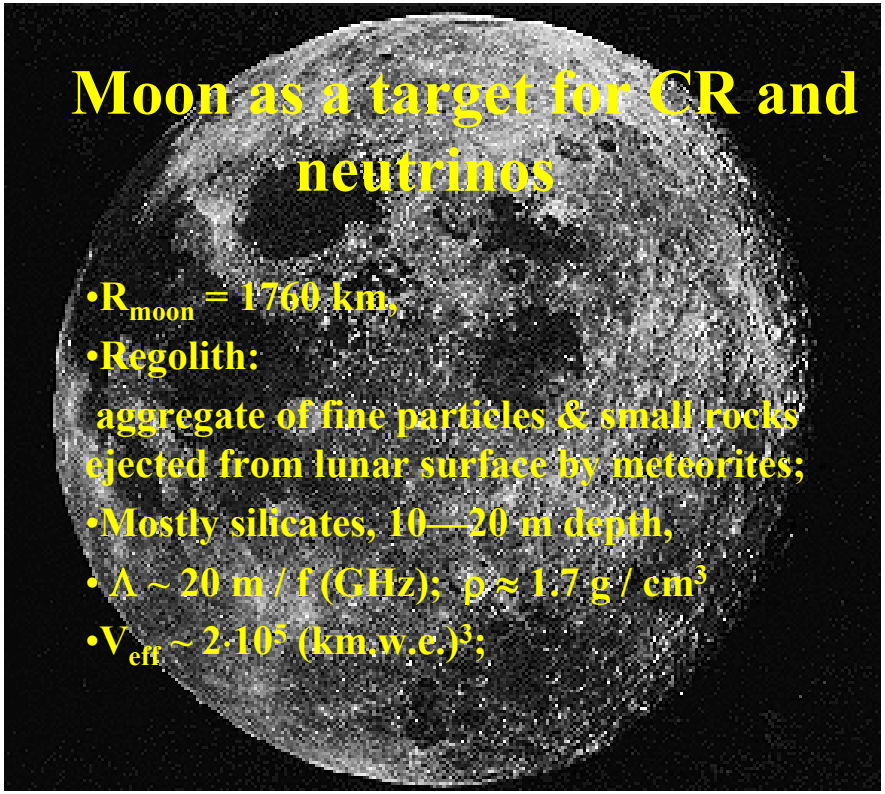
The min merits of the Moon:

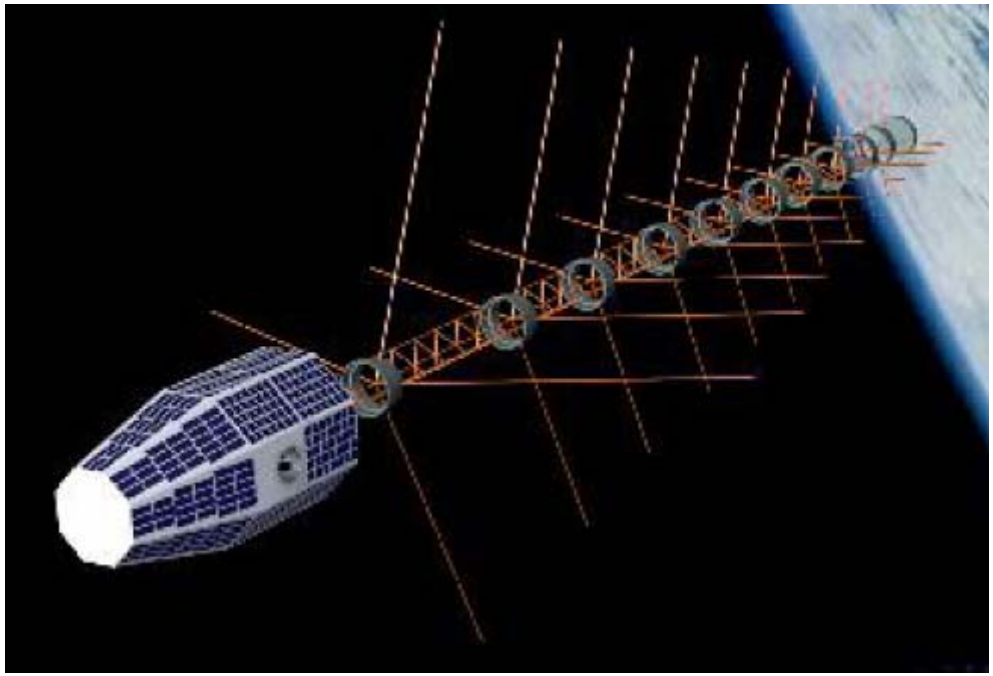
Huge target mass: Veff ~ 10*5 (km.w.e.)3

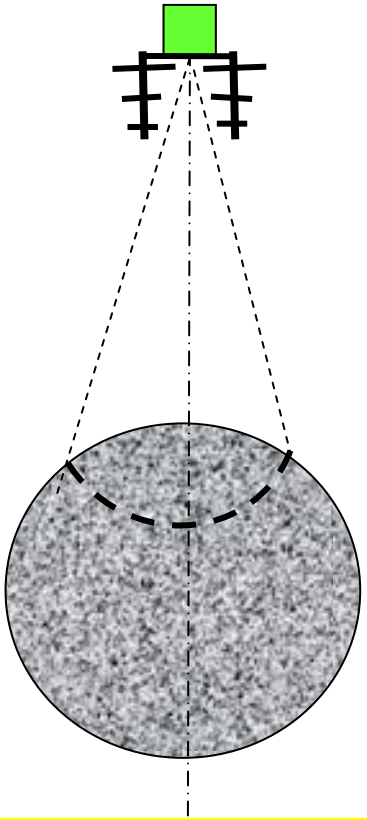
Lunar satellite:

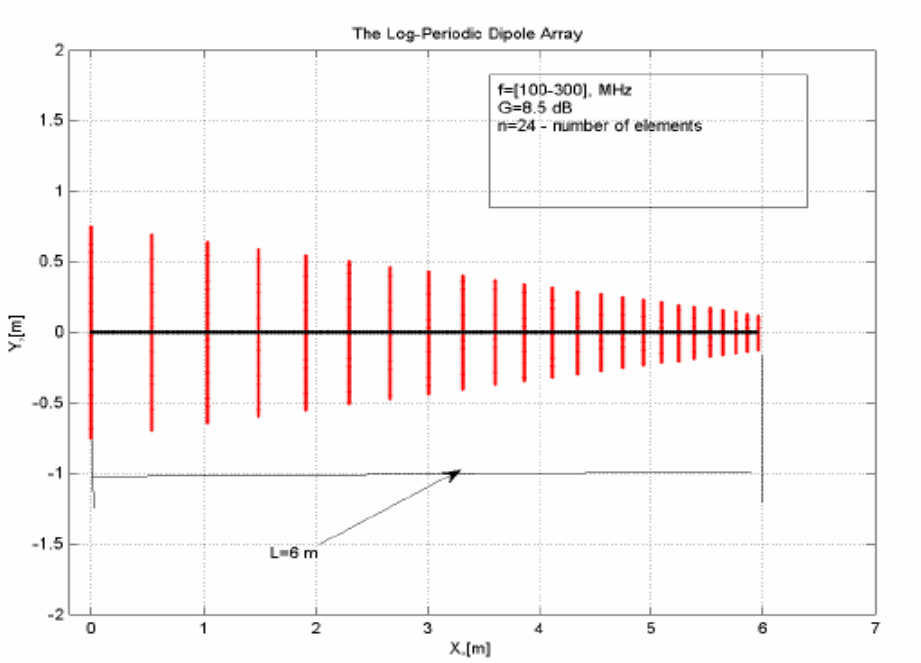
Very favorable background conditions

Short (and variable) distance – high signal





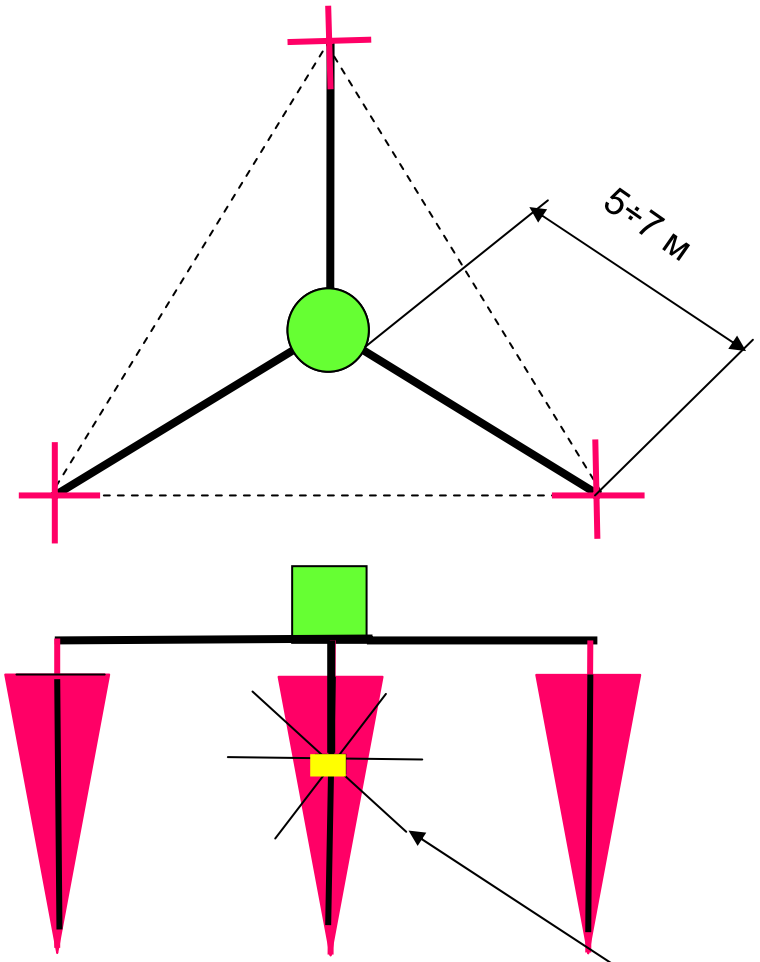




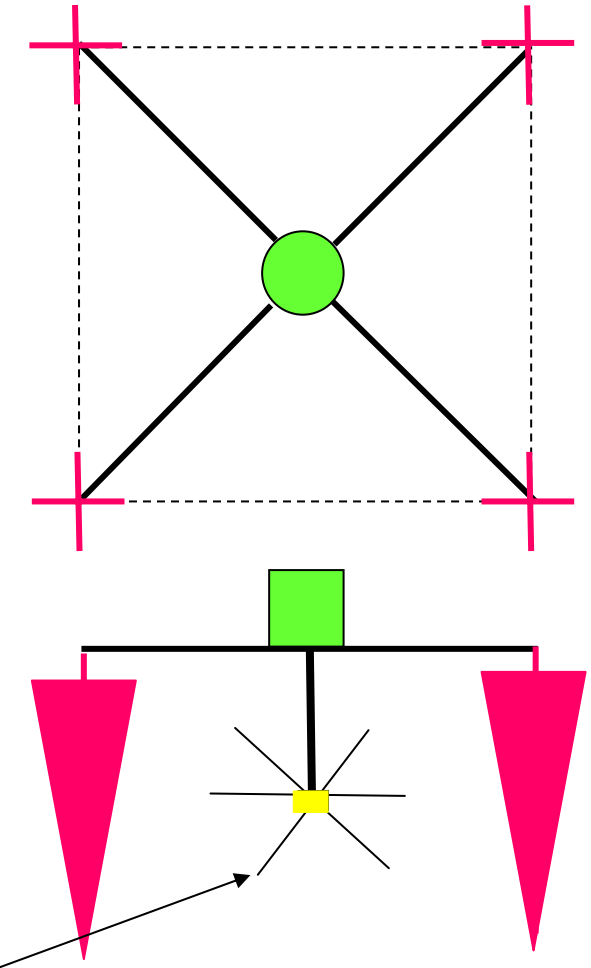
Radiodetector consist of 3-4 log-periodic antennas (frequency range: 100÷300 МГц, polarization - two linear orthogonal, G=8.5 дБ)

Power	20÷25 W
Volume	~0.006 м^3
Data steam	5 MB/day

3 Log-periodic antennas

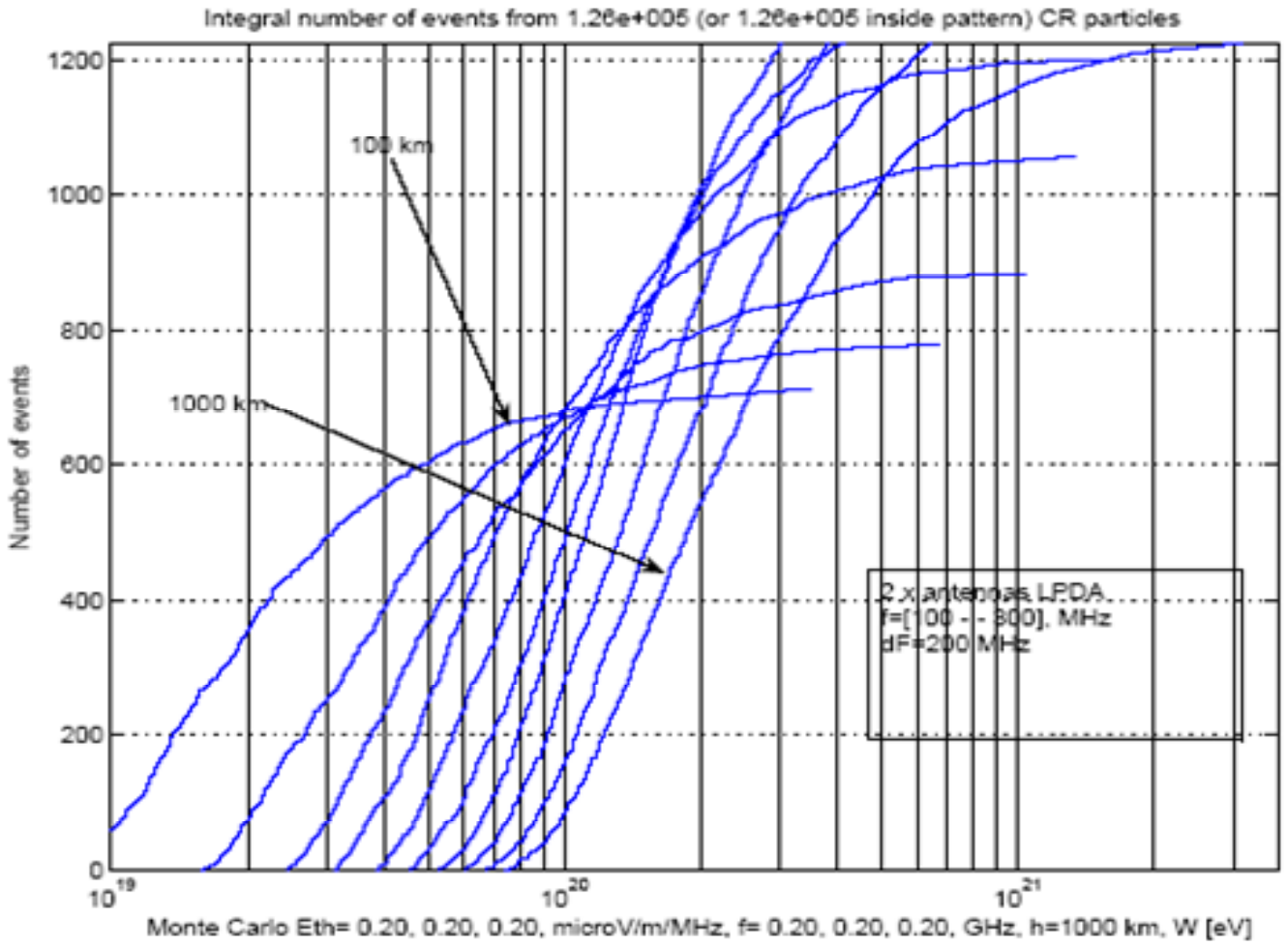


4 Log-periodic antennas



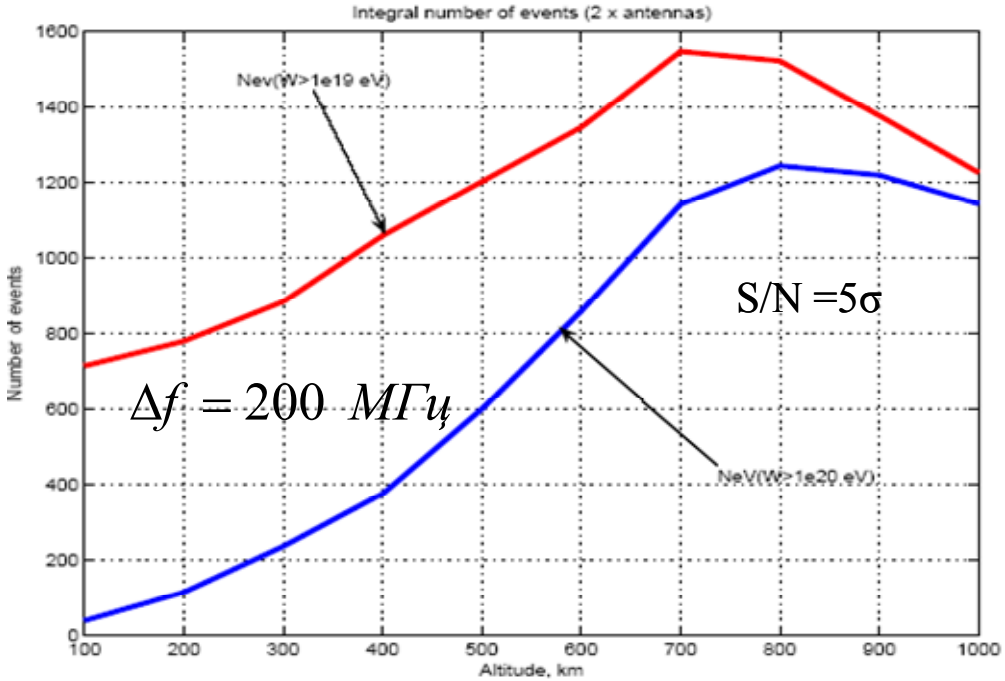
3D - ELVIS

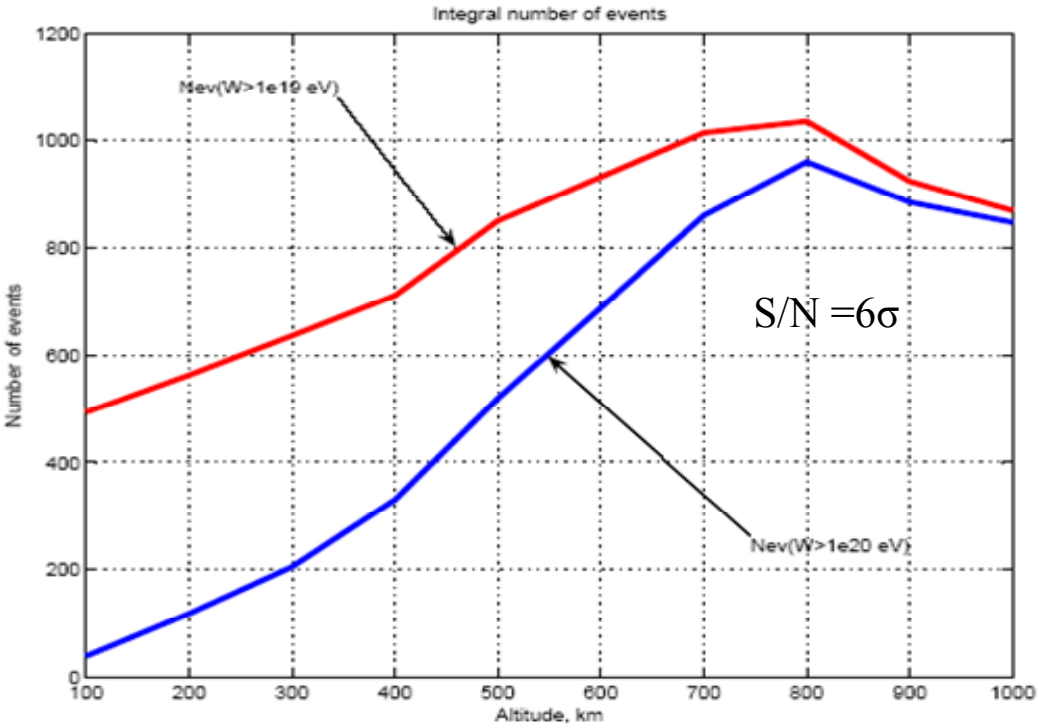
Integral counting rate for the energy interval $10^{19} \div 10^{20}$ eV and various orbit altitudes from 100 км to 1000 км



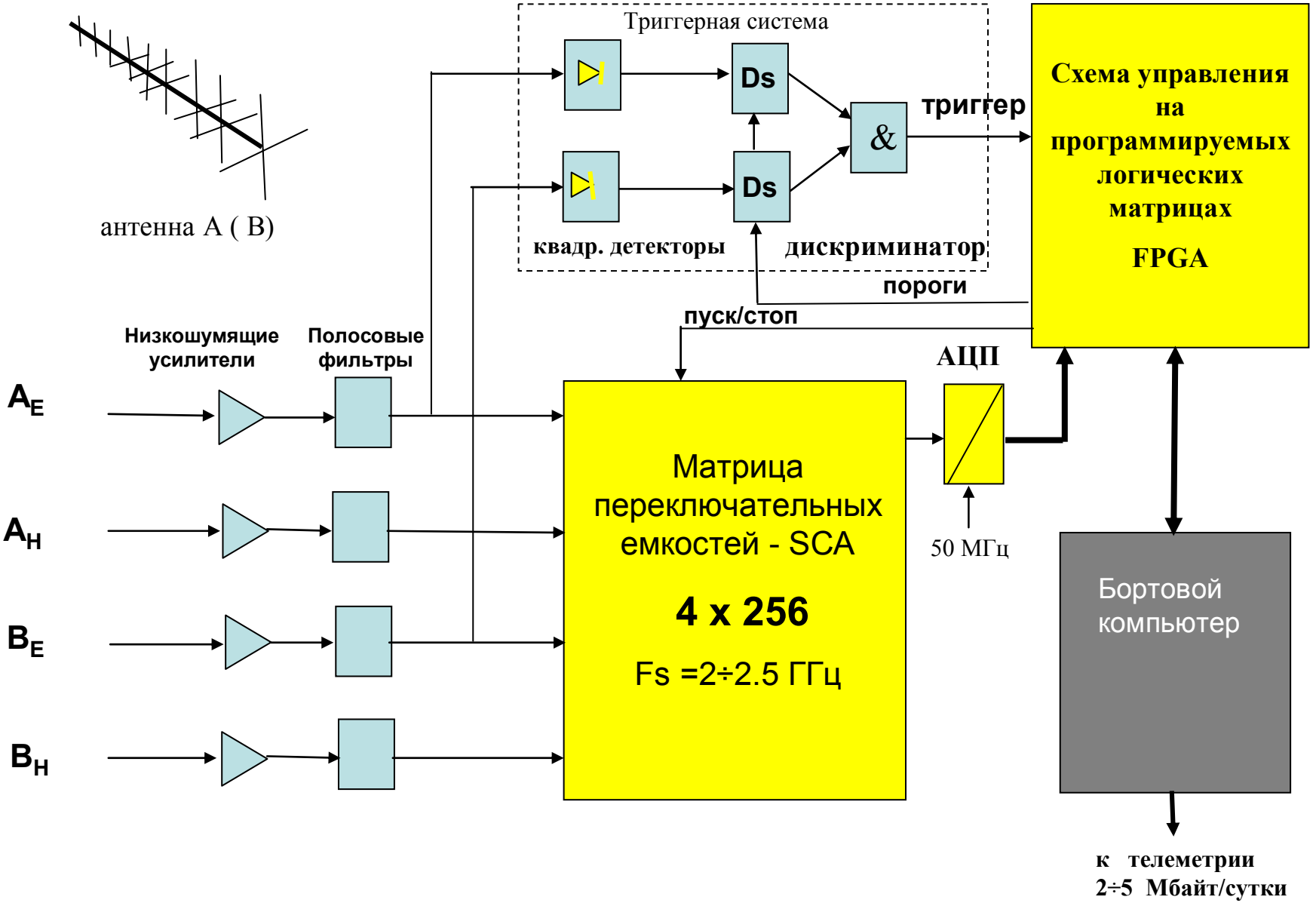
Integral counting rate for S/N =5σ и 6σ

$$E_{th} \approx \frac{1}{\sqrt{A_{eff} \times \Delta f}}$$



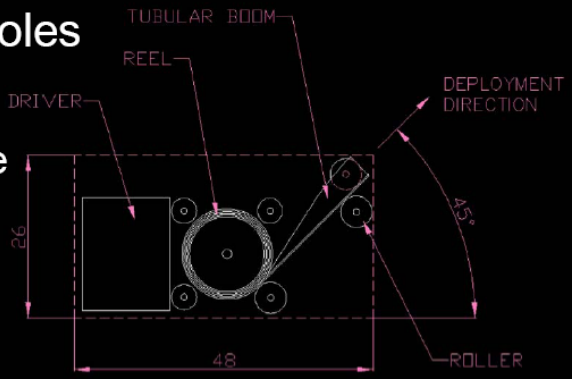


Block diagram (two antennas are shown)



Electric Antennas (EANT)

- 6×2500 mm monopoles
- Metal foil on reel
  - Titanium, Be-bronze or stainless steel
- 150 gram per unit
- Well proven design
  - Alouette, Cassini, …



EANT deployment unit, NS1 25 g/1000 mm version.

LOIS Test Station, the Risinge site, Växjö, Sweden

January, 2005 (after the hurricane)