

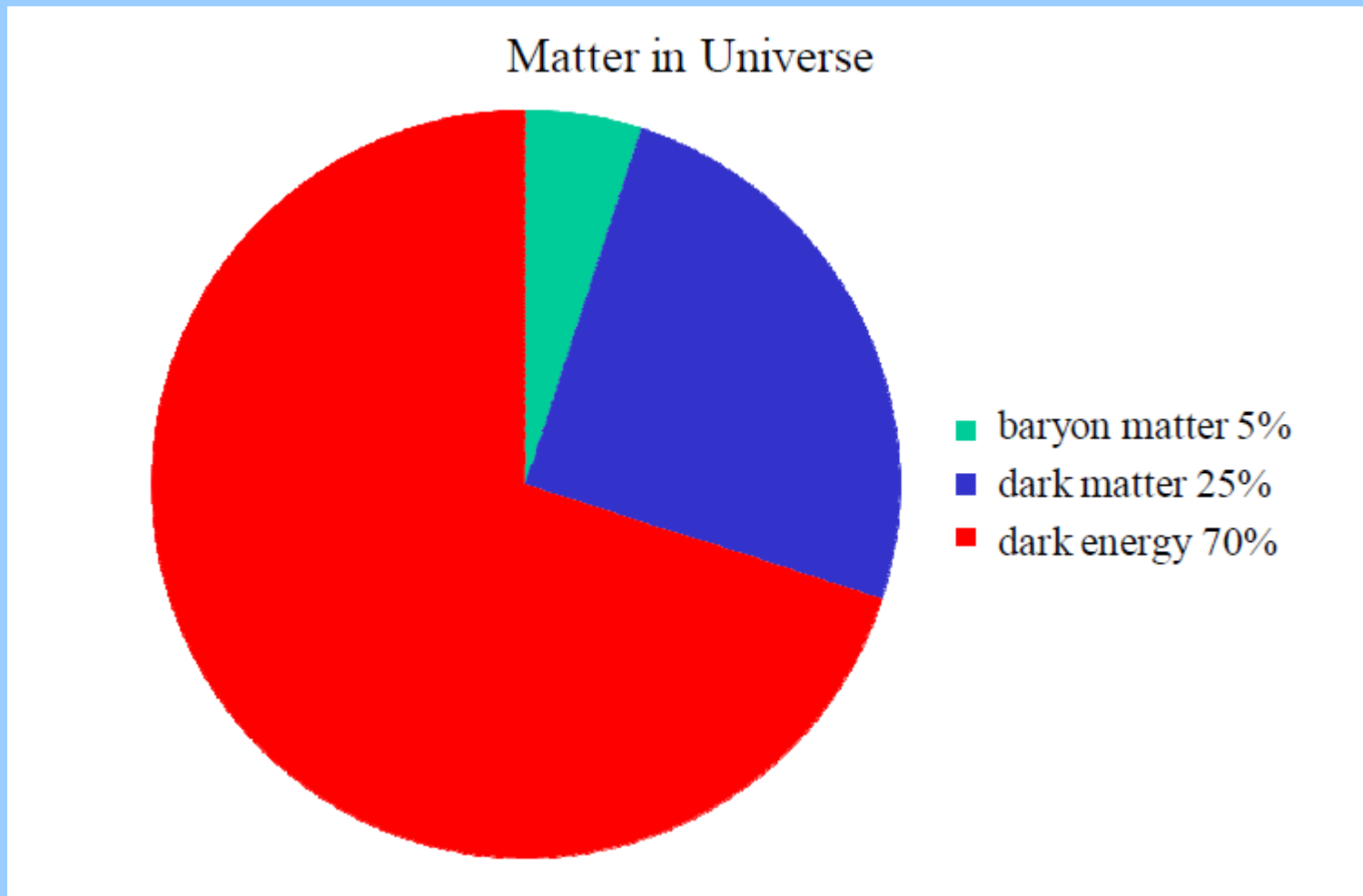
A photograph of a Soyuz rocket on the launch pad. The rocket is oriented vertically, and a large satellite payload is being mated to the top of the rocket. The payload is a large, cylindrical structure with a white and blue color scheme. The launch pad is a complex of metal structures and scaffolding. The background is a clear blue sky.

# SEARCHING DARK MATTER PARTICLES IN SPACE

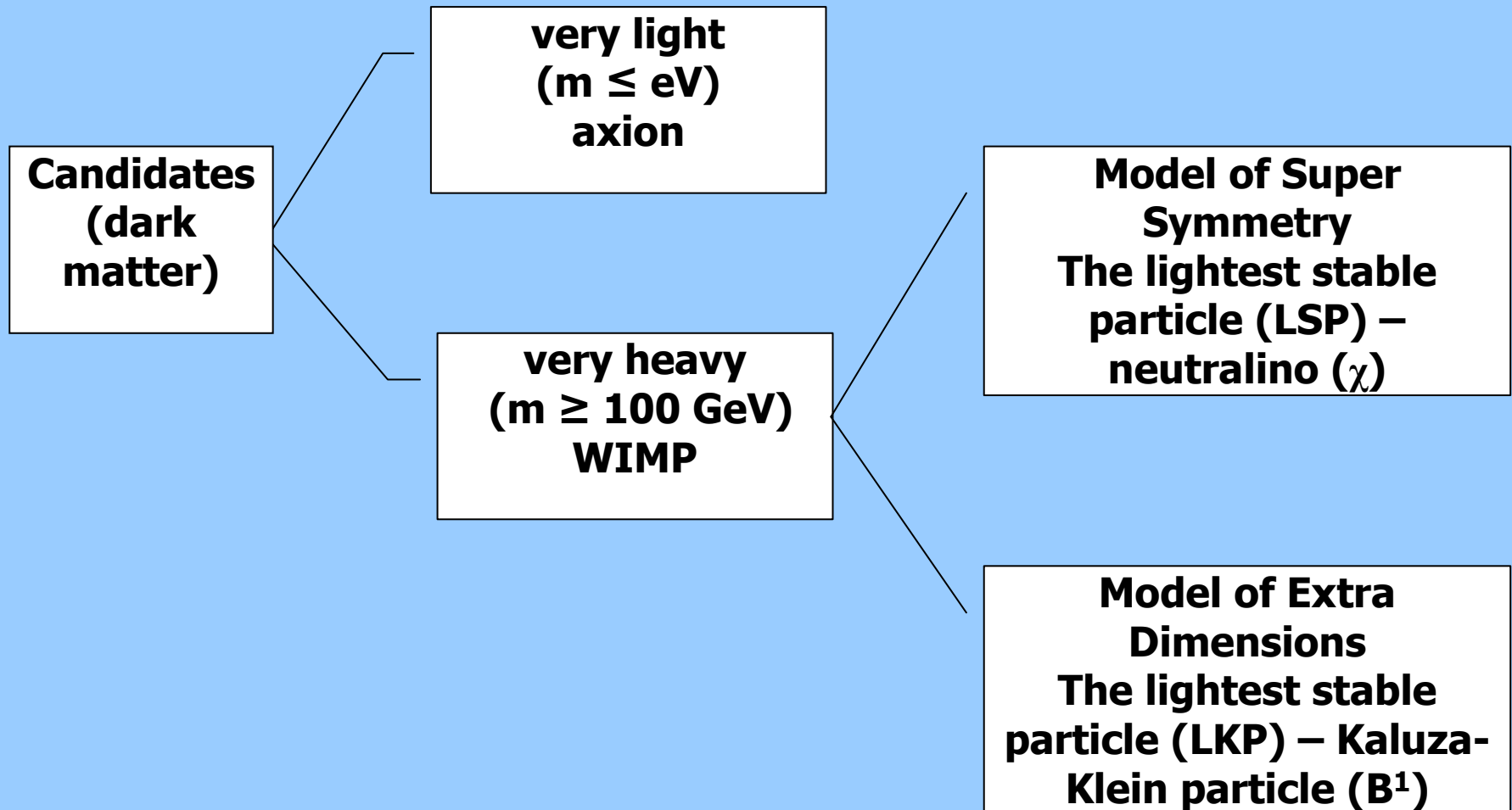
**Professor A. M. Galper**  
**NRNU MEPhI, LPI**

**COPUOS Vienne, February 2012**

# Study of origin of dark matter



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## Status of Direct Searches

Detect WIMP interactions with matter is via their elastic scattering off a detector nucleus.

## Status of Indirect Searches

Detect WIMP annihilation and decay processes:

$$B^l + B^l \rightarrow e^+ + e^-, \gamma + \gamma, \dots$$

$$\begin{aligned} \chi + \chi &\rightarrow b\bar{b}, t\bar{t}, \tau^+\tau^-, Z^0Z^0, Z^0\gamma, W^+W^-, HH \rightarrow \\ &\rightarrow \gamma + \dots, e^\pm + \dots, p\bar{p} + \dots, d\bar{d} + \dots, \dots \end{aligned}$$

$$B_{kk} \rightarrow \gamma\gamma; l^+l^-; Z^0Z^0; Z^0\gamma; W^+W^-; H^0\gamma$$

$$\chi \rightarrow l^+l^-\nu; Z^0\nu; W^\pm l^\pm$$

# PAMELA collaboration

Italy:



Bari



Florence



Frascati



Naples



Rome



Trieste



CNR, Florence

Russia:



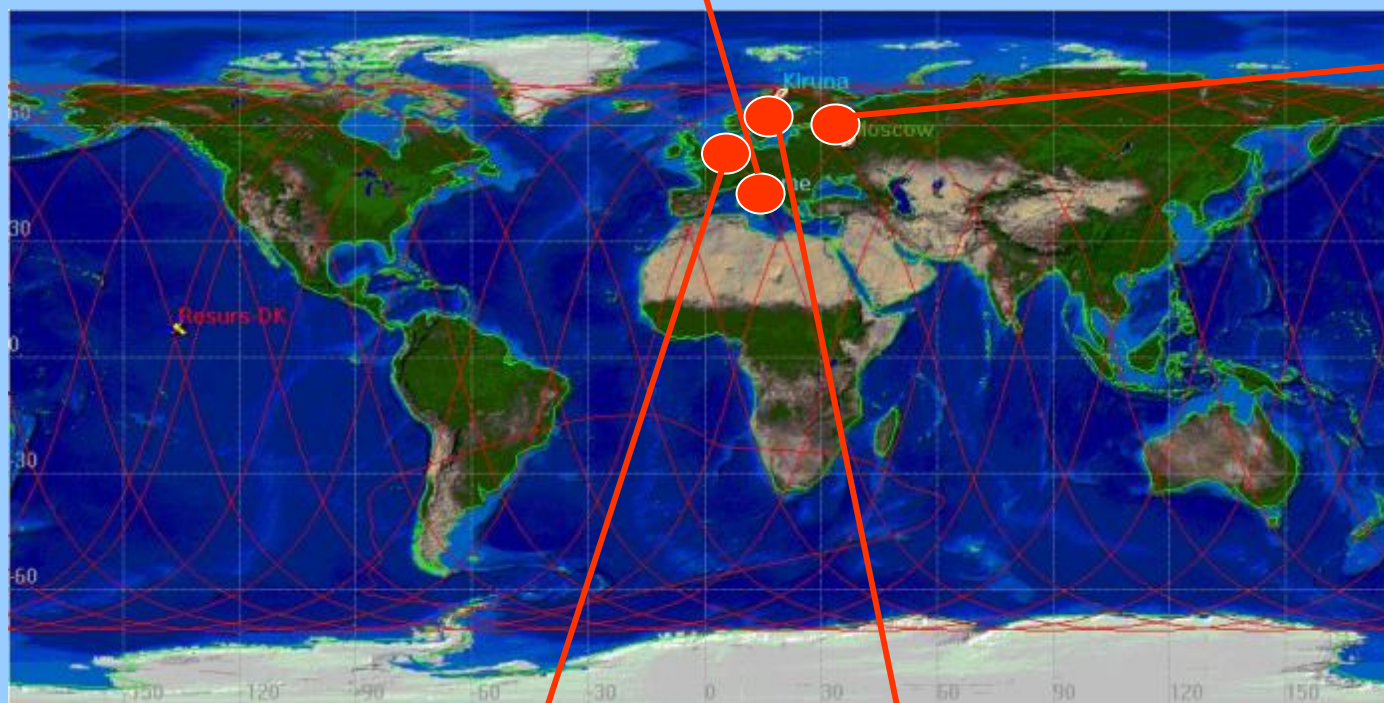
Moscow



Moscow



St. Petersburg



Germany:



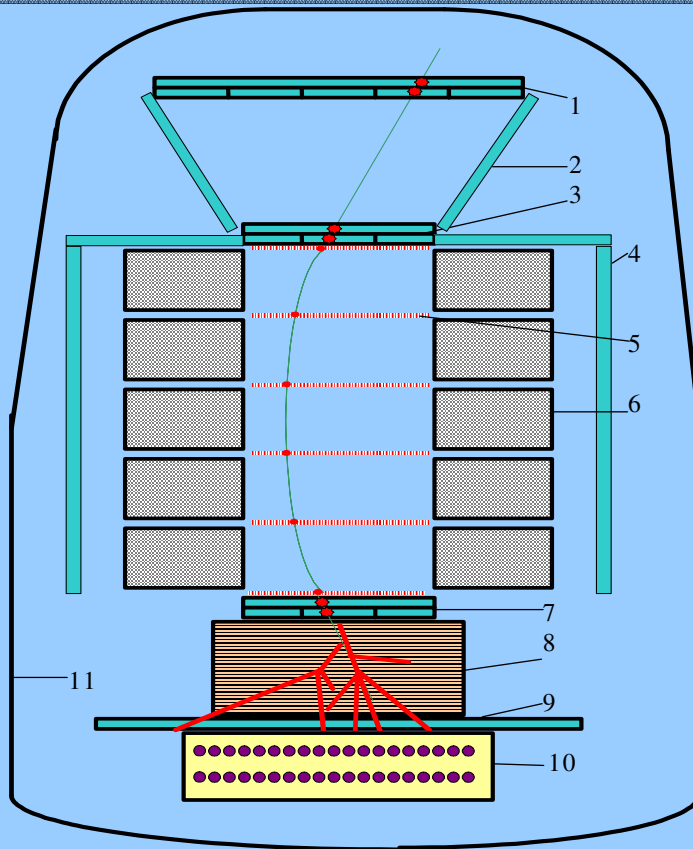
Siegen

Sweden:



KTH, Stockholm

# Physical Scheme Of Magnetic Spectrometer Pamela



- 1, 3, 7- TIME OF FLIGHT SYSTEM;
- 2, 4- ANTICOINCIDENCE SYSTEM;
- 5- SILICON STRIP TRACKER (SIX DOUBLE PLATES);
- 6- MAGNET (FIVE SECTIONS);
- 8- SILICON STRIP IMAGING CALORIMETER;
- 9- SHOWER TAIL CATCHER SCINTILLATOR;
- 10- NEUTRON DETECTOR;
- 11- HERMOCONTAINER.

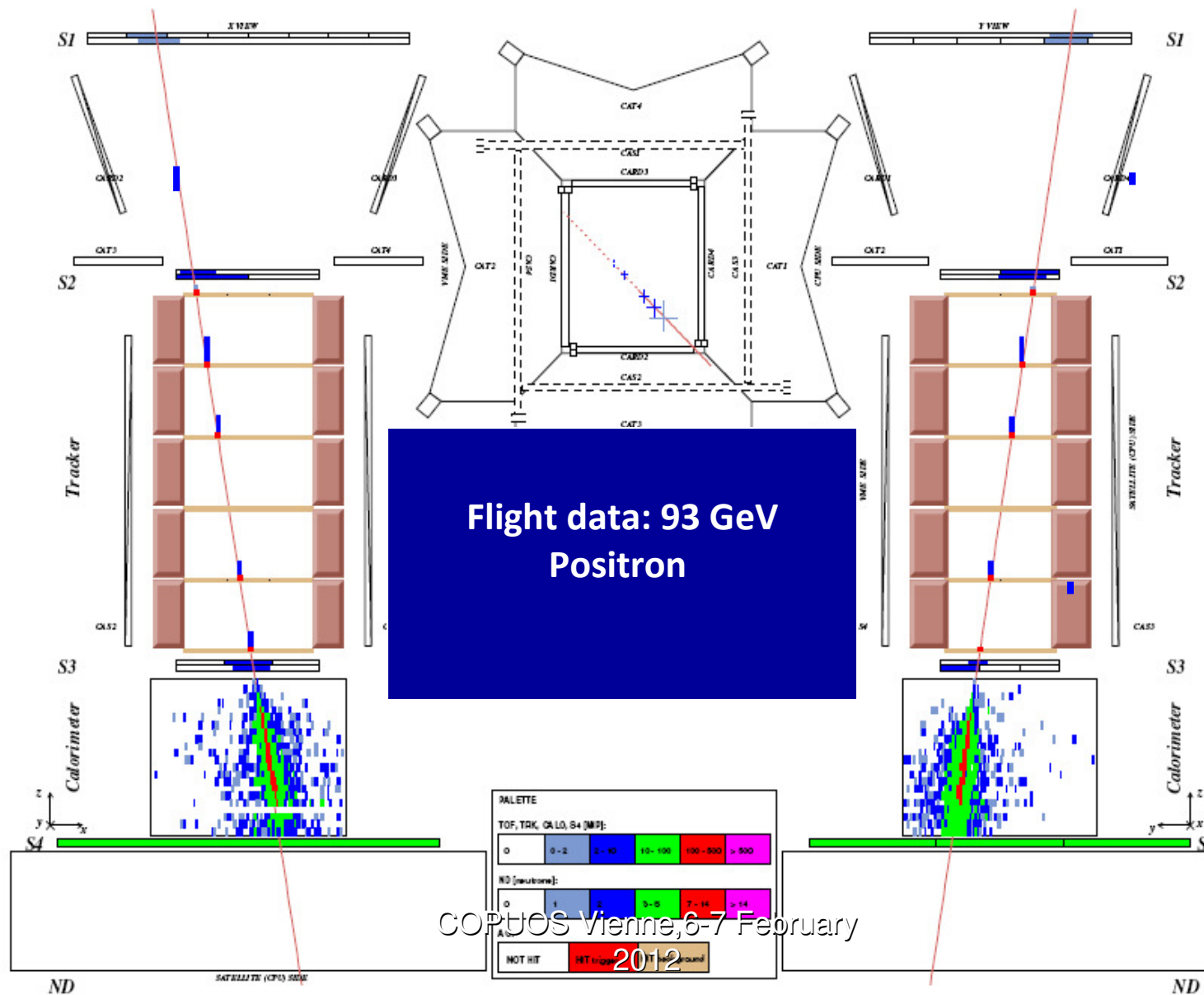
## Measurements:

- time of flight ( $\beta$ );
- deflection in the magnetic field;
- energy losses in all detectors;
- number of neutrons.

## Estimations:

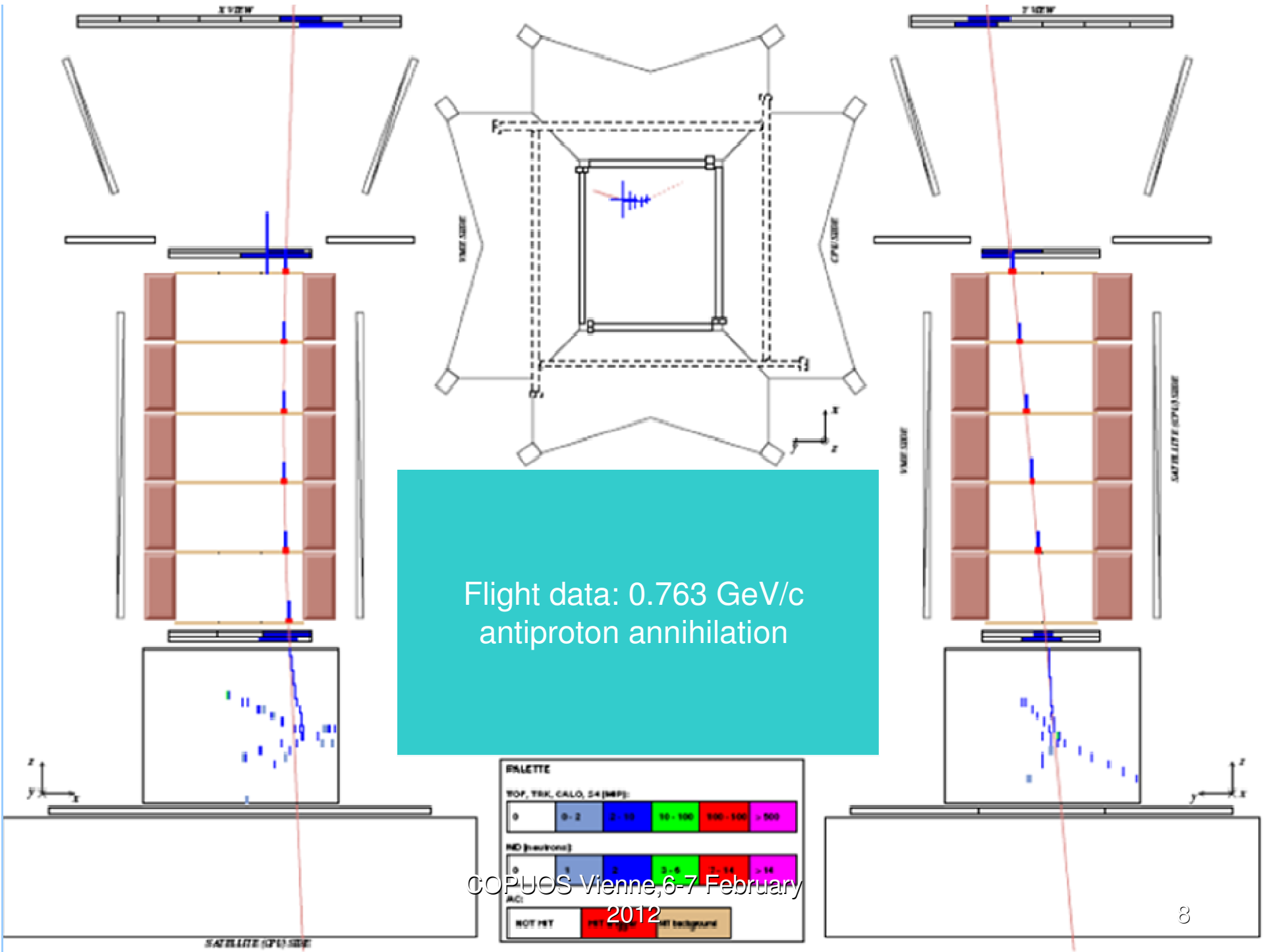
- type of particle (lepton/hadron);
- sign and value of charge ( $\pm Z$ );
- mass of particle ( $A$ );
- rigidity and energy ( $R$  and  $E$ );
- direction of flight;

# The sample of event



COPTOS Vienne, 6-7 February

2012

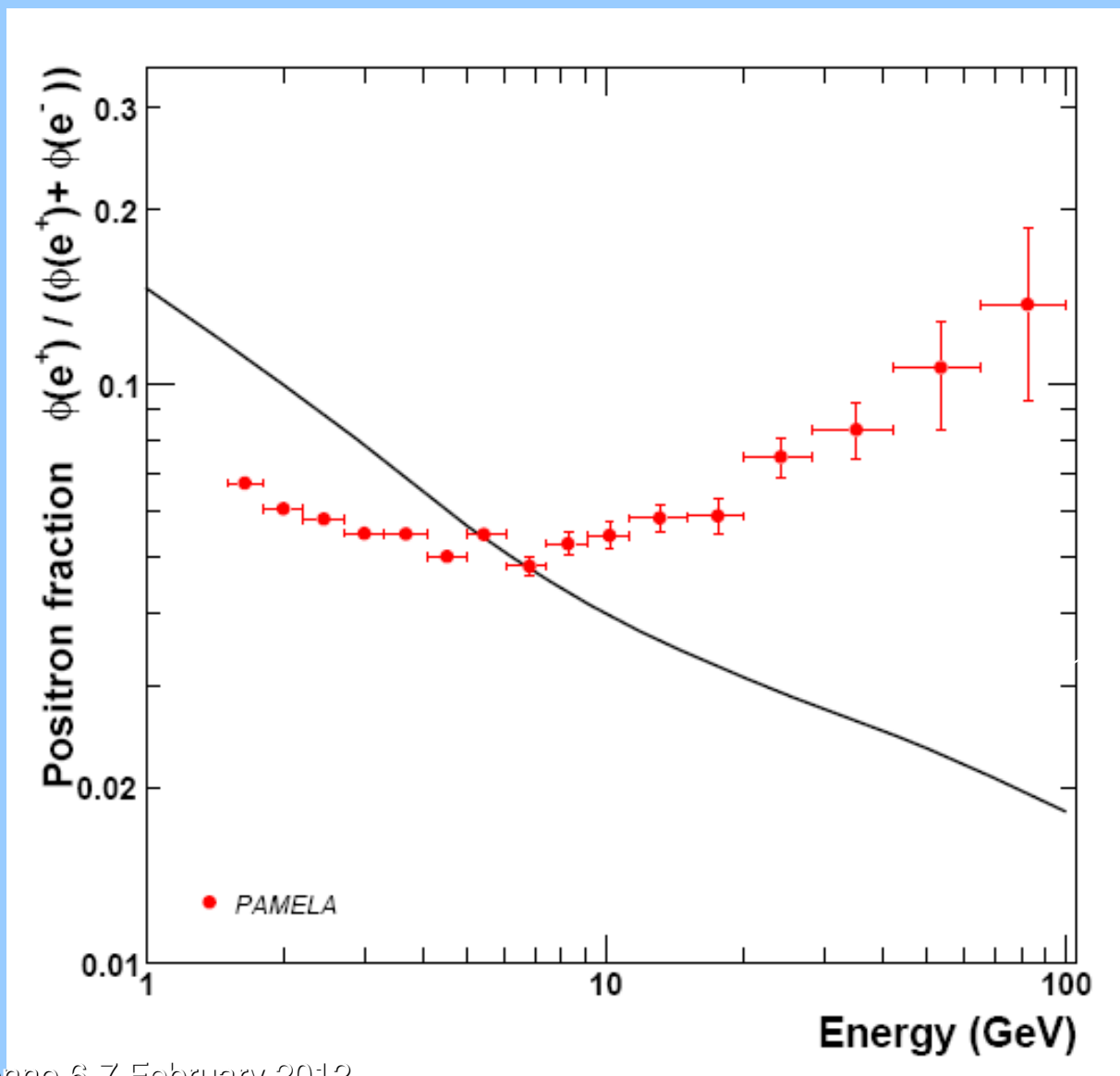


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# Study of origin of dark matter

## positron to electron ratio

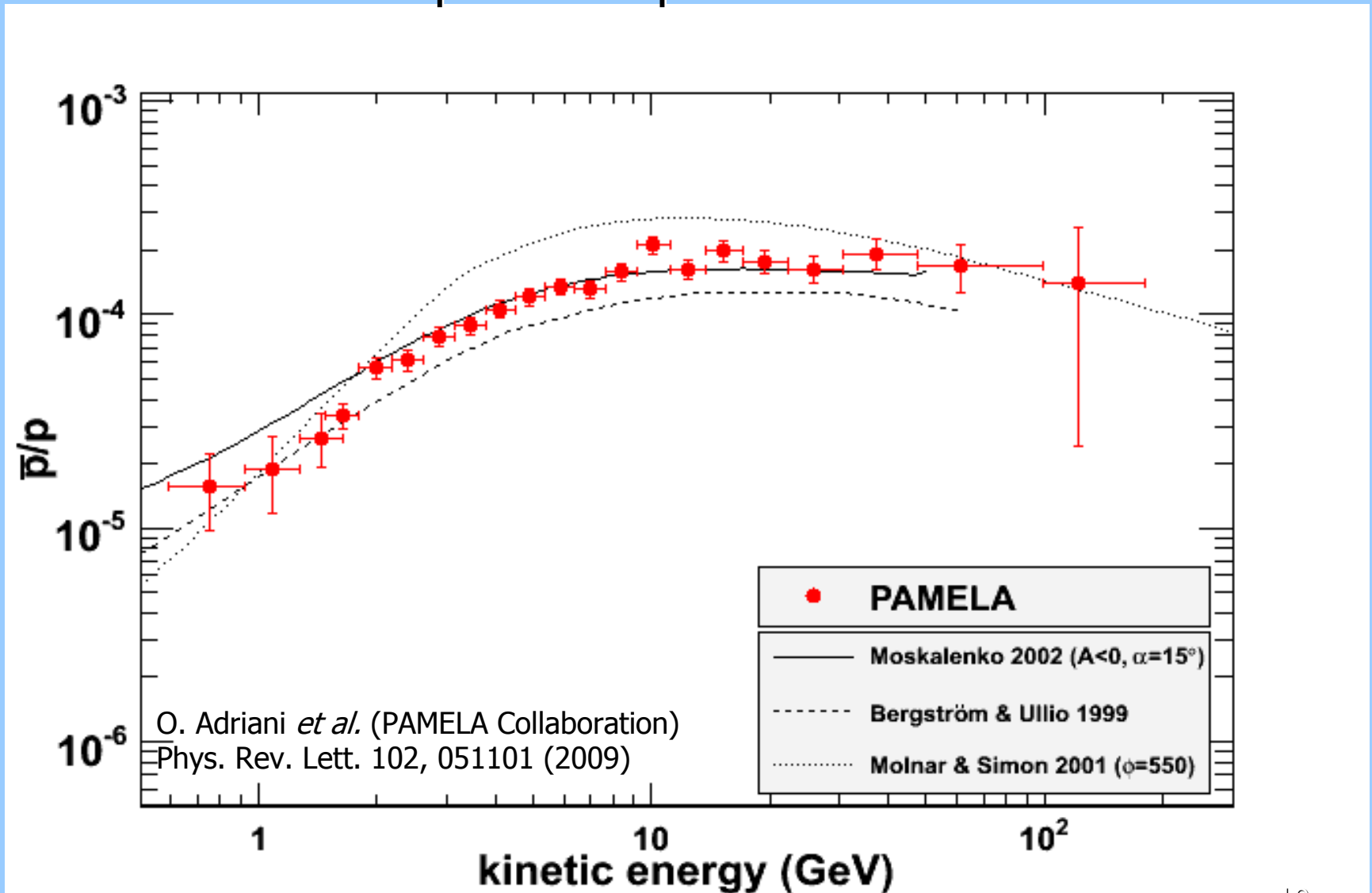


Secondary production  
Moskalenko-Strong  
(1998)

O.Adriani et al. //  
Nature 2009, V.458, P.607

# Study of origin of dark matter

## Antiproton to proton ratio



# TOP TEN PHYSICS STORIES OF THE YEAR 2008

INSIDE SCIENCE RESEARCH --- **PHYSICS NEWS UPDATE** The American Institute of Physics  
**Bulleting of Research News Number 879 #1, December 22, 2008** [www.aip.org/pnu](http://www.aip.org/pnu) by Phil Schewe

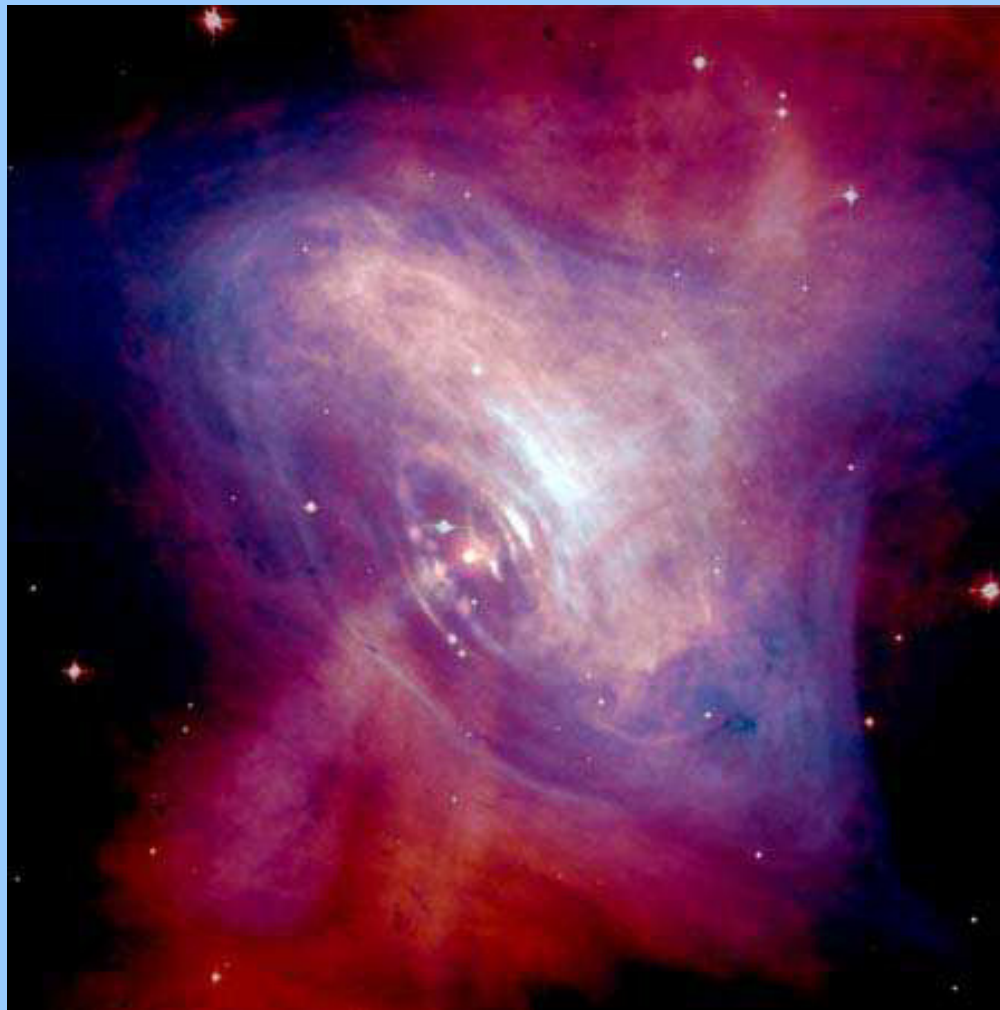
- *SUPERCONDUCTORS*
- *LARGE HADRON COLLIDER*
- *PLANETS*
- *QUARKS*
- *FARTHEST SEEABLE THING*
- *ULTRACOLD MOLECULES*
- *DIAMOND DETECTORS*

- **COSMIC RAYS**

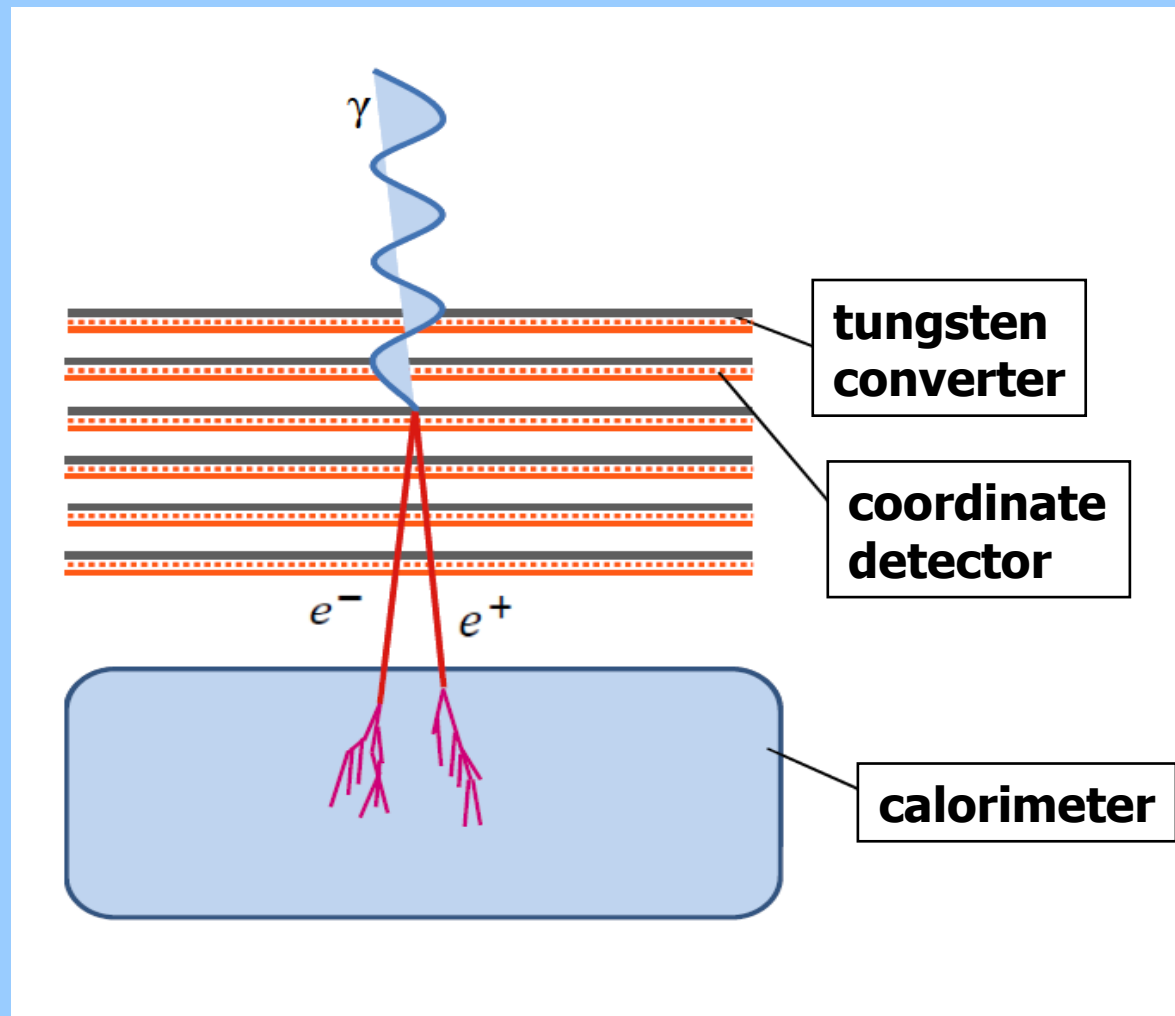
Another mystery pertains to the findings of two detectors held aloft-one by a balloon and one on a satellite-looking for oddities in the number of antiparticles arriving with regular particles among cosmic rays reaching Earth. They see an excess of such particles which some interpret as evidence for "dark matter," a class of very-weakly-interacting particles not seen before. Scientists associated with the balloon-borne ATIC detector (Nature, 20 Nov) and the satellite **PAMELA** (<http://arxiv.org/abs/0810.4995>)

- *LIGHT PASSES THROUGH OPAQUE MATTER*
- *MACROSCOPIC FEEDBACK COOLING*

# SUPERNOVA REMNANT IN CRAB NEBULAE



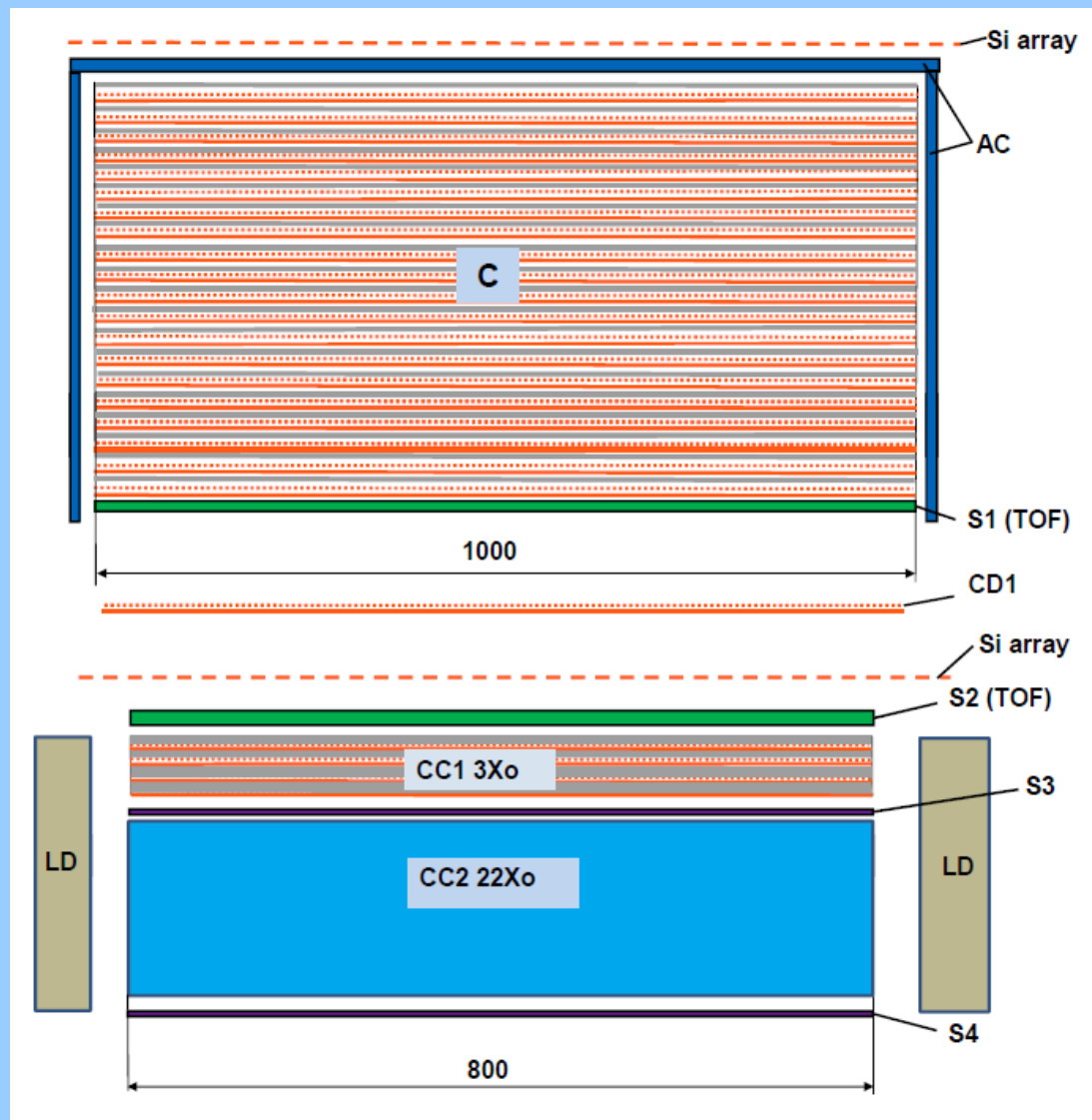
# GAMMA-QUANTA DETECTION PRINCIPLE

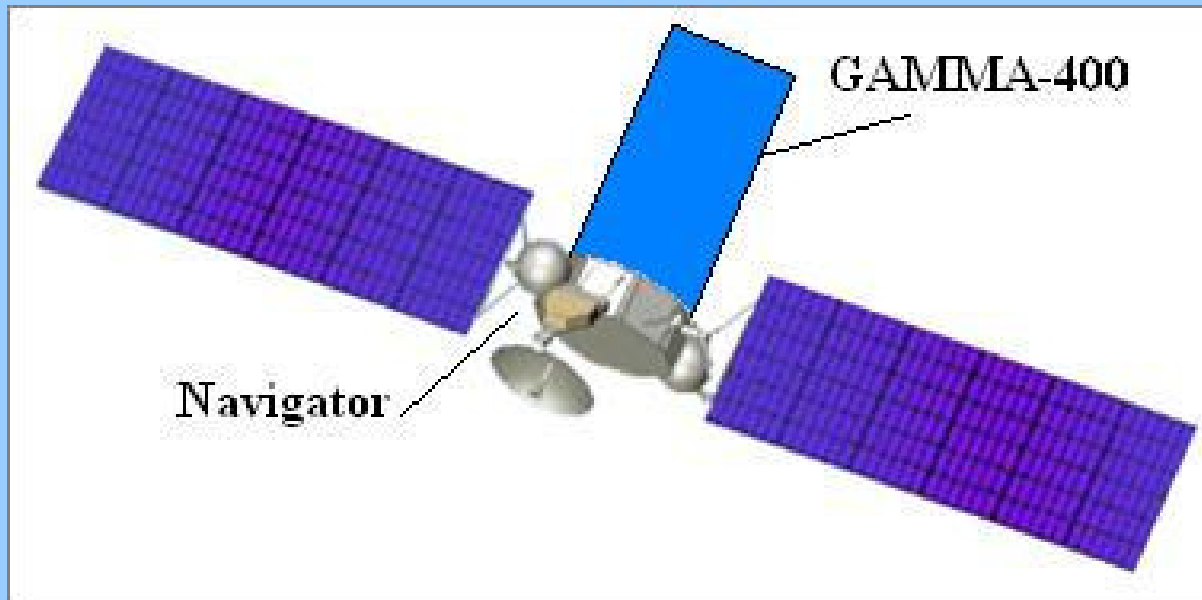


# GAMMA-400 physical scheme

Angular resolution 0.01 deg

Energy resolution 1 %



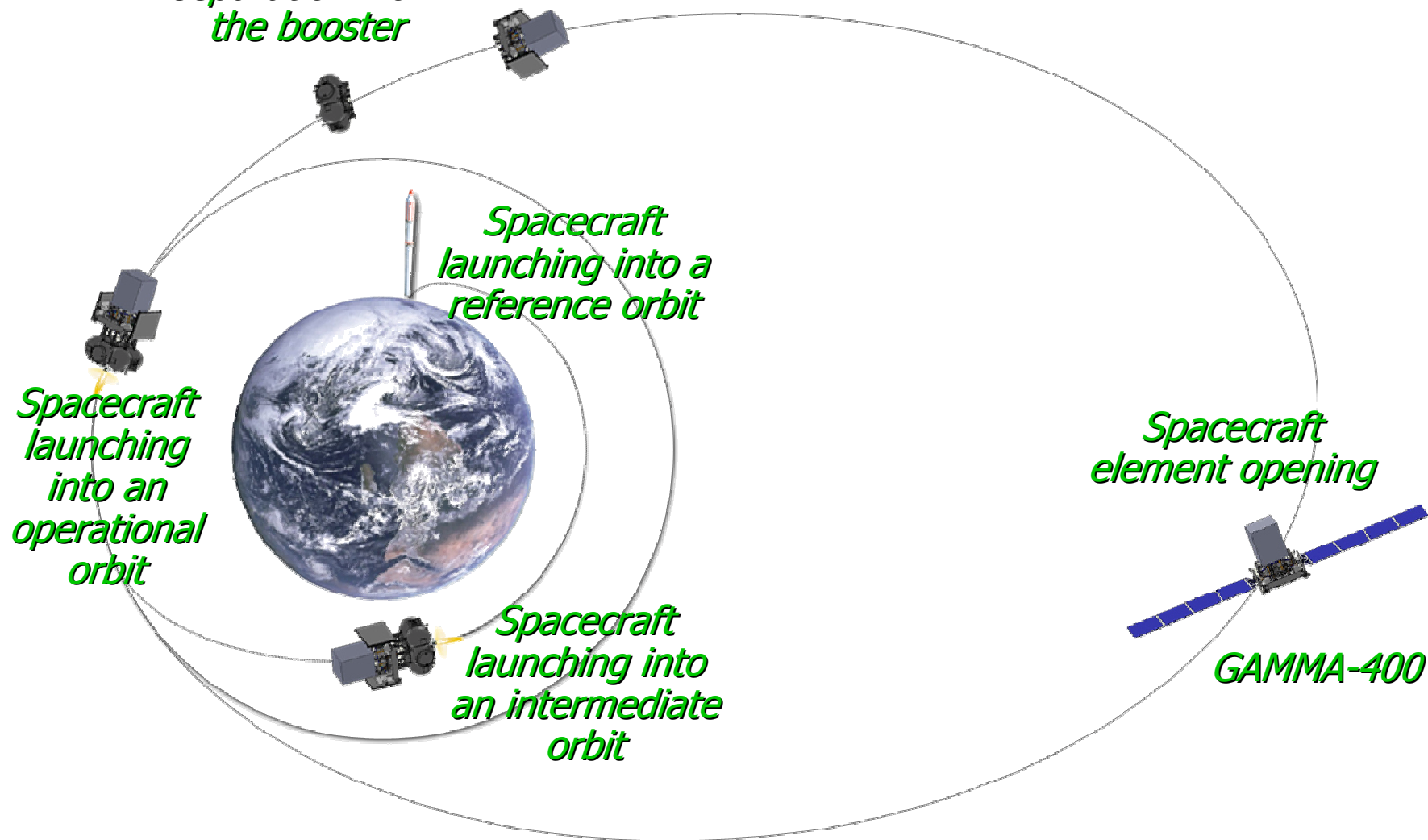


Total GAMMA-400 mass	2500 kg
Power consumption	2000 W
Telemetry downlink	100 GB/day
Launch date	2015
Lifetime	> 7 years

The GAMMA-400 space observatory will be installed on the Navigator service module.

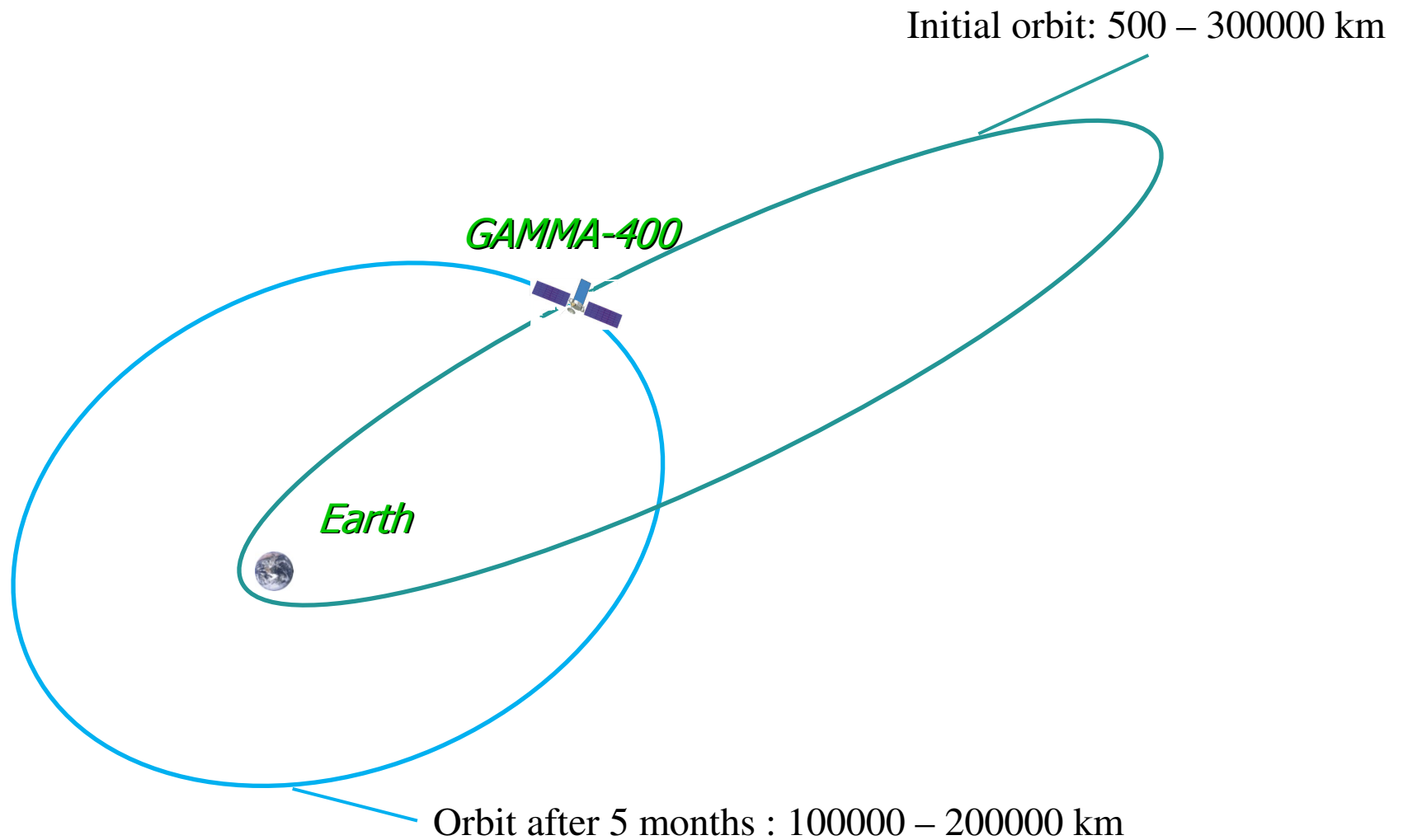
# GAMMA-400 LAUNCHING SCHEME

*Spacecraft  
separation from  
the booster*





# ORBIT EVOLUTION



**Thank you for attention**