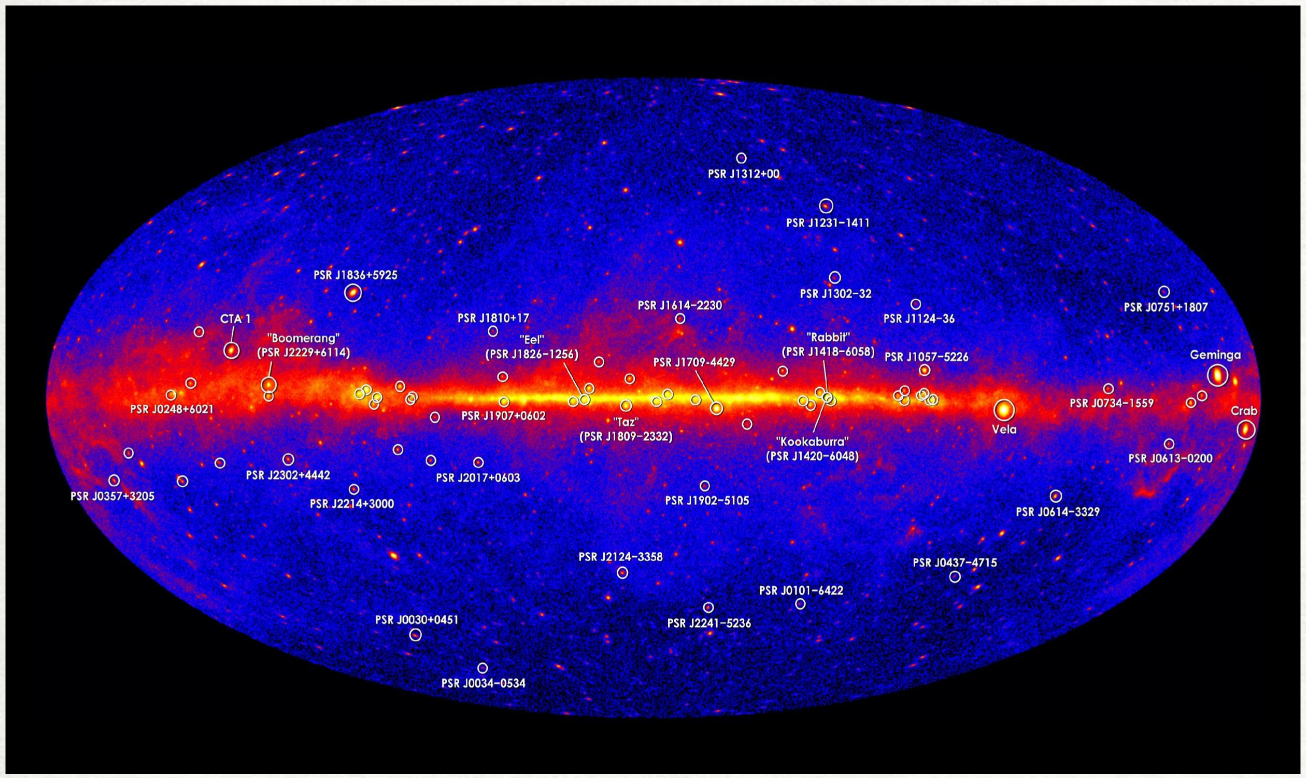
The next Generation Gamma-ray space mission

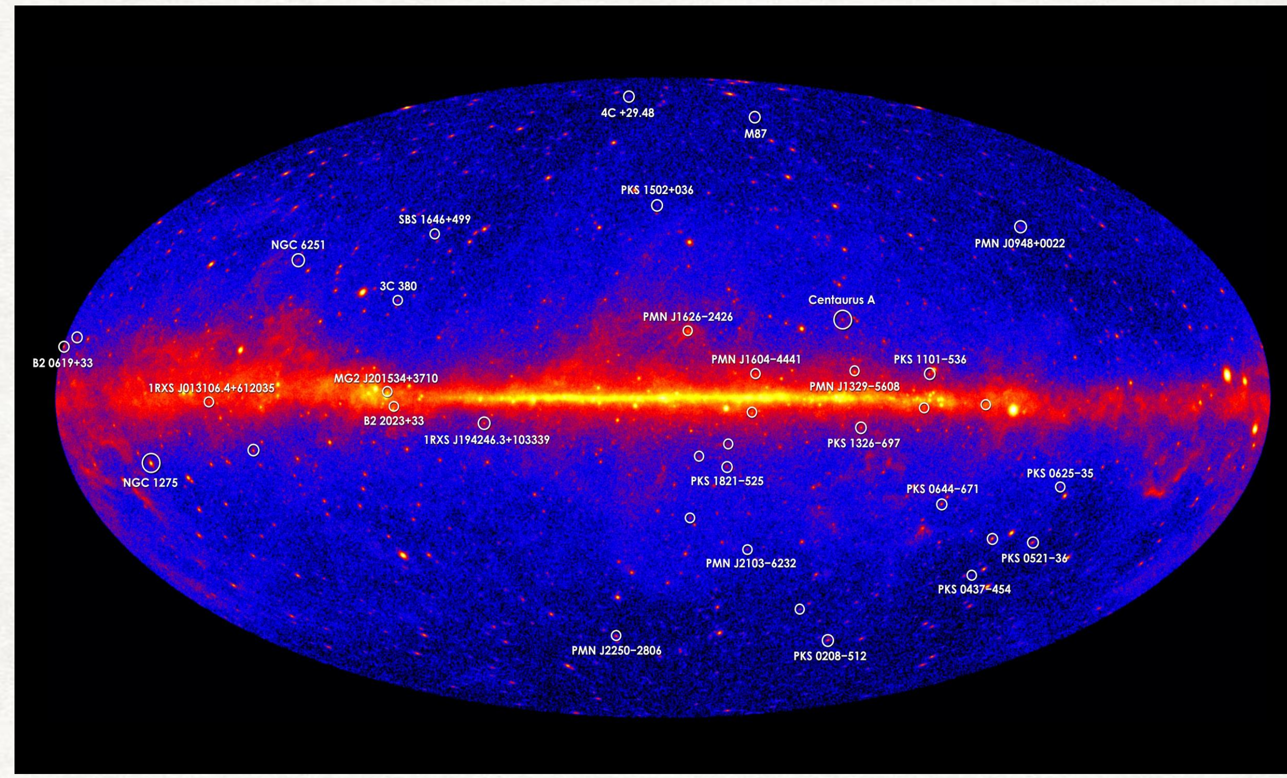
Erik Hogenbirk, Quentin Luce, Maria Munoz Salinas

CURRENT STATUS OF THE GAMMA-RAY DETECTION

- Observations of gamma-rays sources (AGN, pulsars, …)



5 years of Fermi-LAT data: pulsars



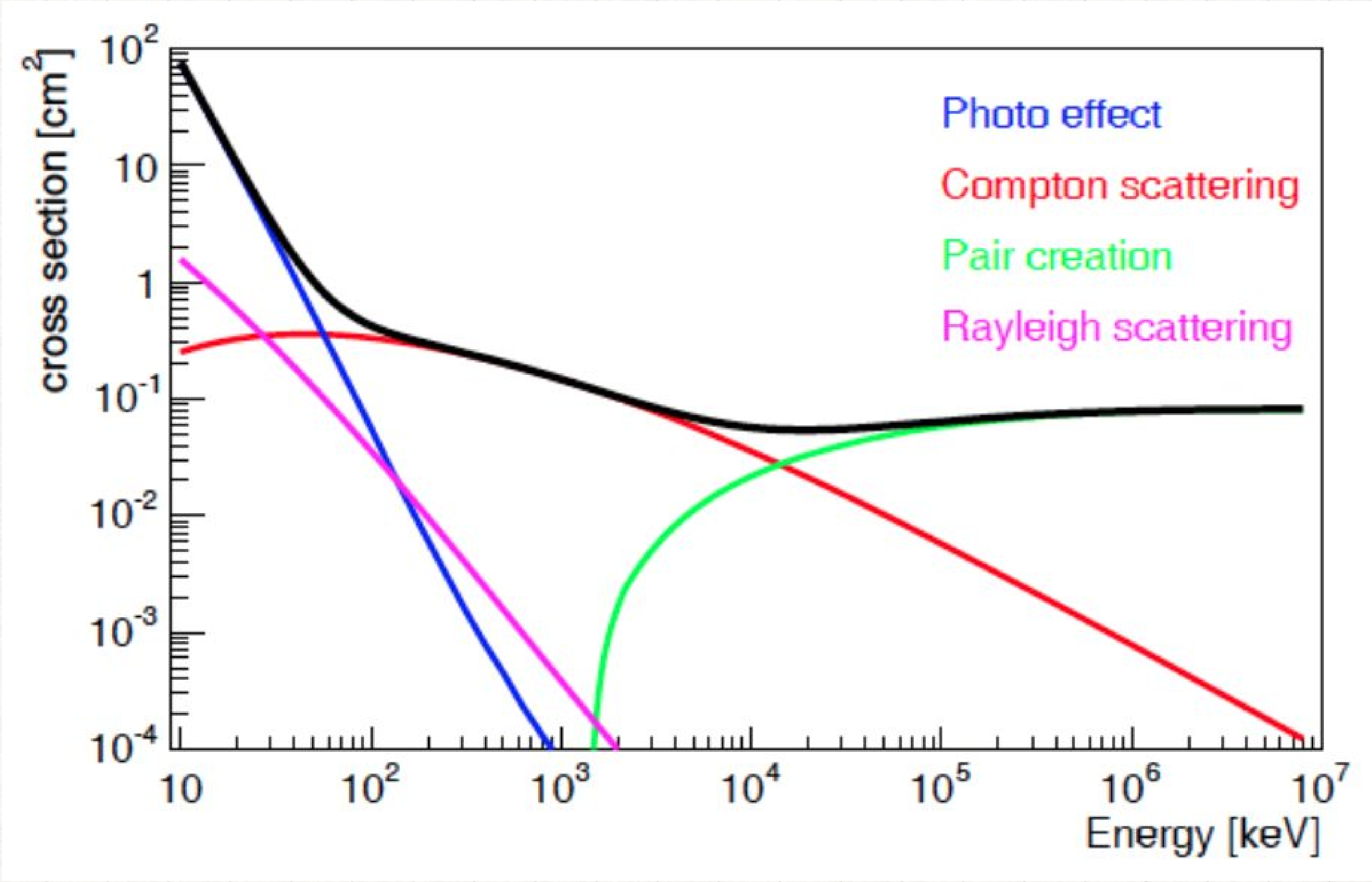
5 years of Fermi-LAT data: active galaxies

- Main open questions:
  - Unobserved MeV region (competition between Compton scattering and pair creation)
  - Galactic center excess
  - Unresolved sources

INTERACTIONS OF GAMMA-RAYS WITH MATTER

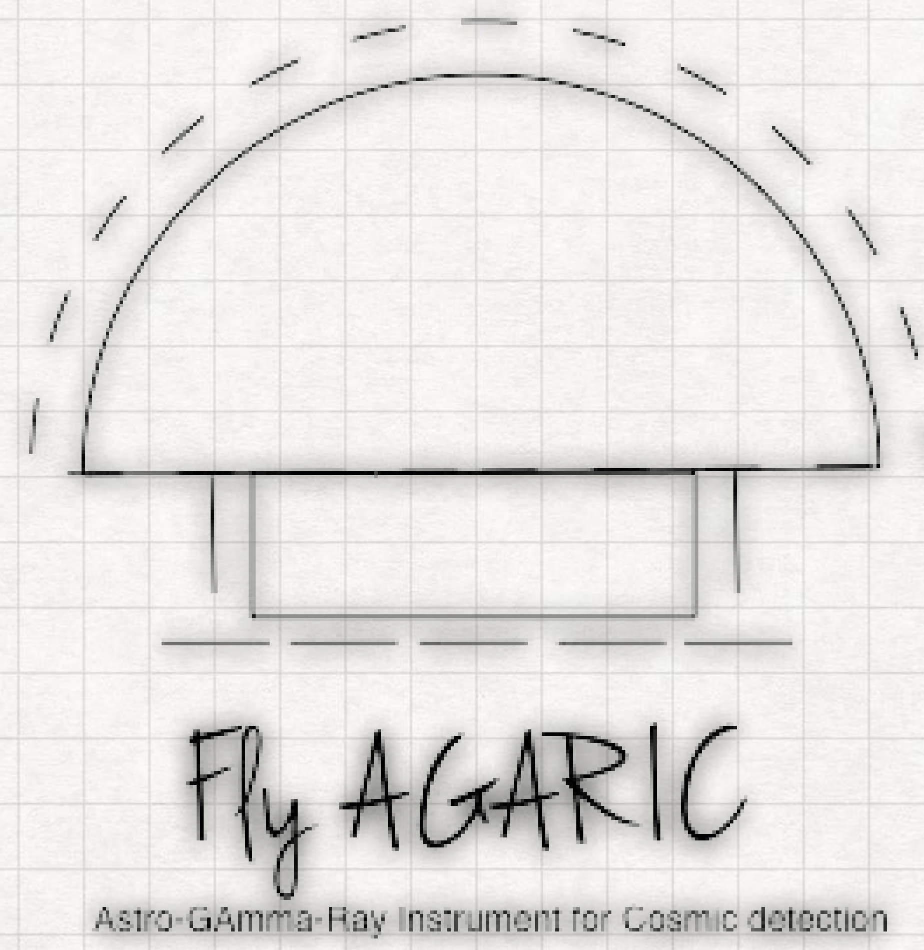
Different energies
↳ different interactions

- Low energies (few hundreds of keV - 10s of MeVs): Compton Scattering is dominant
- High energies (> tens of MeV): Pair production becomes dominant

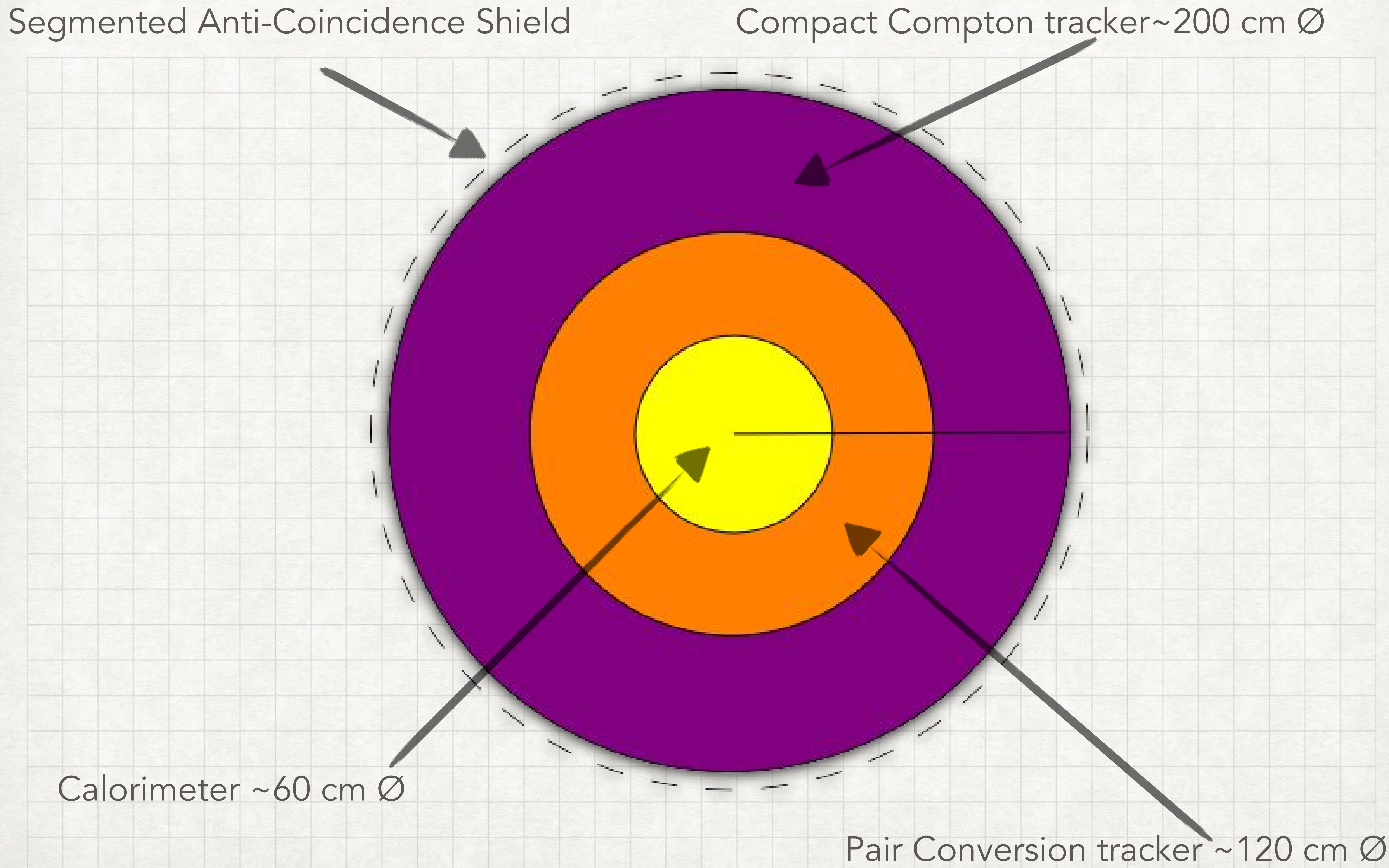


AGARIC MISSION

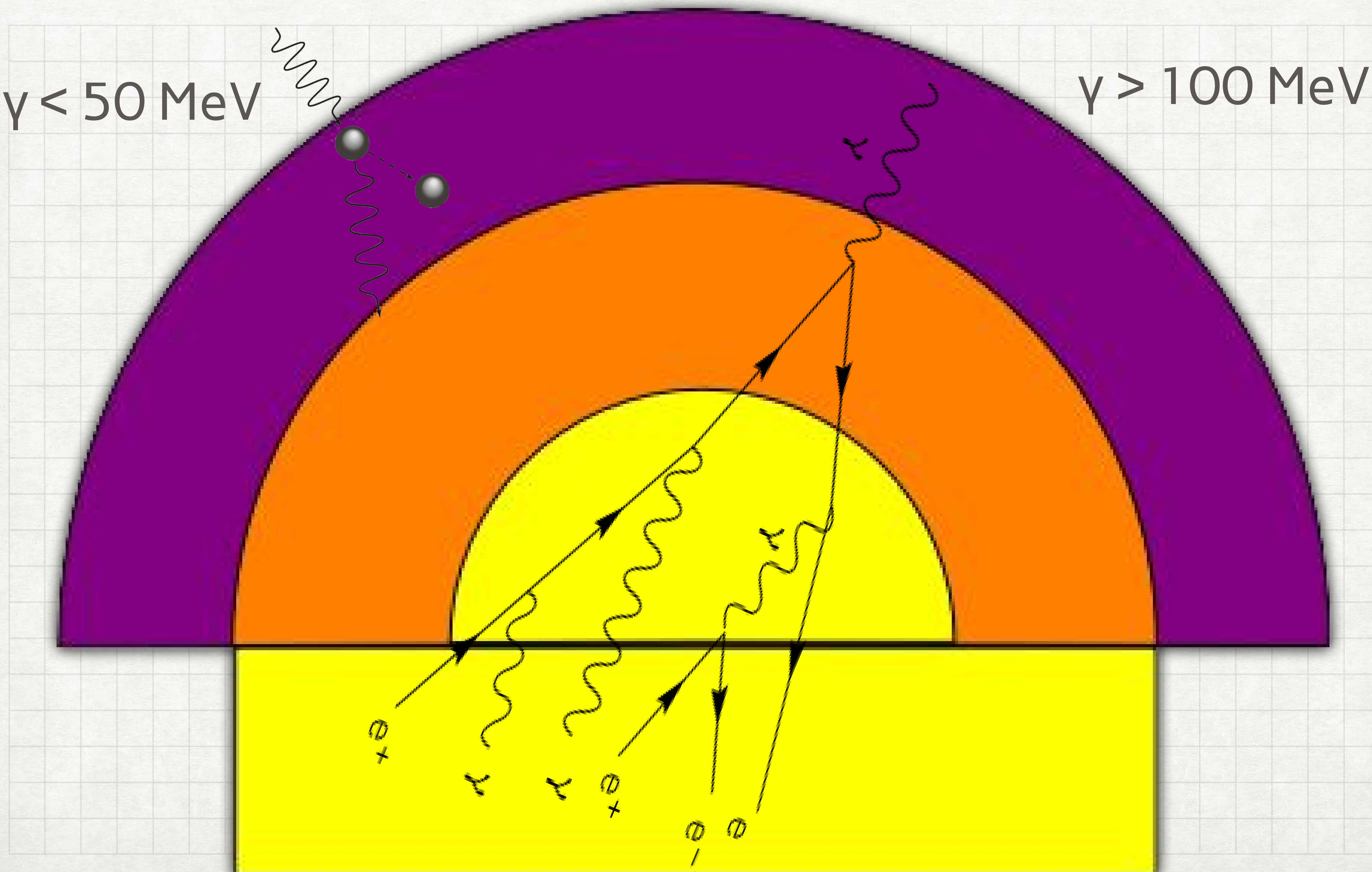
- AGARIC: Astro-GAmma-Ray Instrument for Cosmic detection
- Detection gamma-rays from ~1 MeV to ~10 TeV.
- Excellent position resolution, energy resolution and acceptance.
- Light thin carbon fibre structure
- 2 m diameter -->A~6.3 m2



SCHEMATIC LOOK OF THE INSTRUMENT



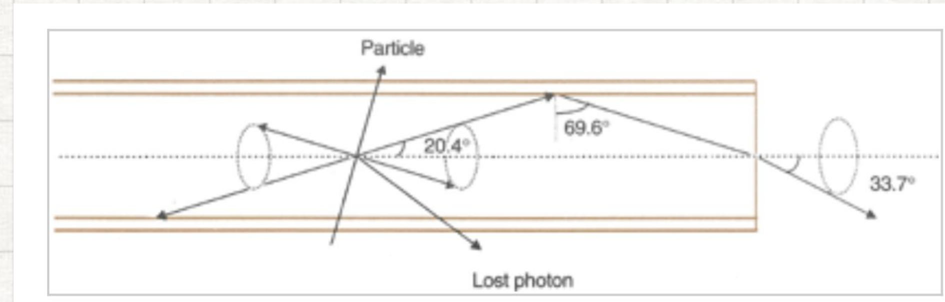
SECTION OF THE DETECTOR



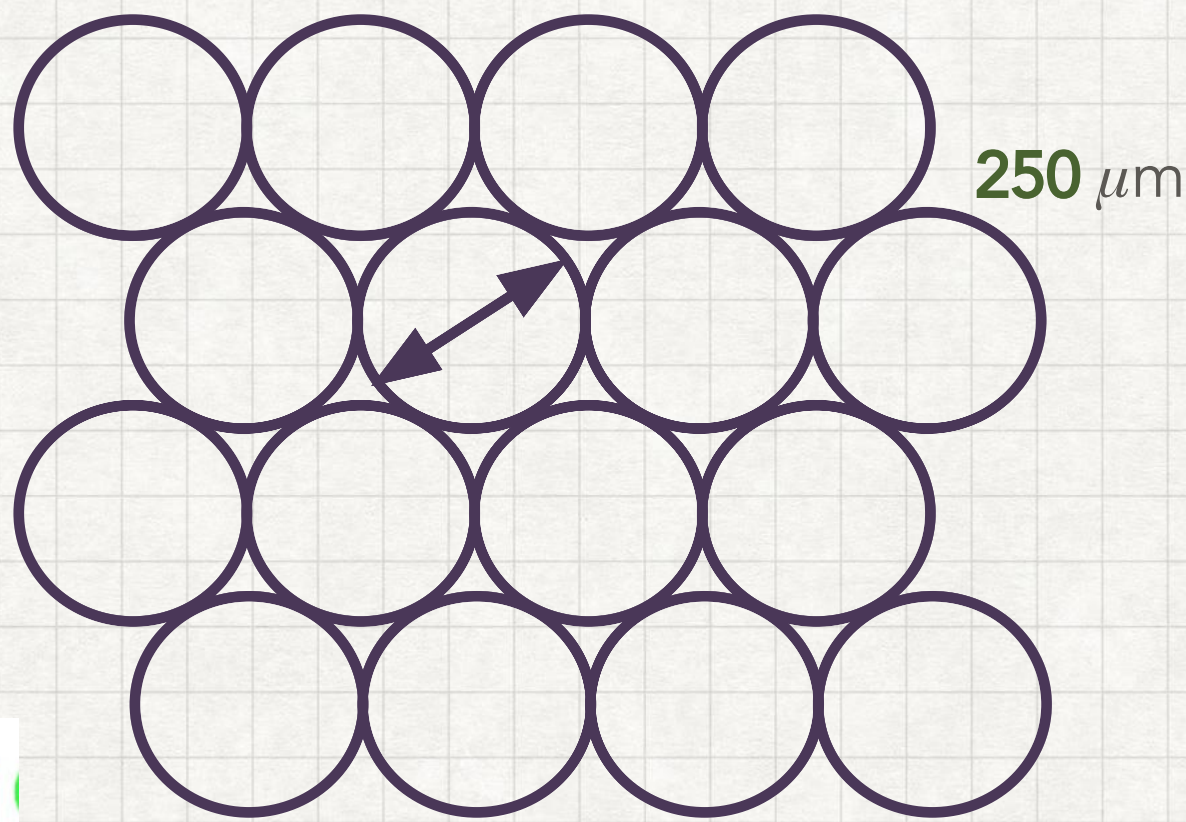
SCINTILLATING FIBER TRACKER

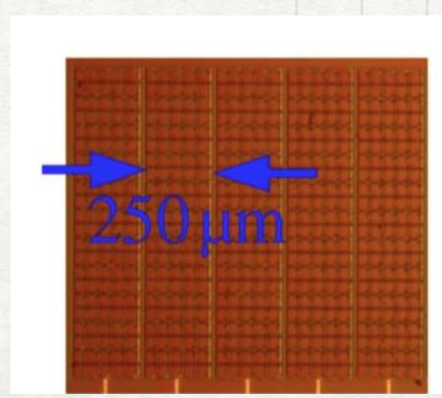
PLASTIC SCINTILLATOR FIBERS

- Each layer is 1 mm i.e. 4 fibres per layer.
- n~1.5: high curvature
- Round Fiber with Cladding (outer layer)
- Read out on both ends with arrays of SiPM, each pixel of 250 μm



Obtained from:http://kuraraypsf.jp/psf/



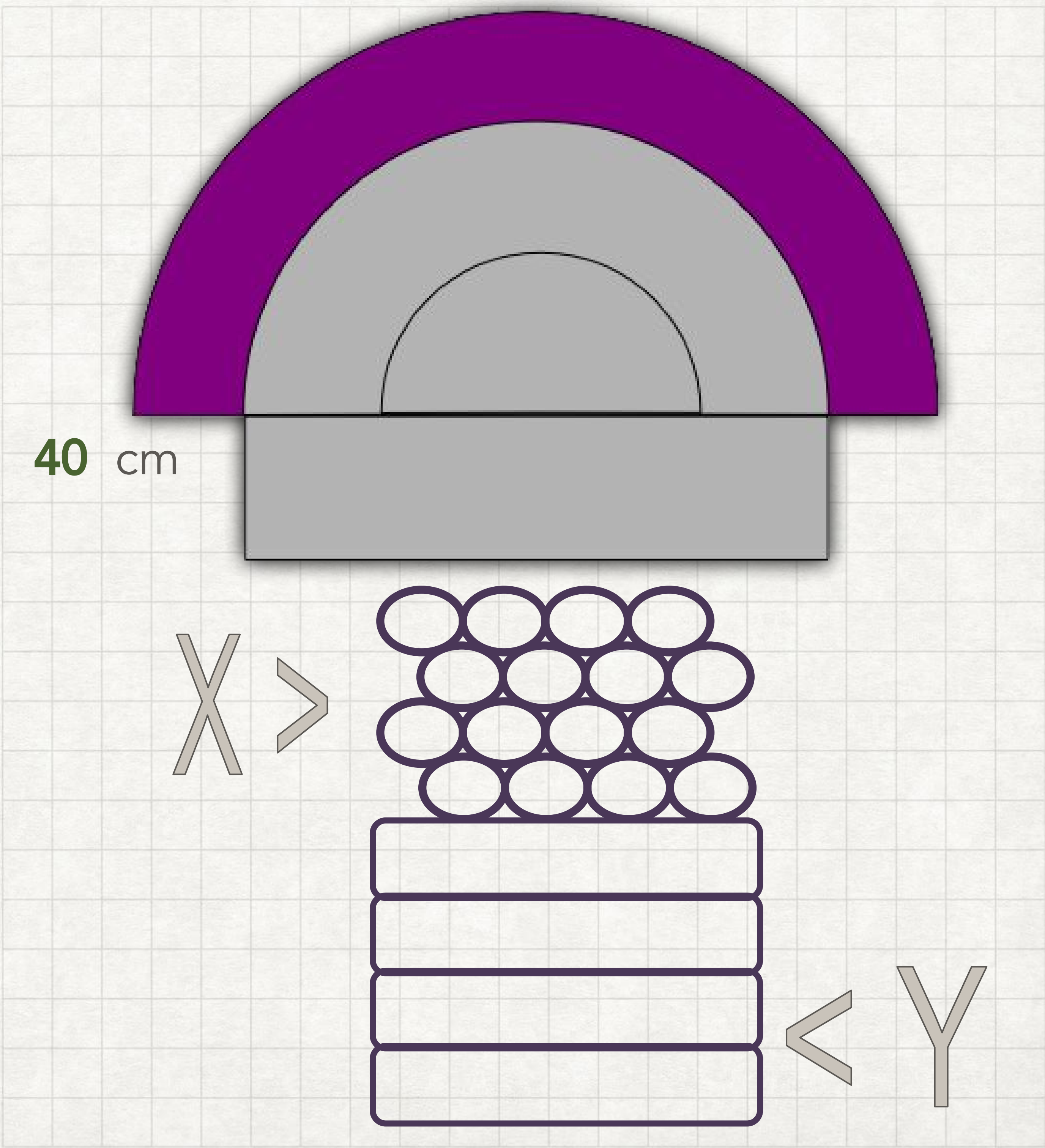


Obtained from:
https://agenda.infn.it/getFile.py/access?contribId=6&resId=0&materialId=slides&confId=7279

COMPACT COMPTON TRACKER

OUTER TRACKER

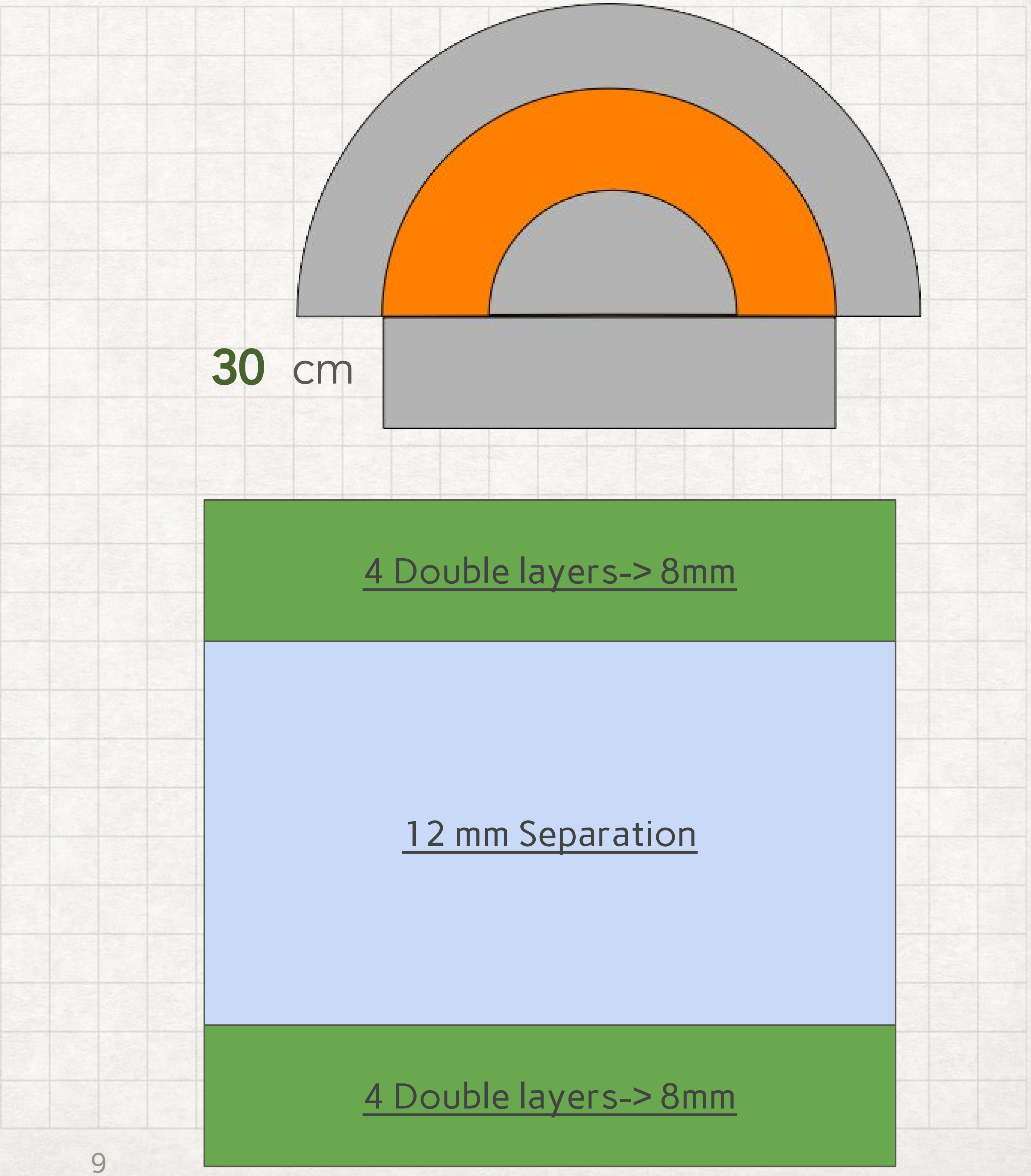
- Dense fiber layers distributed orthogonally
    - Enables x,y - resolution
    - Precision for detecting Compton electron
- 40 cm. Occupied with fibers.
- Weight: 1.7 t



PAIR CONVERSION TRACKER

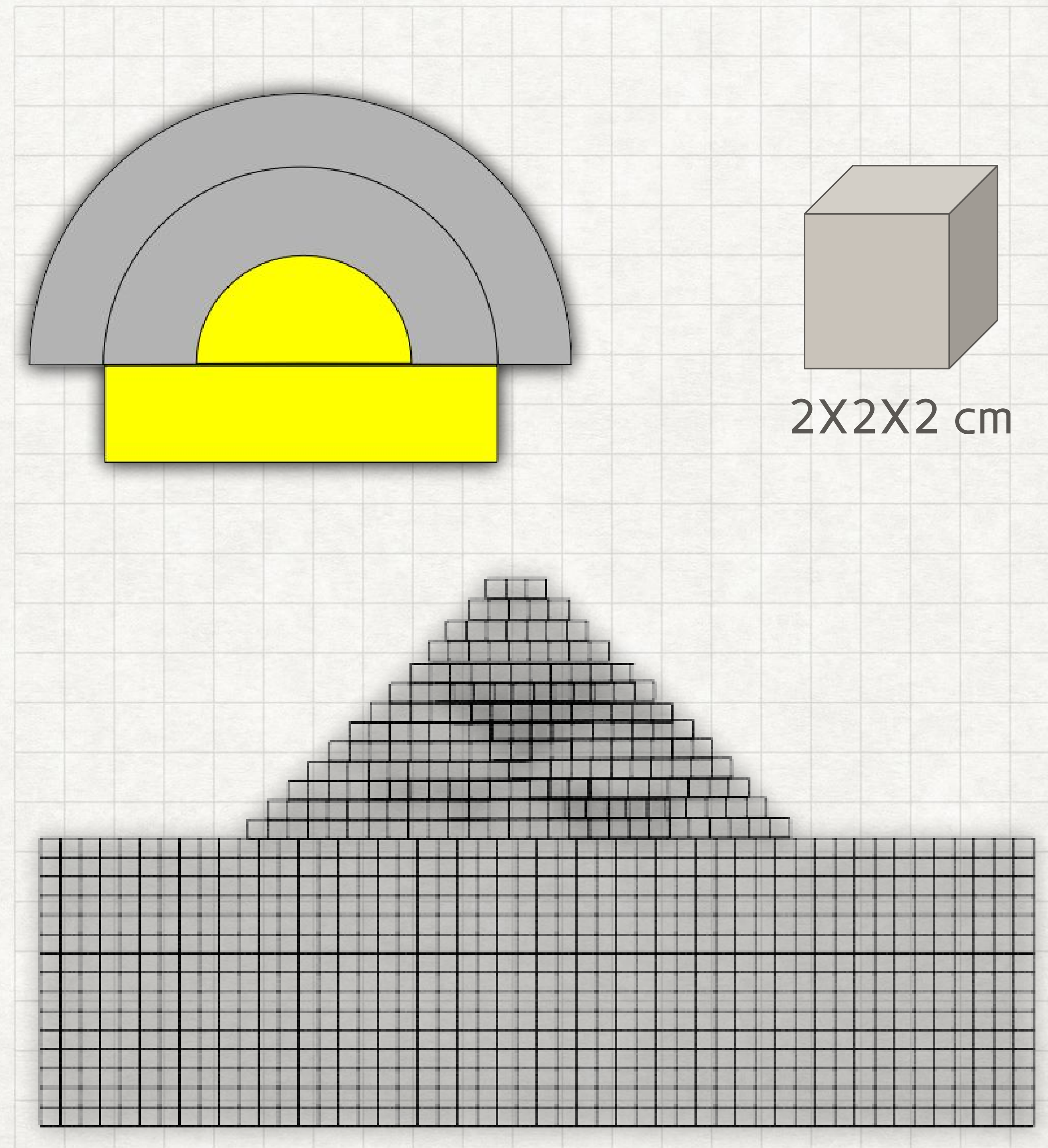
INNER TRACKER

- 2 Double-layered structure Scintillating Fibers x-y measurement
- Promotes pair conversion with the use of thin foil tungsten for energies above 10 GeV
  (4 layers of 1 mm)
- Separated layer with a distance of 12mm
- 15 double layers in total
- Weight: 160 kg + 100 kg (fibers + tungsten)

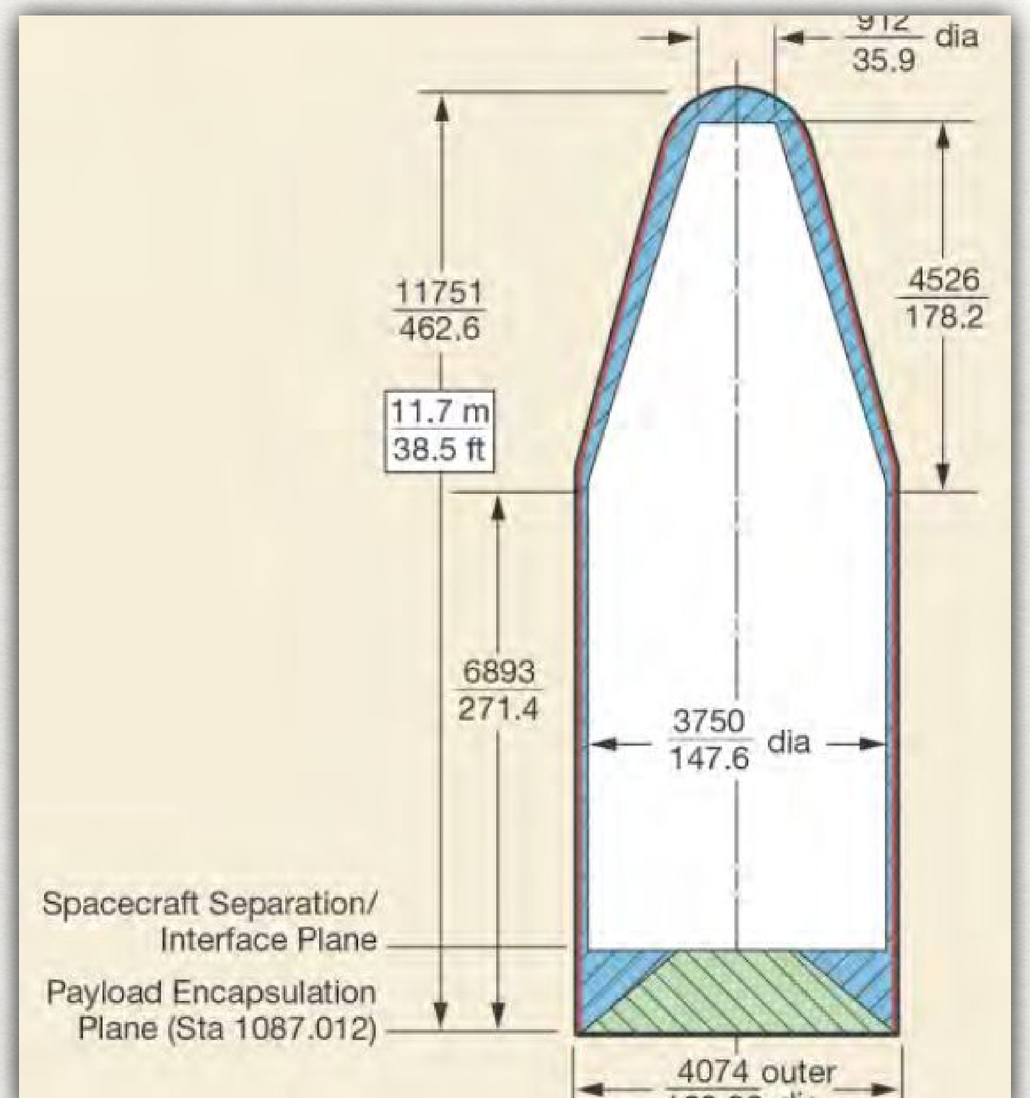


CALORIMETER

- BGO (Bismuth Germanate)
  - density: 7.13 $g.m^{-3}$
  - radiation length: 1.10 cm
- Readout by Optical Fibers coiled in the sides of the crystal read by CCD.
- 26 000 channels (2x2x2 cm^3 blocks)
- Maximum depth 60 cm: 54 X_0
- Weight: 1.6 t

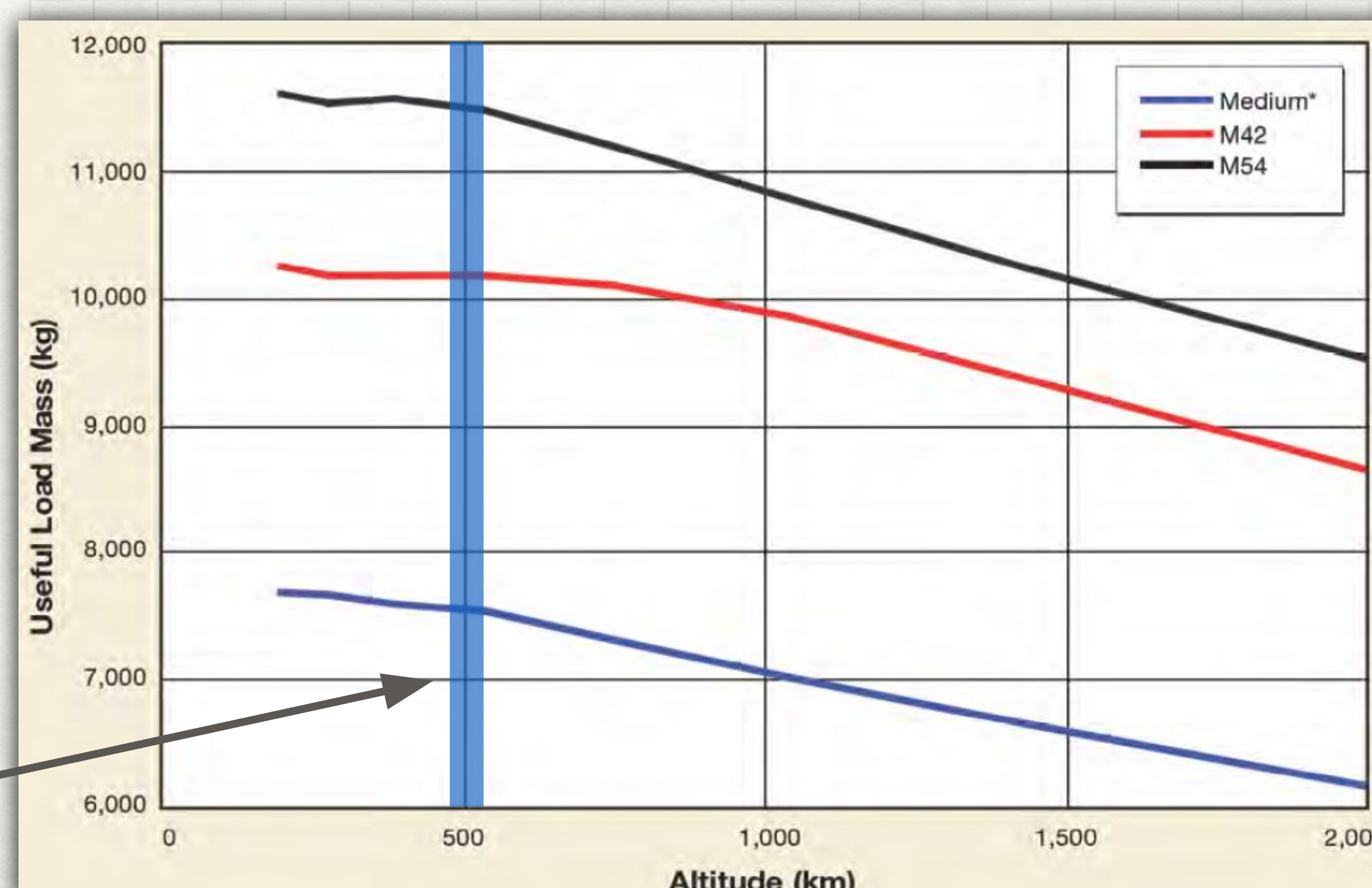


LAUNCH VEHICLE



Delta IV medium

Mass of detector: ~ 4 t (including electronics)



Desired altitude
(bass orbite)

IDEA OF THE COST OF AGARIC

- Rocket launch: 175 M$
- Scintillating fibers: 5 M$
- Silicon photomultipliers: 60 M$
- CCD and optical fibers: 5 M$
- BGO crystal: < 5 M$
- Additional electronics: 25 M$ (but hard to estimate)
- **Total cost: > 275 M$**
- **Additional cost include: R&D, qualification tests and manufacturing costs.**
- Comparison: Fermi-LAT ~700 M$, AMS-02 ~2 G$, LHC 7.5 G$

Conclusions

And Alternatives

The proposed instrument, targets several problems from low energies (~1 MeV) to the VHE (>1TeV)

Unique energy range

Important R&D is needed for space qualification of SiPMs

This detector is proposed in the frame of substituting an experiment like FERMI or AMS, but it could be scaled down keeping the precision at low energies and reducing the maximum energy limit.

Due to its half sphere geometry, naively the acceptance would be ~4 times > Fermi-LAT