



AdEPT

A Full-Sky Discovery Mission for Medium-Energy Gamma-Ray Polarimetry

Monitor the whole gamma-ray sky in the energy range 2 - 500 MeV

Ground-breaking polarization sensitivity

Sensitivity ~100 times better than COMPTEL at 10 MeV

Angular resolution ~10 better than Fermi LAT

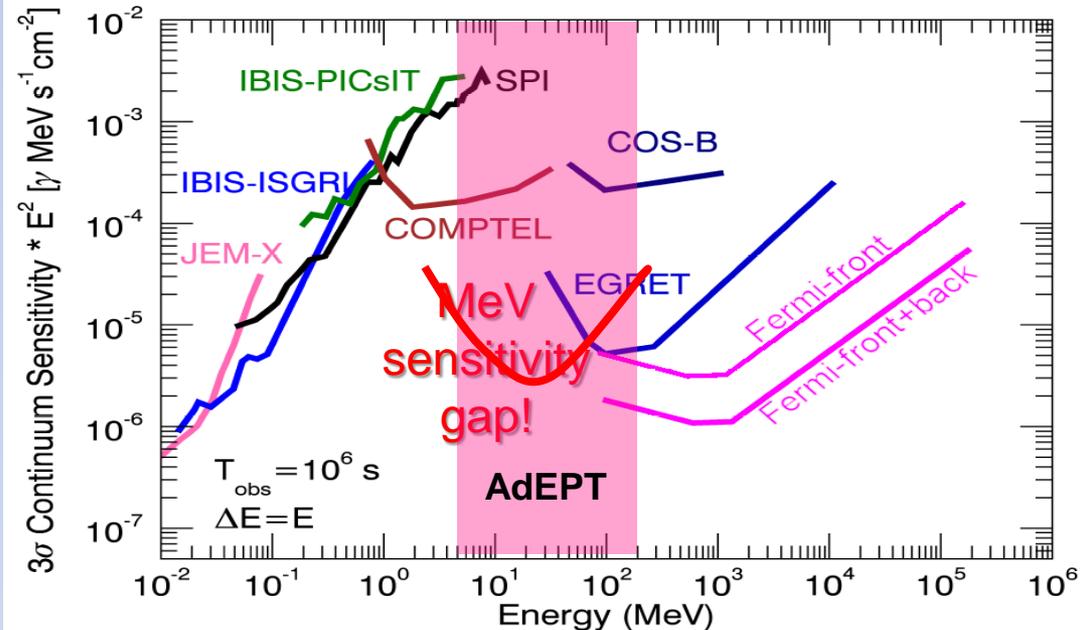
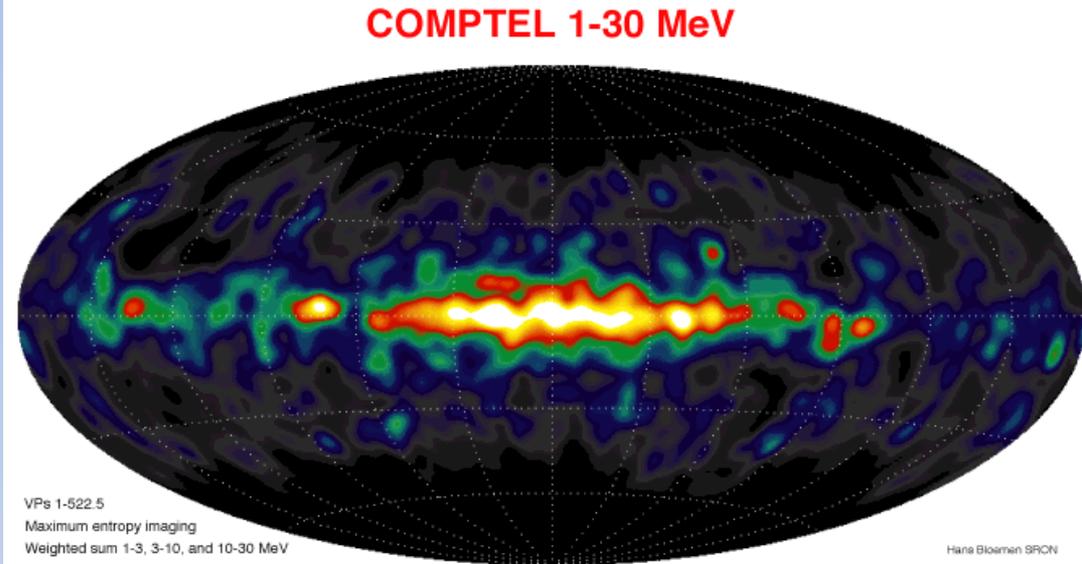
Andrey Timokhin

on behalf of the AdEPT team:

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AdEPT Science: Survey with Polarimetry

- The MeV sky is largely unexplored
 - CGRO/COMPTEL
 - Many Fermi sources indicate peak energy output in MeV range
 - But, we do not know which science topics will provide the most exciting surprises
- Broad science reach supports large user community



AdEPT Science: Overview

Energy Range: 2-500 MeV

- Poorly explored domain
 - Detailed look at known accelerators
PSRs, PWNs, SNR, AGN, GRBs
 - Yet unseen accelerators
 - Polar cap emission in PSRs
 - Magnetars
 - New classes of sources
- $\pi^0 \rightarrow \gamma\gamma$ @ $E \sim 67.5$ MeV
 π^0 - telltale signature of hadrons
 - Leptonic vs. Hadronic acceleration scenarios
 - Dark Matter photon mediators

Polarization: 0.1% MDP

- Polarization measurements:
Geometry of accelerators
no foreground propagation effects
- Strict limits on polarization:
Distinguishes π^0 emission
 $\pi^0 \rightarrow \gamma\gamma$ is unpolarized
- Unique test of relativity
vacuum birefringence effect

Angular Resolution: $\sim 0.2^\circ$

- Excellent source localization
down to $\sim 1'$ ($0.2^\circ/\sqrt{N_{\text{ph}}}$)
- Resolving MeV background
- Dark Matter profiles

Polarization Sensitivity

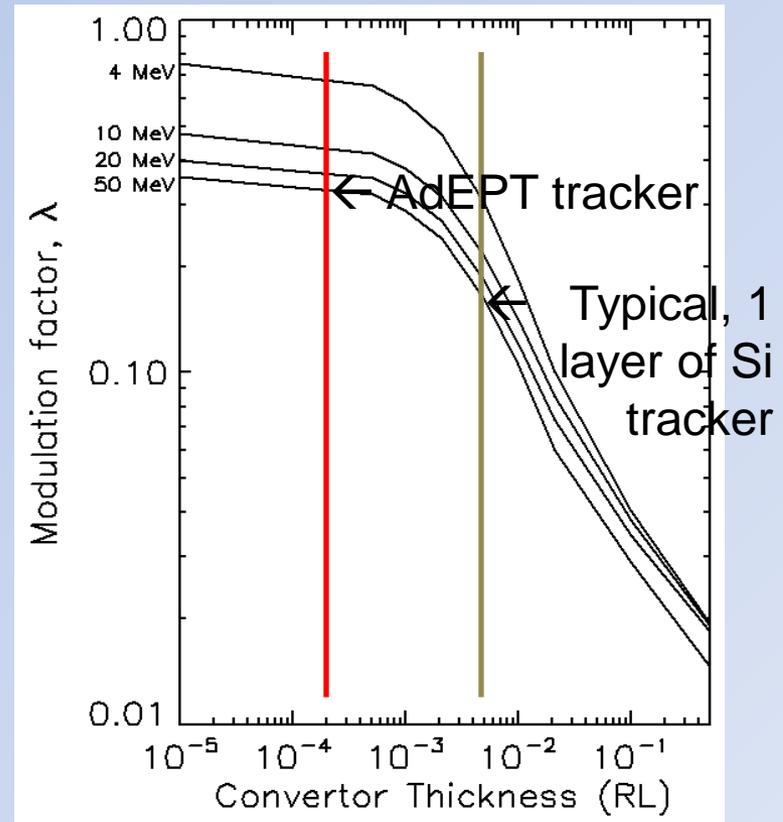
- Modulation factor, λ , decreases exponentially with thickness of tracking medium above ~ 1 mRL

– Measure e^- and e^+ directions in $\lesssim 1$ mRL

- $\sim 100 \mu\text{m}$ of Si
- ~ 8 cm of Ar at 1.5 atm

In polarimeter tracking medium must be a gas.

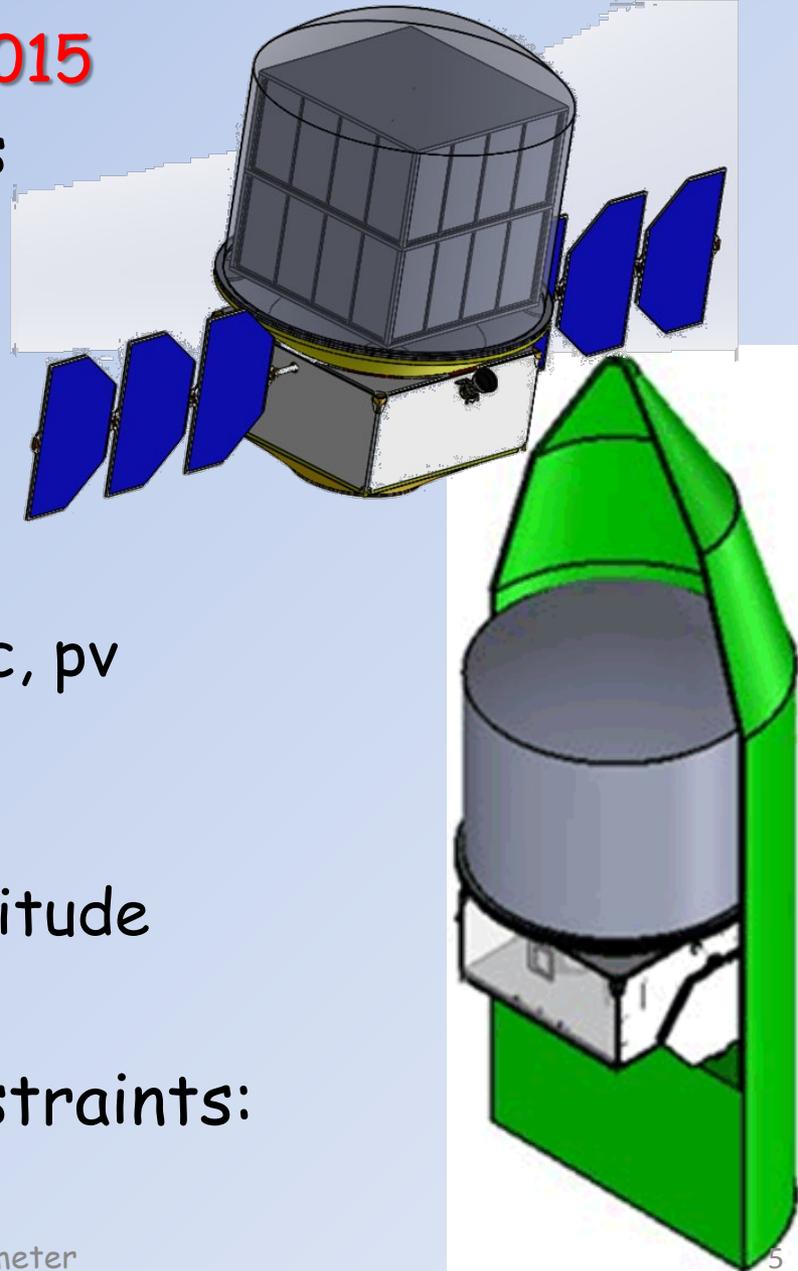
$$\sigma(\varphi) = \frac{\sigma_0}{2\pi} \left[1 + P\lambda \cos^2(\varphi) \right]$$



Kel'ner, Kotov, and Logunov,
Sov. J. Nucl. Phys., 21, 3, 313 (1975)

AdEPT Baseline Telescope

- **ADL Study Feb 2014, IDL in Nov 2015**
- 2×2×2 array of 1 m³ 3-DTI modules
 - A_{geom} : 4 m², ~80,000 channels
- Ar + CS₂, 1.5 atm, 25° C
- Pressure vessel: ~300 cm diameter
Composite PV designed, ~150 kg
- Instrument power: ~500 W,
mass: ~320 kg w/o s/c, pv
- Spacecraft: zenith pointed,
3-axis stabilized, scanning mode
- Orbit: near equatorial, ~550 km altitude
- Athena launch vehicle
- Fits within Explorer mission constraints:
Mass, Power, & Cost



Summary

- AdEPT provides the first polarization measurements in the gamma-ray band
 - Strong, revolutionary science
 - Opening a new observational window
 - Broad community support
- Uses mature detector technology and has a well established, mature instrument concept
- In terms of polarization sensitivity and angular resolution AdEPT design offers the best performance for already available technology.