Cosmic-ray spectroscopy with the balloon-borne PEBS detector

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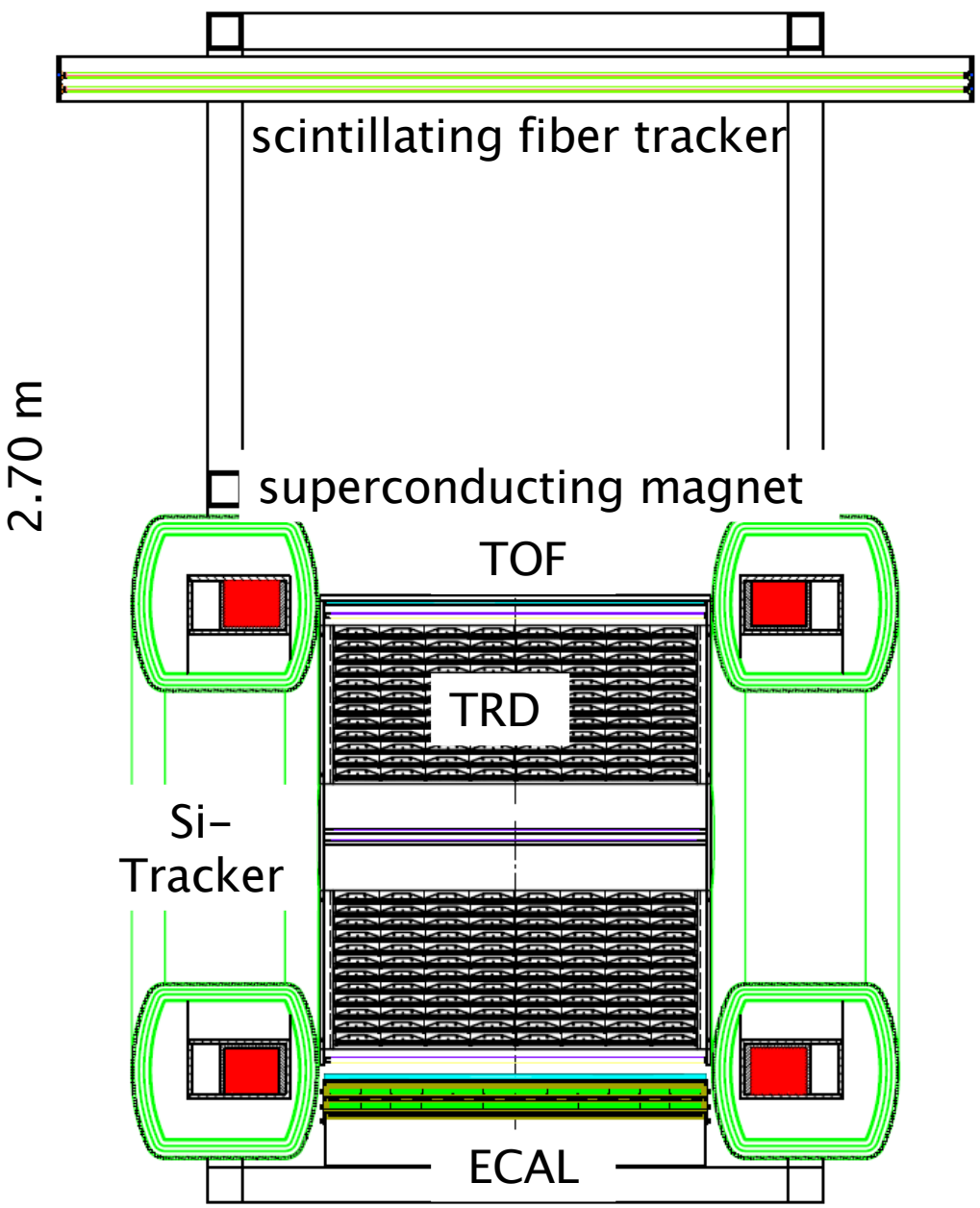
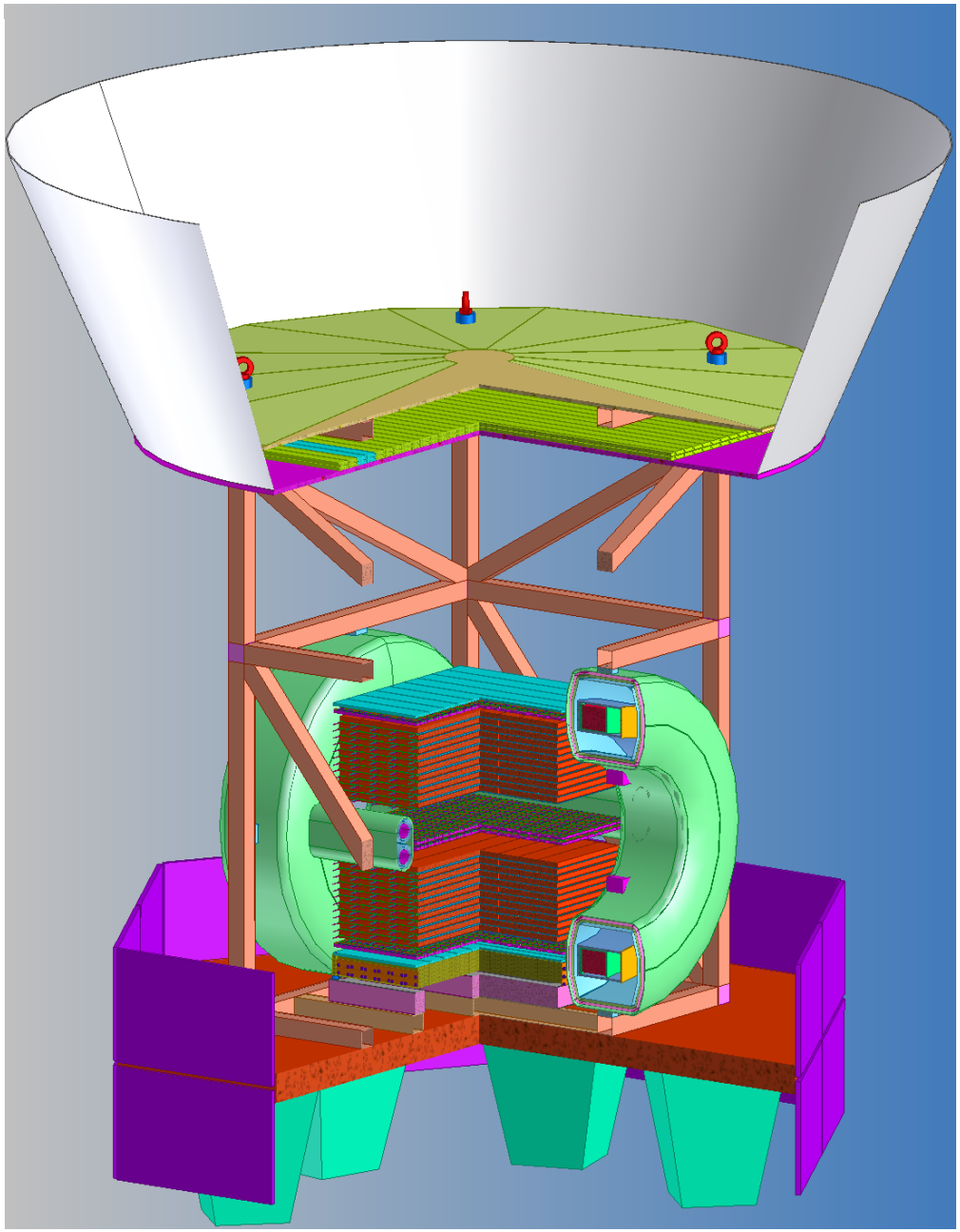
PEBS: design


2.70 m
scintillating fiber tracker
superconducting magnet
TOF
TRD
Si-
Tracker
ECAL

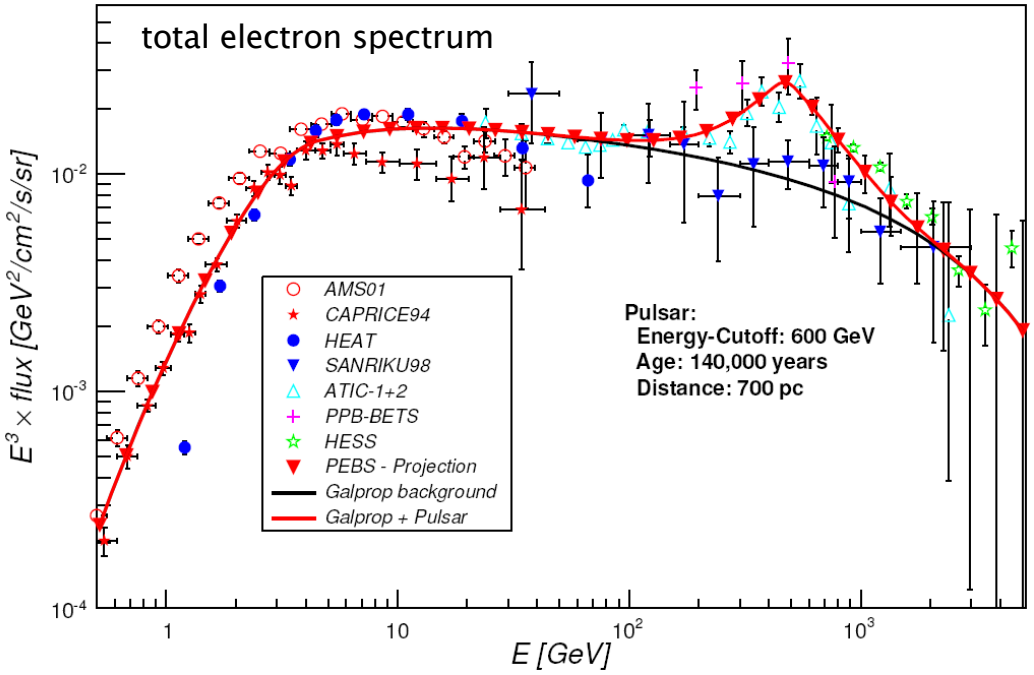


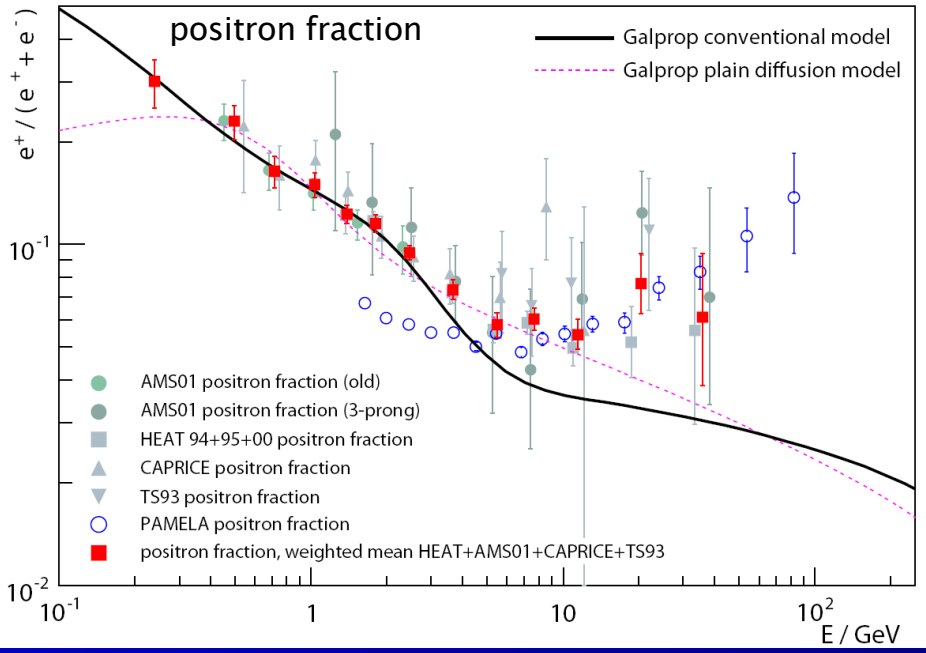
PEBS: physics program

primary targets:
- positron fraction up to 2TeV (→ indirect dark matter search)
- total electron spectrum up to several TeV (→ verify HESS/ATIC (hadronic backgrounds!?); nearby sources?)
- low-energy positron fraction (→ solar modulation and geomagnetic effects)

and maybe:
- antiprotons
- B/C
- ^{3}He/^{4}He (with RICH)

acceptance: 3000 cm^2 sr
design: flights of up to 40 days





PEBS: physics program

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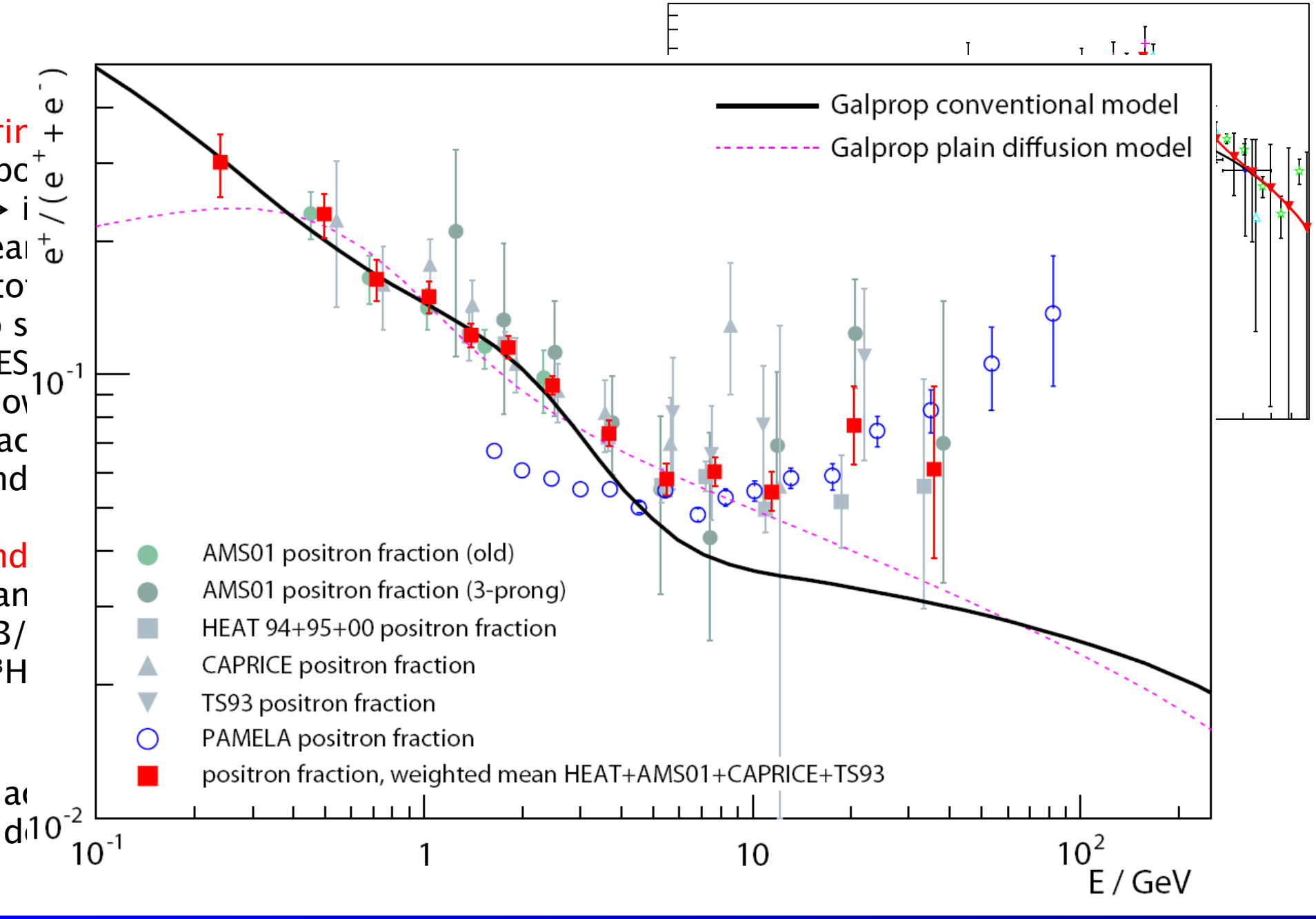
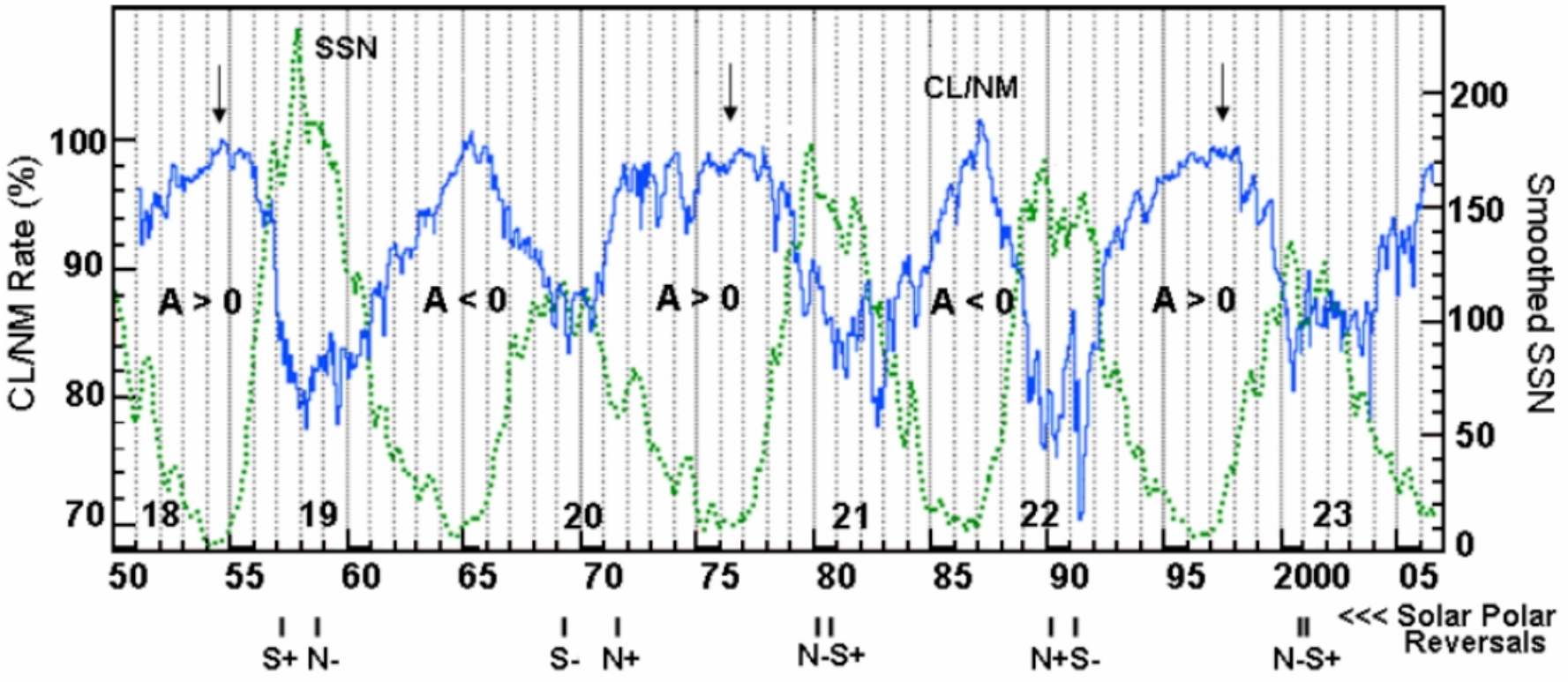
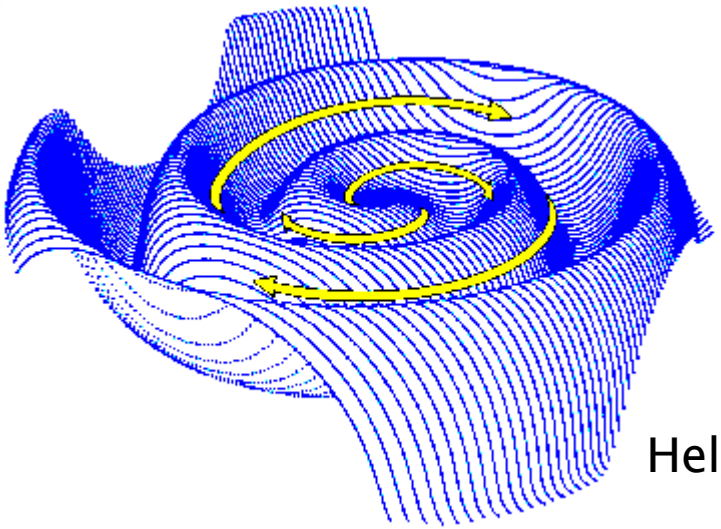


Solar modulation

30th ICRC, 1, 493





Heliospheric current sheet

A simple model for charge-dependent solar modulation

general case: Parker equation (1965)

$$\frac{\partial f}{\partial t} = -(\boldsymbol{V} + \langle \boldsymbol{v}_D \rangle)\nabla f + \nabla(\boldsymbol{K}^{(s)}\nabla f) + \frac{1}{3}(\nabla \boldsymbol{V})\frac{\partial f}{\partial \ln p}$$

- V solar wind velocity
- K diffusion tensor
- v_D related to antisymmetric part of diffusion tensor

force-field approximation (Gleeson and Axford, 1968):

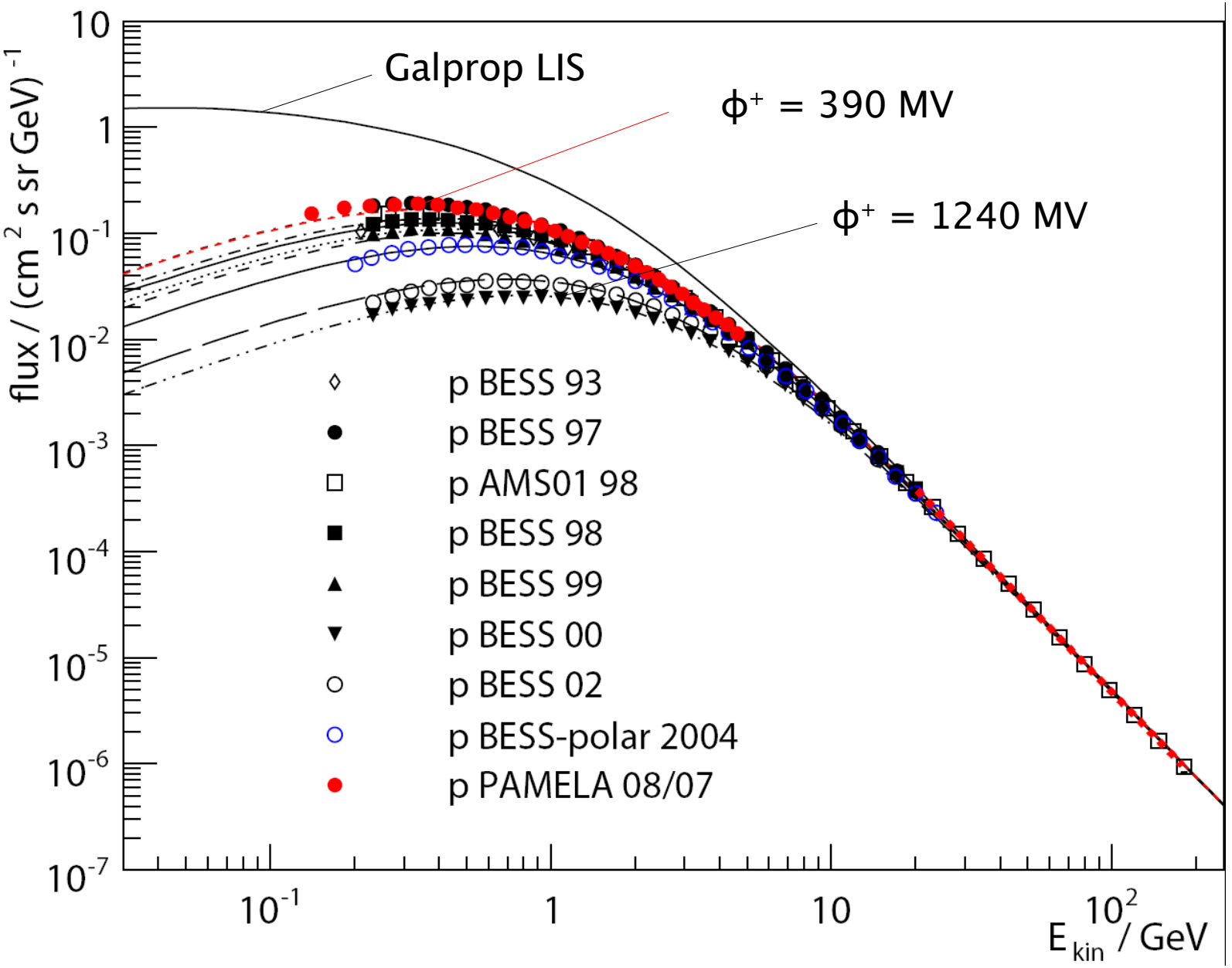
$$J(E) = \frac{E^2 - m^2}{(E + |z|\phi)^2 - m^2} \cdot J_{IS}(E + |z|\phi)$$

simple idea: allow different value of ϕ for positively and negatively charged particles

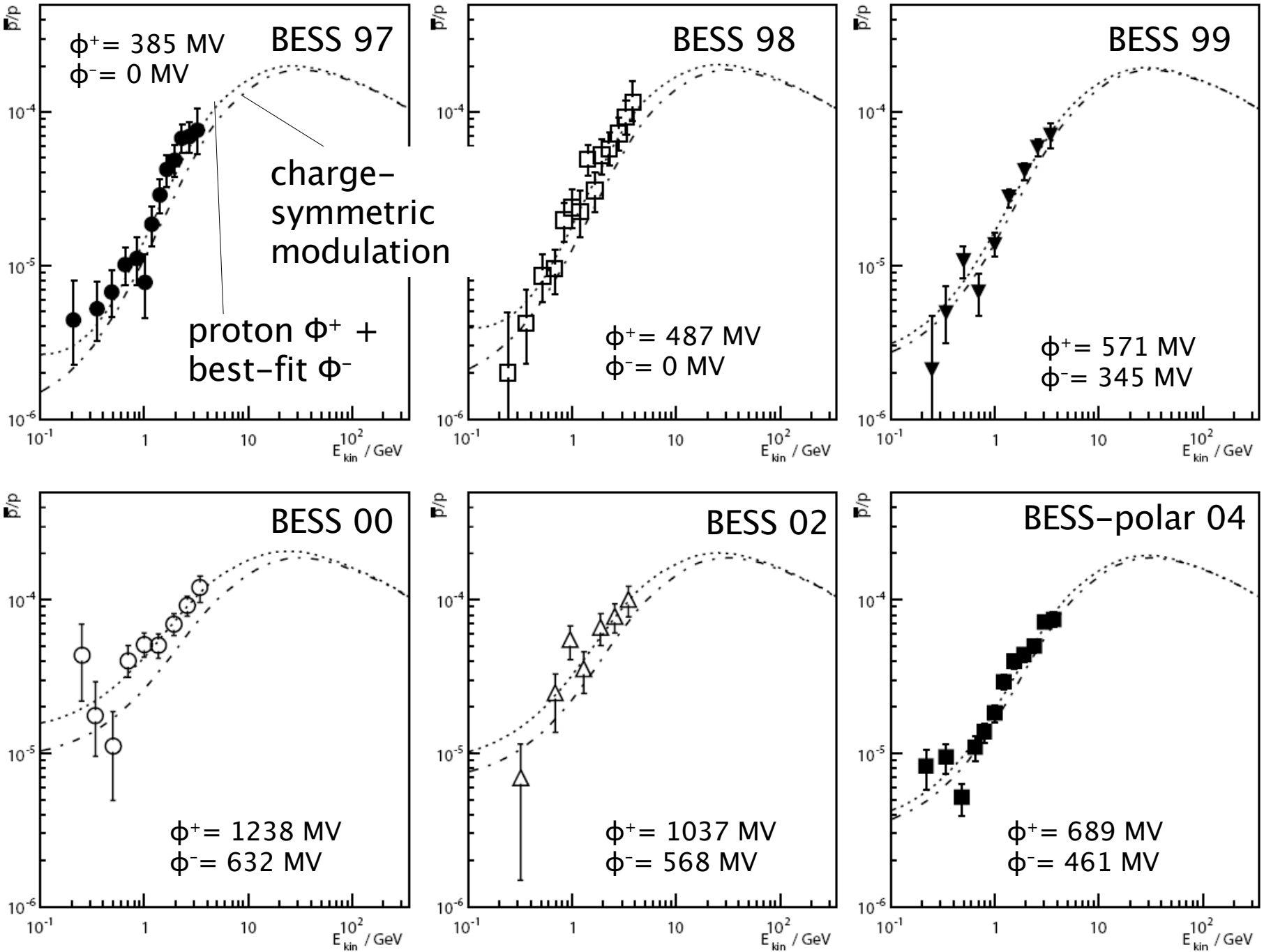
Galprop conventional model is used for the calculation of interstellar flux J_{IS} for all particle species

at low energies: geomagnetic cutoff effects complicate the picture

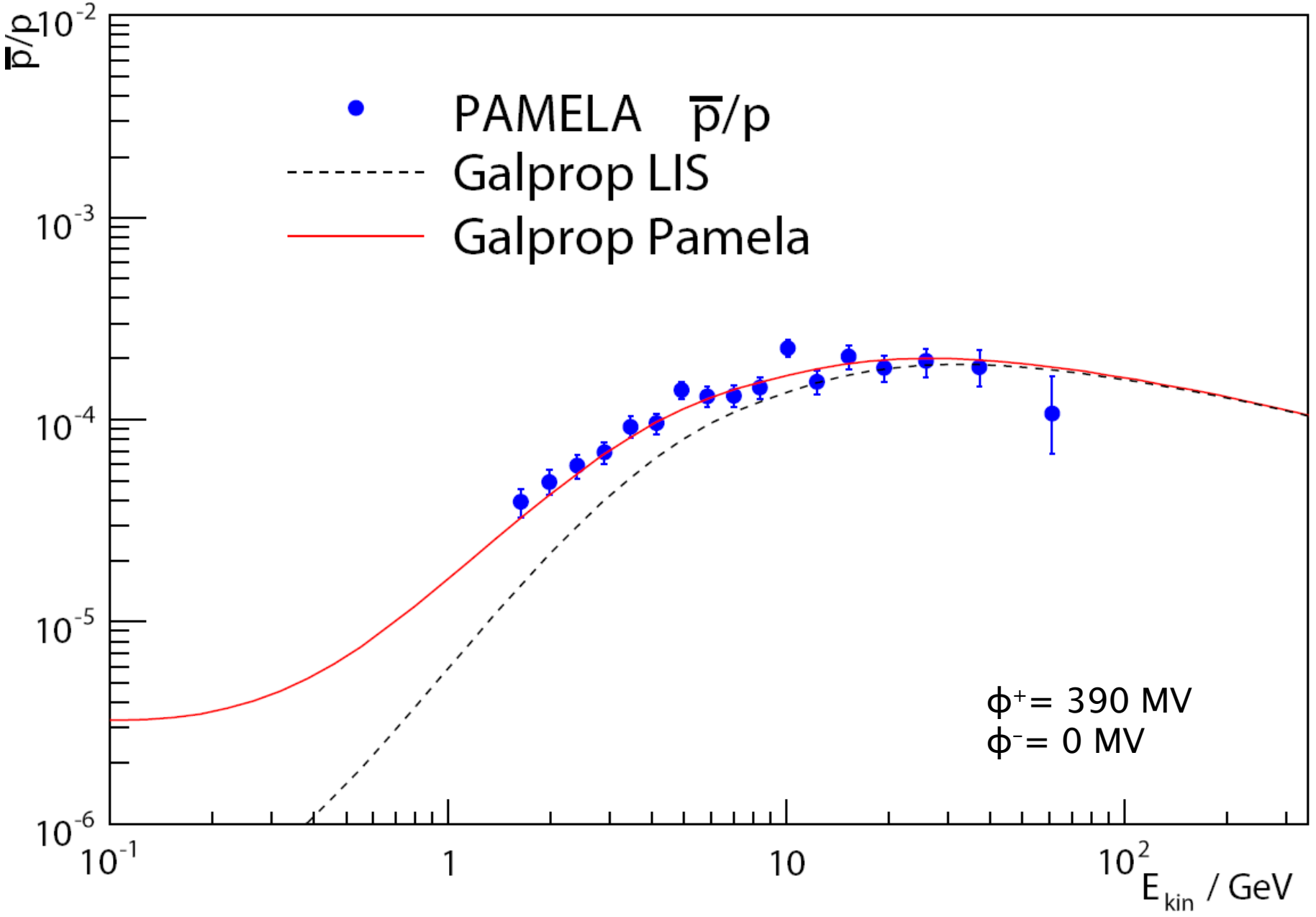
Modulated proton spectra



BESS antiproton/proton ratios

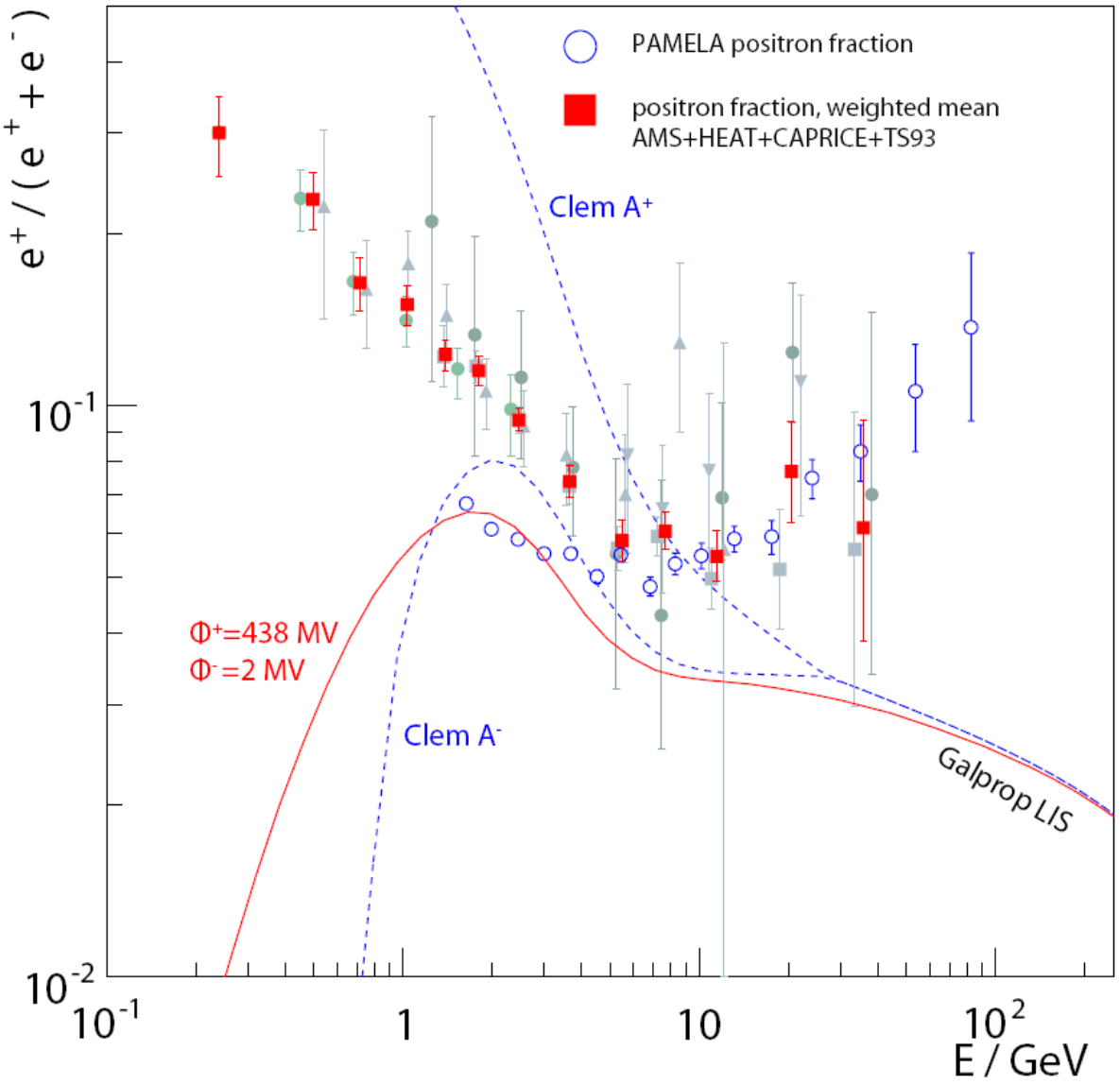


PAMELA pbar/p



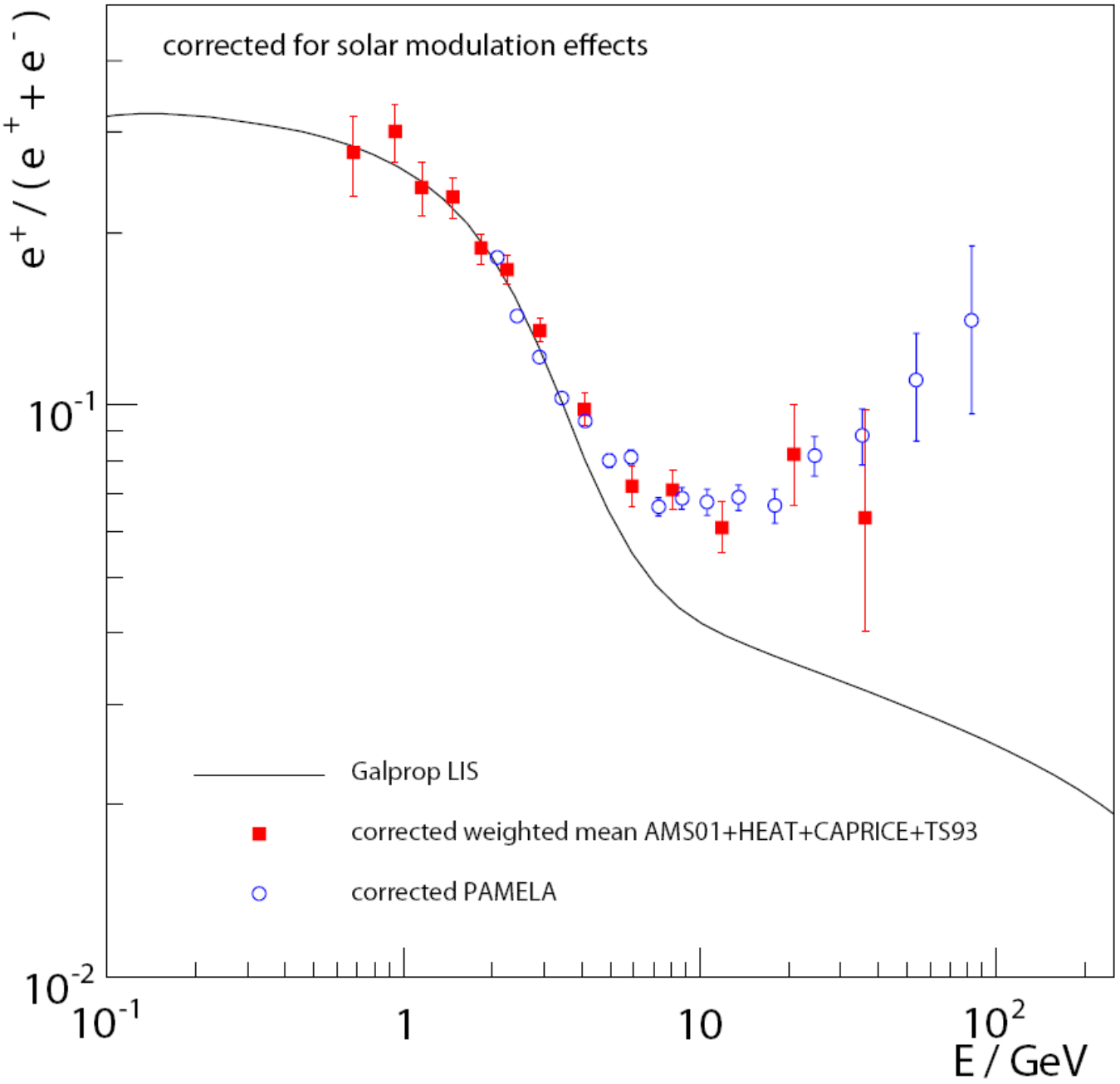
Comparison to model by Clem et al.

$$f_{\mathrm{E}}(P, \phi, qA) = C(q\mathrm{A}, P) \times M(P, \phi) \times f(P)$$

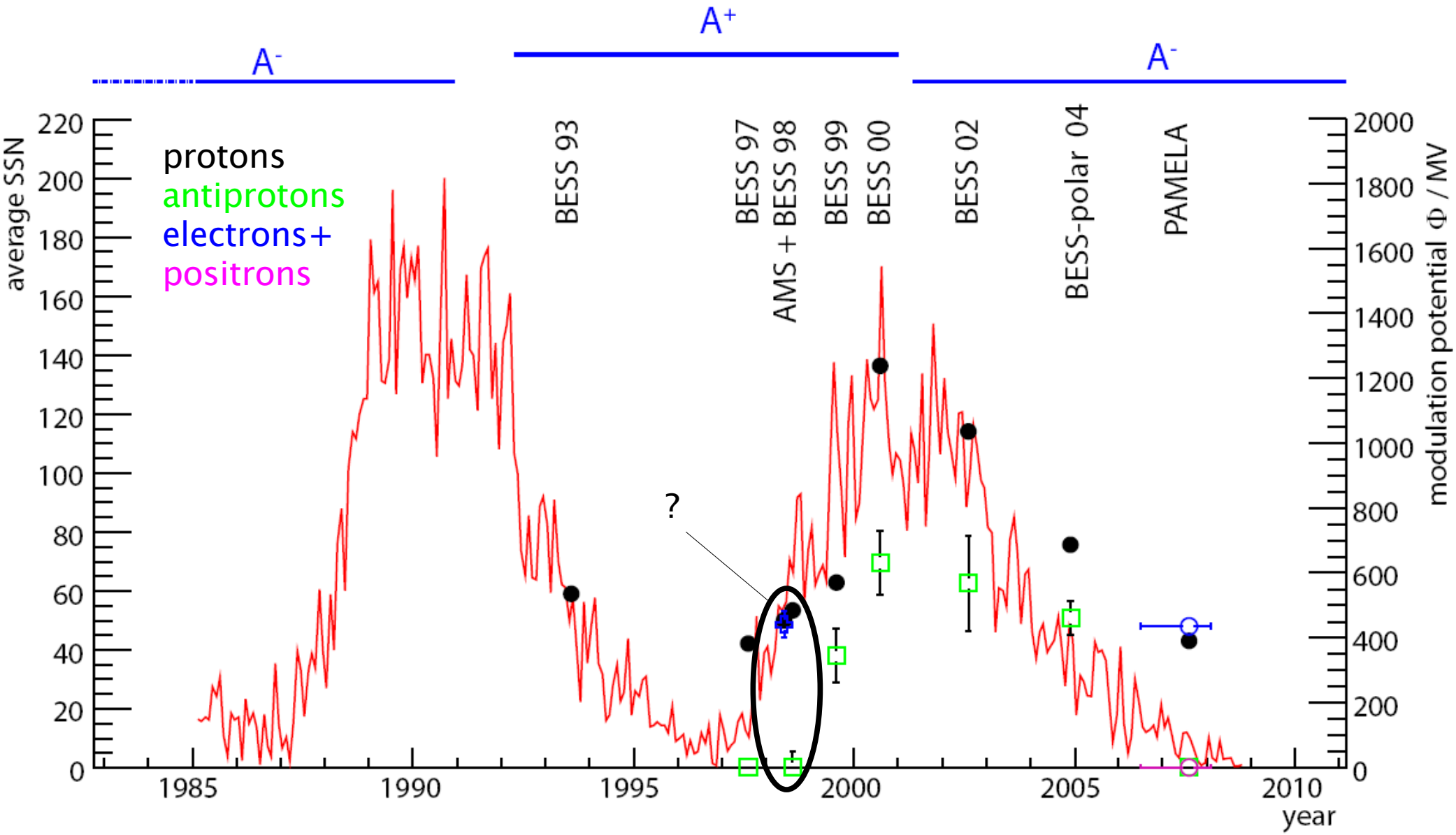


Clem et al.,
ApJ **464** (1996) 507

PAMELA positron fraction II



Correlation with sunspot number



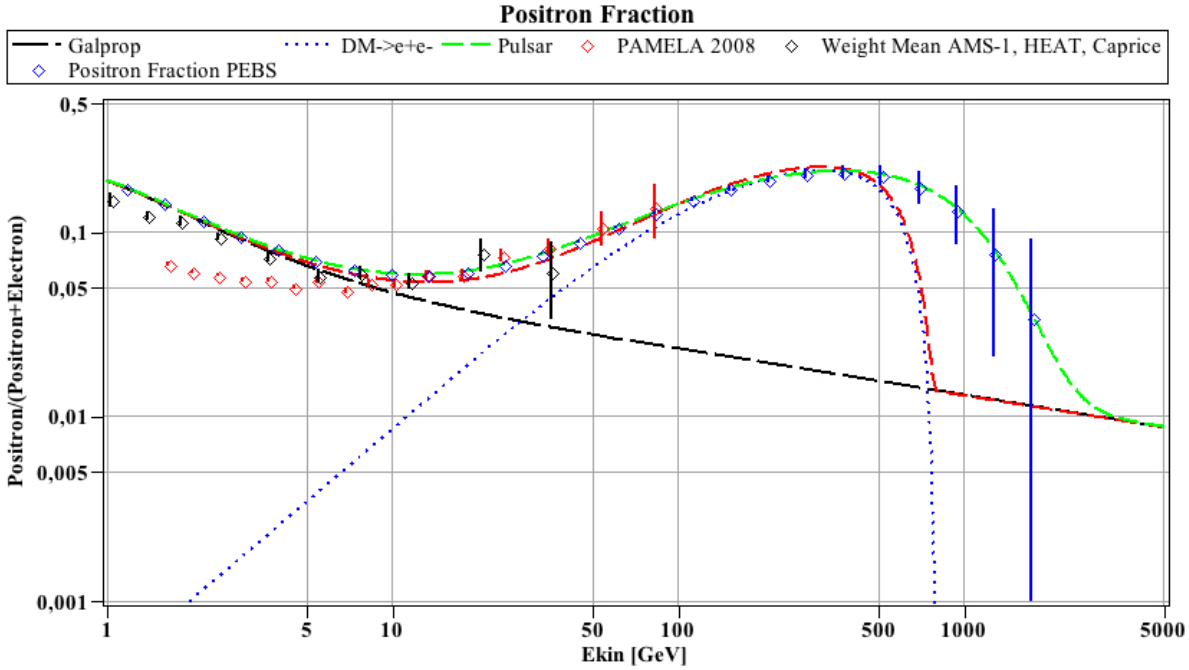
Conclusions and projection for PEBS

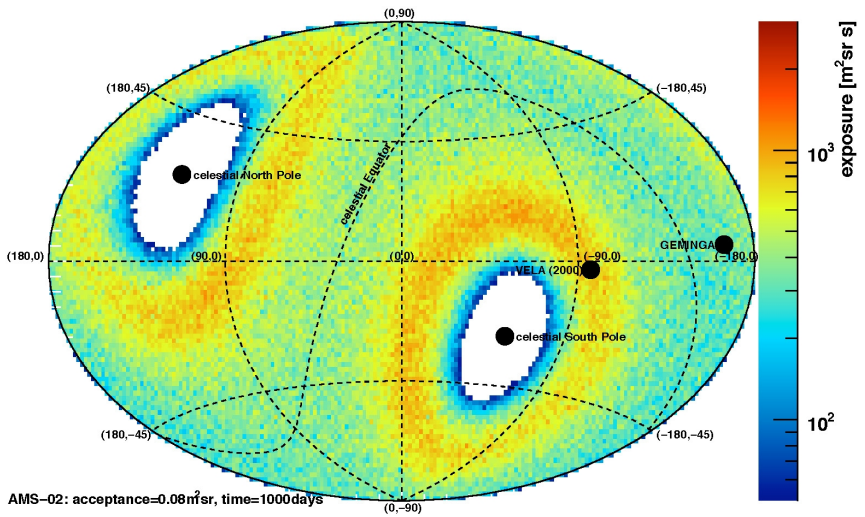
Simple model of charge-dependent solar modulation: Force-field approximation → ϕ^+, ϕ^-

- good description of proton and antiproton data of BESS and PAMELA
- low-energy PAMELA positron fraction data found to be consistent with earlier measurements by AMS-01, HEAT, CAPRICE, TS93.

PEBS designed for unprecedented reach both in terms of energy range and statistics, in positron fraction and total energy spectrum.

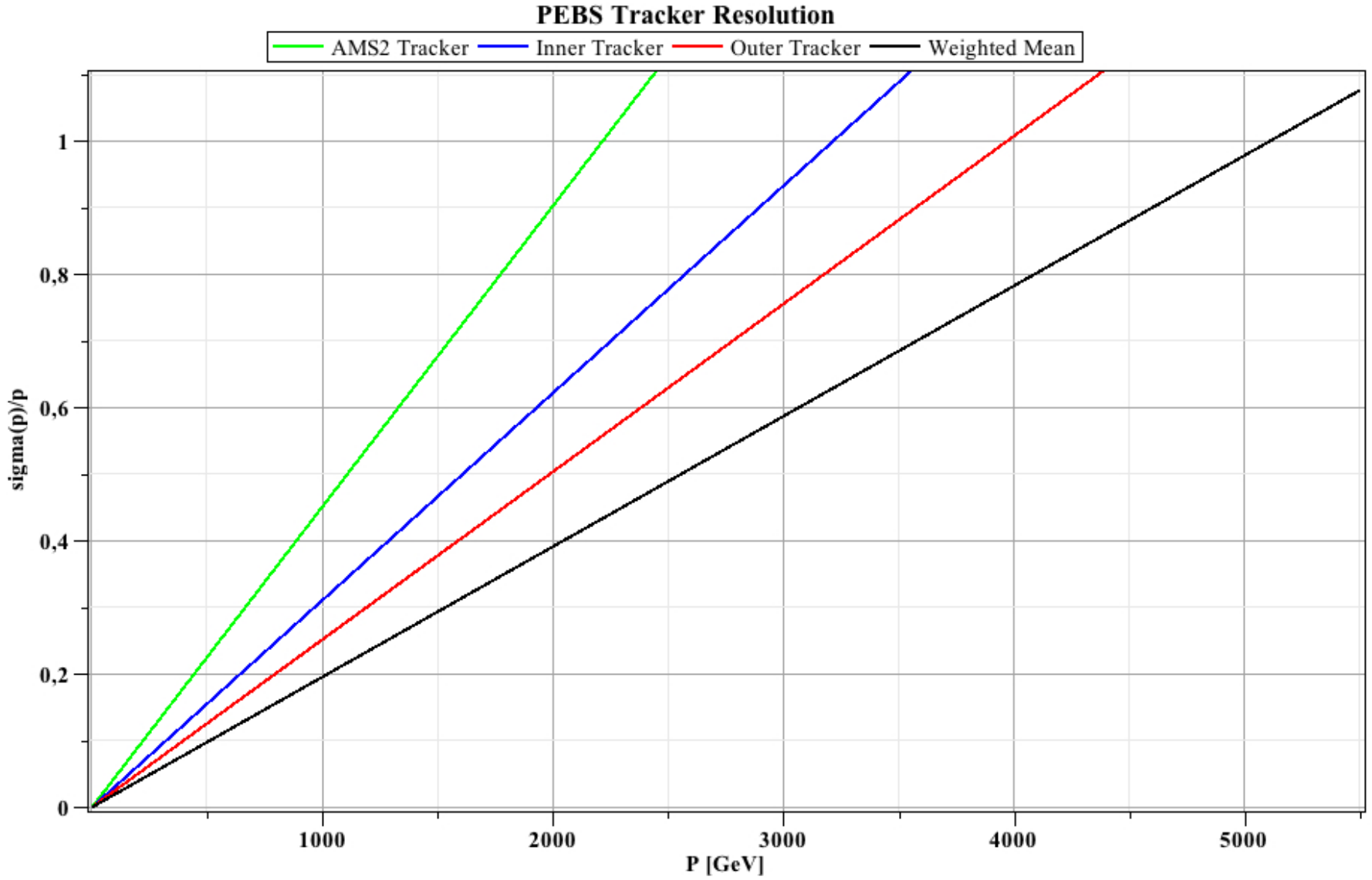
Polar trajectory with low geomagnetic cutoff ideal for studies of solar modulation.





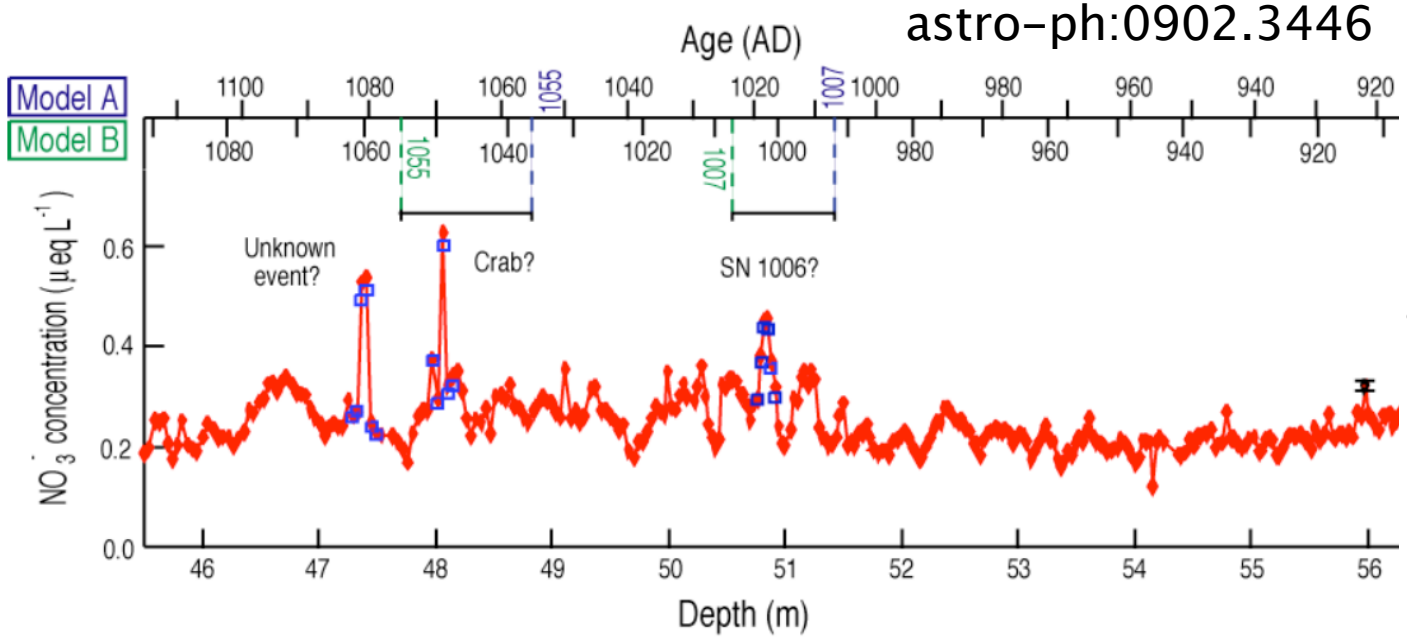
AMS02 sky coverage

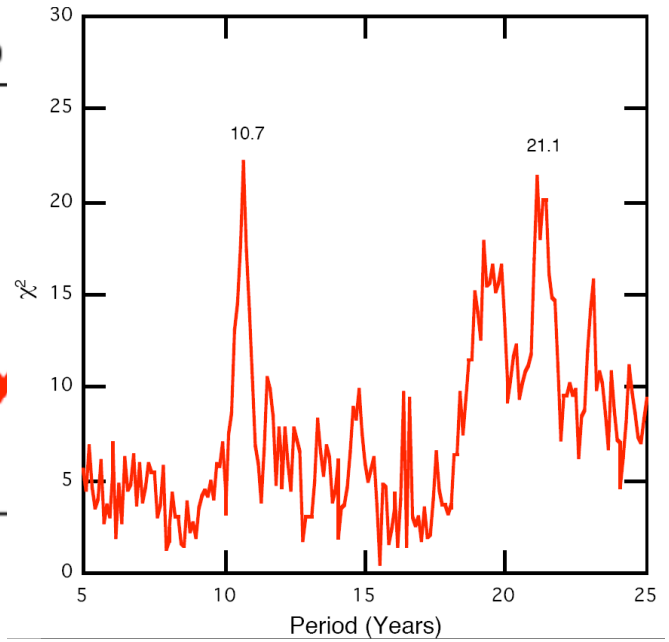
Backup: Momentum resolution



Backup: solar modulation and nitrate concentration

astro-ph:0902.3446





nitrate concentration in Antarctic ice