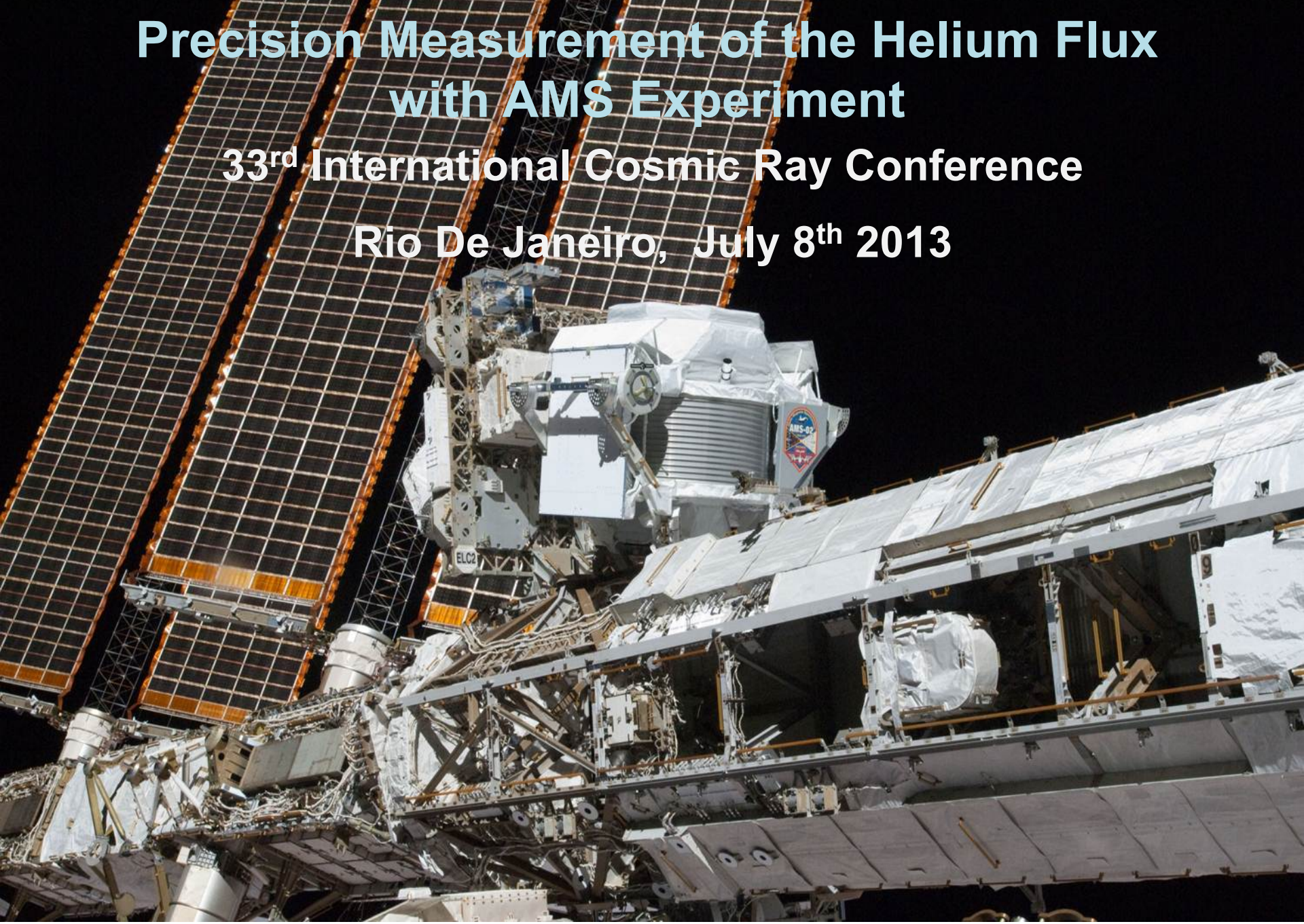
Precision Measurement of the Helium Flux with AMS Experiment

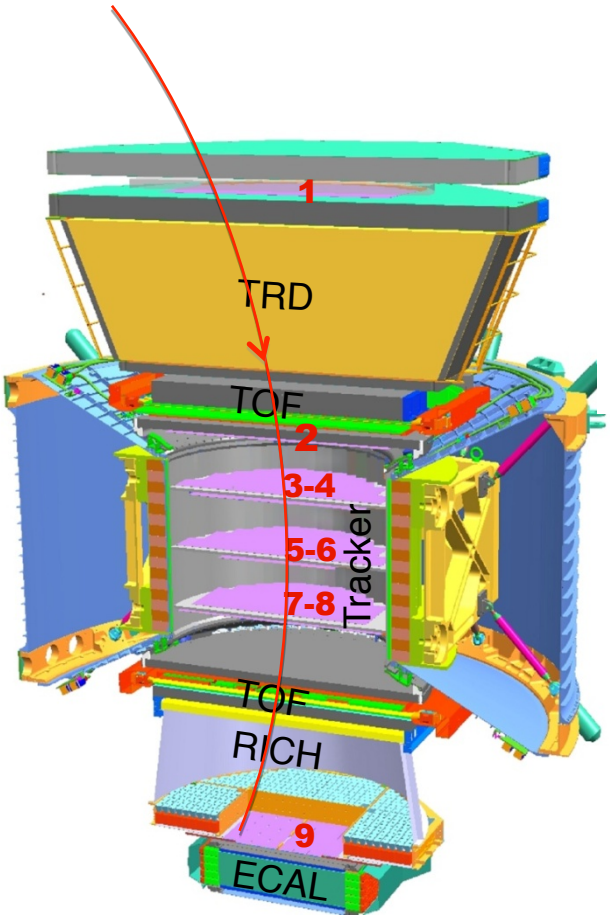
33rd International Cosmic Ray Conference

Rio De Janeiro, July 8th 2013



V. Choutko/M.I.T. on behalf of AMS Collaboration

AMS Detector He Properties Measurement



Rigidity, Direction and Charge Sign

Tracker

Bending Coordinate Resolution 6 to 7 μm

MDR (Z=2) ≈ 3.2 TV

Velocity and Direction

TOF

$\Delta\beta/\beta^2(Z=2) \approx 2\%$

Charge Magnitude Along He Trajectory

TRD, Tracker, RICH ,TOF, ECAL

ΔZ (Z=2) ≈ 0.08-0.2

Helium Selection

(I) Downgoing Particle

$\beta > 0.3$

(II) Rigidity (R) Above Geomagnetic Cutoff (R_C)

$R > 1.2R_C + 2\sigma(R_C)$

(III) Charge Compatible with that of He along Particle Trajectory

For instance, for Inner Tracker $1.6 < Z < 2.6$

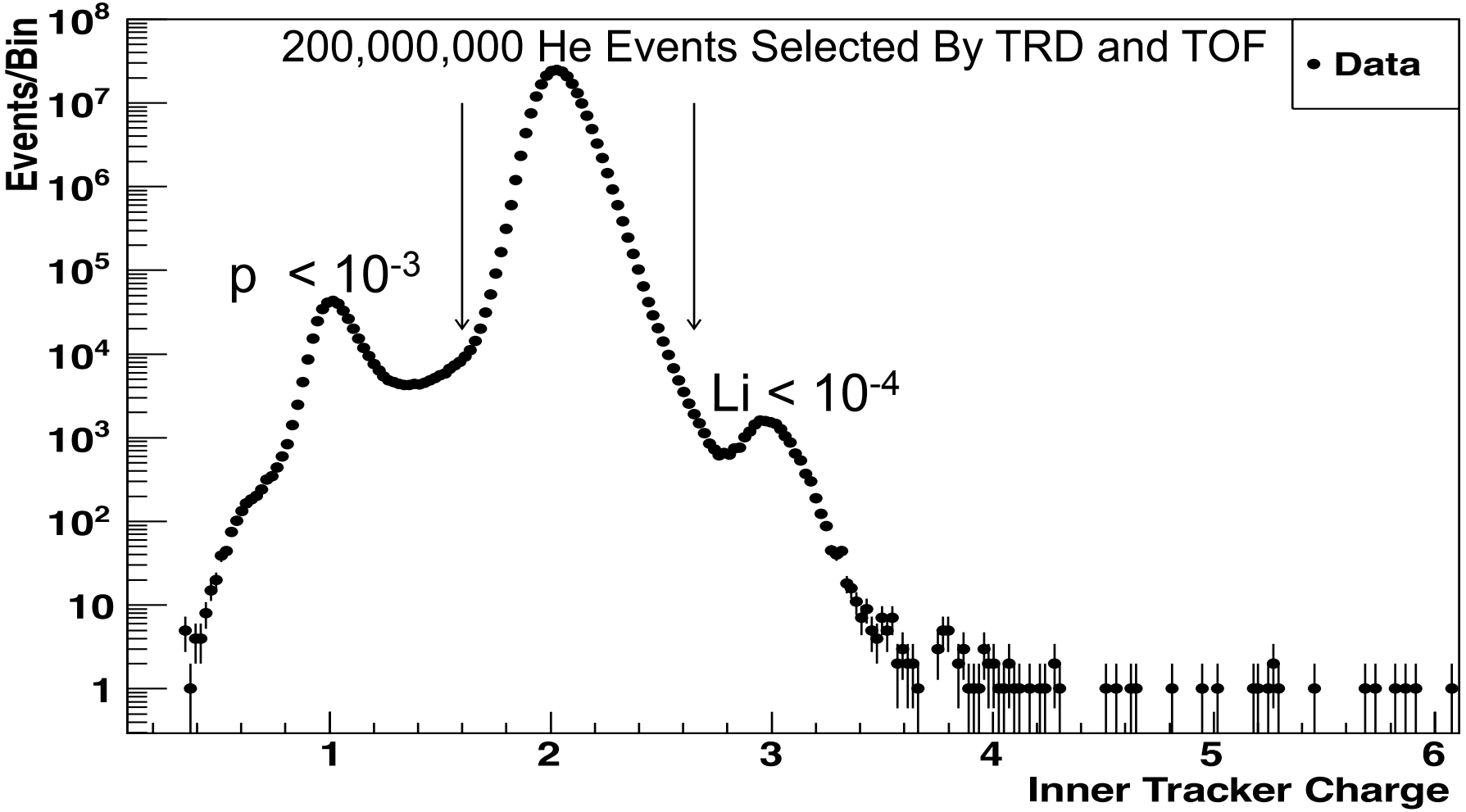
(IV) χ^2 of the Particle Trajectory Fit < 10

Efficiency 98-99 %, Removes Bulk of Events with Large Scattering and Wrongly Measured Rigidity

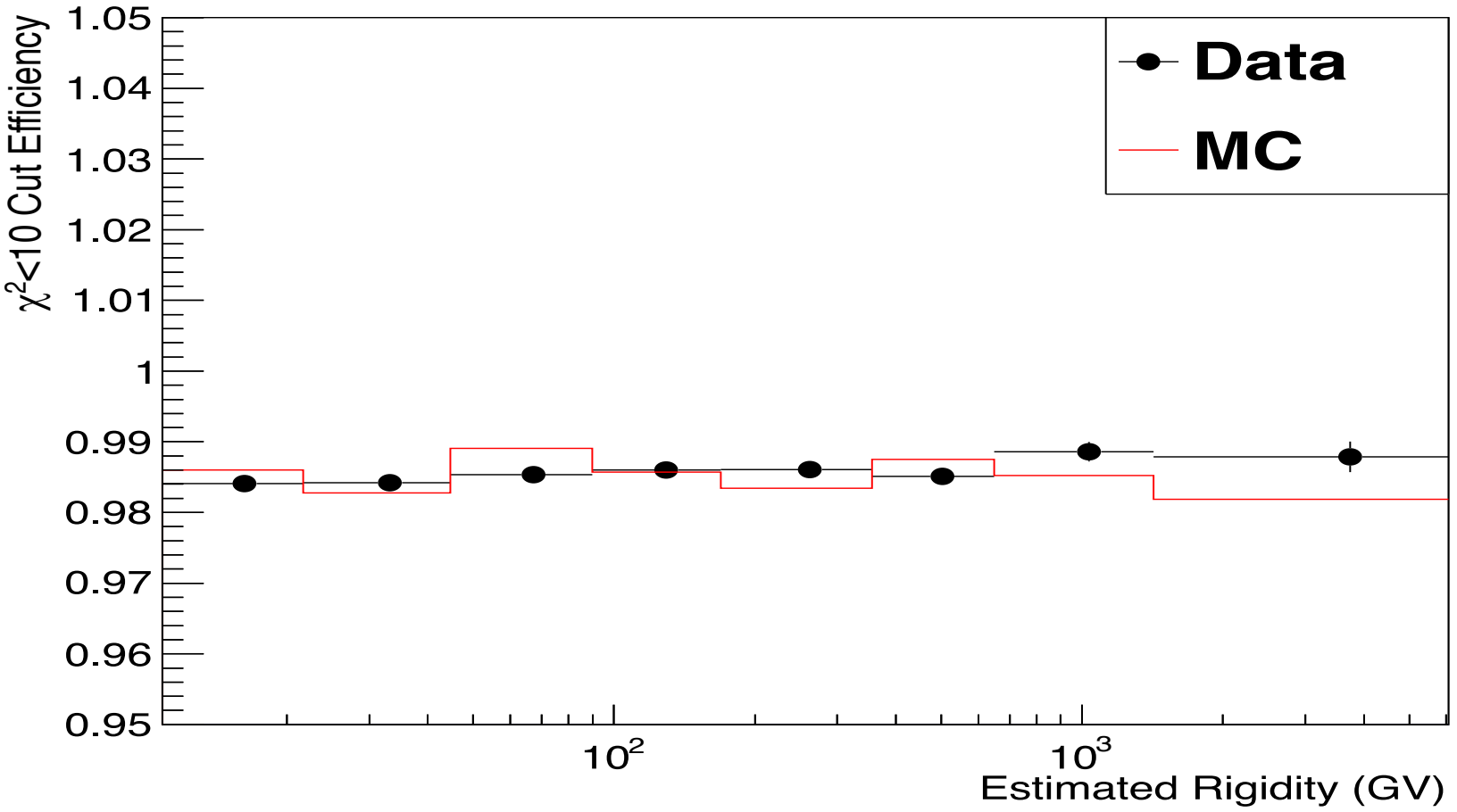
Helium Selection

Proton background: $<10^{-5}$

Main Remaining Background: Ions Interacted on Top of AMS $< 10^{-3}$



Selection Efficiency
Data: Rigidity Estimated by ECAL



Flux Measurement

Assuming flux over geomagnetic cutoff is isotropic
the differential He flux can be defined as

$$\Phi(R) = \frac{1}{2\pi(1-\cos\theta_{max})} \frac{N_{Events}(R,R+\Delta R)}{T(R)\ A(R)\ \varepsilon_{trig+sel}(R)\ \Delta R}$$

R: 2-3200 GV

T: >50 millions seconds

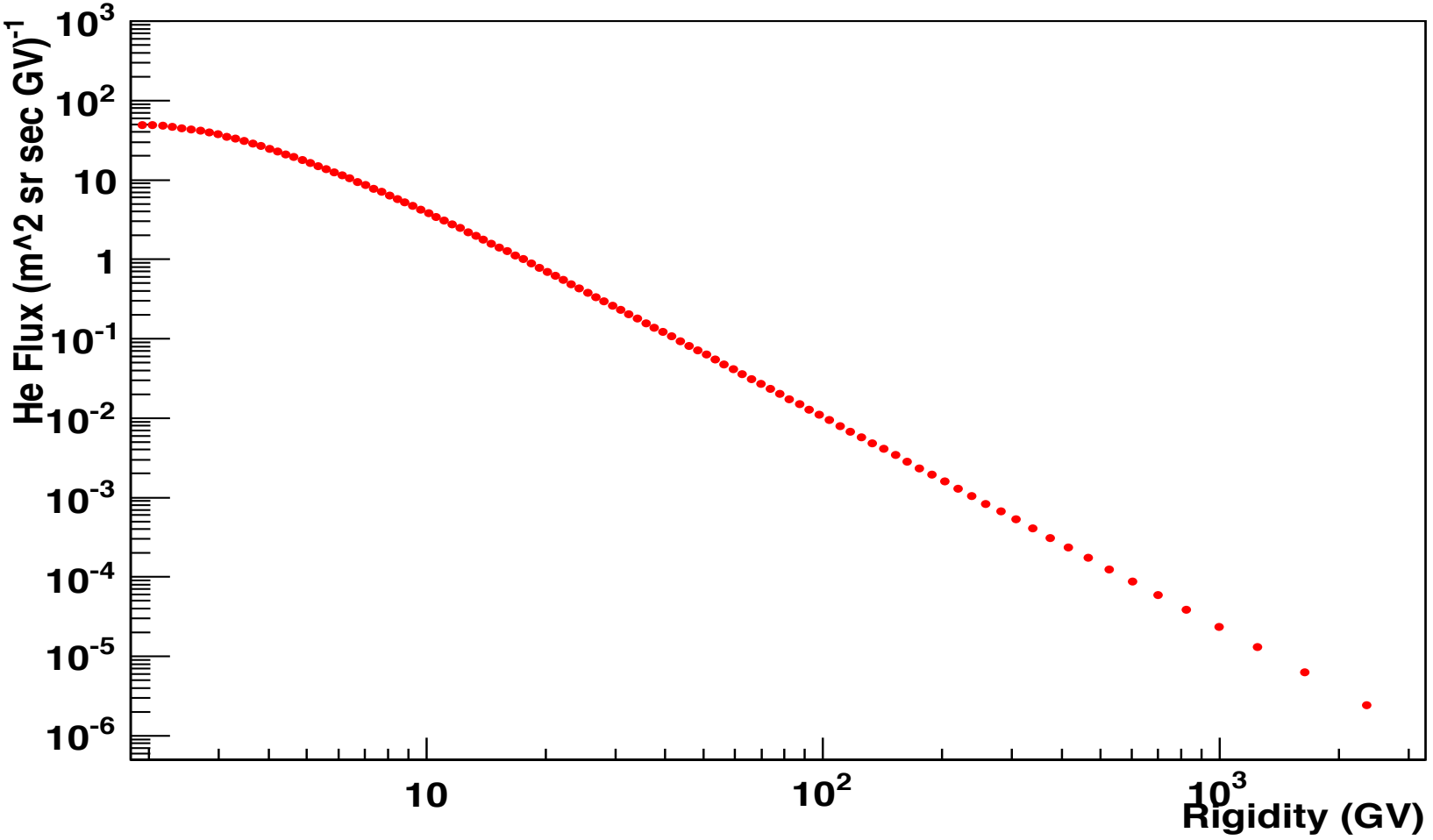
Trigger & Selection Efficiency

Bin width

θ_{Max}: 20^{o}

A: $\int d\phi, d\cos\theta$ of Geometrical Acceptance

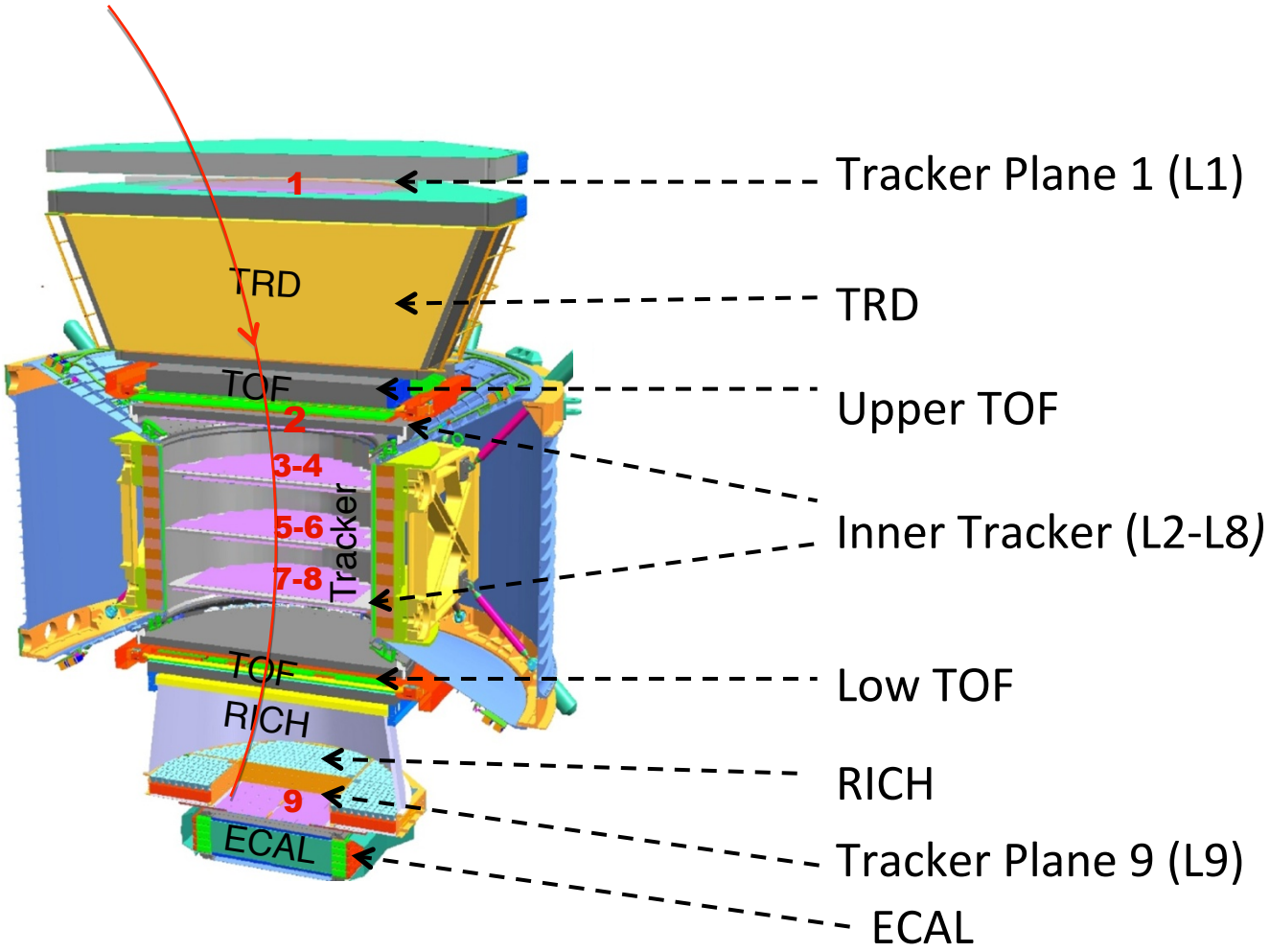
He Flux Statistical Errors Only



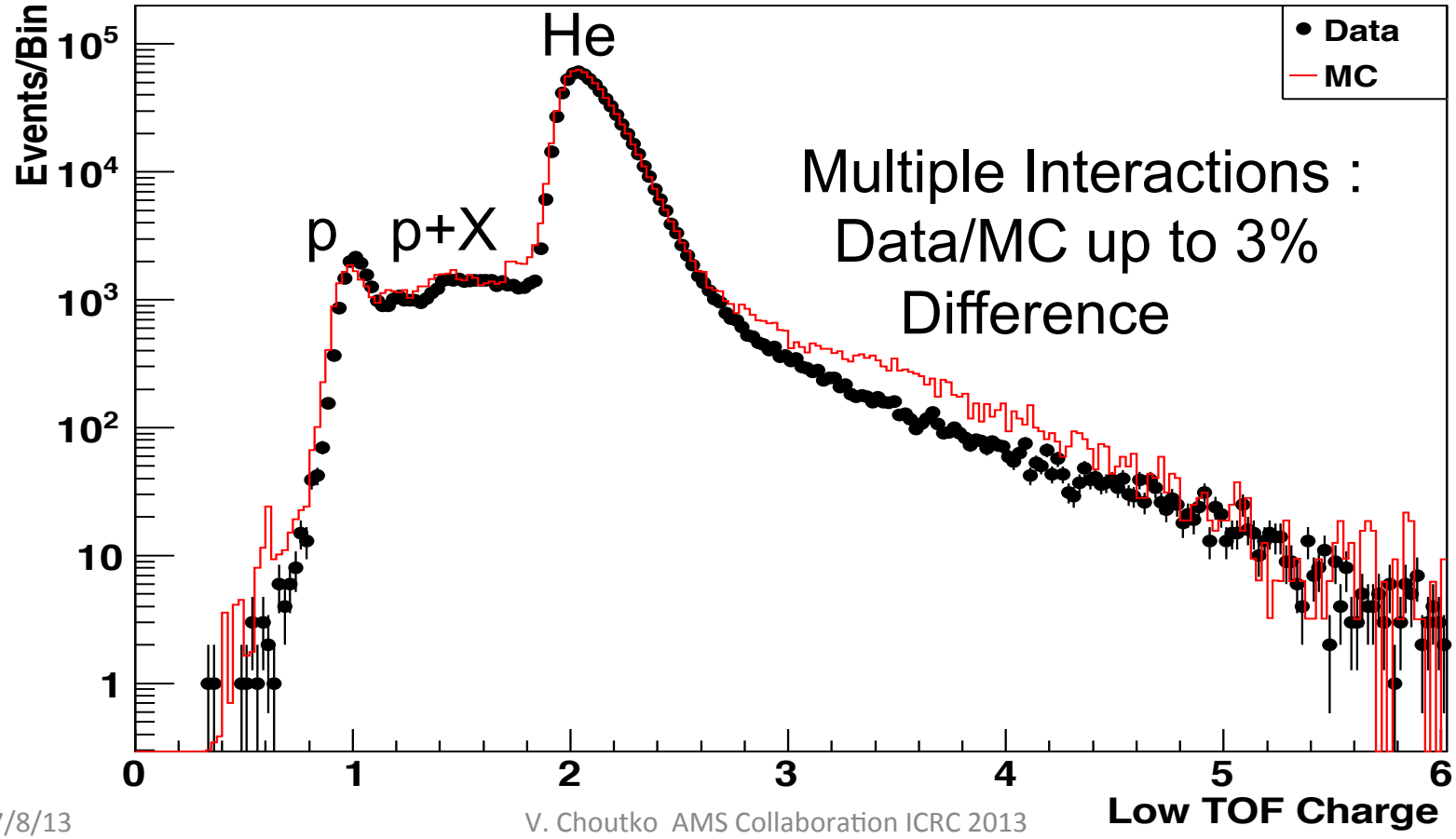
Systematic Errors on Acceptance

Source	Efficiency(%)	Error(%)
Trigger	95-99	0.5
Track and Velocity Fit	95-97	0.7
Event Selection	~80	0.7
• Monte Carlo Statistics		0.7
• Total of The Above		1.3
• Unfolding Errors	<0.5% below 250GV	
	10% above 2 TV	

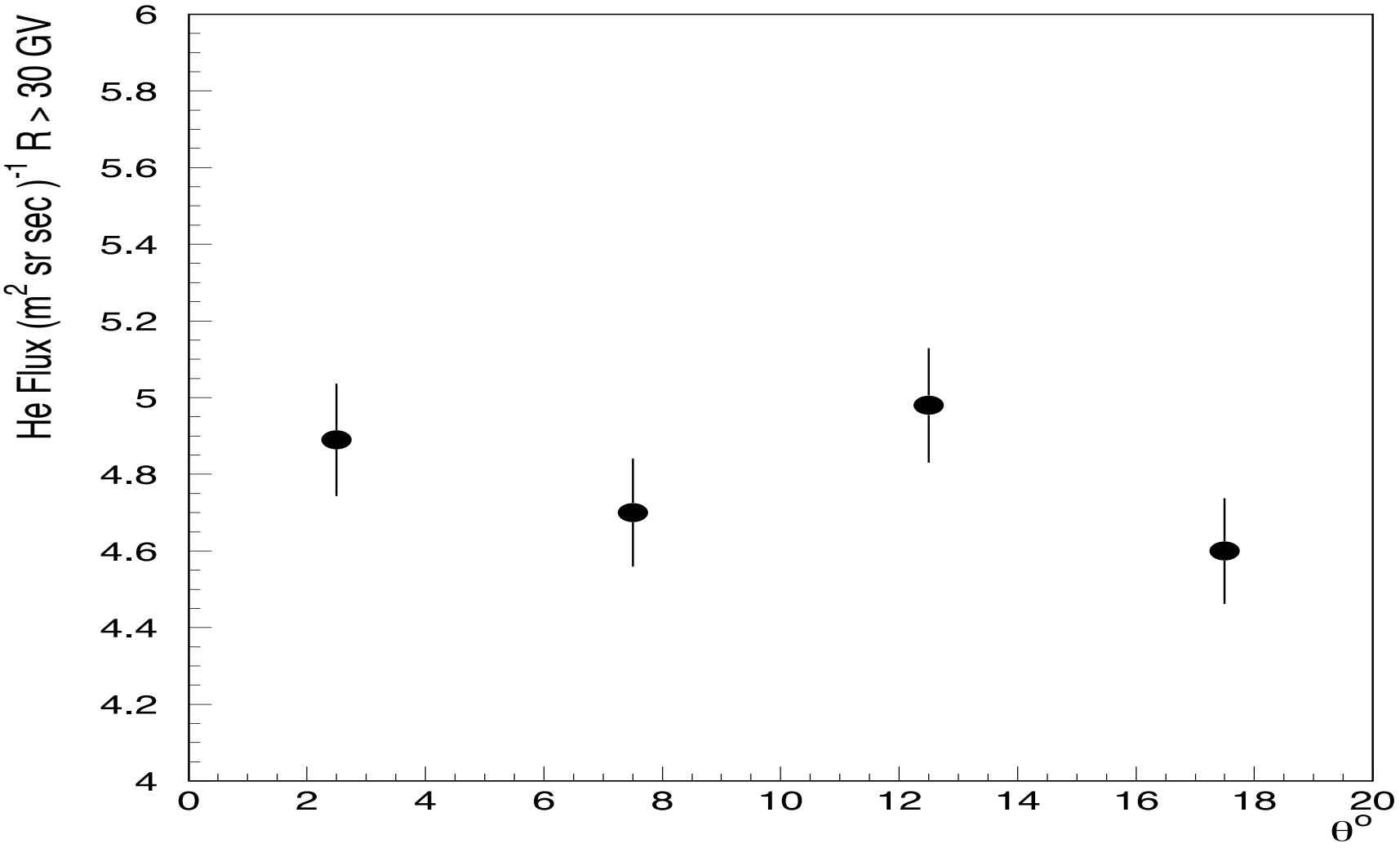
Monte Carlo Helium Interactions Validation by Measuring He Charge Along Trajectory

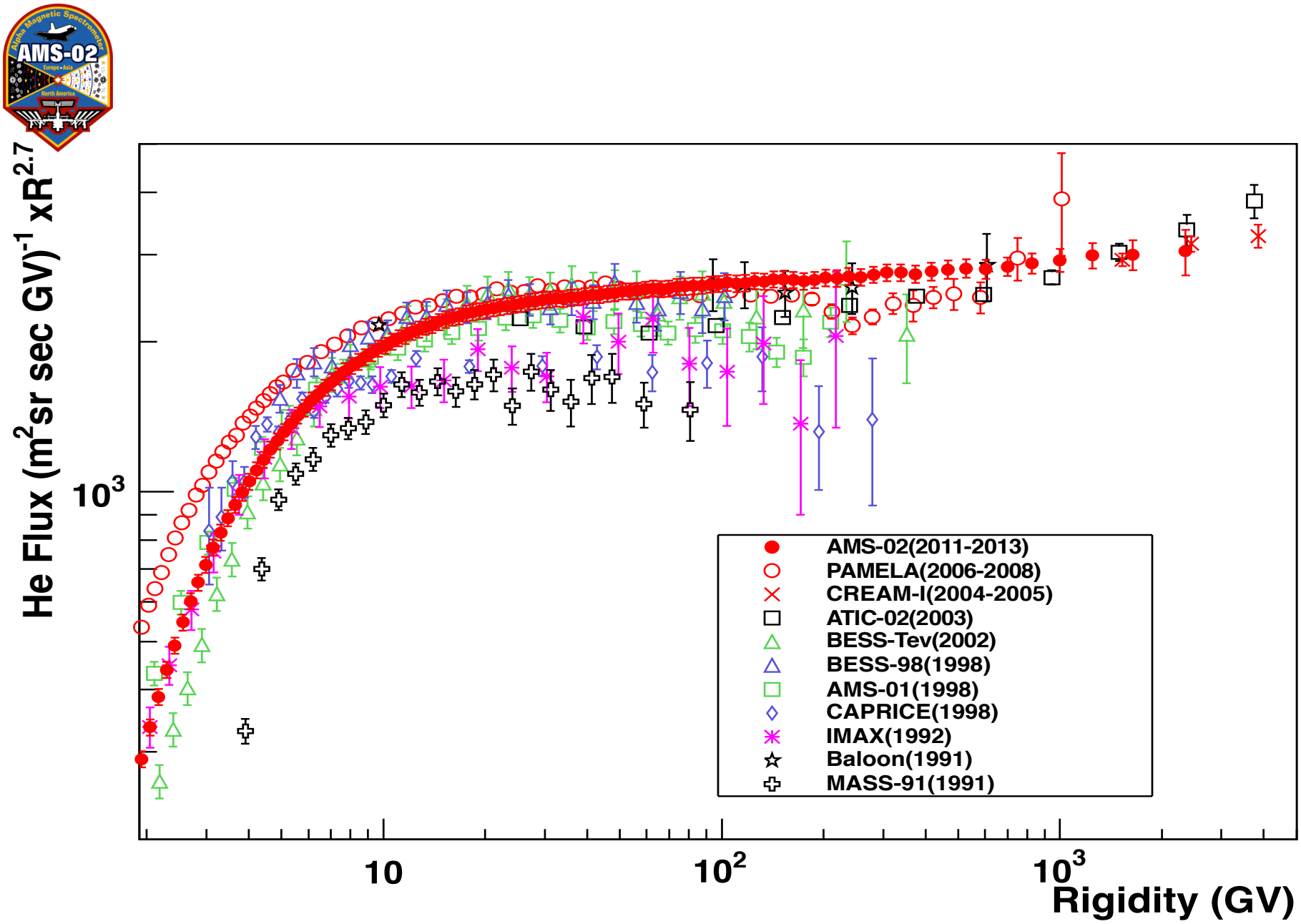


Rigidity>20 GV He Events Selected by Tight Cut on Tracker Layer1 Charge



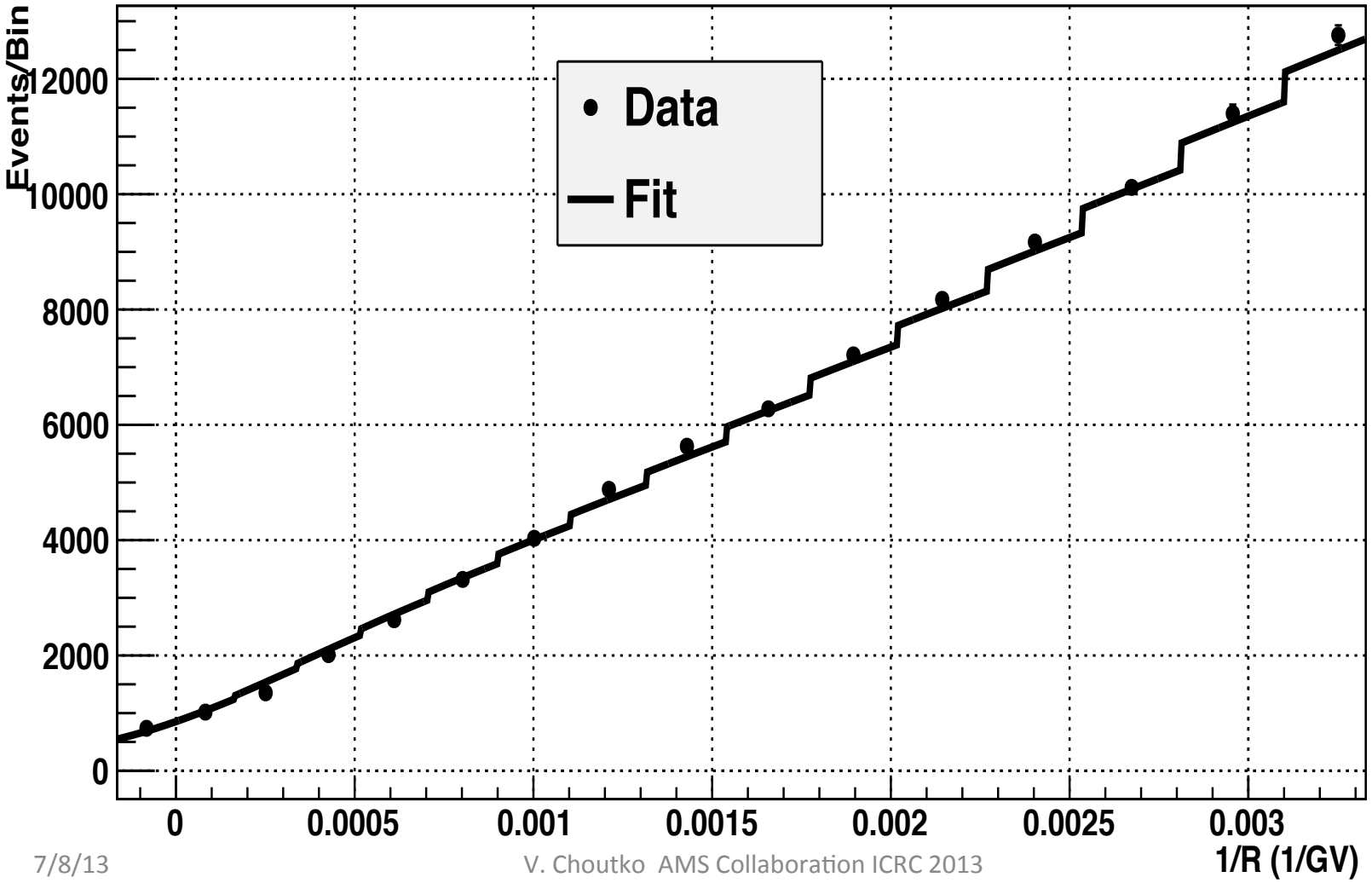
Verification of He Flux Isotropy

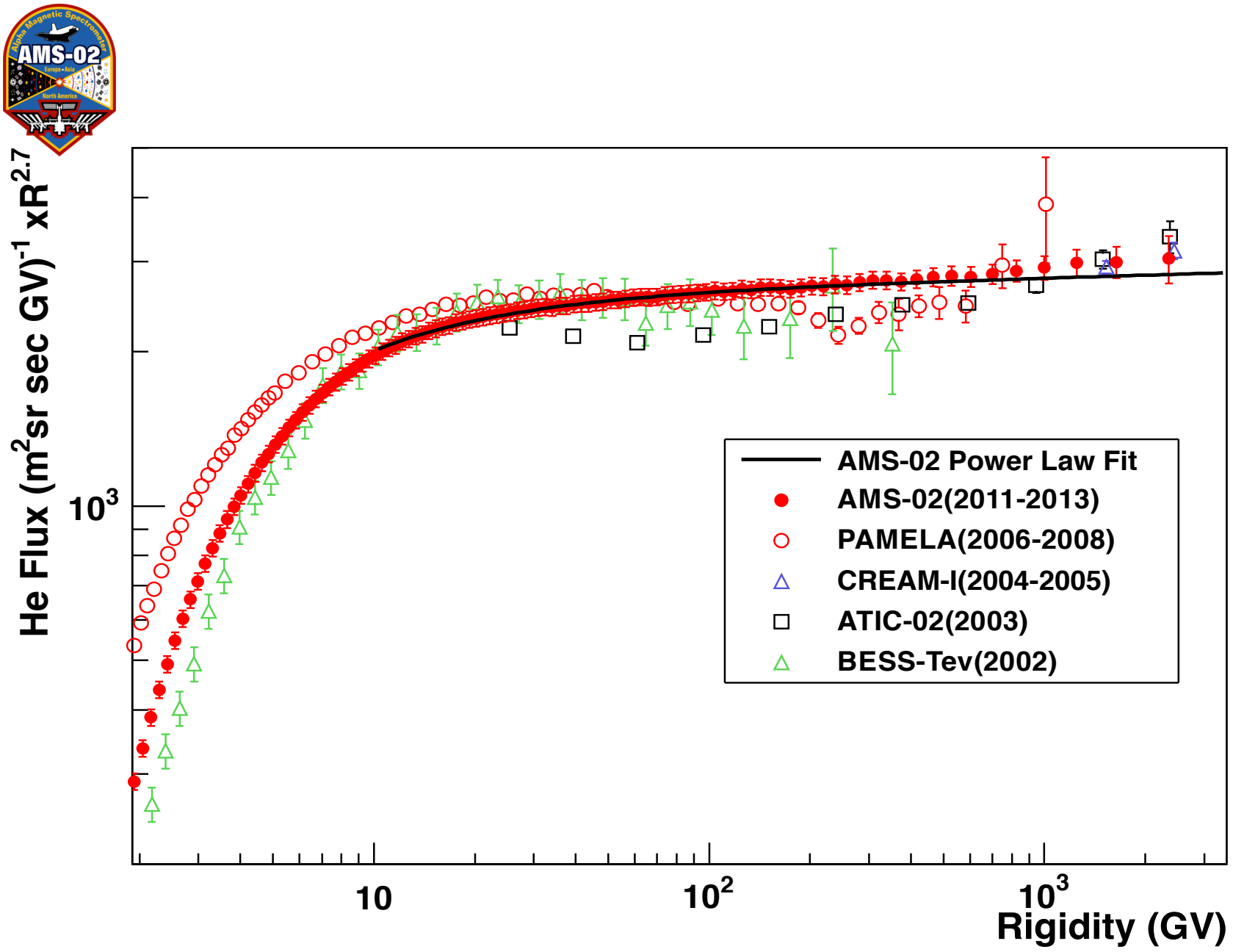



He Flux (m^{2}sr sec GV)$^{-1}$ xR$^{2.7}$
10^3
10
10^2
10^3
Rigidity (GV)
AMS-02(2011-2013)
PAMELA(2006-2008)
CREAM-I(2004-2005)
ATIC-02(2003)
BESS-Tev(2002)
BESS-98(1998)
AMS-01(1998)
CAPRICE(1998)
IMAX(1992)
Baloon(1991)
MASS-91(1991)

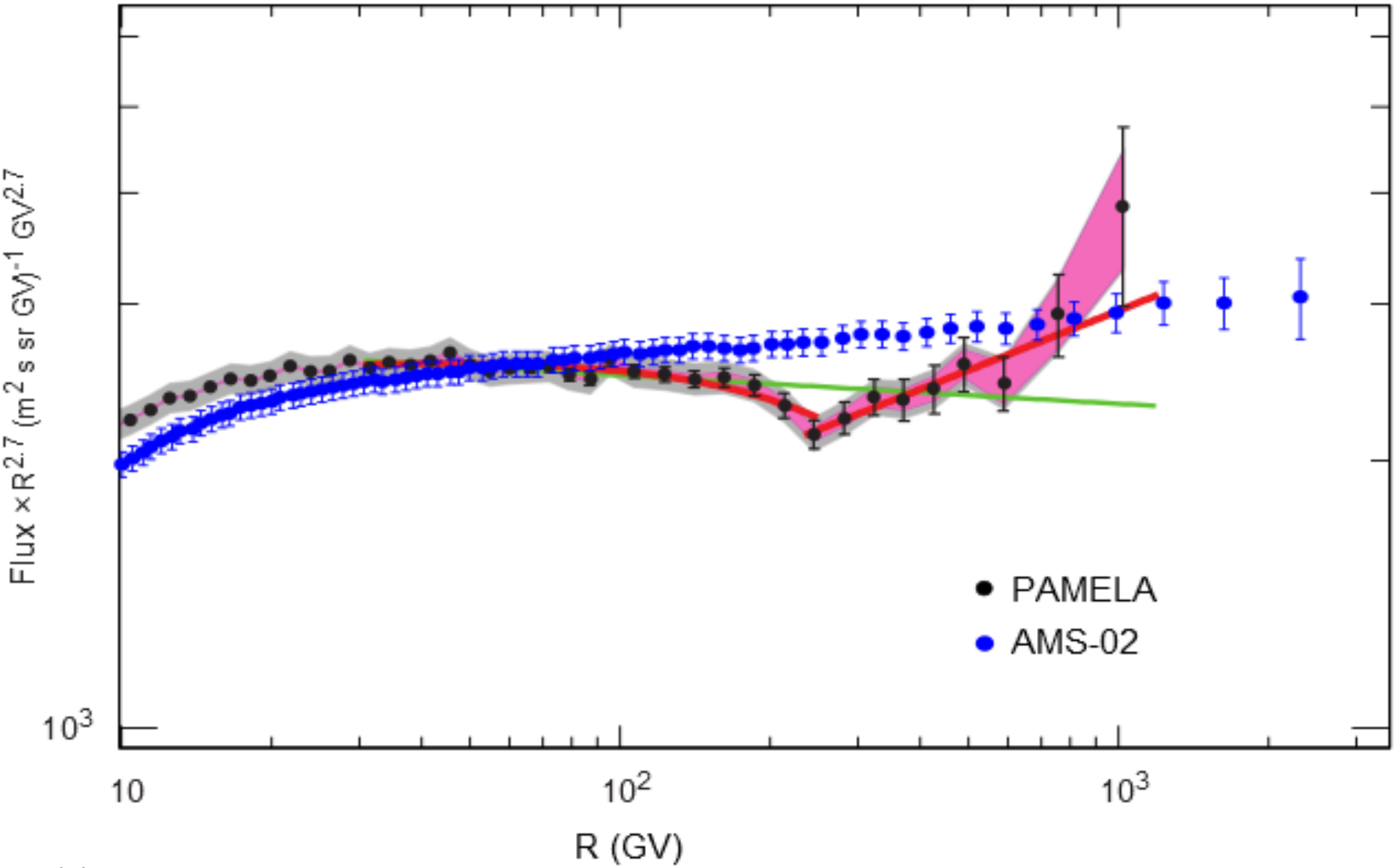
Data Fit with Power Law Function by Convolution with Resolution Function & Acceptance

1/Rigidity<0.033 ; χ^2 = 51/60




He Flux (m^{2}sr sec GV)$^{-1}$ xR$^{2.7}$
10^3
10
10^2
10^3
Rigidity (GV)
AMS-02 Power Law Fit
AMS-02(2011-2013)
PAMELA(2006-2008)
CREAM-I(2004-2005)
ATIC-02(2003)
BESS-Tev(2002)

PAMELA Measurements of Cosmic-Ray Proton and Helium Spectra
O. Adriani *et al.*
Science **332**, 69 (2011);
DOI: 10.1126/science.1199172



Conclusion

- Precision measurement of helium flux with AMS was done from 2 GV to 3.2 TV
- Above 10 GV spectrum can be parameterized by power law
- No fine structures was found in the spectrum