The Compton Spectrometer and Imager

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-J.-L.

The Compton Spectrometer and Imager

COSI is balloon-borne γ-ray telescope designed to

- investigate the origin of Galactic positrons,
- perform polarization measurements of astrophysical sources,
- and study stellar nuclear line emissions.

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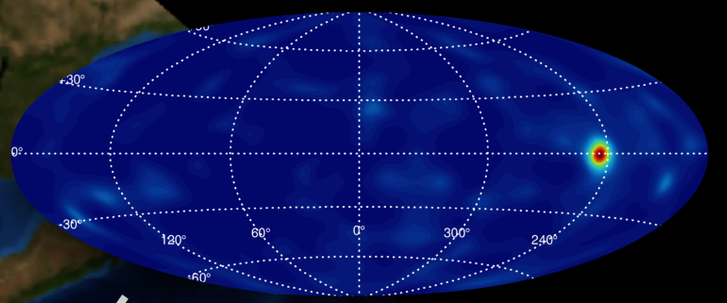
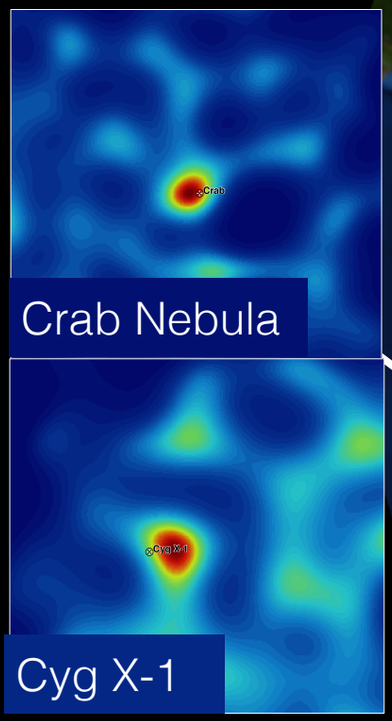
COSI 2016 Flight Summary

After 46 days aloft, COSI makes a gentle landing in southern Peru

COSI detects GRB 160530A



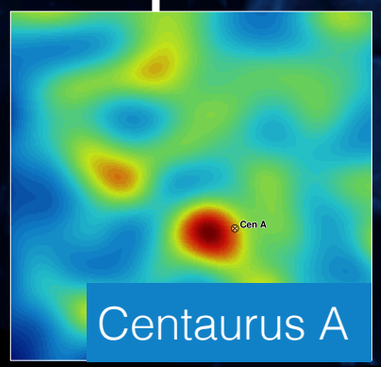
Lowell et al, 2017a
Lowell et al, 2017b



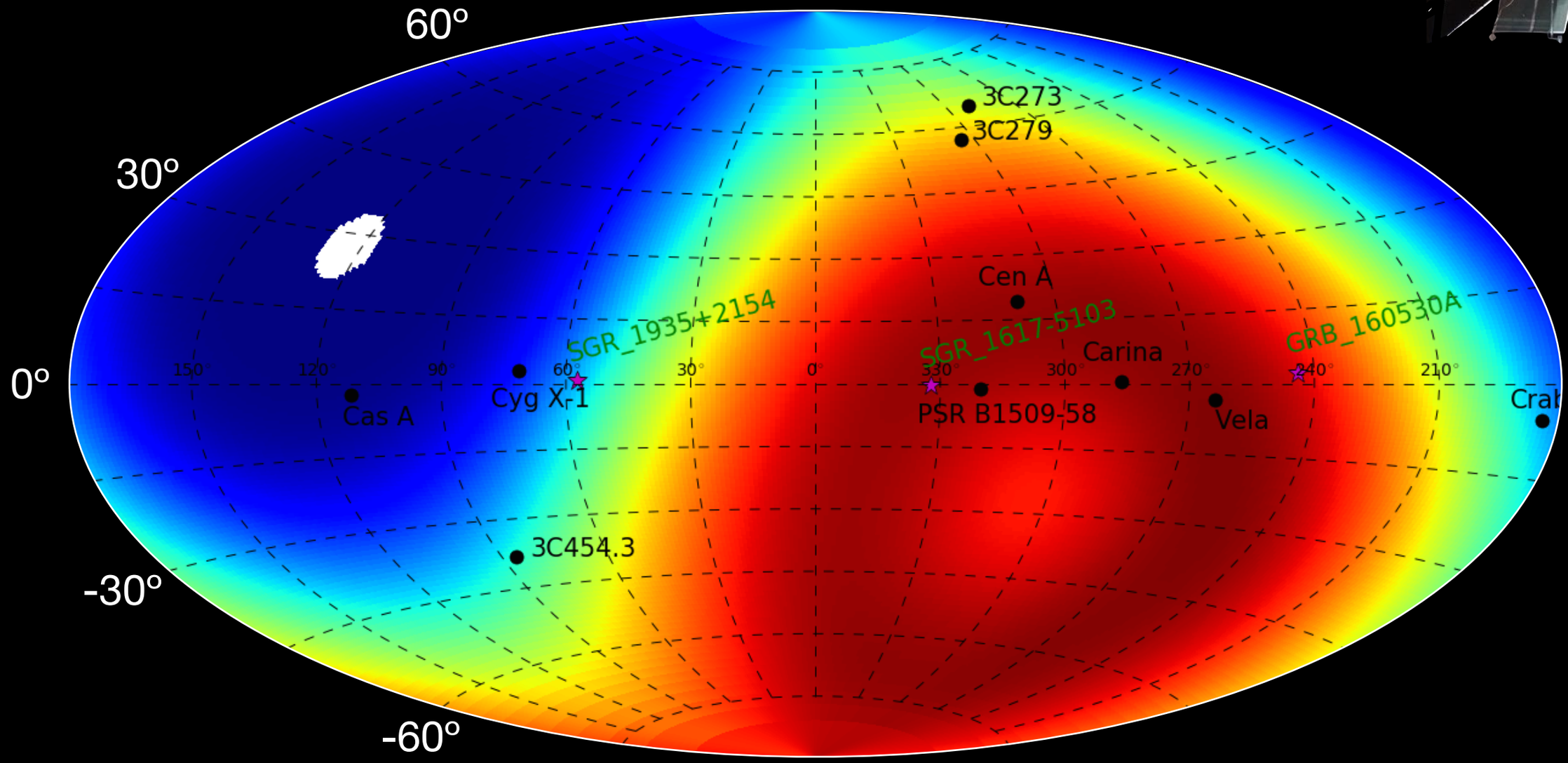
The Crab and Cyg X1 detected as COSI drifts North towards the equator

COSI launches from Wanaka, New Zealand on Super Pressure Balloon, May 16, 2016

COSI detects Cen A at southern latitudes

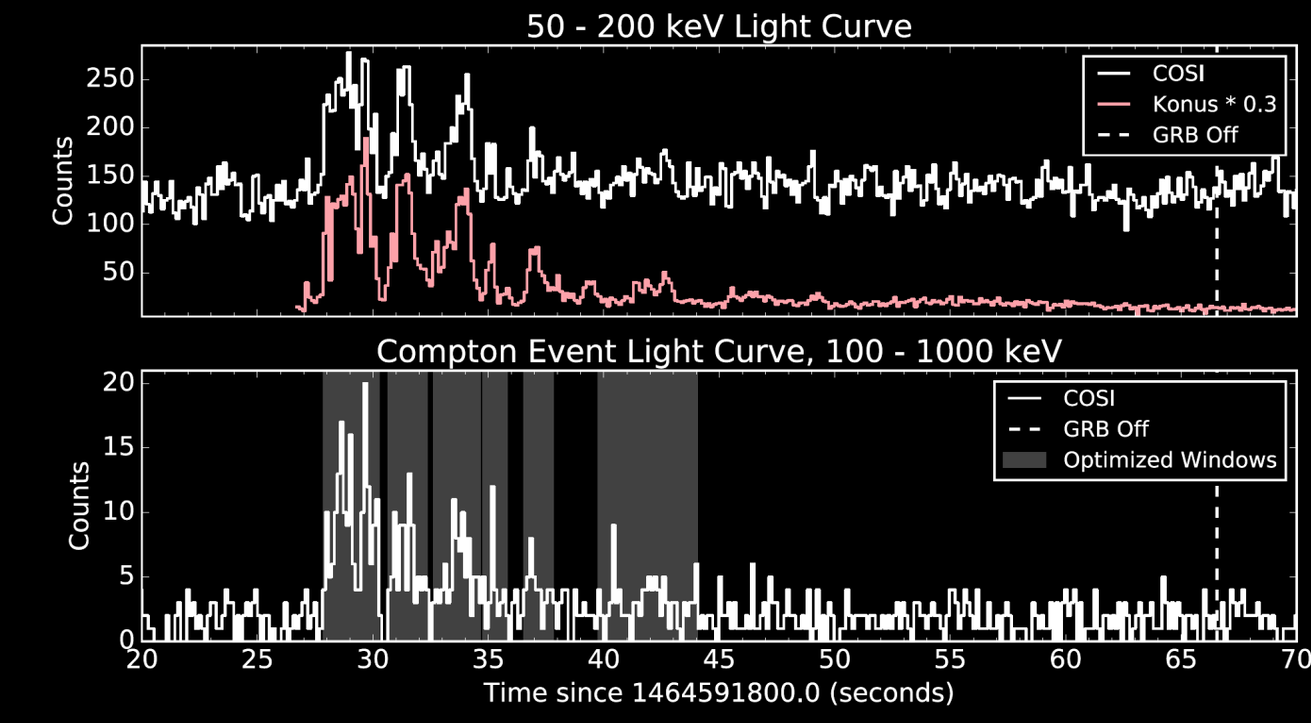


COSI 2016 Galactic Exposure Map



Credit: C.-L. Chiu

GRB 160530A



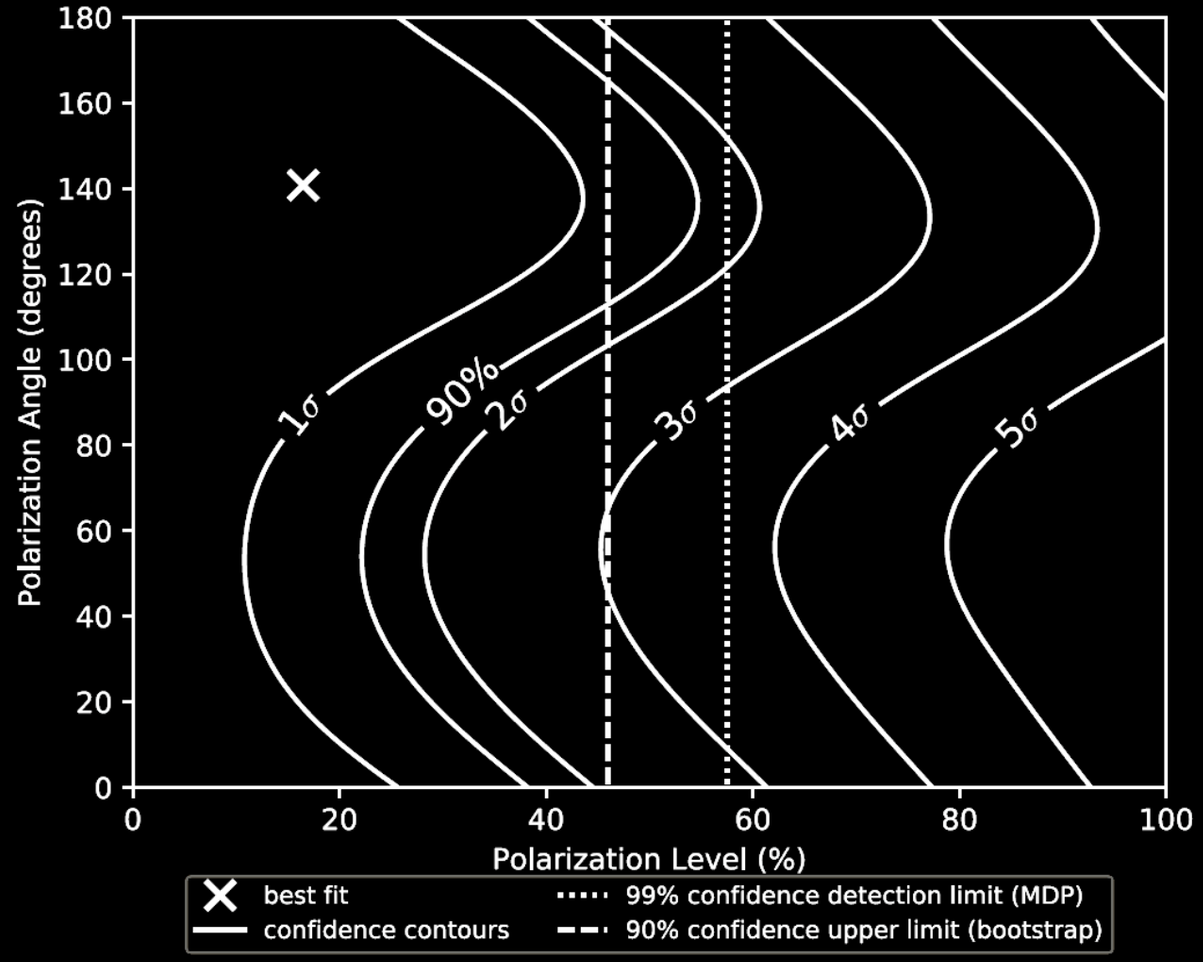
Real-time alert (GCN19473, Tomsick+)

- also detected by AstroSat/CZTI, INTEGRAL/ACS, and Konus-Wind

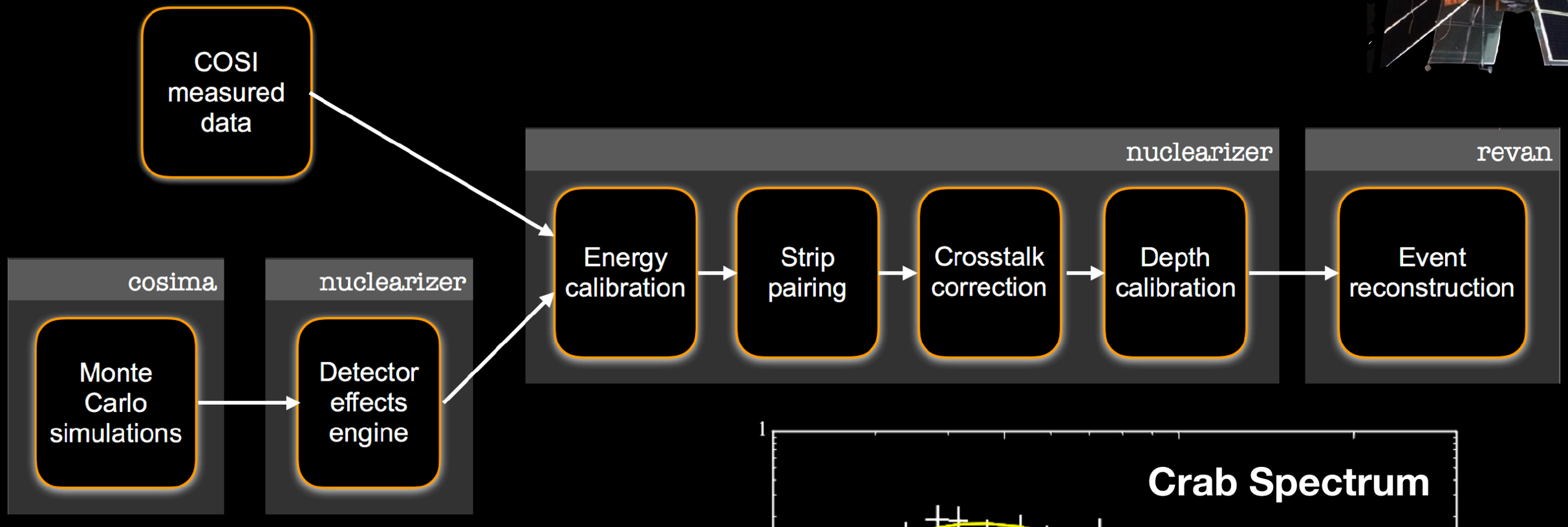
Polarization analysis:

- ML-approach (Krawczynski+ 2011)
- 90% confidence upper limit: <46%
- Best fit: 16^{+27}_{-16} %

A. Lowell+ 2017ab: 2 ApJ papers
A. Lowell Thesis UC Berkeley

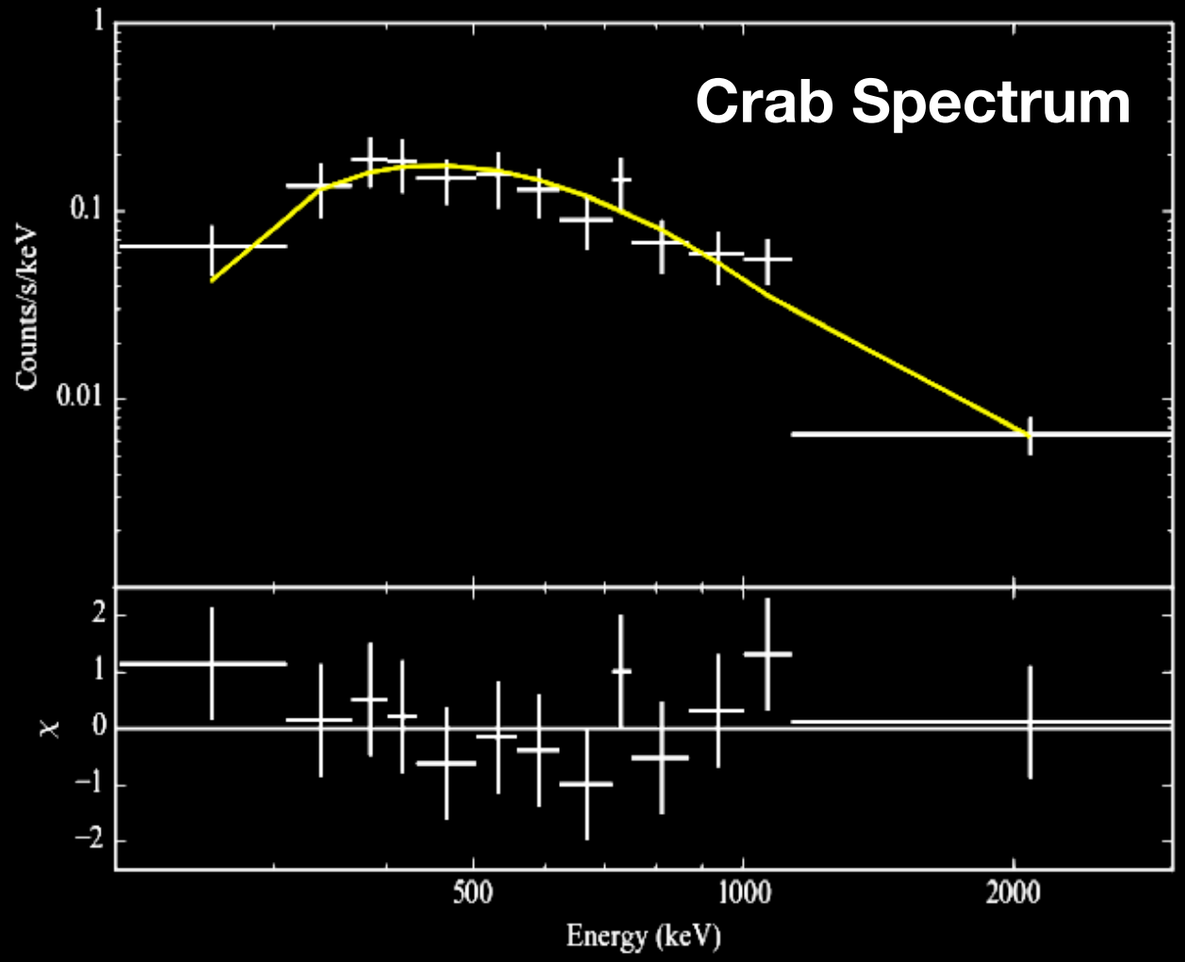


Spectral Analysis Pipeline & Detector Effects Engine



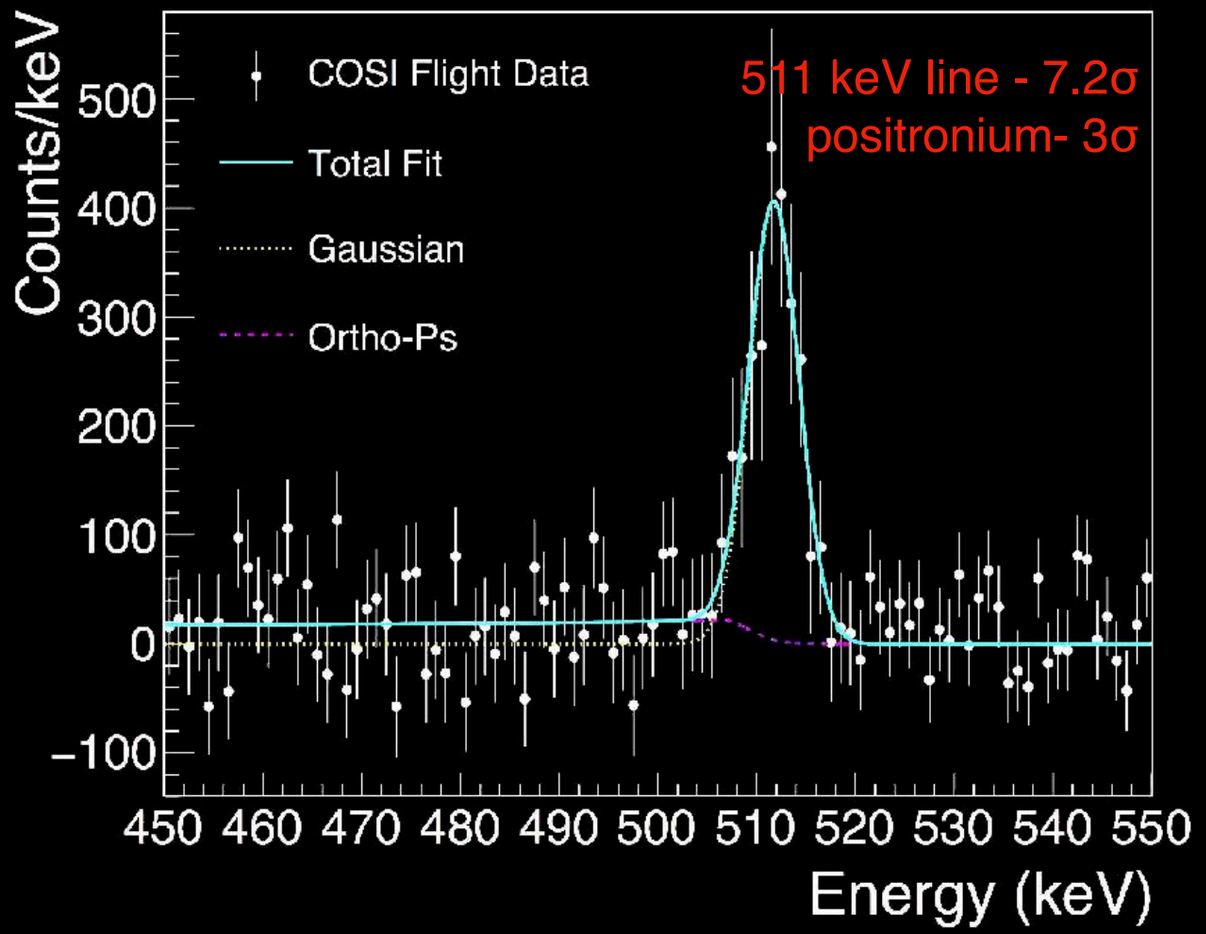
- Spectral analysis pipeline that is compatible with XSPEC
- No detection of polarization (only 25 ks of exposure)

C. Sleator+ 2019
C. Sleator Thesis UC Berkeley



Detection of Galactic Positron Annihilation

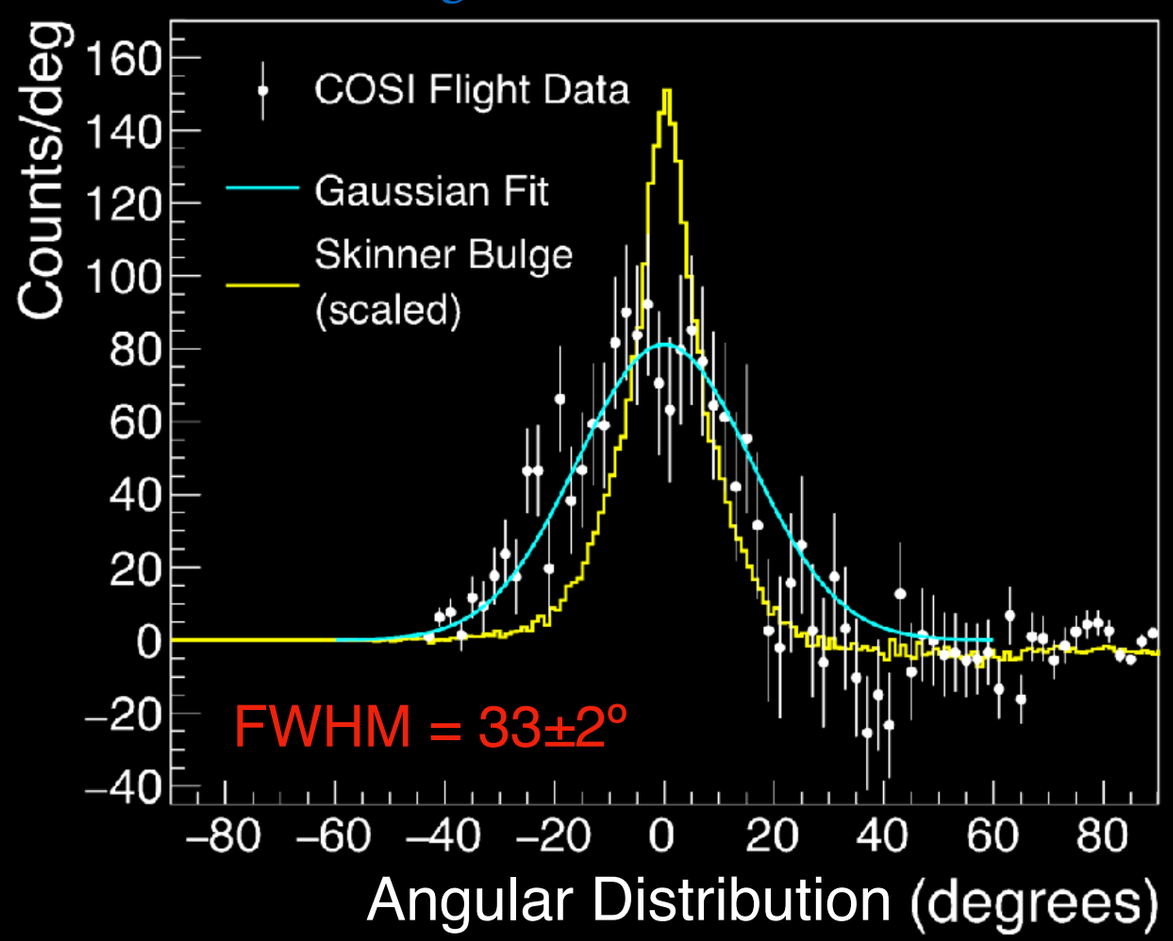
GC Background Subtracted Spectrum



Background estimation for spectral line analysis:

- COMPTEL Data Space (Knödlseder+ 1996)

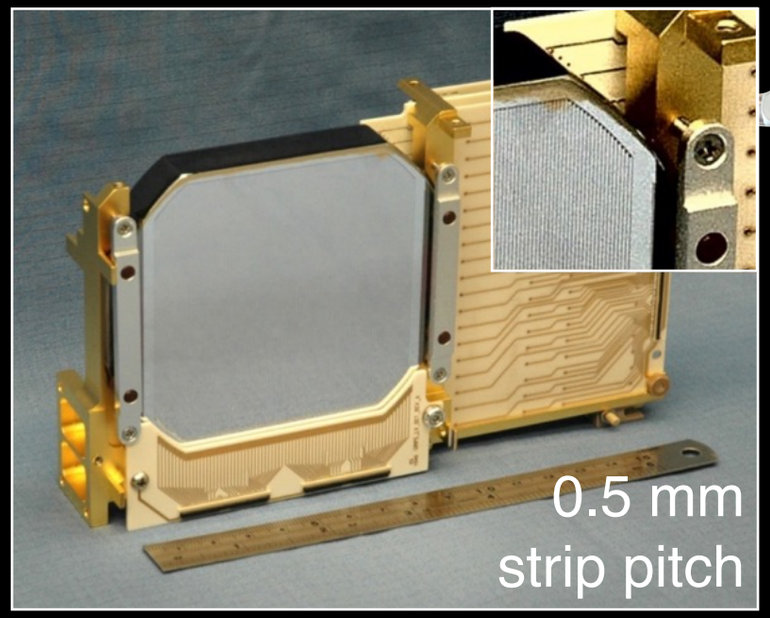
511 keV Angular Distribution around GC



C. Kierans+ submitted to ApJ
arXiv:1912.00110
C. Kierans Thesis UC Berkeley

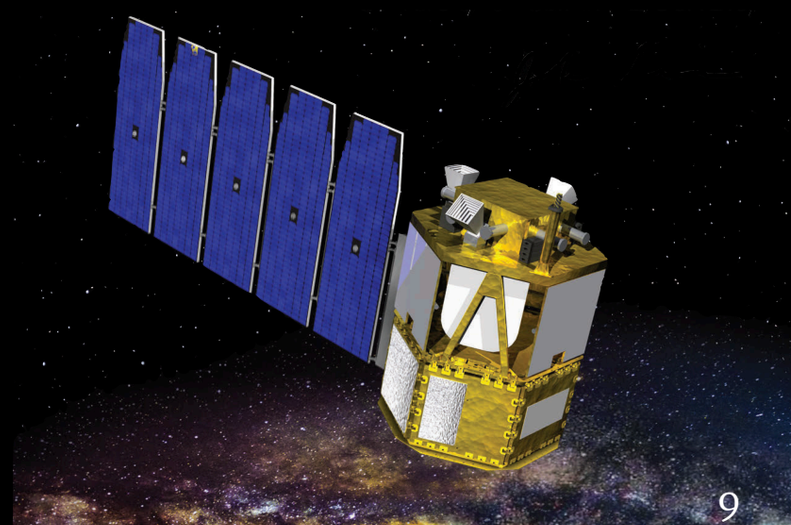
The Future of COSI

COSI-2 to launch from Wanaka, NZ Spring 2020



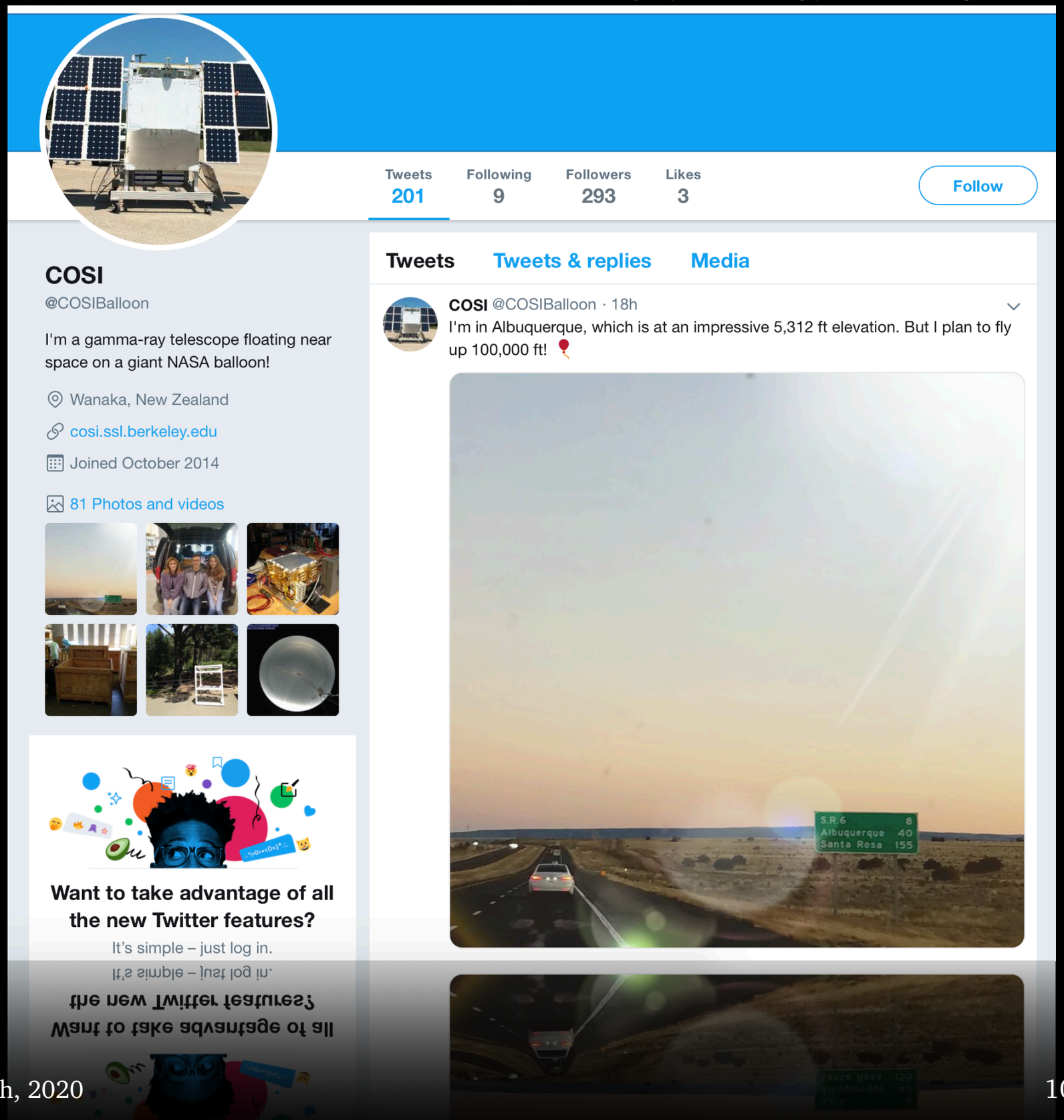
COSI-SMEX

- proposal for satellite submitted 2019
- finer strip pitch detectors give better angular resolution: ×2 at 511 keV



Follow COSI in 2020!

Learn more about COSI and follow our blog at cosi.ssl.berkeley.edu

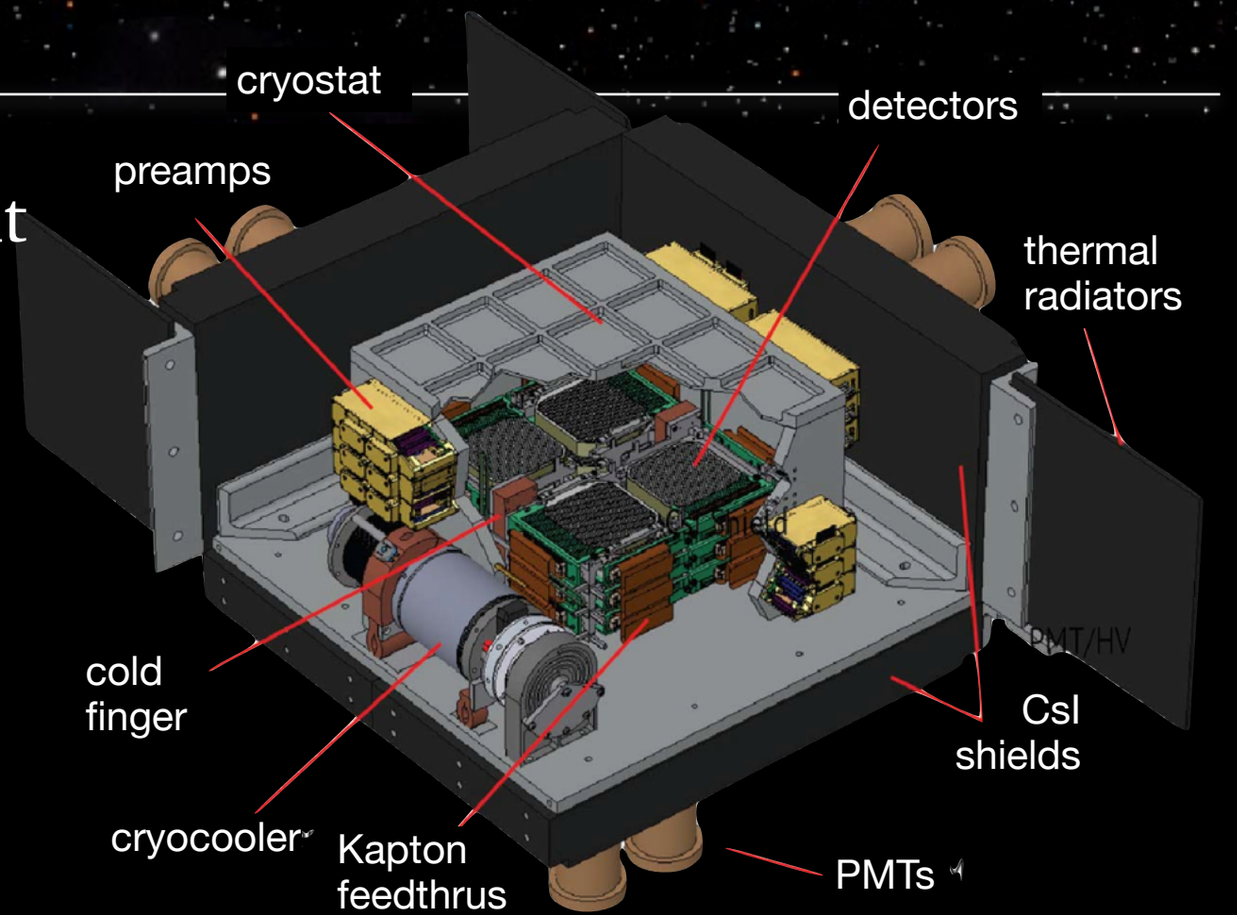


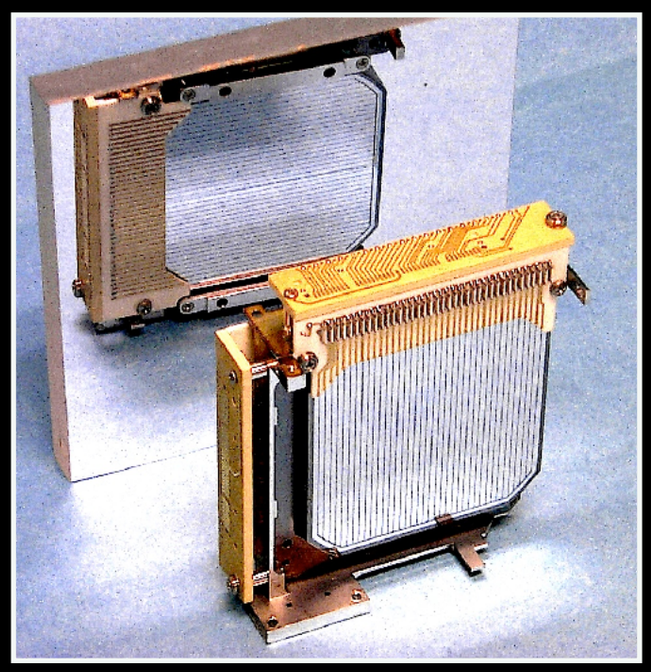
COSI 2016 Launch from Wanaka, NZ

Credit: Bill Rodman/NASA Wallops

COSI Instrument

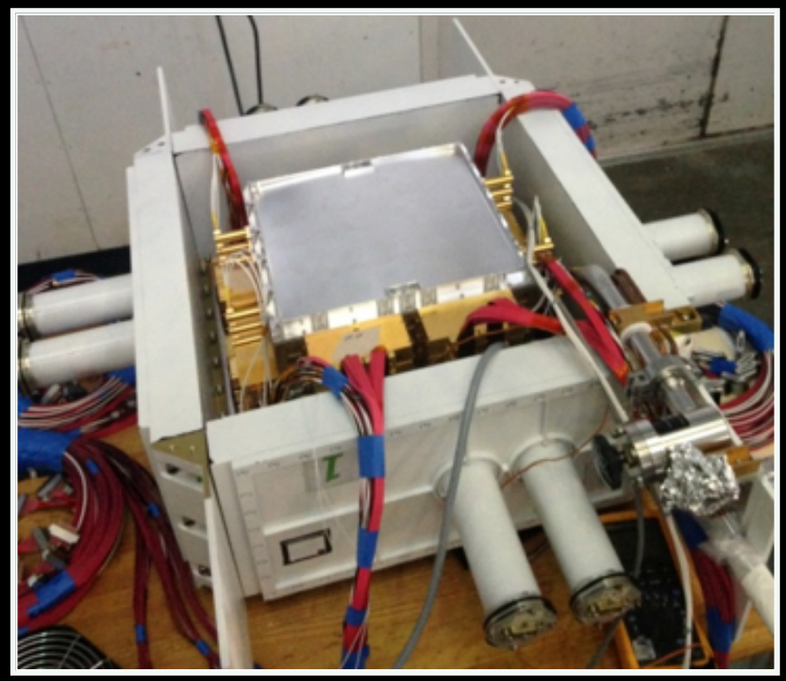
- Evacuated anodized aluminum cryostat
- Sunpower Cryotel cryocooler
  - GeD operating temp ~85K
- Cesium iodide anti-coincidence shields
  - significant background reduction
  - FOV ~25%





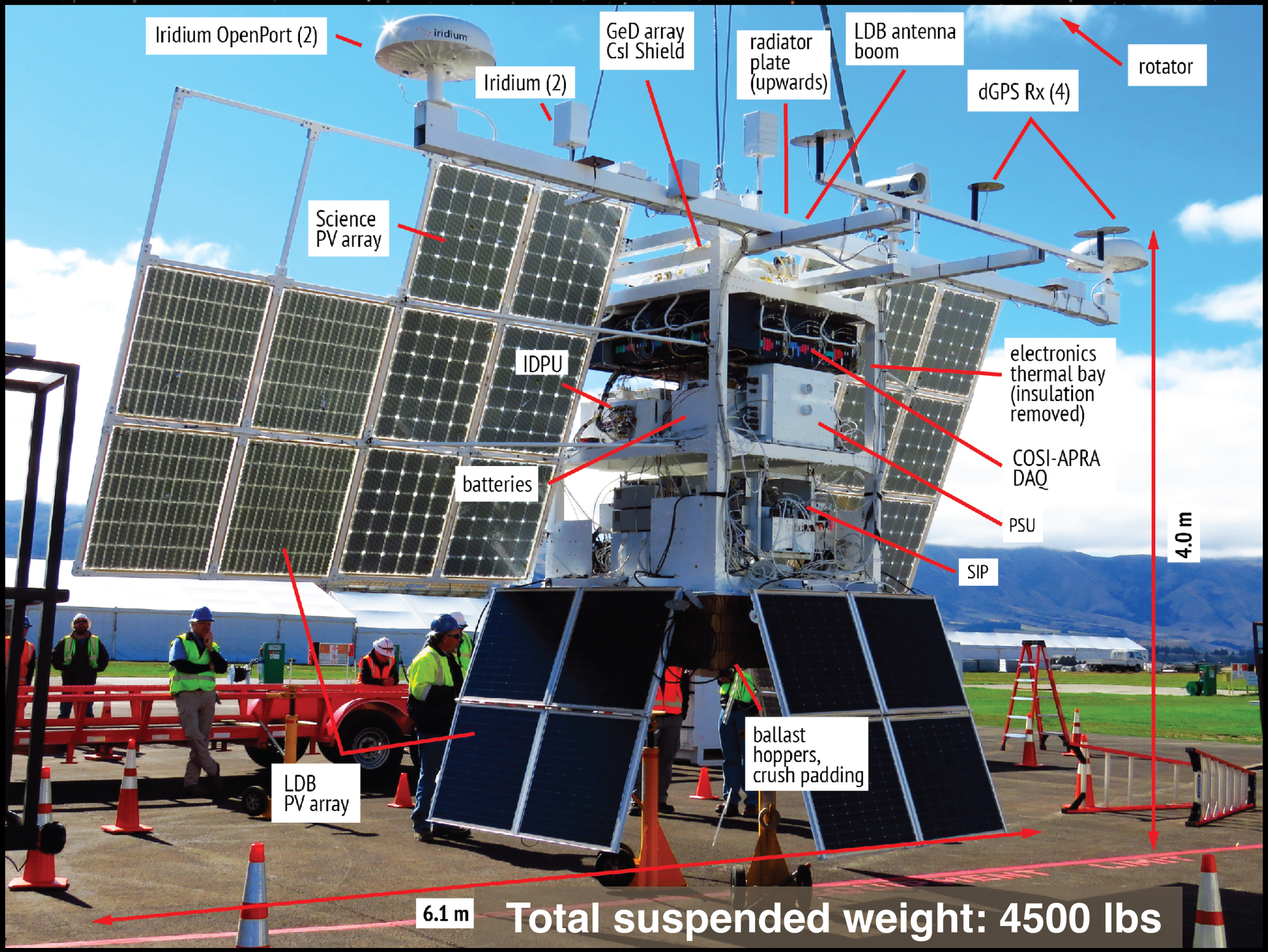
Single GeD with a mirror

Germanium detector array

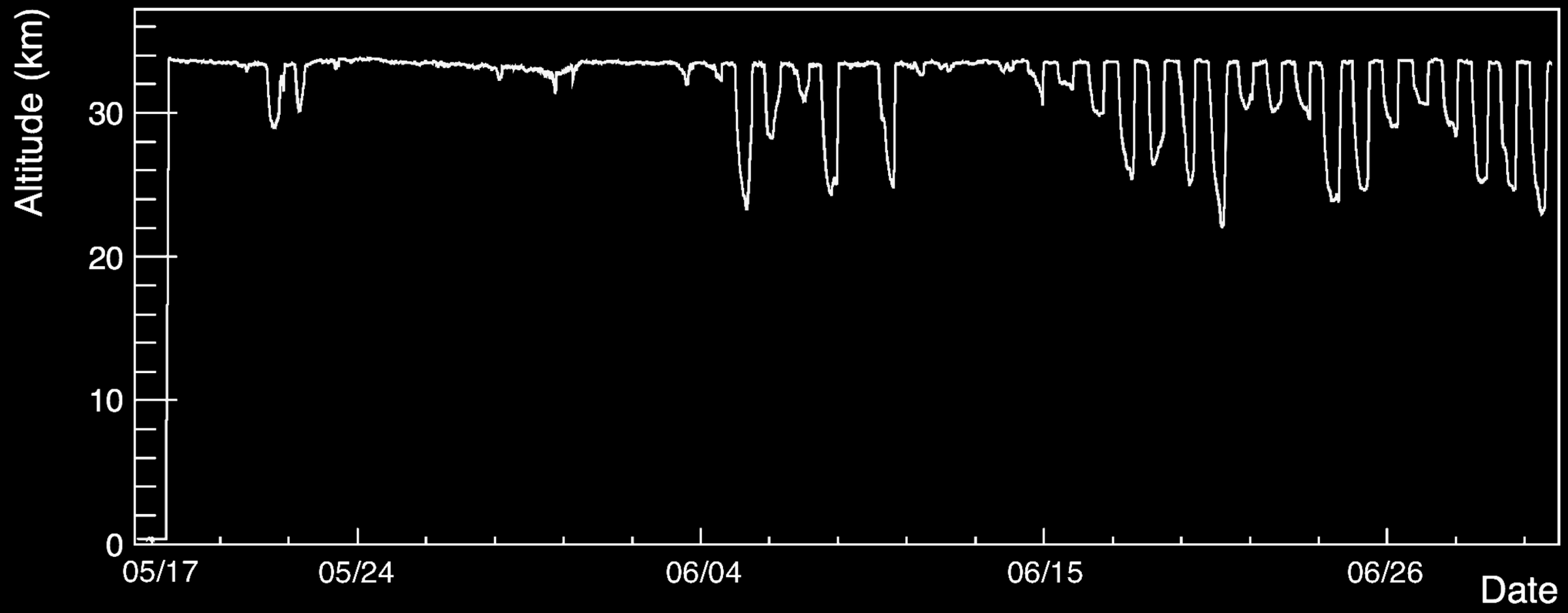


Cryostat and CsI shields

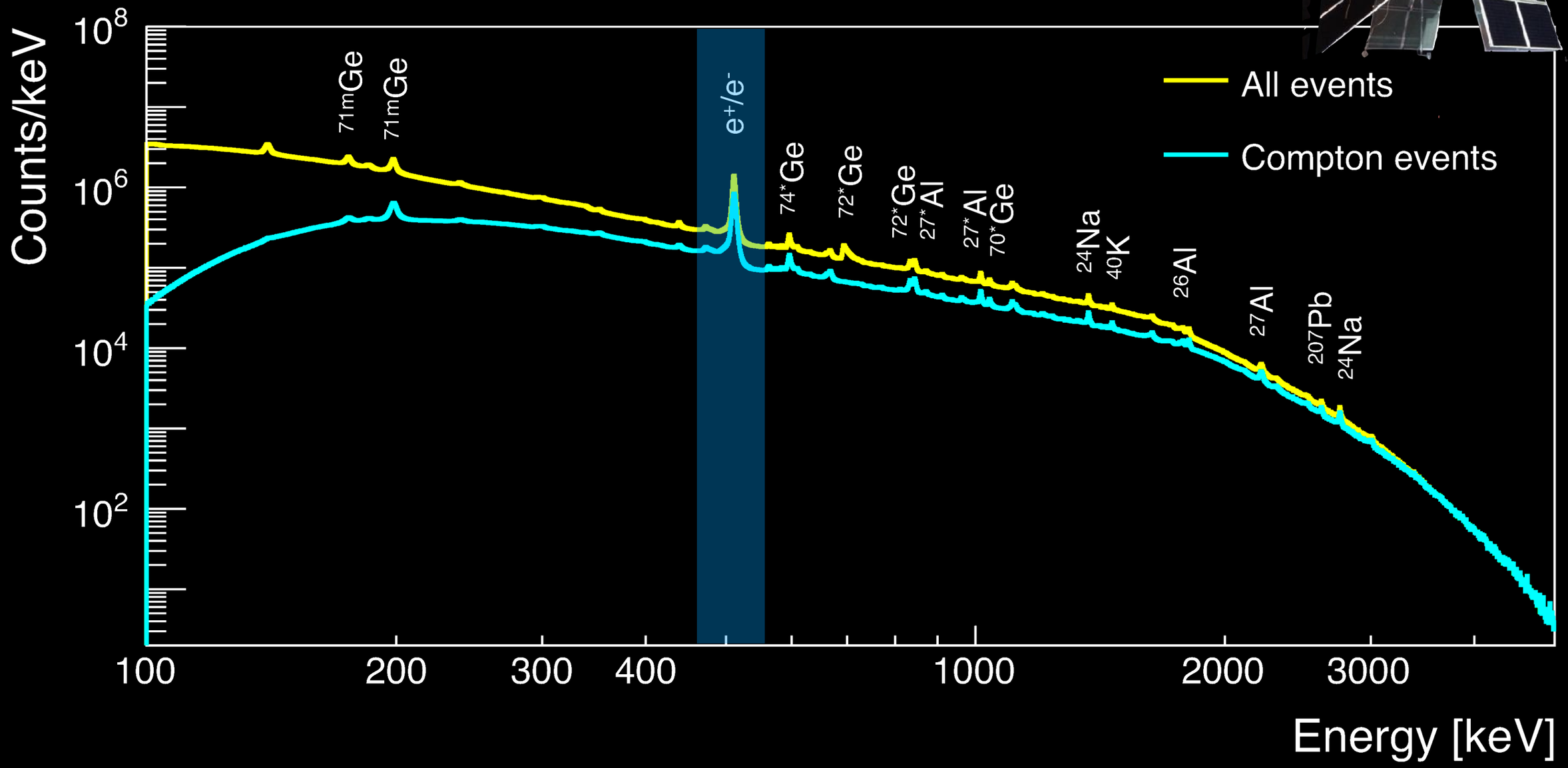
COSI 2016 Wanaka Campaign



COSI 2016 Flight Altitude Profile



COSI 2016 Full Flight Spectrum

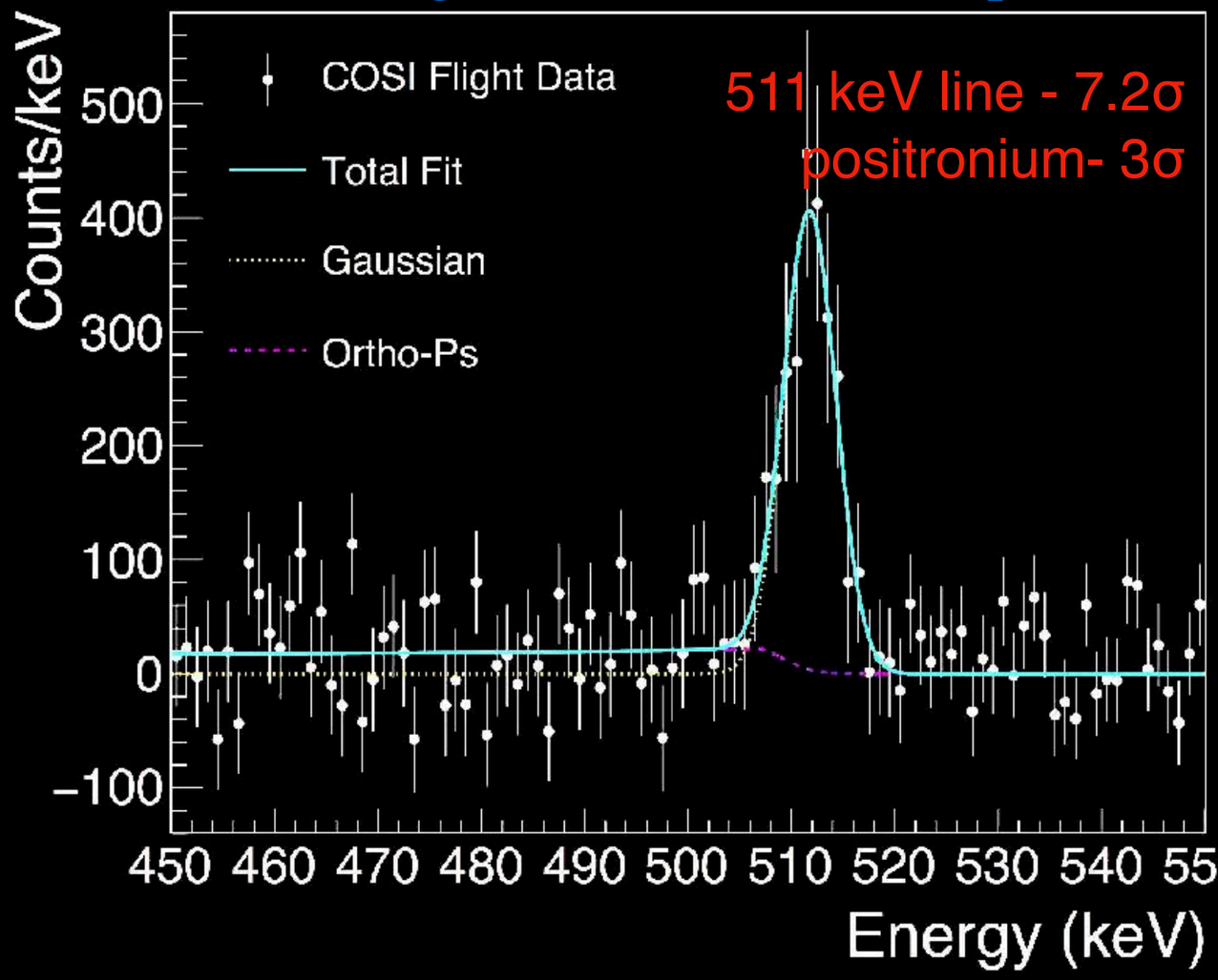


Strong background from the atmosphere and instrument activation.

GC/Background ~5% @ 511 keV

Galactic 511 keV with COSI

GC Background Subtracted Spectrum



$$F(E) = A \exp\left(-\frac{(E-\mu)^2}{2\sigma^2}\right) + BF_{oPs}(E)$$

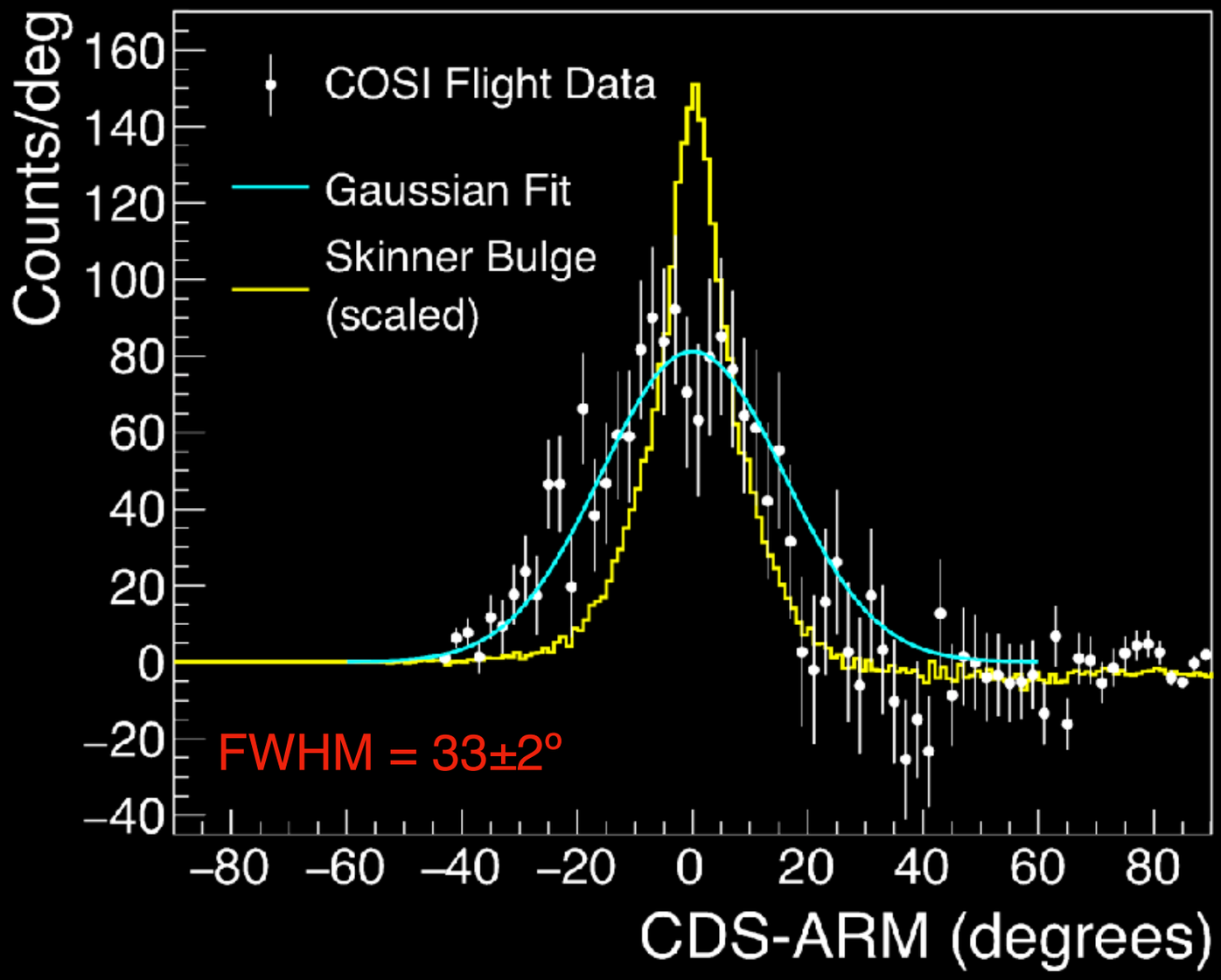
Parameter		Value
Gaussian Fit	μ	511.8±0.3 keV
	σ	2.5±0.3 keV
	A	403±57 cts/keV
o-Ps Fit	B	12±4 cts/keV
χ^2/d.o.f.		193.0/196
511 keV line counts		2560±300 cts
o-Ps continuum counts		5110±1700 cts
f_{Ps}		0.76±0.12

Flux measurement
$(3.9\pm0.4)\times10^{-3}$ γ/cm²/s

CK et al. submitted to ApJ

Galactic 511 keV with COSI

511 keV Angular Distribution around GC



Parameter		Value
Gaussian Fit	μ	fixed at 0
	σ	14.0±0.7°
	A	89±0.6 cts
χ^2/d.o.f.		52.1/52
FWHM		33±2°

Twice as broad as SPI bulge models

CK et al. submitted to ApJ