

The Compton Spectrometer and Imager



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GammaSIG @ AAS - January 8, 2020

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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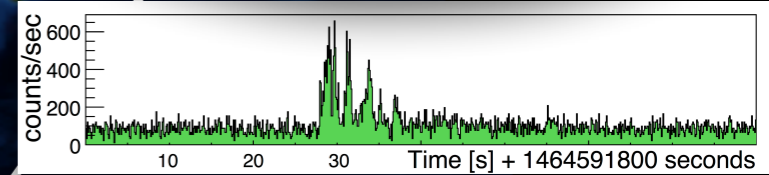
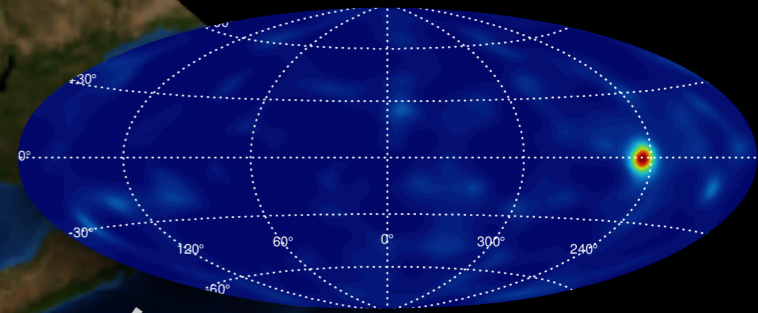


COSI 2016 Flight Summary

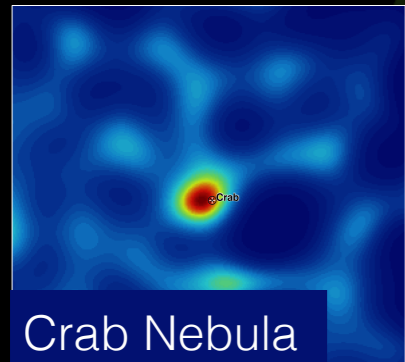


After 46 days aloft, COSI makes a gentle landing in southern Peru

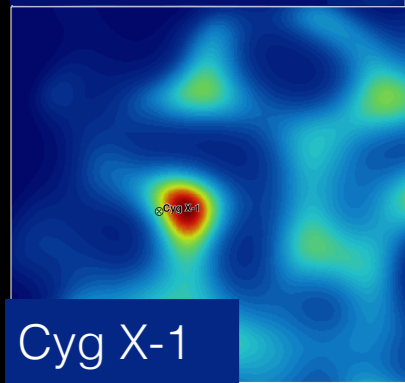
COSI detects GRB 160530A



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



Crab Nebula



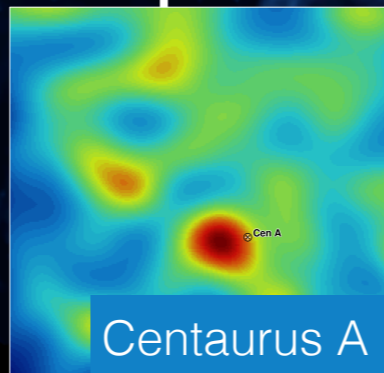
Cyg X-1

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

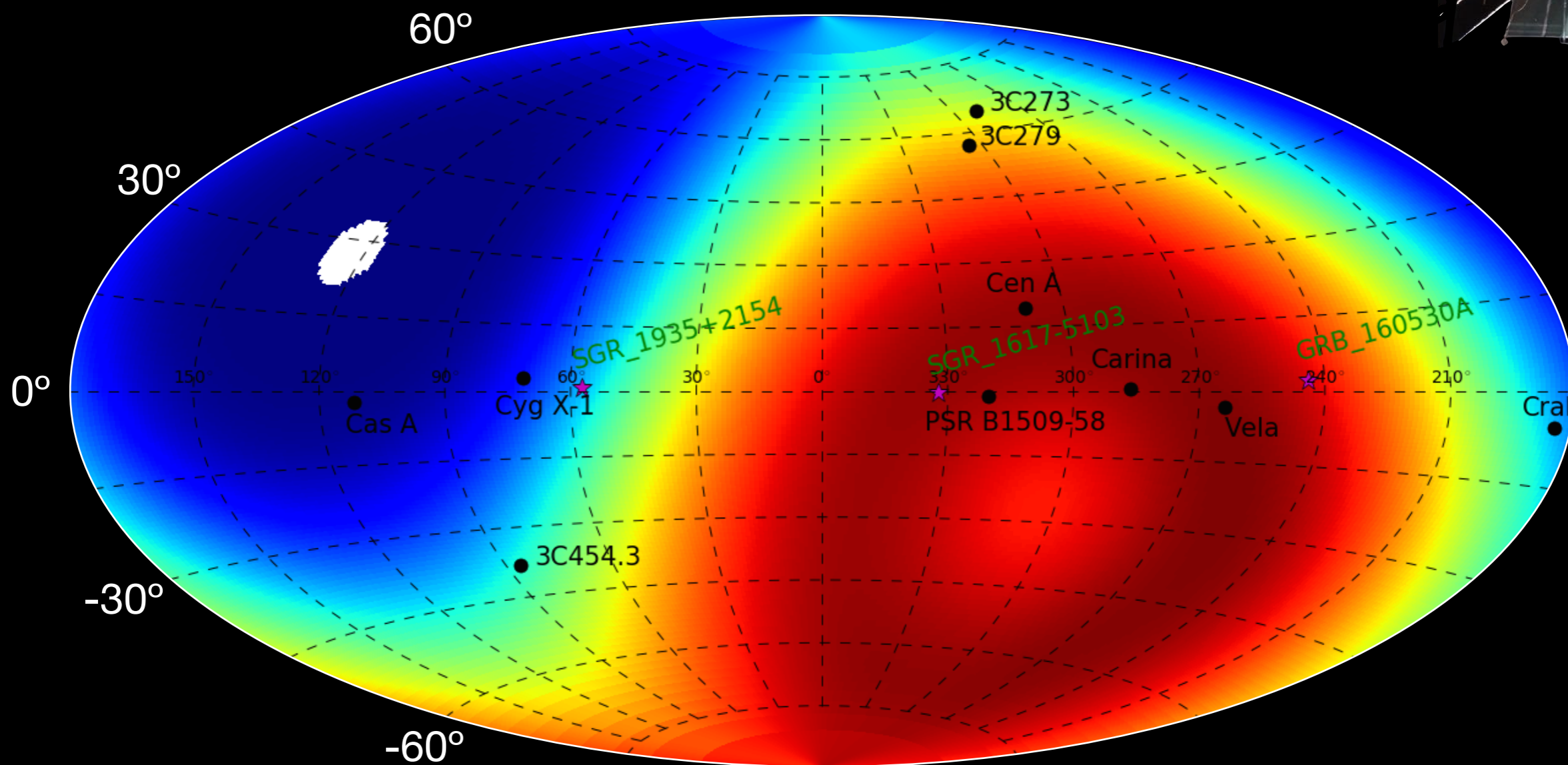


COSI detects Cen A at southern latitudes



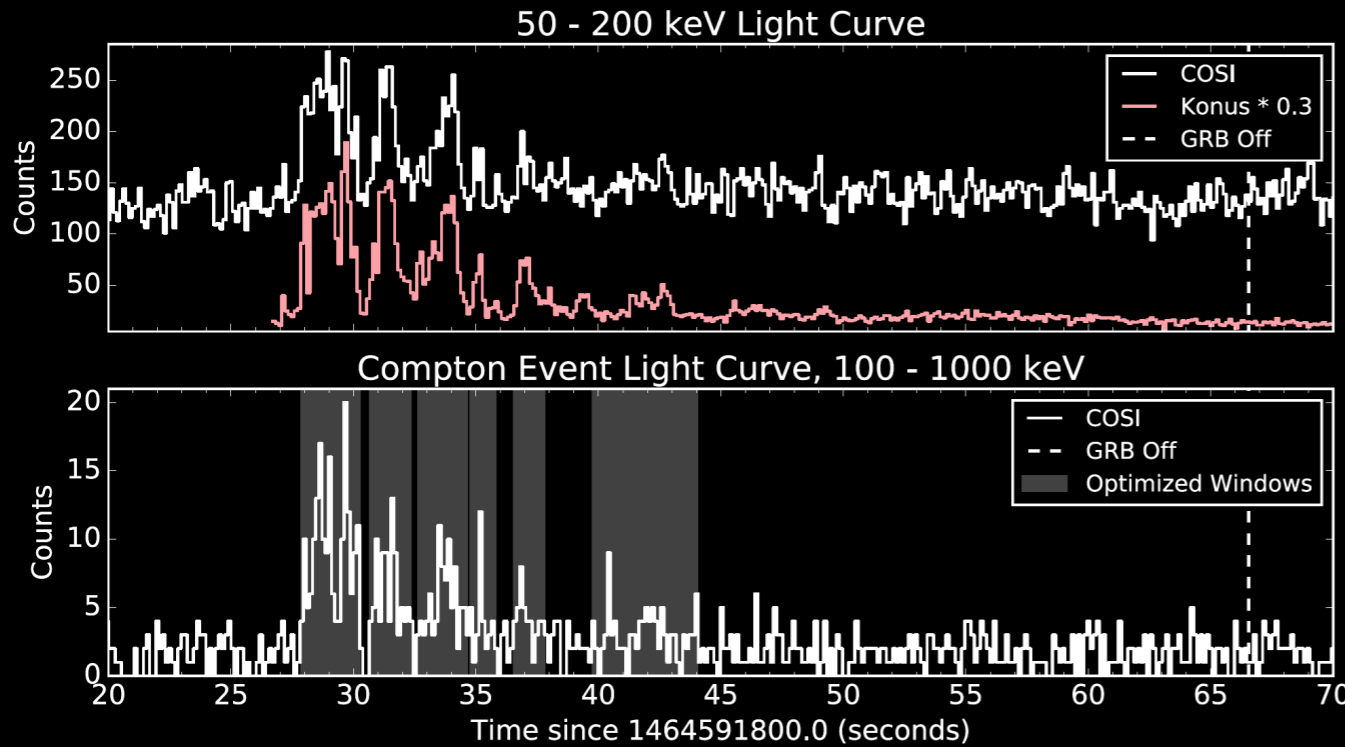
Centaurus A

COSI 2016 Galactic Exposure Map



Credit: C.-L. Chiu

GRB 160530A

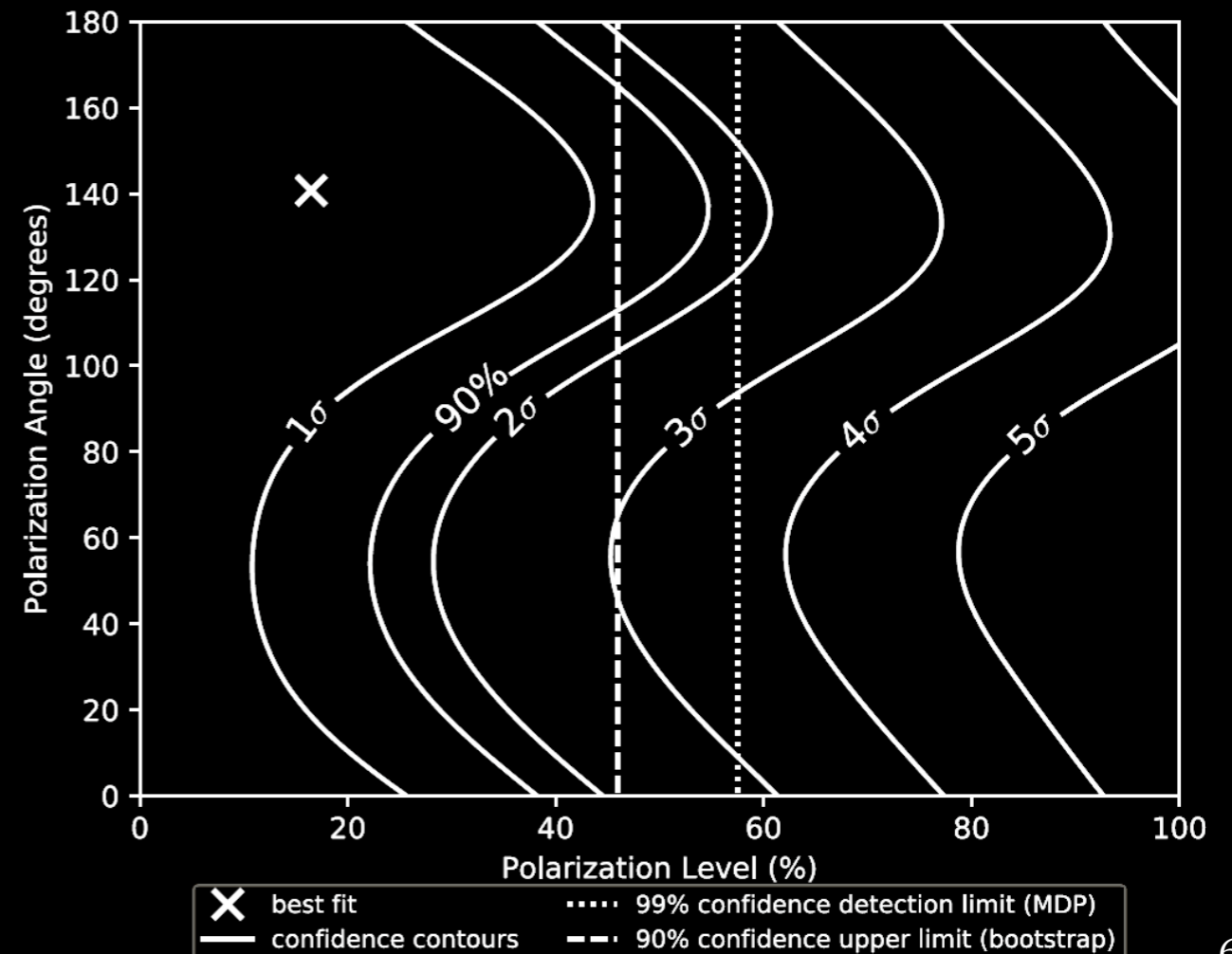


Real-time alert (GCN19473, Tomsick+)

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

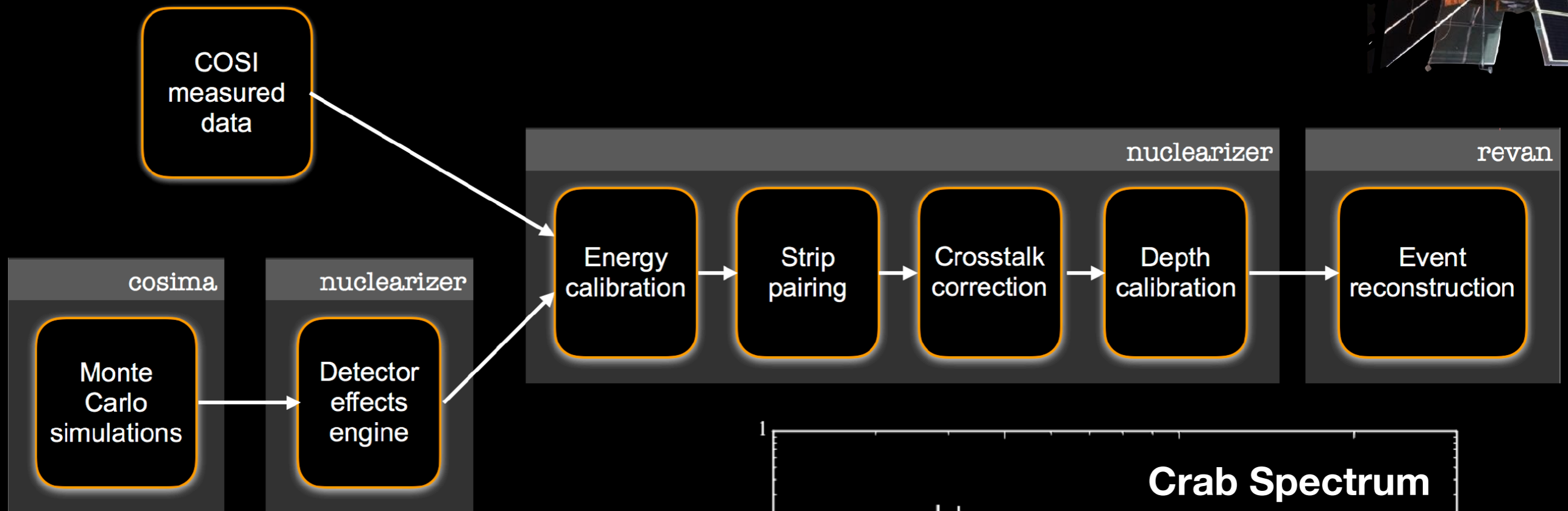
Polarization analysis:

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



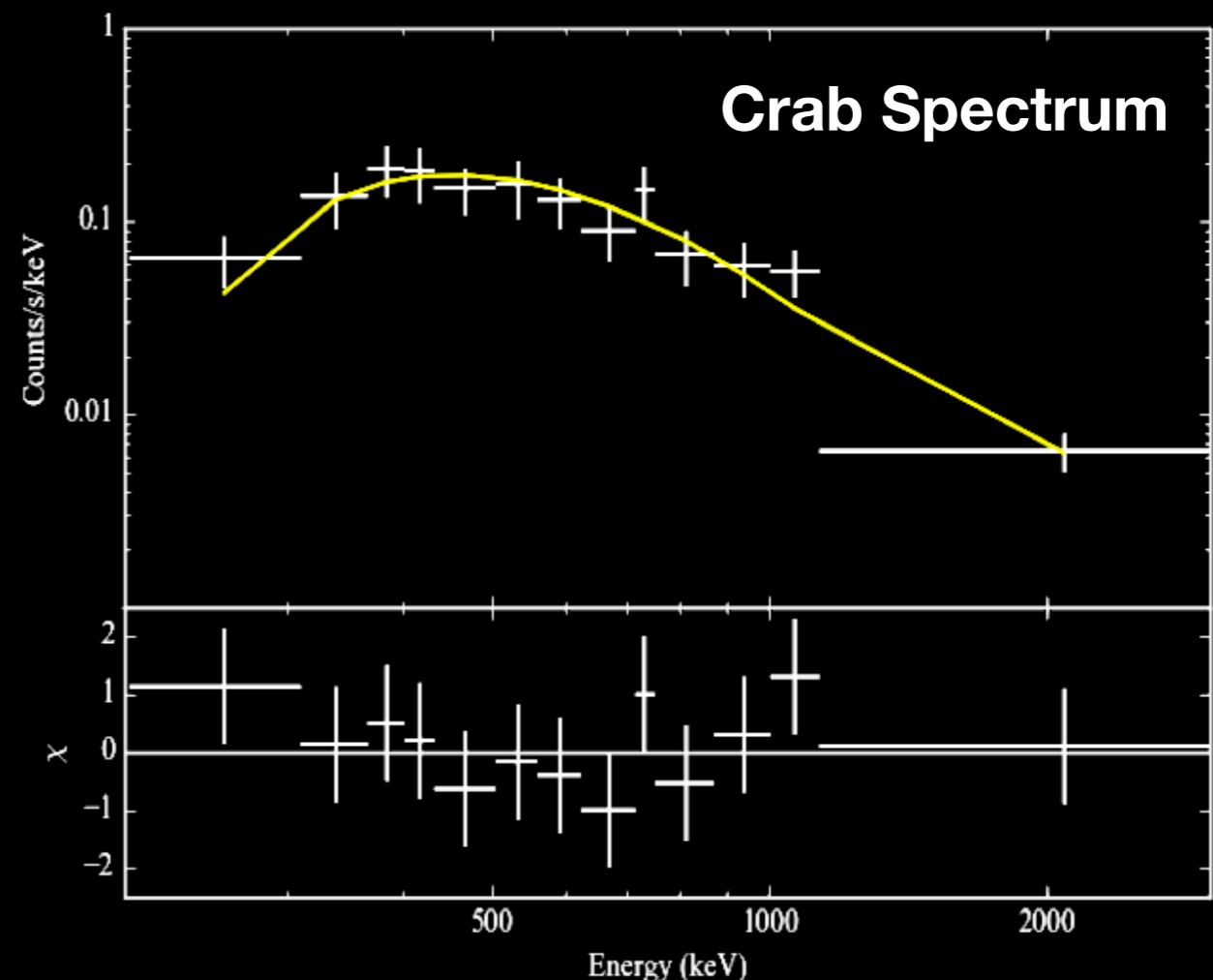
A. Lowell+ 2017ab: 2 ApJ papers
A. Lowell Thesis UC Berkeley

Spectral Analysis Pipeline & Detector Effects Engine



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

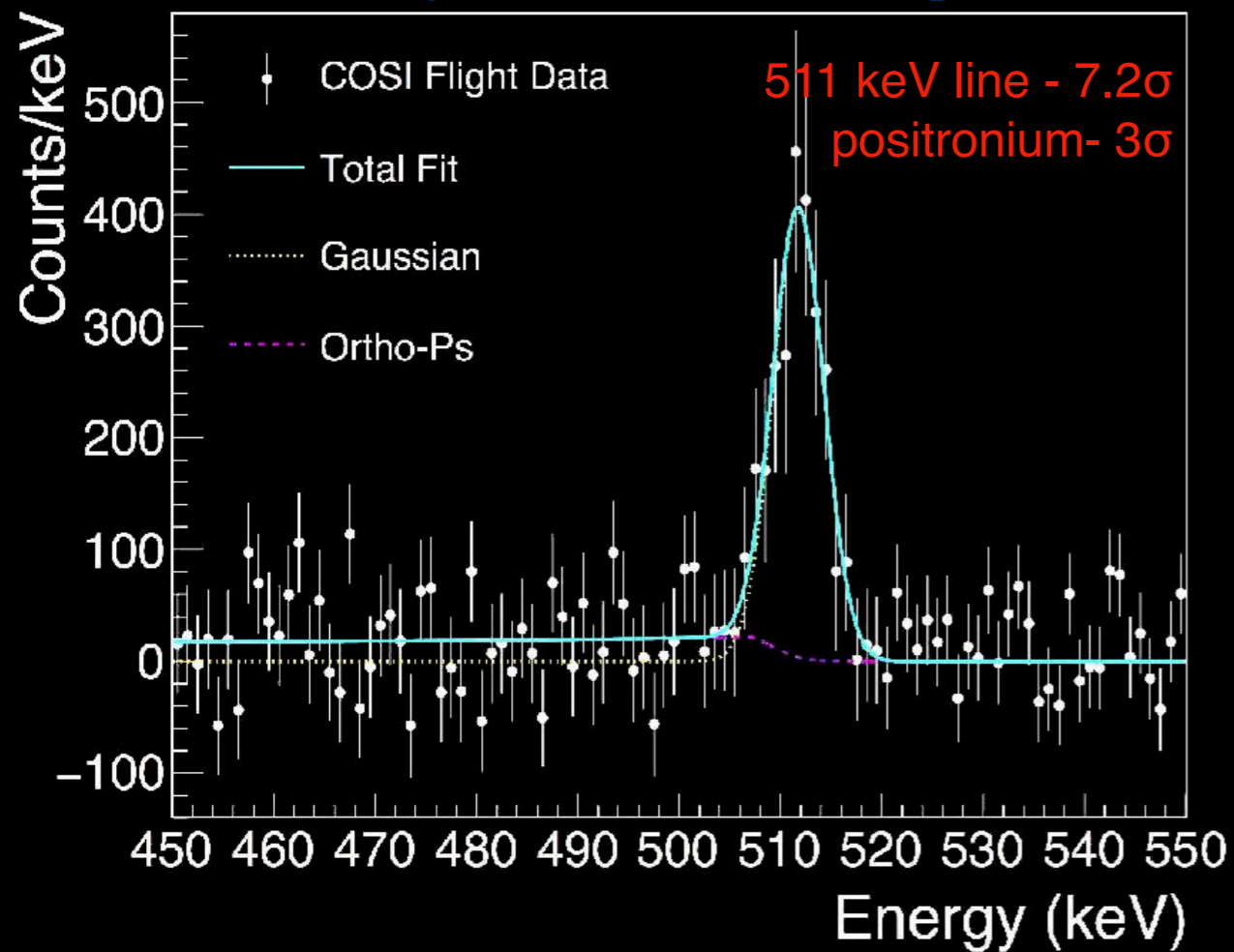
C. Sleator+ 2019
C. Sleator Thesis UC Berkeley



Detection of Galactic Positron Annihilation



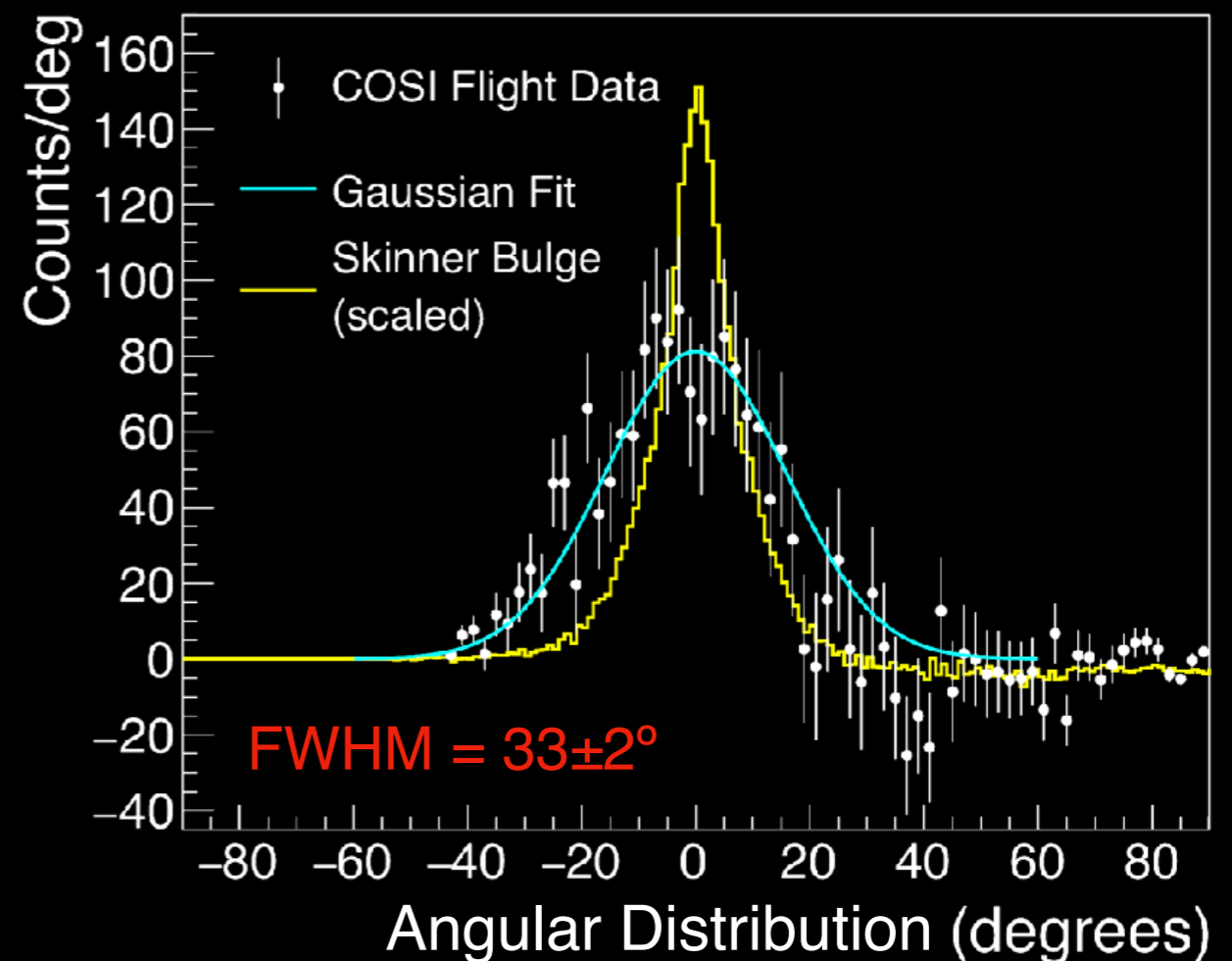
GC Background Subtracted Spectrum



Background estimation for spectral line analysis:

- COMPTEL Data Space (Knödlseeder+ 1996)

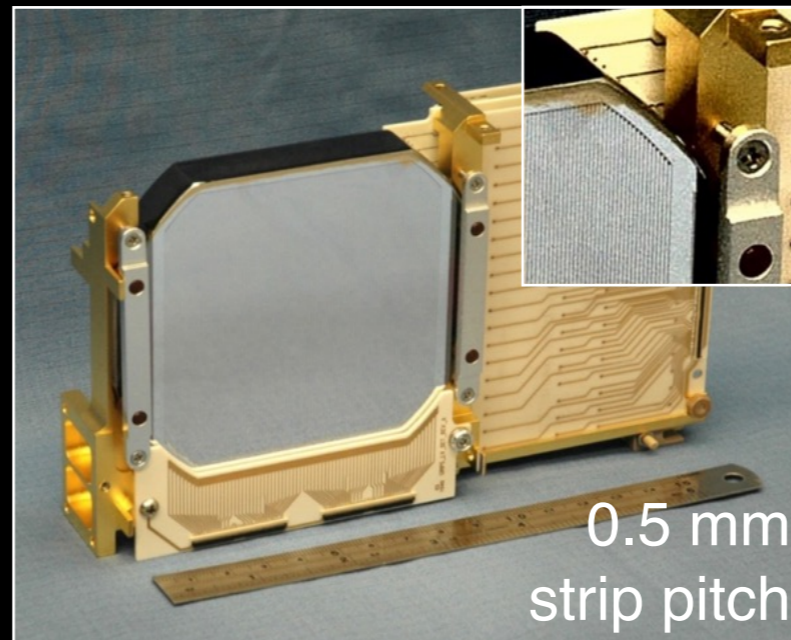
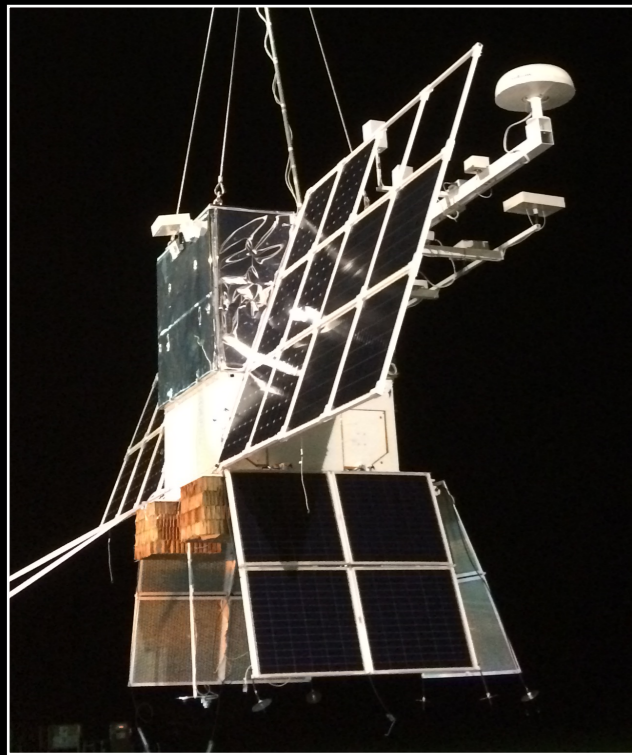
511 keV Angular Distribution around GC



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

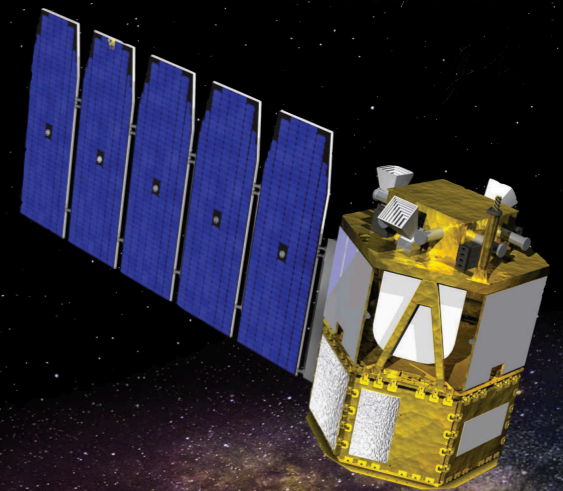
The Future of COSI

COSI-2 to launch from Wanaka, NZ Spring 2020



COSI-SMEX

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



Follow COSI in 2020!



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

COSI
@COSIBalloon

I'm a gamma-ray telescope floating near space on a giant NASA balloon!

Wanaka, New Zealand
cosi.ssl.berkeley.edu
Joined October 2014
81 Photos and videos

Tweets **Tweets & replies** **Media**

COSI @COSIBalloon · 18h
I'm in Albuquerque, which is at an impressive 5,312 ft elevation. But I plan to fly up 100,000 ft! 📍

The screenshot shows the Twitter profile for COSI (@COSIBalloon). The profile picture is a circular image of the COSI instrument on a trailer. The bio states it is a gamma-ray telescope on a NASA balloon. The location is Wanaka, New Zealand, and the website is cosi.ssl.berkeley.edu. A recent tweet from 18 hours ago shows a photograph of a highway at dusk with a road sign for Albuquerque (40 miles) and Santa Rosa (155 miles). The tweet text says, "I'm in Albuquerque, which is at an impressive 5,312 ft elevation. But I plan to fly up 100,000 ft!"

Want to take advantage of all
the new Twitter features?

It's simple – just log in.

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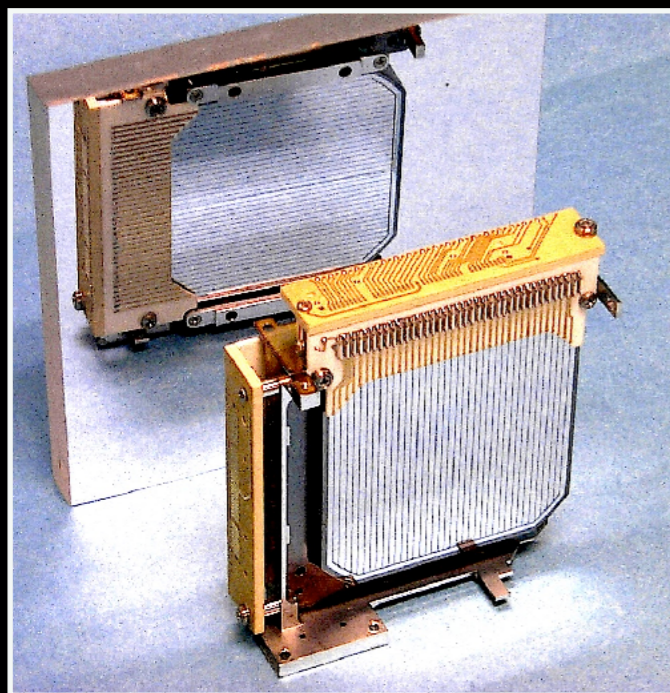
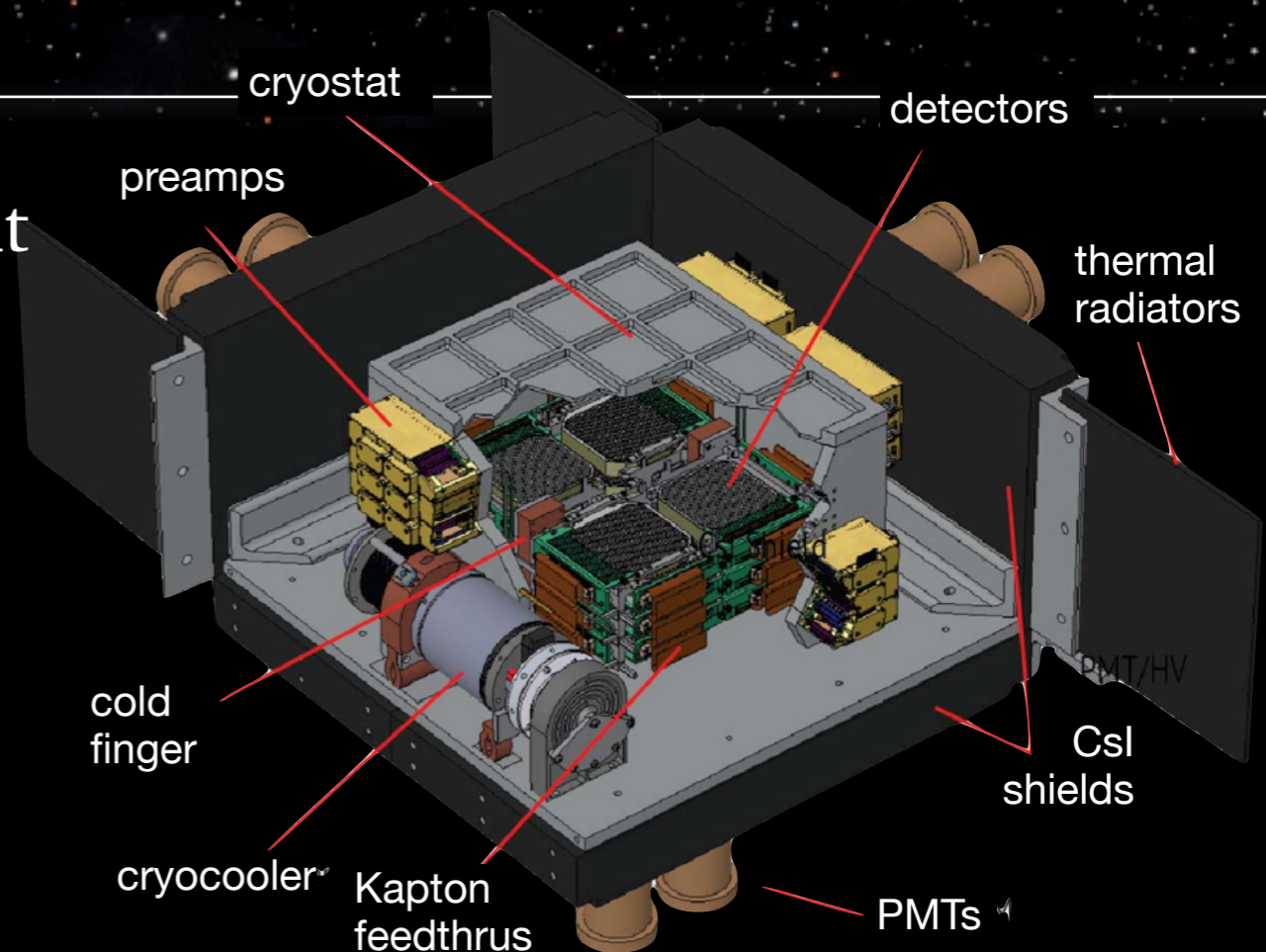
COSI 2016 Launch from Wanaka, NZ



Credit: Bill Rodman/NASA Wallops

COSI Instrument

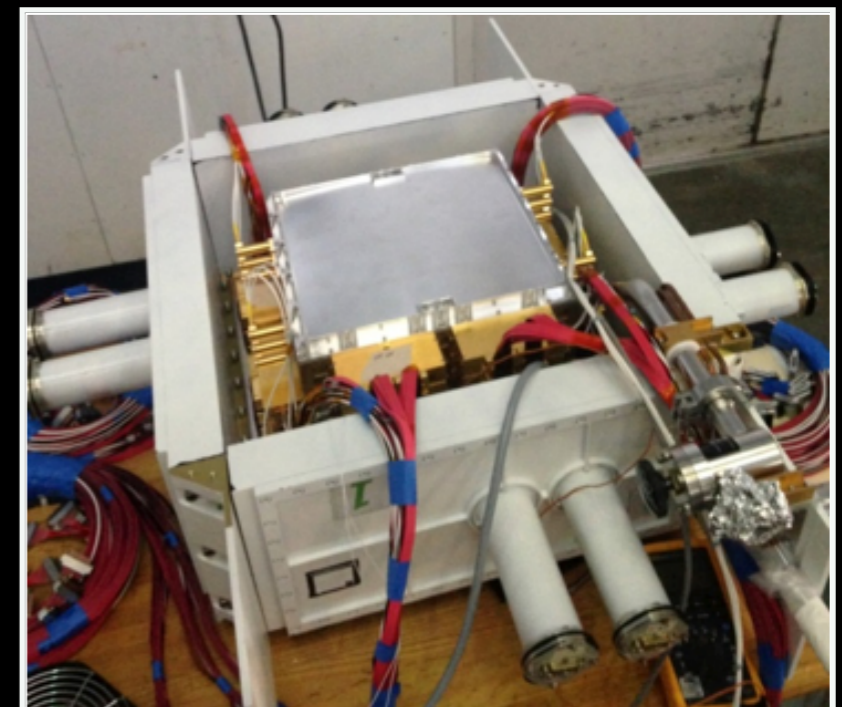
- Evacuated anodized aluminum cryostat
- Sunpower Cryotel cryocooler
 - GeD operating temp $\sim 85\text{K}$
- Cesium iodide anti-coincidence shields
 - significant background reduction
 - FOV $\sim 25\%$



Single GeD with a mirror

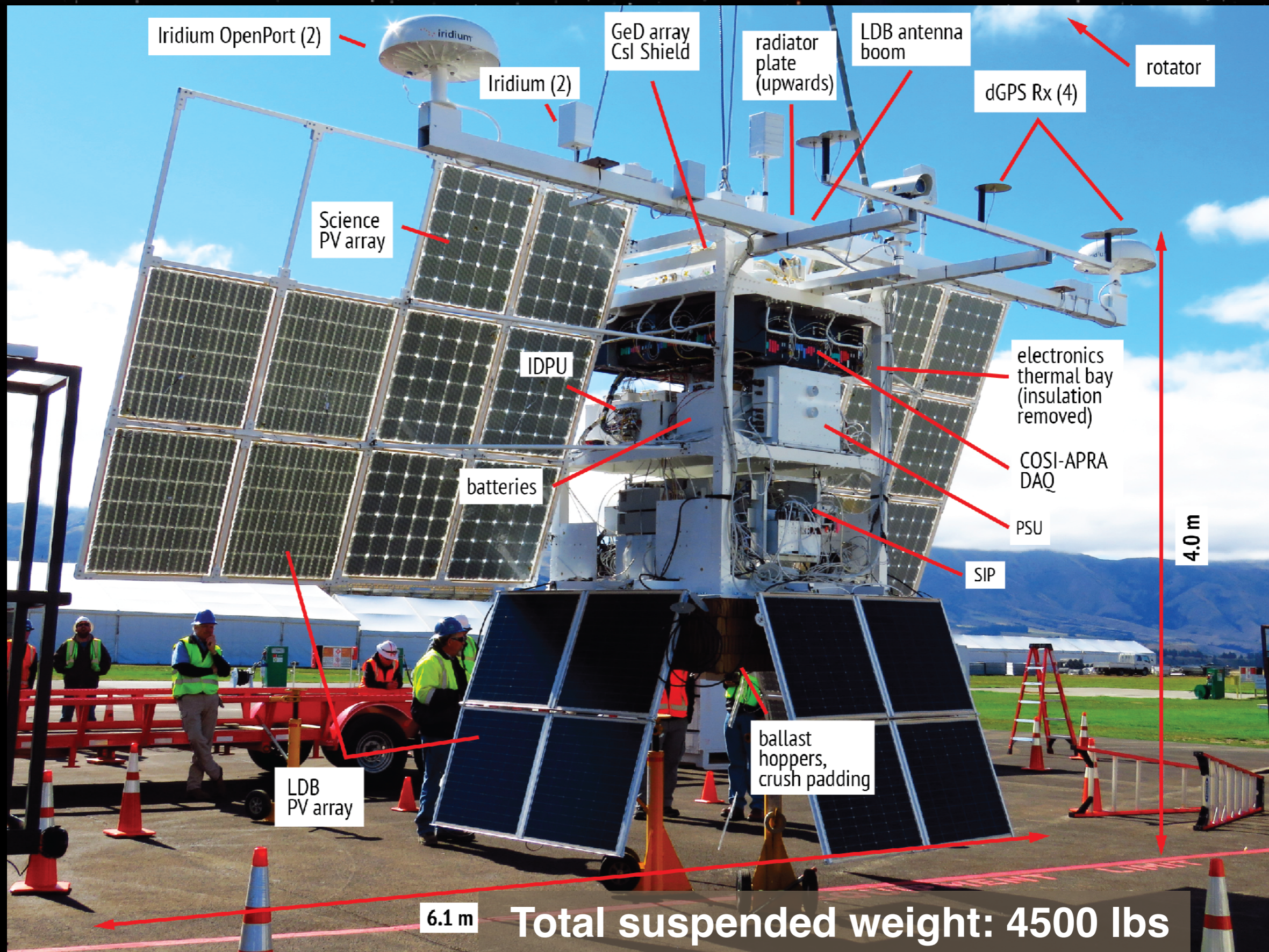


Germanium detector array

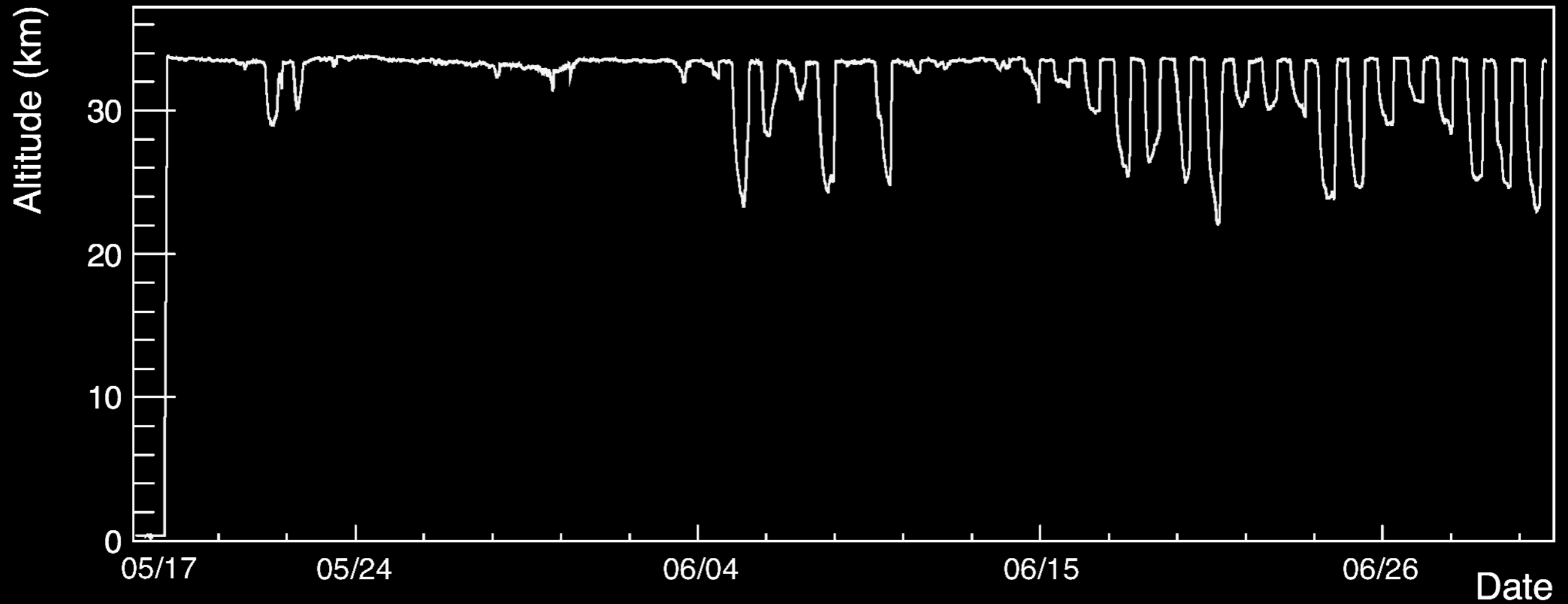


Cryostat and CsI shields

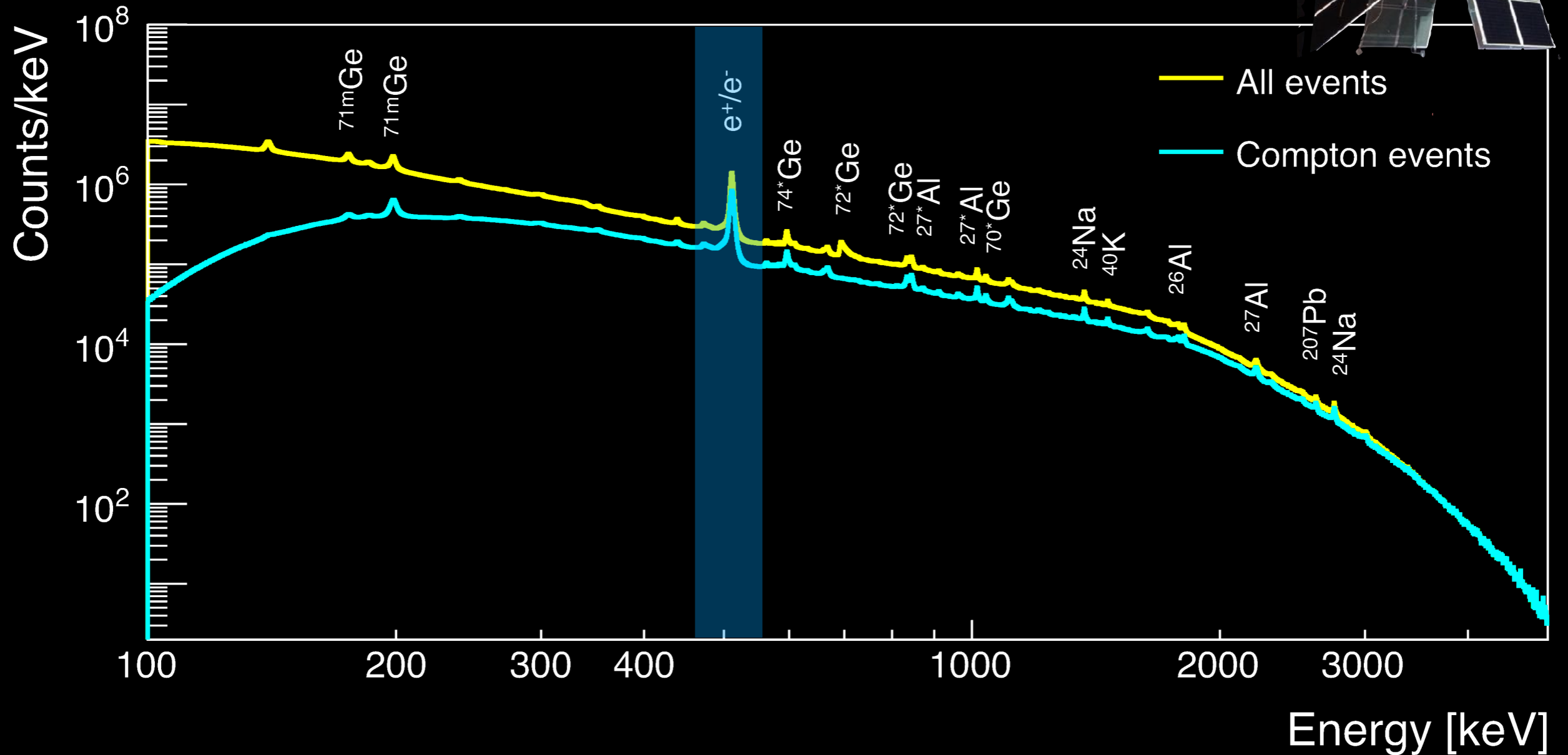
COSI 2016 Wanaka Campaign



COSI 2016 Flight Altitude Profile



COSI 2016 Full Flight Spectrum



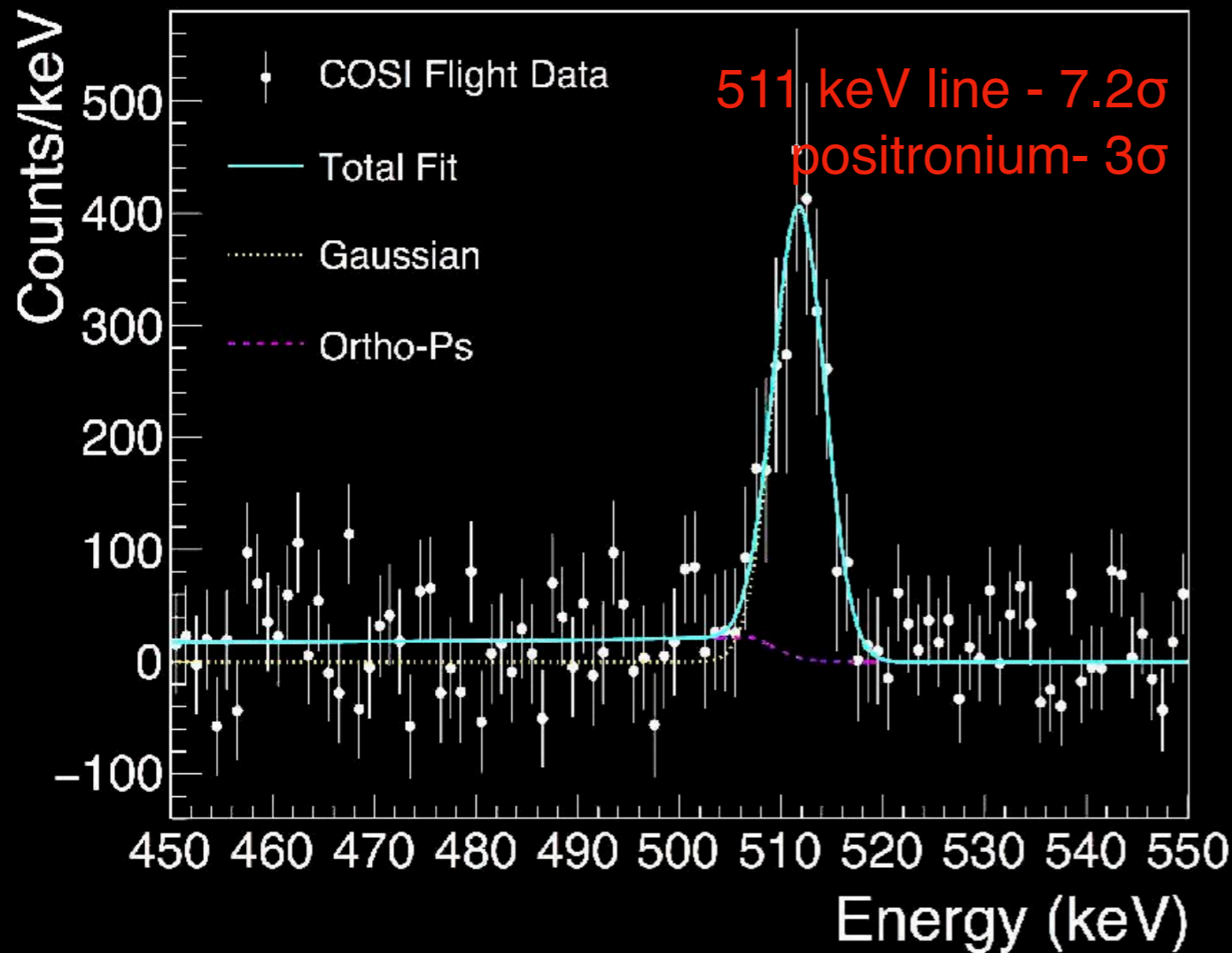
Strong background from the atmosphere and instrument activation.

GC/Background $\sim 5\%$ @ 511 keV

Galactic 511 keV with COSI



GC Background Subtracted Spectrum



Flux measurement
 $(3.9 \pm 0.4) \times 10^{-3} \gamma/\text{cm}^2/\text{s}$

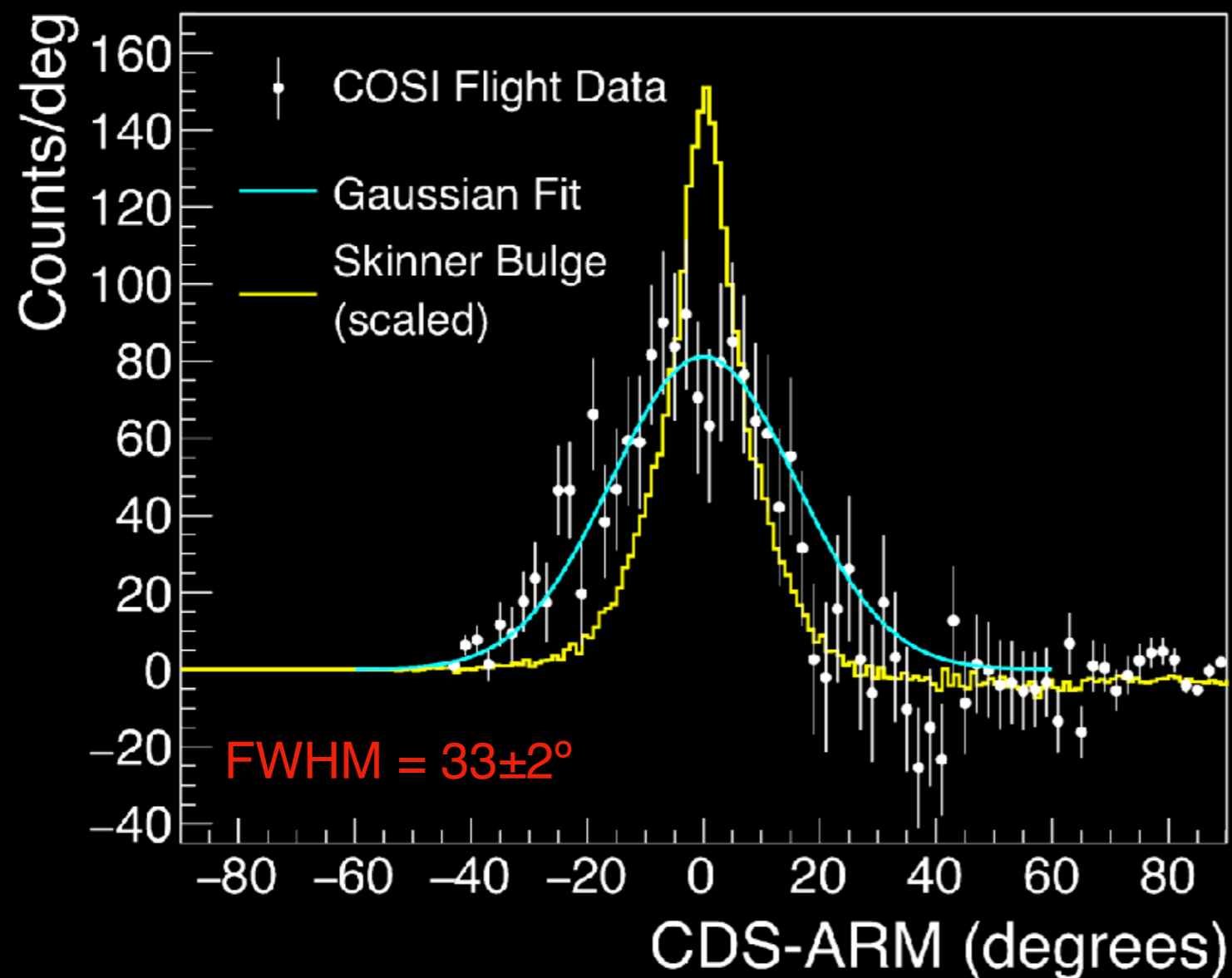
$$F(E) = A \exp\left(-\frac{(E - \mu)^2}{2\sigma^2}\right) + BF_{oPs}(E)$$

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

Galactic 511 keV with COSI



511 keV Angular Distribution around GC



Parameter	Value
Gaussian Fit μ	fixed at 0
σ	$14.0 \pm 0.7^\circ$
A	89 ± 0.6 cts
$\chi^2/\text{d.o.f.}$	52.1/52
FWHM	$33 \pm 2^\circ$

Twice as broad as SPI bulge models

CK et al. submitted to ApJ