Polarimeter to Unify the Corona and Heliosphere

STEAM

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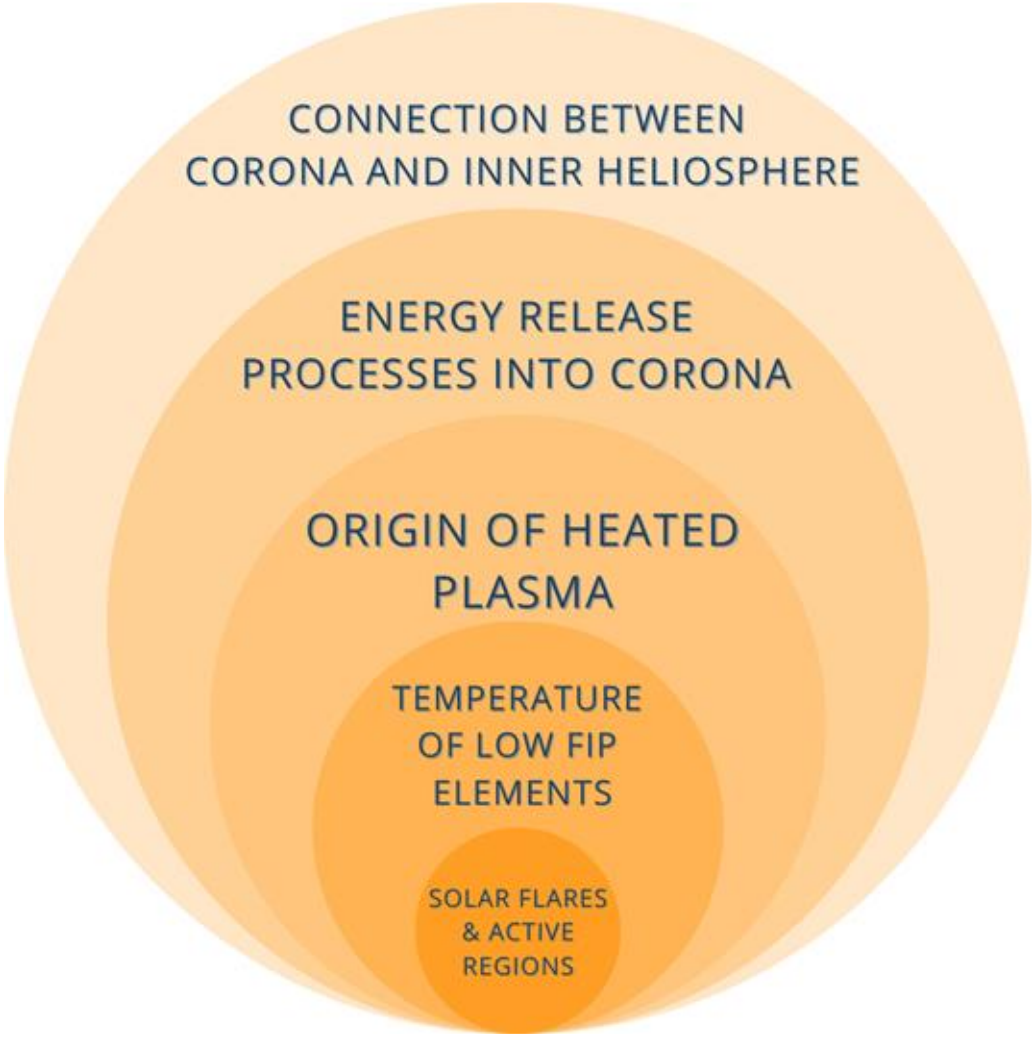
PUNCH 5 Science Meeting
June 20, 2024
UCAR

Connections to PUNCH



PUNCH

STEAM

Introduction

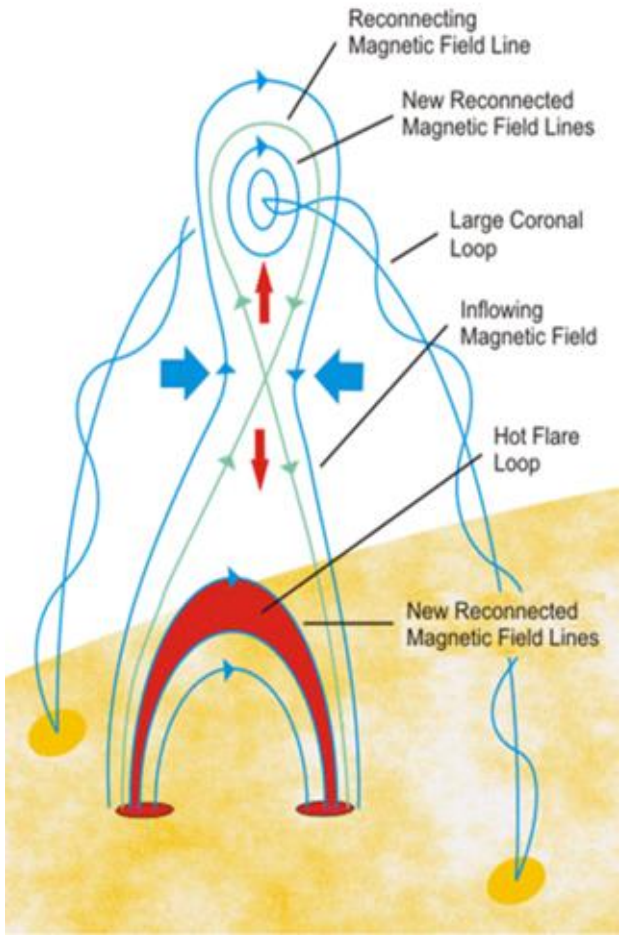
Science Objectives

Explore the enhancement of low First Ionization Potential (FIP) elements in the solar corona.

Explore how solar coronal plasmas are heated in flares and quiescent active regions.

Support PUNCH science in understanding the source regions of solar wind and coronal mass ejections.

Magnetic Reconnection & Plasma Heating



Oppositely oriented field lines cancel

↓

Field lines rearrange themselves into a lower energy state

↓

Releases an explosion of energy

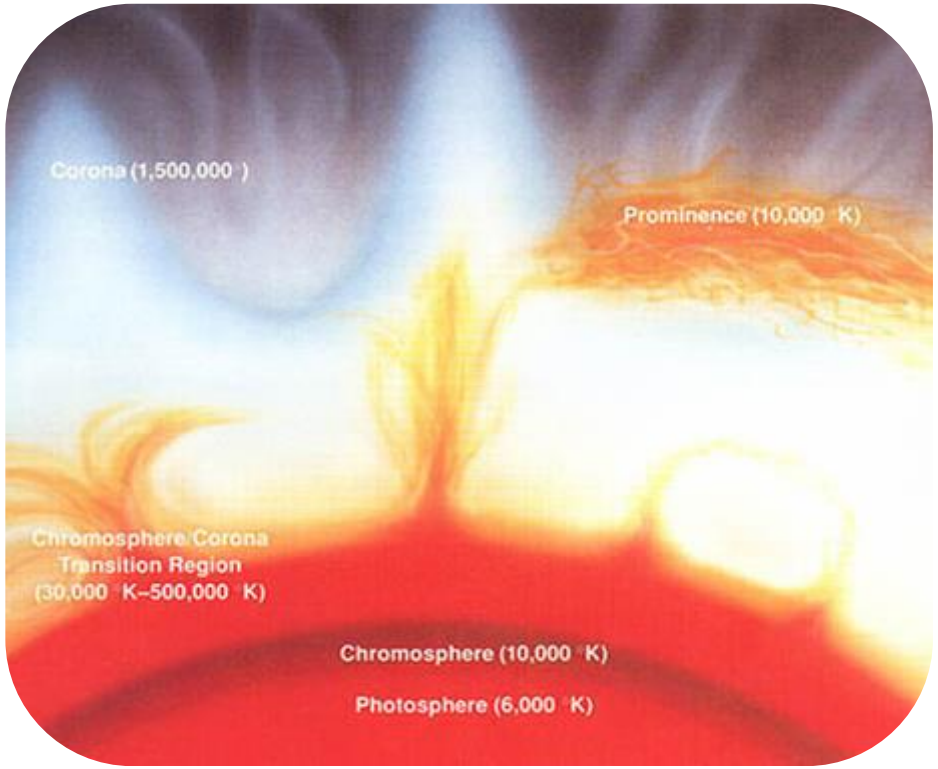
↓

Releases heat and energy into the corona

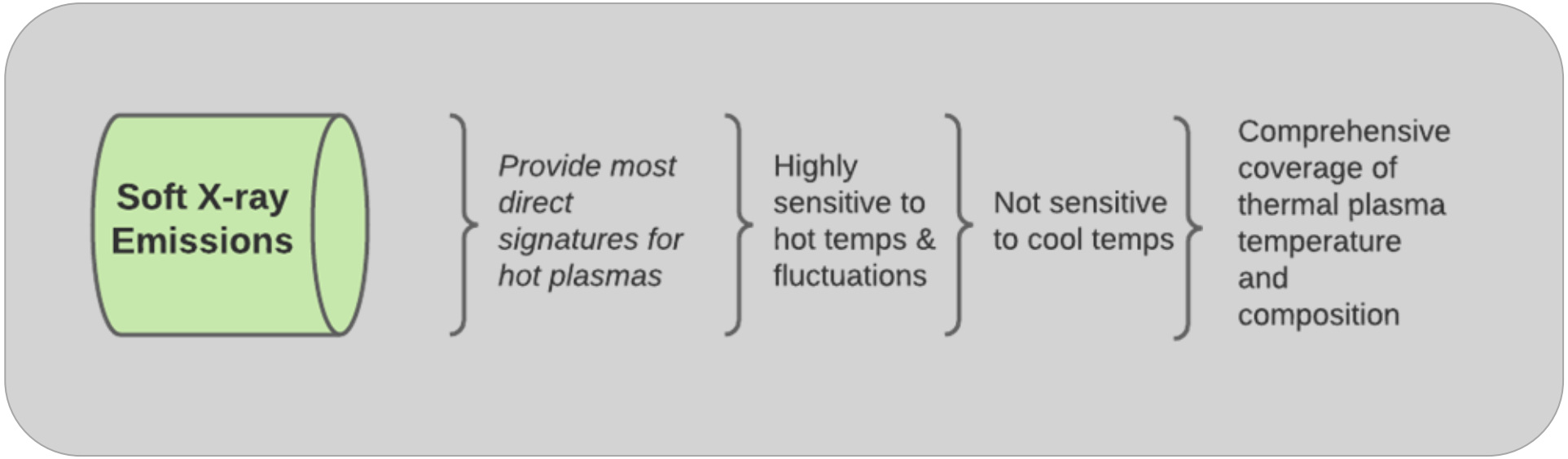
Low-FIP Elements in the Corona

Low FIP (< 10 eV) elemental abundances point to origin of plasma

- Prominent above thermal continuum
- Abundances enhanced by a factor of ~4 in corona over chromospheric values
- Abundances allow STEAM to infer origin of plasma for flares and active regions (AR)



Why X-rays



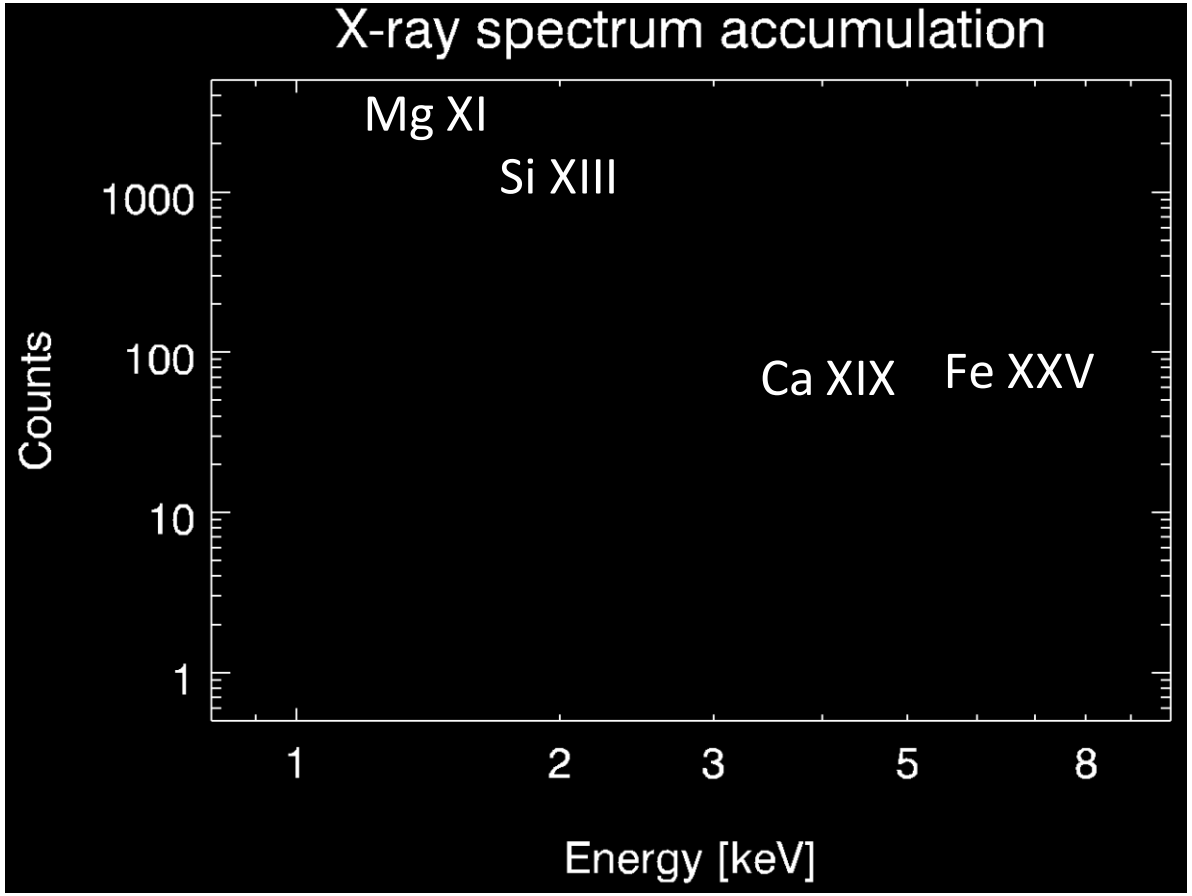
STEAM's Hard X-ray spectrometer was damaged during TVAC and was electrically disconnected. The hardware remains within STEAM but it will not collect any data

What is STEAM?

Soft X-ray Measurements → Silicon Drift Detector

Expected Performance	SXR
Energy Range	1 to 7 keV
Resolution	< 0.3 keV
Field of View	5.25° to 10°
Aperture Size	300 µm
Filter	PI, 5.5 µm

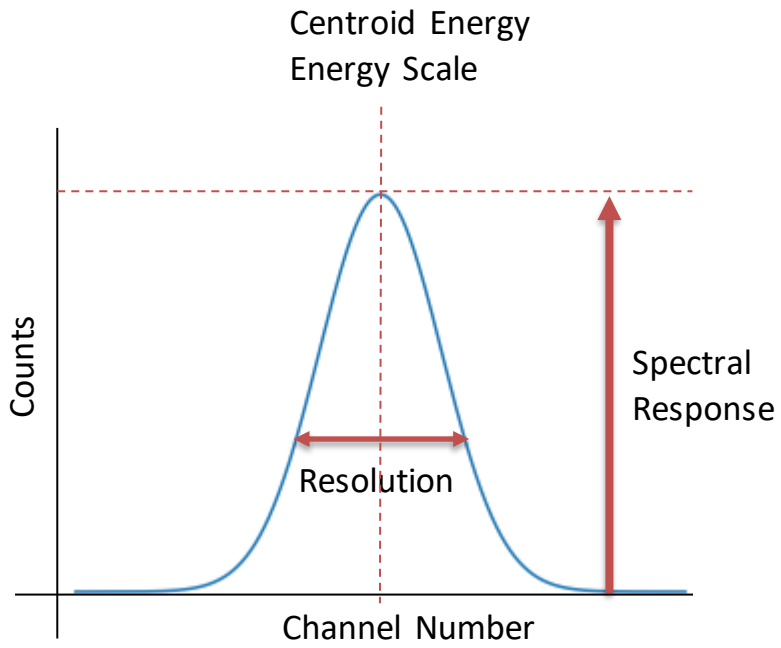
Integrating Photon Counts Over Time

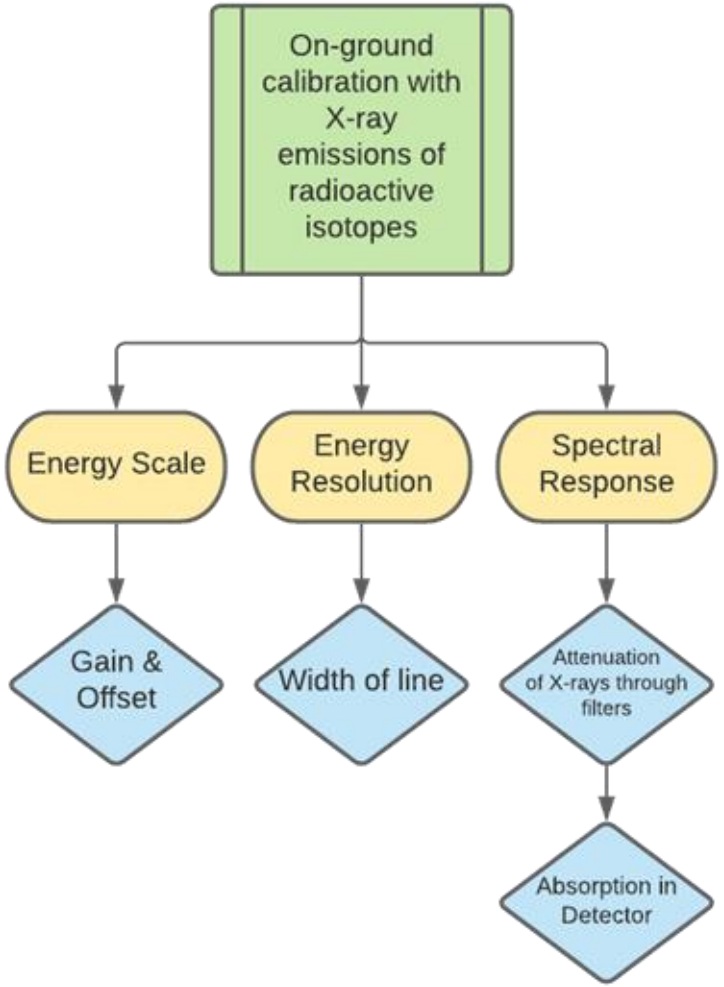


The individual histograms from 10-second integrations (red) can be summed to create a spectrum (white).

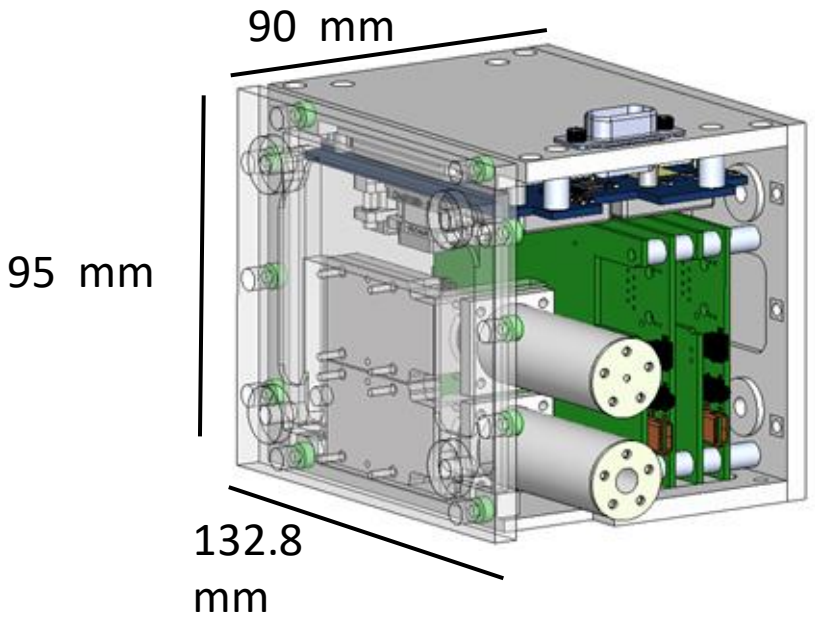
Spectrometer Calibration

Below is a schematic of an emission line we would use to calibrate the energy scale of our detectors

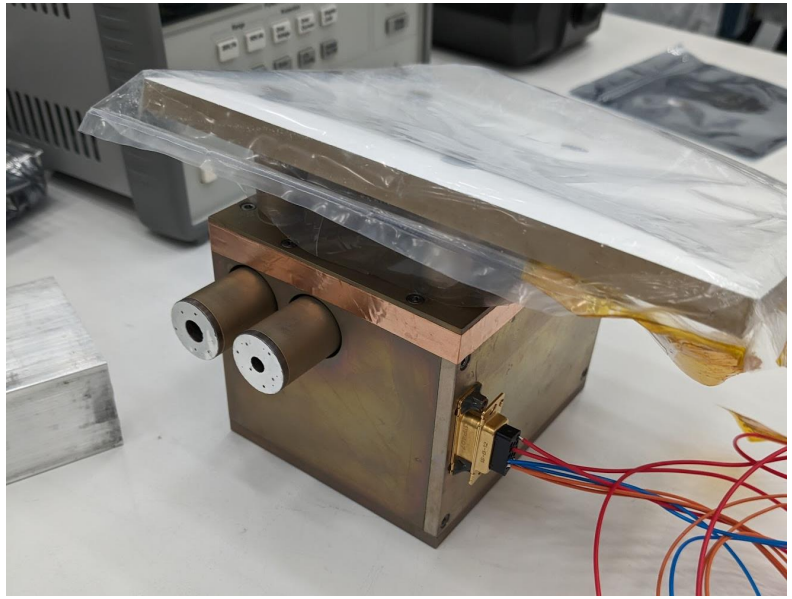




Current Model & Hardware



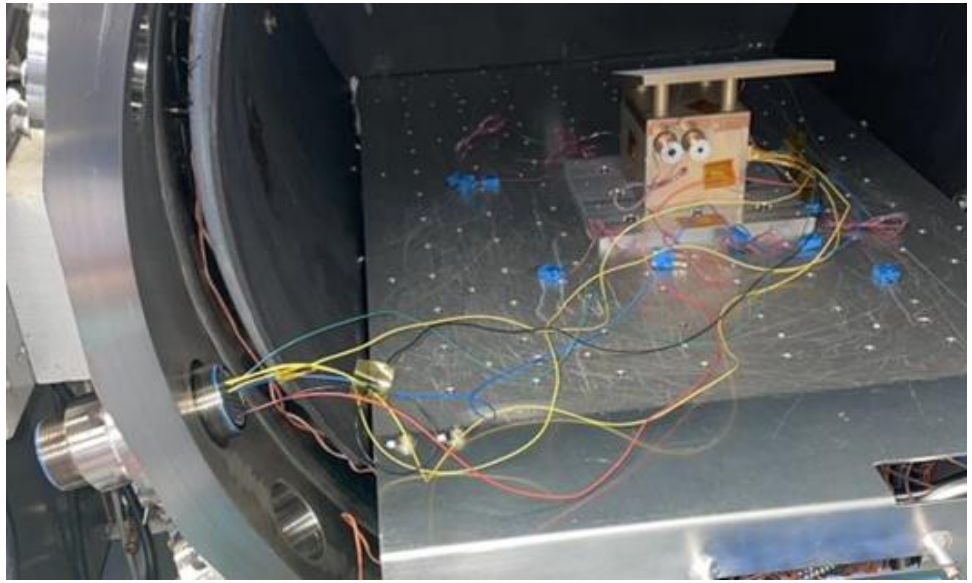
A rendering of the STEAM instrument and its dimensions



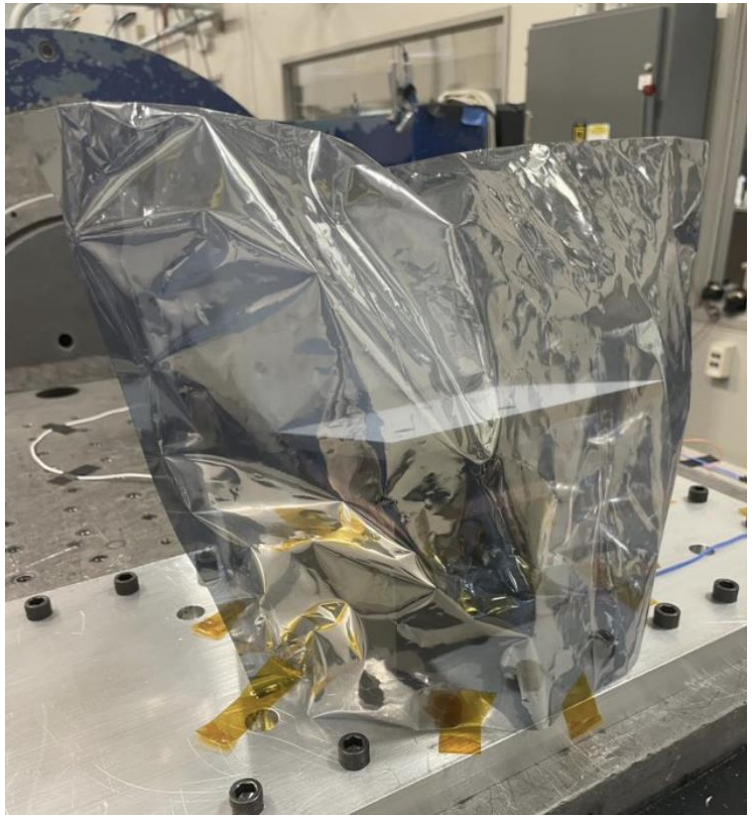
STEAM as delivered with radiator attached

STEAM Environmental Testing

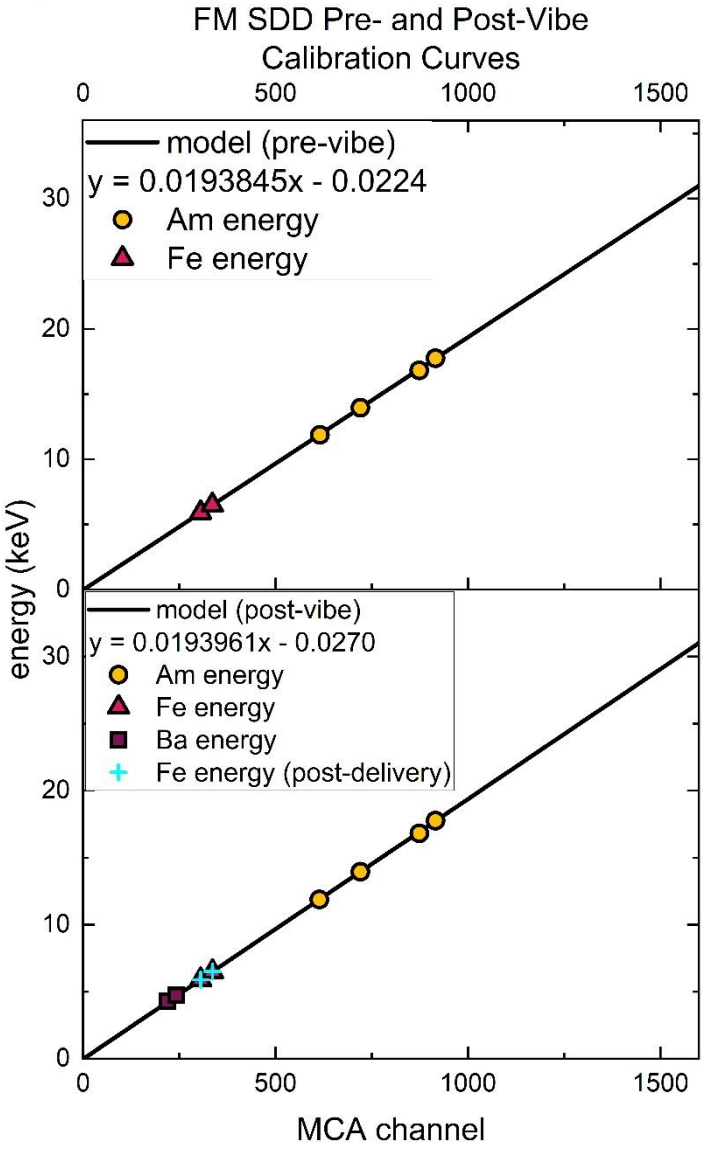
STEAM at TVAC



STEAM at Vibration Testing

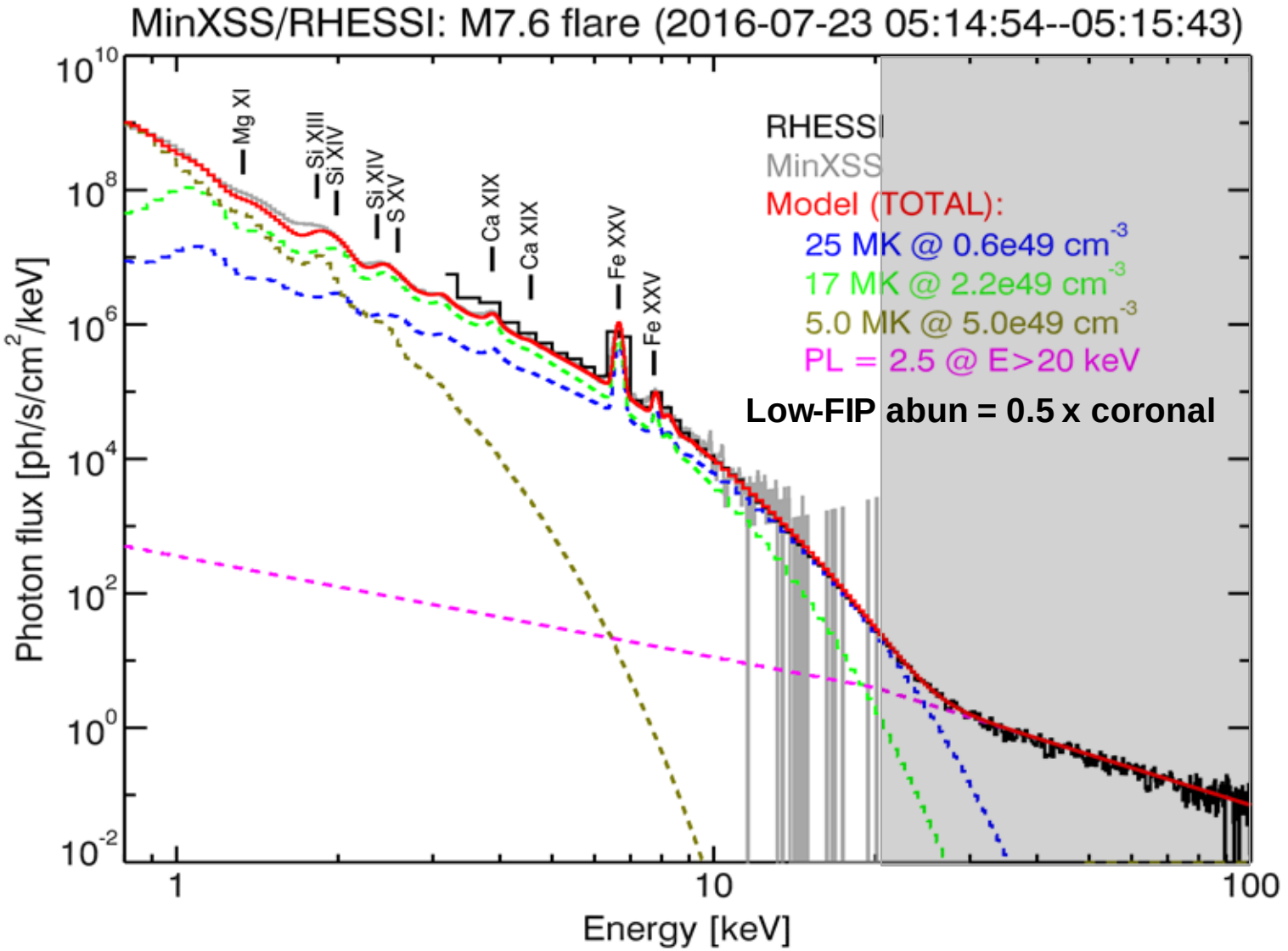


Pre- and Post-Vibe Calibration



- The top graph shows calibration curves pre-vibe testing
- The bottom graph shows calibration curves post-vibe testing
- Little change between the results give good confidence that launch will not affect data collection

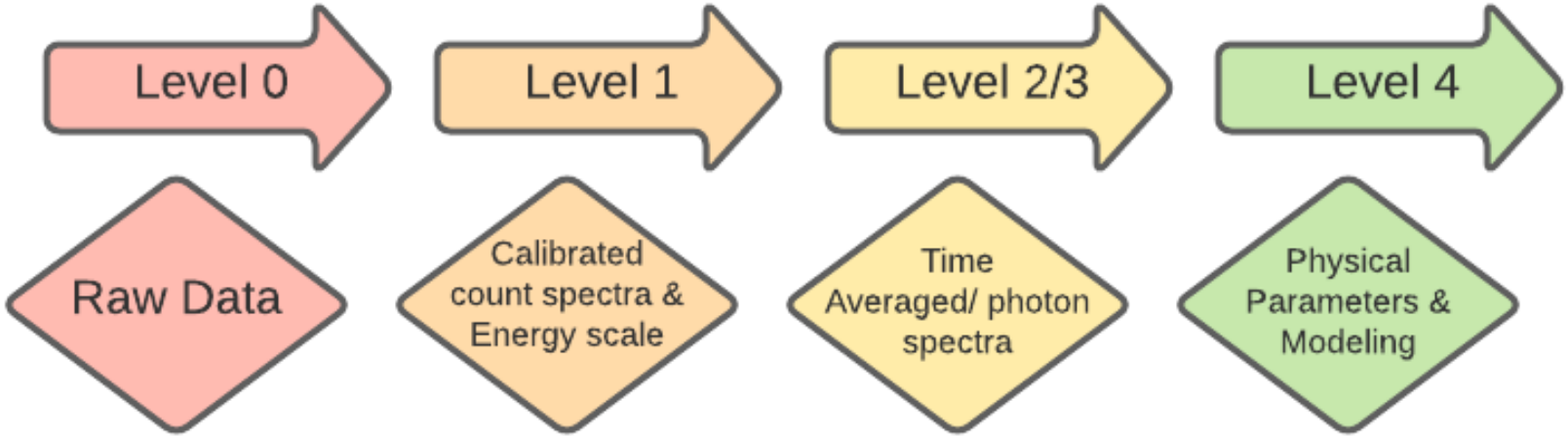
Expected Data & Analysis/Modeling

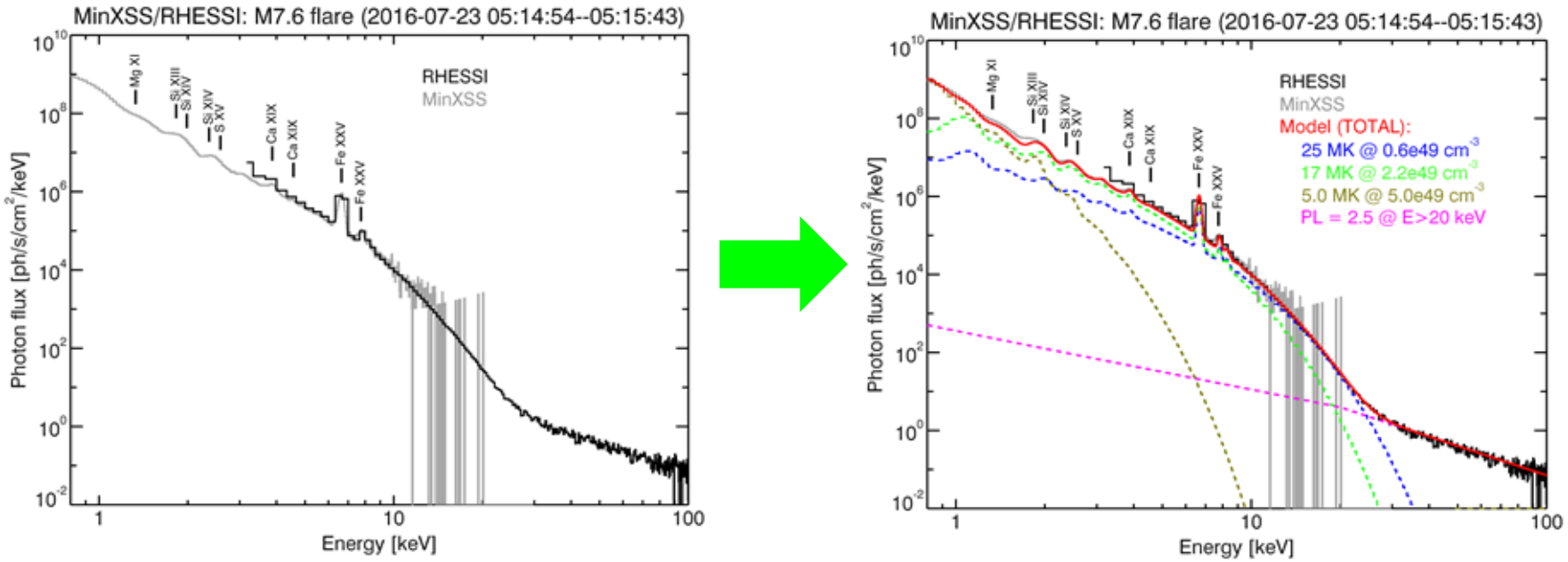


Achieving Science Goals

Observables	Applying the Physics	Modeling
	Define continuum and spectral line emissions	Continuum shape & line intensities
	↓	↓
X-ray photons from source	Fit temperatures and abundances	**Forward Modeling**
↓		↓
		Use Bremsstrahlung and atomic emission databases
	SXR (bound-bound radiation) Majority of line emissions	↓
Respective energies		**Chi-squared minimization** to derive physical parameters
	HXR (free-free and free-bound radiation) Helps to constrain continuum shape	

Tentative Data Pipeline





Conclusions

- STEAM was delivered with the SXR detector in October 2023
- Preliminary data pipeline has been established
- Student work has paused but will continue with data analysis after launch