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DUBLIN



# Pixon Image Reconstruction for STIX

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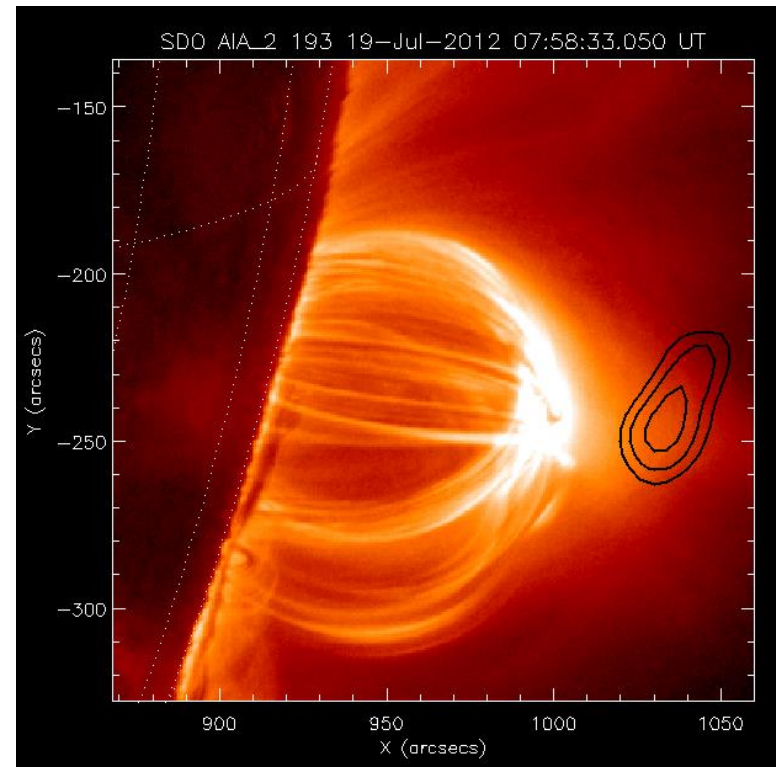
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Richard Schwartz – NASA GSFC & Catholic University of America

STIX Software Team (FHNW, Graz, Wroclaw, l'Observatoire de Paris, UC Berkeley)

# Overview

- RHESSI X-ray imaging heritage
  - image reconstruction algorithms compared
- X-ray imaging with STIX
- Pixon image reconstruction
- Status and future work



# RHESSI Spacecraft & Imager



Launched February 2002

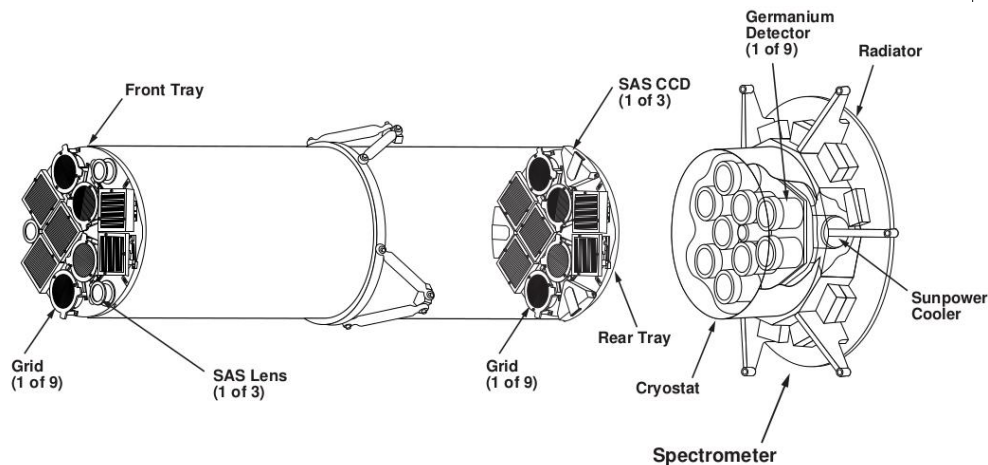
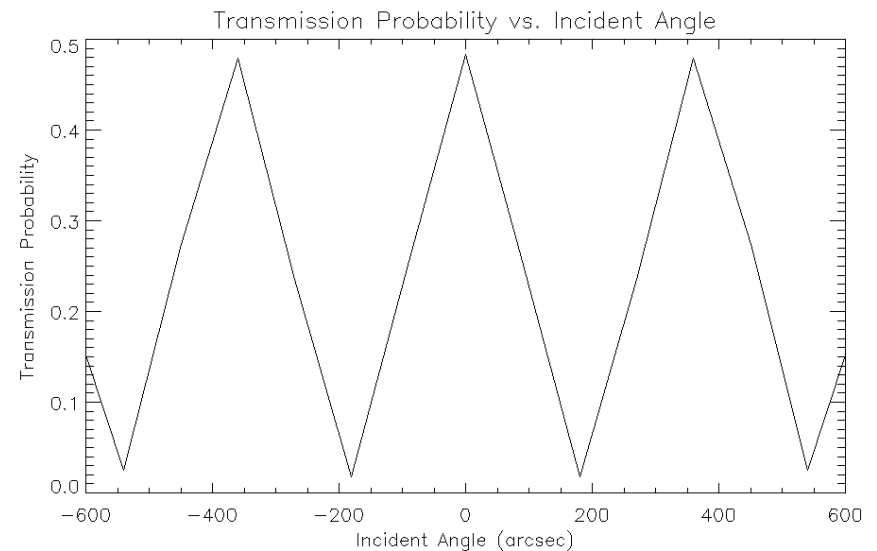
Full-Sun FOV

2.3 arcsec imaging resolution

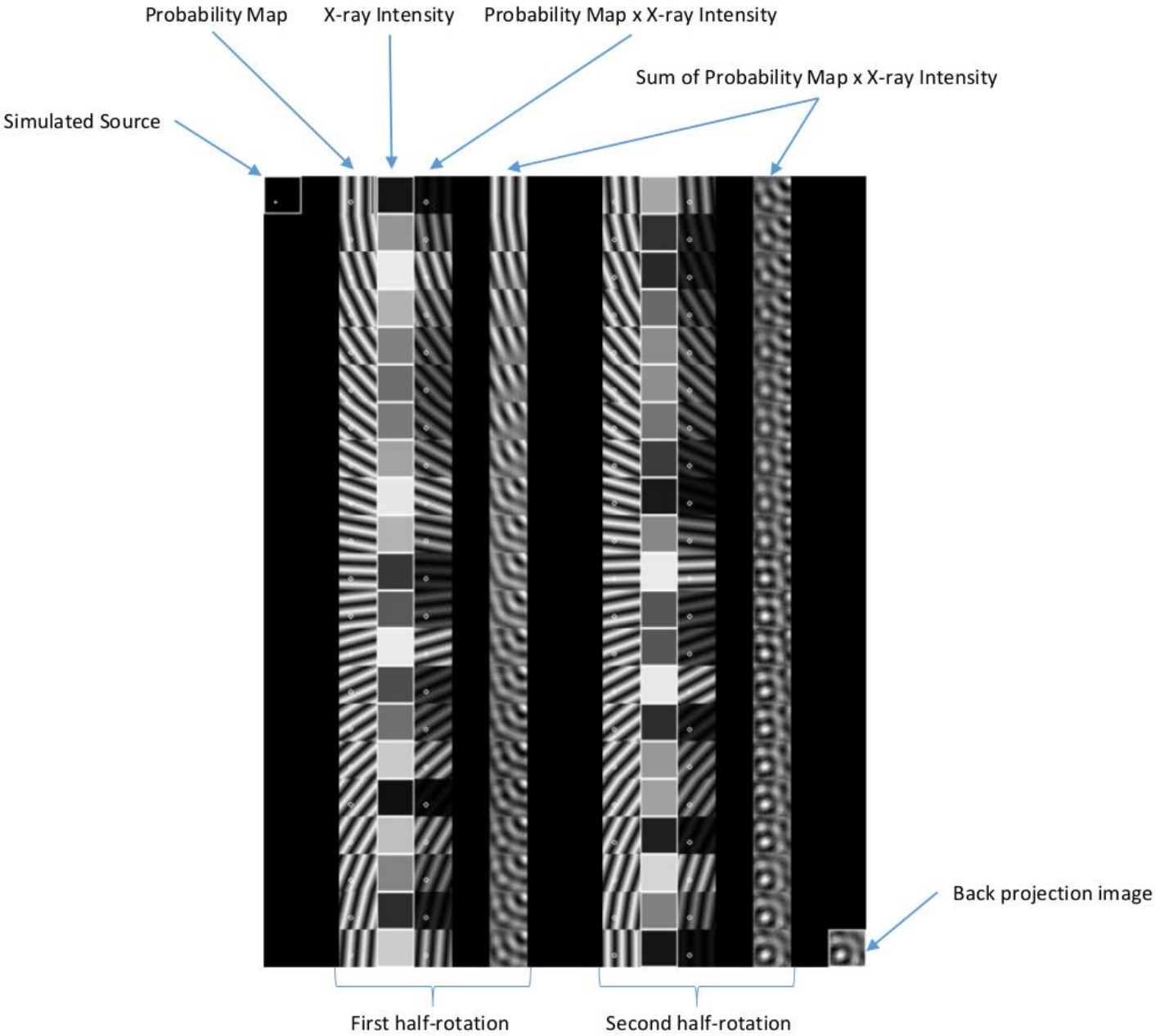
3 keV – 17 MeV energy range

1-10 keV FWHM spectral resolution

Spin stabilised @ 15 RPM

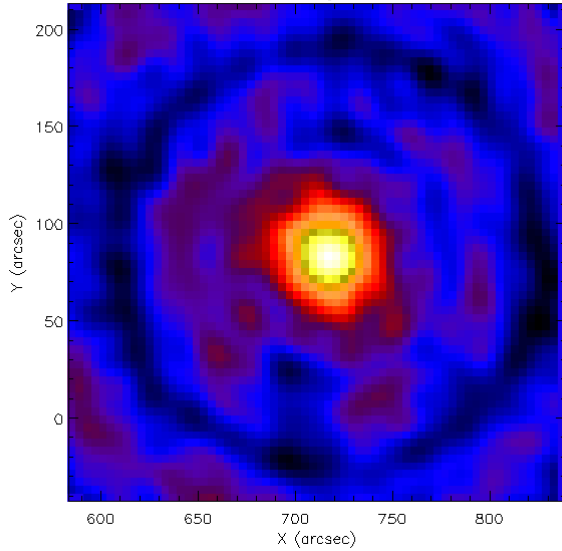


# RHESSI Back Projection

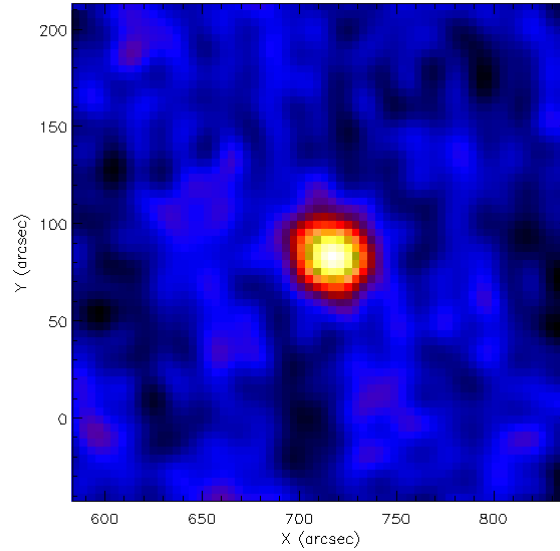


# Back Projection, CLEAN, Pixon

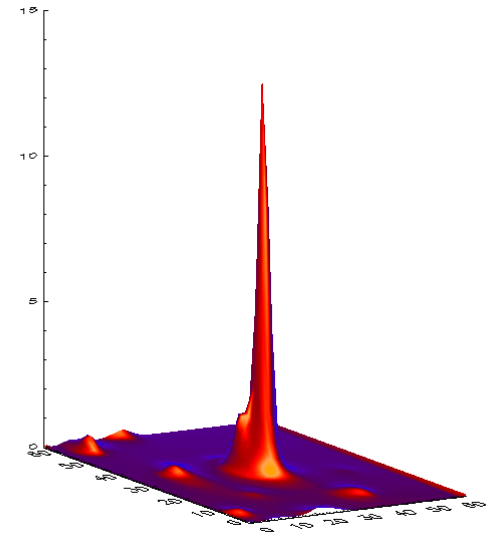
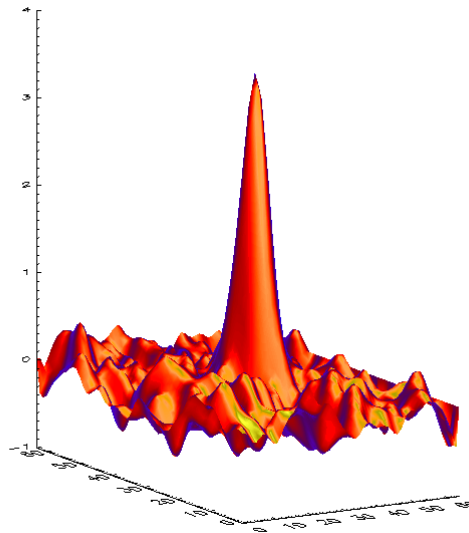
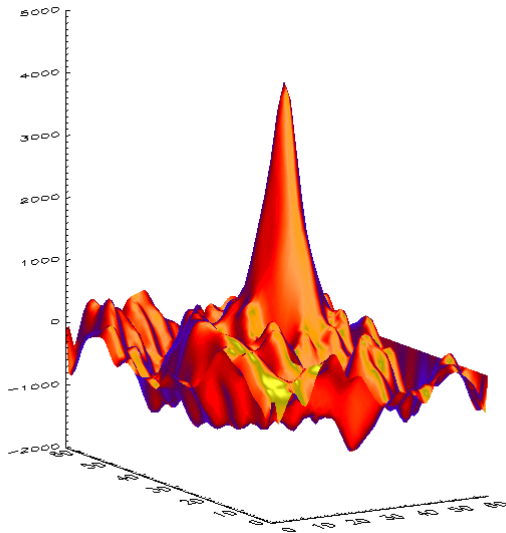
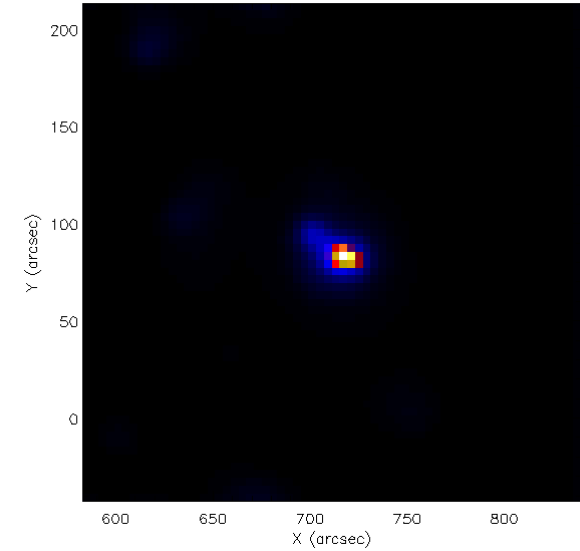
Back Projection



Clean



Pixon

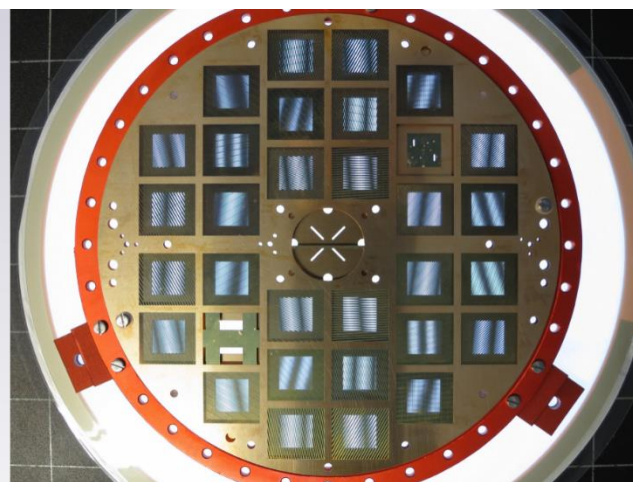
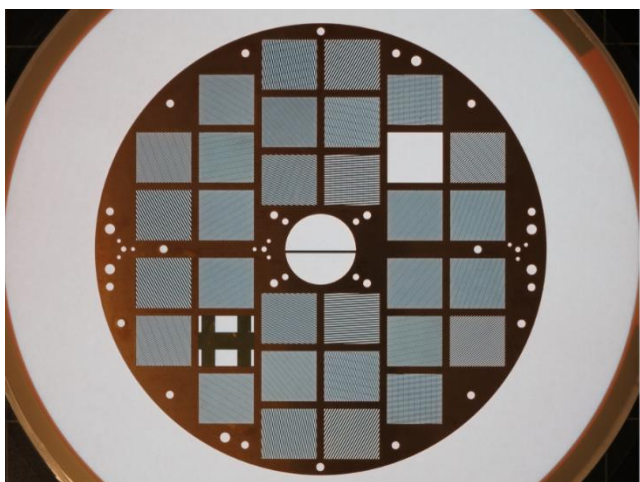
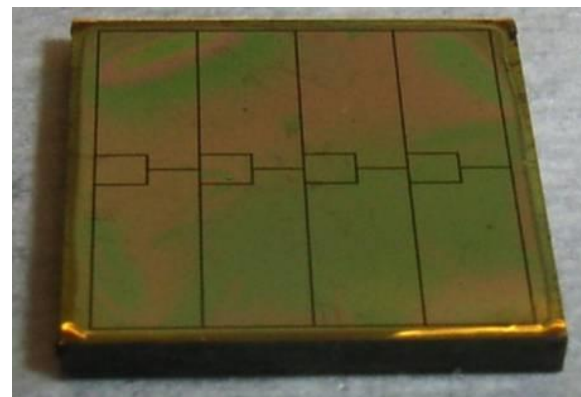
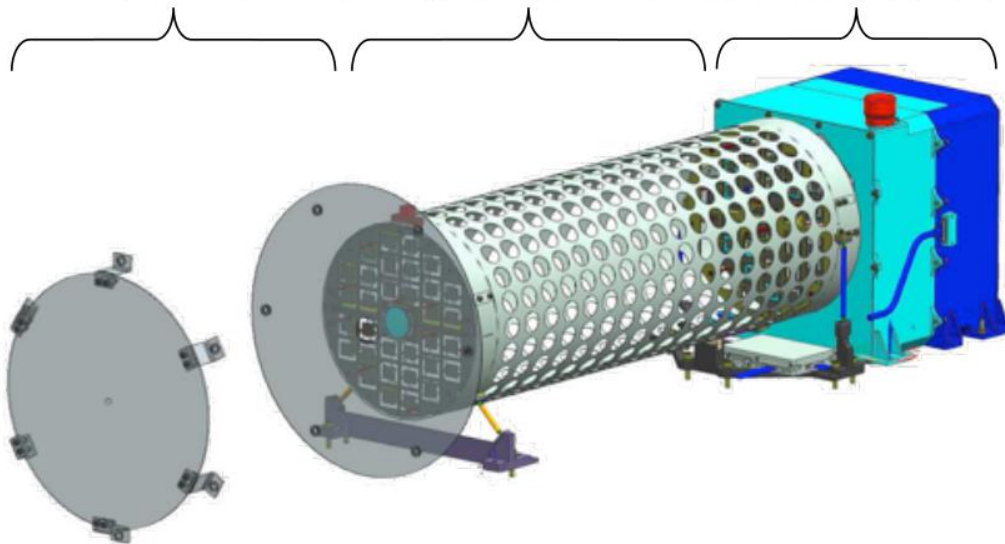


# STIX Instrument

**X-ray windows**  
in the spacecraft  
heat shield

**Imager tube**  
with tungsten grids  
and Aspect system

**Detector Electronics Module**  
with X-ray detectors and  
on-board data processing



# Pixon Image Reconstruction

- Image reconstruction relates the following concepts
  - Image - this is what we *want*
  - Data - this is what we *have*
  - Model – this is how we relate what we *have* to we *want*
- Bayes Theorem shows that maximizing the joint probability of the image, model and data is the same as maximizing:

$$p(\text{image}, \text{model} \mid \text{data}) \propto p(\text{data} \mid \text{image}, \text{model}) \times p(\text{image} \mid \text{model})$$

- e.g., Puetter (1995) suggests that we could:
  - Maximise  $p(\text{data} \mid \text{image}, \text{model})$  using a chi-squared test on the residuals of the data and the proposed image and model
  - Maximise  $p(\text{image} \mid \text{model})$  by using as few pixons as possible to account for as much image as possible

# Status and Next Steps

- STIX Software Team has implemented the STIX imaging software environment
  - Supports source simulation and therefore imaging algorithm evaluation
- Genoa has
  - implemented a number of heritage RHESSI imaging algorithms in STIX
  - implemented new algorithms e.g. multi-scale CLEAN
- Next steps – liaise with Genoa and NASA to
  - Reproduce heritage Pixon functionality in STIX imaging environment
  - Pixon heritage will provide good initial choices of  $p(D|I,M)$  and  $p(I|M)$
  - Research ways to
    - Improve the *functionality* of the Pixon algorithm
    - Improve the *performance* of the Pixon algorithm
- GPU implementation perhaps?



# Thank You

