Johnson Noise Analysis of MgB_2 Detector AND Star Camera Development

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Johnson Noise Analysis of MgB_2 Detector

Mentors:
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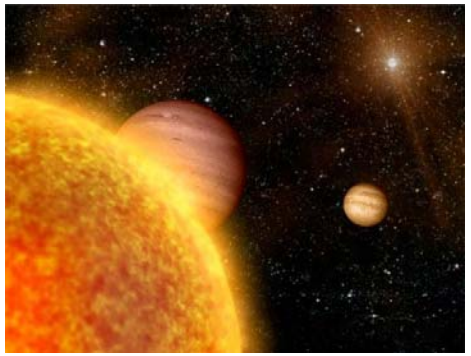
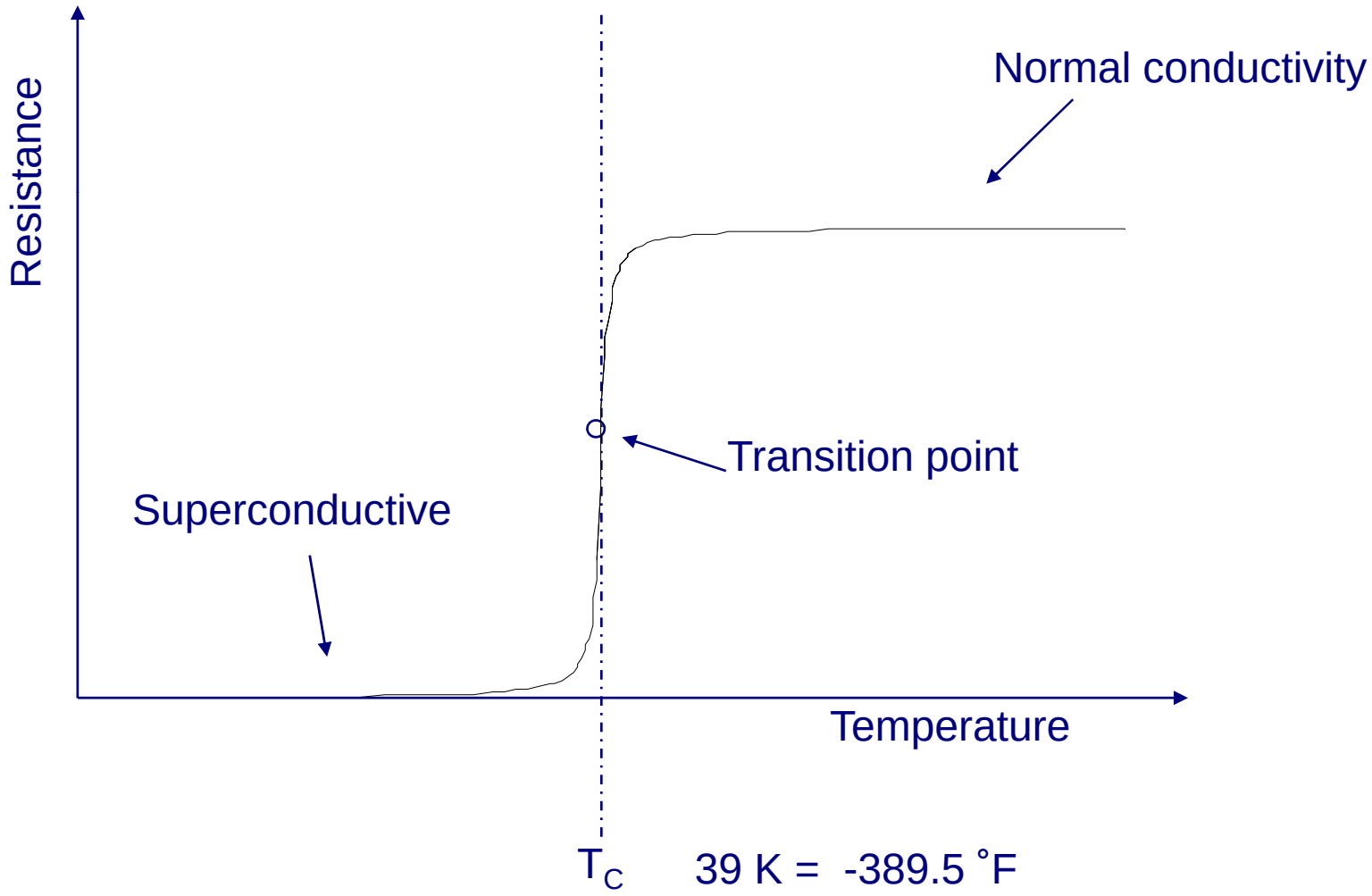
MgB_2 Bolometer

- Bole (G*reek*): for something thrown like a ray of light
- Measures Infrared Radiation from deep space
- Need robust material for future missions to Saturn and Jupiter, which have harsh radiation environments



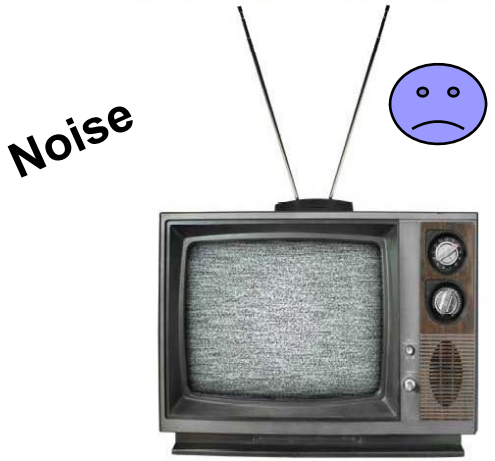
Superconductor Transition

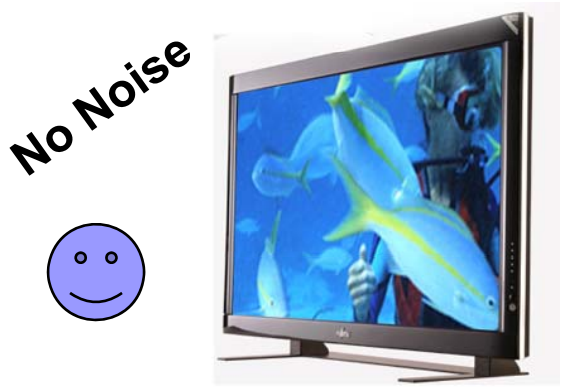


What is Noise?

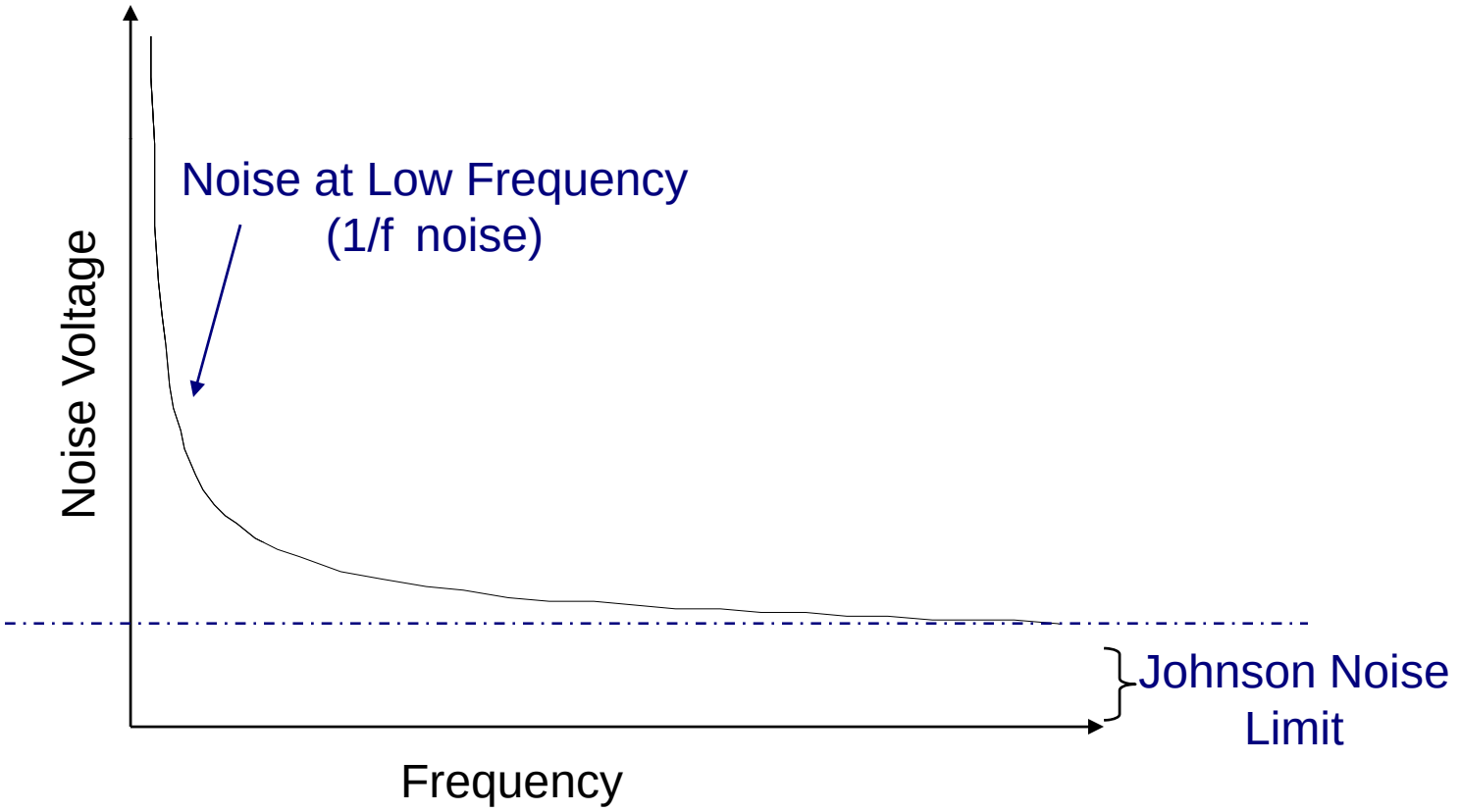
Thermal Noise == Johnson Noise

Johnson Noise is a thermally excited agitation of the charged carriers in the conductor.





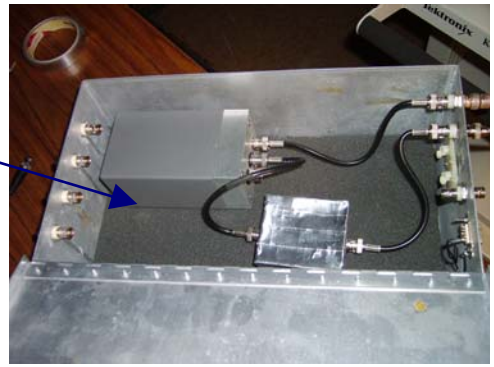
Lower Limit Detectivity of MgB_2 Detectors



First we get rid of as much external noise as possible

Shield room

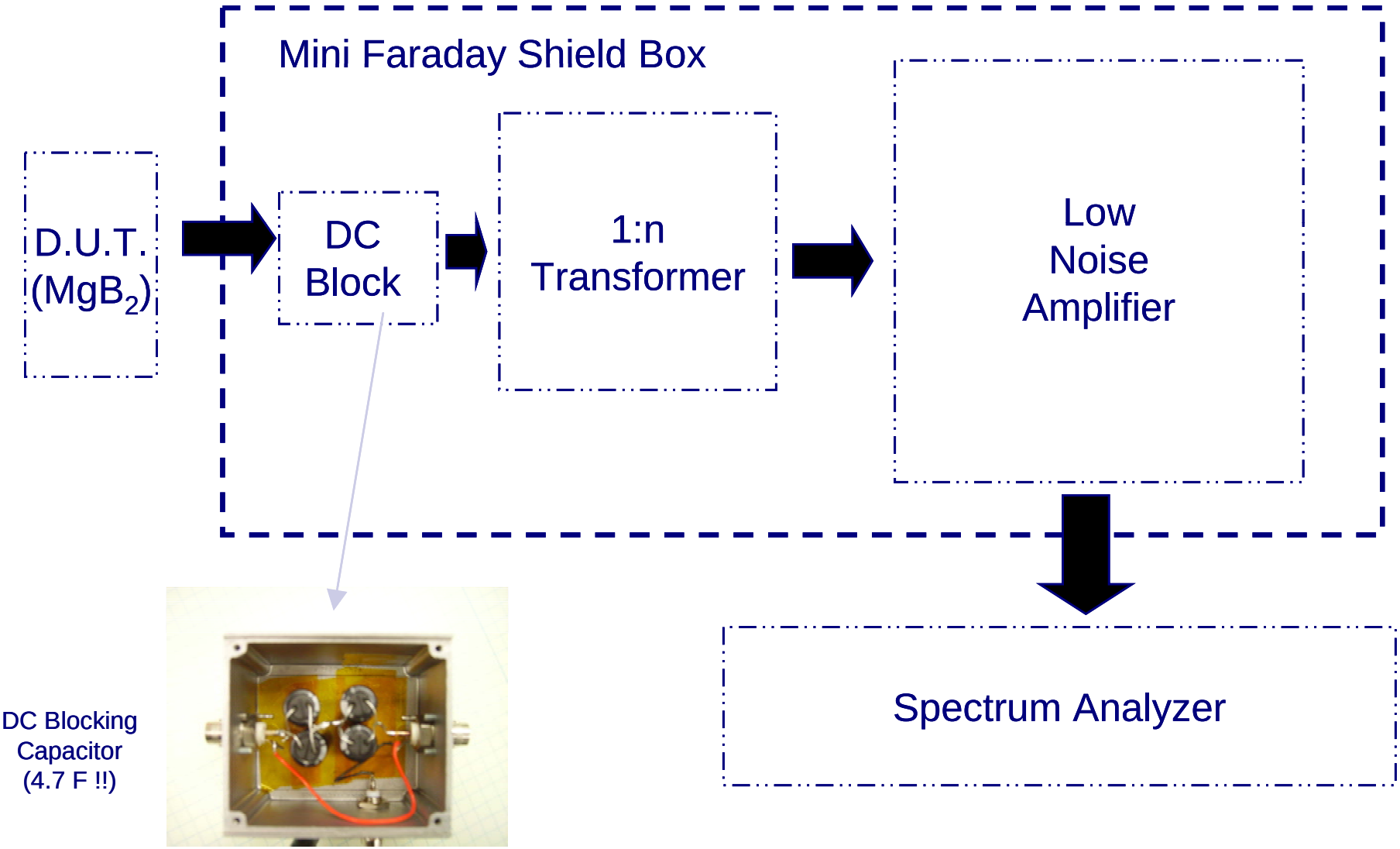
Insulated



Foam

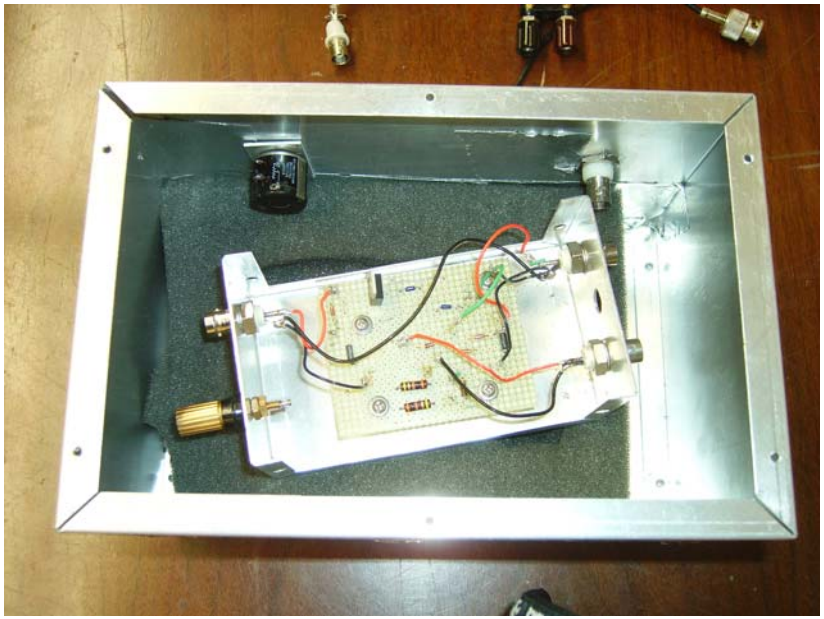
★ A ***faraday cage*** blocks out external static electrical fields

Experimental Set Up



To Date

- Testing on heater (voltage regulator)
- Frequency response measurements of the transformer



The Plan

- Calibration measurements on noise measurement system
- Run noise measurements on the MgB_2 bolometer

Star Camera Development

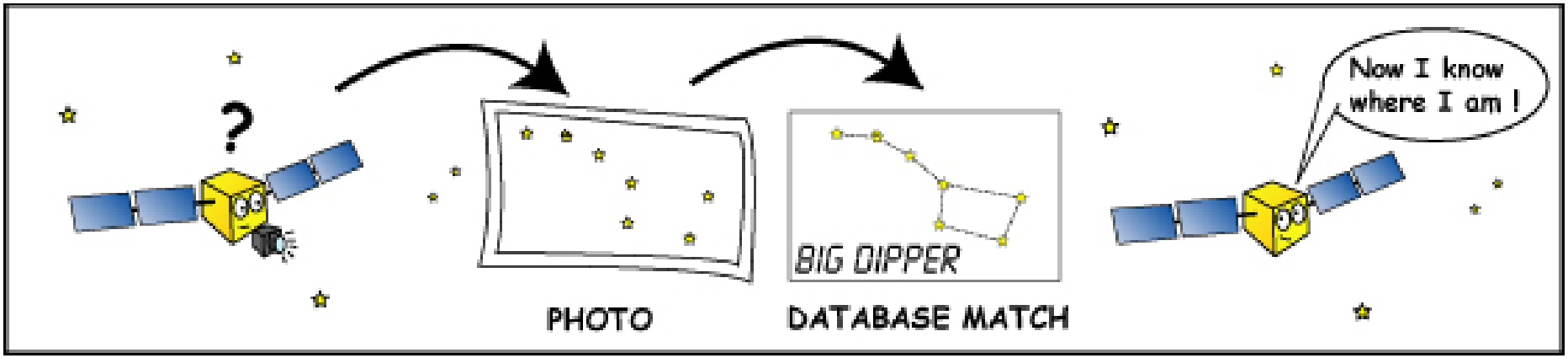
Mentor:

Fred Herrero

The Mini Star Camera (MiSC)

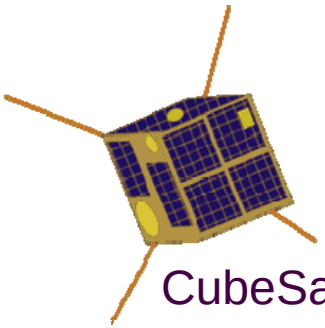
What is it?

A device used to determine the orientation of a satellite via the stars

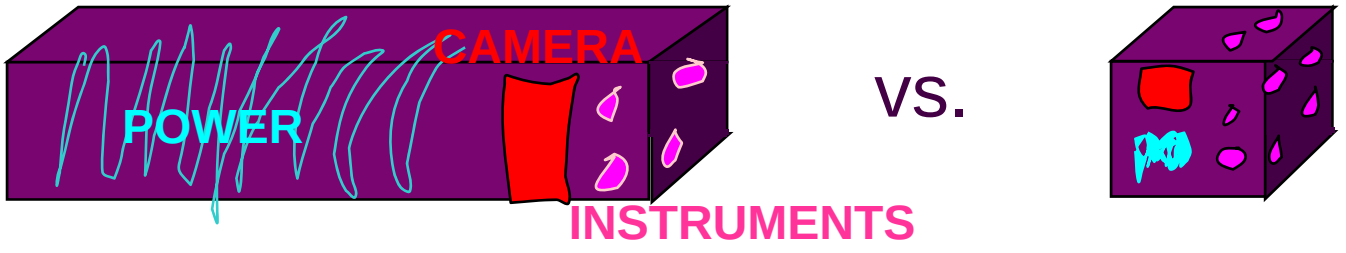


Credit: NASA

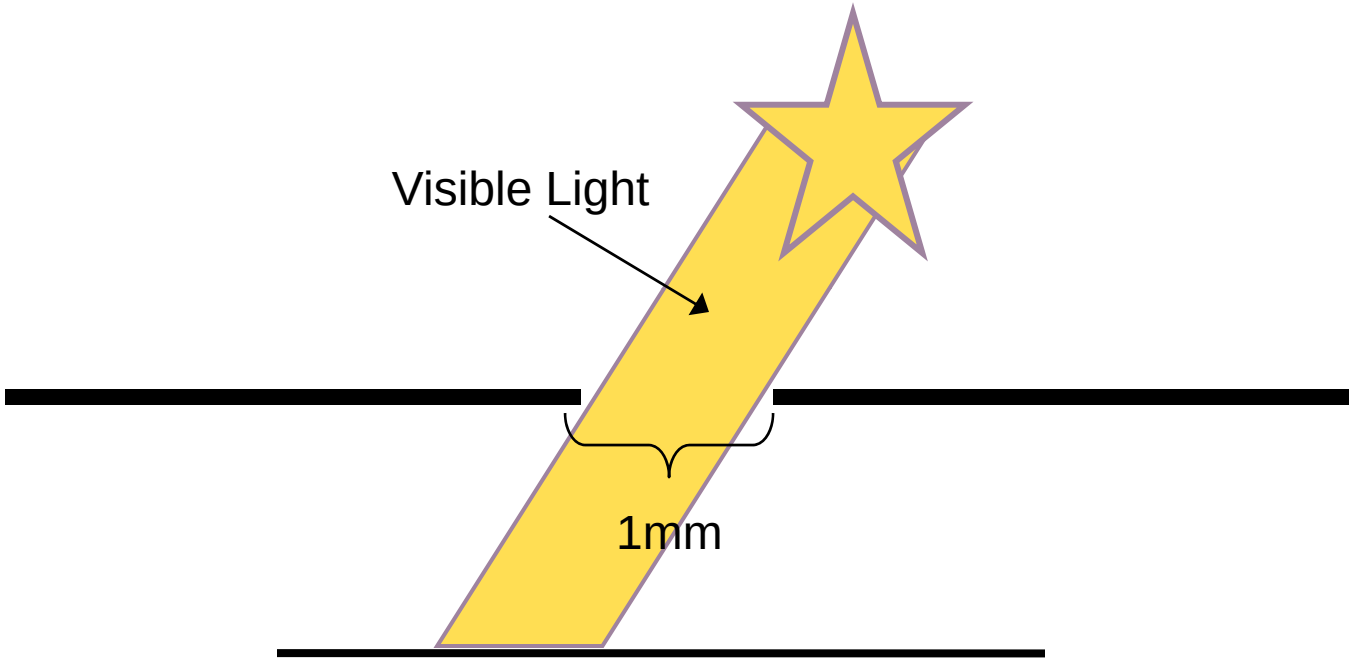
Small and Cheap


CubeSat

- More room in CubeSat for instruments
- Weighs less so that it is cheaper to fly and consumes less power
- Use a common point-and-shoot camera CCD
- Focusing lens not necessary-advantages and disadvantages



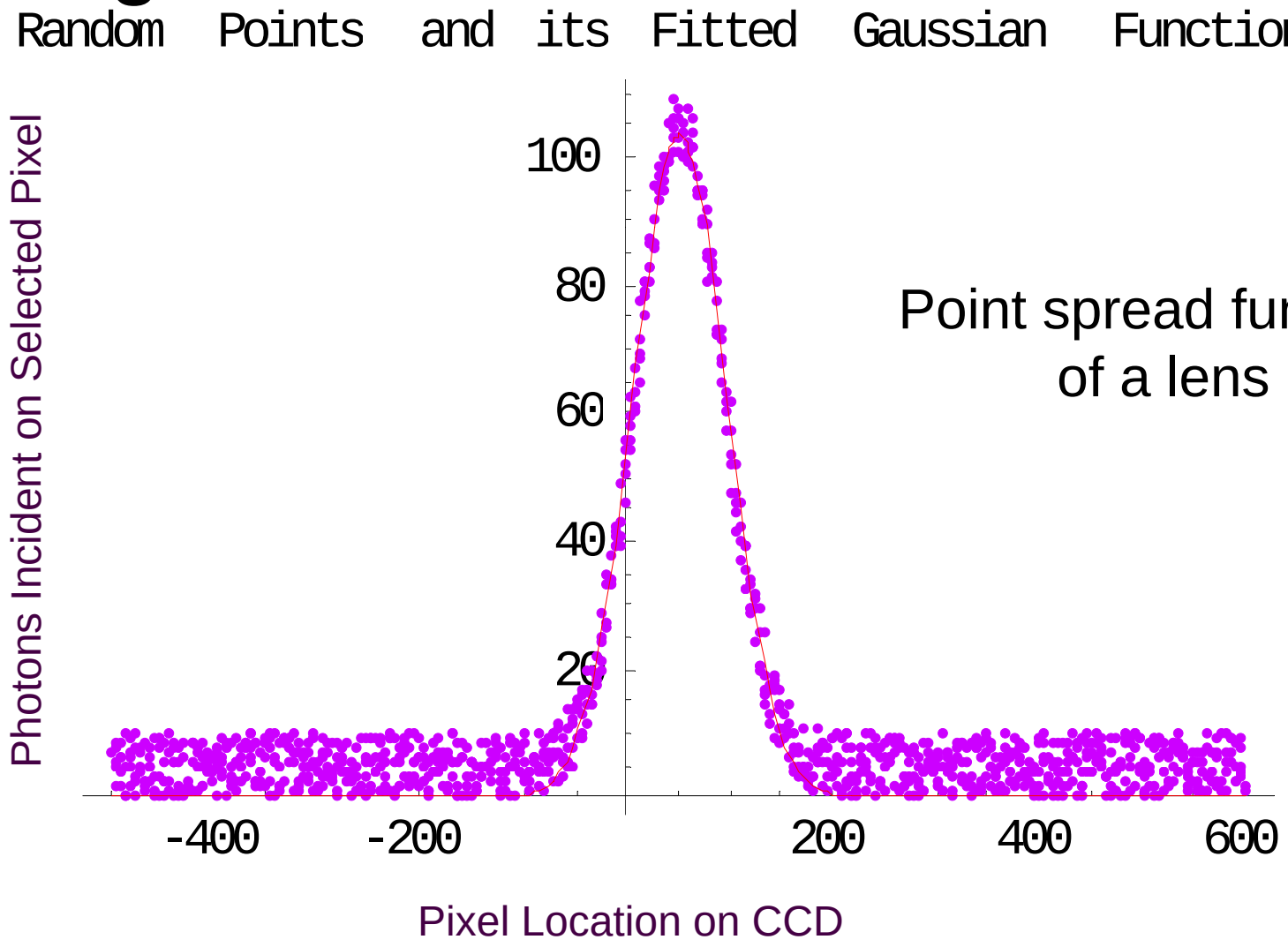
Pin Hole Camera



(Charged Coupled Device)

(Simply a detector you can find in your digital camera)

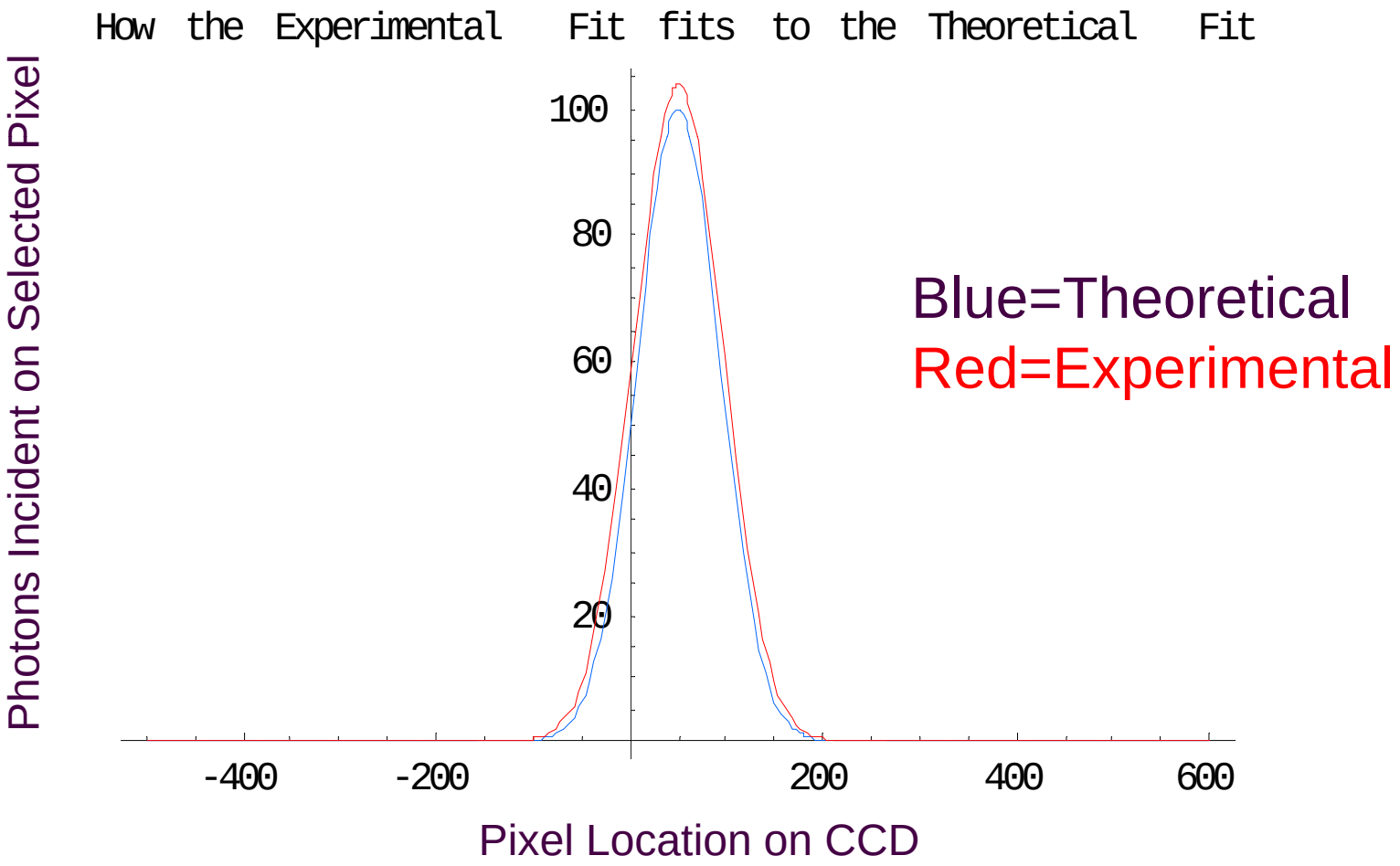
Where is the Centroid of the Image?



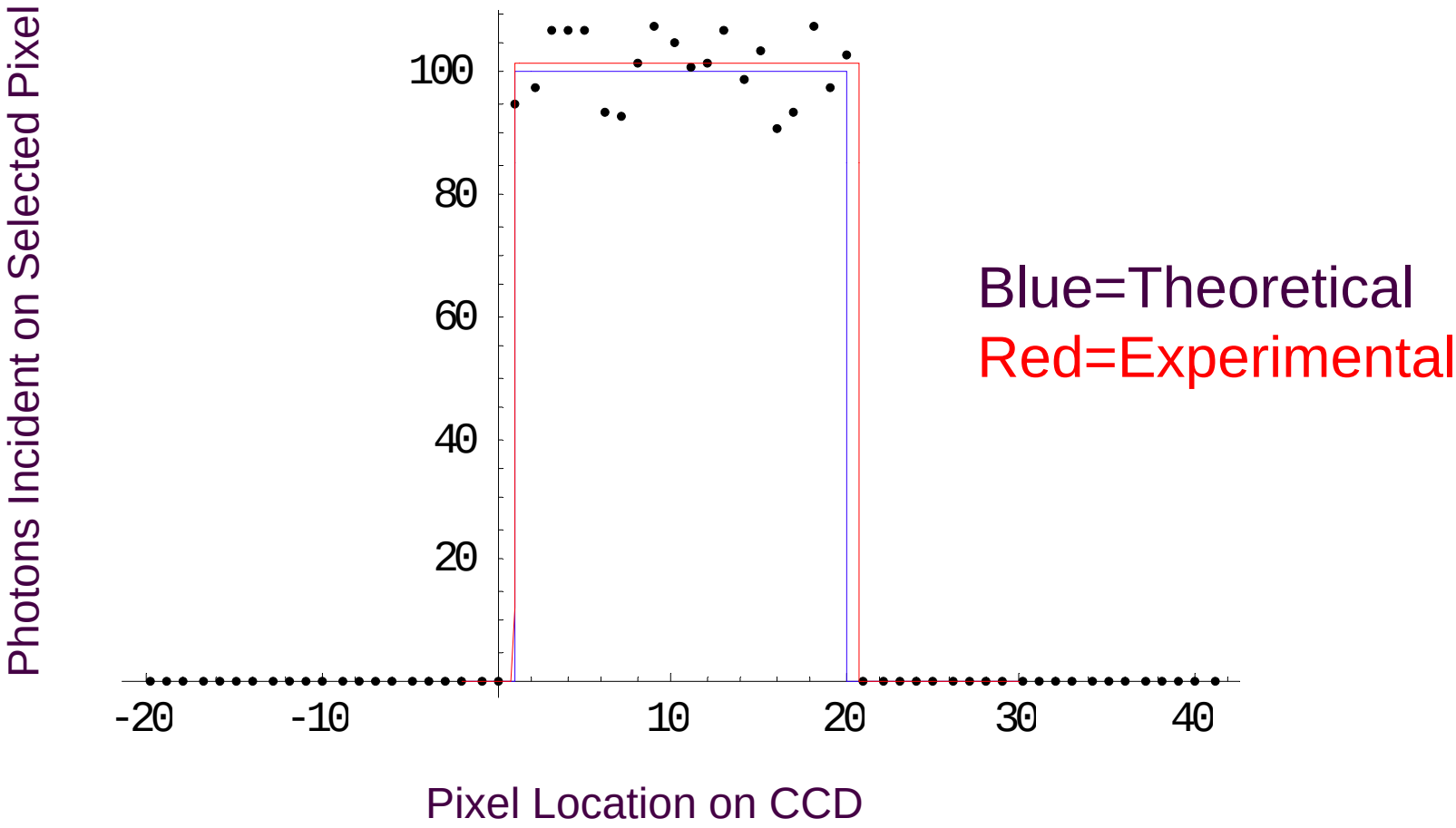
Point spread function of a lens

Error in Centroid

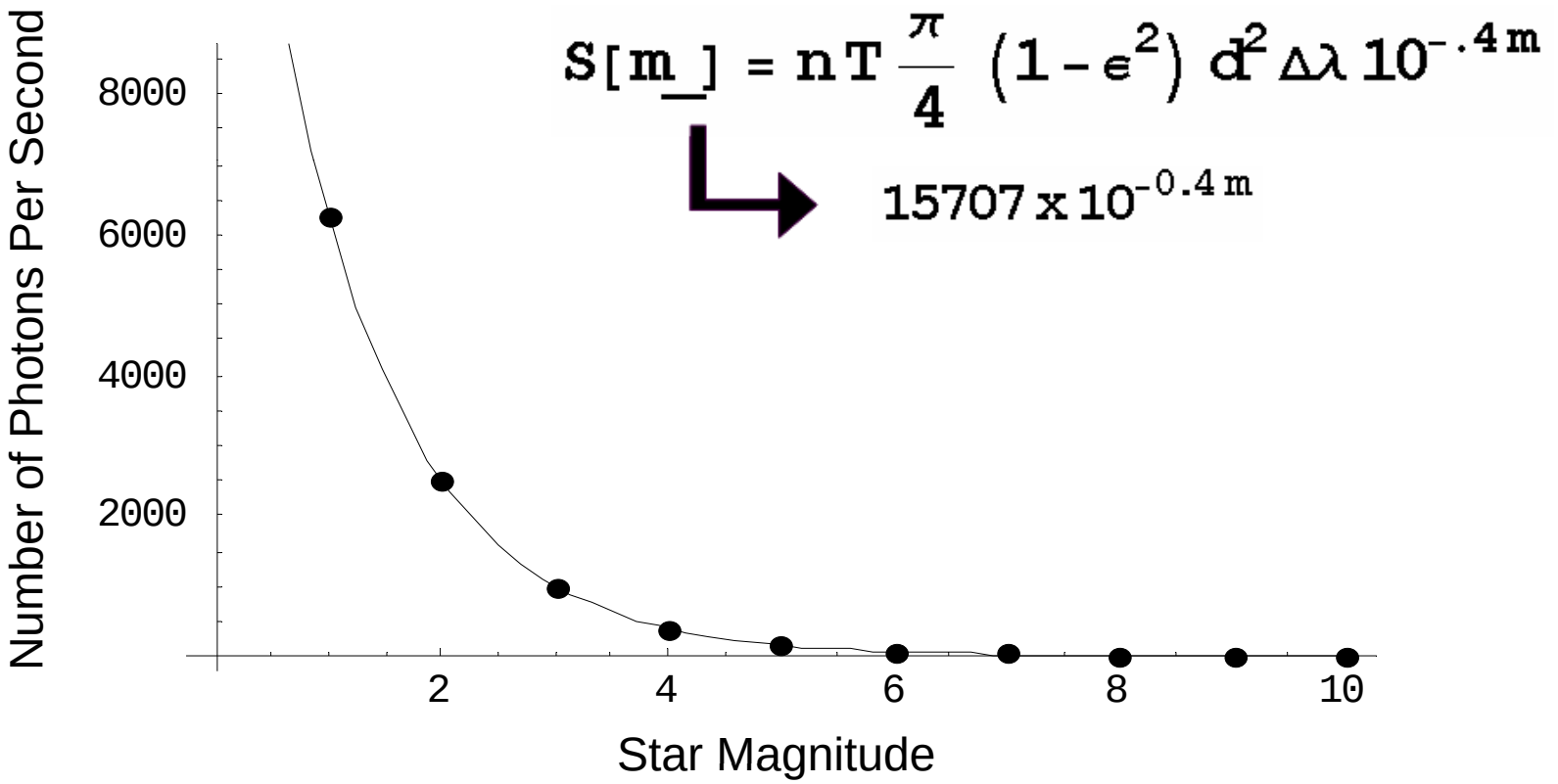
Gaussian Function: $a e^{\frac{-(x-b)^2}{2\sigma^2}}$, b = centroid



My Plan: Pin Hole Error Analysis



Star Magnitude vs. Photons per Second Falling On 1mm^2

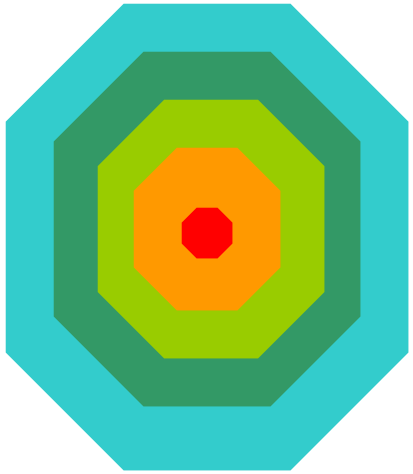


$$S[m\_] = nT\frac{\pi}{4}\left(1-\epsilon^2\right)d^2\,\Delta\lambda\,10^{-.4\,m}$$

$$\rightarrow\ 15707 \times 10^{-0.4\,m}$$

Defocused

We can get better measurements without a lens

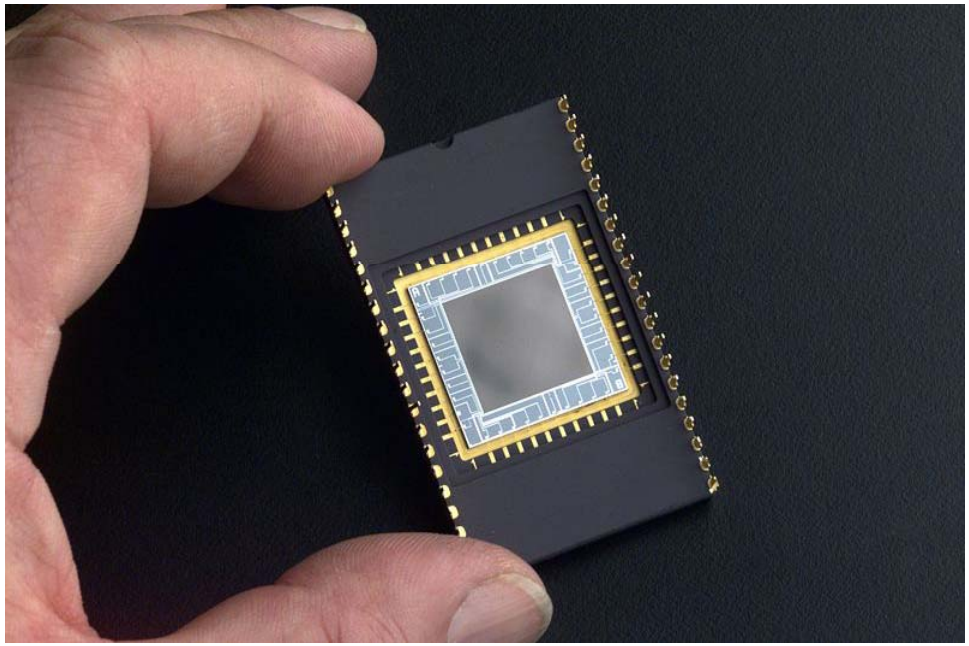


Photon Distribution with a lens (Gaussian)

Photon Distribution from a Pin-hole (Uniform)

Radiation hardness

- We need to prevent the CCD from getting harmed by the radiation incident on the CCD in space



Acknowledgments

NASA GSFC
- Fred Herrero
- Shahid “Ish” Aslam
- Hollis “Rusty” Jones
- Patrick Roman
- M. Donnelly (GOES-R program)

SPS
- Gary White
- Kendra Rand
- Tom Olsen
- Jack Hehn

The Comrades
- Mary, Brian, Daniel, Ian, Jose, Scott, Leslie, Laurie, Brad, Erica, Raina

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