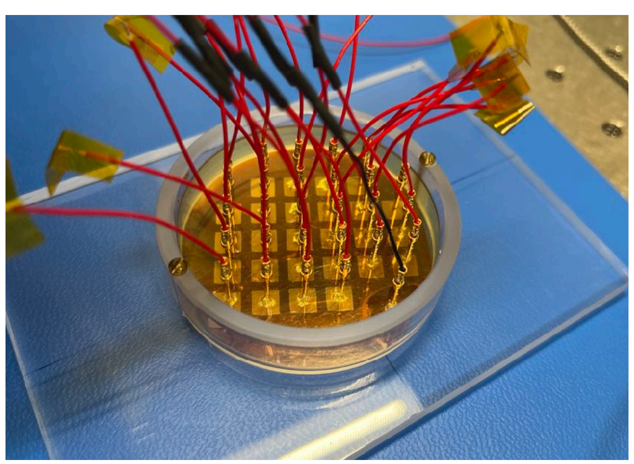
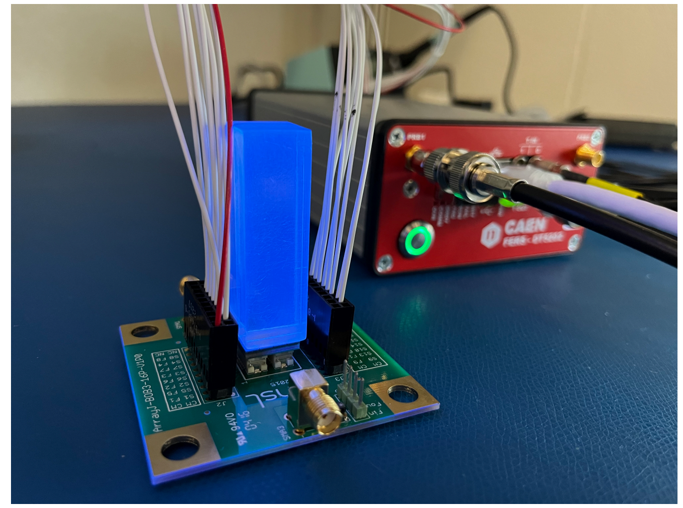
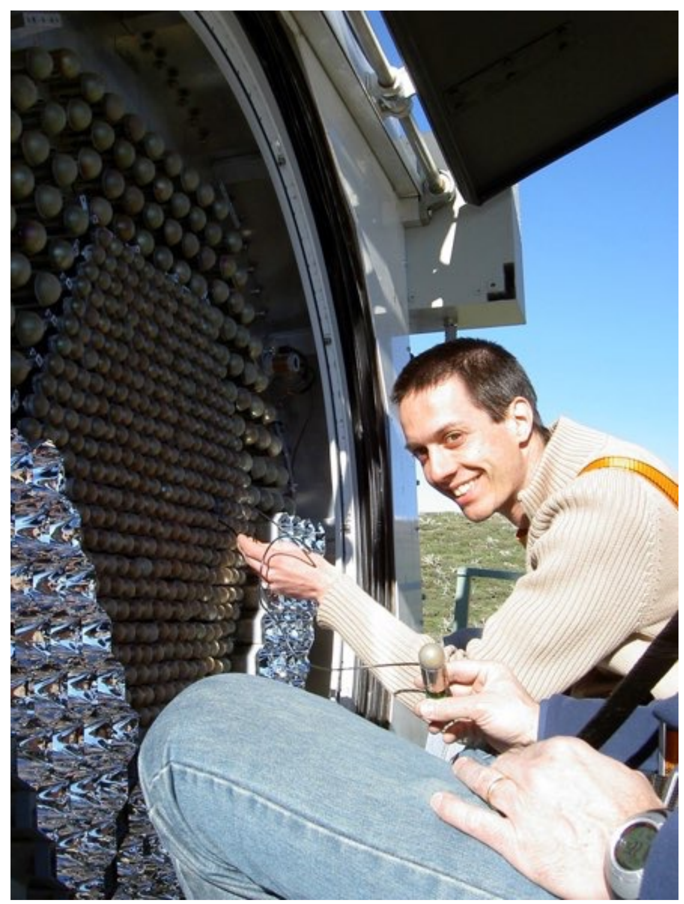
# Technology development for early career scientists

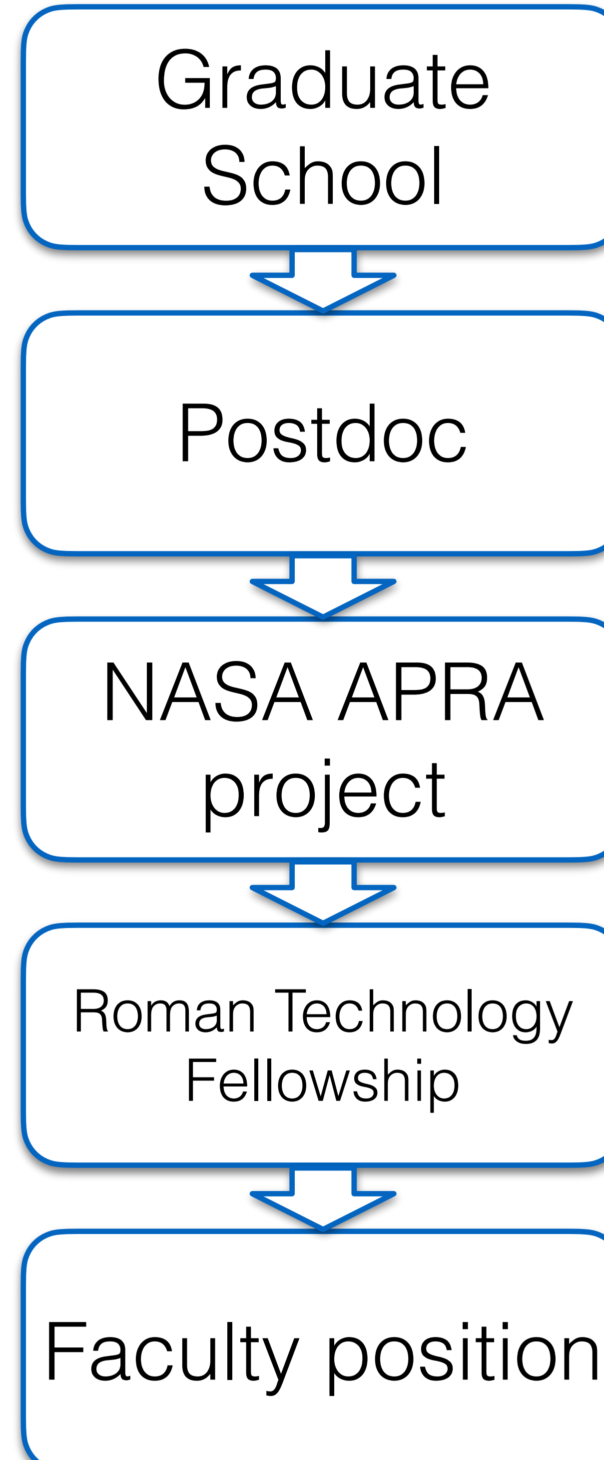
Manel Errando
(Washington University in St. Louis)

PCOS Early Career Workshop, 19-21 Nov 2024



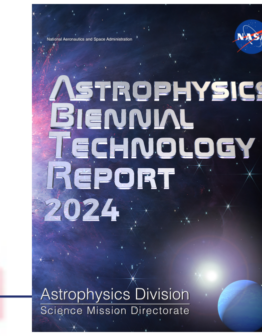





Graduate School
Postdoc
NASA APRA project
Roman Technology Fellowship
Faculty position

# NASA Astrophysics Research and Analysis (APRA)


- Supports instrumentation development, suborbital missions, CubeSATs.
- Solicited every year (due in Jan/Feb).
- Typically 1-3 year duration programs.
- 15-page proposal + full budget.
- It helps to have some preliminary data / prototype.

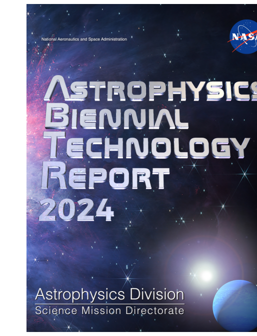



## Tier-1 Technology Gaps

Coronagraph Contrast and Efficiency in the Near IR
Coronagraph Contrast and Efficiency in the Near UV
Coronagraph Stability
Cryogenic Readouts for Large-Format Far-IR Detectors
Fast, Low-Noise, Megapixel X-ray Imaging Arrays with Moderate Spectral Resolution
High-Bandwidth Cryogenic Readout Technologies for Compact and Large-Format Calorimeter Arrays
High-Efficiency, Low-Scatter, High- and Low-Ruling-Density, High- and Low-Blazed-Angle UV Gratings
High-Efficiency X-ray Grating Arrays for High-Resolution Spectroscopy
High-Performance Sub-Kelvin Coolers
High-Reflectivity Broadband Far-UV-to-Near-IR Mirror Coatings
High-Resolution, Lightweight X-ray Optics
High-Throughput, Large-Format Object-Selection Technologies for Multi-Object and Integral-Field Spectroscopy
Integrated Modeling for HWO: Multi-Physics Systems Modeling, Uncertainty Quantification, and Model Validation
Large-Format, High-Resolution Far-UV (100 - 200 nm) Detectors
Large-Format, High-Resolution Near-UV (200 - 400 nm) Detectors
Low-Stress, Low-Roughness, High-Stability X-ray Reflective Coatings
Mirror Technologies for High Angular Resolution (UV/Visible/Near IR)
Optical Blocking Filters for X-ray Instruments
Scaling and Metrology for Advanced Broadband Mirror Coatings for HWO
Segmented-Pupil Coronagraph Contrast and Efficiency in the Visible Band
UV Multi-Object Spectrograph Calibration Technologies
UV Single-Photon Detection Sensitivity
Visible/Near-IR Single-Photon Detection Sensitivity

## Tier-2 Technology Gaps

Advanced Cryocoolers
Broadband X-ray Detectors
Compact, Integrated Spectrometers for 100 to 1000 μm
Cryogenic Far-IR to mm-Wave Focal-Plane Detectors
Far-IR Imaging Interferometer for High-Resolution Spectroscopy
Far-IR Spatio-Spectral Interferometry
Heterodyne Far-IR Detector Systems
High-Performance Computing for Event Reconstruction
High-Resolution, Direct-Detection Spectrometers for Far-IR Wavelengths
High-Throughput Focusing Optics for 0.1-1 MeV Photons
High-Throughput UV Bandpass Standalone and Detector-Integrated Filters and Bandpass Selection
Improving the Calibration of Far-IR Heterodyne Measurements
Large-Format, High-Spectral-Resolution, Small-Pixel X-ray Focal-Plane Arrays
Large-Format, Low-Noise and Ultralow-Noise, Far-IR Direct Detectors
Low-Power Readout and Multiplexing for CMB Detectors
Millimeter-Wave Focal-Plane Arrays for CMB Polarimetry
Optical Elements for a CMB Space Mission
Starshade Deployment and Shape Stability
Starshade Starlight Suppression and Model Validation
Stellar Reflex Motion Sensitivity: Astrometry
Stellar Reflex Motion Sensitivity: Extreme Precision Radial Velocity
Warm Readout Electronics for Large-Format Far-IR Detectors




**Tier-3 Technology Gaps**

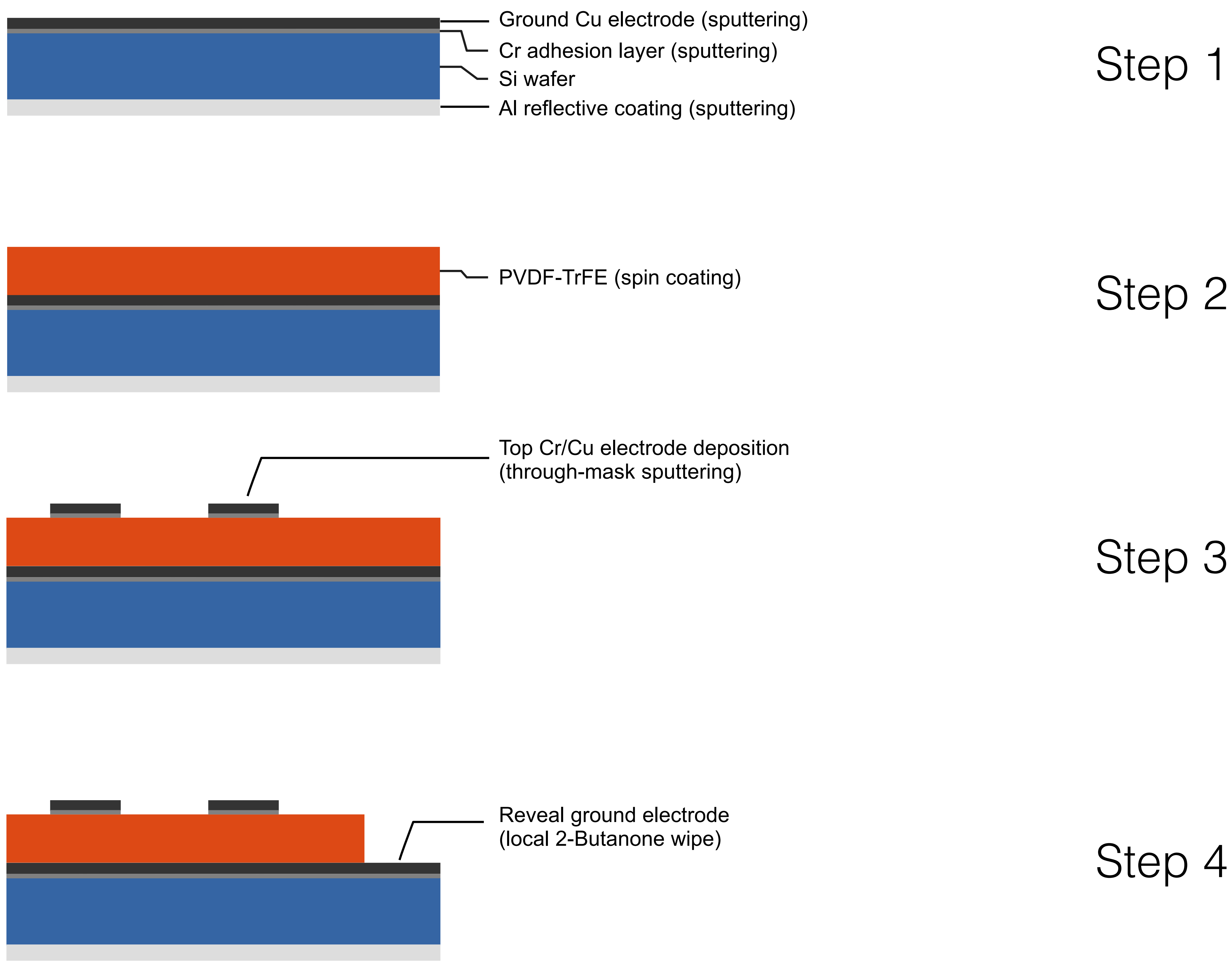
Broadband X-ray Polarimeter
Charged-Particle-Discriminating X-ray/Gamma-Ray Detectors
Dynamic Switching for Ultra-Low-Power, High-Resolution Charge Readout
High-Energy-Resolution Gamma-Ray Detectors
Large-Aperture Deployable Antennas for Far-IR/THz/sub-mm Astronomy for Frequencies Above 100 GHz
Large Cryogenic Optics for the Mid IR to Far IR
Large Field-of-View and Effective-Area Gamma-Ray Detectors
Low-Power, Low-Cost Semiconductor Detectors
Low-Power Readout for Silicon Photomultipliers
Photometric and Spectro-Photometric Precision of Time-Domain and Time-Series Measurements
Precision Timing Measurement Technology
Radiation-Tolerant, Photon-Counting Light Detectors
Sensitive Spectrometer for CMB Spectrum Measurement
UV/Optical/Near-IR Tunable Narrowband Imaging Capability

**Non-Strategic**

Advancement of X-ray Polarimeter Sensitivity
Detection Stability in Mid-IR

- Look at the most recent ABTR.
- See what technology gaps NASA has identified, and whether you have an idea on how to advance to close these gaps.

# Device fabrication process

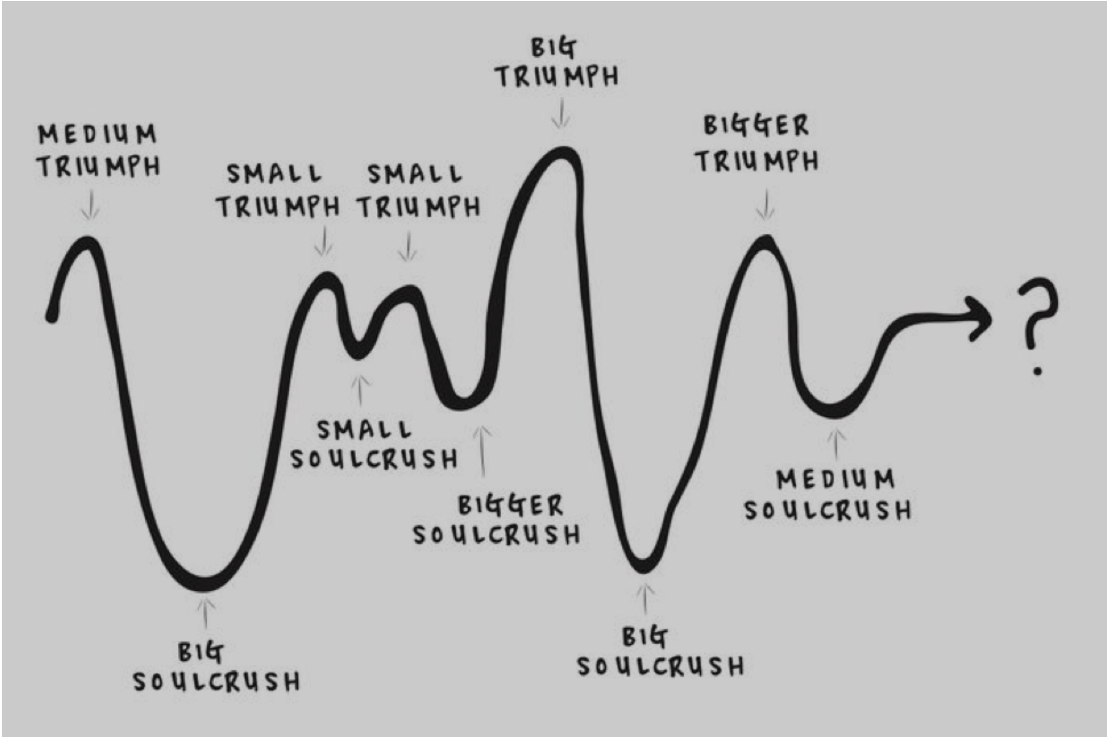


# Roman Technology Fellowship

- Eligible if you are early career and the PI of a funded APRA project.
- Comes with seed funding that you can access if you get a permanent-track position—essentially, NASA contributes to your startup.
- ~3 awards per year.

# Ups and downs (from personal experience)

- It took me three attempts to get my first APRA proposal funded (and two attempts to get it renewed).
- Instrumentation communities tend to be small. It is easy to feel alienated if you are trying to break into a new field.
- I found it very helpful to meet (and become friends) with other instrumentation scientists at my career stage.



# Graduate students

- Do not shy away from getting involved in instrumentation projects.
- Your research group and network of collaborators are a huge asset. Make the best use of it!
- Make an effort to understand how every aspect of your instrument / experiment works.
- Apply for a NASA FINESST graduate fellowship.
- Instrumentation expertise puts you at a very good position for finding a good postdoc. Graduates with hardware experience “fly of the shelves”.

# Graduate students

- Try to convert conference proceedings into refereed journal articles (JATIS, Astroparticle Physics, Physics, NIM A).
- Attend the SPIE Astronomical Telescopes conference (next one in Summer 2026).
- Discuss with your advisor whether you can identify a “side” project that will lead to publications.
- Don’t count yourself out of prize postdoctoral fellowships such as the Hubble.
- Volunteer to be a note-taker at a NASA grant review panel.

# Postdocs

- Ask for what facilities you will have access to at your institution—clean room, specialty equipment, lab space, seed funding?
- Ask/negotiate for some percentage of your time that you can spend on your "side" project.
- Identify experts that you can ask for advice / bounce your idea—they may not be in the Physics or Astronomy department!.
- If you are on a running project, consider if there is a small spin-off of it that you could make yours (and write an APRA!)
- When applying for faculty positions, have a picture of what your lab will look like (how much space you need?), and a spreadsheet with all the equipment you need (with $ value).

# Thanks for your attention!

and good luck!
Feel free to reach out if I can be of any help: errando@wustl.edu