

Practical Optical Design Seminar, pt. III

SPEcking the TABLES

Wednesday, March 4, 2020 11:03 AM

What 3 Parameters are needed for every design?

- Aperture
- Field
- Spectrum
 - Two of these parameters formulate any design space
 - Wavelength informs material choice
- Performance Requirements
 - Detector (pixel size, Nyquist)
 - Image Quality
 - Distortion
 - Ray Angles (AOI, AOR, Telecentricity)
 - Relative Illumination
 - Vignetting
- Packaging Requirements
 - Optics don't float in vacuum
 - Leave room to hold your optics
 - Glasses have blanks of finite size
 - How much space do you need around optics to hold them?
 - How will you hold them?
- Sample Spec Table
 - Link to references
 - Details for clarification
- Hold all things equal except for design form
 - Informed by performance/science requirements
 - The science will dictate the performance needed
 - Constrain volume, less thru put, less signal, less everything
- Tolerancing Space Things
 - Inform tolerances based on statistical distribution of the likely change

NEO Identification

- Shao M. et al.
- Synthetic Tracking of asteroids
 - Constellation of 9U
 - Minimize blur on object your tracking by distributing apertures and syncing framerates
- WISE is now NEO WISE
- Want to track all near Earth objects with ACTUAL OPTICS

LWIR Thermal Imaging of Earth

- Pushbroom
- 11x1 deg FOV
- Can look at environmental, atmospheric stuff

What are CubeSats used for? (Maryam)

- Beanie Babies inspired CubeSats
- Space walkie talkies
 - Relay sats?
 - One of the MARco
- Weather walkie talkies
- Space sensors
- Low-risk proof of various concept
- Planet probbers

Existing CubeSat Designs (Yanqi)

- Spatial heterodyne spectrometers for Fourier Transform Spectrometry
 - Able to use the tilt of two wavefronts to look at one wavelength with very high resolution
 - $R = 30,000$
 - Use the Lytro angle (an X of the wavefront) to measure precisely
 - Grating and two mirrors to perfectly contain ± 1 orders in a perfect retroreflection
 - Slight deviations of wavelength, i.e. the Sodium d-line
 - Look up Keck HiRISE instrument
 - This is that, and way better
 - Could be used for spectral polarimetric characterization of the lunar surface as a function of wavelength
- Reflective
 - People are launching on axis telescopes in CubeSats, surprisingly
 - Most designs Ritchey-Chretien, TMA's

Last Minute Ideas (Joel)

- Biggest issues are packaging size and other limiting parameters

- Deployable mirrors
 - UK CubeSat with petal aperture pattern (300 mm) and a clever way of co-phasing
 - Four primary mirrors
 - Not quite a parabola
 - SO it's probably a Richtey-Chretien
 - Unreported details of secondary, may be conic
 - Even w/o co-phasing, could still do some cool science
 - Mylar mirror
 - Could cram a 0.5 meter mylar mirror in there
 - Use an AO and active optics system to control wavefront from wacky (biconic) primary
- Laser Comm
 - Quicker to use laser comm on the ISS
 - Decentration of the wavy jello that is the ISS up to 10 cm
 - That's a whole lot of wiggle!!!
 - Find a way to align two-way laser comm w/o active pointing up to 2 km
 - Current pointing accuracy of 0.05 deg
 - Maybe could design a CubeSat LGS, beacon to provide a reference for finding the CubeSats, wherever the hell they are
 - Suppose you had some sort of IR beacon on each, where you could then use a telescope to find the CubeSats and relay a laser comm signal across the solar system (including to Mars)
 - Could build out specs and design a CubeSat looking for a small point source somewhere
- Jaren proposed you don't need four petals in a deployable CubeSat primary to do transit photometry
 - You only need to have high-res in one dimension (could use two mirrors)
- Hyperspectral Imaging Fan
 - URSA: hyperspectral imaging of oil spills and stuff (Maryam's mother in-law)
 - Optical-SWIR (~2 um)
 - Oil spills? Environment motivation seems to garner lots of funding
- FYI: NASA CubeSat Launch Initiative

We need to pick something really solid, something that people see MUST BE funded. Like a business proposal.
Also need to pick something that's easy enough to build with our current resources.

Want to have a FLESHED OUT SPEC TABLE in TWO WEEKS

- Two ways
 - We each do our own
 - Or, we keep talking throughout, and then we all research parts of our spec table
 - "Find a nail and build a bunch of hammers." - Joel, March 4th, 2020
 - Once we define a science goal, then we can define a design space
 - Would like to define the science goals of hyperspectral imaging
 - UV seems to be the way of things
 - UV-vis could be super fascinating
- NASA Earth Science Decade may be a good place
- Let's keep an active discussion on the Slack to narrow down choices