

MKID 850um splinter
meeting

The case for a new continuum camera

- We believe that there is a very strong science case for building a new continuum camera – to supersede SCUBA-2 (at 850 μ m).
- The workshop this week will test this idea
- Our aim is that the workshop will be a springboard for promoting the science case amongst our users and within the regions nation science foundations, Universities and the wider astronomy community.
- Our aim is to lay the foundation for a collaboration to build the instrument ourselves.
- We have to address many important technical issues and understand how best to build this instrument – and for future continuum instrumentation for any new larger submillimetre and millimetre telescopes

What is the concept of the instrument?

- The simplest design and smallest cryostat, that is compatible with the instrument requirements
- The biggest array that we can put into that cryostat
- The maximum field of view available at JCMT (without modifying the antenna structure)
- Detectors that are more sensitive than the best SCUBA-2 TES, with a large linear dynamic range, that are stable
- Excellent control of stray light and excess emission
- Polarisation sensitive detectors (with a waveplate for polarisation mapping)
- Keep SCUBA-2 operational

Design Choices and requirements

- We chose (initially), to make this a single wavelength instrument.
- We have chosen to use the established state of the art MKID technology from NIST, Boulder.
- **A requirement/goal – is to map 10x faster than SCUBA-2 at 850um.**
[Polarimetry mapping will be 20x, by virtue of the pixel design]

SCUBA-2 can map 1 SQ Degree to the confusion limit in ~32Hours

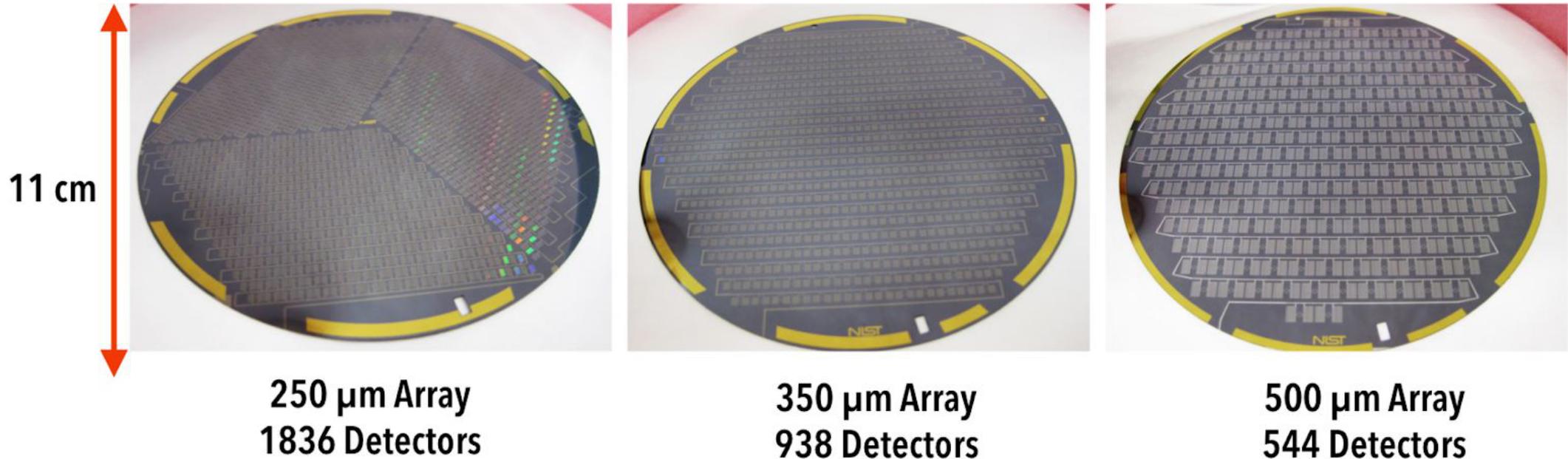
The GOAL is therefore to map 1 SQ Degree in 3 hours

The Concept

- Circular 12 arcmin FOV
- ~ 3600 $1f\lambda$ spaced, hexagonal closed packed pixels, each with 2 detectors
- A smoothwall feedhorn design, that terminates in $850\mu\text{m}$ matched waveguide section
- Focal plane temperature $< 200\text{mk}$
- 1K enclosure surrounding array and final mirrors
- Effective baffles at 4K
- Rotating half-wave plate for polarimetry

The NIST MKID Array

Will be based on existing designs, adapted for 850um and JCMT

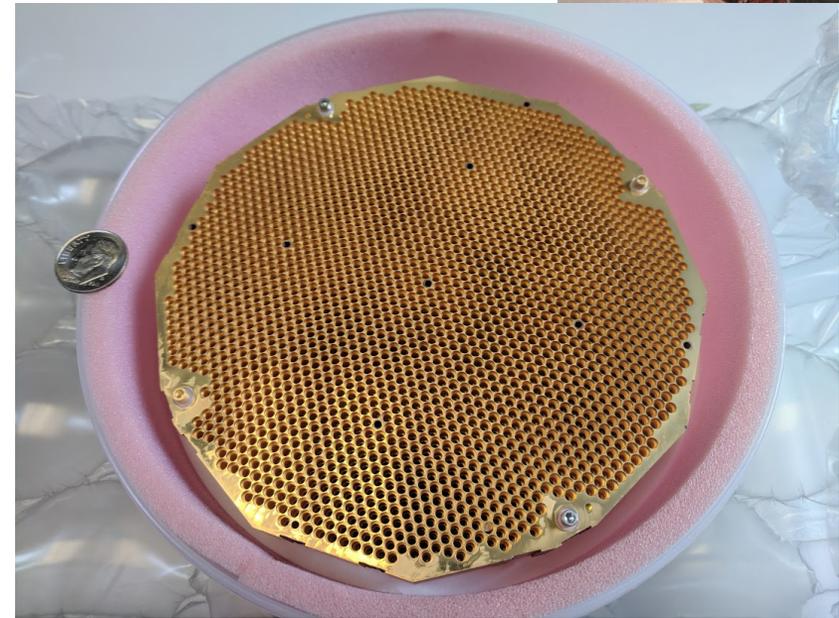
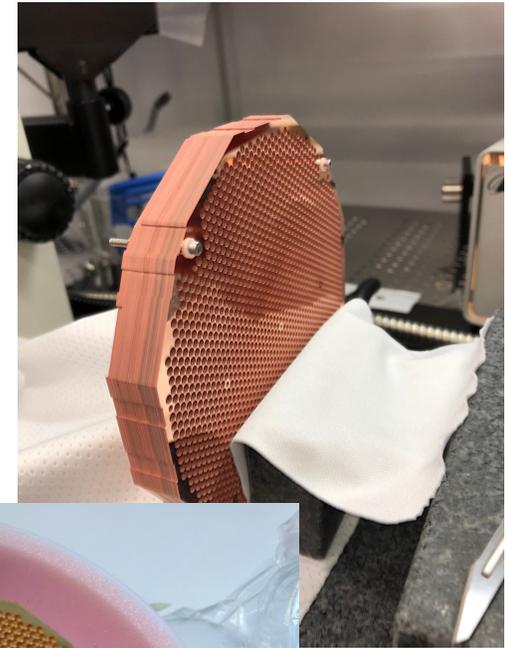


Feedhorn coupled MKID Array

Each pixel is comprised of two lumped element MKID that are sensitive to orthogonal linear polarization. The MKID form a resonant circuit consisting of an inductive strip and an interdigitated capacitor.

In the NIST MKID design arrays, the inductor is identical for each pixel, while each capacitor is trimmed to a unique value. The inductor is made from TiN/Ti multilayers, allowing the T_c to be tuned by varying the thickness and number of layers. The inductor also serves as the absorber that couples to radiation from the waveguide.

The choice of T_c , inductor geometry and impedance matching determine the optimal coupling, polarisation efficiency and saturation power. An aluminium layer over portions of the inductor provides further tuning of the optical coupling. The goal is to optimise these parameters for $850\mu\text{m}$ observing at JCMT.



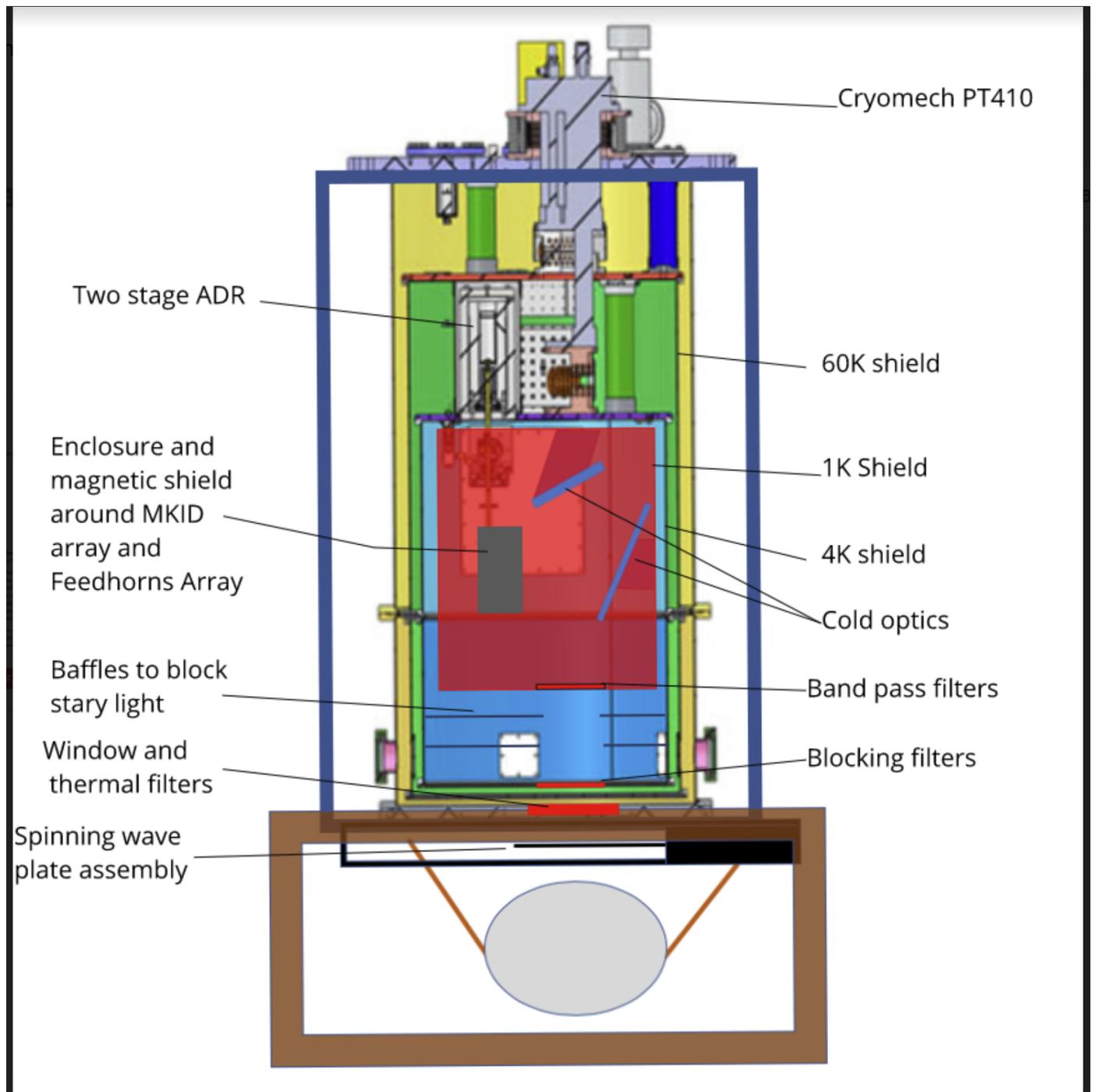
ToI TEC Instrument 1.1mm Feedhorns, (Umass)

Cryostat concept

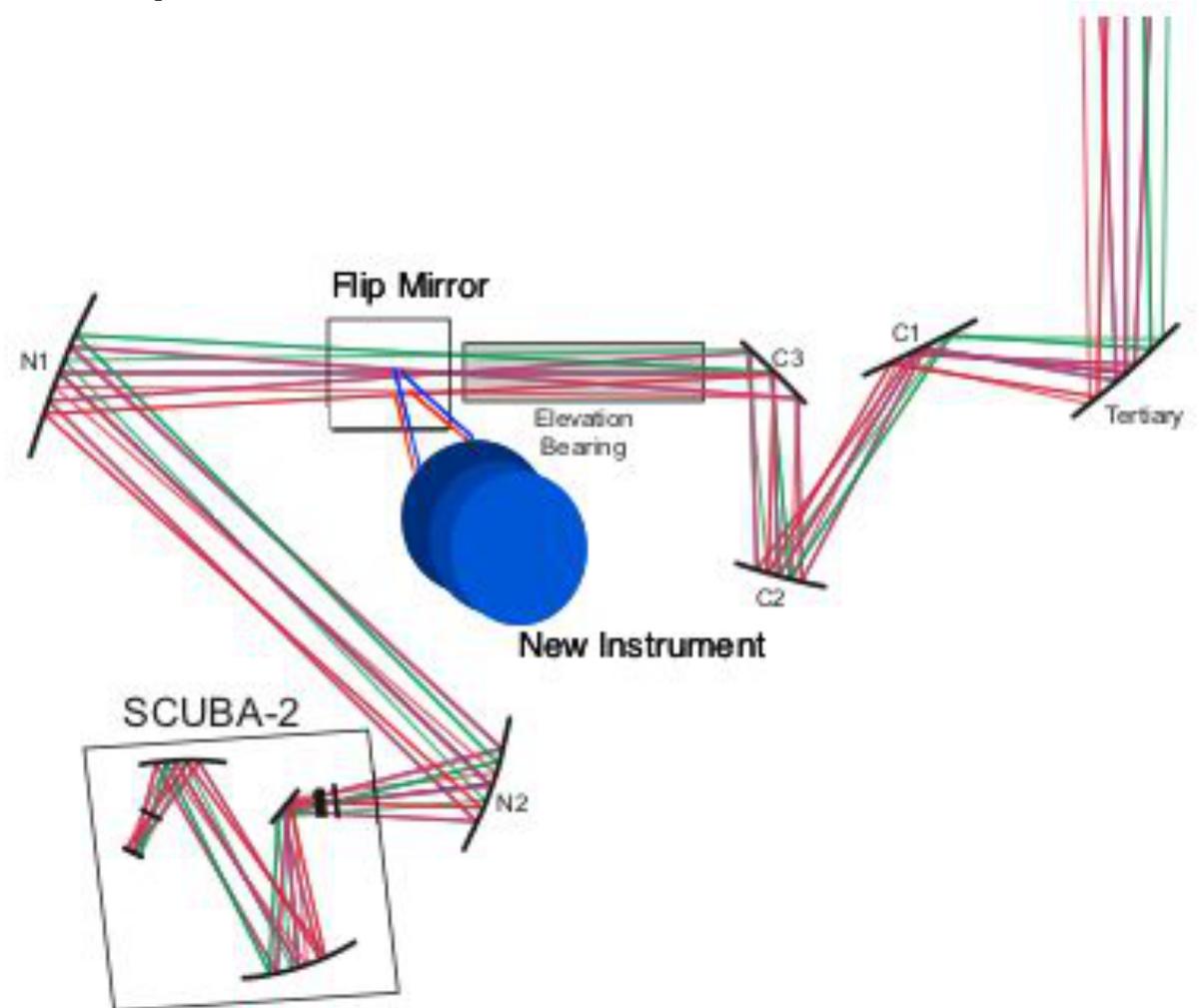
This is a concept

AAO is working to produce an engineering mechanical design

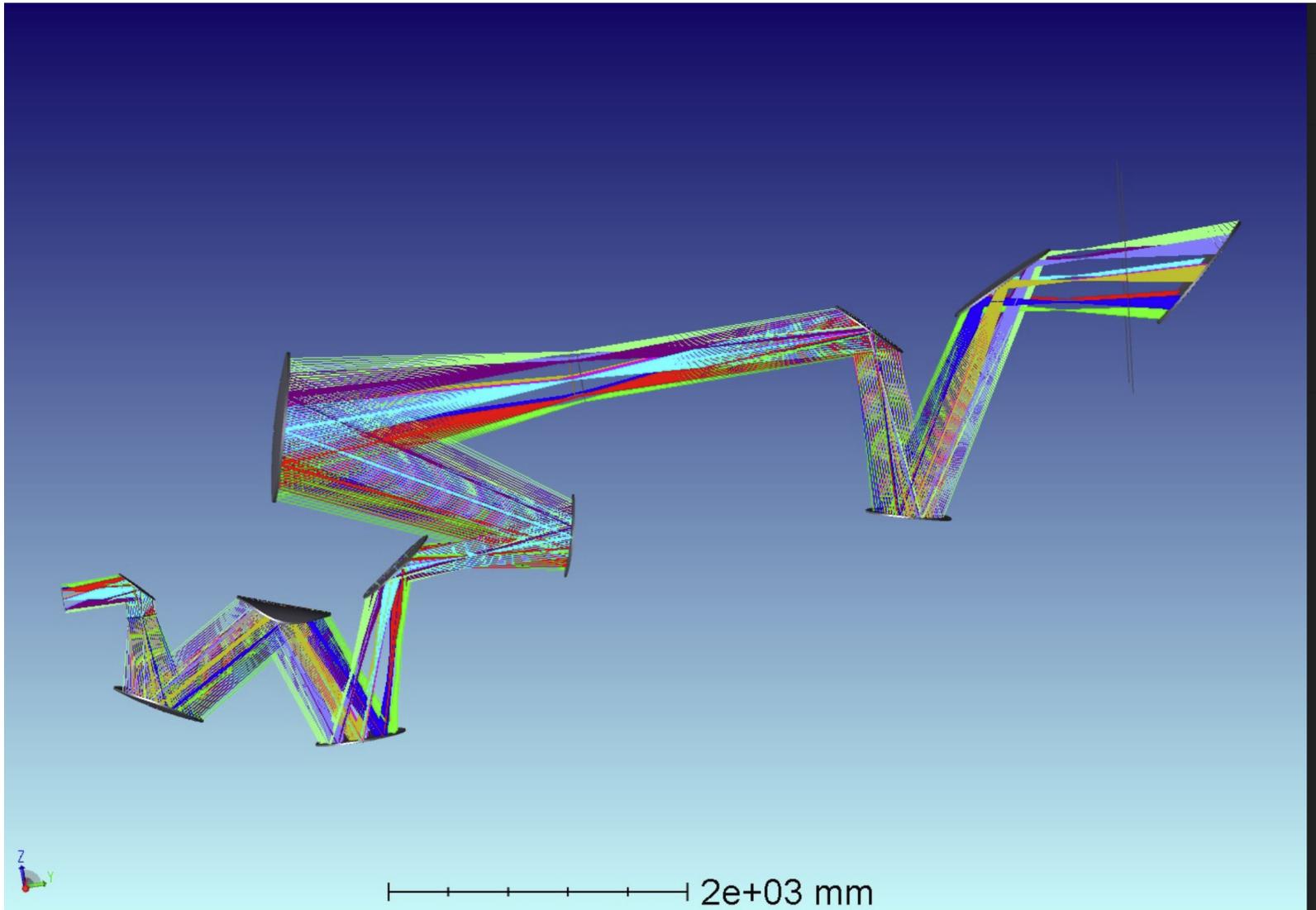
Lots of details to model and work out – such as the array mounting and magnetic shielding



Optical Path - our concept



The reality is more complex



Project Status

- EAO are ready to purchase the array and feedhorns from NIST.
- Canadian Universities have a \$1.5M funding proposal in, to cover readout hardware and the hiring of firmware and software engineers.
- UK Universities (Cardiff and Central Lancashire) have a £900,000 funding proposal in.
- AAO (Australian Astronomy Observatory) are developing a mechanical design of the cryostat and mounting to JCMT.
- Co-opted an engineer from GEMINI to work on the optical design from the JCMT cabin to the new instrument, that keeps SCUBA-2 operational.

Key Aspects of the project that need attention

- Optical modelling for stray light
- Finalise the mechanical design and cryogenics
- Plan for the readout development – decide on the multiplex ratio
- Group to work on the polarimeter - should the wave plate be internal?
- Filters, windows and other optical components – are part of the Cardiff grant proposal
- Decide where to fabricate and assemble the cryostat
- Test bed for the arrays - arrays can be completed in 18months

What we would like to come out of the workshop

- A stronger science case – that reflects the future needs of the EAO community
- A series of white papers
- Agreement on the framework for the instrument collaboration, and if possible, a division of work
- We would like to explore partnering to create one or more instrumentation studentships to focus on this instrument
- A date for a formal review of the cryostat design