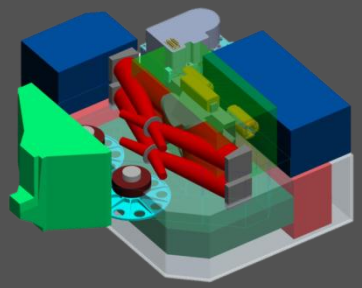
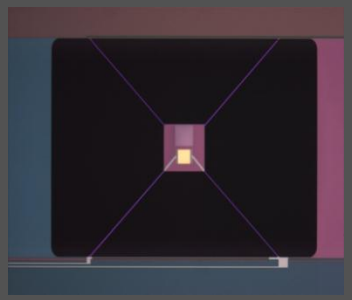
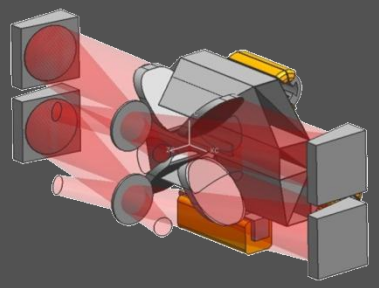
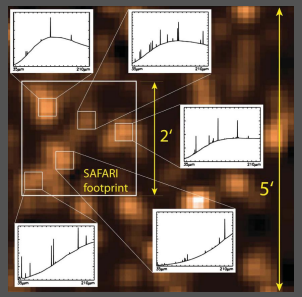
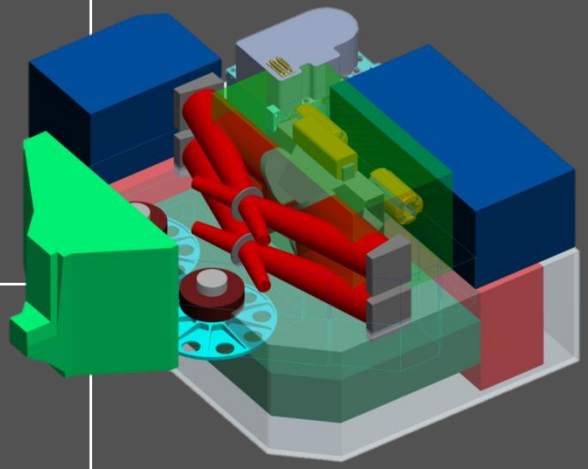
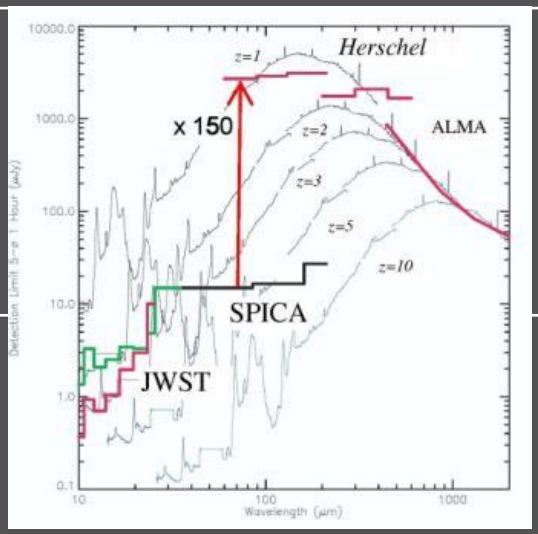
The SAFARI instrument
(current) baseline concept

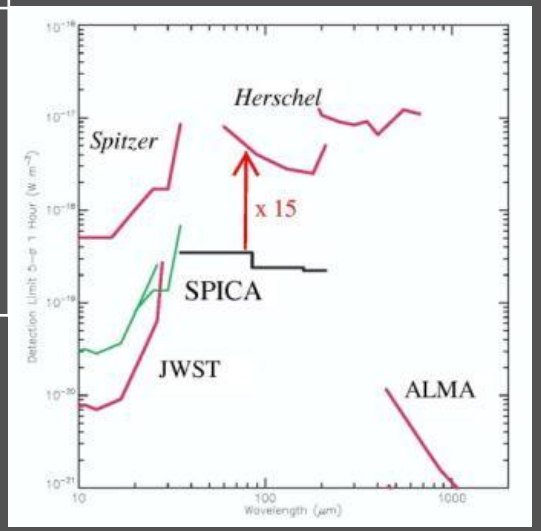






Instrument requirements/specifications

Field of view	2' x 2' (close to) Nyquist sampled
modes:	
photometry	$\lambda/\Delta\lambda \sim 3$
SED mode	$\lambda/\Delta\lambda \sim 150$ - 200
spectroscopy	$\lambda/\Delta\lambda \sim 2000$
line sensitivity	few x 10^{-19} W/√Hz (5σ-1h)
continuum sens.	<20 μJy (5σ-1hr)
bright sources	up to 1 Jy without ND filter
3 bands:	
SW, 34-60 μm	43x43
MW, 60-110 μm	34x34
LW, 110-210 μm	18x18

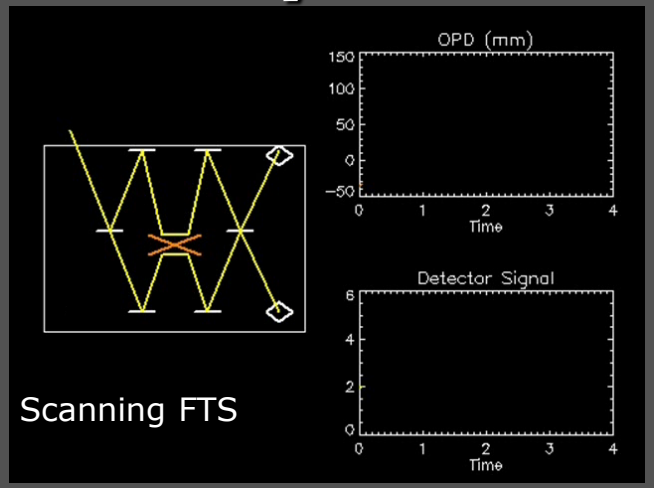






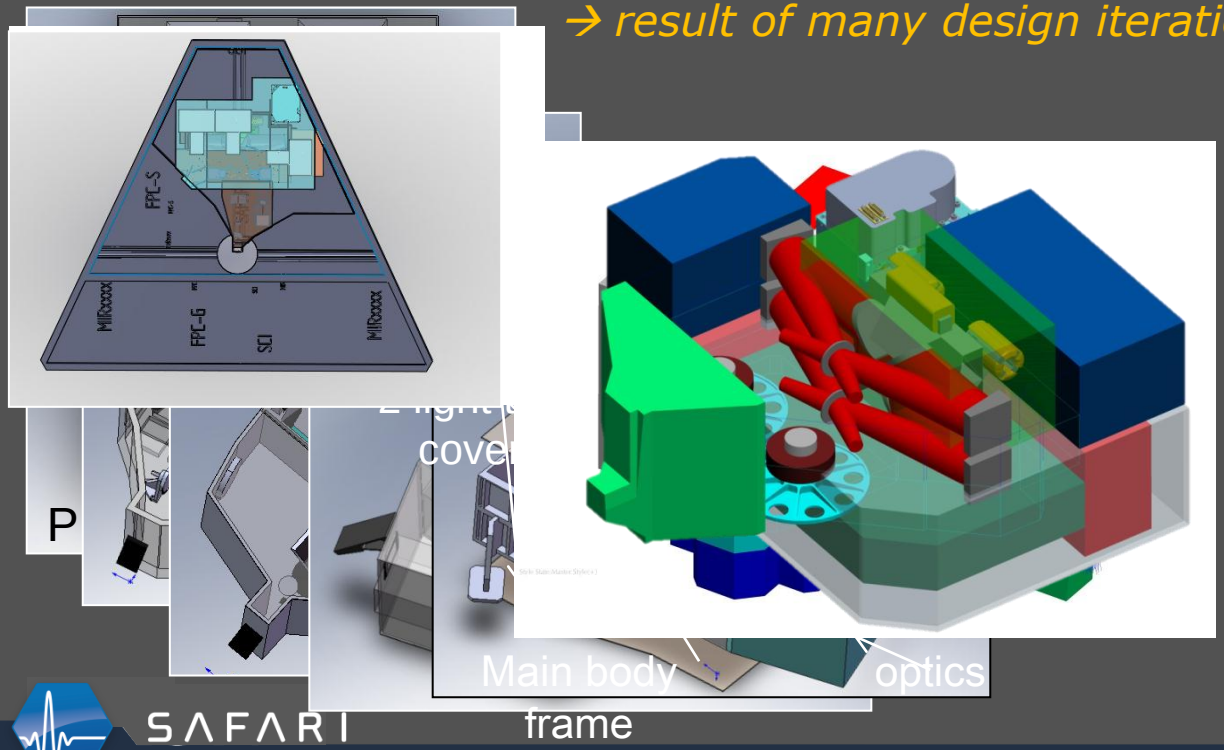
The SAFARI instrument - summary

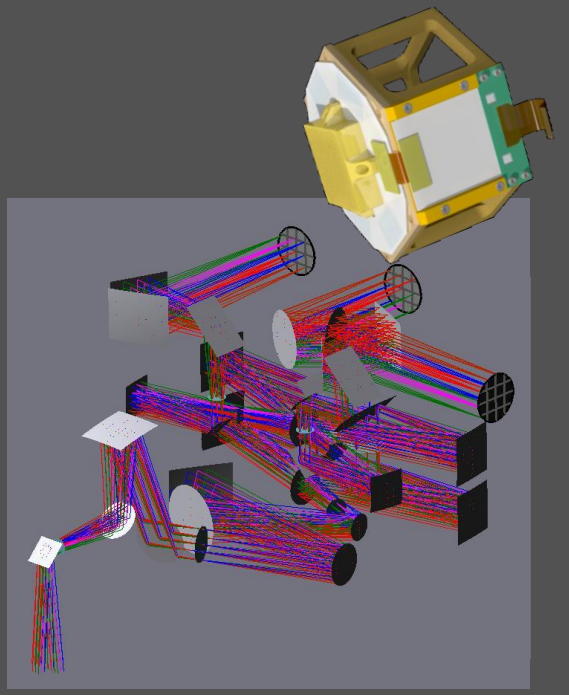
- Scanning Fourier Transform Spectrometer with 2'x2' FoV
- Simultaneously observing in 3 bands (34-210μm)
- Ultra sensitive TES detectors/SQUID read out at 50 mK
  → almost ***200 times*** more sensitive than Herschel
- Frequency Domain Multiplexing
- To be built by an SRON-led consortium
  - ~15 institutes in Europe, Canada, Japan - cost ~170M€



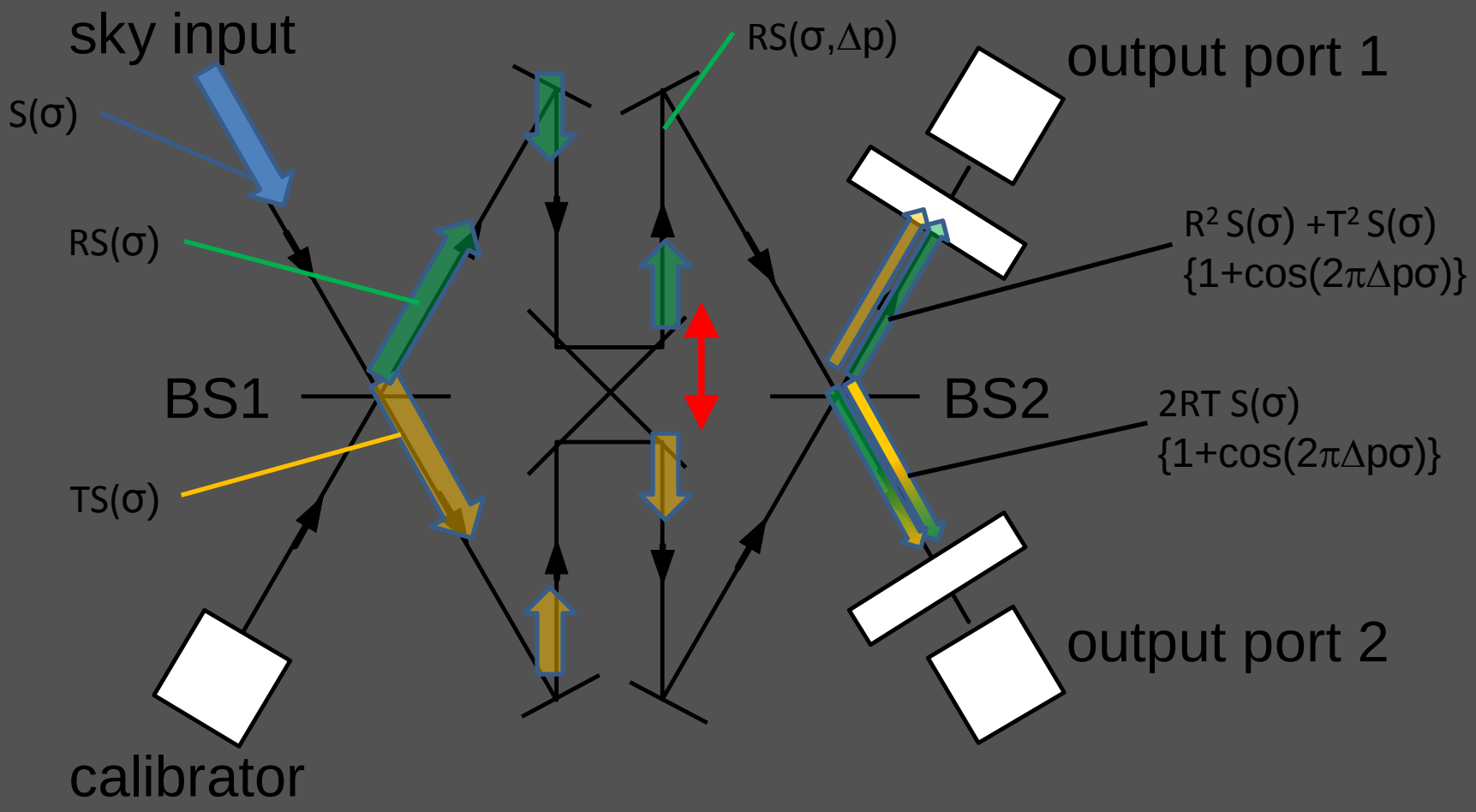
…a complex instrument

→ result of many design iterations

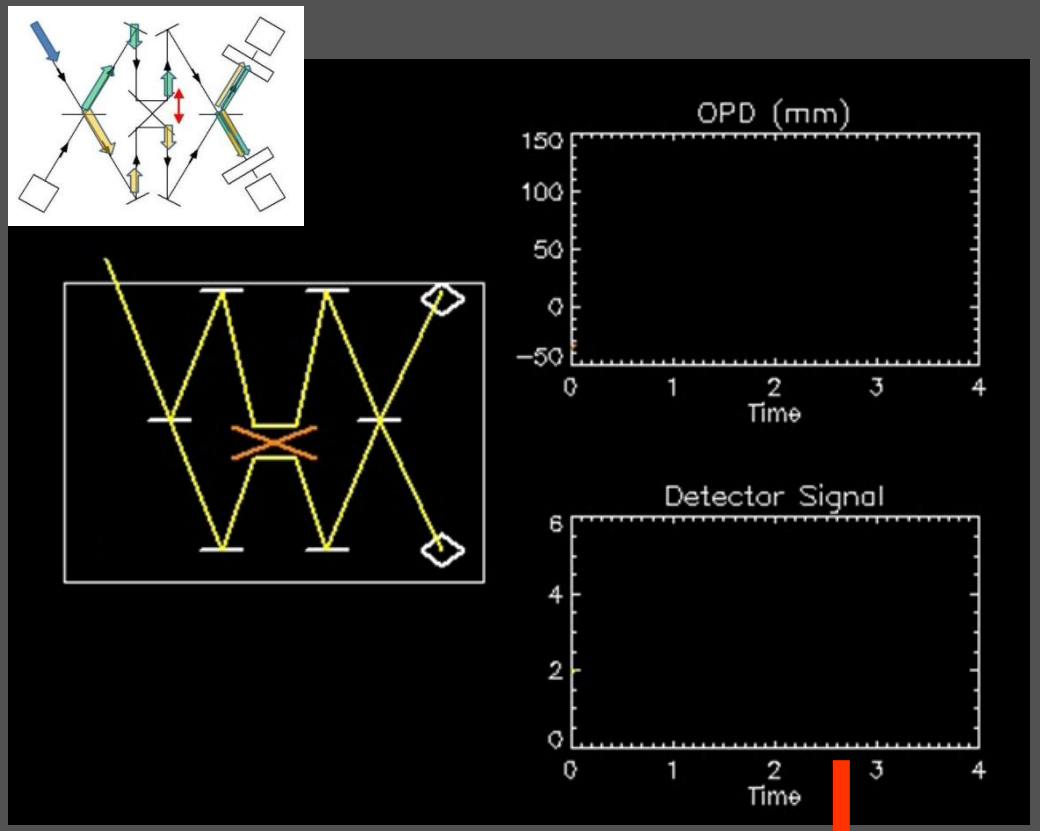




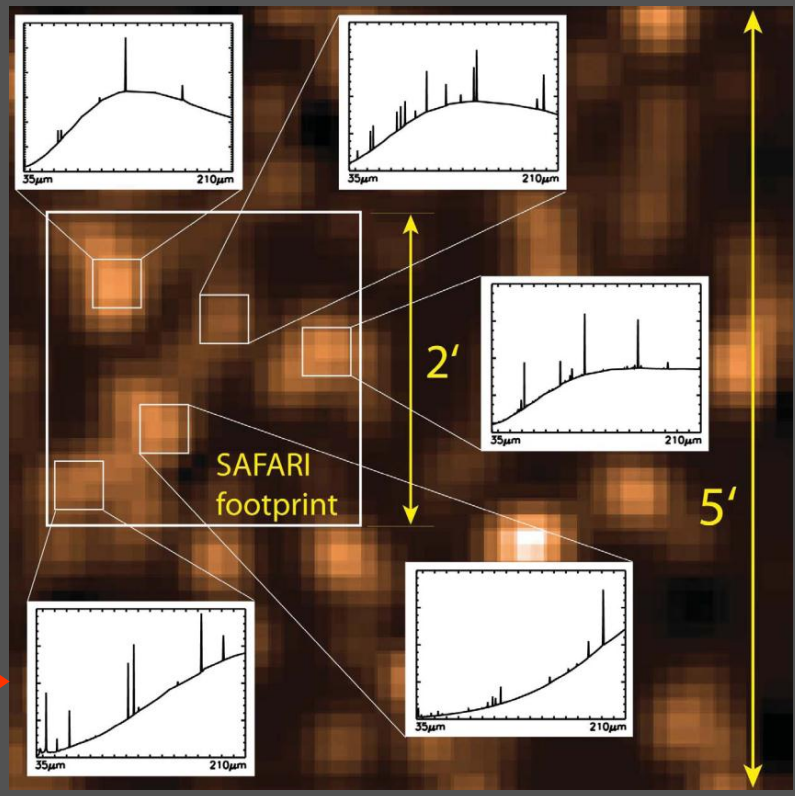
The Mach-Zehnder interferometer



The basic Mach-Zehnder interferometer in motion



FFT



Instrument toplevel

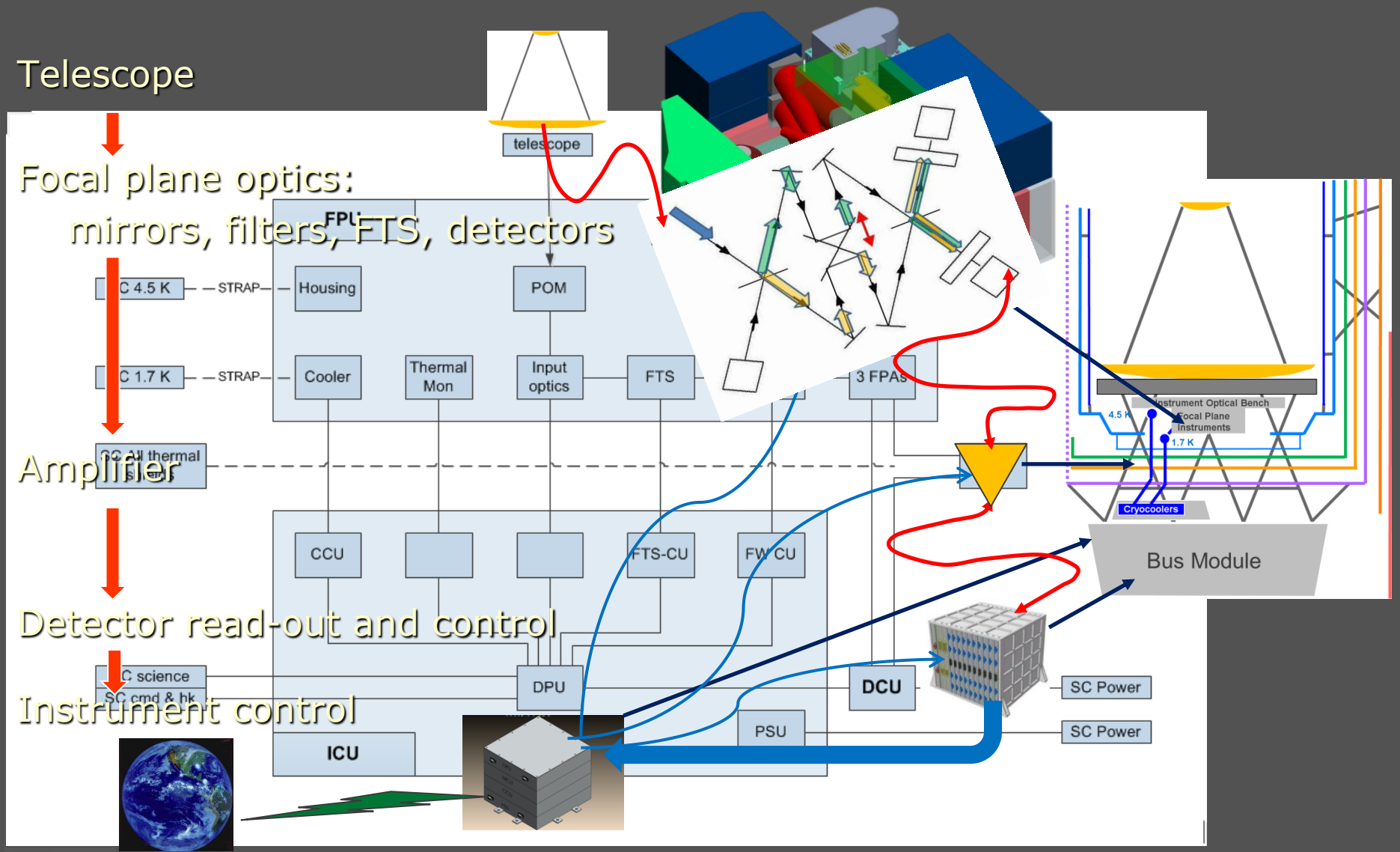
Telescope

Focal plane optics:
mirrors, filters, FTS, detectors

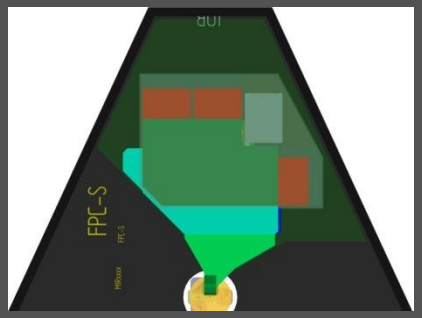
Amplifier

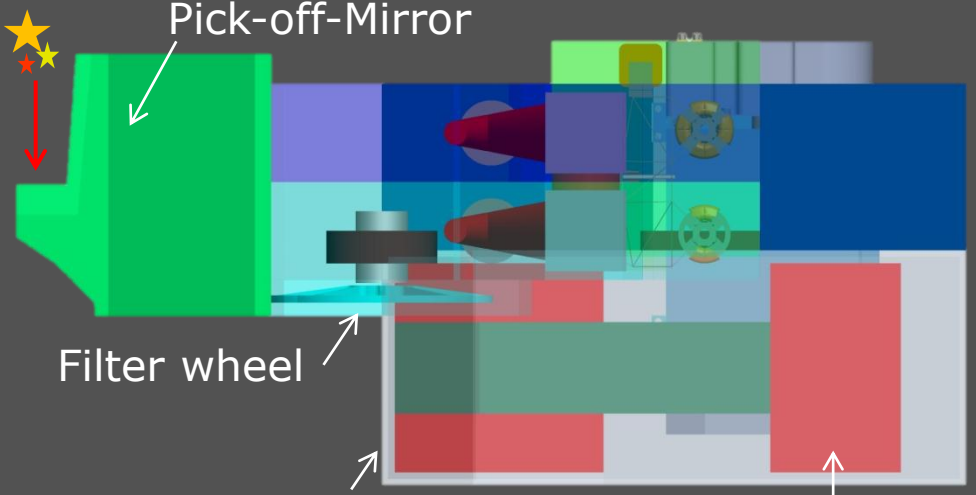
Detector read-out and control

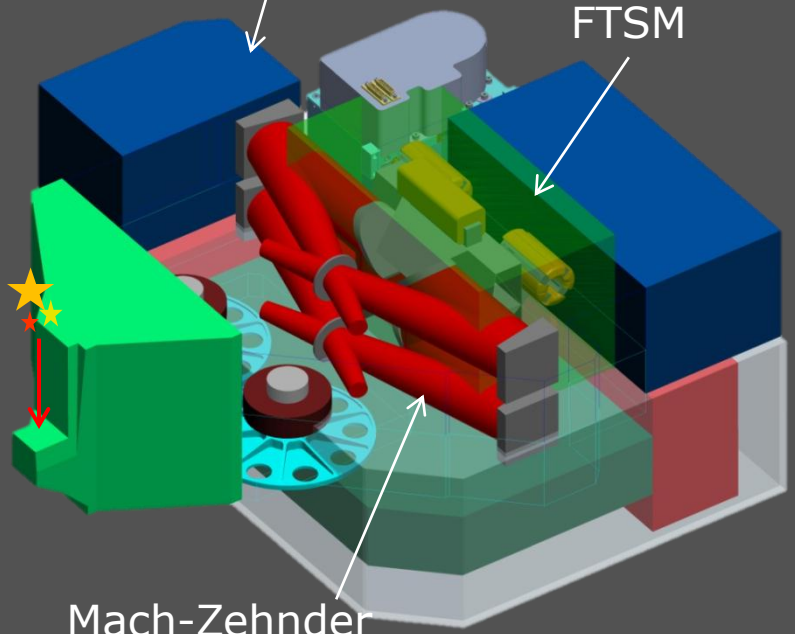
Instrument control

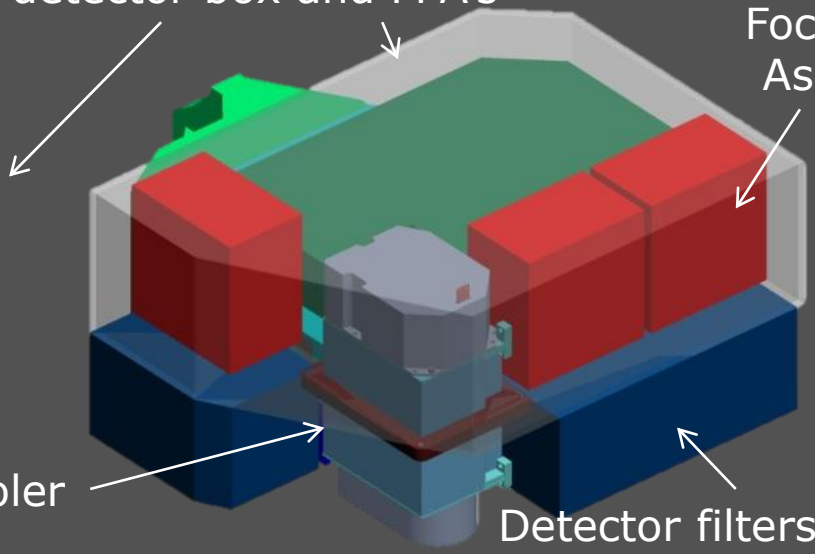


Reference design - SAFARI Focal Plane Unit

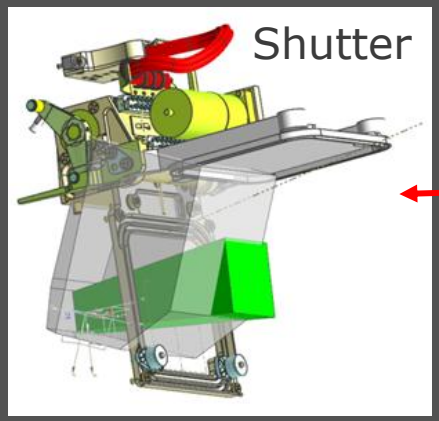


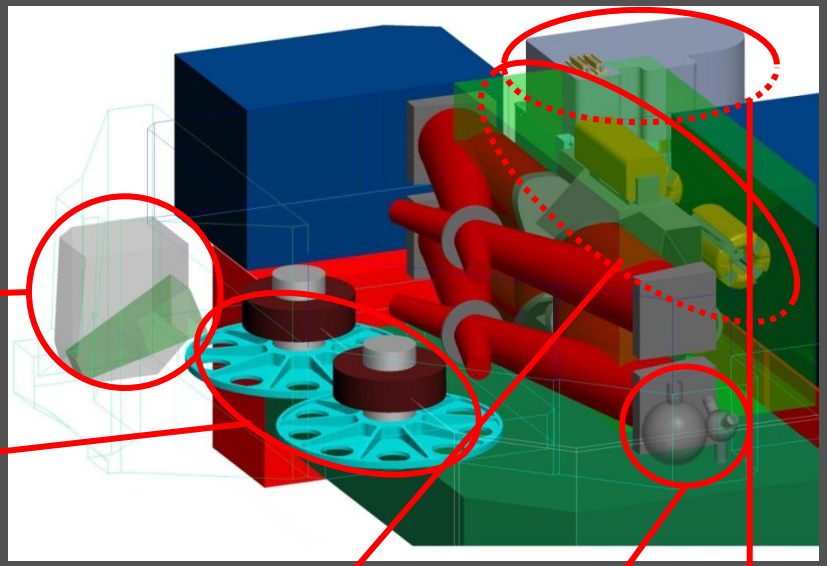


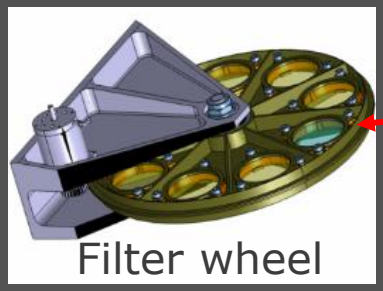


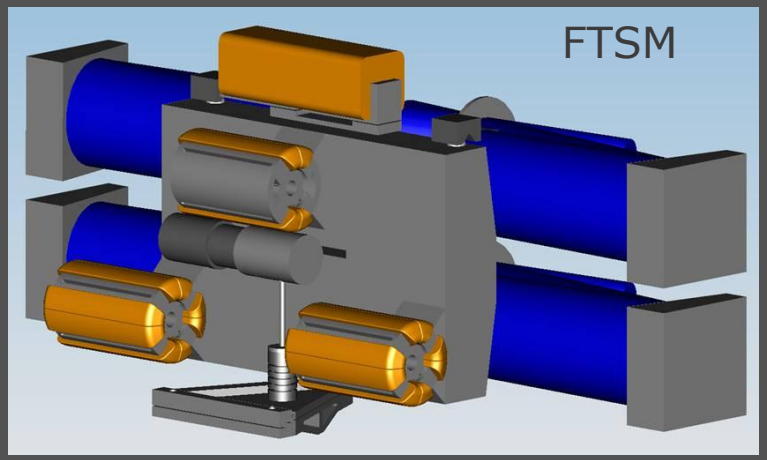


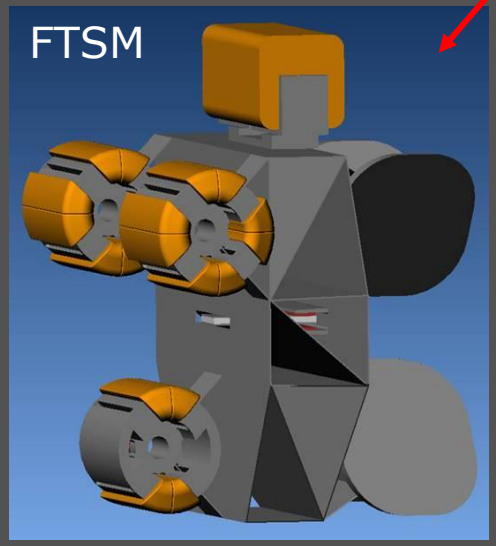
SAFARI FPU mechanisms

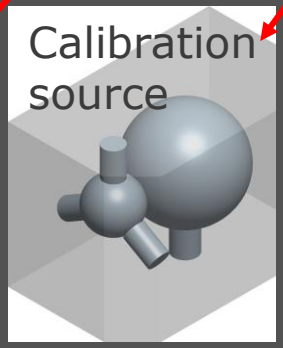


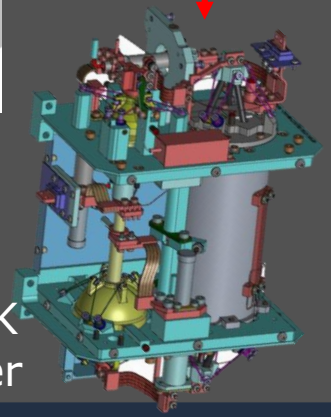




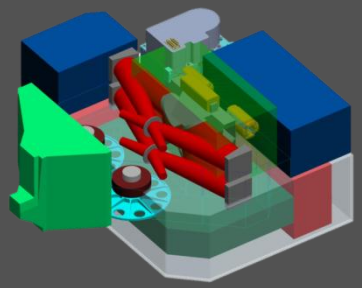
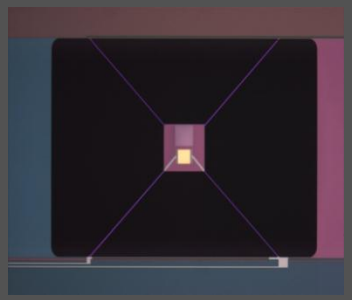
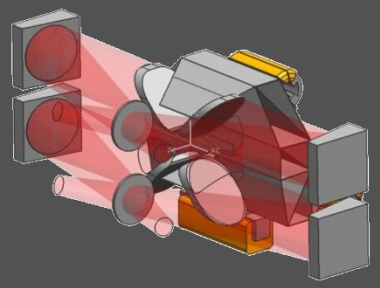
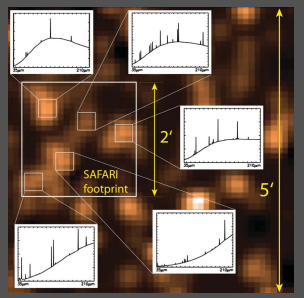




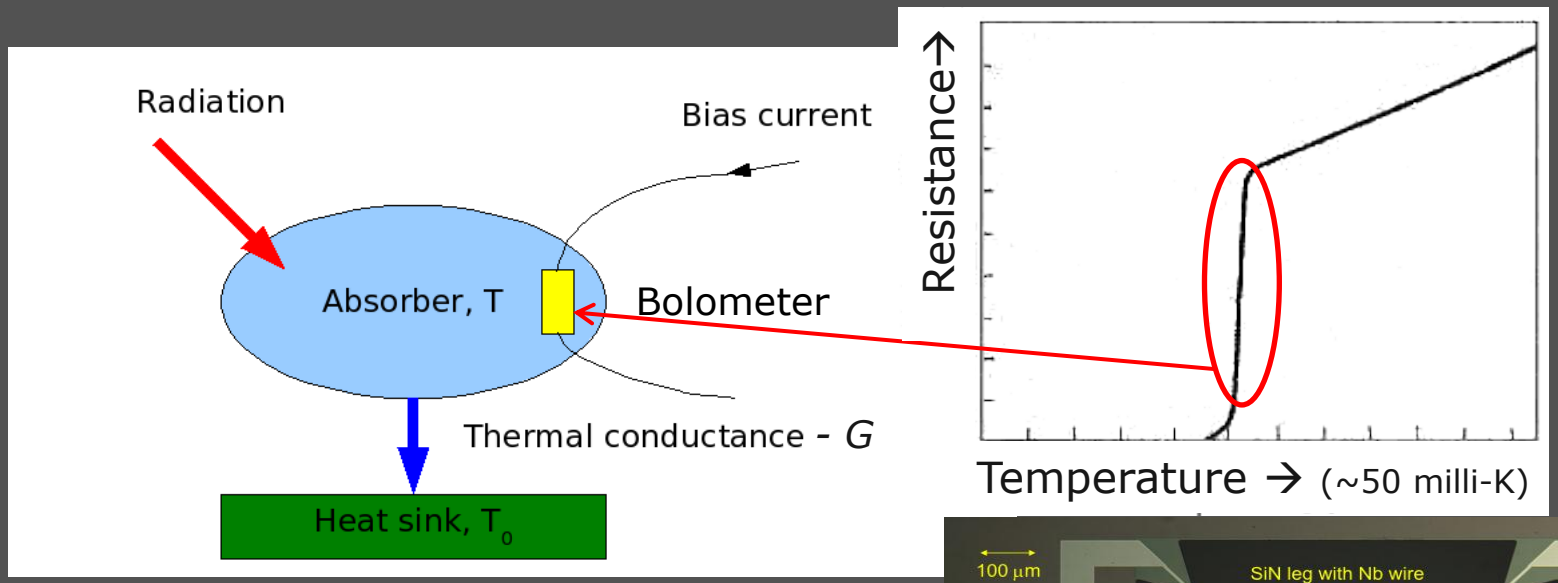




SAFARI's ultimate sensitivity: Transition Edge Sensors

Ultimate sensitivity – Transition Edge Sensors

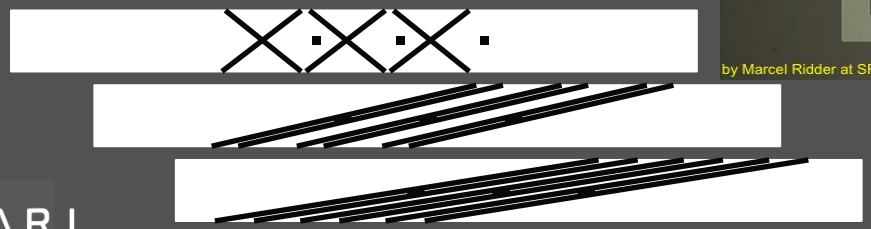


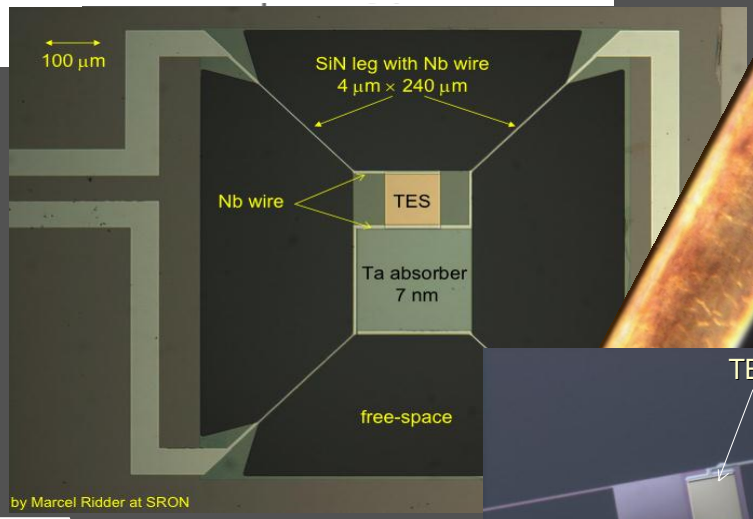
- Phonon-noise NEP~T√*G*

Challenges:

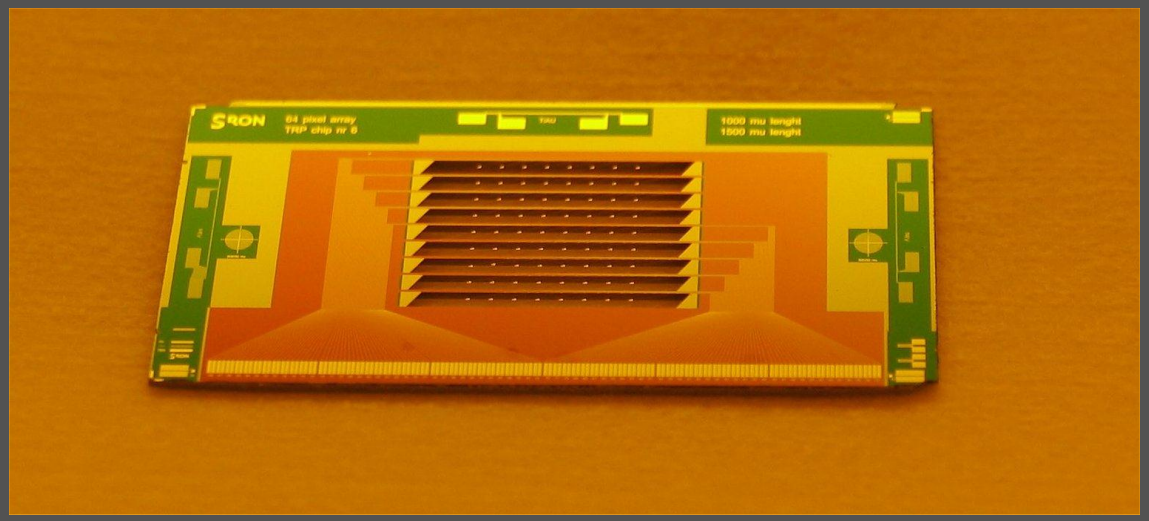
- *~milli-K* environment
- *Very sensitive* to E/B fields
- *Small* pixels (480 μm) and *low G*

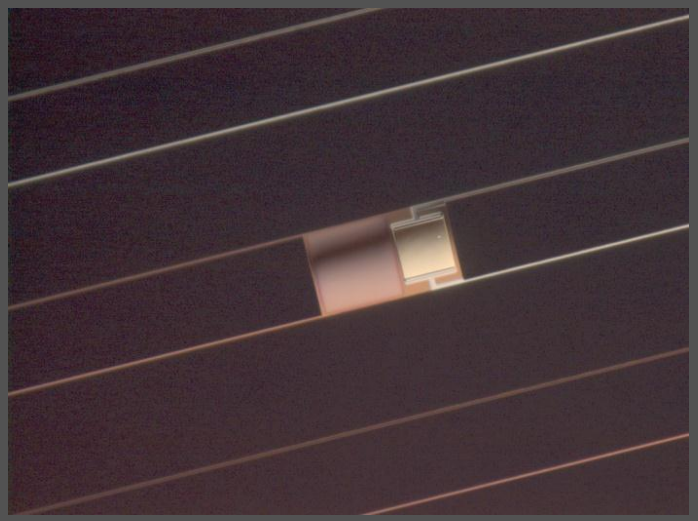
→ trying layout with 'long thin legs'





Prototype: 8x9 S-band arrays on 250 nm SiN





- 100 % yield, T_c=105 mK (~ 2 %)
- NEP=5-6 x10^{-19} W/√Hz
- Varying saturation level

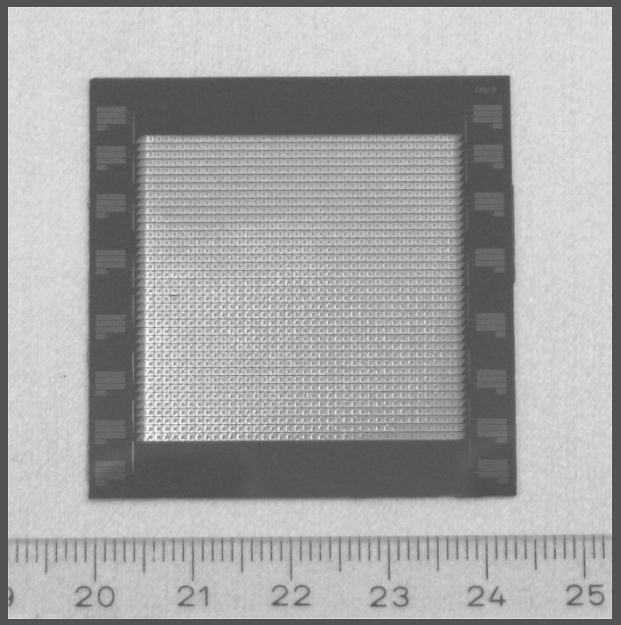
Manufactured to date:

38 x 38 array (M-band)

20 x 20 array (S-band)

Sensitivity reached to date:

NEP=5-6 x10-19 W/√Hz



Detector system - Focal Plane Assemblies

- Unit to hold TES's + LC filters + SQUID's
  - One FPA per detector array
  - Isolate temperature levels: 50mK/300mK/1.7K
  - Shielding: quasi-static B-fields, radiated EMI, stray light
- Challenges
  - Multiple functions ⇔ volume/mass constraints
  - High launch loads
  - Compact, light-weight B-shield
  - Harness for upto ~2000 pixels