Synoptic All-Sky Infrared (SASIR) Survey

✦ Overview ✦

Josh Bloom (UC Berkeley)

http://sasir.org

http://www.inaoep.mx/~progharo/gh2008/

Outline

- *Overview of the Survey & the Science*
- *Series of Questions & Goals for this Workshop*
- *Timeline for Action & Decisions*

SASIR vision: In a Nutshell

6.5 meter telescope
(Magellan-inspired)

- site: San Pedro Mártir
- ~0.8° diameter field of view
- **Filters:** Y J H K (3 dichroics)
- cover entire sky in ~3 months; 4 year survey
- "shallow" (~2.5 π; 12 visits per filter), "medium" (0.5 π; 200 visits) & "deep" (~1000 sq deg; 10^3+ visits) surveys

New Phase Space:
***Aperture* + *wavelength* +**
Field of View* + *Time

Backdrop: Modern OIR Large-Area Surveys

2MASS [1997 - 2000]

4 π, simultaneous JHKs on 1.3m telescopes, 2500+ papers

Sloan Digital Sky Survey (SDSS I & II) [2000 - 2008]

~1.5 π (North), ugriz on 2.5m, 250 sq. deg synoptic

Pan-STARRS [2008 - 2011]

~2.5 π (North), ugrizy on 1.8m, 20000 sq. deg synoptic

LSST [2013 - 2020?]

~2.5 π (South), ugrizy on 8.5m, 30000 sq. deg synoptic

JDEM/SNAP [2013 - 2018?]

~4 π (space), ugrizyJH on 2m?, 5000 sq. deg synoptic

Multi-threaded Science Goals

Static Sky

- uncover the entire brown dwarf & Y dwarf population with 25 pc
- IMF studies *(A. Porras)*
- dwarf/dark matter problem & Galactic structure *(O. Valenzuela)*
- galaxy evolution studies *(V. Ávila-Reese)*
- galaxy clusters $z > 1$ *(A. Stanford)*
- lensing (w/ GTC & LMT) *(J. A. de Diego)*
- obscured quasars *(B. Becker)*
- high-redshift quasars z > 7 *(J. X. Prochaska)*

Multi-threaded Science Goals

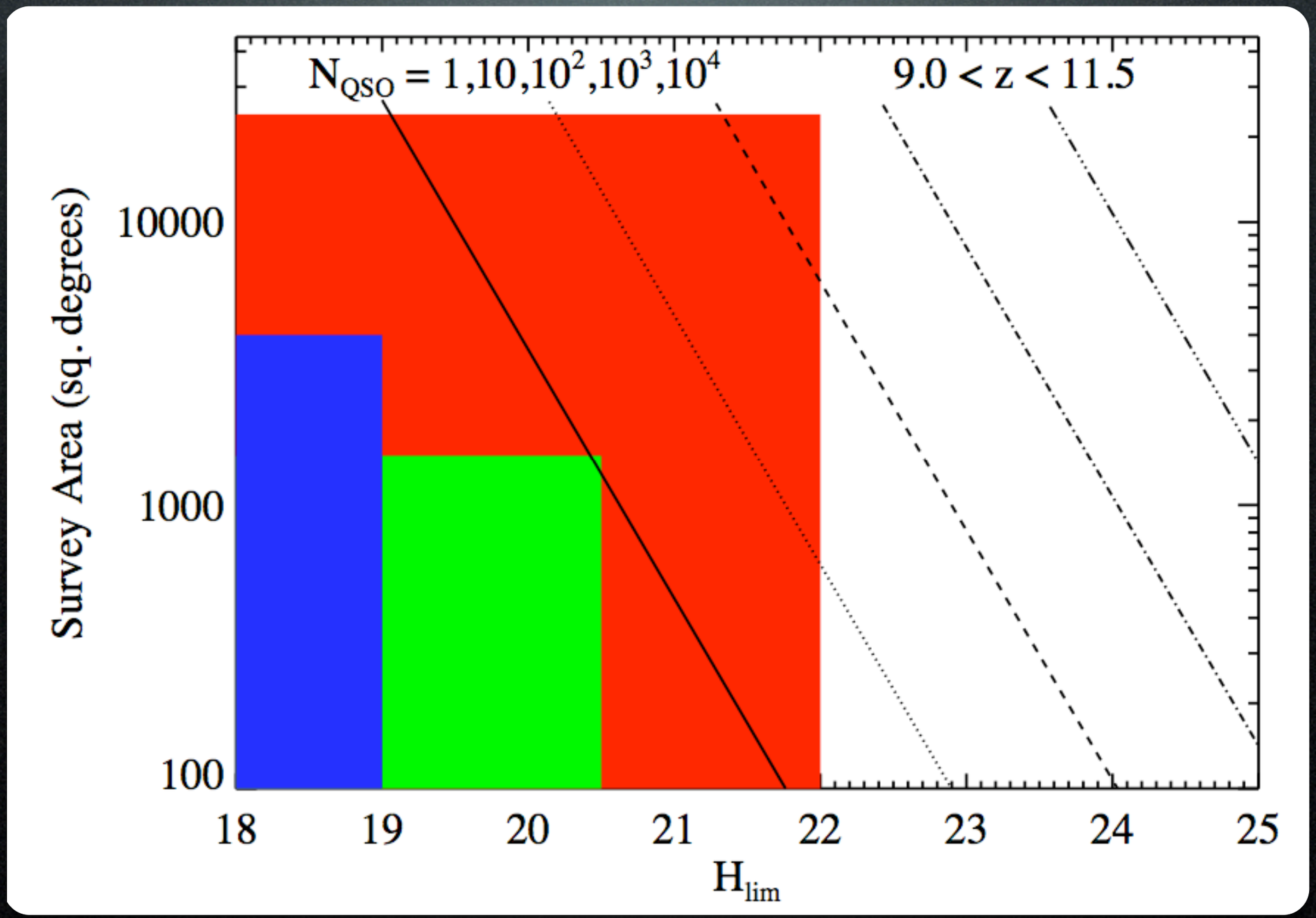
Transients

- fast transients (orphan GRB afterglows?)
- local distance scale (< 4 Mpc) with Mira Variables *(L. Georgiev)*
- exoplanet transit survey
- cosmology/distance ladder: supernovae, RR Lyrae, etc.
- E&M connection to GWs (advanced LIGO) & cosmic particles
- high redshift transients (e.g. GRBs)
- connection to high-energy universe *(T. Miyaji, A. Carramiñana)*

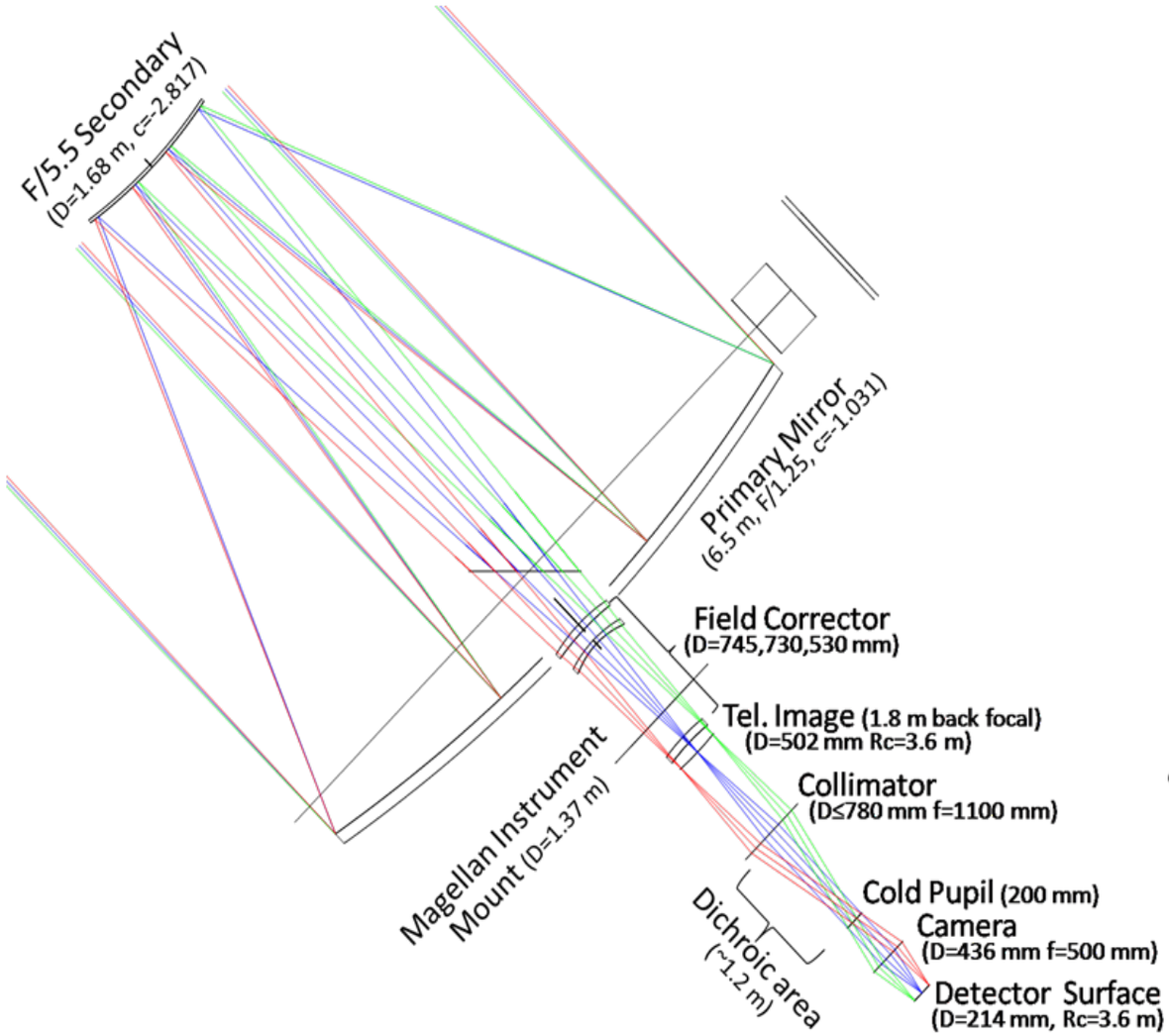
Critical Connection to Other Projects

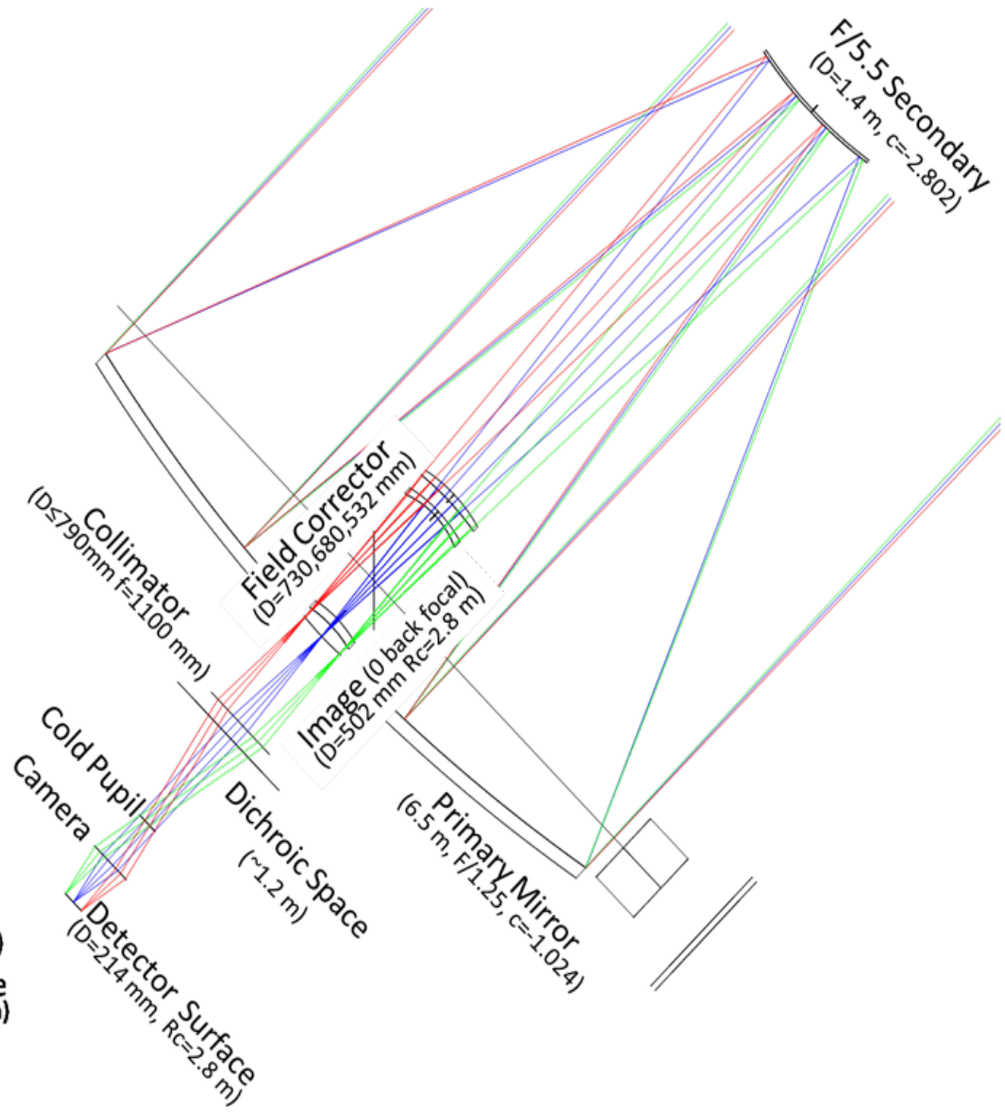
- LMT *(D. Hughes)*
- adaptive optics grid *(J. Girard)*
- great photo-z improvement over LSST (e.g. BAO)
- support for GTC & Keck/TMT

Identifying the Killer Science:
Discovering the High-redshift Universe

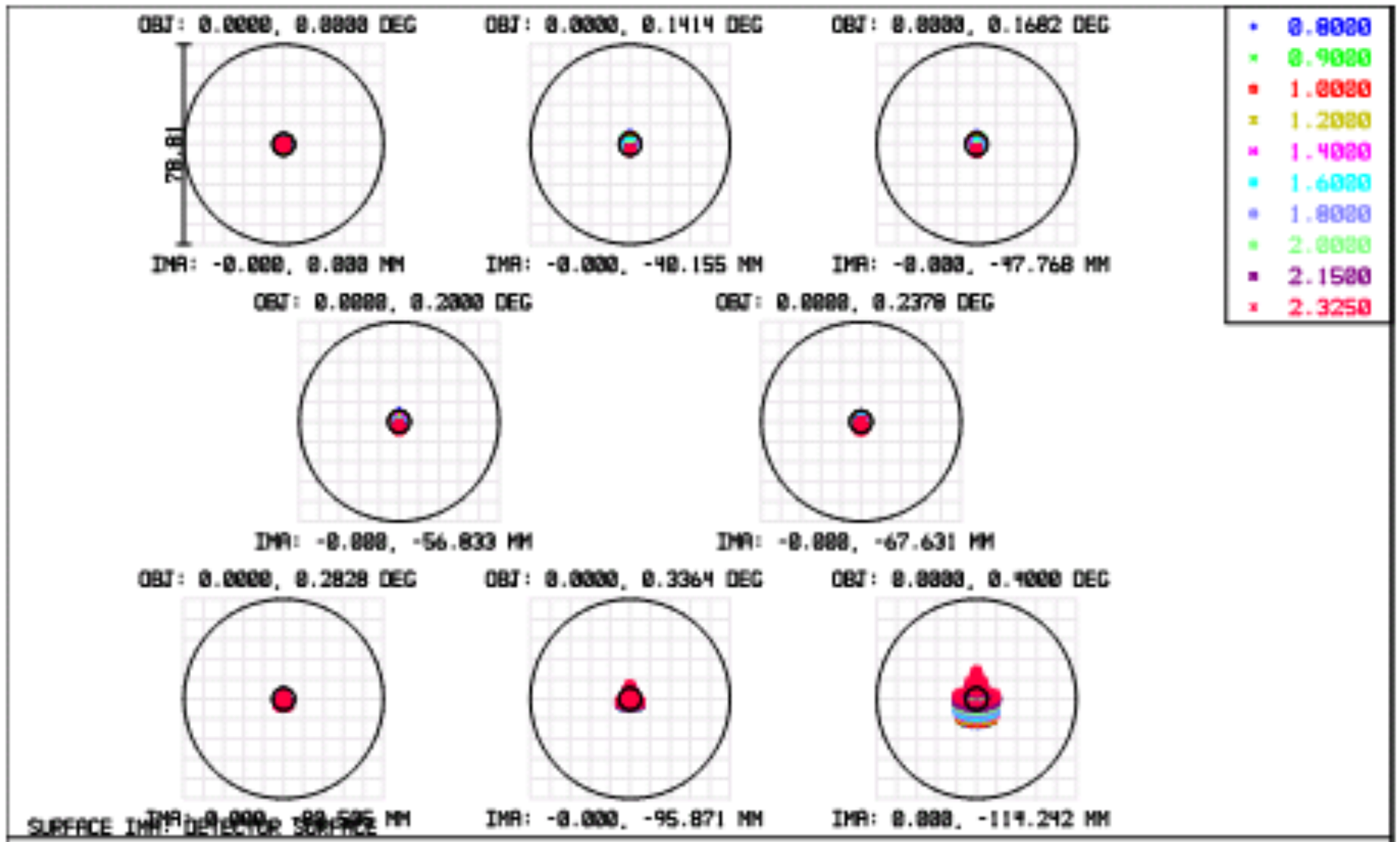


2 Nominal Optical Designs





details from Jesus Gonzales



SPOT DIAGRAM

SASIR TELESCOPE (0.0 MM BACK FOCAL)
MON JUN 2 2008 UNITS ARE μm. AIRY RADIUS : 4.337 μm

FIELD :	1	2	3	4	5	6	7	8
RMS RADIUS :	1.301	1.696	1.698	1.687	1.682	1.519	2.198	4.796
GEO RADIUS :	2.682	4.192	4.118	3.738	3.715	3.679	5.798	11.593

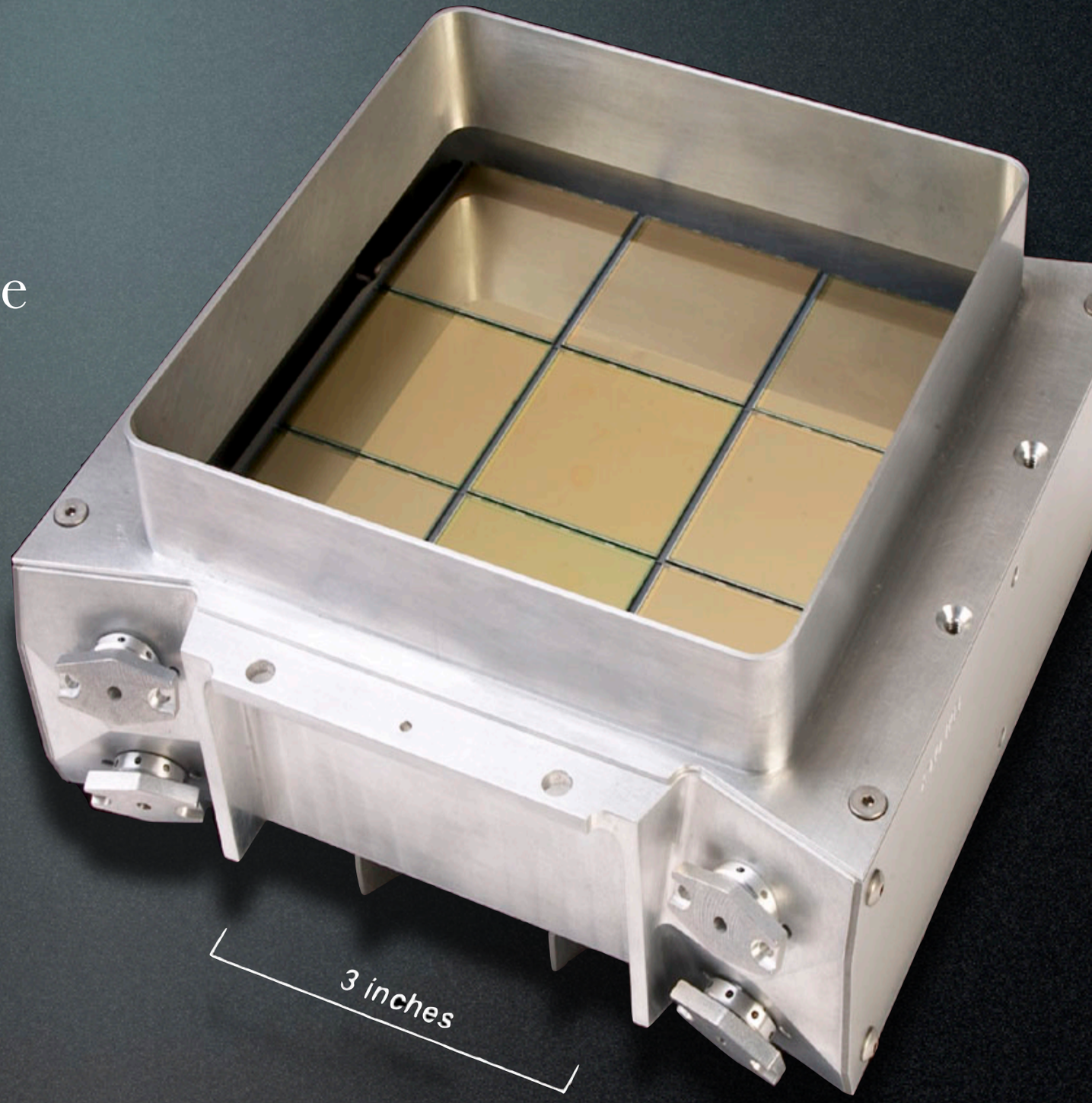
CIRCLE DIAM: 78.81 REFERENCE : CENTROID

SASIR PROJECT
WIDE-FIELD NIR TELESCOPE
(PARAXIAL COLLIMATOR & CAMERA)

J. J. GONZALEZ (IA-UNAM)
CONFIGURATION 6 OF 21

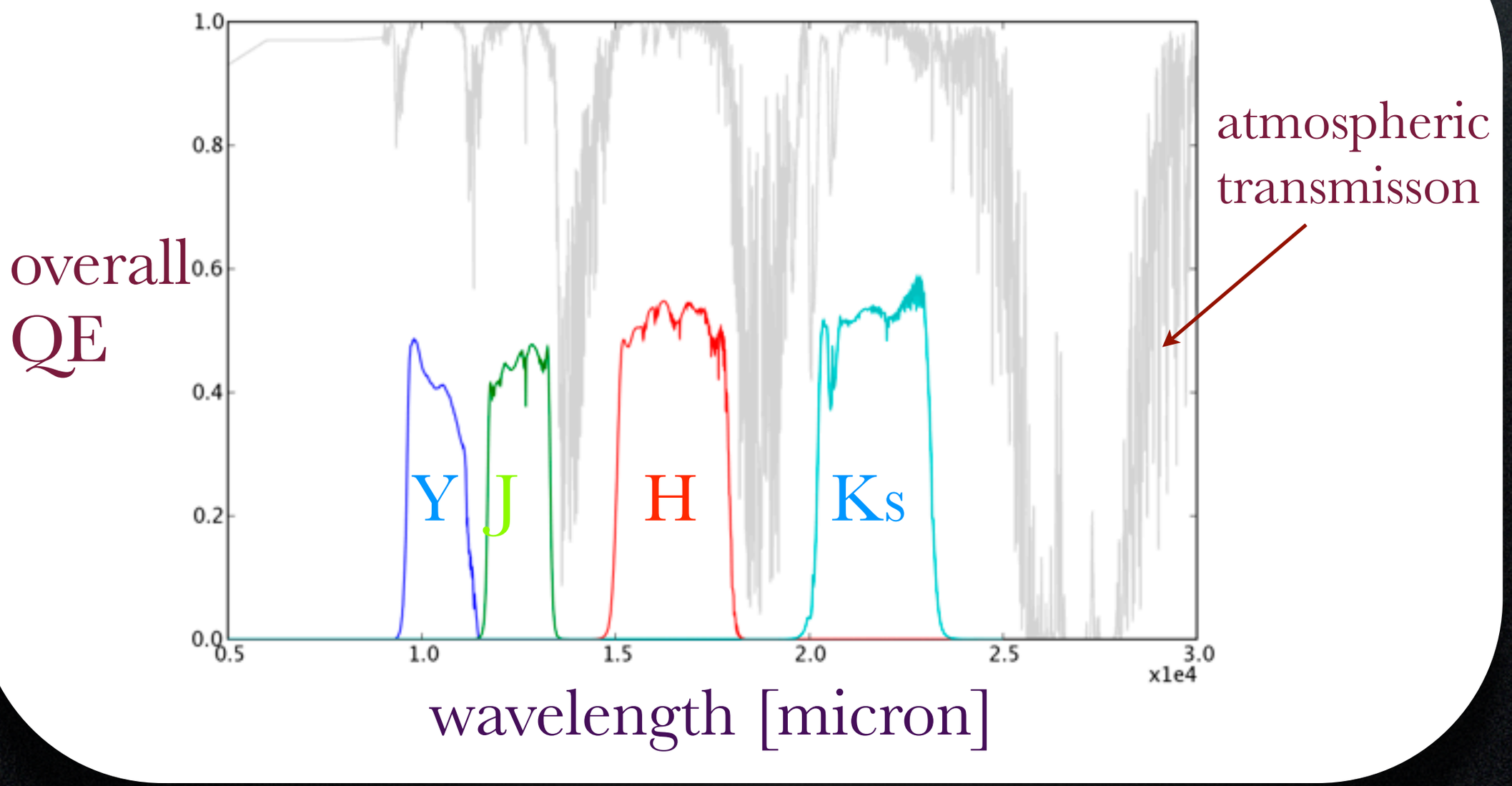
The Camera

- 3 dichroics - size may be one of the most significant constraints (~0.5 m)
- cold optics
- 80 - 100 2k x 2k H2RG or VIRGO arrays (15 - 20 micron = 0.2 - 0.3”/pix)
- data rates: ~1.5 Gb per double correlated read
  ~2 Tb/night
  ~300 Mbps
- $30 - 40M



(data flow: Peter Nugent
detectors: Josh
camera optics: Jesus)

Bandpasses (for now)



from simple simulation code

Quick SASIR Simulation

```
    self.filt_names = [x.name for x in self.filts]

    self.get_response_curves()

def get_response_curves(self,req_range=(5000.,25000),n=2000,n_surfaces=4):
    self.lams = scipy.arange(req_range[0],req_range[1],(req_range[1] - req_range[0])/float(n))

    ## start at the atmosphere and work your way down
    ## atmospheric transmission
    self.resp = scipy.interp(self.lams,self.site.atm_trans[0],self.site.atm_trans[1])

    ## telescope
    self.resp *= scipy.interp(self.lams,self.telescope.primary_reflectance[0],self.telescope.primary_reflectance[1])
    self.resp *= scipy.interp(self.lams,self.telescope.secondary_reflectance[0],self.telescope.secondary_reflectance[1])

    ## camera
    #  dewar window
    self.resp *= scipy.interp(self.lams,self.dewar_tp[0],self.dewar_tp[1])

    #  internal optics coatings
    surf= scipy.interp(self.lams,self.lens_tp[0],self.lens_tp[1])
    for i in range(n_surfaces):
        self.resp *= surf

    ## array
    self.resp *= scipy.interp(self.lams,self.irarray.qe[0],self.irarray.qe[1])

    ## loop through each filter to finish up
    self.filt_response = []
```

Comparison to Other Surveys

Filter	5 sigma limiting mag [AB]	flux density μJy
J	18.13	202
H	17.63	320
Ks	17.55	346

2MASS

5 sigma limiting mag [AB]	flux density μJy
22.54	3.5
22.04	5.5
21.95	6.0

SASIR/single epoch

5 sigma limiting mag [AB]	flux density μJy
23.89	1.0
23.39	1.6
23.30	1.7

SASIR/shallow

NOTE for a fixed S/N:

$$\text{Limiting flux ratio} \propto \sqrt{1/t} \times (\text{FWHM}) \times 1/r$$

$$\text{Limiting mag difference} = 1.25 \log t + 2.5 \log \text{FWHM} + 2.5 \log r$$

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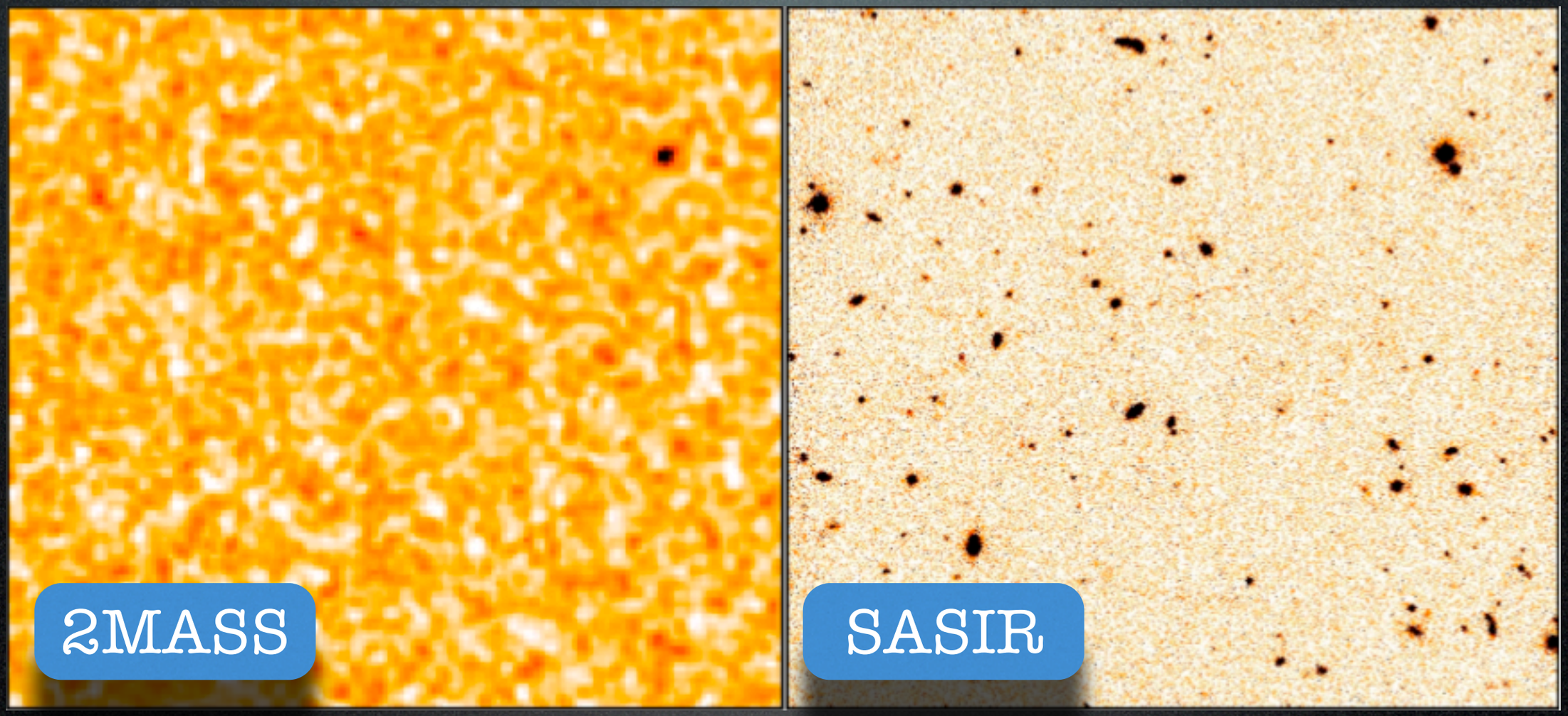
SASIR/shallow

Extended Source Sensitivity ("shallow")

Filter	5 sigma limiting mag [AB arcsec^{-2}]	flux density μJy arcsec^{-2}
Y	23.32	1.7
J	22.78	2.8
H	22.42	3.8
Ks	22.29	4.4

Comparison to Other Surveys

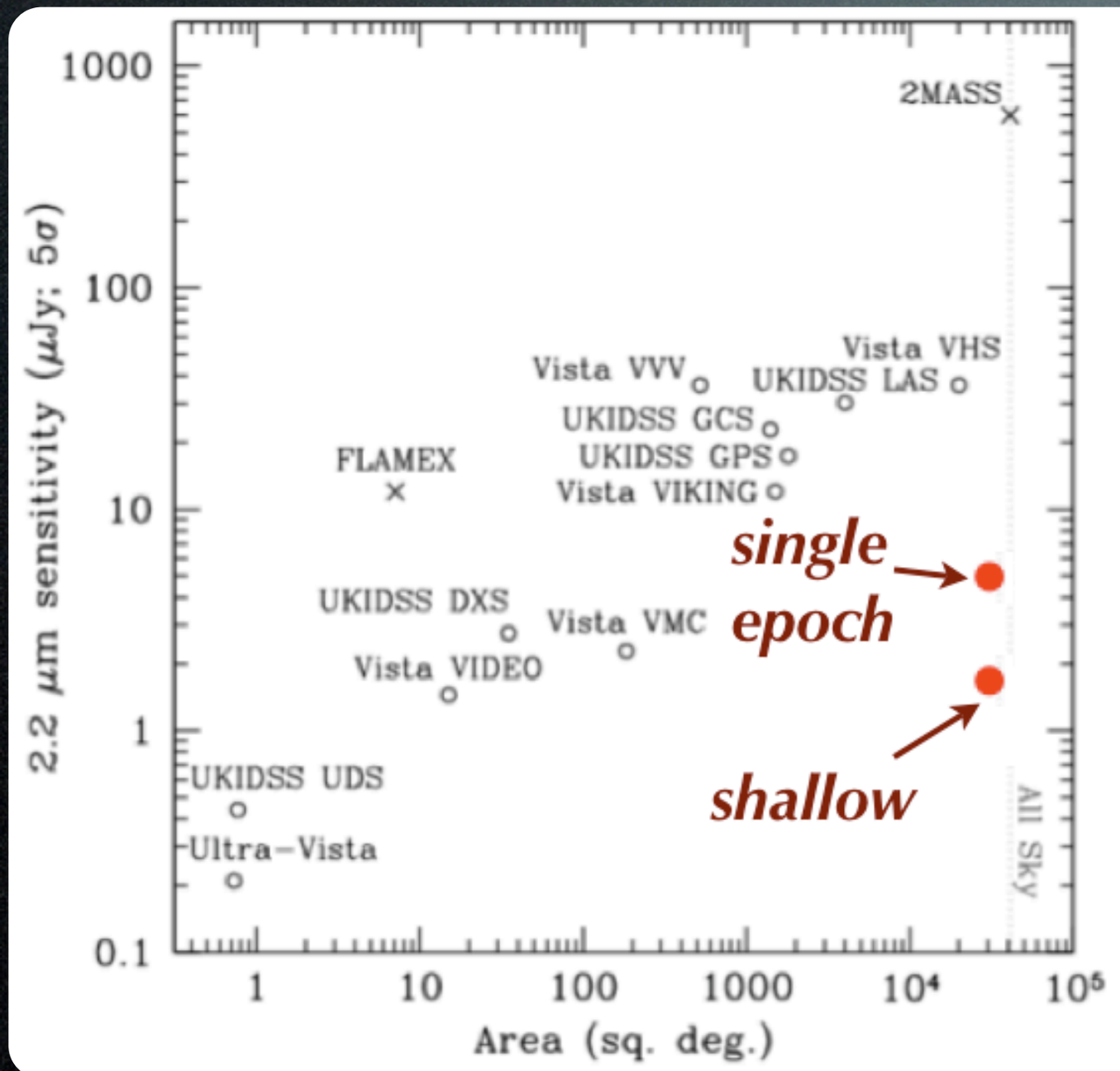
K-band Imaging

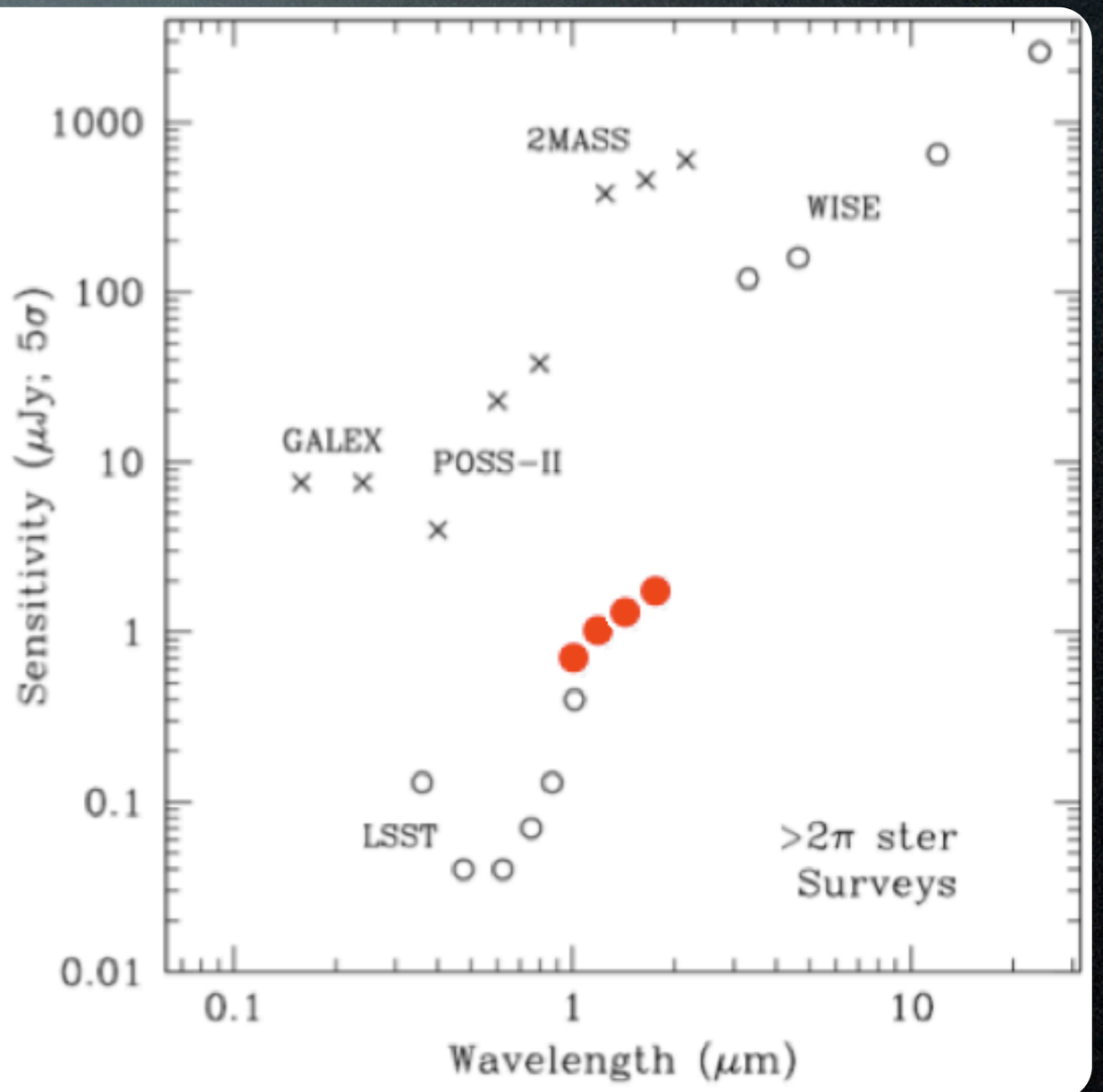


2MASS [Skrutskie *et al.* 2006]

VLT/ISSAC (GOODS) [Retzlaff *et al.* 2008]

Comparison to Other Surveys





Questions & Goals

{ see William/Xavier's email with formal questions }

Science

- What are main science results you want from SASIR? (Where would we excel over existing & planned surveys?)
- What are the specific technical requirements of the survey to achieve this science?

  Examples:

  - local cool stars parallax demands at least 3 visits, with 2 visits separated by ~6 months
  - we must have K-band because...
- What are the synergies with planned missions (JDEM, LSST, JWST, etc.)?

Technical

- What are the ranges of reasonable parameters for the mirror, telescope & camera?
- What are the innovations & long-lead time items we need to worry about now?
- What are the main "show stoppers" for each sub-system?

Collaboration

- Continue to build & grow the science & technical partnerships
- Develop a roadmap for engaging our colleagues
- Start discussing details of collaboration agreement
- Start discussing extensions to partnership (i.e. other institutional partners, facility-leveraging)

Timeline for Action

[Bolte, Guichard, Franco]

Funding Outlook for Design Phase

(more from Pepe & Mike)

What	Due	For What	Funding Profile
UC-Lab Research Program	4 Aug 08 [pending]	project management, optical designer, LSST-like simulation, collaboration meetings in Mexico	$1.5M over 3 years (2009-2011)
NSF/Advanced Technologies and Instrumentation	1 Nov 08	TBD	$<2M over 3 years (2009-2011)
NSF/Major Research Instrumentation Program	21 Dec 08 (LOI) 22 Jan 09	TBD	$<4M

Also Critical:

SASIR whitepaper for **Decadal Survey** by March 2009