

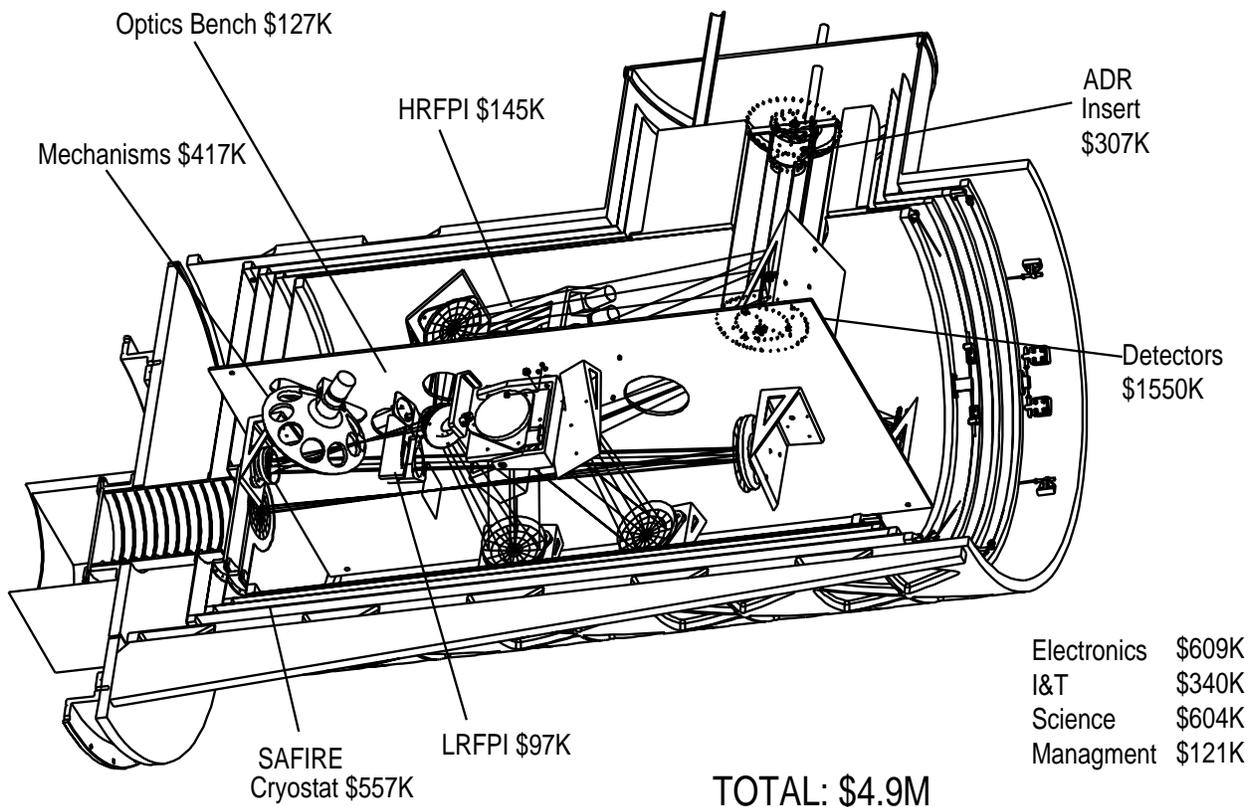
# SAFIRE-Lite

A “don’t kill the messenger” proposal by  
Benford, Shafer, & Voellmer

Assertion:

SAFIRE *cannot* be built.

Why not?



Required: \$4.9M    Allocated: \$1.3M

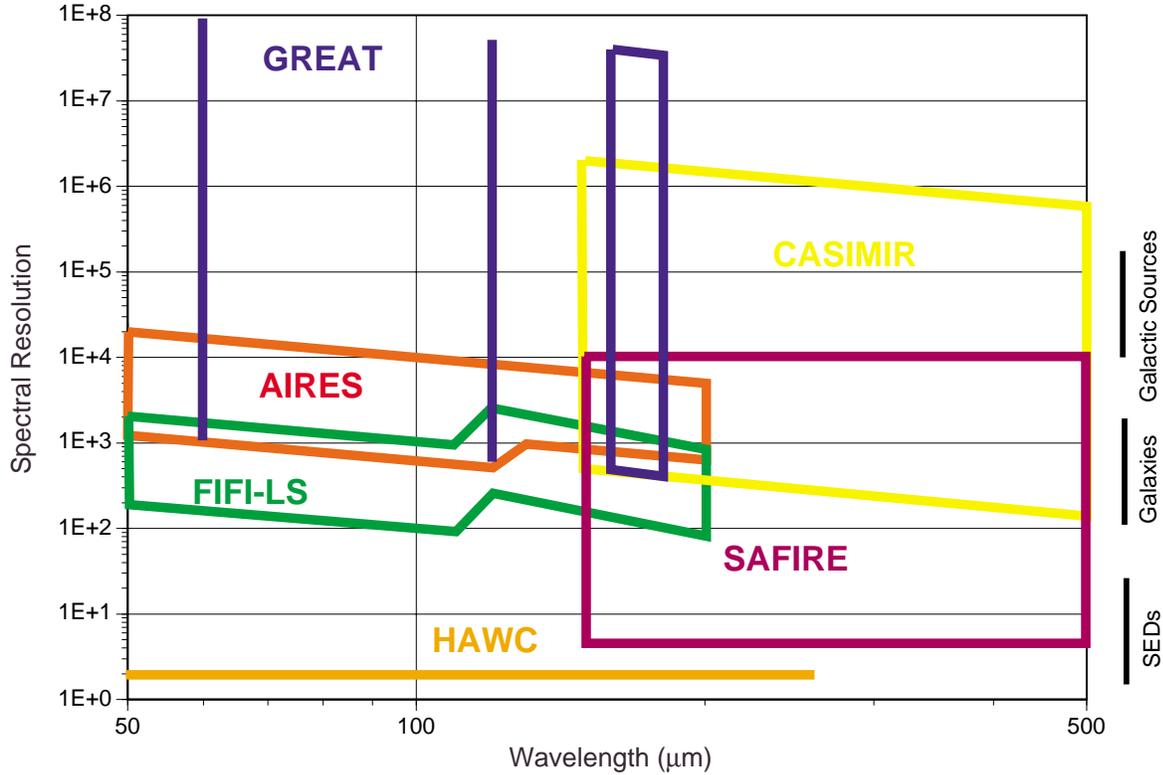
*The problem is only in the bottom line!*





# How to Downsize SAFIRE without Sacrificing Science Goals:

## SOFIA Instruments

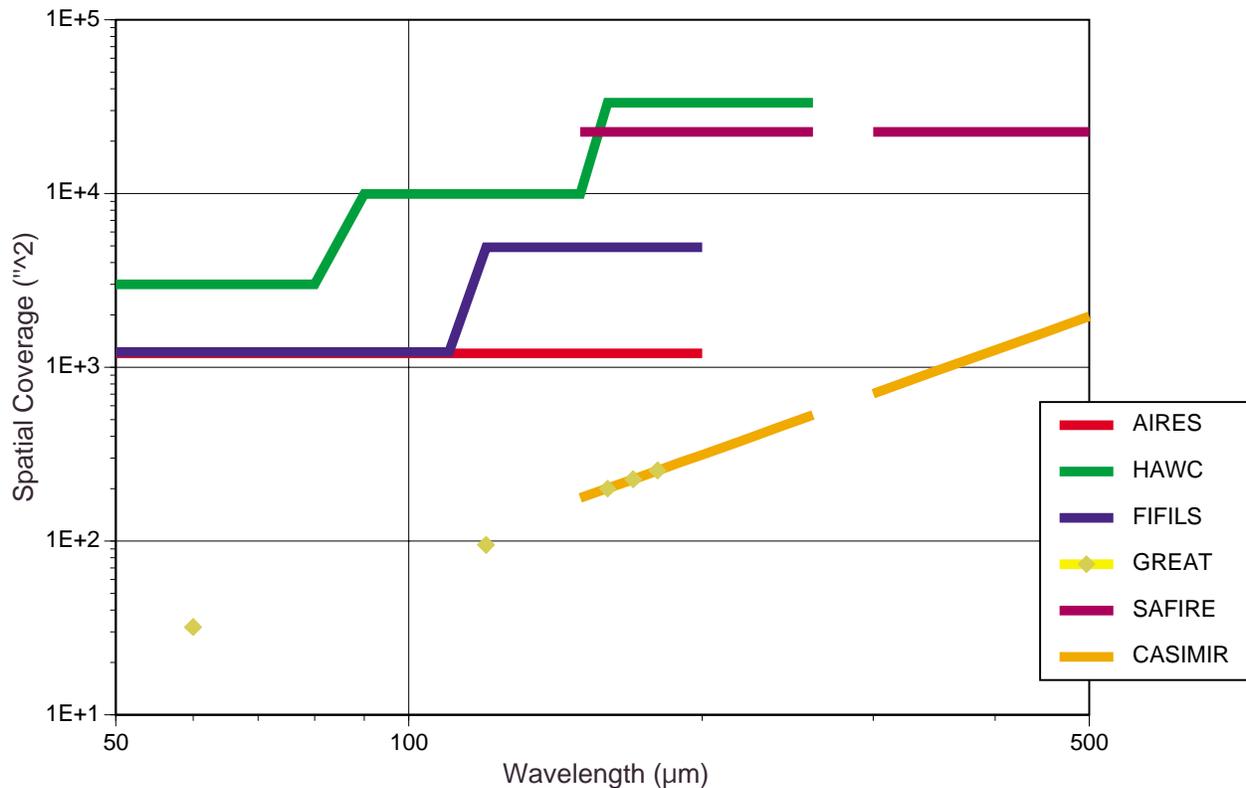


SAFIRE's unique capability is in providing spectroscopy at  $100 < R < 1000$ , at  $150 < \lambda < 600 \mu\text{m}$   
Ideal for Far-Infrared extragalactic astronomy.

At shorter wavelengths & higher resolutions, SAFIRE is less competitive; same is true at very lowest resolution.

Note that *no* other instrument will be able to search effectively for CII (158μm) emission at  $z > 0.25$ , or even NII (205μm) in nearby galaxies!

## SOFIA Instruments Spatial Coverage



Furthermore, SAFIRE has a great advantage in areal coverage as compared with other spectroscopic instruments.

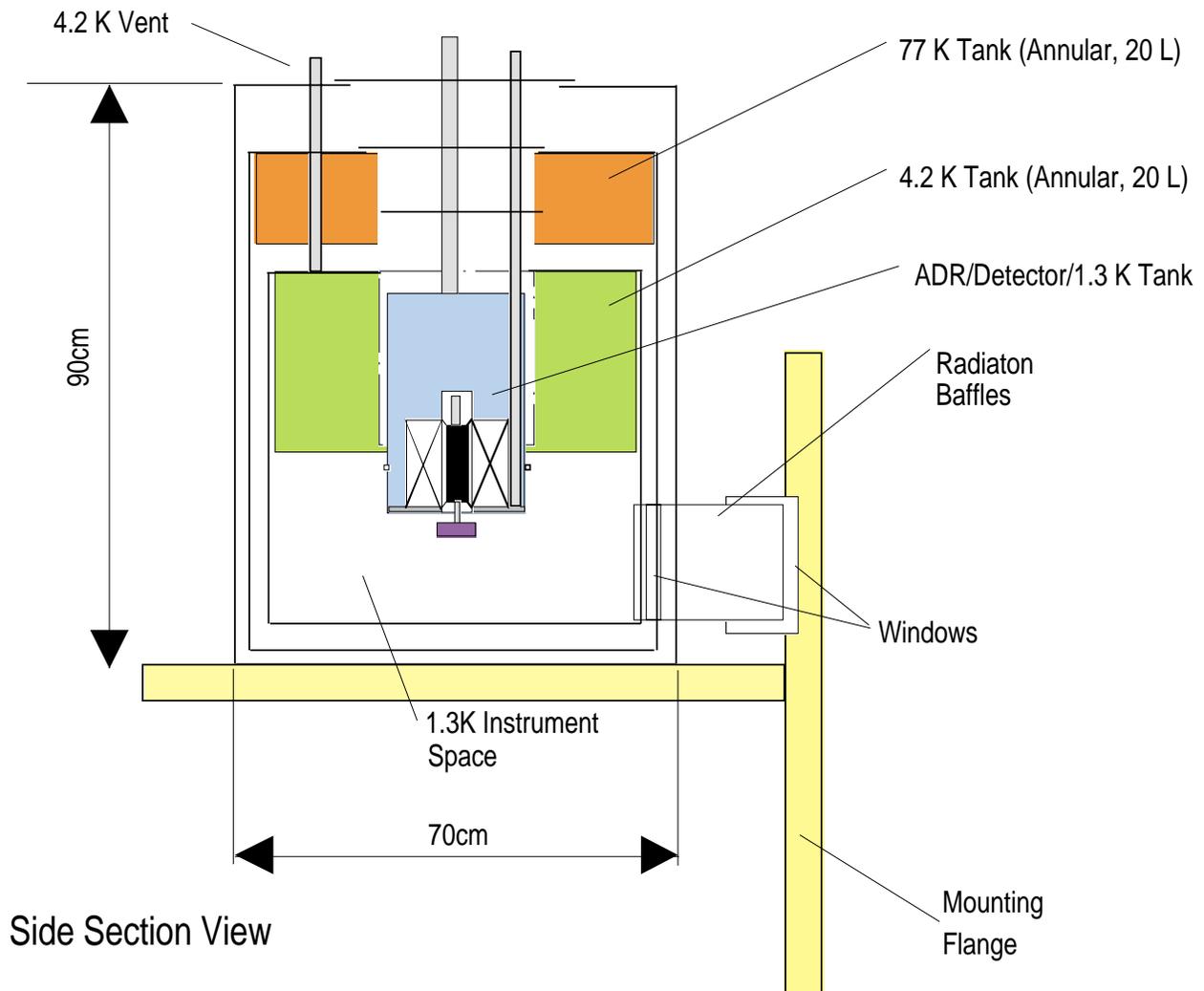
We *must* use this capability to our advantage, so we must continue to use arrays of >100 bolometers.

For extragalactic studies, this advantage can be tremendous:  
SAFIRE is 30 times more powerful  
when searching for  $z=1$  CII emission!

# SAFIRE-Lite Proposal:

- To allow for the  $100 < R < 1000$  spectroscopy:  
*install only the LRFPI.*
- Reduce the complexity of SAFIRE by building  
*only the test cryostat – “SAFIRE-Lite”*  
with enough room for the LRFPI optics and a  
HAWC-duplicate filter wheel for band selection.
- To further reduce expense,  
*use IAS Fabry-Perot (FIBRE) and electronics*
- Savings on manpower by implementing  
*planar bolometer arrays with planar MUX arrays*
- Savings on electronics by  
*re-use of all SPIRE hardware possible*  
data acquisition can use both MkIIs  
housekeeping uses existing BACUS hardware
- Savings on overall I&T & Science budgets by  
*descope project and relying on scientists elsewhere*  
I&T will be faster for a simpler system  
FIBRE will provide crucial learning *directly* applicable  
Data analysis to be taken on by graduate students
- Future expandability is maintained through the use of hardware  
which can be fully reused. A new cryostat for the HRFPI can be  
built for SAFIRE-II phase, but will use the ADR insert as-is.

# New cryostat design:

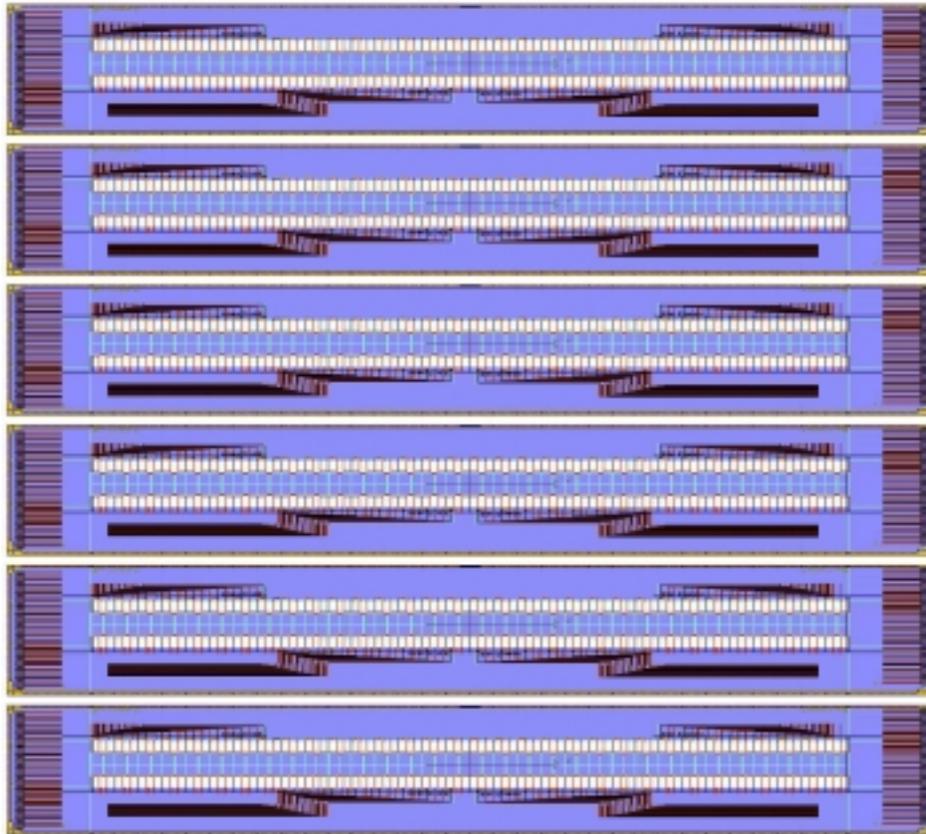


Volume is appropriate for weekend hold time, LRFPI optics; can be mounted on SOFIA like CASIMIR and GREAT.

Smaller cryostat means faster turnaround; same cryostat used for detector testing and instrument. Weight no longer an issue.

## Bolometer array:

Six 1x32 flat PUDs with side-placed bond pads covers full 5.7' field (final 32x32 array design)



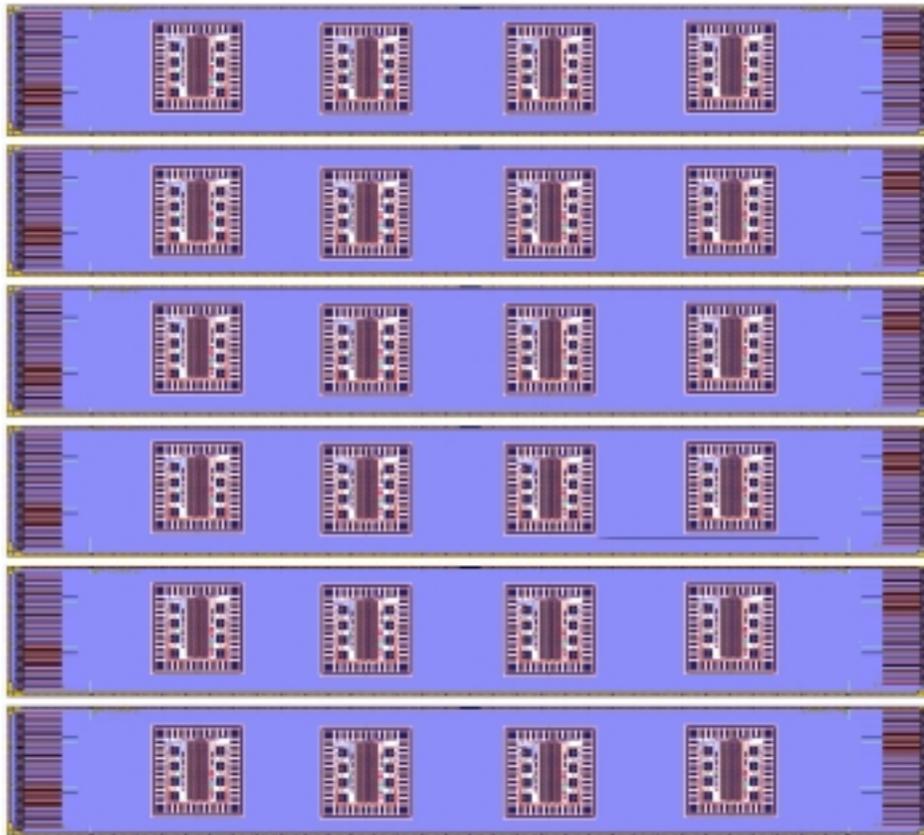
Minimum effort; PUDs can be batch processed and glued directly to a ceramic substrate.

Technology is available almost immediately.

Some reduction ( $\sim x2$ ) in effectiveness for mapping small objects due to lack of filled array; no impact on mapping extended objects or for blank-field surveys. The disadvantage could be eliminated by using 1x2mm bolometers (e.g. MIRA).

## SQUID Mux Array:

Using whatever technology NIST can provide, make a similar 6  
1x32 Mux Array on ceramic boards:



These boards are mounted to the underside of the bolometer array carrier & attached through wirebonded gold-on-kapton flexible cables to maximize robustness.

MUX array can be a separate unit from bolometer array, but suspended with bolometers.

Bridge chips out the sides (not shown) connect to warmer stages. Wiring as a 6x32 can be done with ~82 wires!

# SAFIRE

## As Proposed Here

### Requires :

- Only test cryostat
- LRFPI with only filter wheel
  - Use IAS Fabry-Perot + electronics!
- Detectors: TES / SQUIDs in easy, flat configuration
  - LRFPI makes detectors less sensitive -> easier
- Electronics for DA, HK
  - Use SPIRE or SPIRE-like systems; reuse if possible
- I&T and Observing

### **SAFIRE Costs**

As Rightsized

**Total Budget: \$K 2,208**

\$K 2,666 less than before

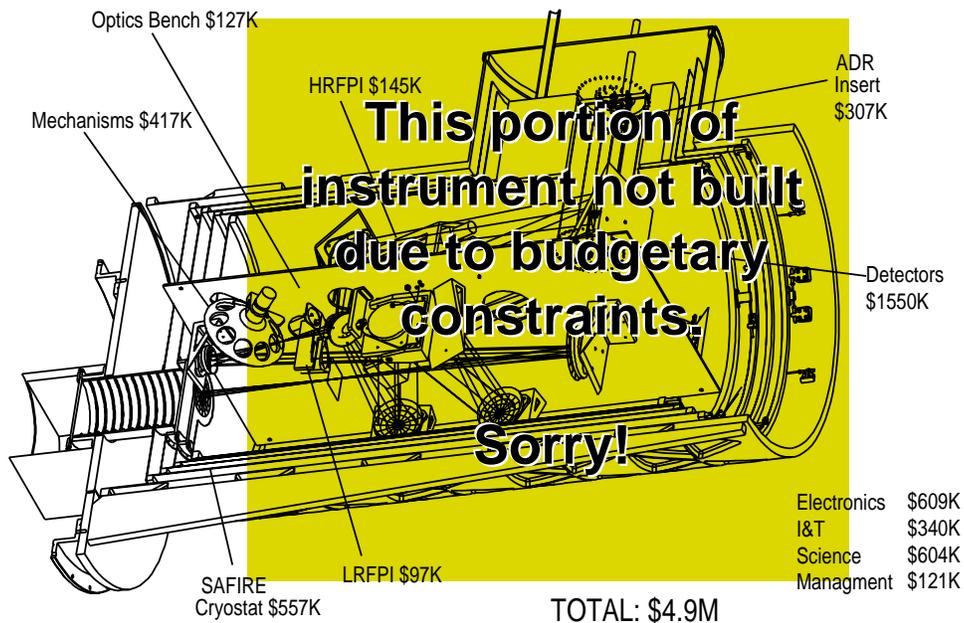
Mgmt	\$K 121	Optics	\$K 33	Cryo	\$K 324	Detect	\$K 1300	Elect	\$K 180	I&T	\$K 150	Science	\$K 100
Juan	71	Design	3	Cryostat	5	PUD Fab	1000	Data Acq	50	Testing	100	Observe	50
George	37	Elemnts	5	ADR	294	PUD Ass'y	50	HK	25	Airplane	50	Data Reductn	20
SOFIA	13	Mounts	5	Wiring	5	SQUIDs	250	Softwre	100			E&O	10
		LRFPI	0	Test Cryostat	20			Mechs.	5			Thinking	20
		HRFPI	0										
		Mechs.	20										
		Bench	0										

Note: no savings on bolometer array have been assumed; simpler design may reduce part count by 50% due to elimination of handling errors. This could save  $\leq$ \$500K.

# Summary:

- **Initial Proposal appears to be \$4.9M**

*We run a substantial risk of failure to deliver a working instrument at all. Having current funding implies that we build:*



- **Downscaled Proposal is \$2.2M**

*Science return is reduced, but SAFIRE-Lite's place in SOFIA instruments is still the best for all extragalactic science at  $150 < \lambda < 600 \mu\text{m}$ .*

*Instrument is fully compatible with eventual SAFIRE goals. Phase II would require the cryo-opto-mechanical system for the HRFPI only (~\$2M); everything else would be re-used.*