TRW Space & Electronics Group

TPF Study Results

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Results Based on Broad Comparison of Architectures Using JPL Criteria

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- We have developed a representative list of candidate architectures that can perform planet detection and characterization
  - For analysis we have normalized each architecture to the parameters needed to accomplish the detection mission
- We compared architectures on their basic science utility for exo-planet studies and general astrophysics
- Risks associated with implementation and on orbit performance (reliability and robustness) were ranked and the ability of the basic architecture to provide technology to the third generation of Origins missions (legacy) were evaluated
- Results show that many compelling options exist beyond the baseline nulling interferometer approach
- Further study is needed to develop these concepts to the same level of understanding as the interferometer and perform cost and risk comparisons

Only Visible & Infrared Measurements Meet TPF Mission Requirements

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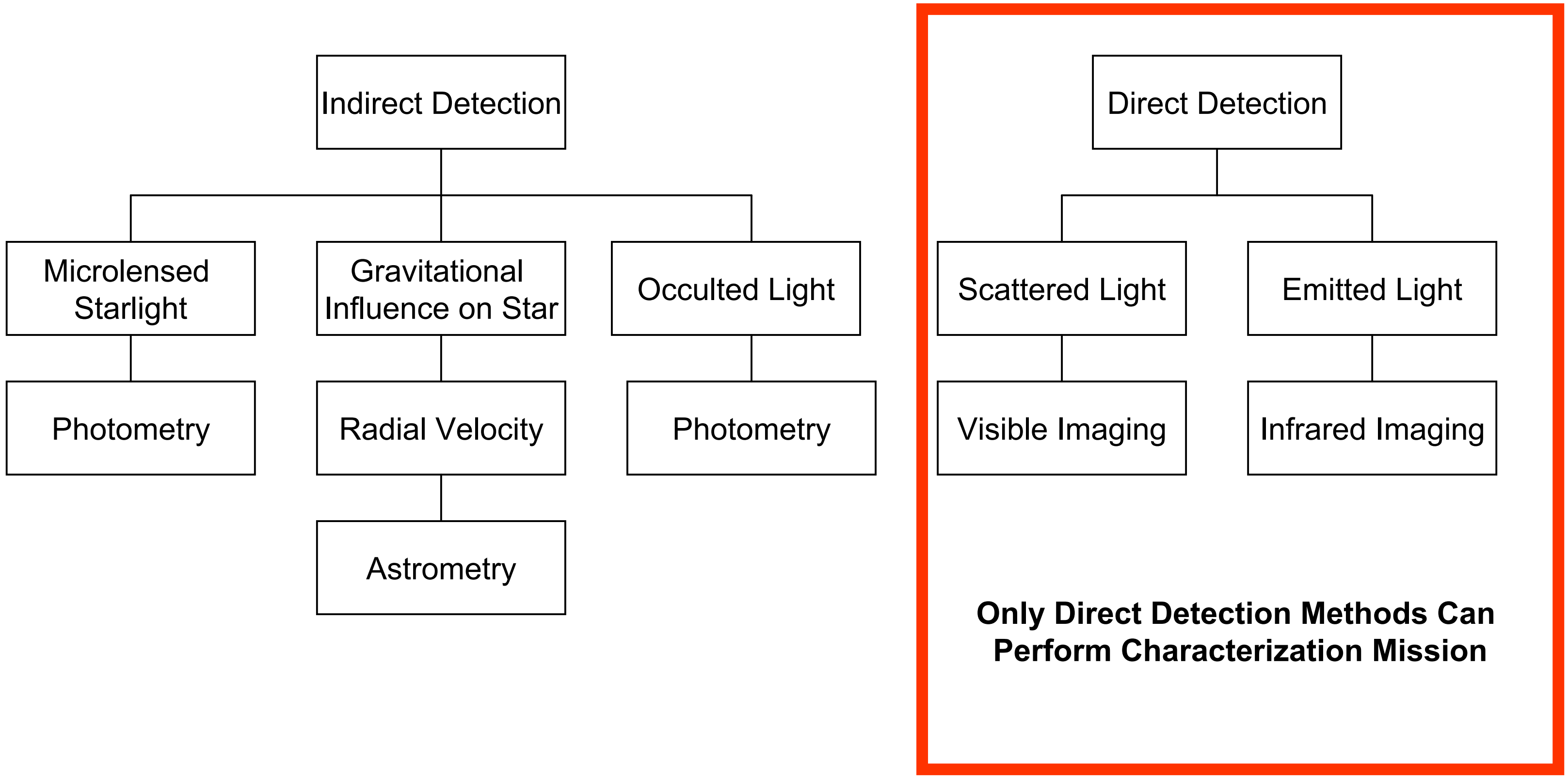
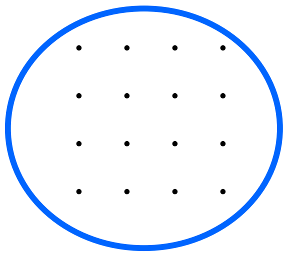


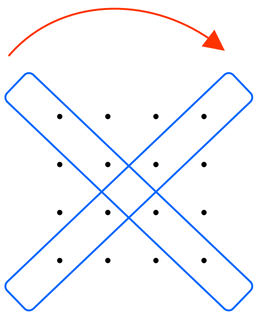
Classes of Direct Detection

- Goal of detecting and characterizing exo-planets necessarily requires large collecting apertures
- Large aperture obtained via:

Using an aperture to Directly Image by simultaneously providing many points in the uv-plane



Using Synthetic Imaging techniques where the uv-plane is sampled sequentially



Issues With Synthetic Imaging Techniques

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- Each technique performs planet detection mission, since planets will be unresolved point sources
- Synthetic imaging techniques are not good for investigating extended source
  - Good imaging requires good uv coverage
  - Sampling process can lead to aliasing
- Synthetic imaging methods are subject to confusion in the presence of complex scenes

Cost Constraint on Science Utility

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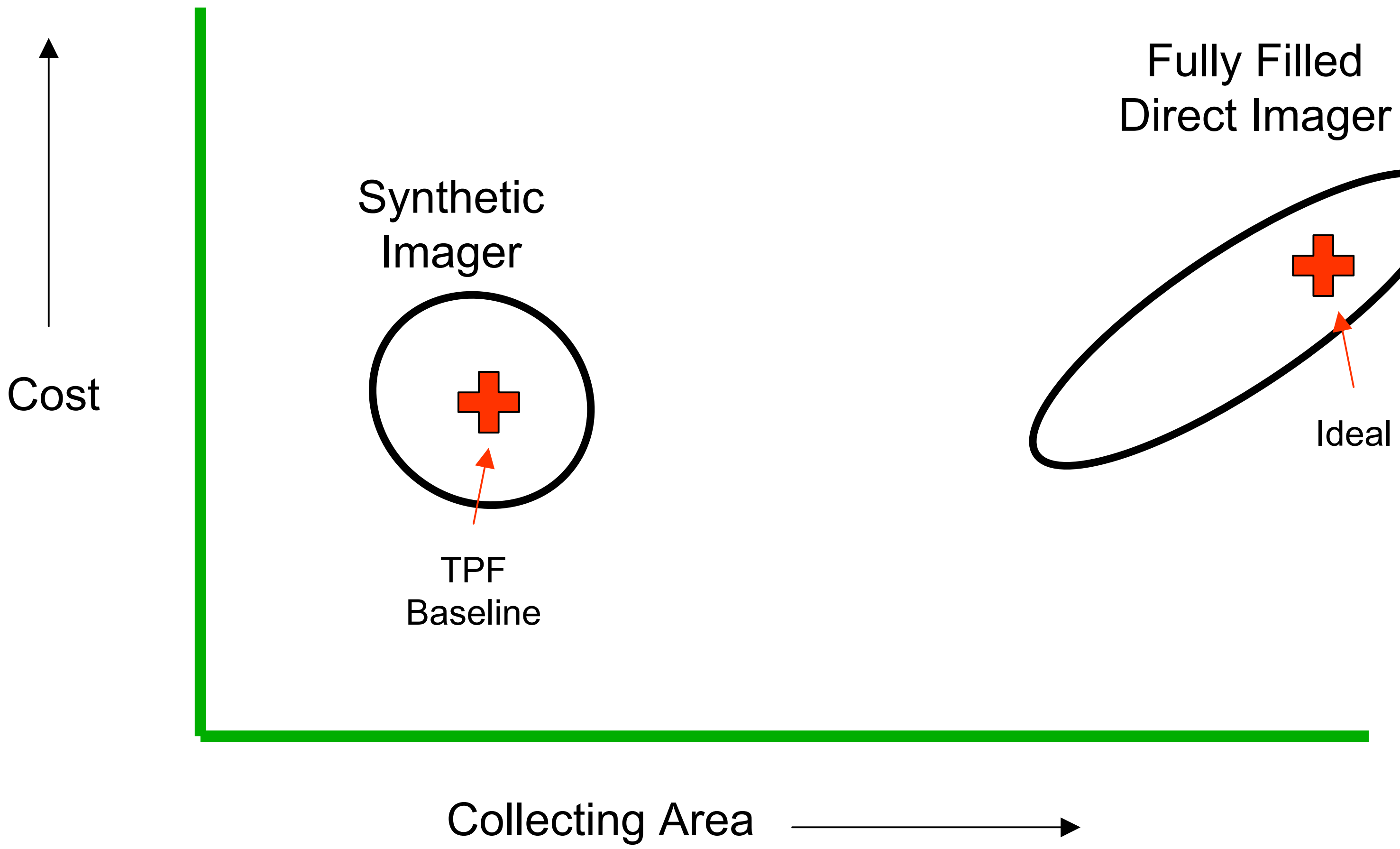

Our Studies Filled This Gap

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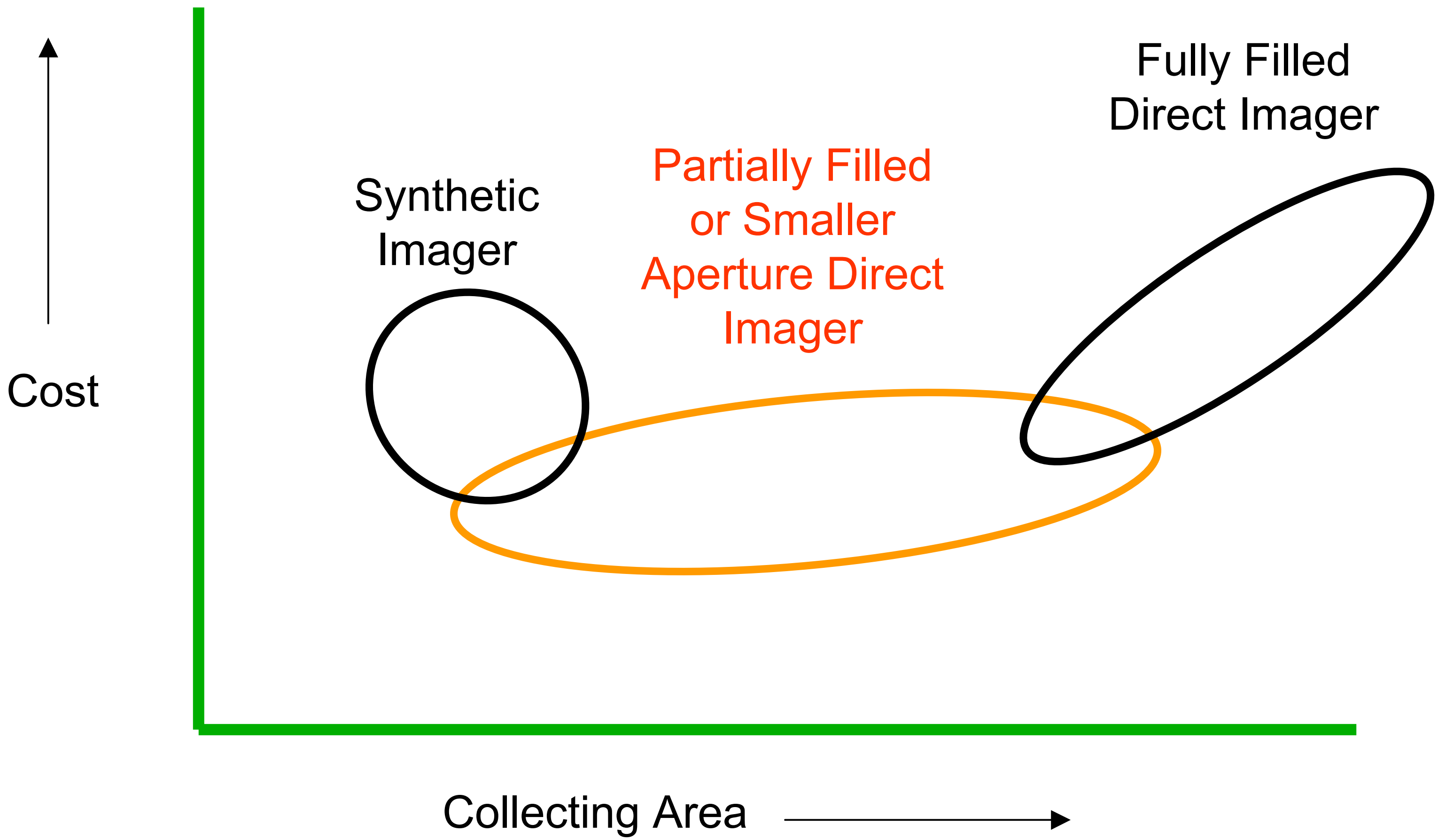

Direct Imagers are Plausible in TPF Timeframe

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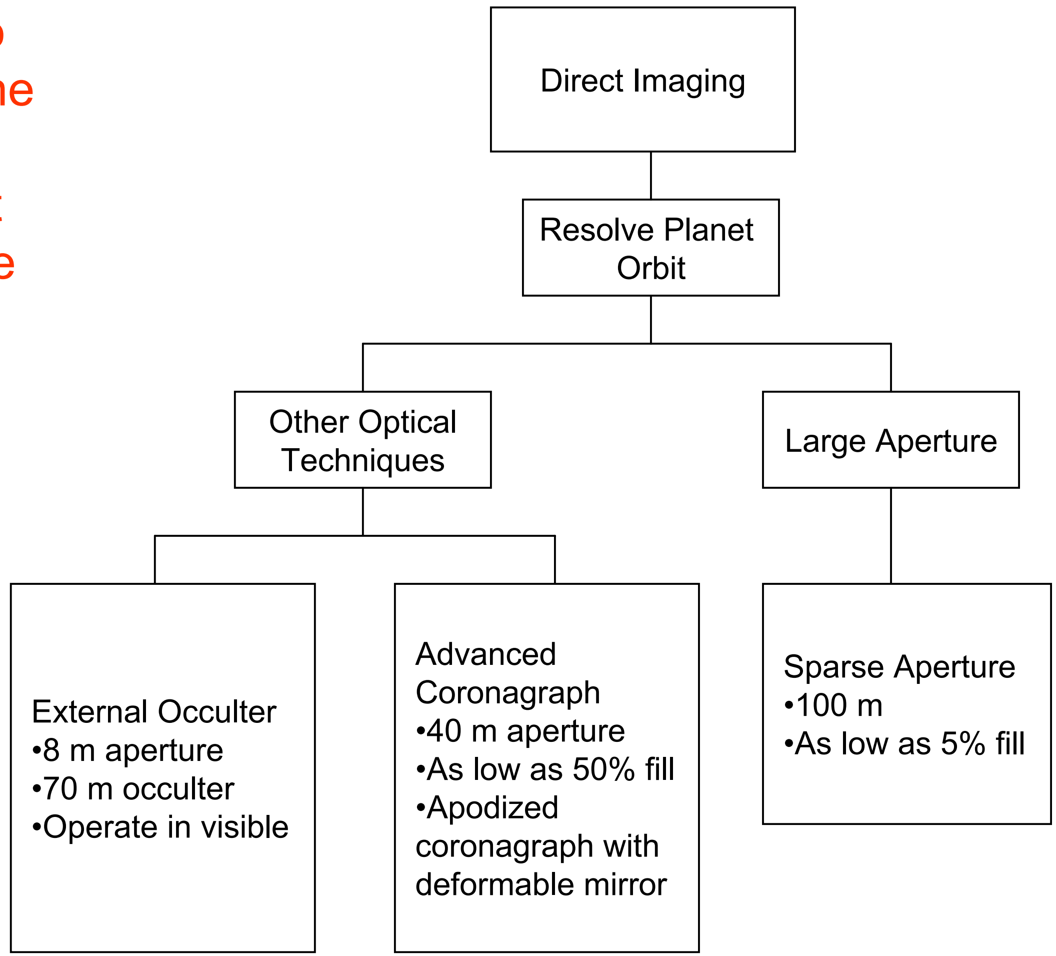
Object is to minimize the amount of “glass” that needs to be placed in space



TPF Terrestrial Planet Finder

Overcoming Planet/Star Contrast Defines Measurement Approaches We Examined

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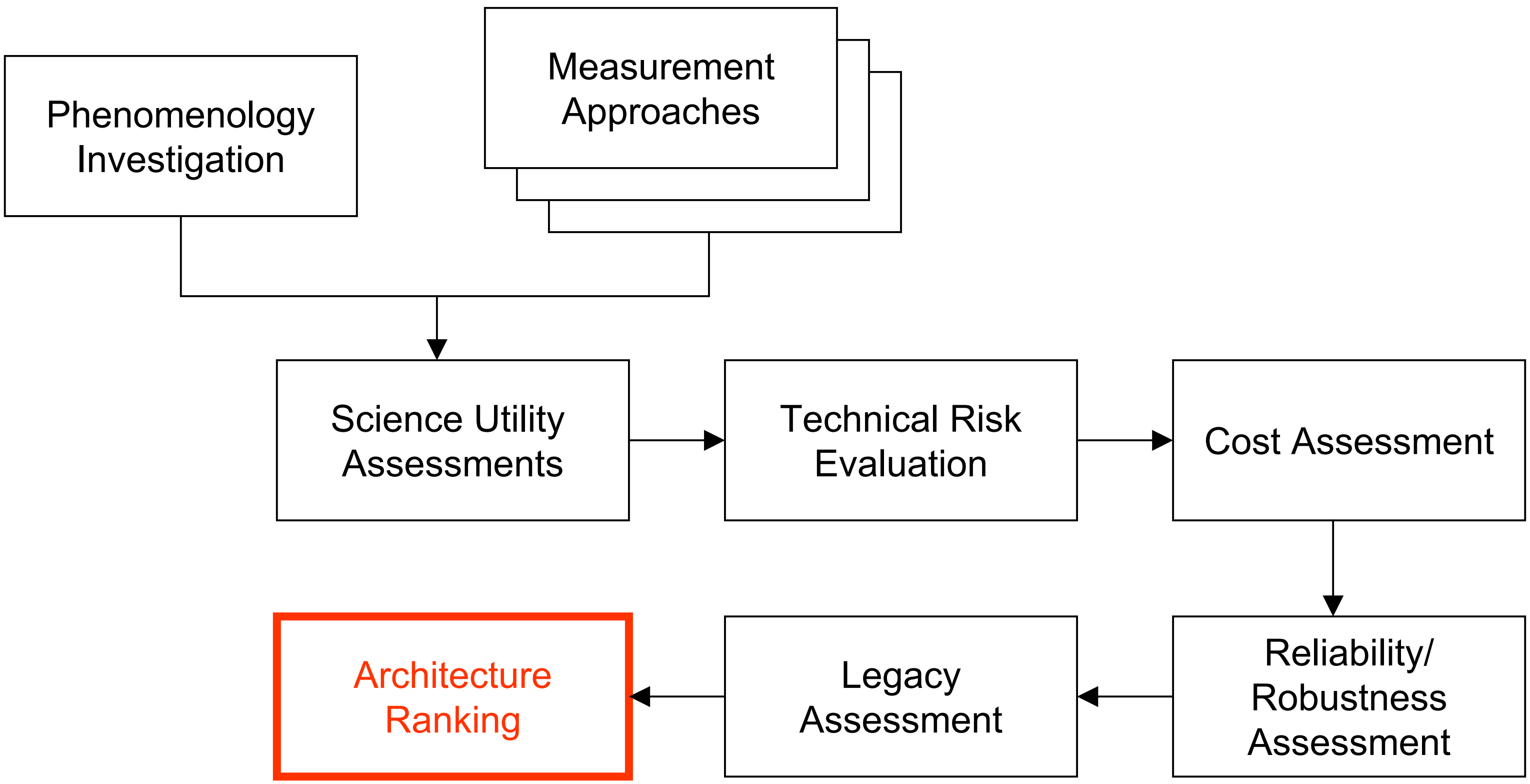
Architecture Name	Abbreviation	Wavelength	Method for Addressing Contrast
Nulling Interferometer (Monolith or Formation Flying)	NI (M) or (FF)	Thermal Infrared	Starlight suppressed through interferometric cancellation
Large Aperture with Coronagraph	LAC	Thermal Infrared	Starlight suppressed by apodized occluding spot in instrument optics
Free-flying Occulter	FFO	Visible	Starlight suppressed by occulting body external to telescope
Fresnel Lens	FL	Thermal Infrared	Operates as large aperture with coronagraph, but with transmitting instead of reflecting primary optics
Ultra-Large Sparse Aperture	ULSA	Visible to Near Infrared	Aperture sized sufficiently large to resolve planet and star, starlight suppressed with simple internal occluding spot

This does not represent an exhaustive list, since additional combinations of techniques and wavelengths may also be viable

Our Conclusions are Supported When Compared Against JPL Criteria



Small Direct Imagers Provide Optimal System Utility per Dollar

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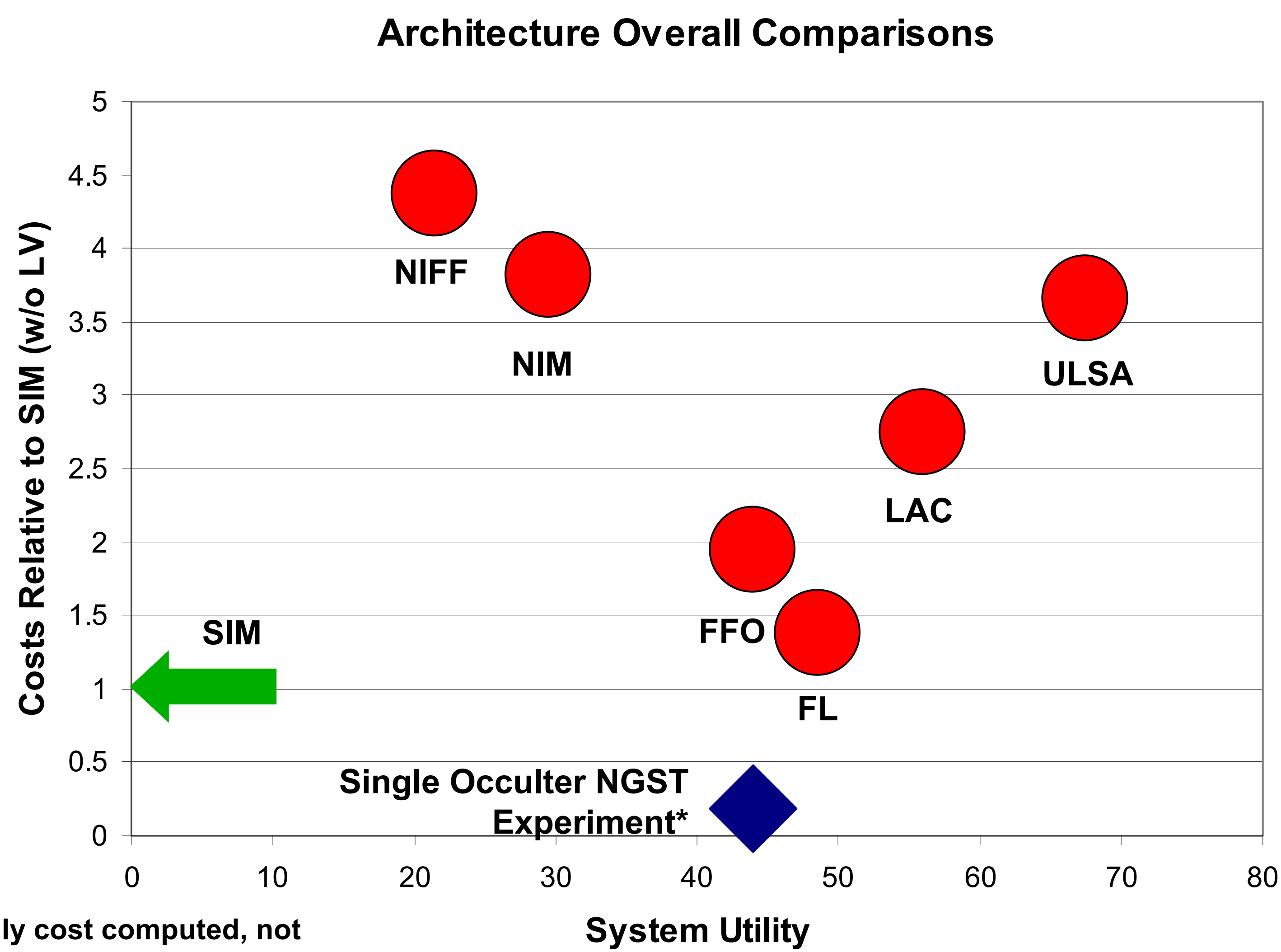

*Only cost computed, not system utility

Key Results of Architecture Assessments

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Architecture	Major Strengths	Major Weaknesses
LAC	• High science utility • Good heritage from NGST • High Agility	• Technical risk associated with low areal densities • Deployment complexity
FL	• High science utility • Moderate system complexity • Some heritage from NGST	• Distributed system impairs agility • Technical risk associated with deploying
USLA	• Extremely high science utility • Best path to third generation Origins missions • High system robustness	• High system complexity (especially in formation flying implementation) • Low agility • Highest cost
FFO	• Good heritage from NGST • Potential as a low cost experiment for NGST • Simple system	• Extremely low agility and field of regard • Limited range of angular resolution
NI(M)	• Smaller collecting apertures • Least technical risk of interferometer implementations	• System complexity • Operation complexity • Sun angle limitations impair field of regard • Confusion • Low legacy
NI(FF)	• Smaller collecting apertures • Variable aperture size	• System complexity • Operation complexity • Sun angle limitations impair field of regard • Confusion • Low legacy • Moderate agility • High cost