

IEMT Comments on Hybrids

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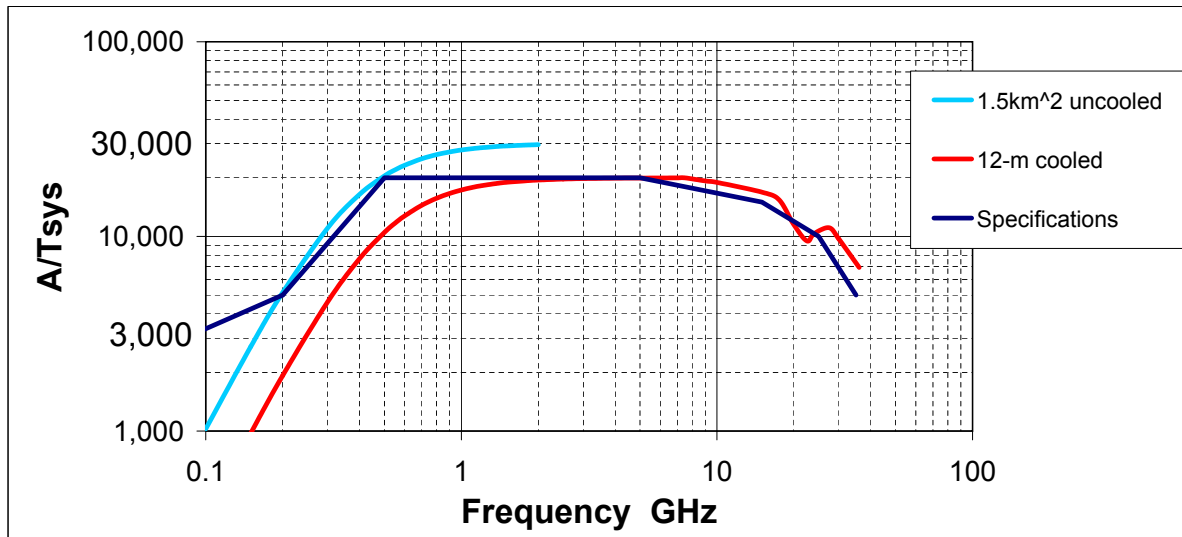
Introduction

- ▷ IEMT met last week and discussed hybrids and the process of convergence
- ▷ Considered following concepts:
 - ▷ LAR as a hybrid substitute
 - ▷ Aperture Array + Small Dishes
 - ▷ Cylinders + Small Dishes
 - ▷ also introduced to wide-field dishes with focal-plane arrays

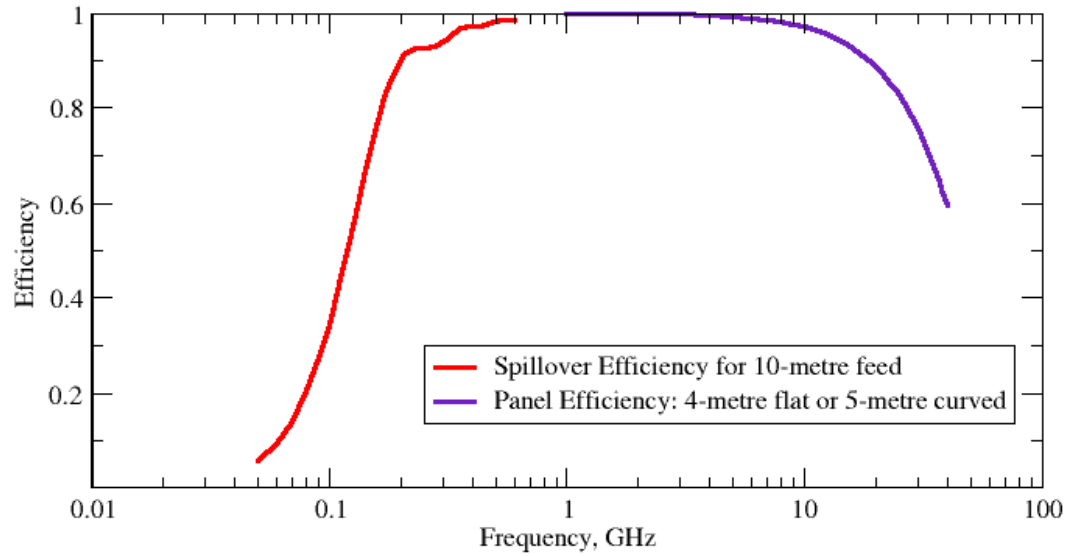
Why Consider Hybrid Configurations?

- ▷ Does not reduce the risk of reaching cost or performance goals
- ▷ Expands some of the capabilities of the SKA
- ▷ Changes “trajectory” through parameter space
- ▷ But probably have a higher cost and/or lower A_{eff}/T_{sys}
- ▷ Should we be using expensive high-frequency capable aperture at low frequencies where a much lower-cost solution is available?

Generic Hybrid



LAR—An Alternative to Hybrids



LAR—Phased-Array Feeds

- ▷ Only one experiment involving a phased-array feed has been performed to date
- ▷ Phased-array feeds are essential for the LAR so that the feed pattern matches the elliptical profile of the reflector and so that a wide field-of-view is obtained
- ▷ Uncooled LNAs may be adequate to ~ 2 GHz and cooled required above
- ▷ How confident will we be in 2008 that high-performance phased-array feeds can be built for the LAR?
- ▷ How confident will we be in 2008 that high-performance *cooled* phased-array feeds can be built for the LAR?

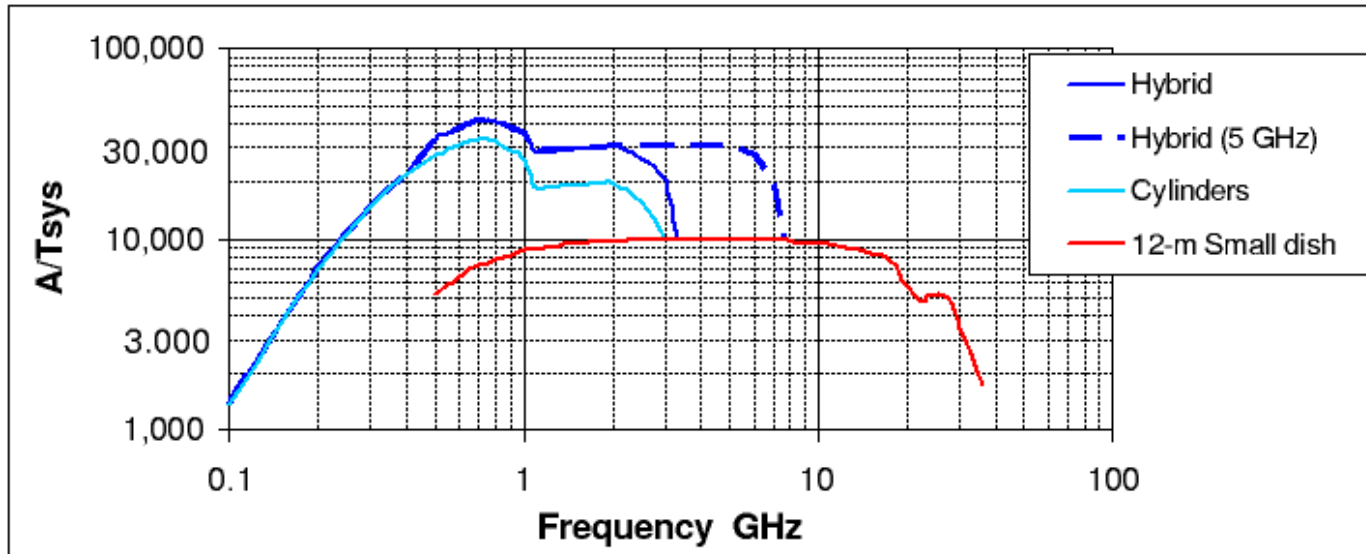
LAR—Low-Frequency Performance

- ▷ Latest SKA spec calls for 200 square degrees field-of-view at 0.7 GHz
 - ▷ LAR has a field-of-view limited by focal-package size ($\sim 10\text{m}$?)
- ▷ Specification calls for widely-separated field-of-views, either by sub-arrays or phased-array techniques
 - ▷ Small-n arrays will have poor performance in sub-array observing modes

SD + FPA—Another Alternative

- ▷ SD could be either Indian PPD or US hydroformed dish
- ▷ US SD meets high-frequency spec's
- ▷ SD cannot provide multiple, widely-spaced beams on the sky without sub-arrays
- ▷ Recently proposed that wide-field spec be met with a focal-plane array
 - ▷ to get 200 sq. deg. need field width $\sim 15^\circ$
 - ▷ how large will aberrations be this far off axis?
 - ▷ earlier concerns on focal-plane array development apply here too

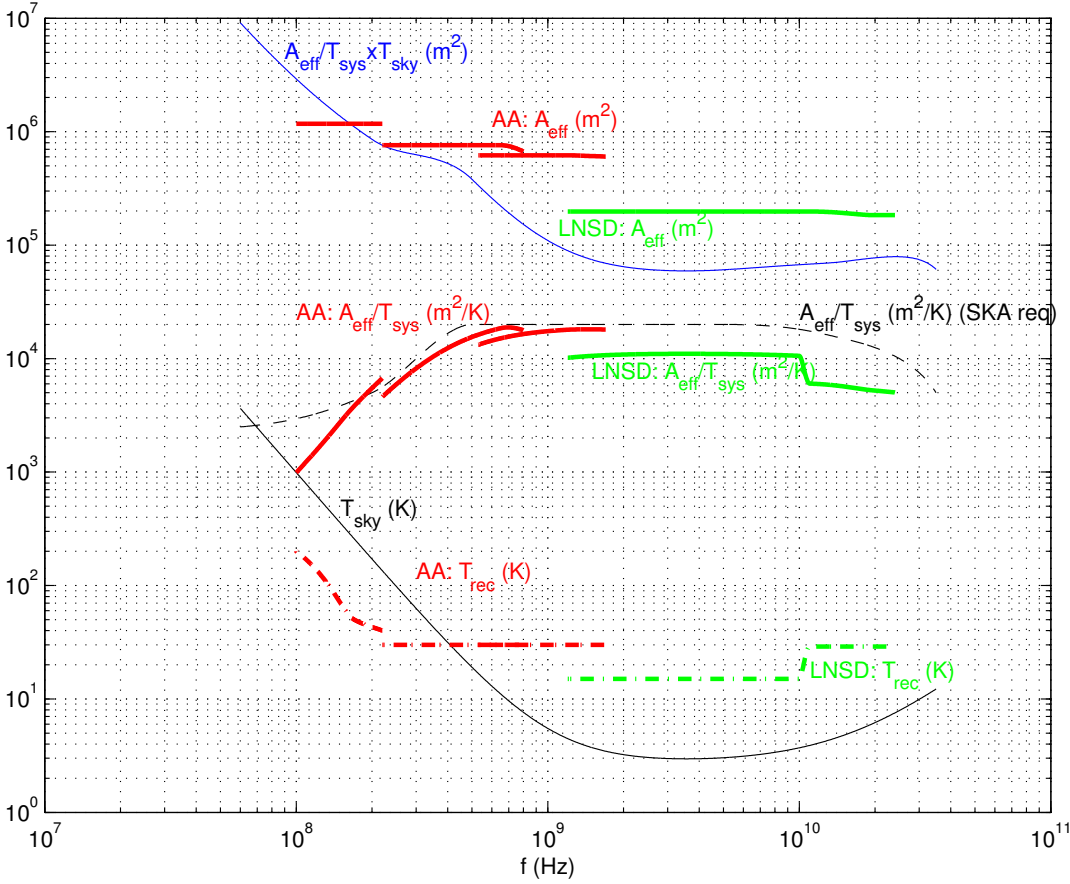
CYL + SD



CYL + SD (2)

- ▷ Offers very wide field-of-view at low frequencies
- ▷ Does not provide independent widely-spaced beams
- ▷ Wide-band line feed yet to be demonstrated
- ▷ Again, dependent upon phased-array feed technology
- ▷ Although many beams within a large field-of-view are available, only the central beam can be pointed independently...how will these other beams be used?
- ▷ Requires more thorough investigation of fabrication cost of cylinders

AA + SD Hybrid



AA + SD Hybrid (2)

- ▷ *Heavily* dependent upon low-noise phased arrays
- ▷ Construct much more than a square kilometre because each receiving band has a separate aperture
- ▷ Have a huge number of receivers \Rightarrow need very low-cost
 - ▷ scepticism concerning cost extrapolations
 - ▷ Moore's Law helps electronics, but not radomes etc.
- ▷ Although EMBRACE will be completed by 2008, will have very little operational experience

Are hybrids affordable?

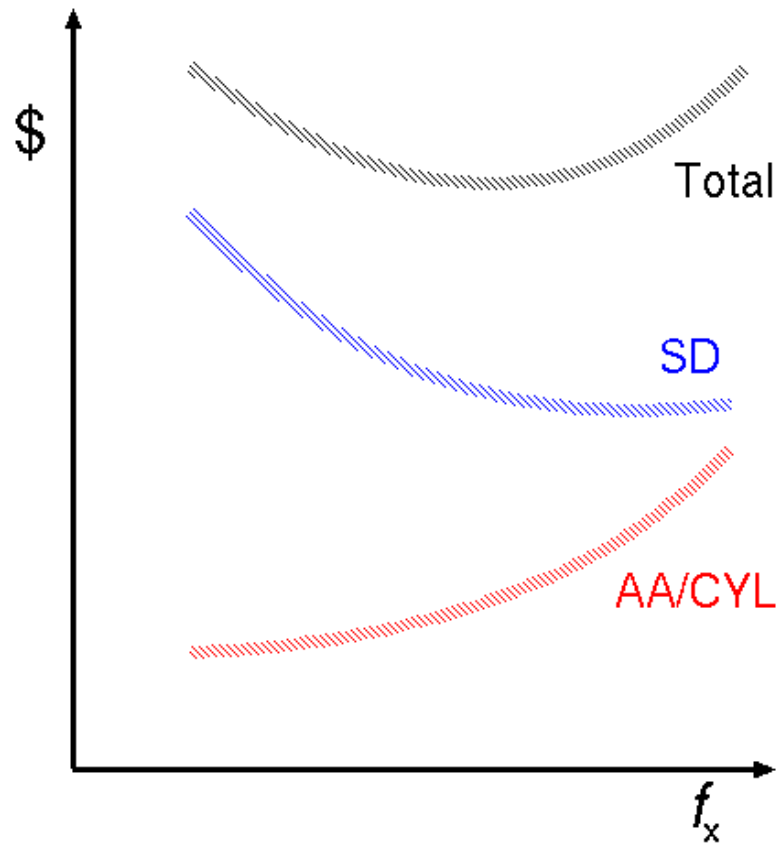
- ▷ \$1.2–1.4 billion
- ▷ Hybrids will have $2\times$ NRE
- ▷ Added operational expenses
- ▷ Jaap Bregman has an interesting optimization procedure that should be looked at carefully
- ▷ high-level economic analysis

area	:	rx	:	correlator	type
6	:	2	:	1	single field
3	:	2	:	1	survey

Should There be Any Frequency Overlap?

- ▷ Can be argued that one way to optimize components in hybrid (performance/cost) is to minimize frequency overlap
- ▷ Also concerns that wide-field imaging will be very difficult with different concepts because of dissimilar beams (may not be a problem for non-imaging applications)
- ▷ Counterargument is that overlap is a way to boost sensitivity
 - ▷ if we have the concentrator area, use it as much as we can
- ▷ Hybrid demonstrator probably not needed if no frequency overlap

Should There be Any Frequency Overlap? (2)



Strawman Hybrid

- ▷ Have used AA+SD as a strawman
- ▷ Should not be viewed as an expression of preference
- ▷ Strawman is to be viewed as a target
- ▷ Should be seen as something to try to surpass

Discussion of Risk

- ▷ Presently highly subjective
- ▷ Probably relative risk, not absolute
- ▷ US Decadal Review forces 2008 concept selection date, making it difficult to reduce risk because of time constraints
- ▷ Take the point of view of a reviewer in 2008, what is the risk of missing cost and/or performance targets?

Risk of Possible Components

Concept	Freq	Cost Risk	Performance Risk
LAR	< 22 GHz	High	High ^{2,3}
KARST	< 2 GHz	High	Medium–High ²
CYL	< 2 GHz	Medium	Medium ²
AA	< 2 GHz	High	Medium
SD	> 1 GHz	Low ¹	Low
PPD	< 5 GHz	Low ¹	Medium ²

¹ Technology risk is low but computing cost uncertainty may increase to medium

² Low-frequency FPA unproven

³ Cooled FPA yet to be developed

Where do we go from here?

- ▷ Cost calculator will help in costing hybrids and with optimization
- ▷ AA+SD deserves further study
- ▷ Suggested that SD+LAR be investigated
- ▷ PPD+FPA interesting concept for wide-field low-frequency observing
- ▷ “Year in the life of” studies to better understand how the hybrids will be used?
- ▷ Begin a more formal risk analysis