

FRONTIERS IN ASTRONOMY

with the World's Largest Radio Telescope
Washington Sep 12-13, 2007

Focal Plane Array Technologies for Arecibo

By Germán Cortés M.



**National Astronomy
and Ionosphere Center**



Cornell University
Ithaca NY 14853, USA




National Astronomy and Ionosphere Center




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Overview

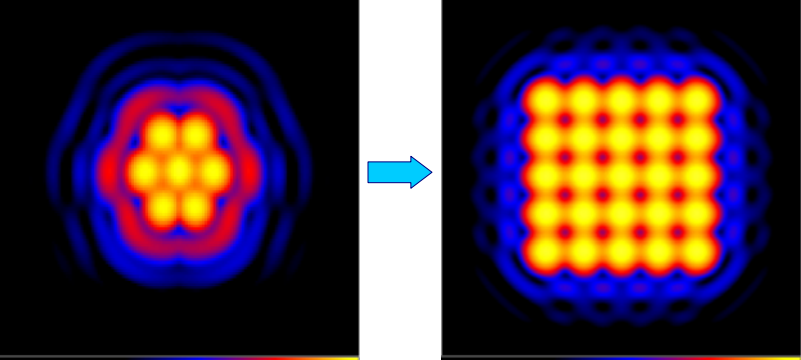
- Motivation
- Focal Plane Array Technology Paths
- Focal Plane Cameras New Possibilities
- Focal Phased Arrays
- Summary

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Motivation


Now **Next**



ALFA **M-ALFA**

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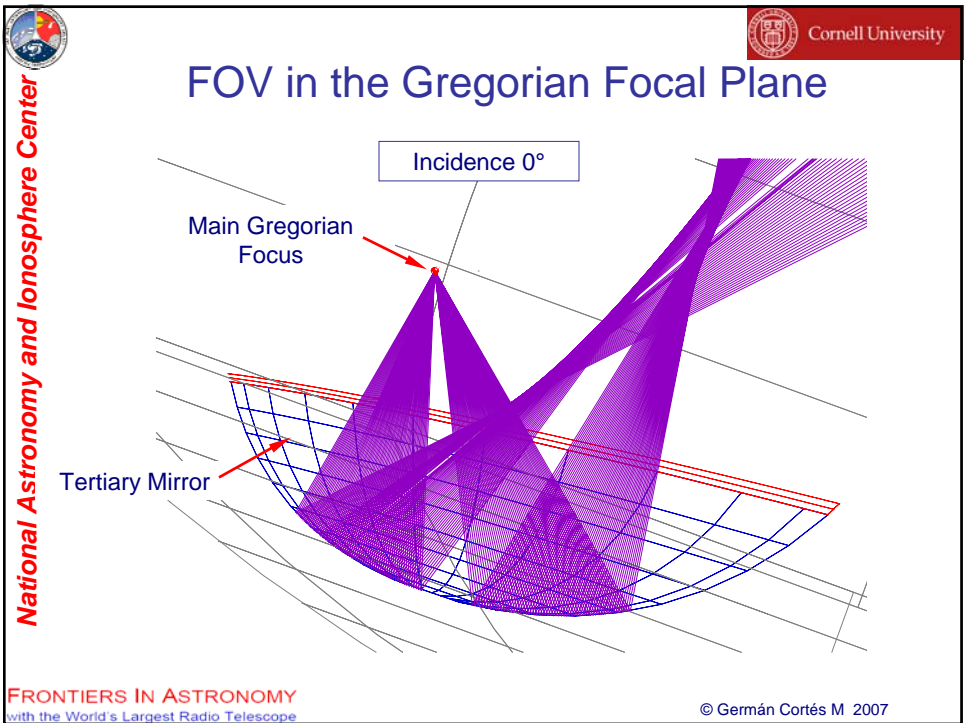
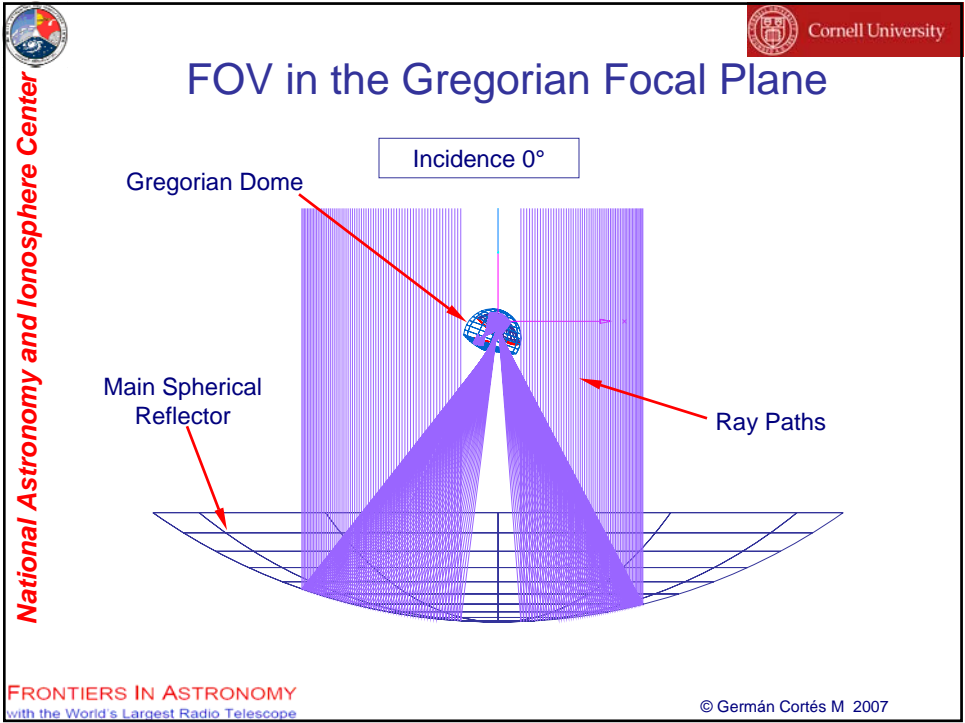
 **National Astronomy and Ionosphere Center**

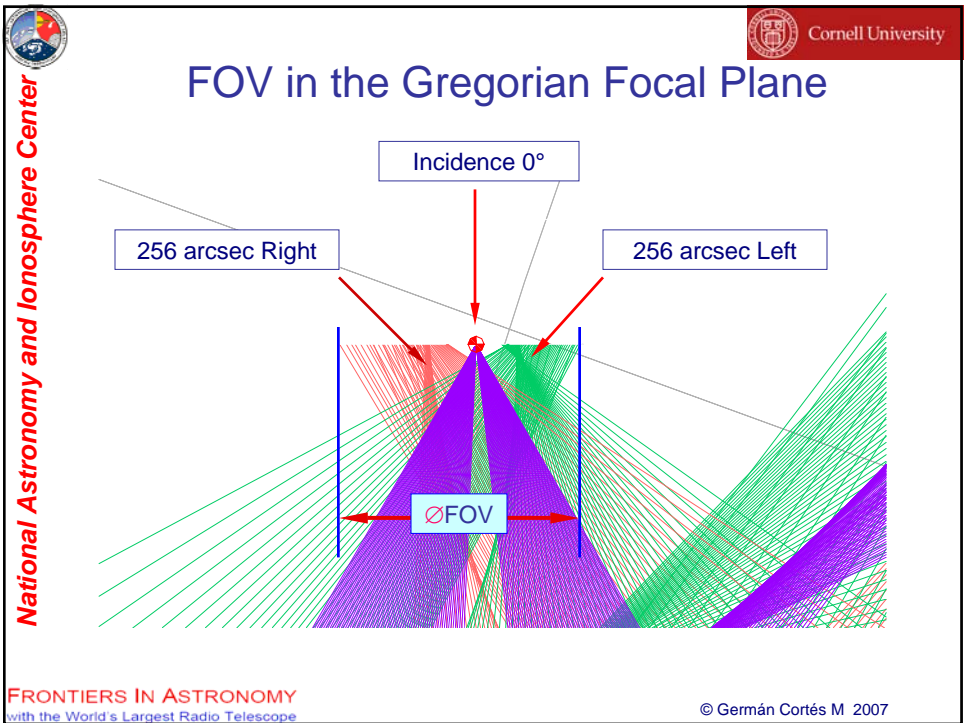
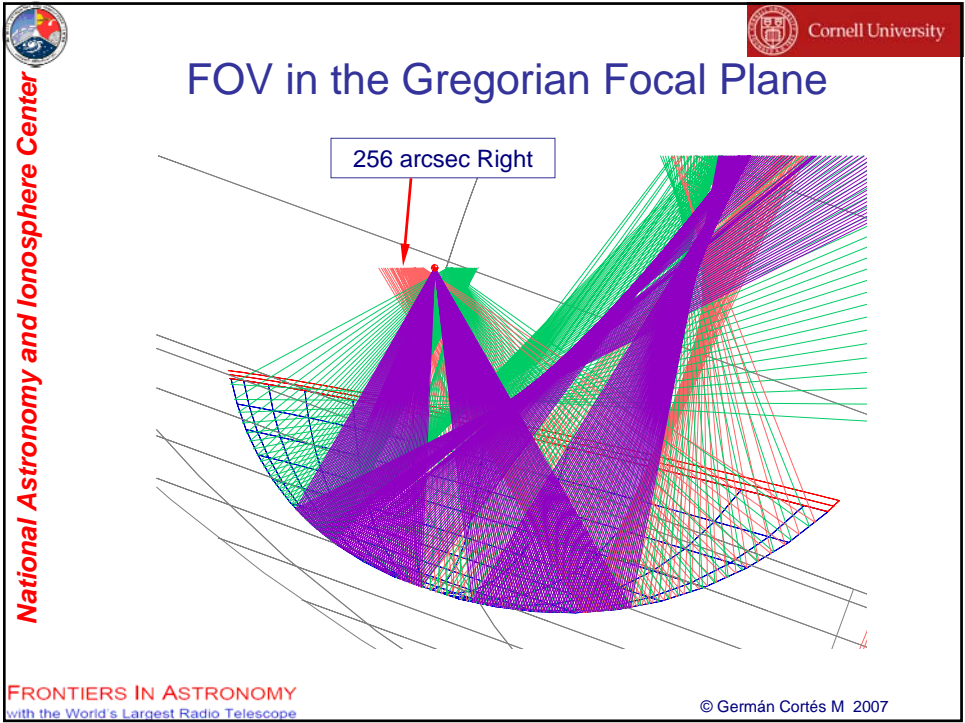
 Cornell University

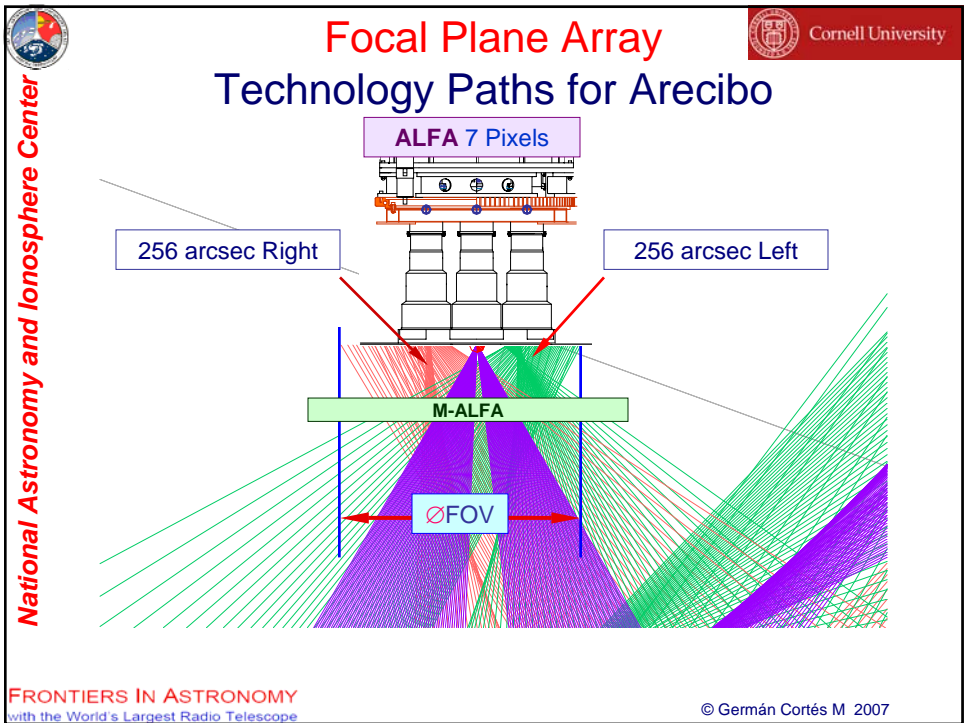
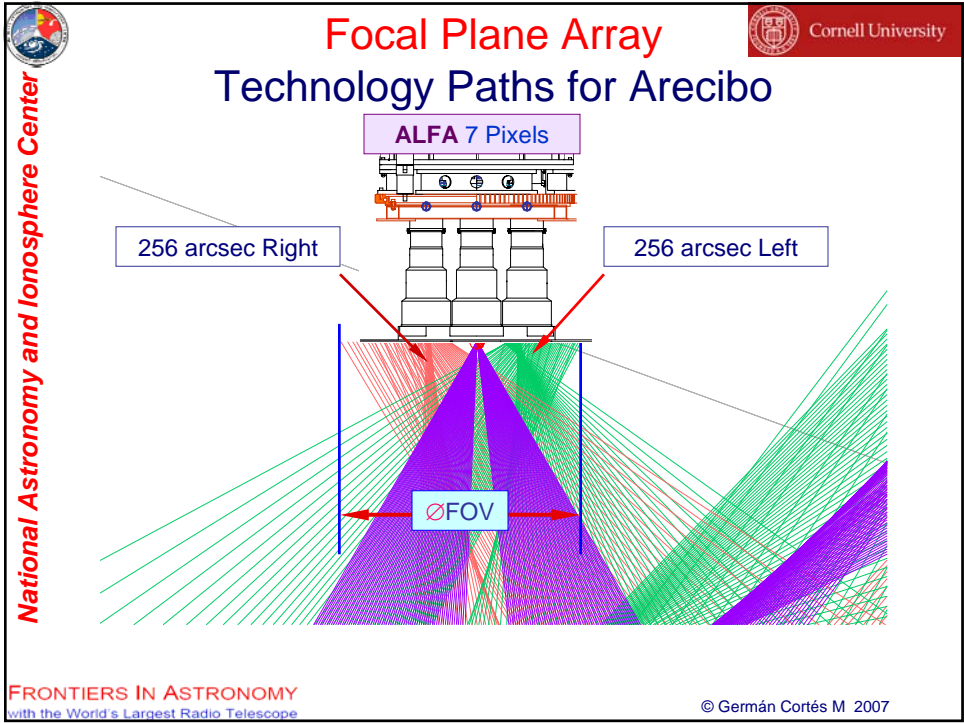
Gregorian Field of View Tour

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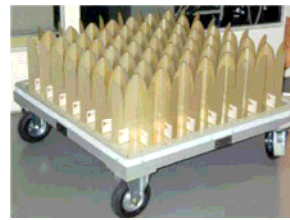






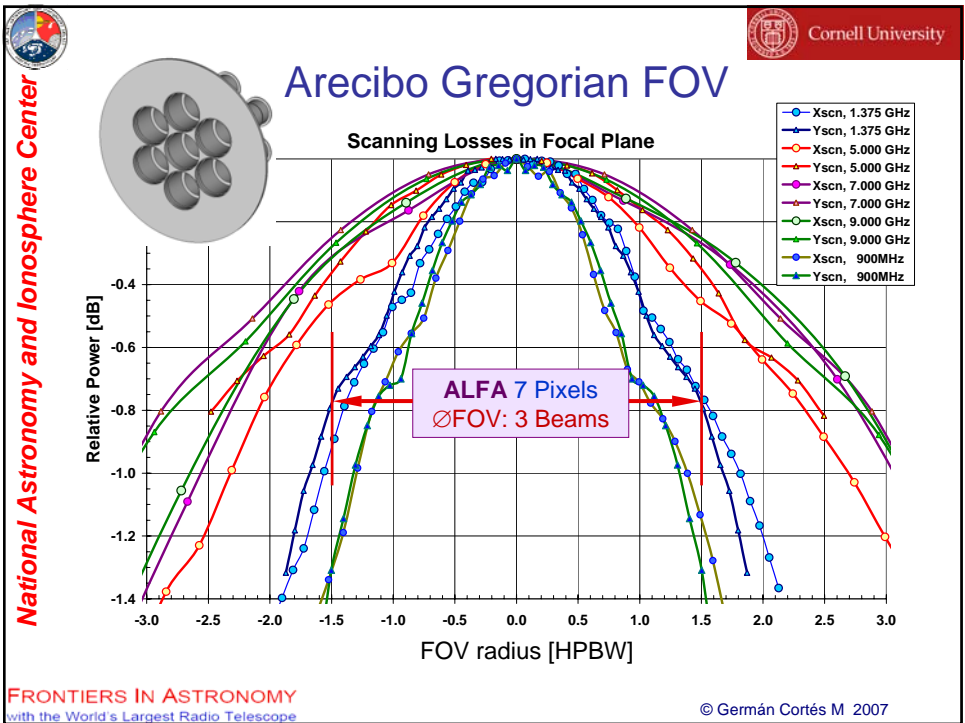
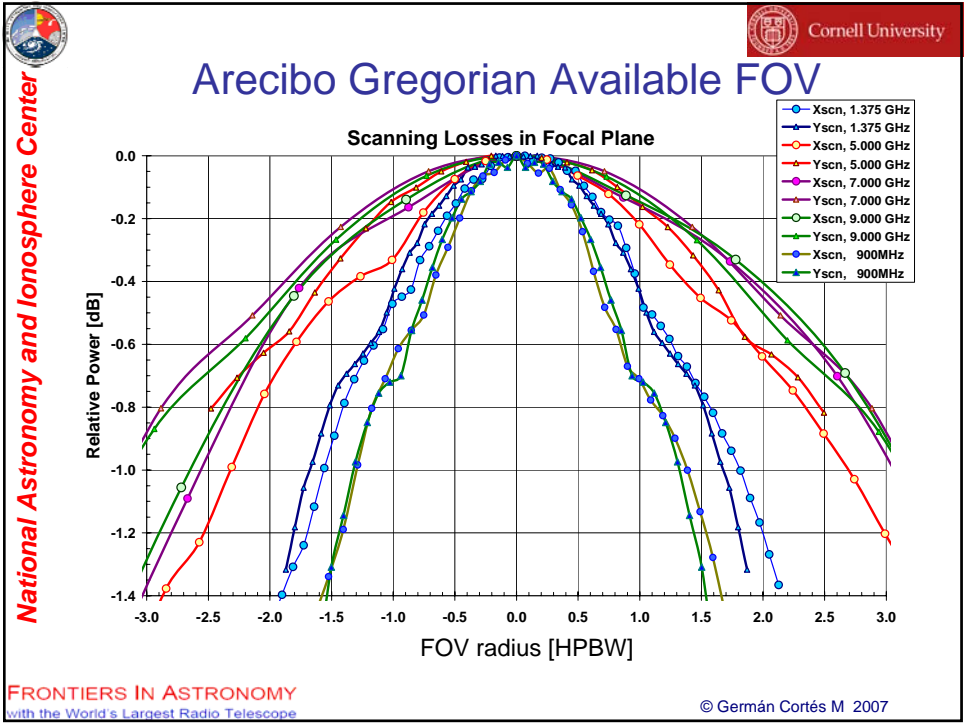
Focal Plane Array Technology Paths for Arecibo

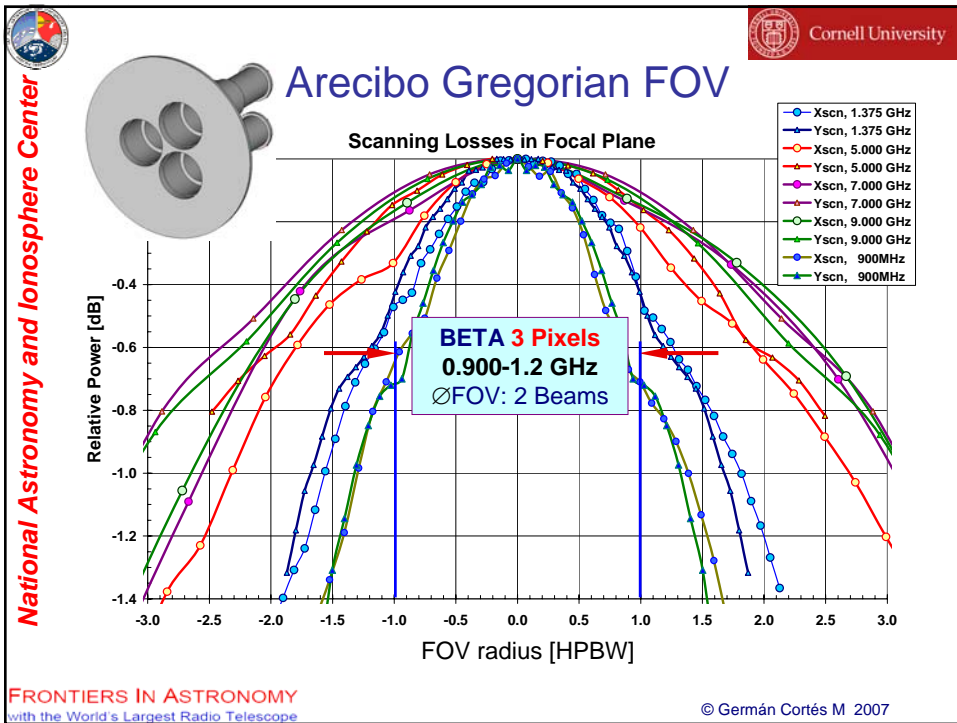
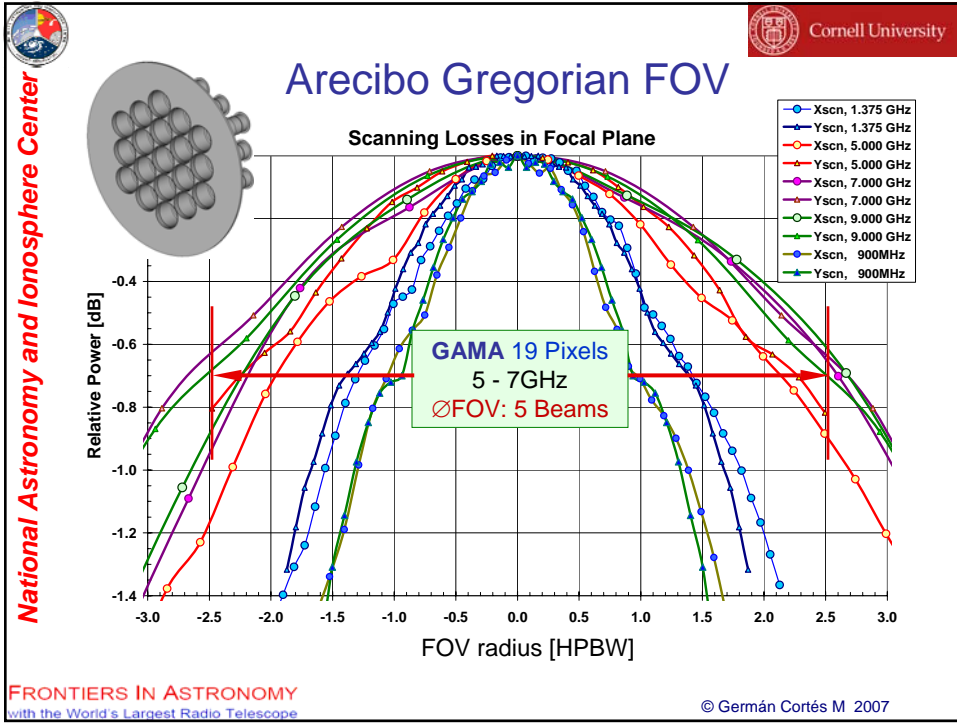
- Multi-Pixel Cameras: **ALFA**
- Focal Phased Arrays:
Phased Antenna Arrays in
The focal plane of the telescope



Focal Plane Cameras

New Possibilities





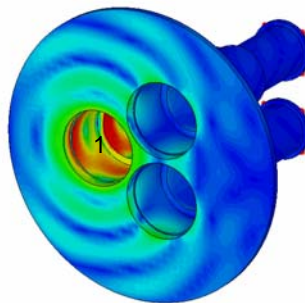


Focal Plane Cameras New Possibilities

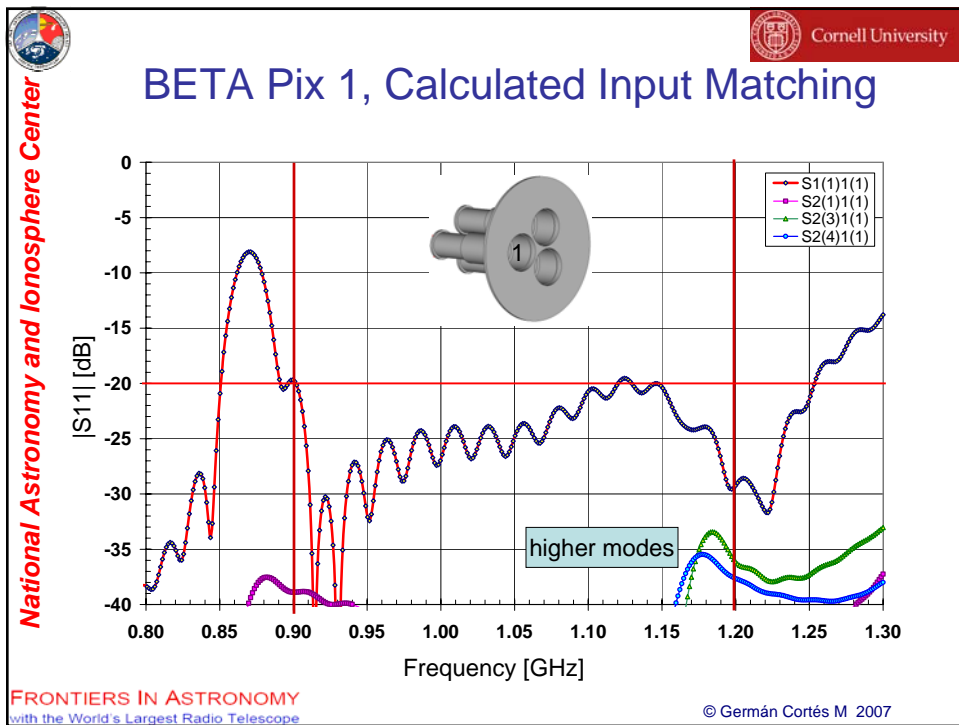
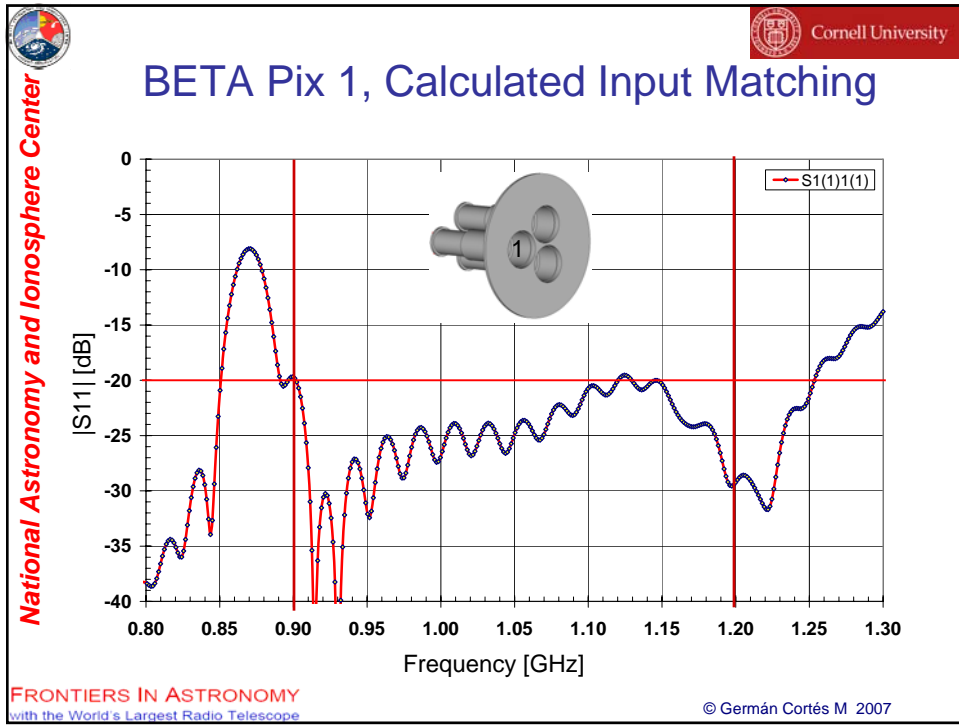
Going BETA...

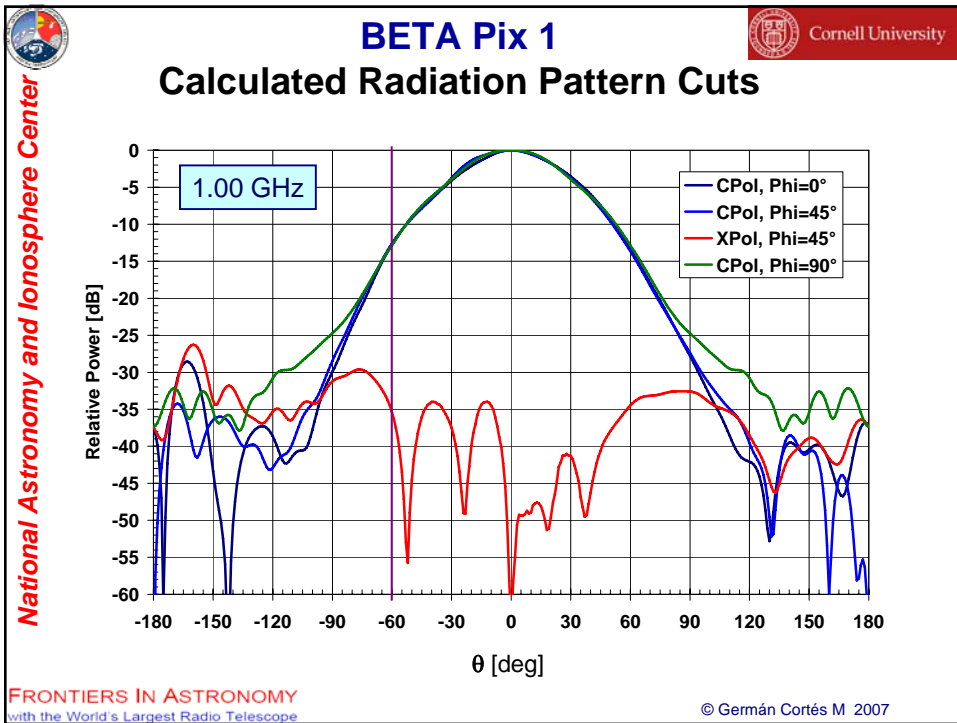
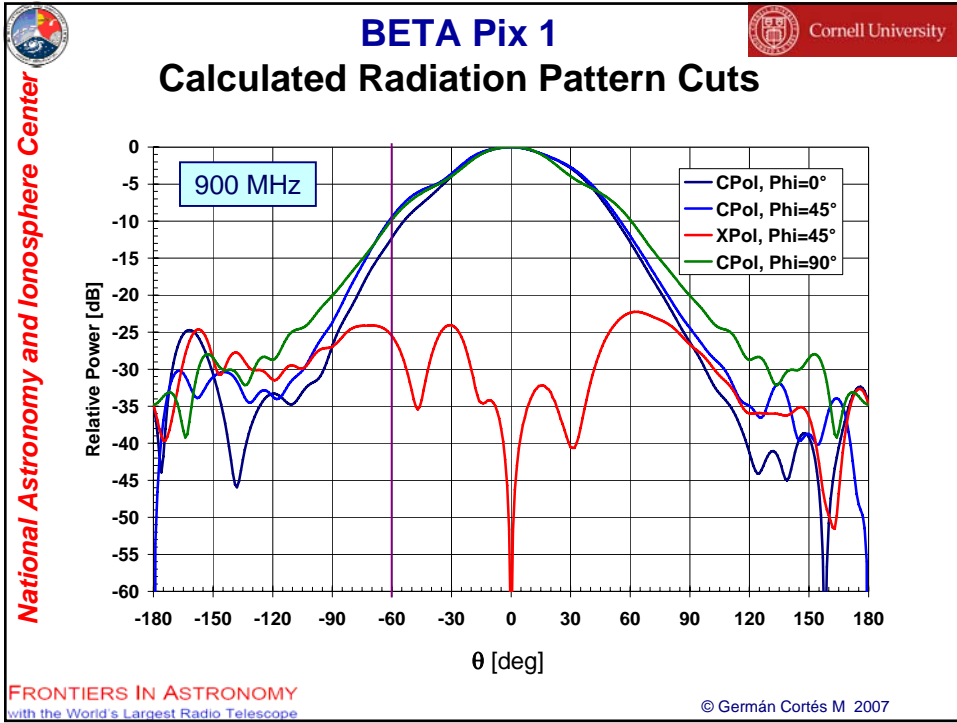


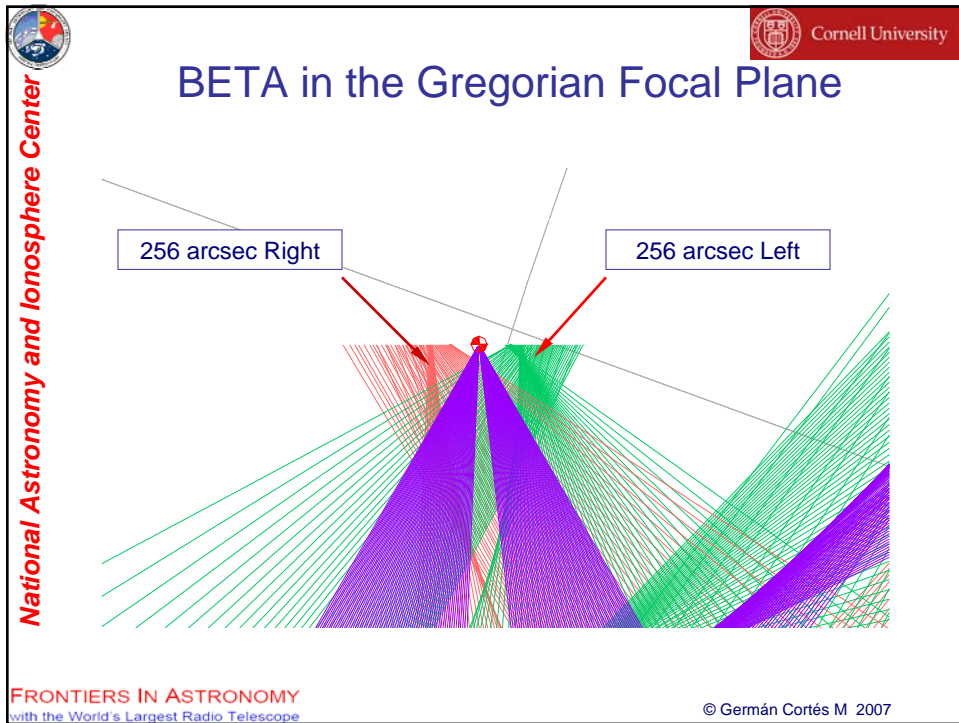
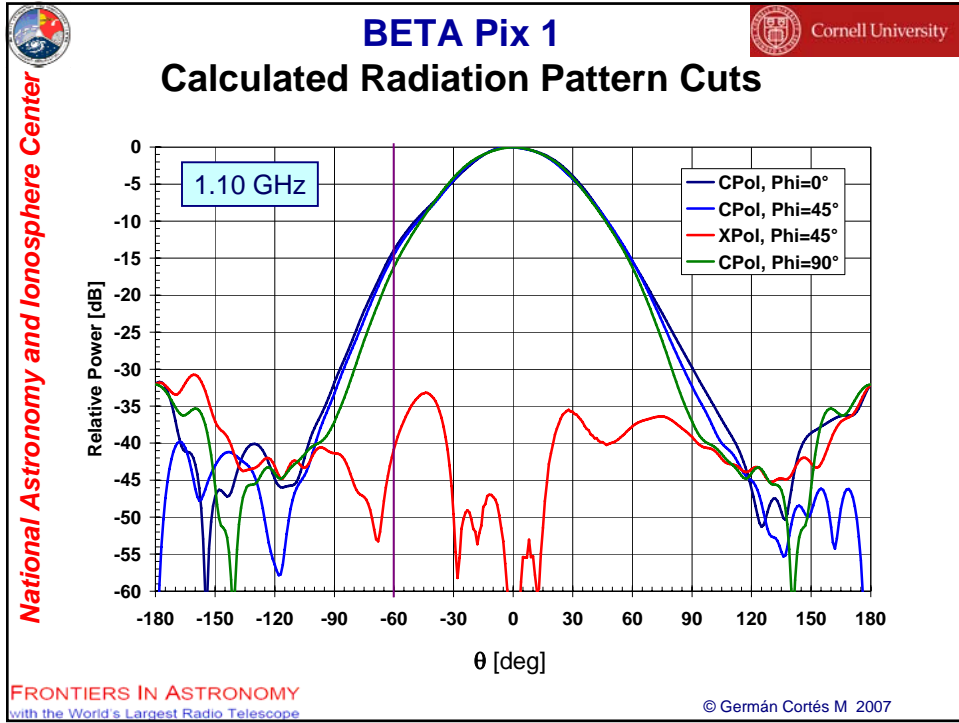
BETA Feasibility

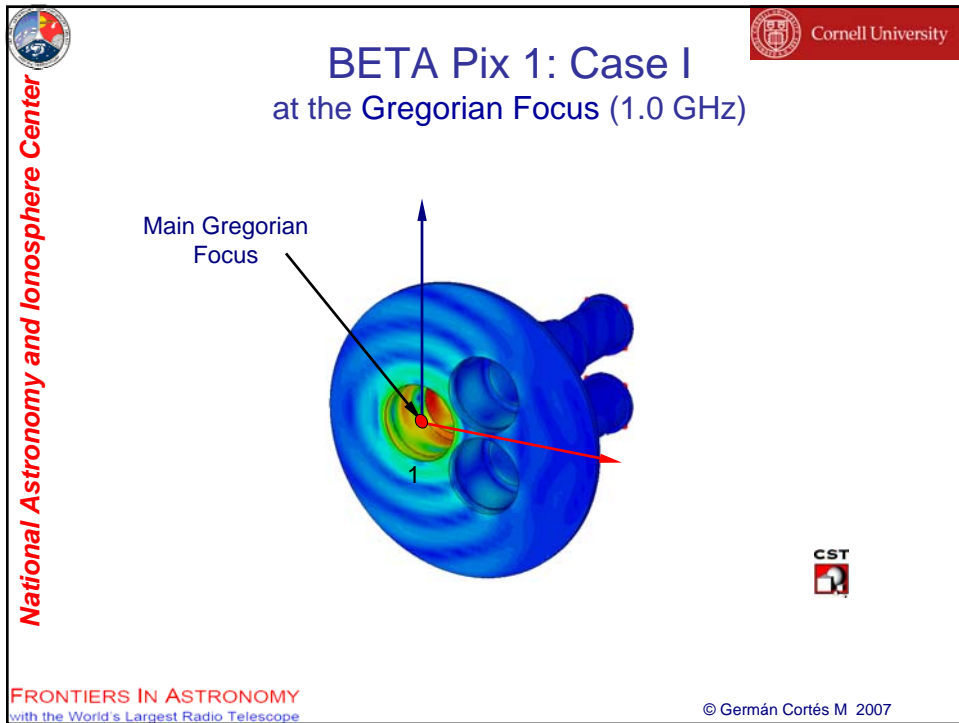
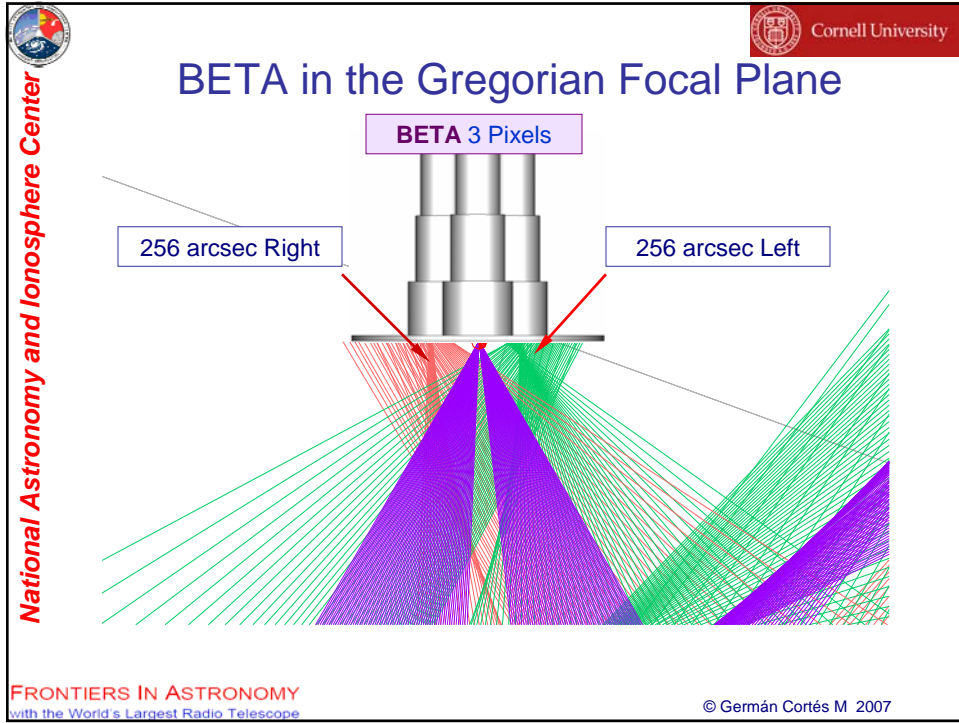


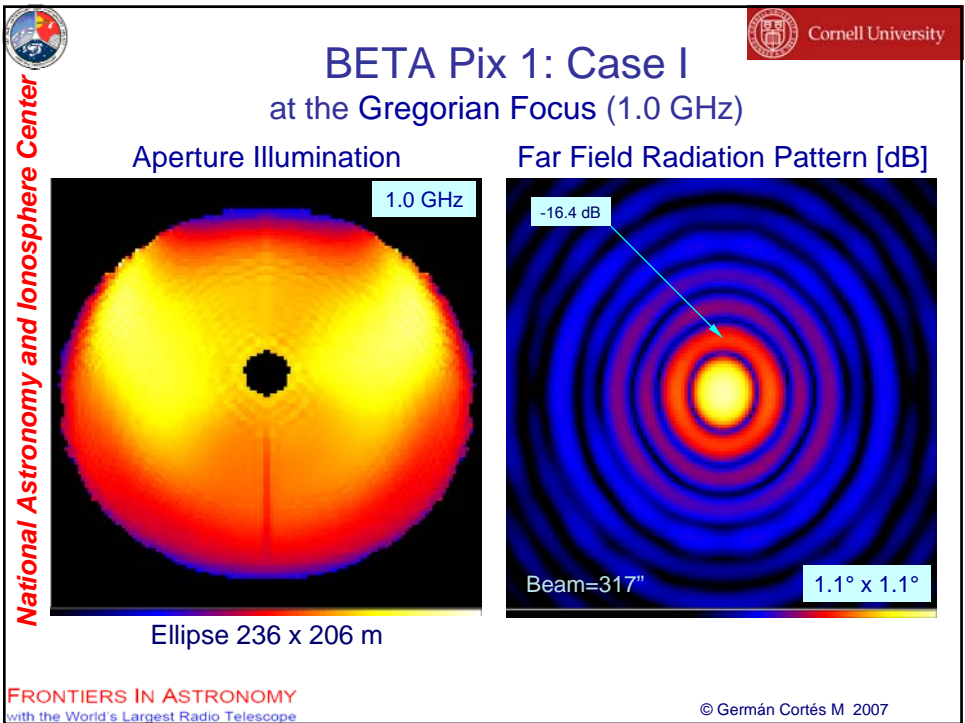
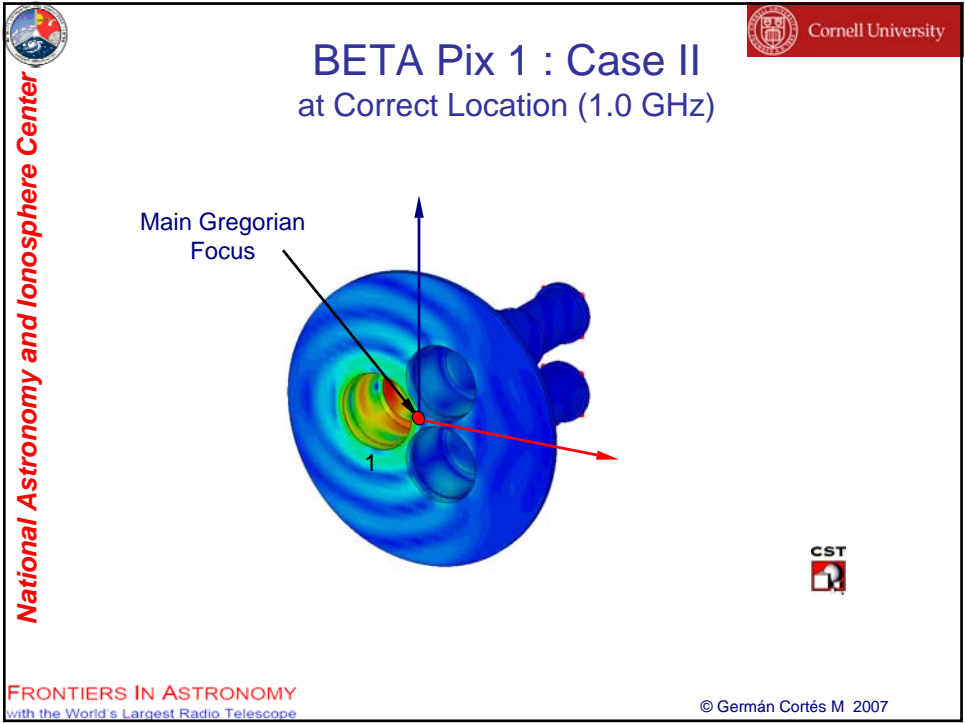
Type = H-Field (peak)
Monitor = h-Field (Fw0.5) [1(1)]
Component = Abs
Max/min/3d = 2.38261 A/w at 11.2963 / -10.8144 / -1043.78
Frequency = 0.9
Phase = 337.5 degrees

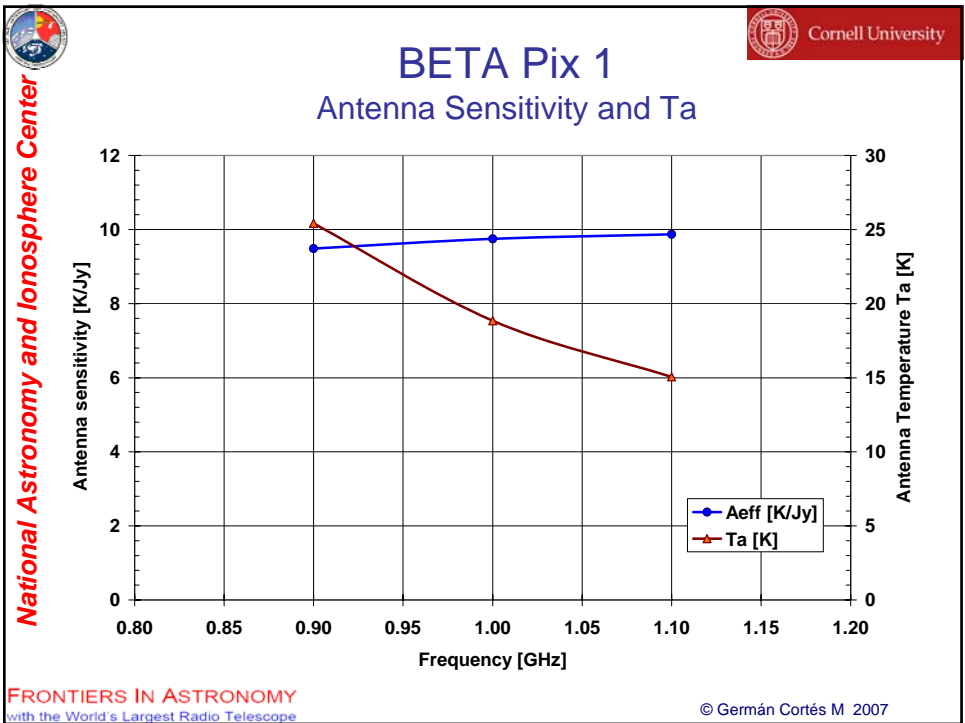
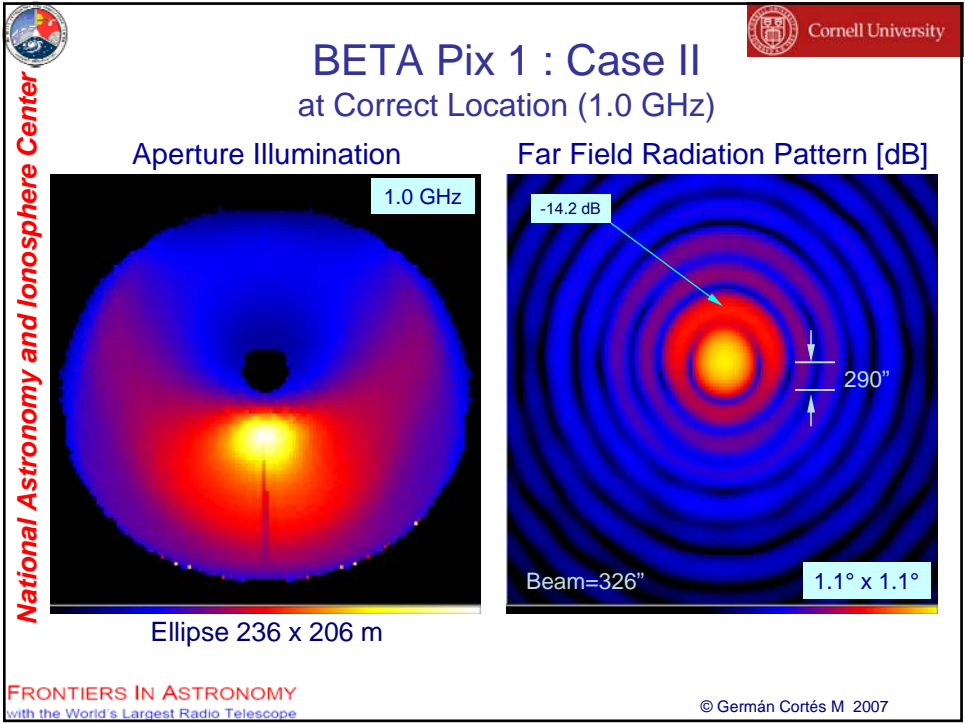










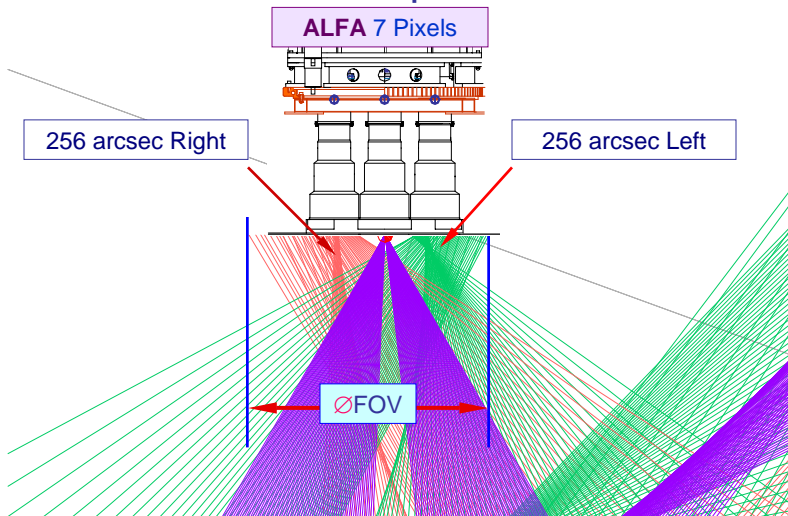


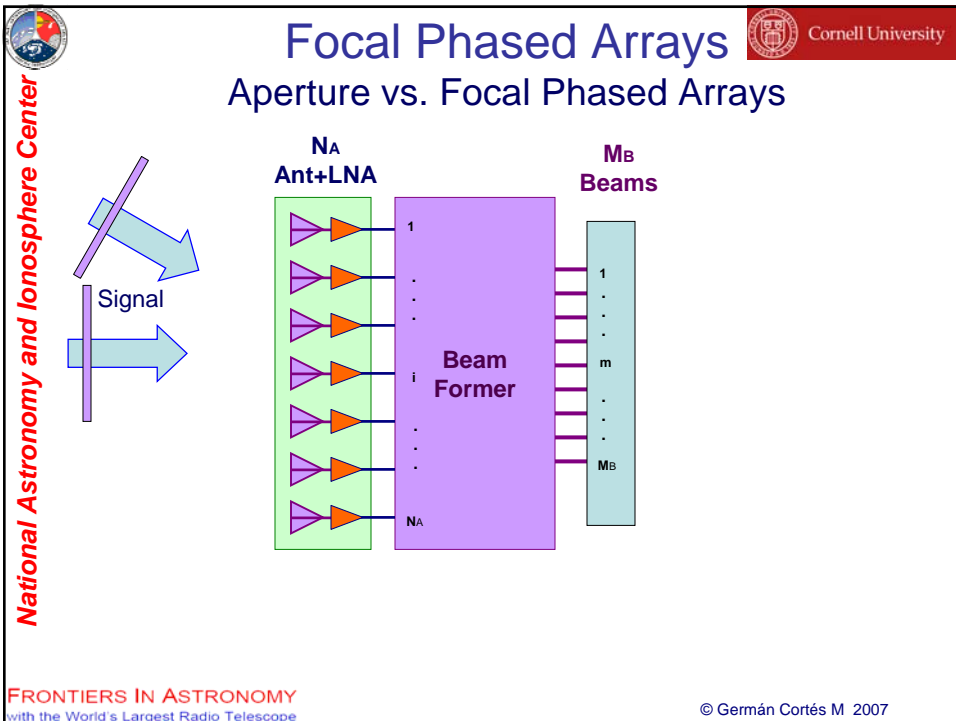
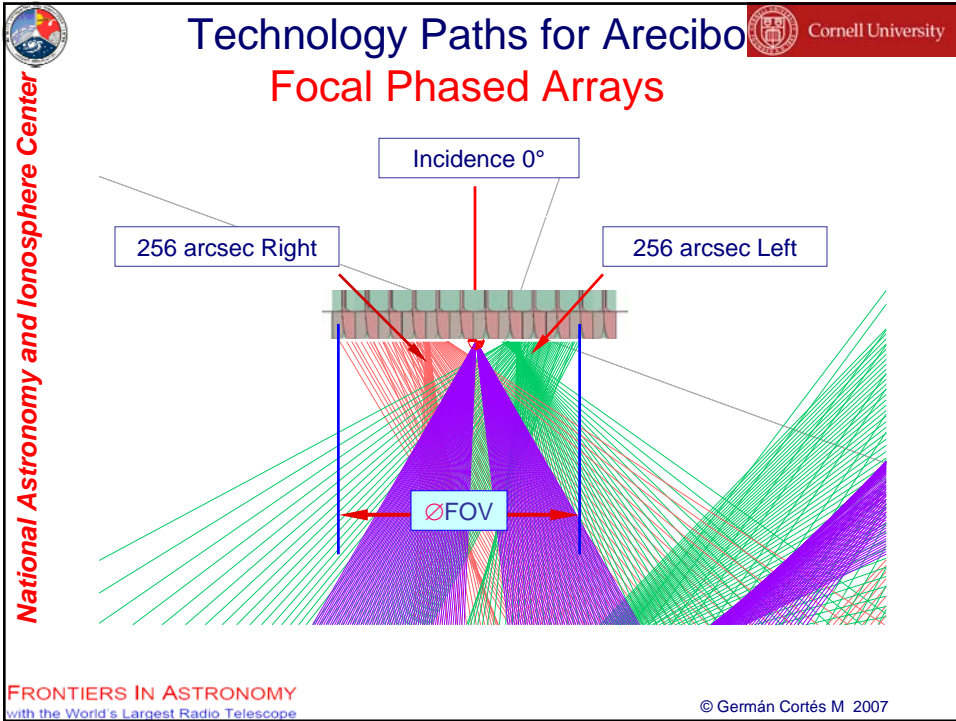


The Other Path...



Technology Paths for Arecibo The other path...





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Focal Phased Arrays

Aperture vs. Focal Phased Arrays

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Focal Phased Arrays

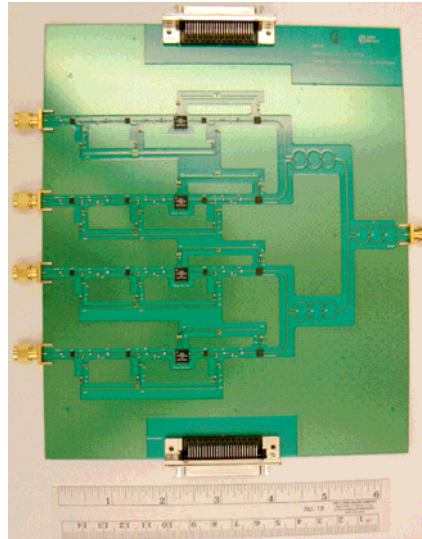
Beam Forming

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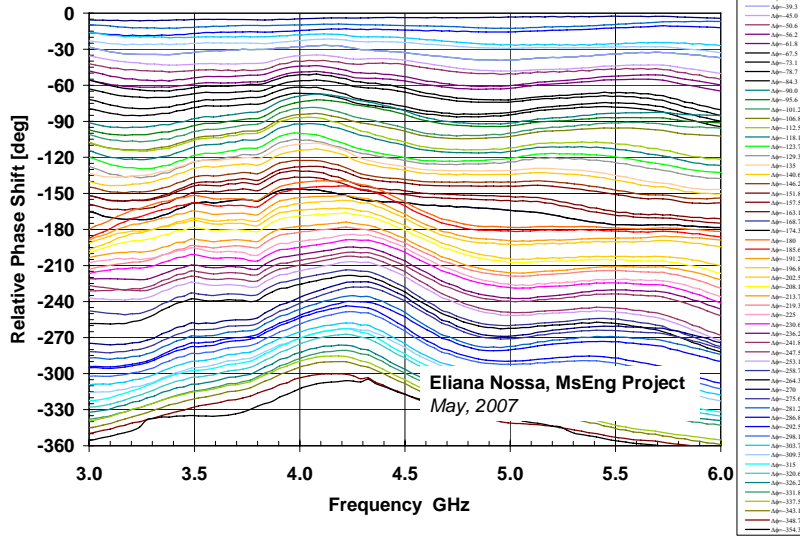
NAIC Beam Former Card

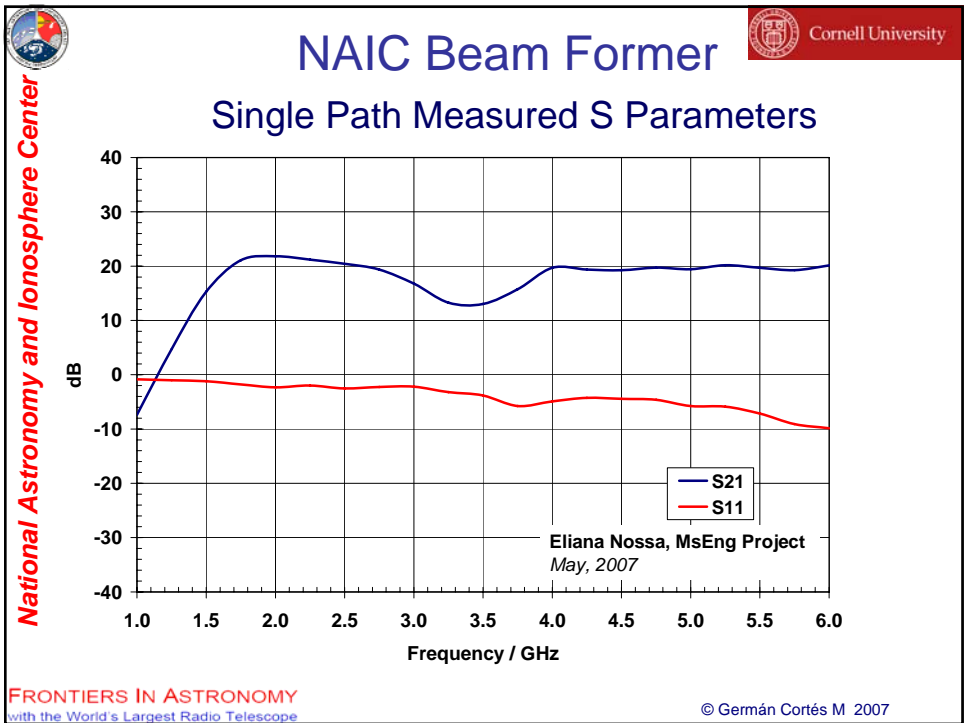
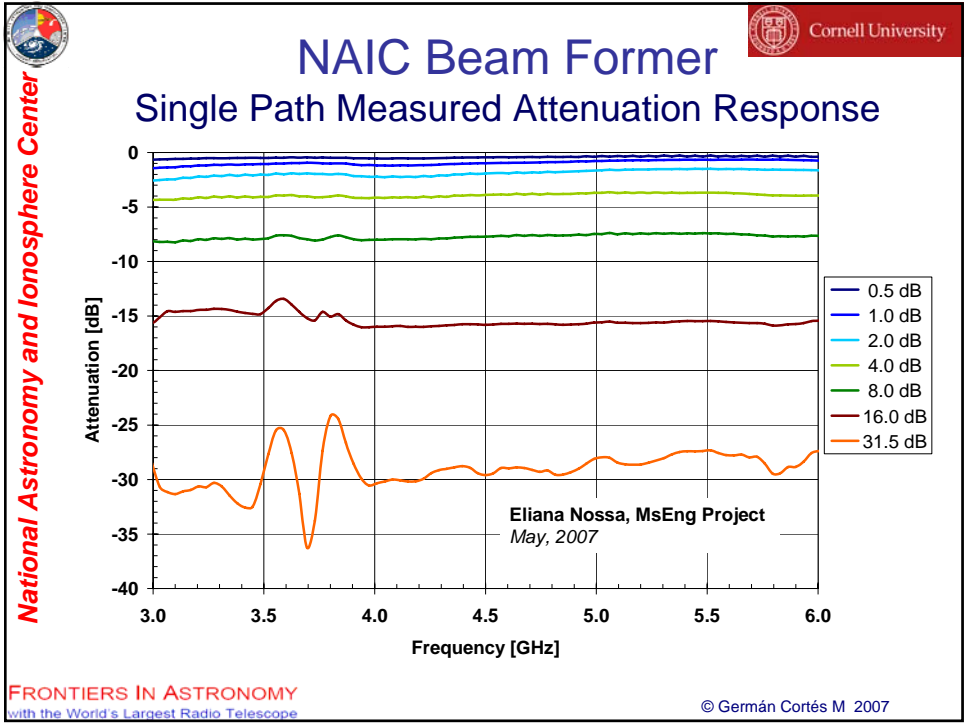


Eliana Nossa, MsEng Project
May, 2007



NAIC Beam Former Single Path Measured Phase Response





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Focal Phased Array Open Issues for Arecibo

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• Location →

1.252 m

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1.252 m

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• Location →

1.252 m

At Image of Aperture ...

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Focal Phased Array Open Issues for Arecibo

• Location →


1.252 m

At Image of Aperture ...

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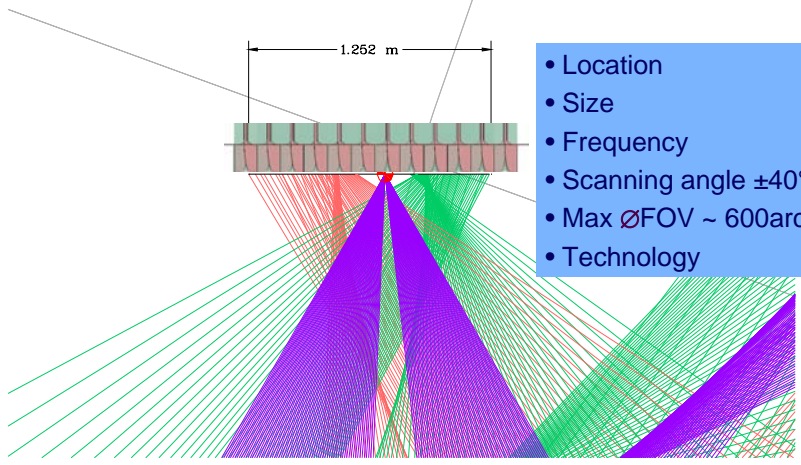
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Focal Phased Array Open Issues for Arecibo



1.252 m


- Location
- Size
- Frequency
- Scanning angle $\pm 40^\circ$
- Max \varnothing FOV ~ 600 arcsec
- Technology

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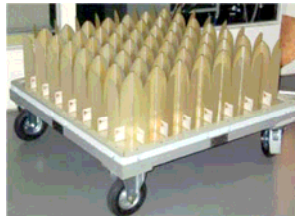
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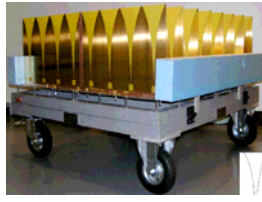
Focal Phased Array Front End Technologies



**Vivaldi Array
Astron**

EMBRACE Specs

- Single Polarization 8x8
- 2 simultaneous beams
- Bandwidth 3:1 (0.5 to 1.5 GHz)
- Scanning $\pm 45^\circ$
- Input Matching < -10 dB
- Noise Temp ~ 50 K to 100K



Embrace Antenna Design, Michelle Zuliani
URSI Meeting, Ottawa, July 25, 2007

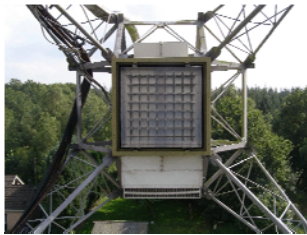
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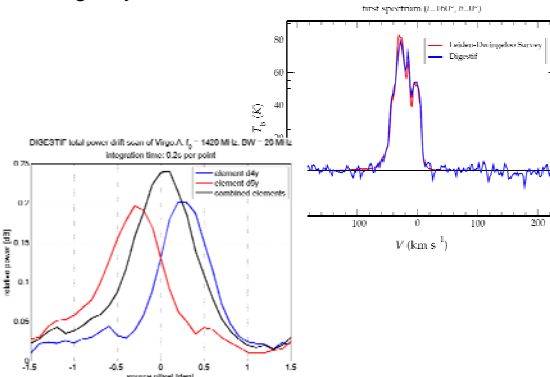
Focal Phased Array Front End Technologies



Pathfinder: APERTIF (APERTure Tile In Focus)



- DIGESTIF ("DIGital Early Stage Tile In Focus")
- Westerbork Synthesis Radio Telescope WSRT
 - Dual Polarization 112 elements [2x(7x8)]
 - Digitally Processed "off line"



Focal Phased Array Front End Technologies



ASKAP Specs

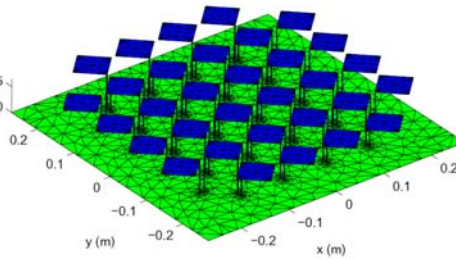
- 45 dishes, $\varnothing 12m$
- Max baseline 8 km
- Frequency 700 – 1800 MHz
- FOV 30 deg²
- Bandwidth 300 MHz
- Resolution 5 kHz
- Channels 16k
- Data rate ~1TB/s spectral line

Australian SKA Pathfinder (ASKAP) on behalf of the ASKAP Team, David DeBoer Australia, 23 August 2007.



Focal Phased Array Front End Technologies

Checkerboard Array



Broadband array antenna using a self-complementary antenna array and dielectric slabs, M. Gustafsson, Lund Inst. Tech., 2004

FPHA for ASKAP

- Dual Polarization 10x10
- Frequency 0.7 to 1.8 GHz
- Input Matching < -10dB
- Noise Temp Tsys goal 35K
- Low Profile, (Cryogenic ?...)



Multi-Pixel Cameras at Arecibo Summary

PROS	CONS
<ul style="list-style-type: none"> •Technology is readily available •Very High Sensitivity •Excellent Matching: < -20dB •Excellent Cross-Pol < -30dB •Partial/Total Cryogenic •Very Low Noise Trx ~5K 	<ul style="list-style-type: none"> •Limited FOV available at Arecibo -Non uniform pixel gains: scanning loss -Gaps Between beams: Image Scale of the Optics -Number of beams in FOV determined by image scale, horn sizes, & scanning loss. •Limited Bandwidth ↻
<ul style="list-style-type: none"> •Simultaneous Multiple beam Systems: Survey Speed. •Uniform pixel gains •Beams can be electronically scanned inside the FOV •No gaps between beams=> Nyquist 	<ul style="list-style-type: none"> •Technology is not mature ~3 to 5 yr. •Sensitivity... 80% of Multipixel •Acceptable input match <-10dB •Acceptable(?) Cross-Pol lev.<-10dB •Not Feasible Fully Cryogenic •Tsys ~40K to 100K



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End

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