Transparent feed legs

Improving the ASKAP survey speed

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ATUC - 24 Nov 2016

Continuum Survey Speed

$$SS_s = \Omega B n_p \left(\frac{A N \eta_a \eta_c \sigma_s}{2kT_{sys}} \right)^2$$

General

$$SS_s \propto \boxed{B} n_p \left(\frac{\boxed{D} N N_b \boxed{\eta_a} \eta_c \sigma_s}{2k(\boxed{T_{rec}} + \boxed{T_{scat}})} \right)^2$$

Dishes

SS = Survey Speed
Omega = Field of View
B = Bandwidth
np np = Number of polarisations
A = antenna area
N = number of antennas
eta_a = Antenna Efficiency
Eta_c = Correlator efficiency
sigma_s = Desired continuum sensitivity
k = Boltzmann's constant
Tsys = System Temperature
Trec = Receiver Temperature
Tsca = Scattering Temperature
D = Antenna Diameter

SEFD Measurement is tricky - measurements are ongoing

Upgrade Menu

Parameter	Current	Upgraded	Method	Delta SS
Trec (K)	40	20	Rocket PAF	4.0
Tscat (K)	20	16	Transparent Legs	2.0
eta_a	0.7	0.8		
D (m)	12	15	Petals	1.6
B (MHz)	300	384	More Correlator	1.2
Totals				~15

Improving Tsys and eta_a with Transparent Legs

Transparent wha?

- Scattering of ground radiation off the quadrupod feed legs increases ASKAP Tsys/eta ~ 15-20K (see Stuart Hay's PAFs & beams talk 15 Sep 2015)
- Transparent (i.e. non-conducting) feed legs could help
- Early in the ASKAP project, ATNF investigated transparent feed legs as a method reducing side lobe confusion.
- MJK contacted ISOTRUSS for a sample and tested its transparency at 1.6 and 4.1 GHz using ATCA holography (see Mike Kesteven's P&B talk 16 Feb 2016).
- The sample was much heavier than what we would have used. Nonetheless its performance at 1.6 GHz was encouraging
- We abandoned the idea when we got a price for a 3rd axis (sky mount). It was perceived at the time that this would be a simpler option and more likely to succeed, at least as far as side lobe confusion goes.

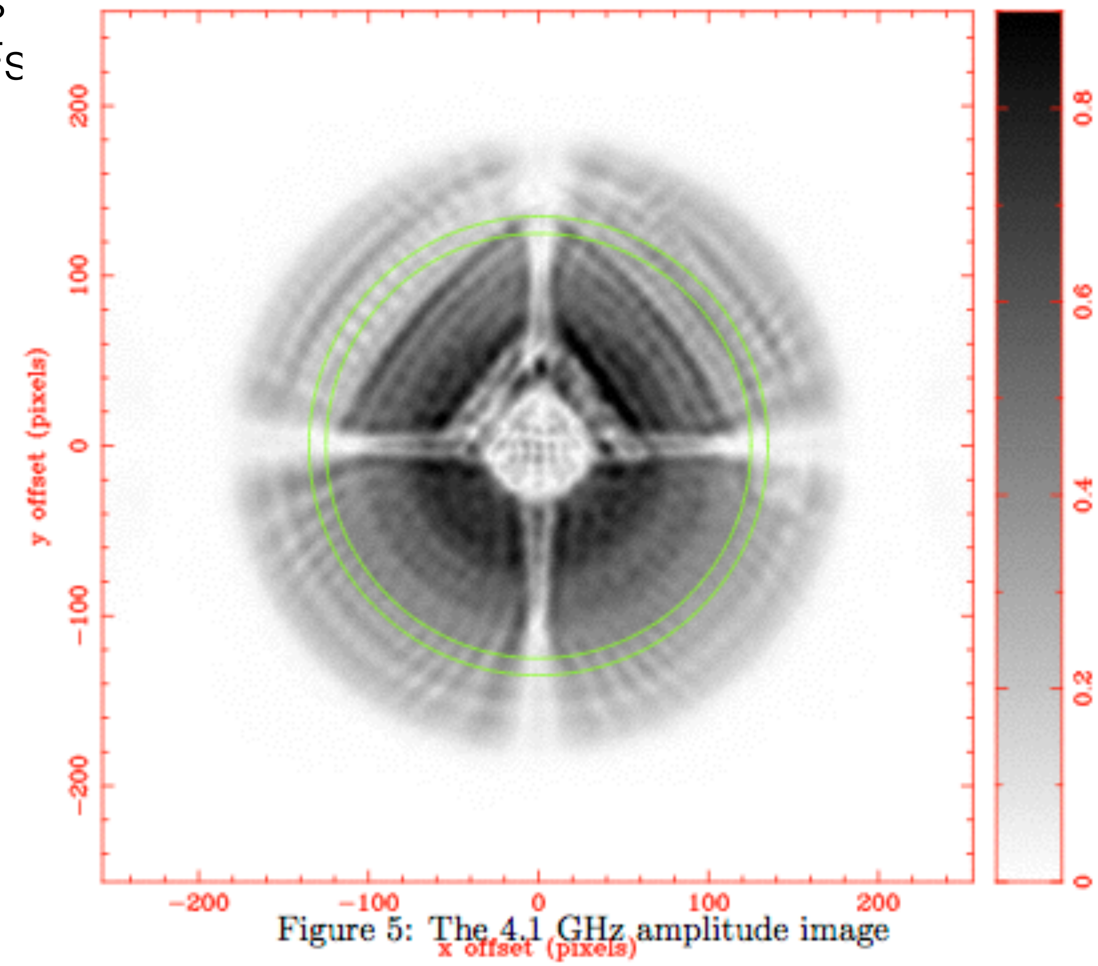
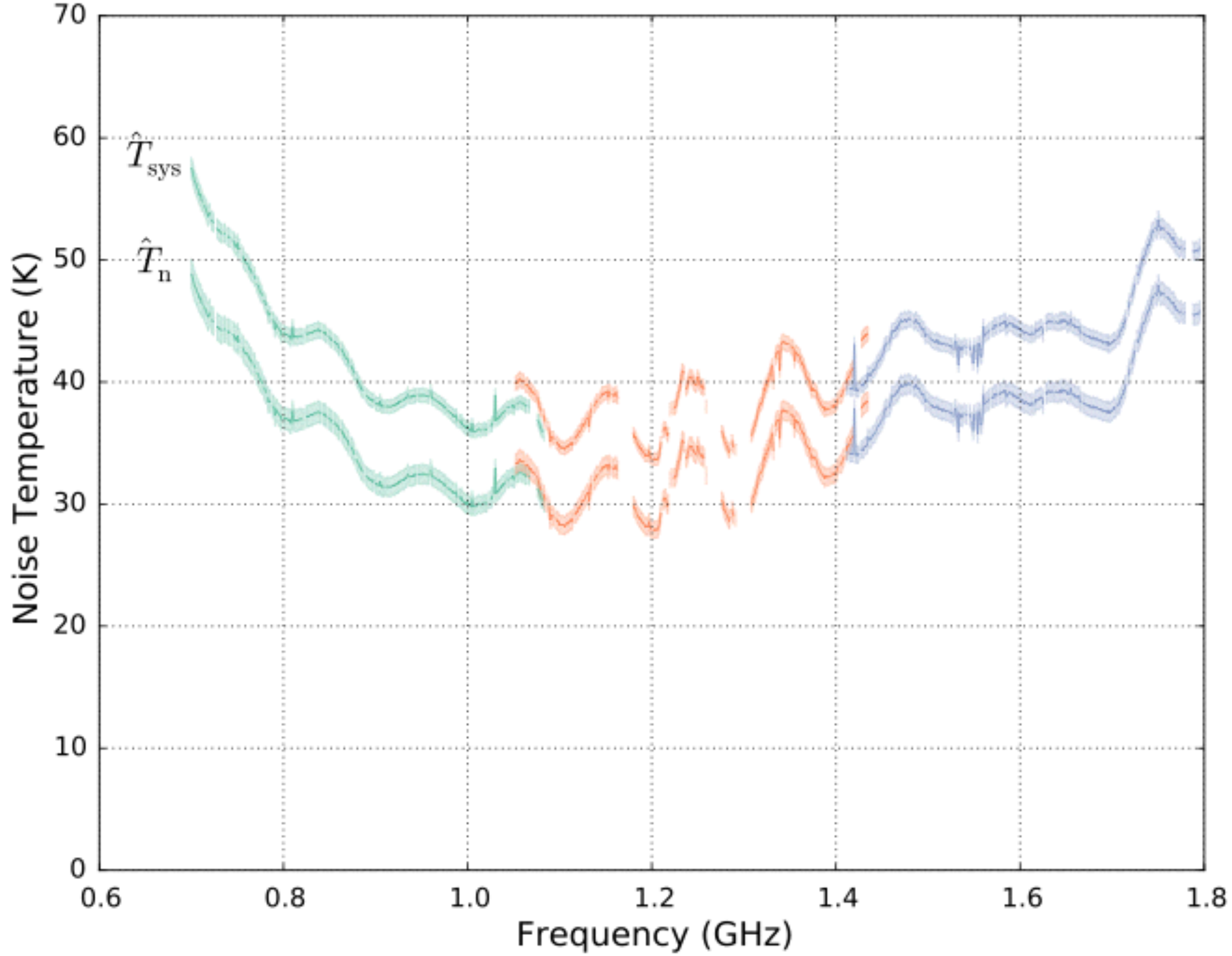


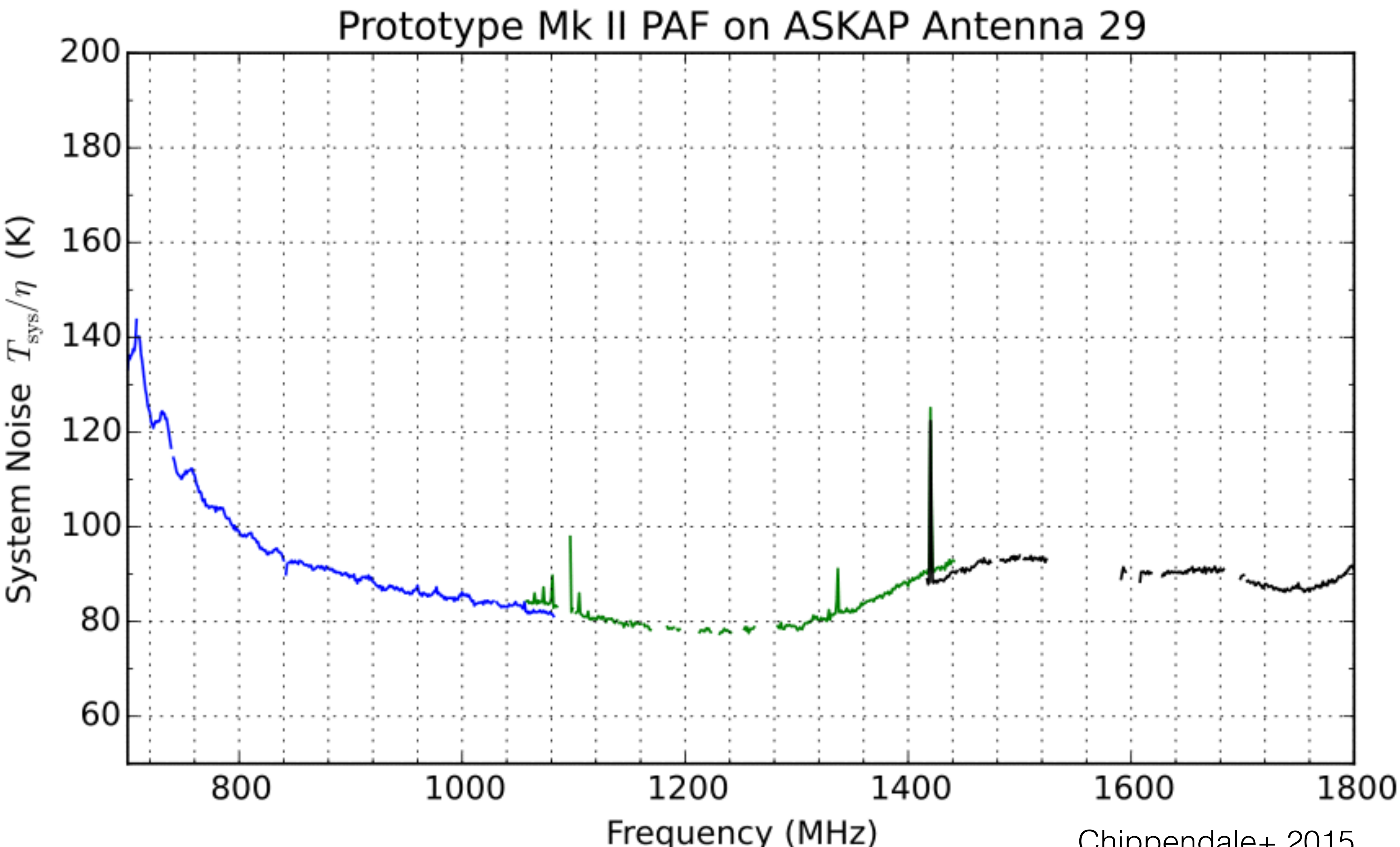
Figure 5: The 4.1 GHz amplitude image

Holography amplitude with a ISOTRUSS slung in the aperture. Kesteven+2007

ADE PAF in Aperture Array



ADE PAF on Dish

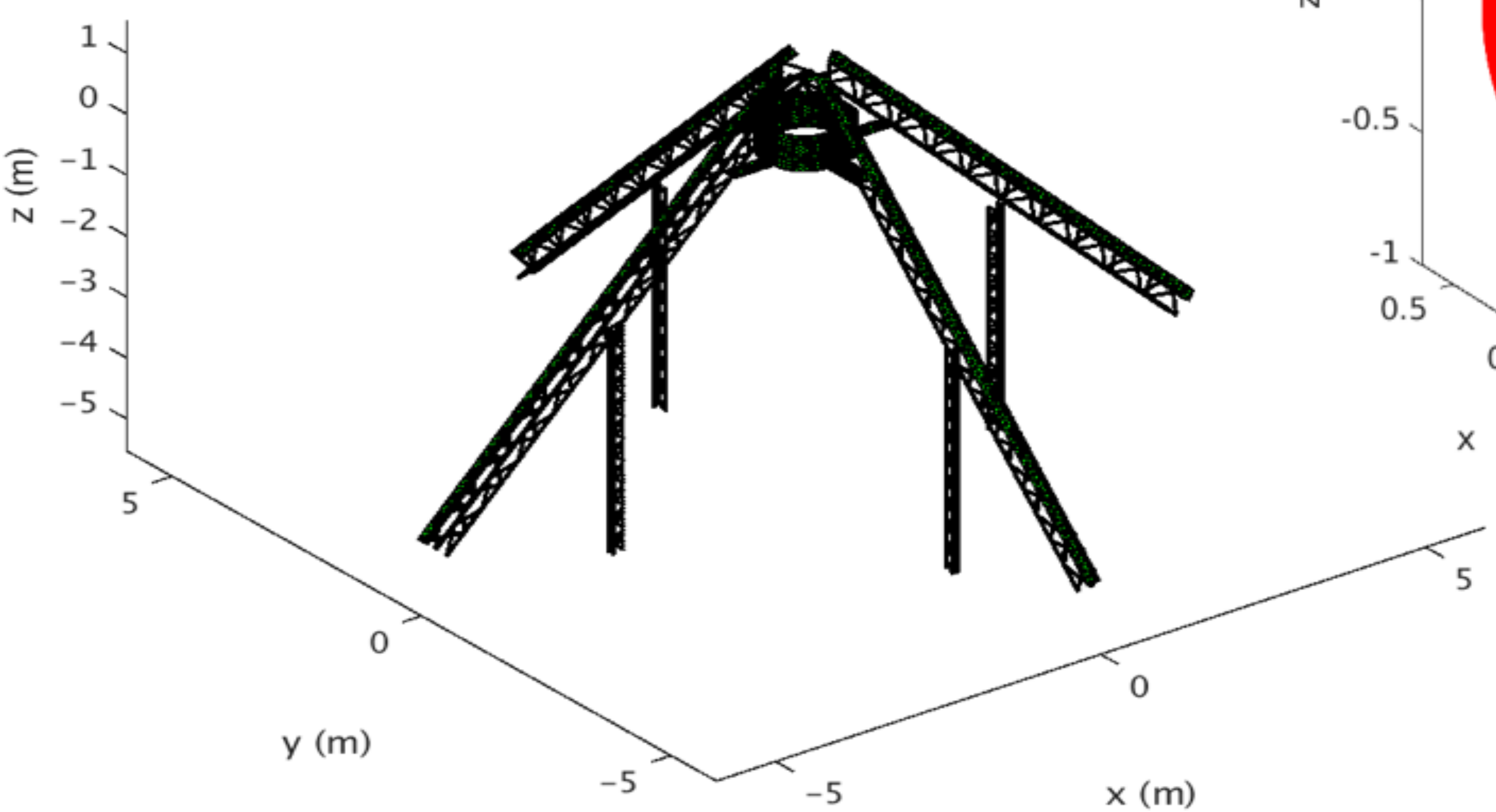


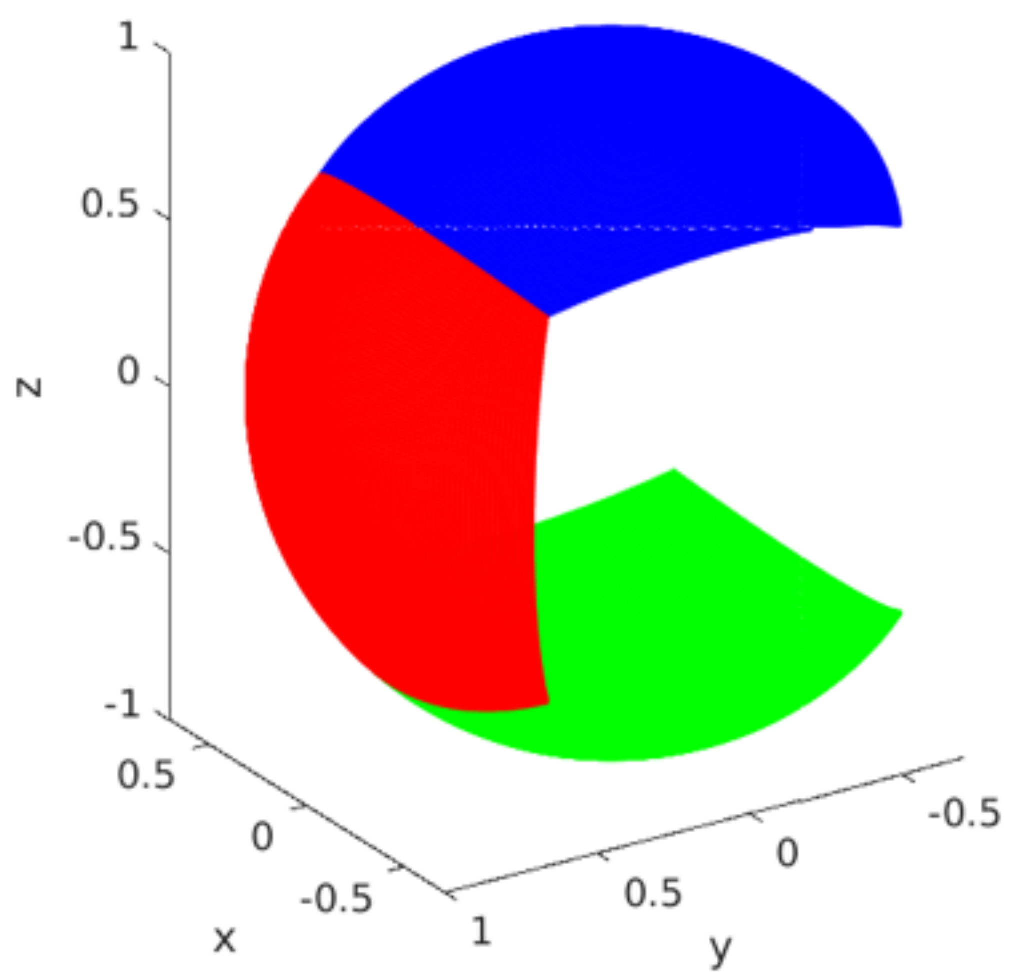
Chippendale+ 2015

Modelling results

Stuart Hay (Data 61)

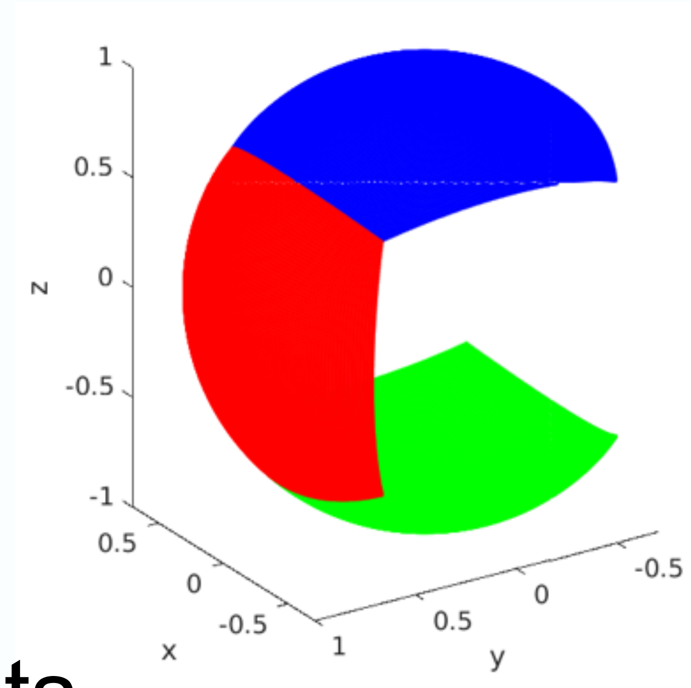
Strut Geometry and Regions on Far-field Sphere

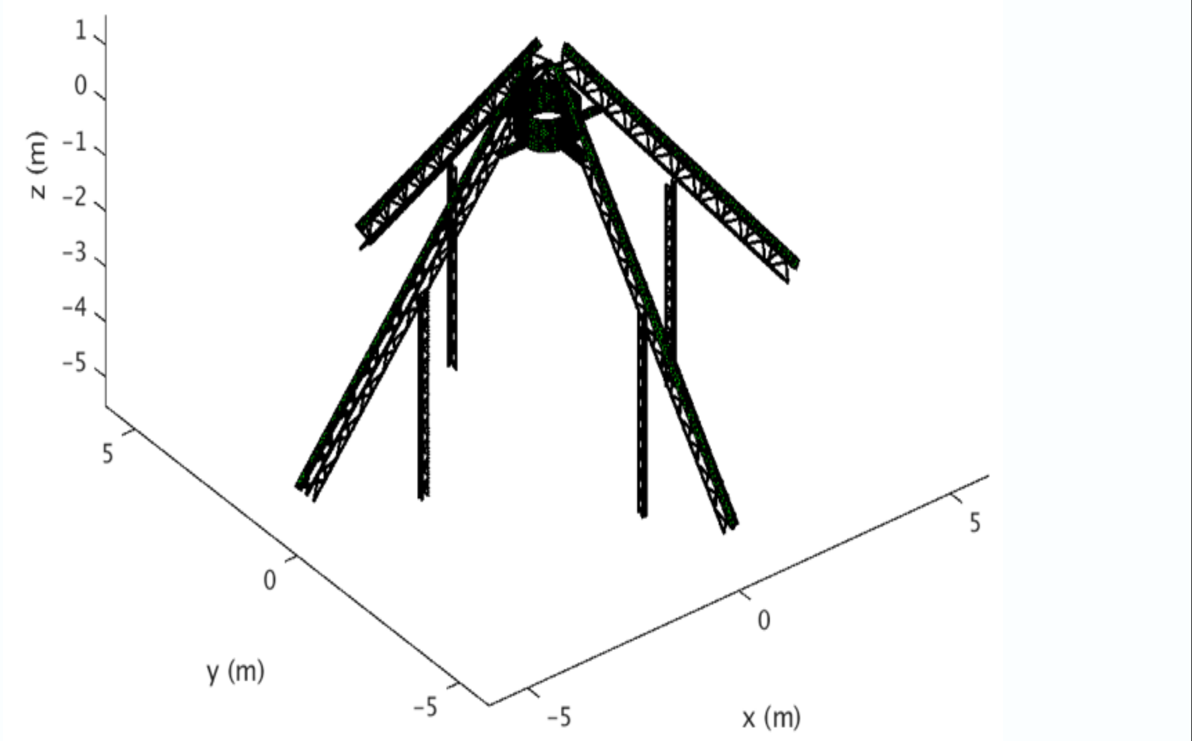




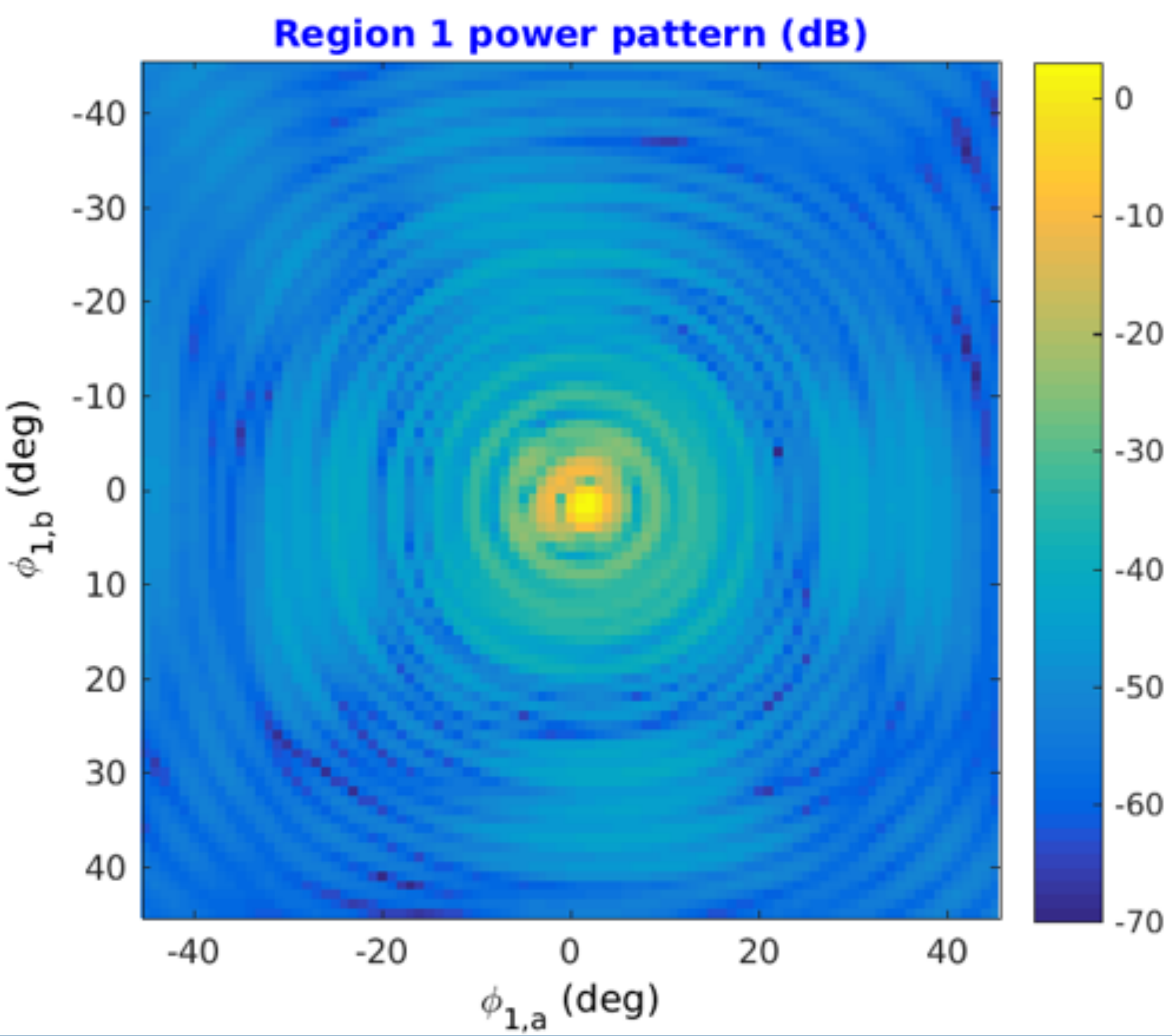
Blue Region

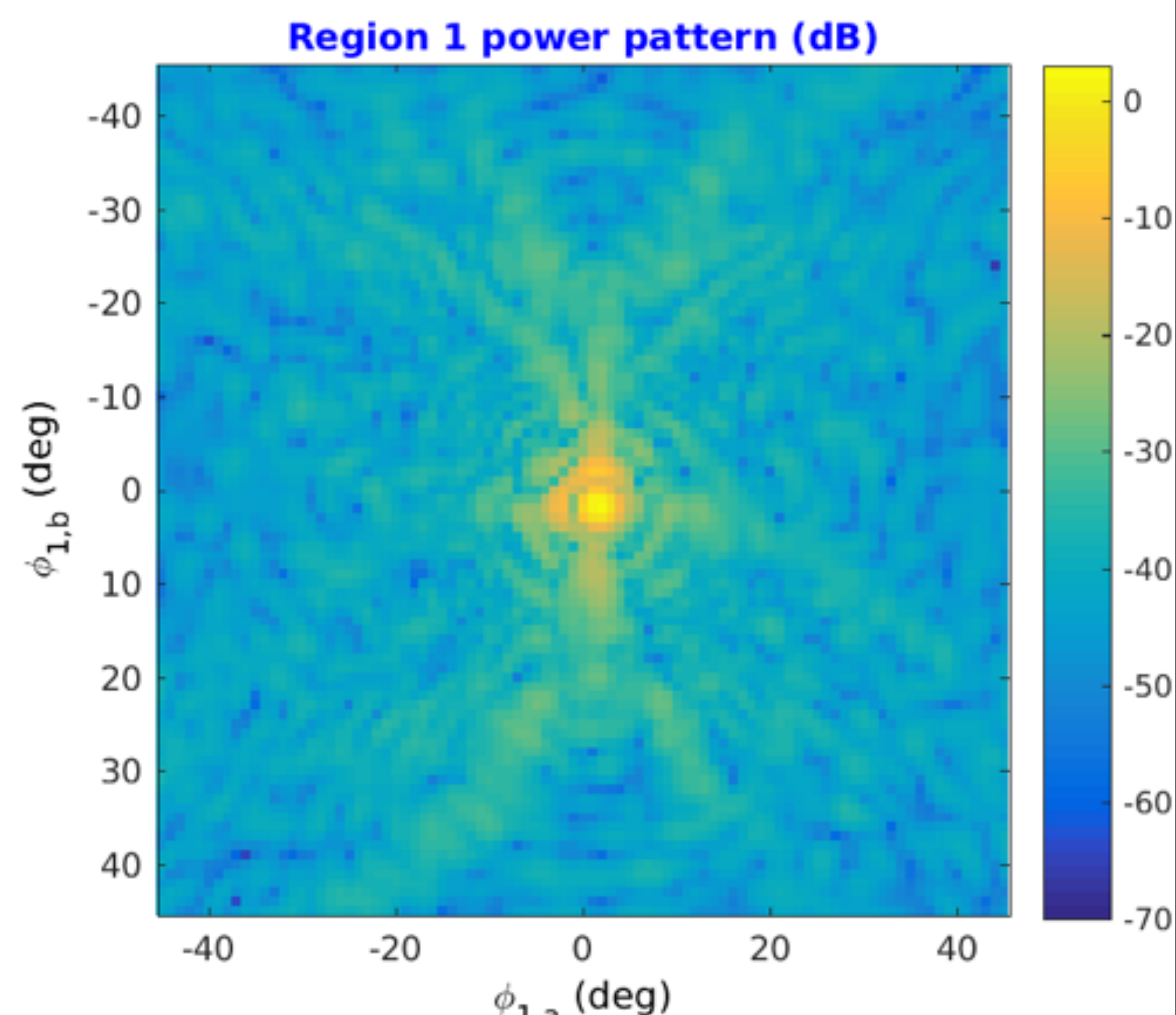
0.724GHz
FoV at zenith
Max-SNR weights





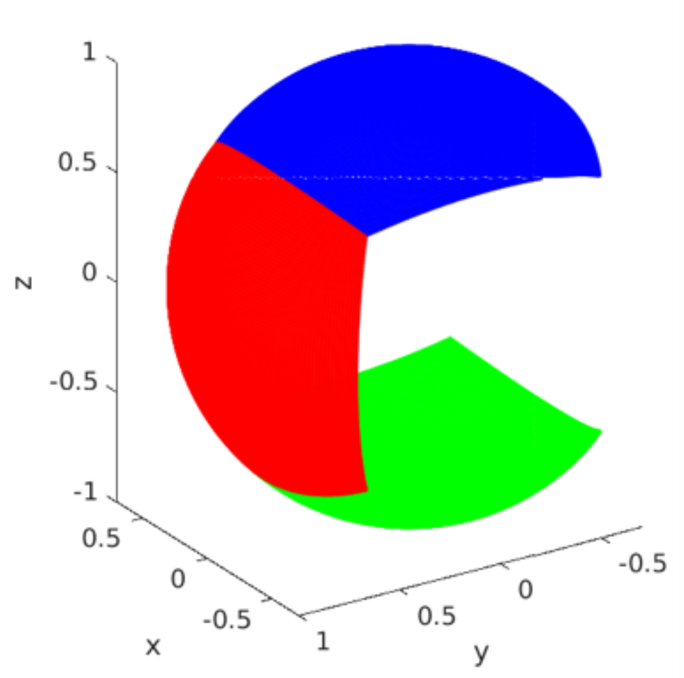
No struts

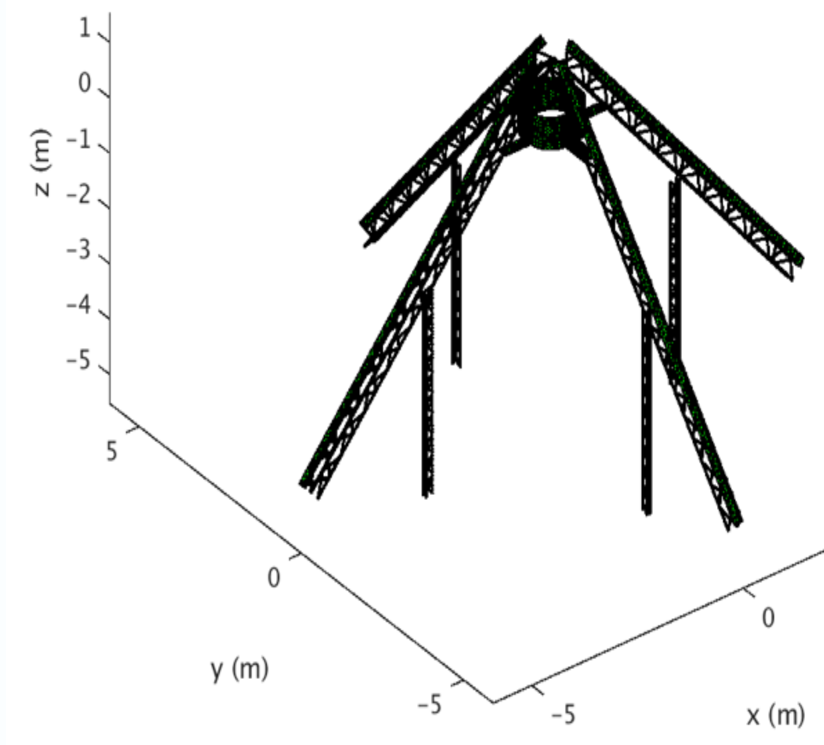




Red Region

0.724GHz
FoV at zenith
Max-SNR weights





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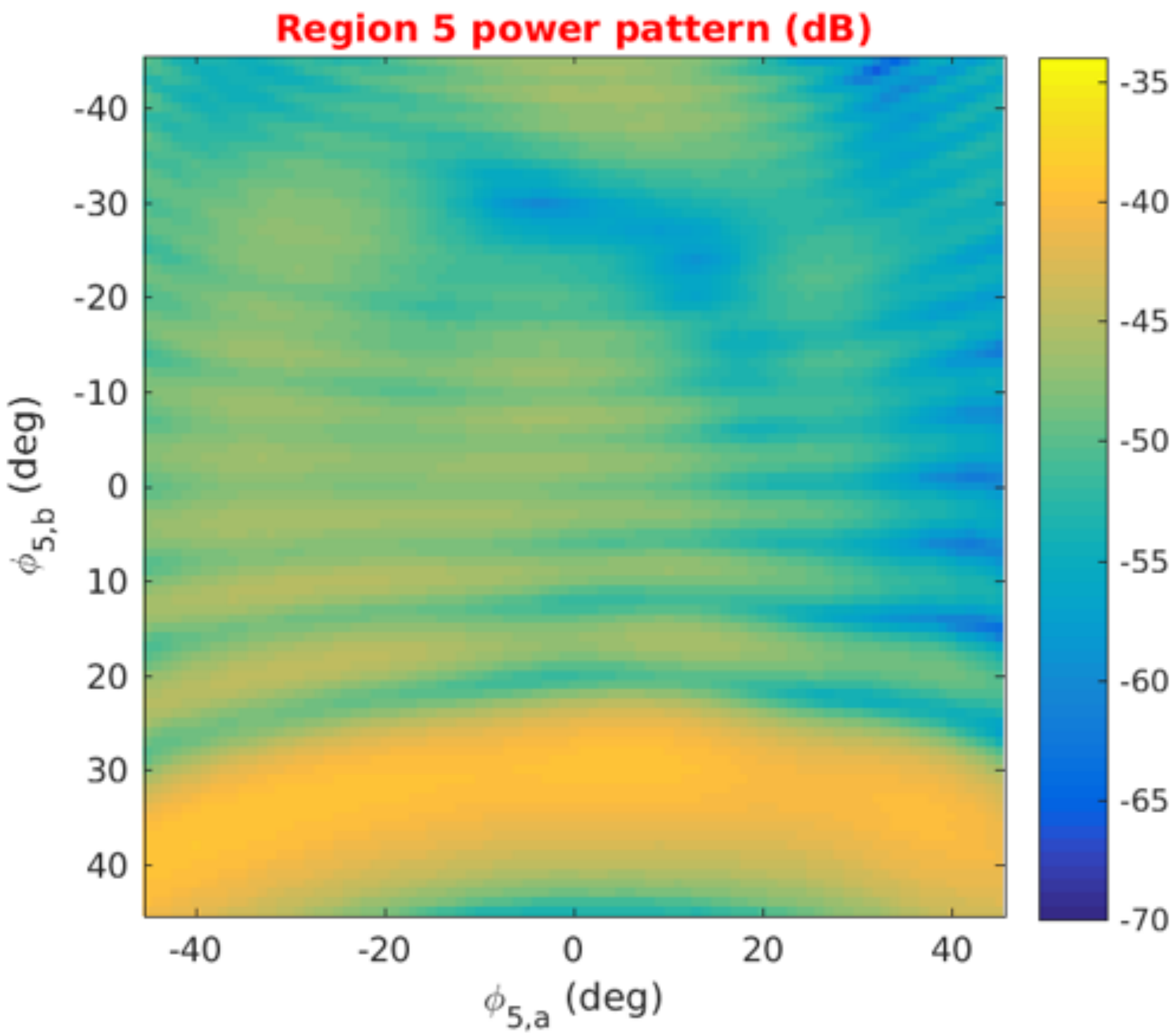
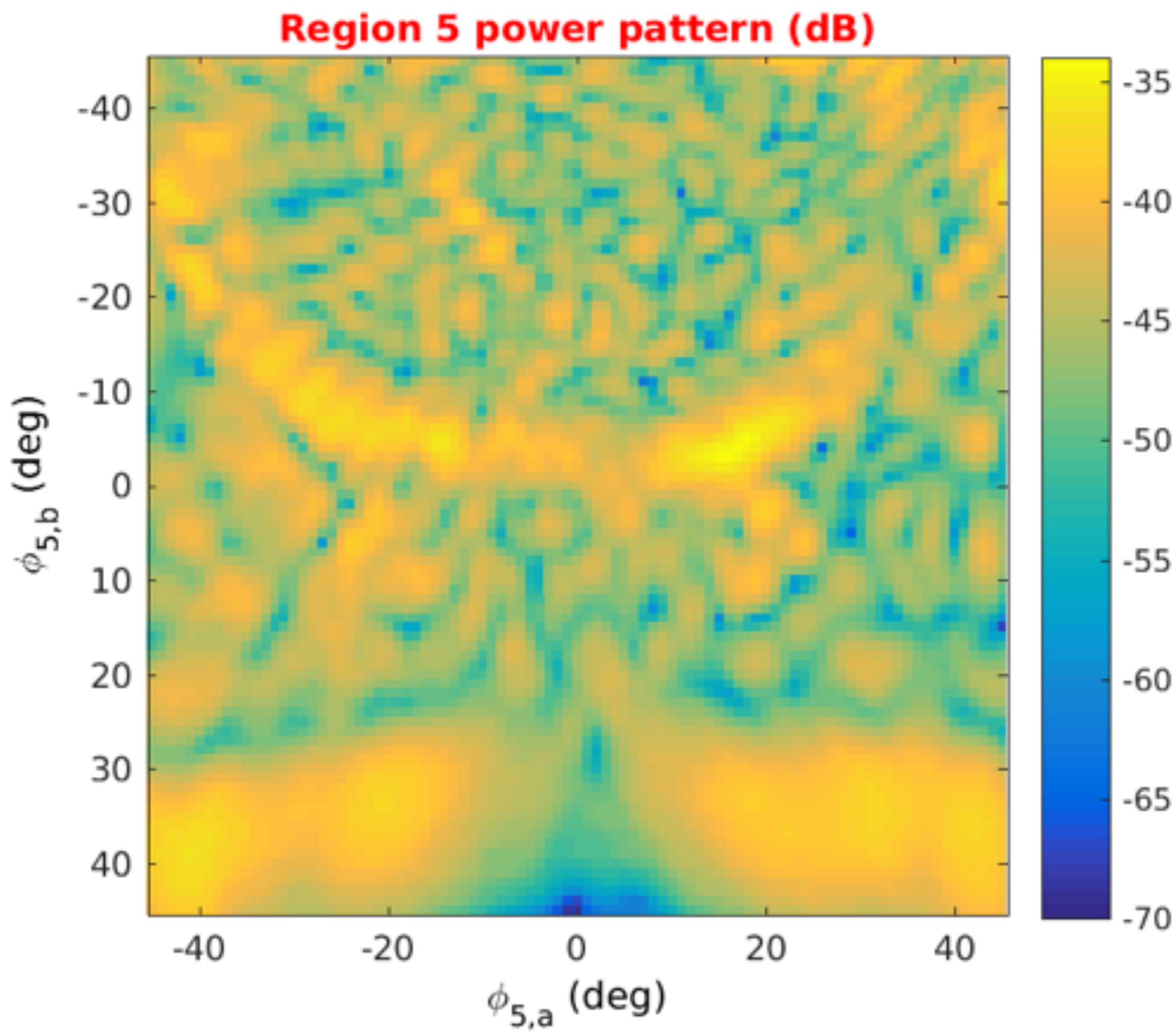
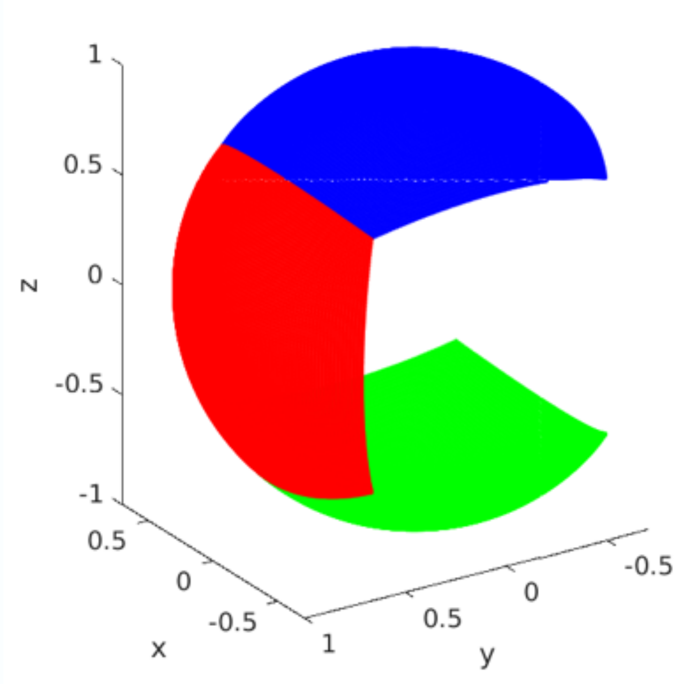
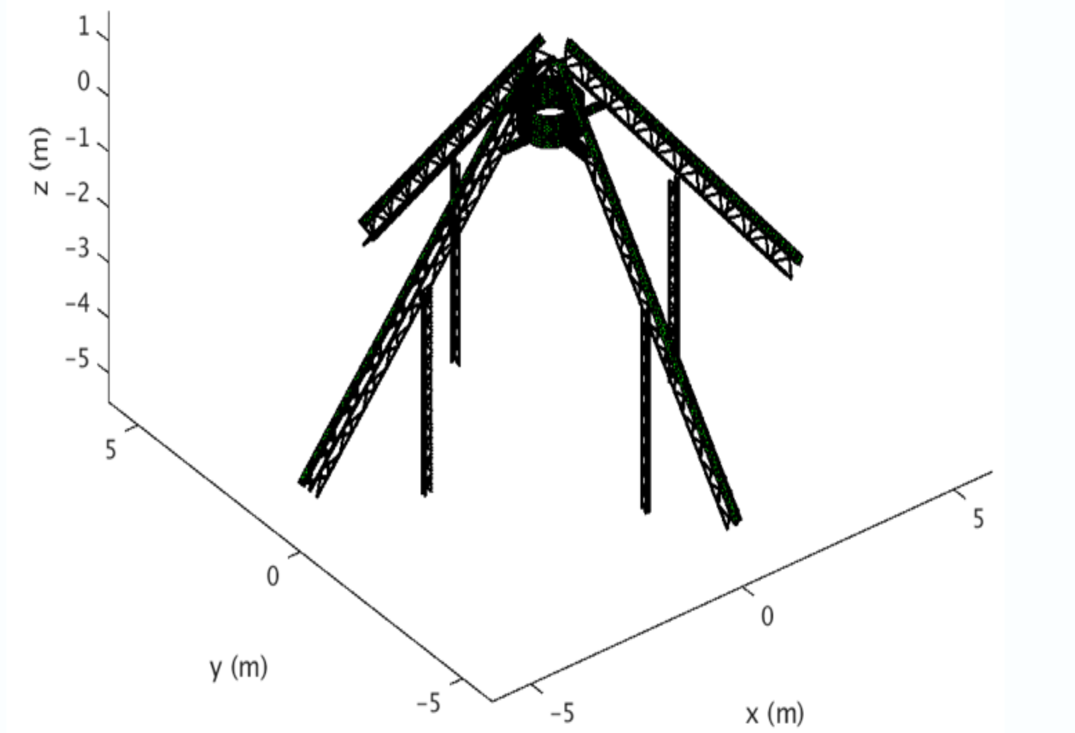




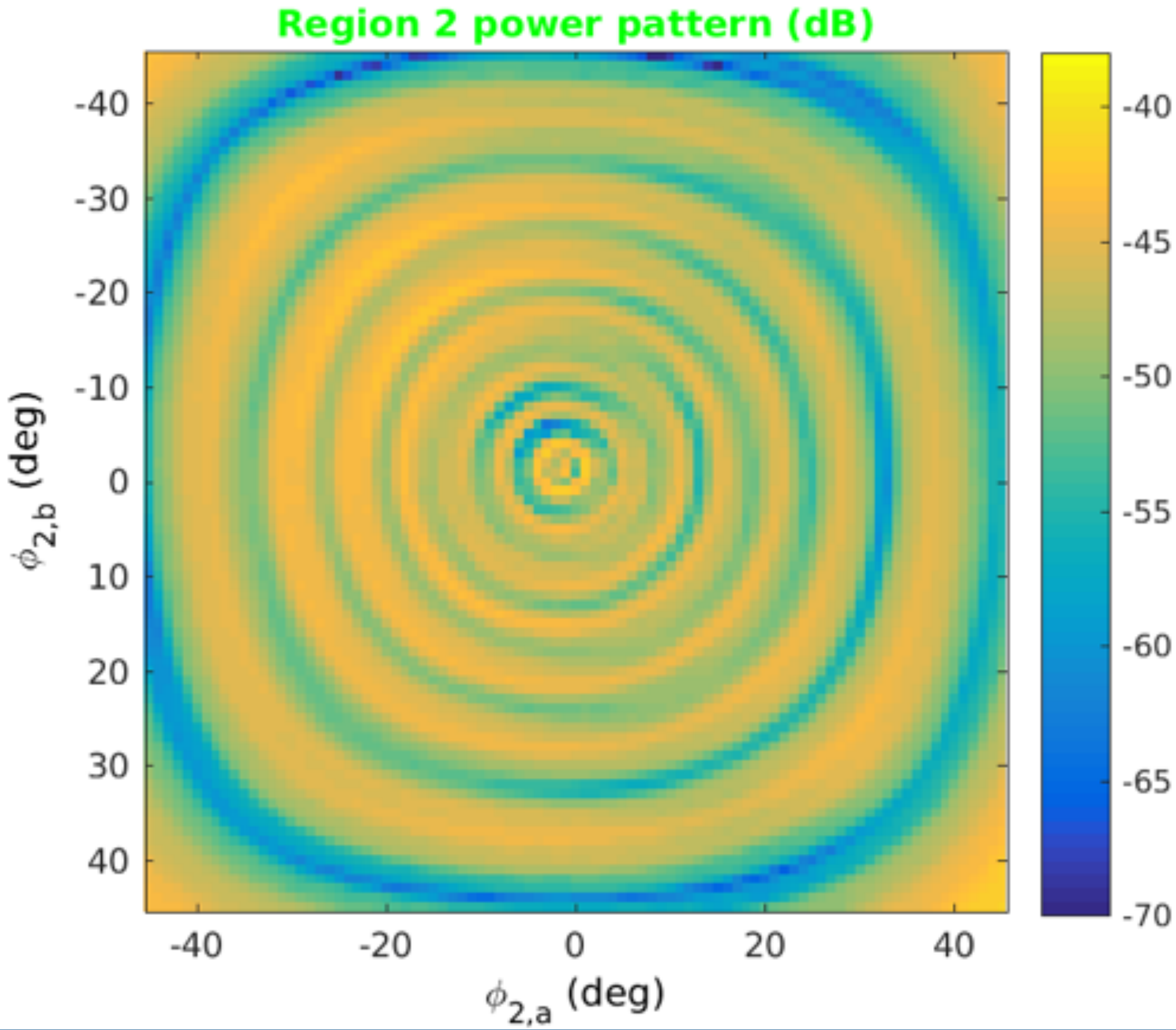
Green Region

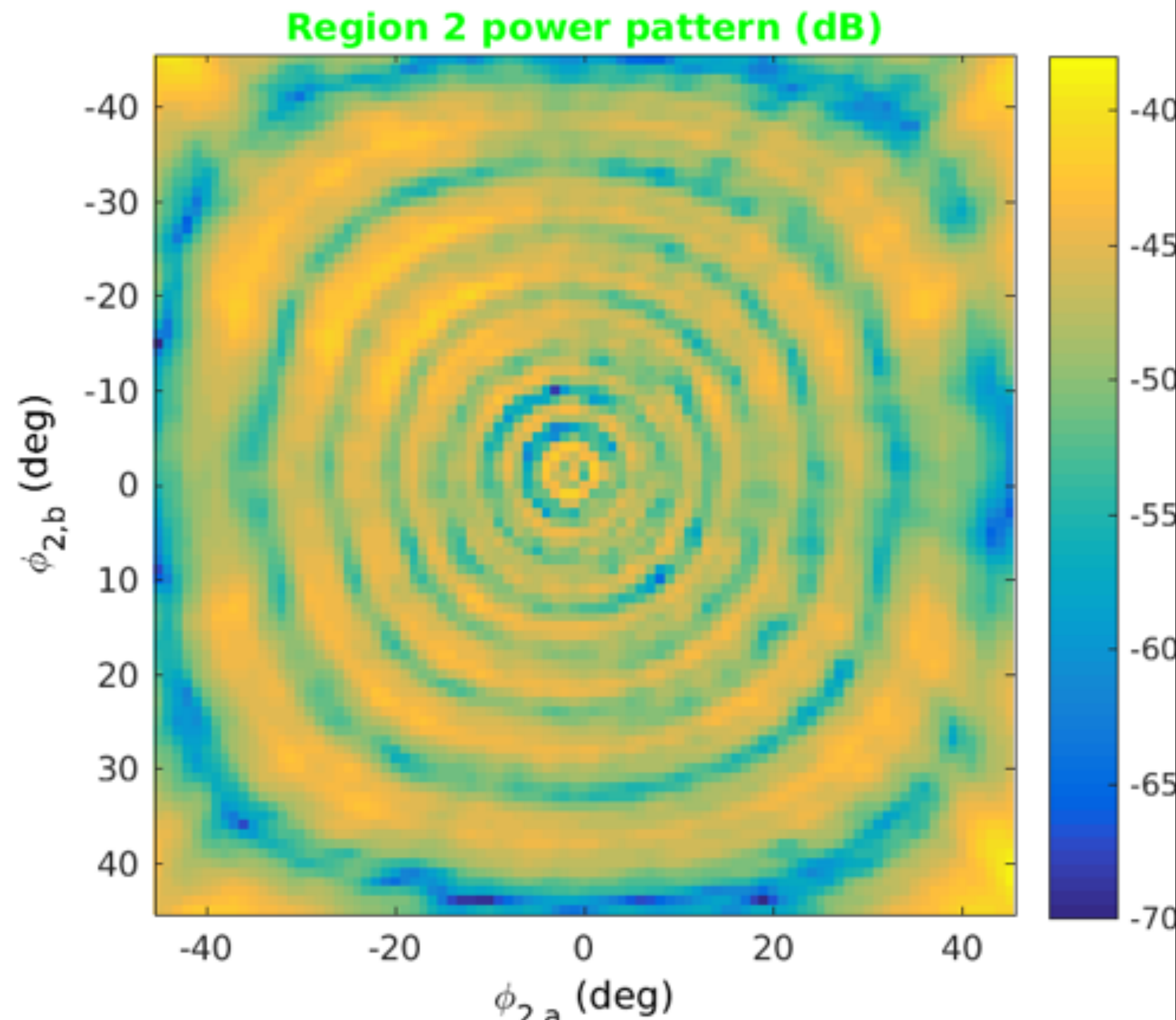
0.724GHz
FoV at zenith
Max-SNR weights



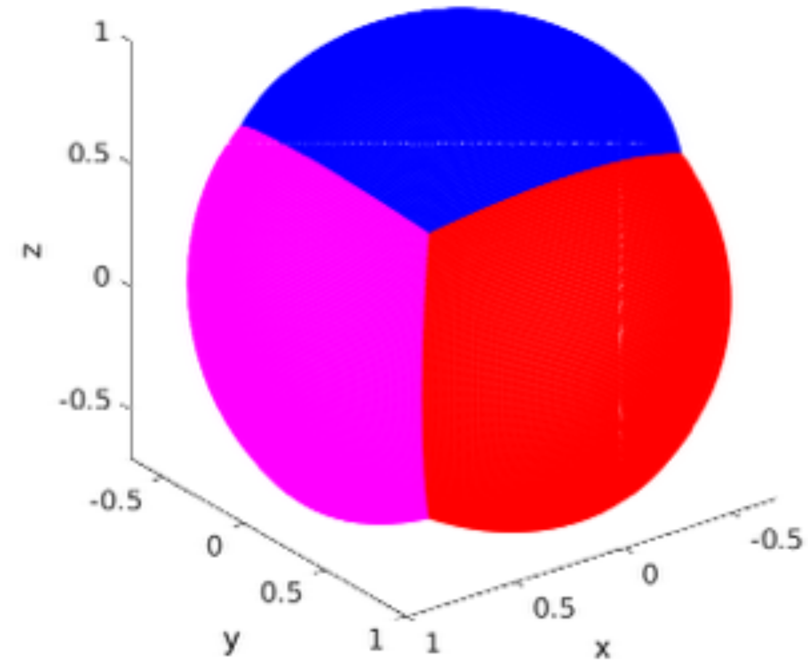


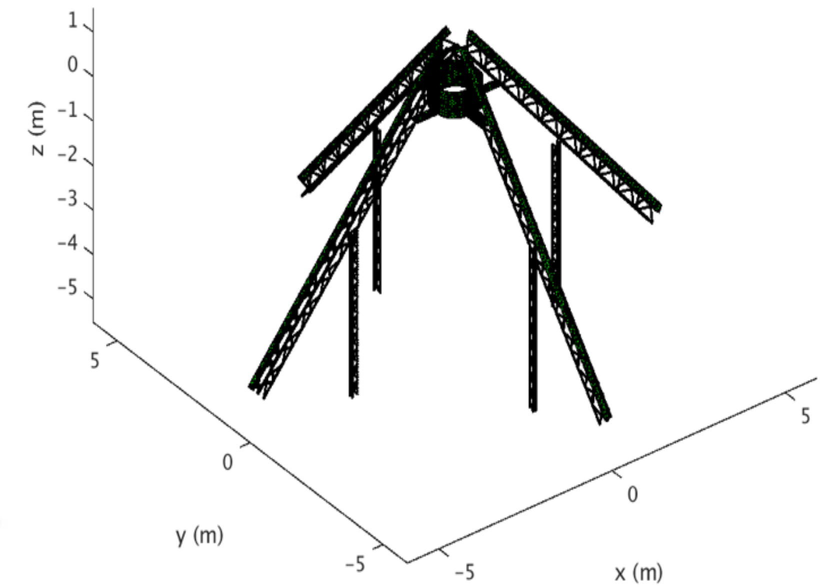
No struts



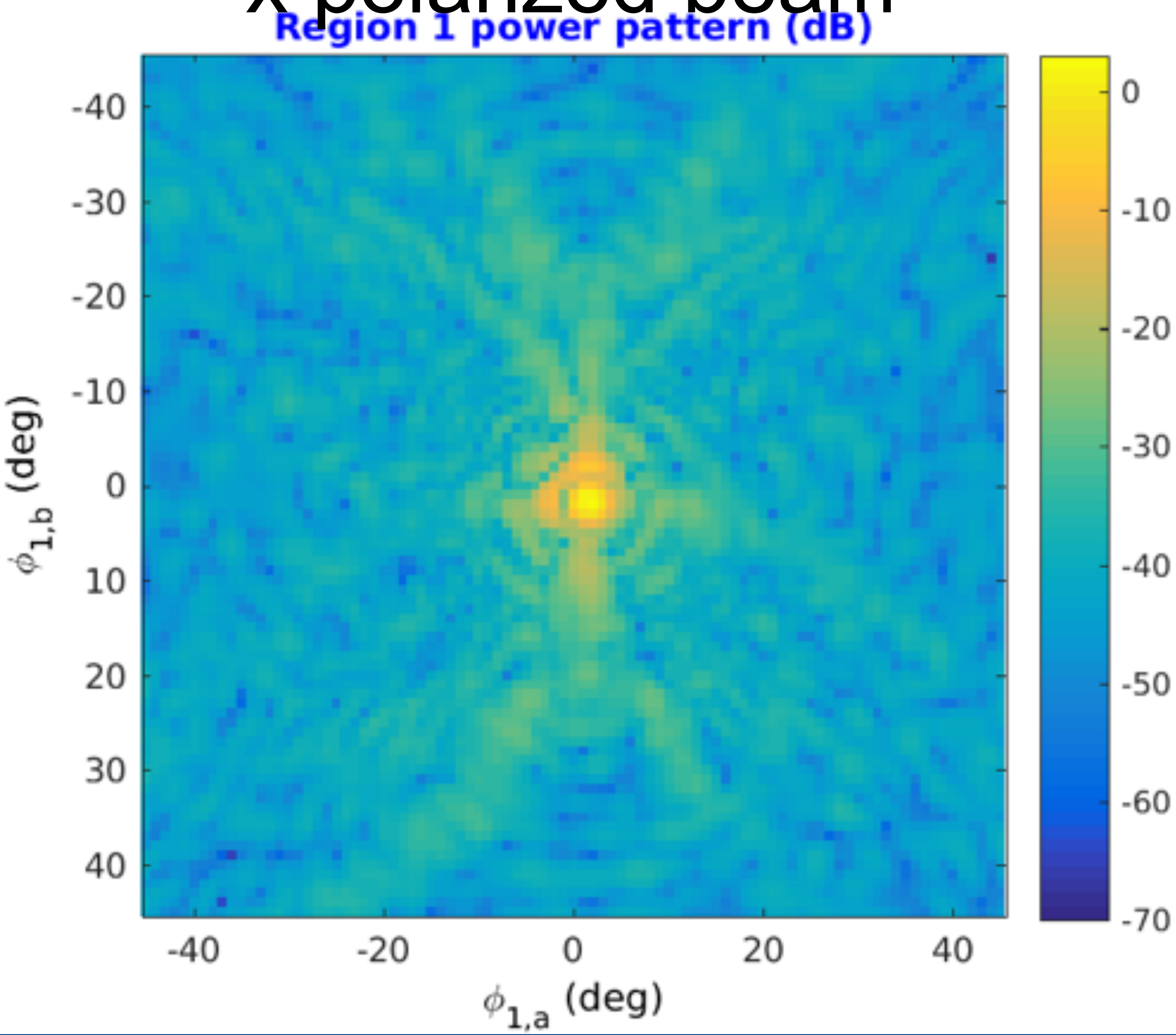


Blue Region

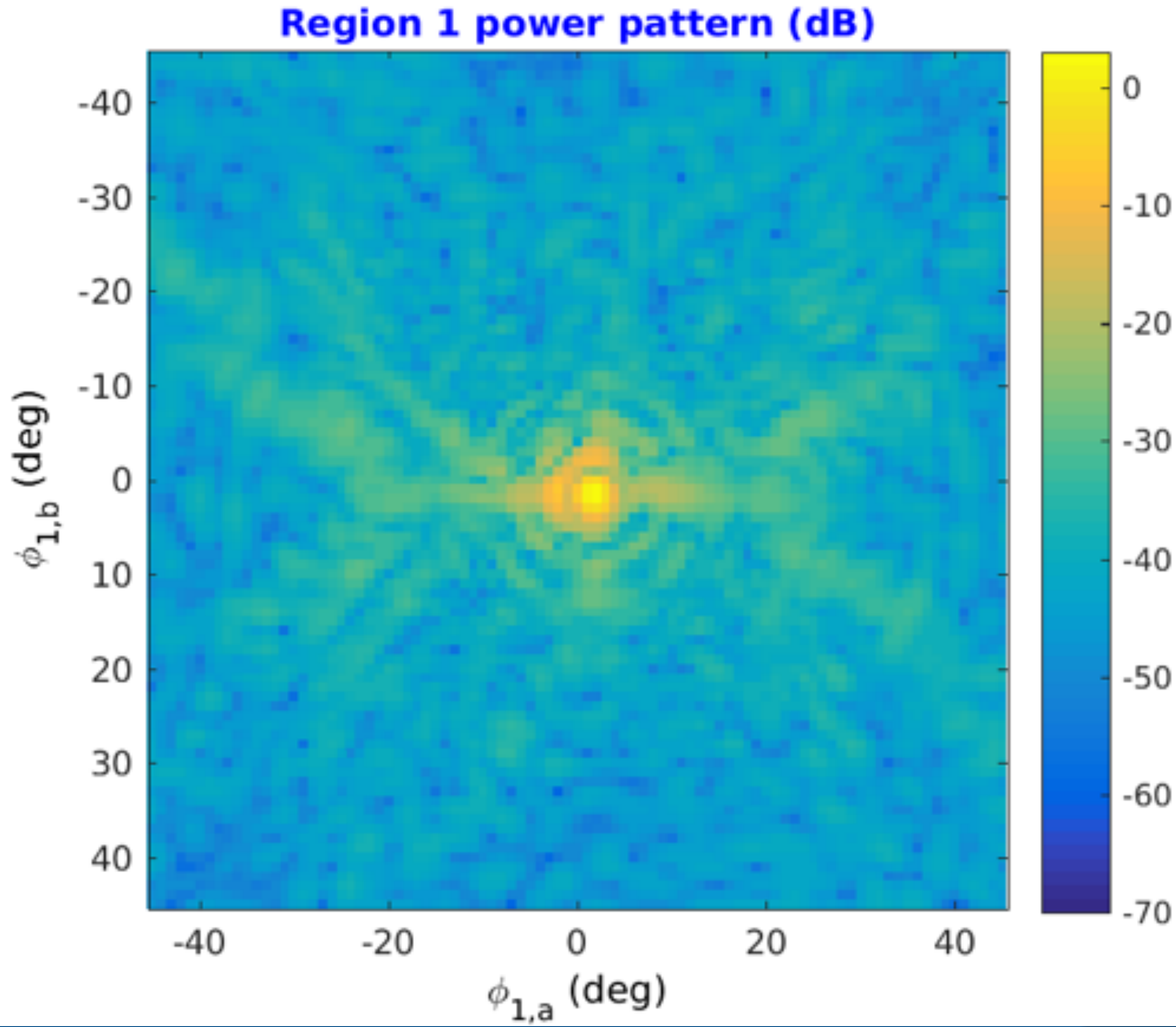




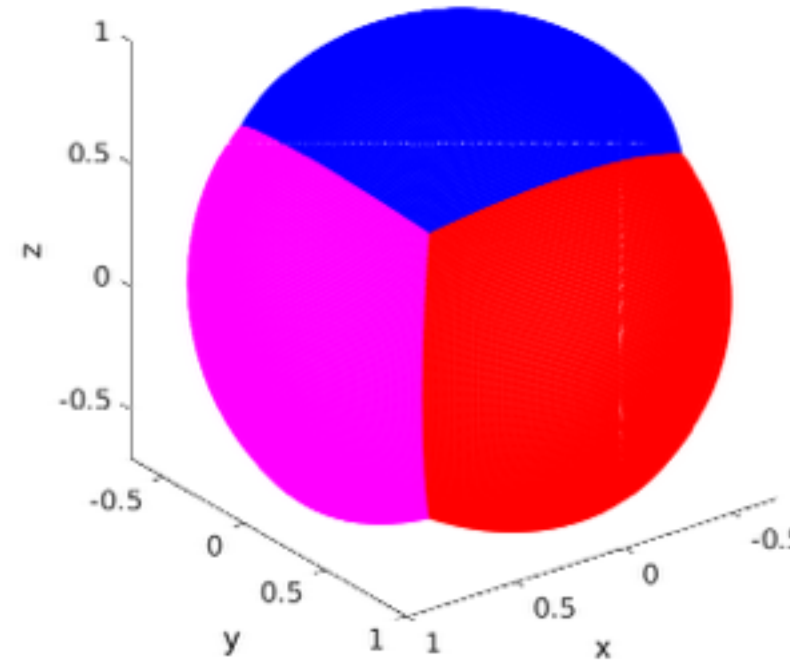
x polarized beam

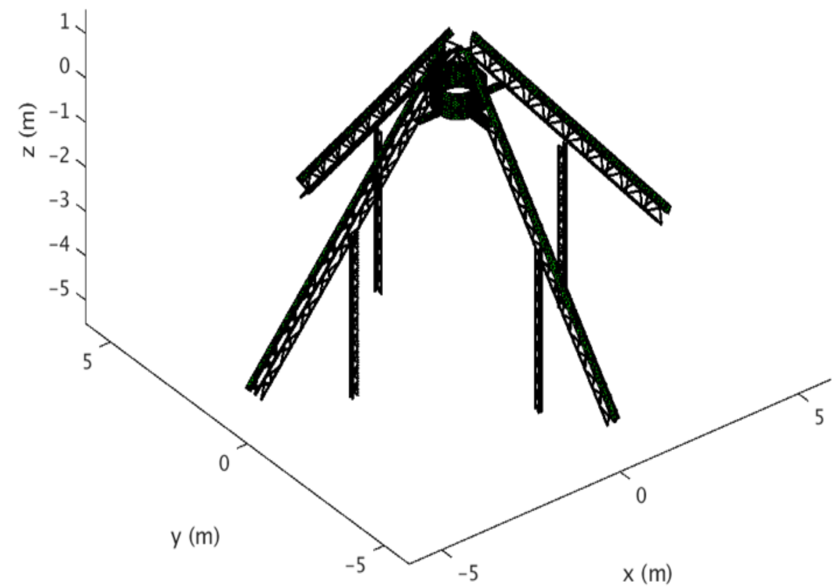


y polarized beam

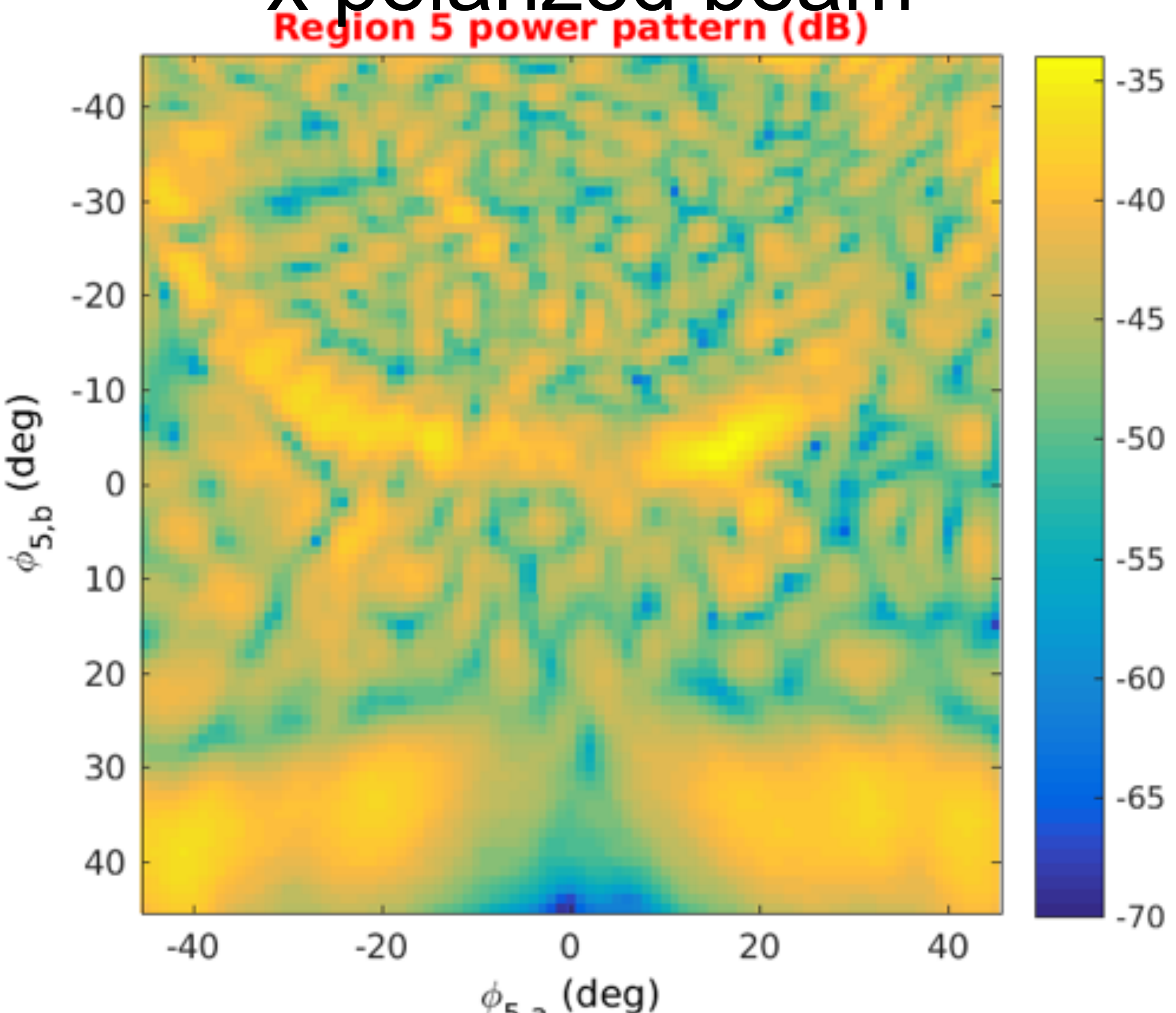


Red Region

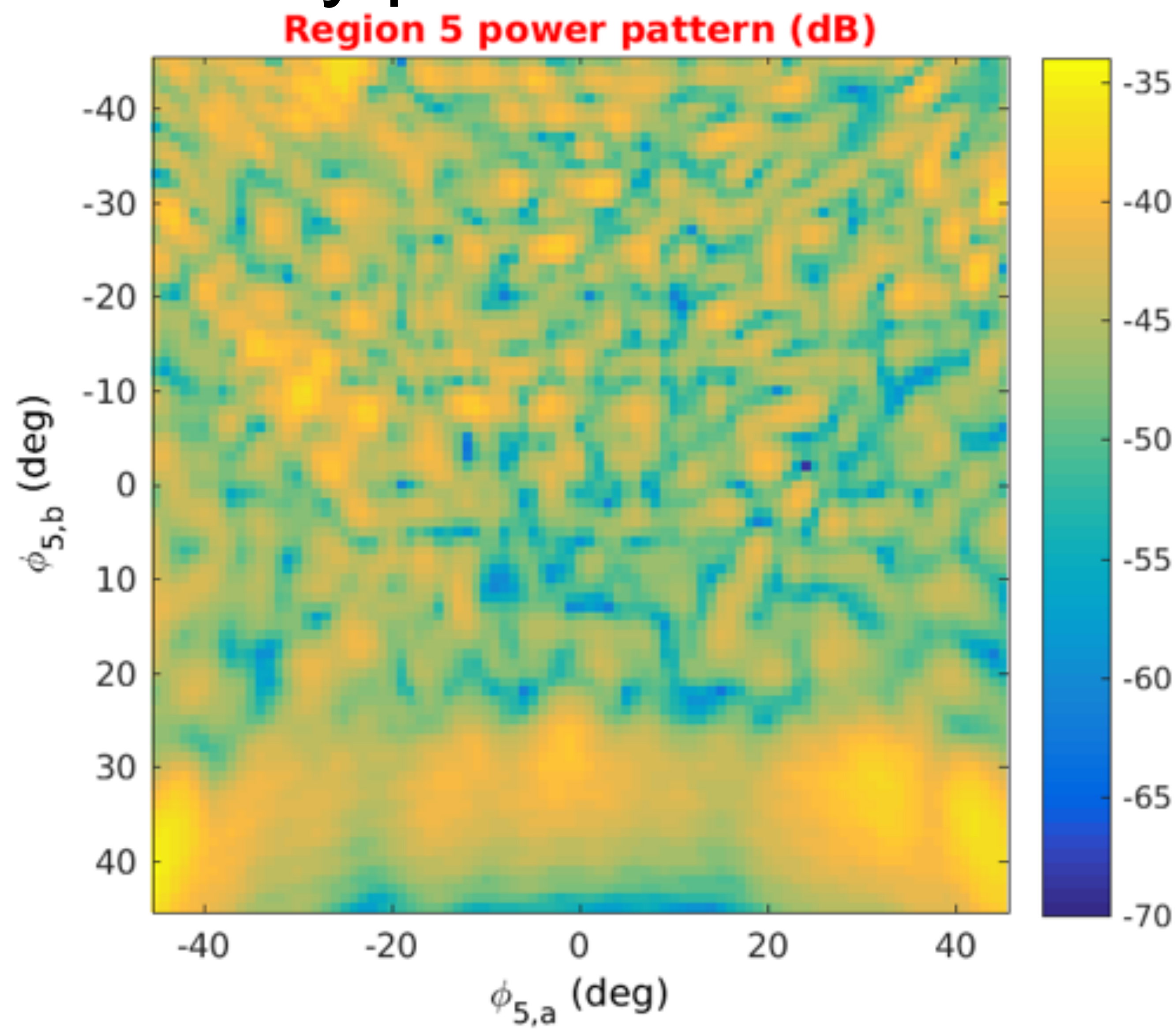




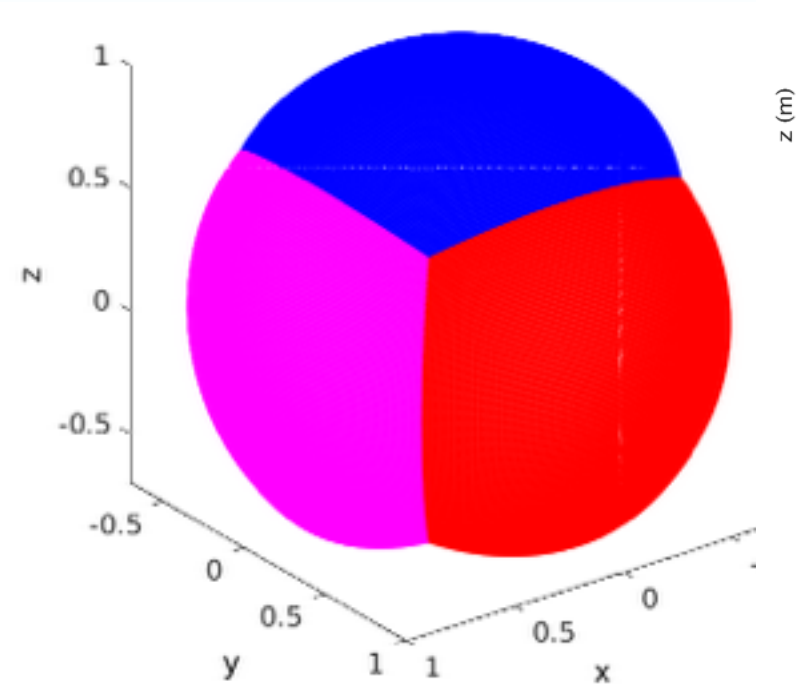
x polarized beam

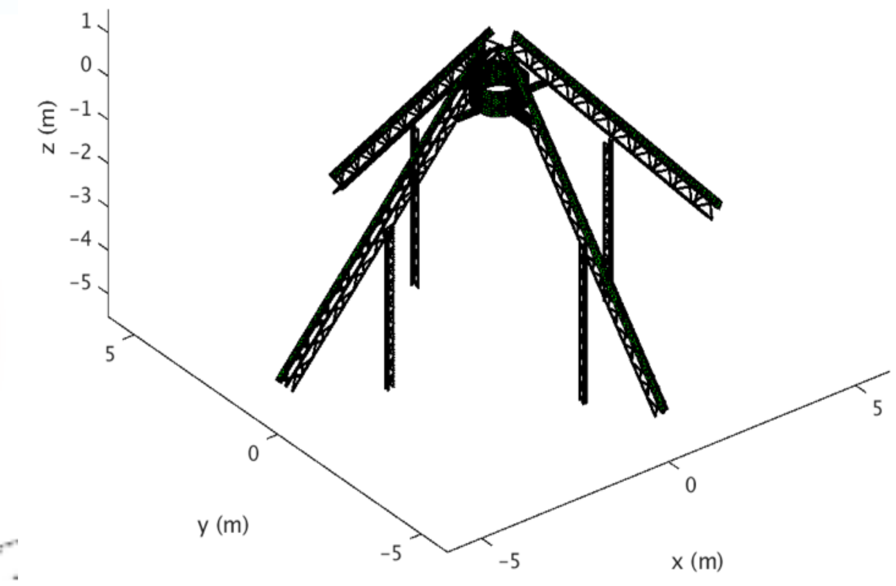


y polarized beam

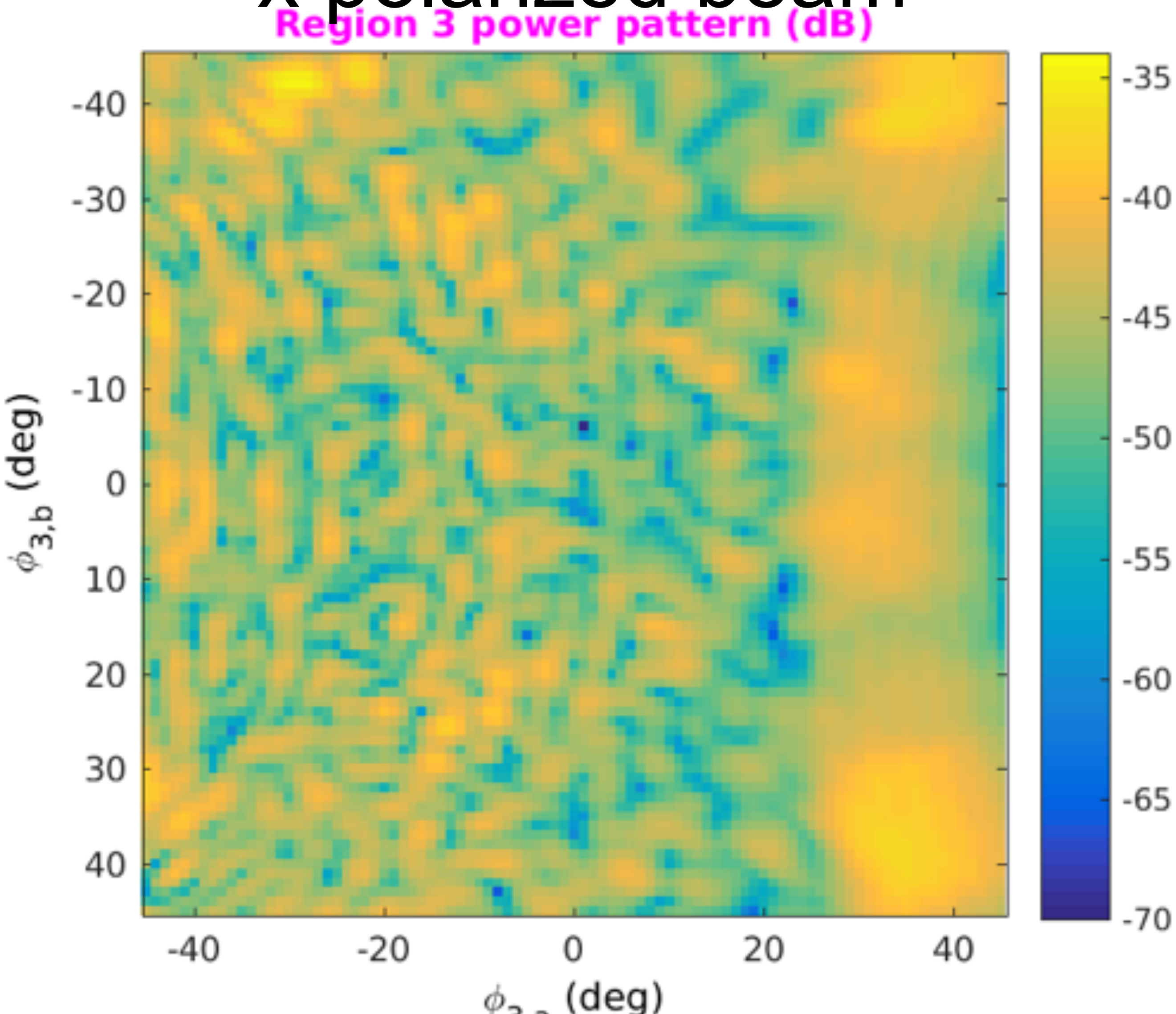


Magenta Region

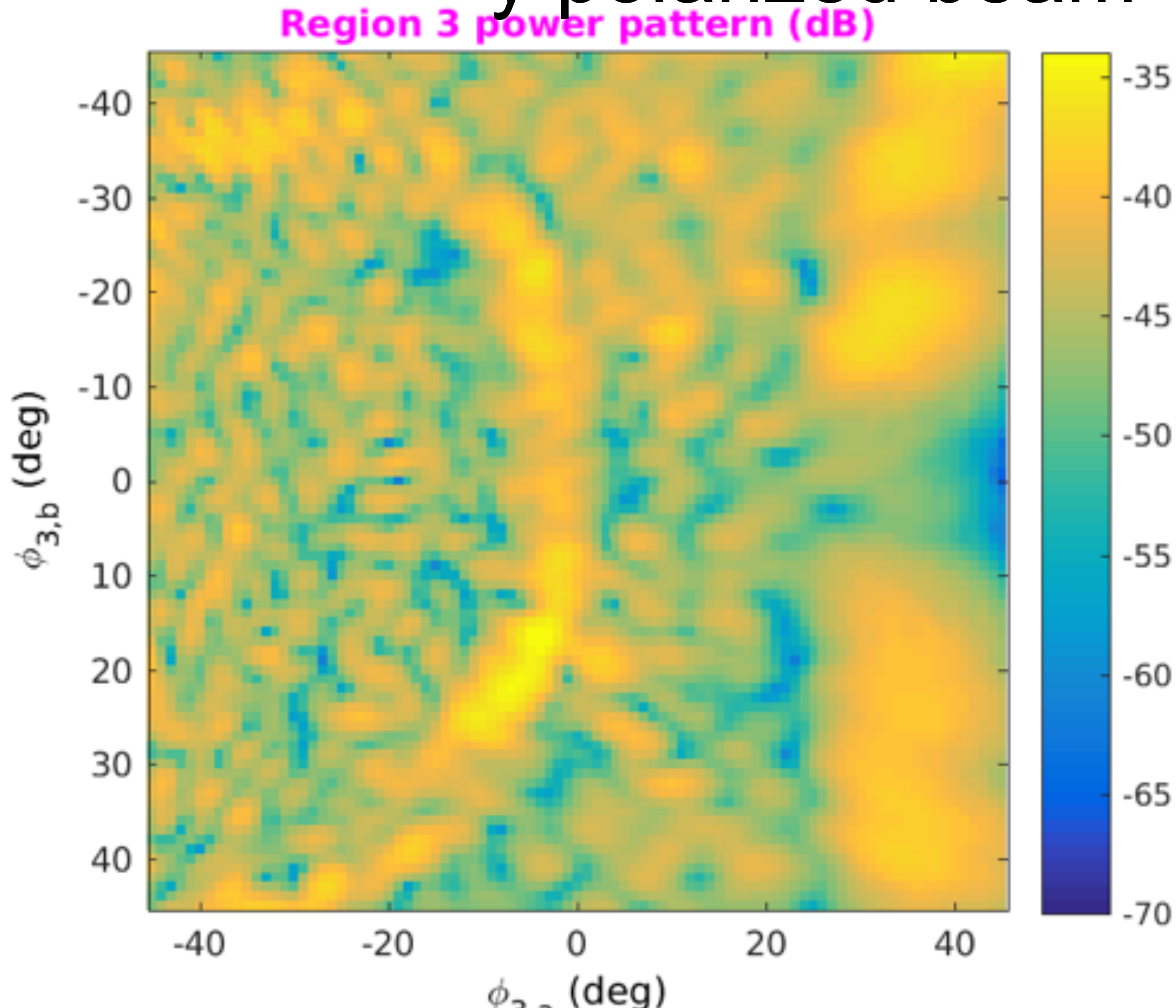


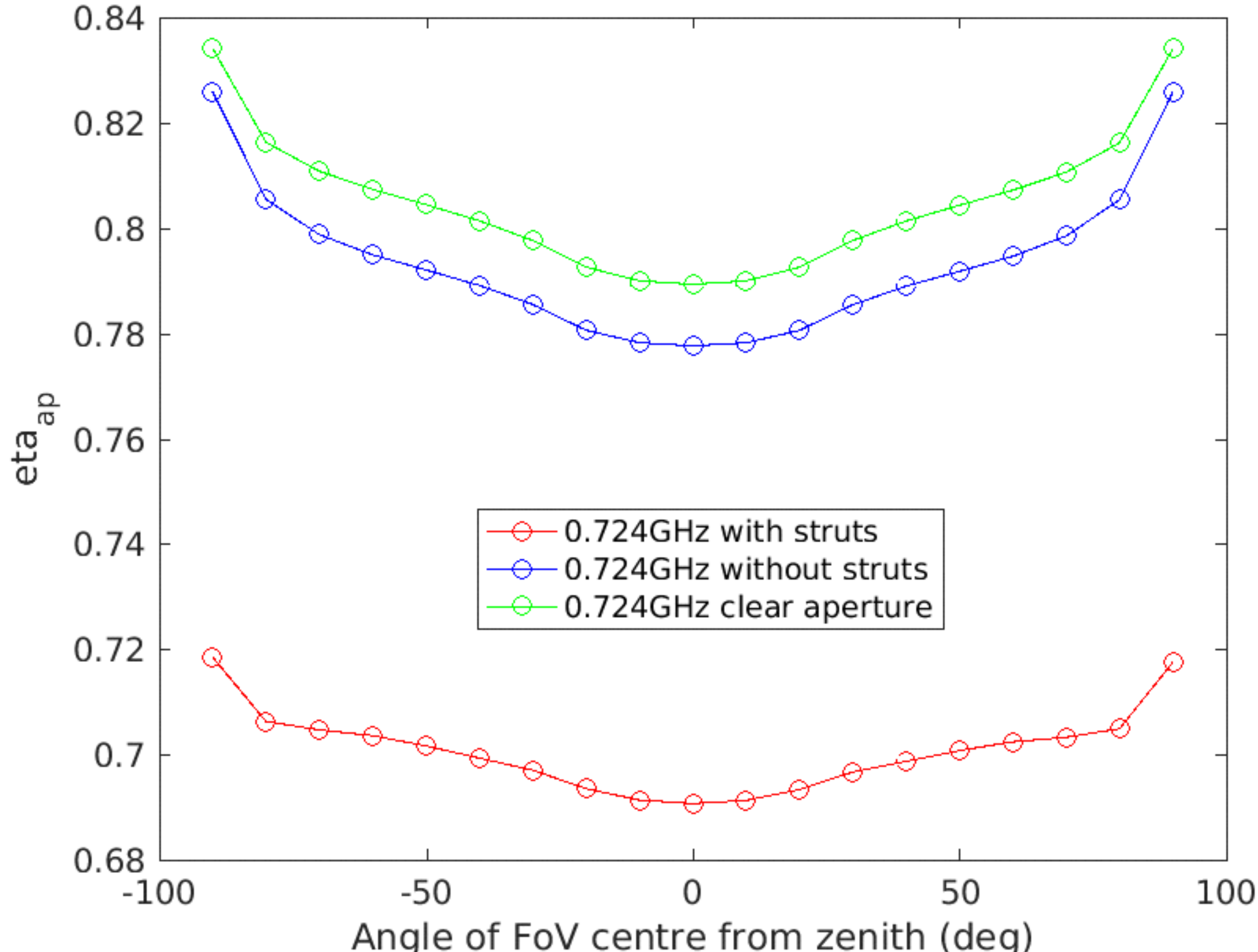


x polarized beam

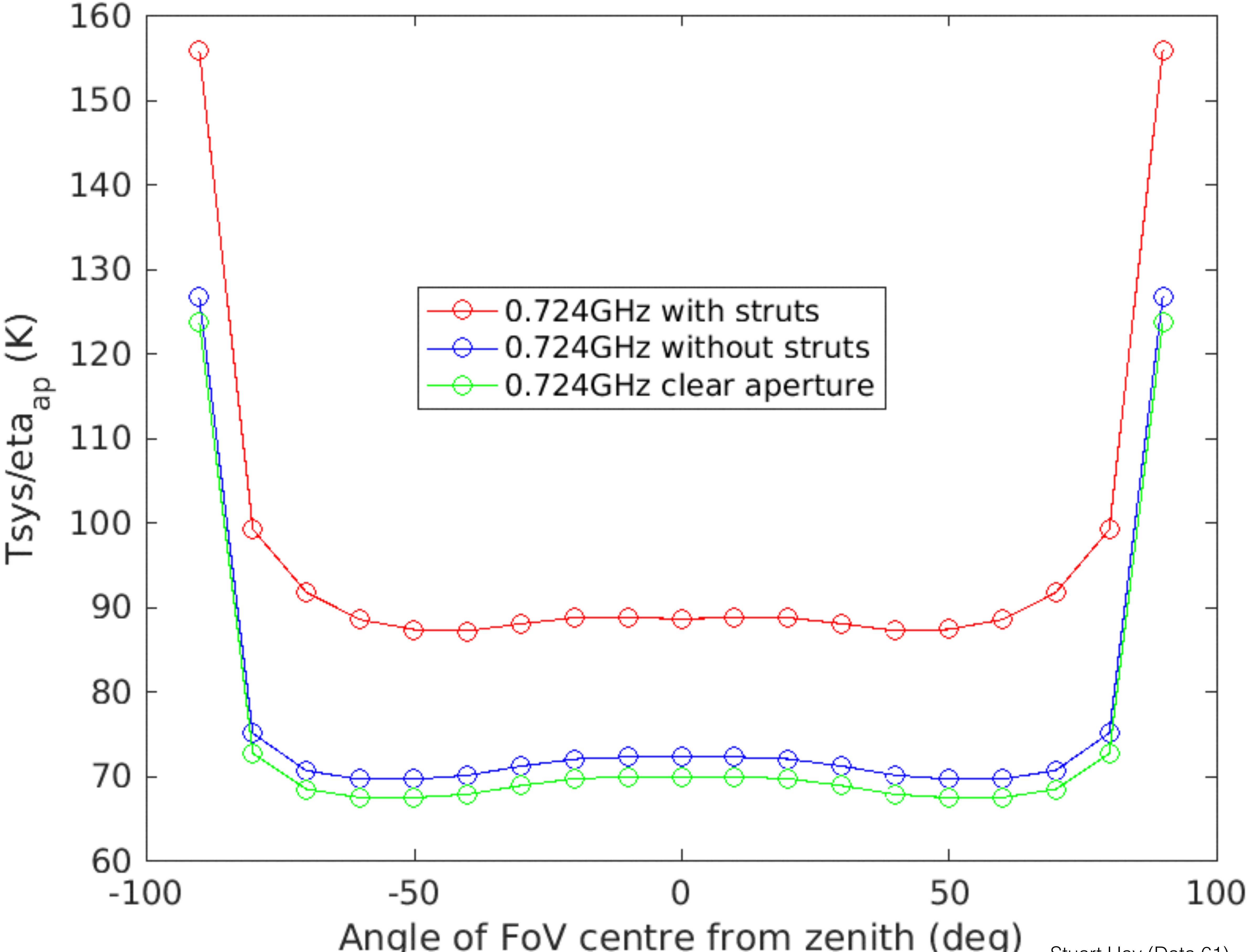


y polarized beam





Stuart Hay (Data 61)



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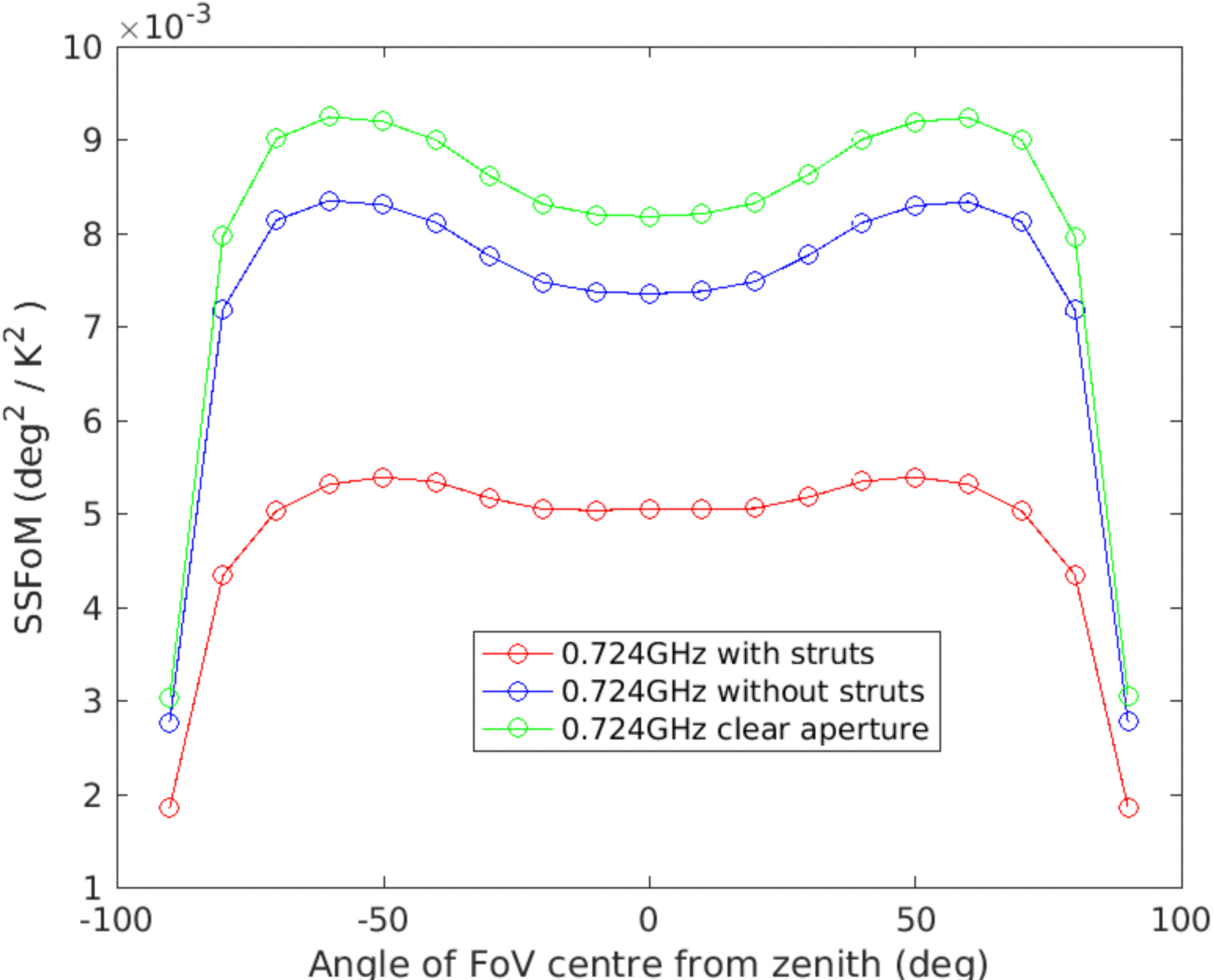
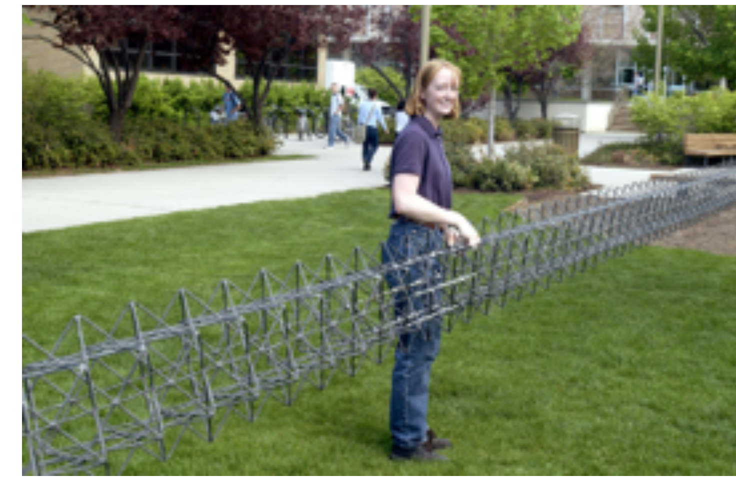


Stuart Hay (Data 61)

ISOTRUSS

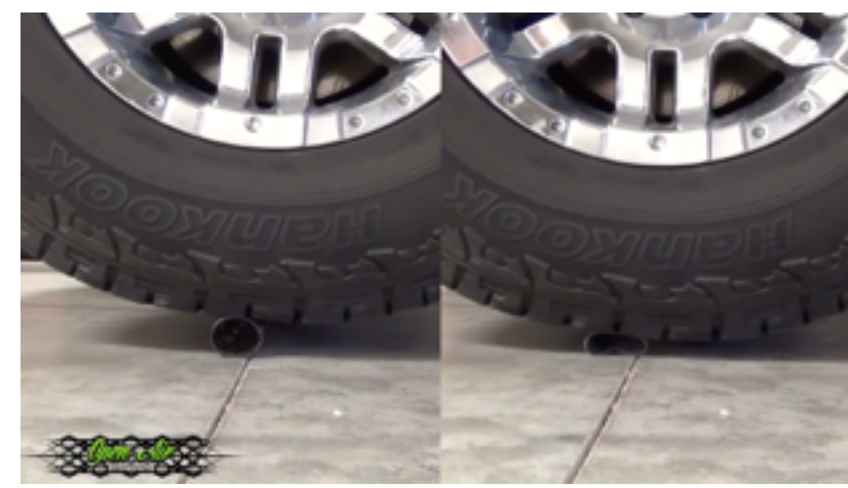
93m tower in Spanish Fork, Utah - isotruss.com

One of the worlds lightest and strongest bikes - isotruss.com



12x stronger than steel and 1/12 the weight - isotruss.com

Useful for climbing. And also waving - isotruss.com



ISOTRUSS

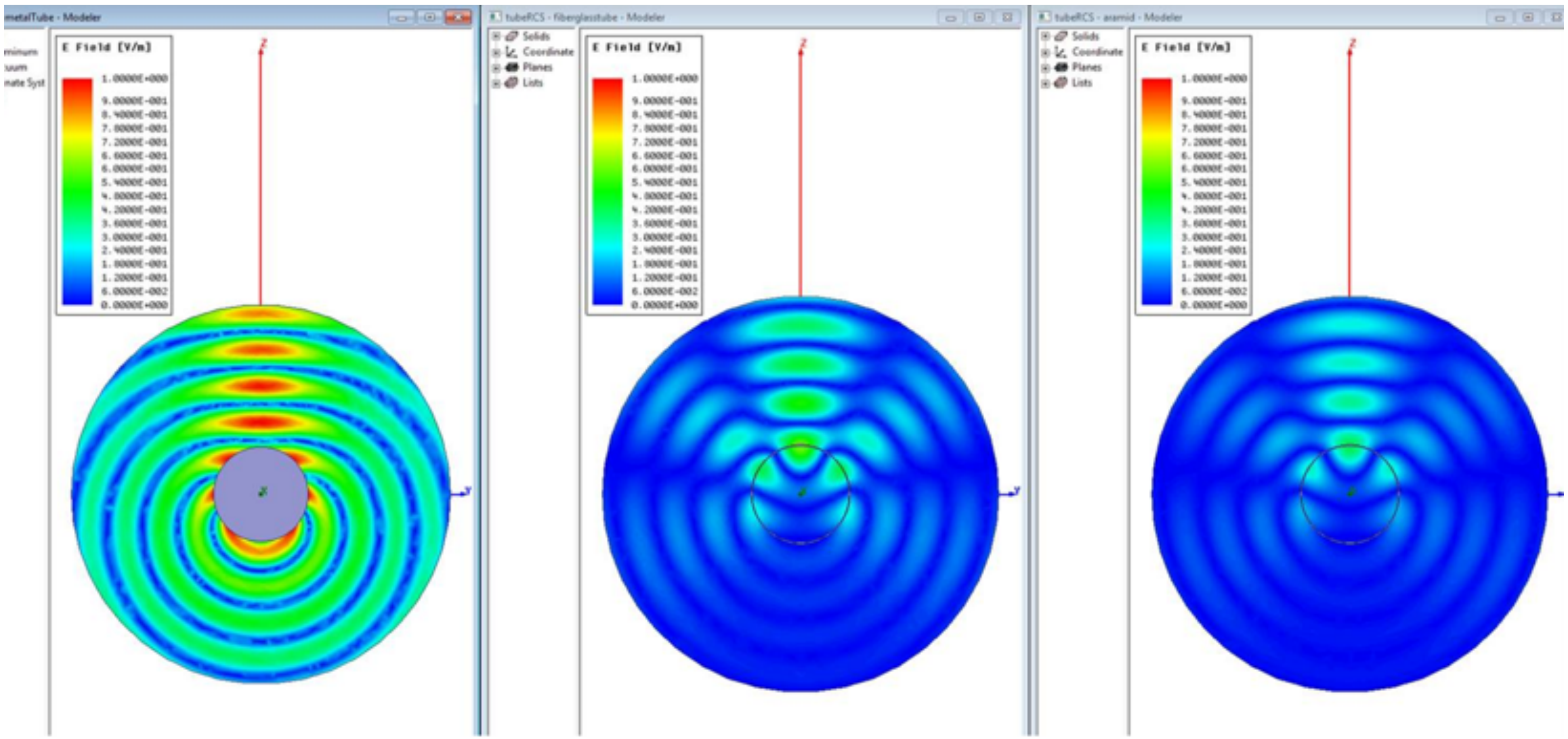
Carbon tube

And driving on. - Open Air Composites

Tubes

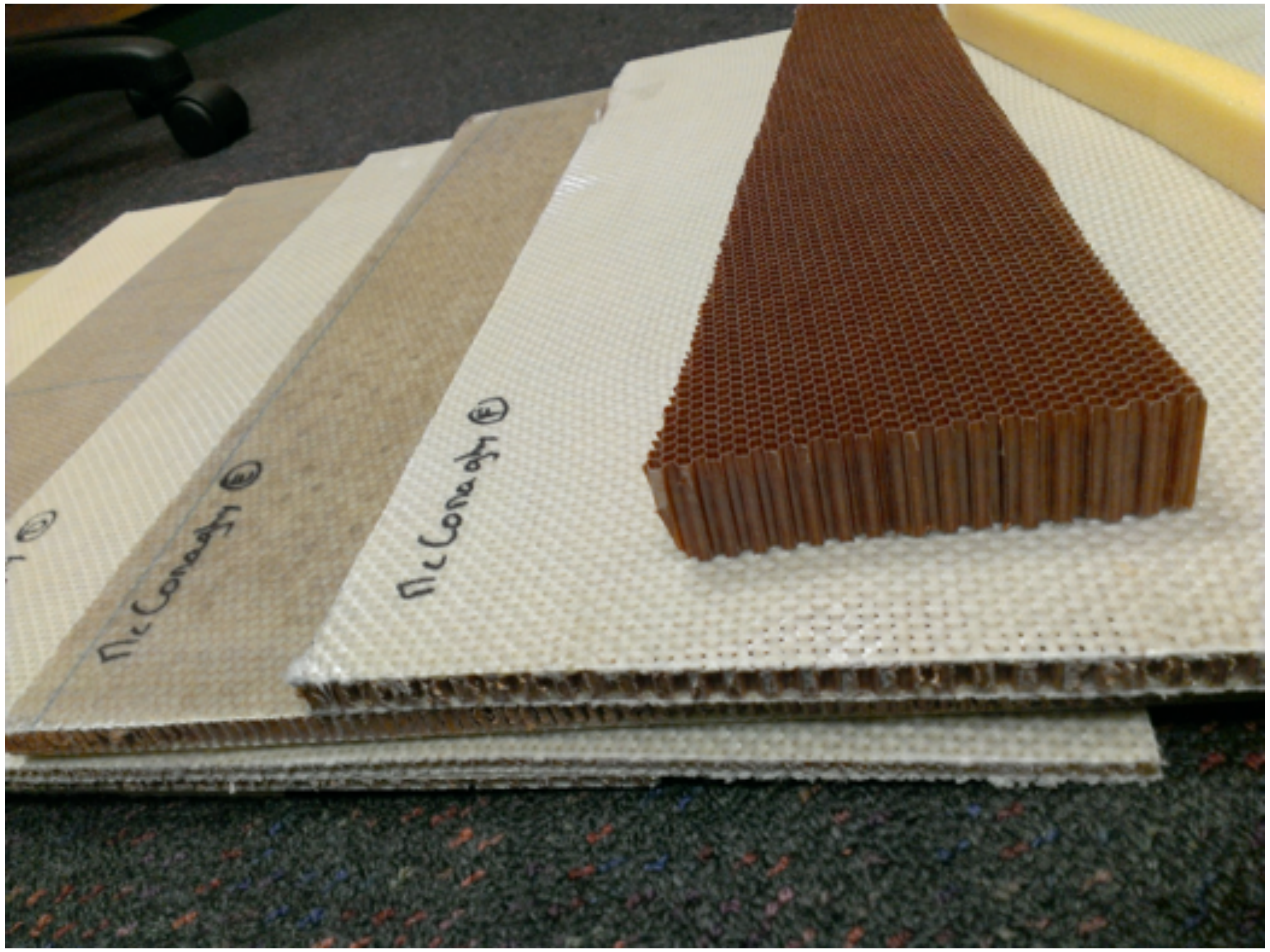
“Budget estimate (non binding) AUD$1.5M ± 20% of tubes and centre (focal point) end-fitting only supply”

EM Simulation of Tubes



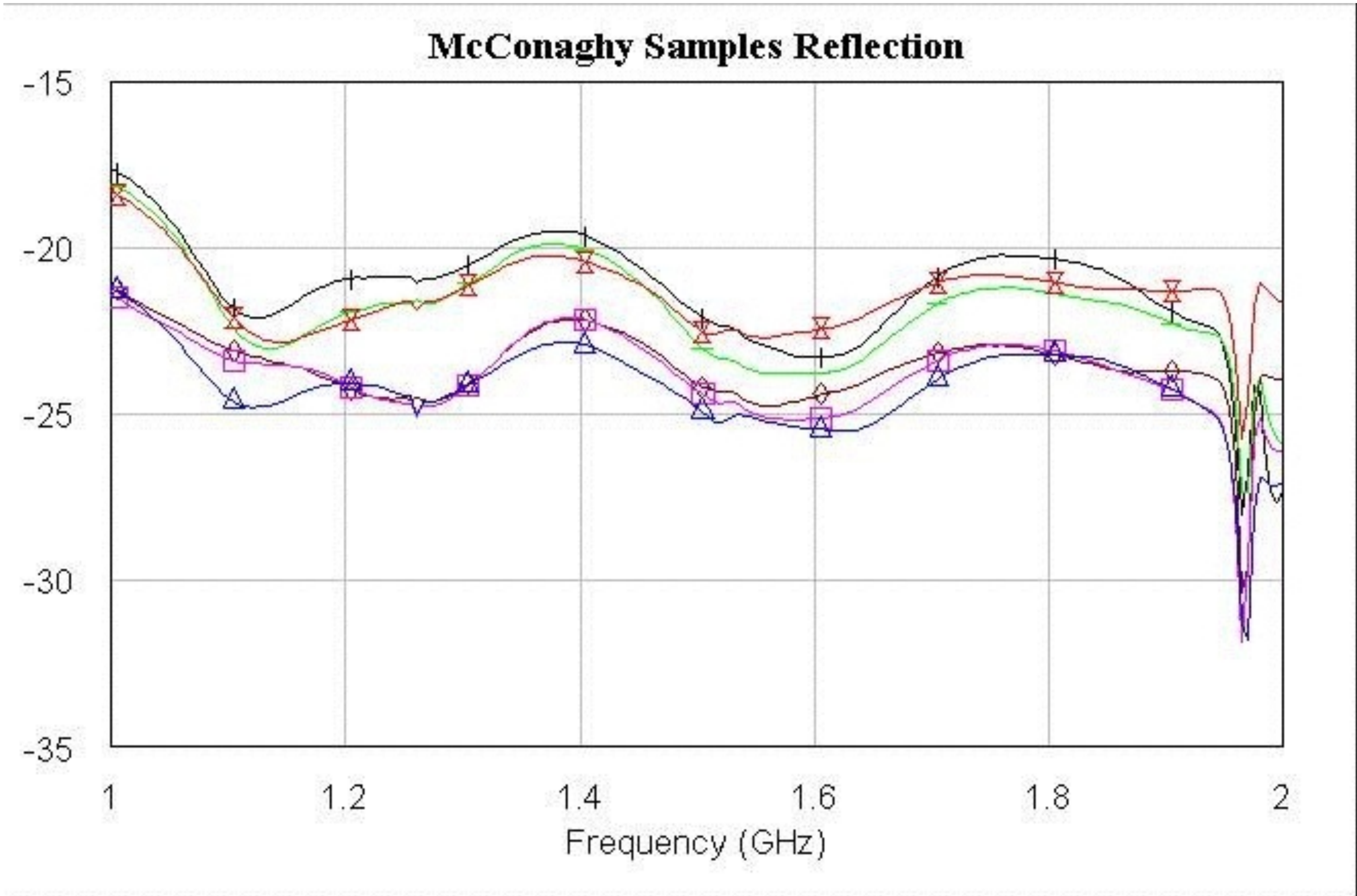
Alex Dunning

Foam Sandwiches



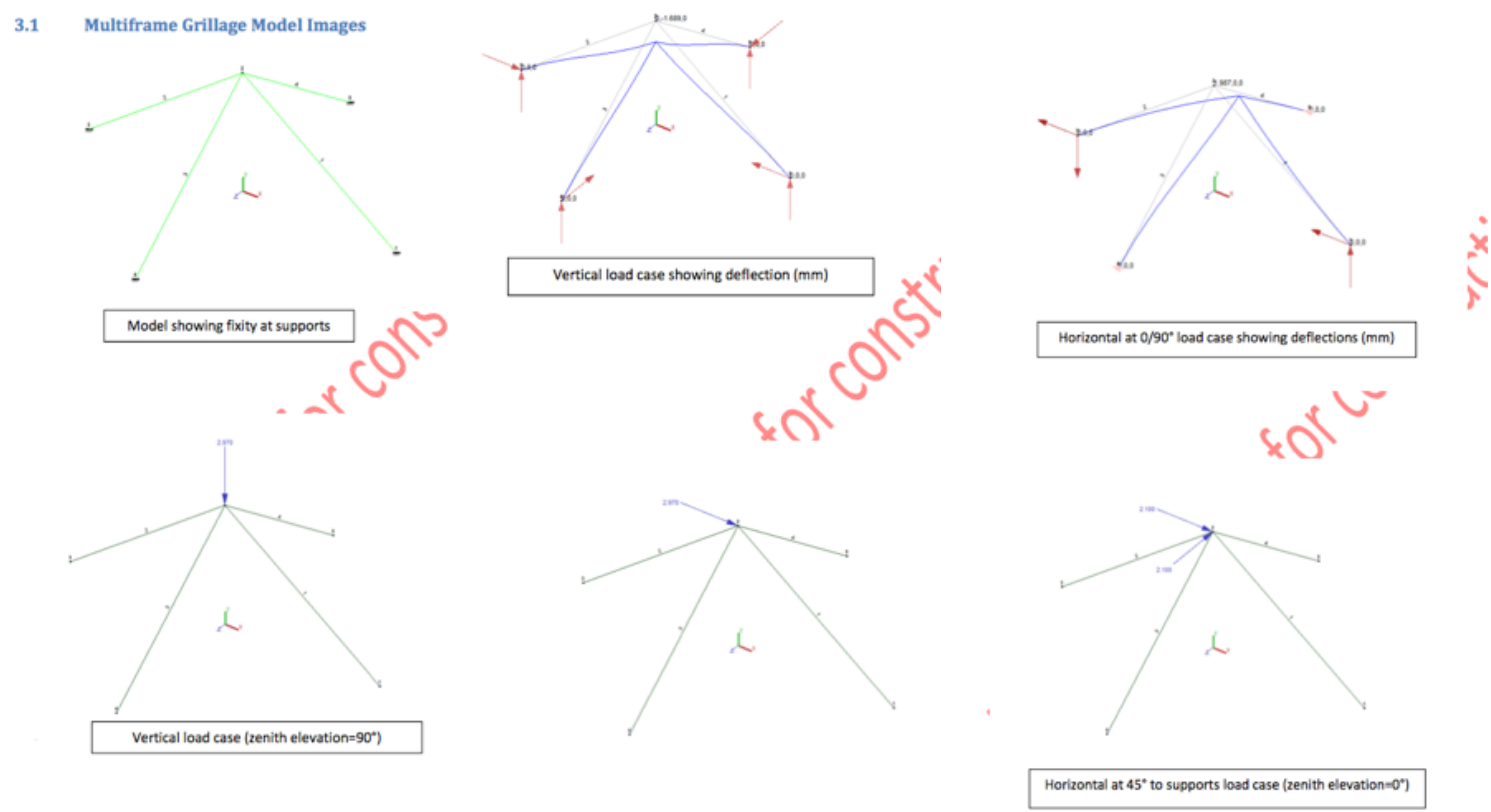
The foam core is made of SAN = styrene acrylonitrile.

Reflection



Alex Dunning

Foam sandwich tube: “Grillage” model

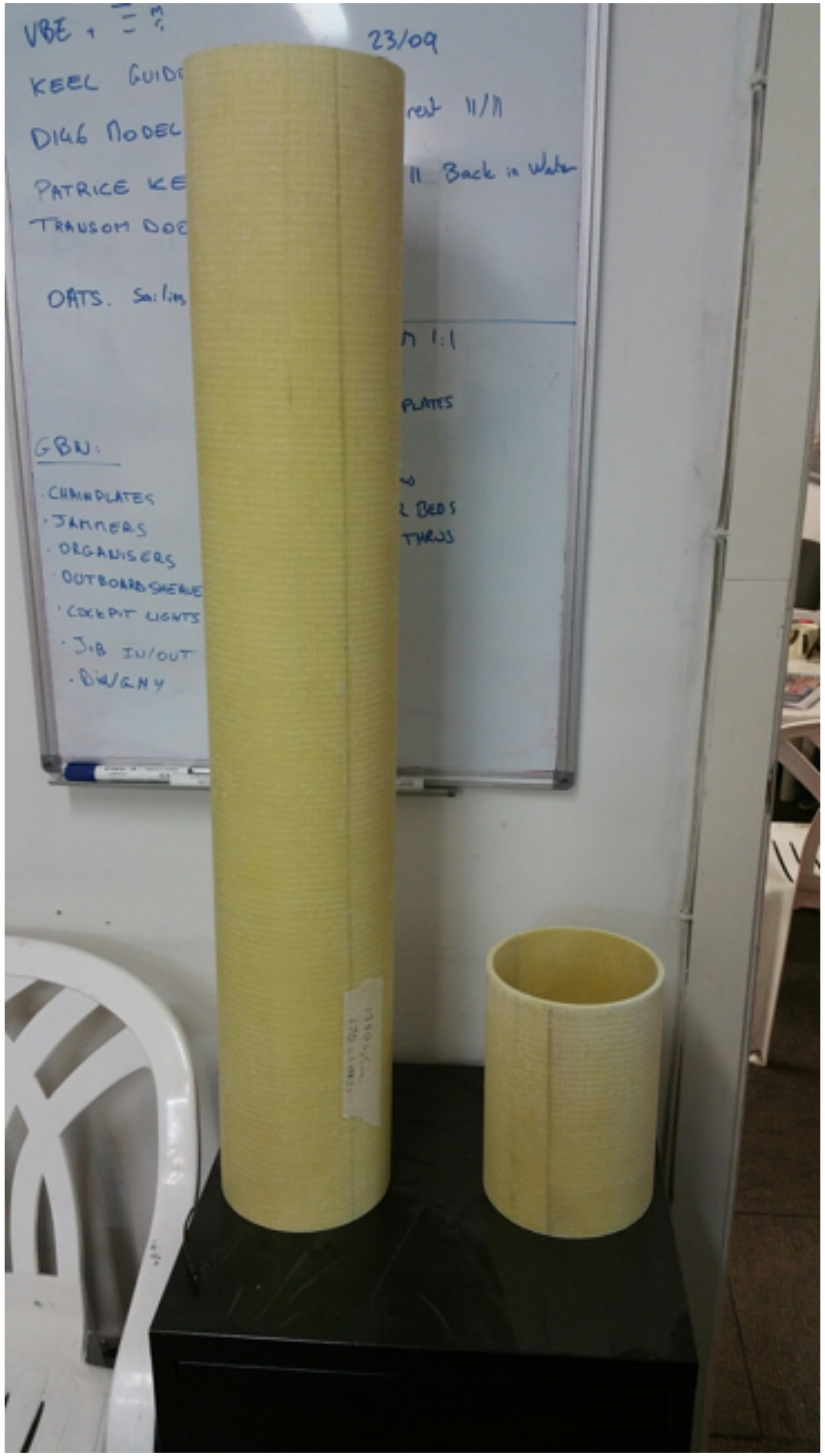


Design

Support Tube Preliminary Laminates

QTY	Ply Name	Fibre Angle	Description	Process	FVF	FWF	Thickness (mm)	Ply Weight (g/m²)
1	EDB125 Ehfv	±45°	Stitched double bias E-glass	vacuum consolidated epoxy	0.46	0.64	0.11	222
1	UT-E300 Ehfv	0°	Unidirectional E-glass	vacuum infused epoxy	0.47	0.65	0.25	448
1	Corecell M60		SAN foam core				5.00	325
1	UT-E300 Ehfv	0°	Unidirectional E-glass	vacuum infused epoxy	0.47	0.65	0.25	448
1	EDB125 Ehfv	±45°	Stitched double bias E-glass	vacuum consolidated epoxy	0.46	0.64	0.11	222
1	resin grams= 1000	-	core prime	infusion	-	-	0.00	1000
						Totals	5.7	2664.9

McConaghy Sample



Approximate Material Costs

- Solid Tubes: AUD$1.5M ± 20%
- Foam Sandwich tubes: $400k

Future work

- Measure samples in the antenna range
- Finalise simulation work
- Far sidelobe holography using ASKAP-12
- Compare measurements with simulations
- Single-antenna prototype???