First Steps to On The Fly Mapping at ATA

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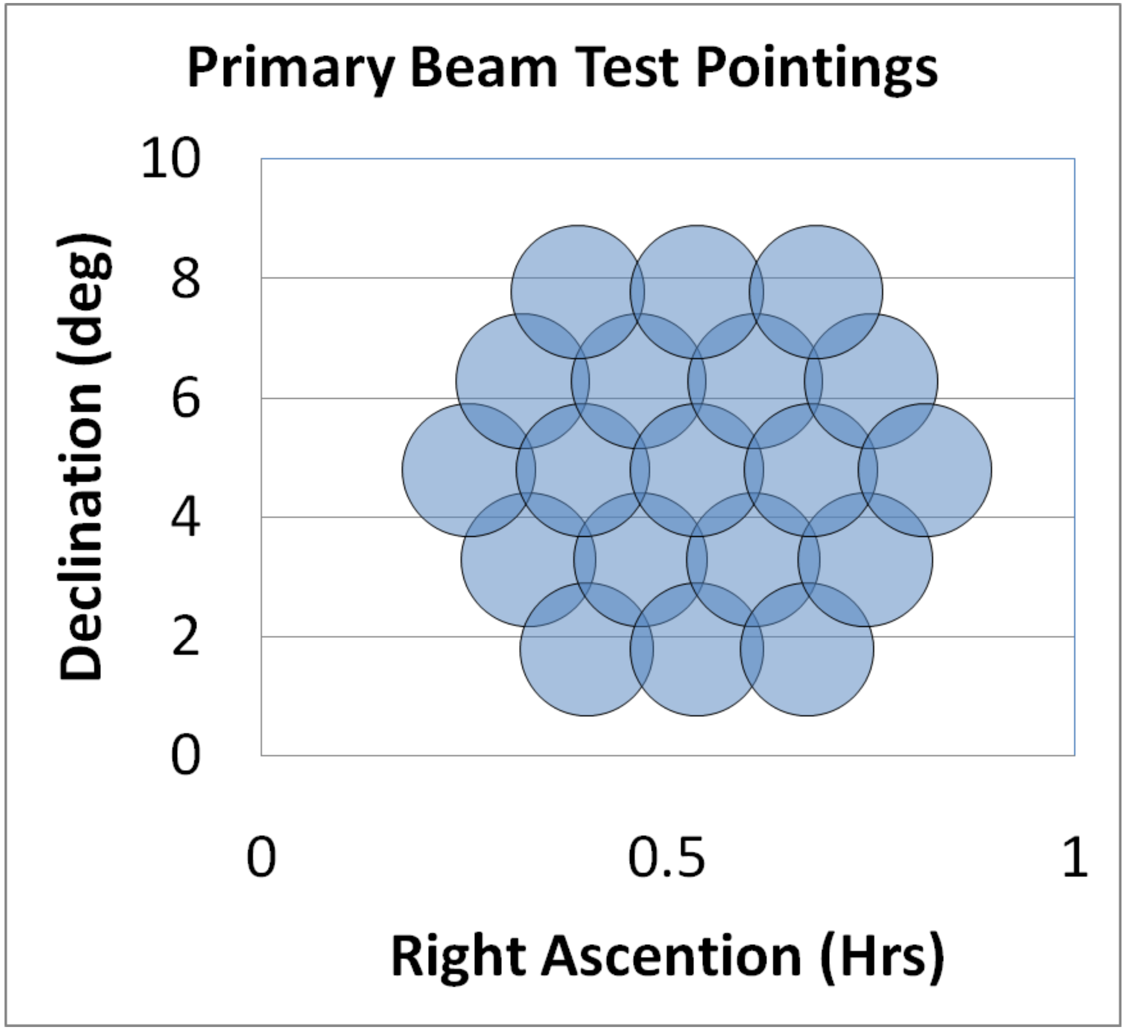
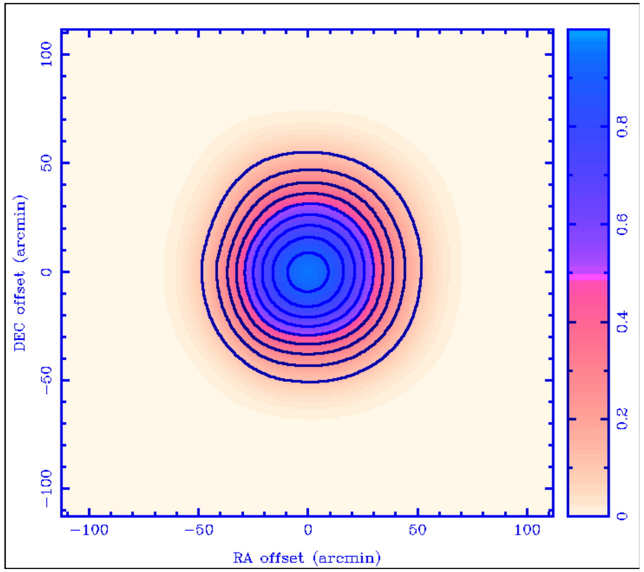
Traditional Mosaic

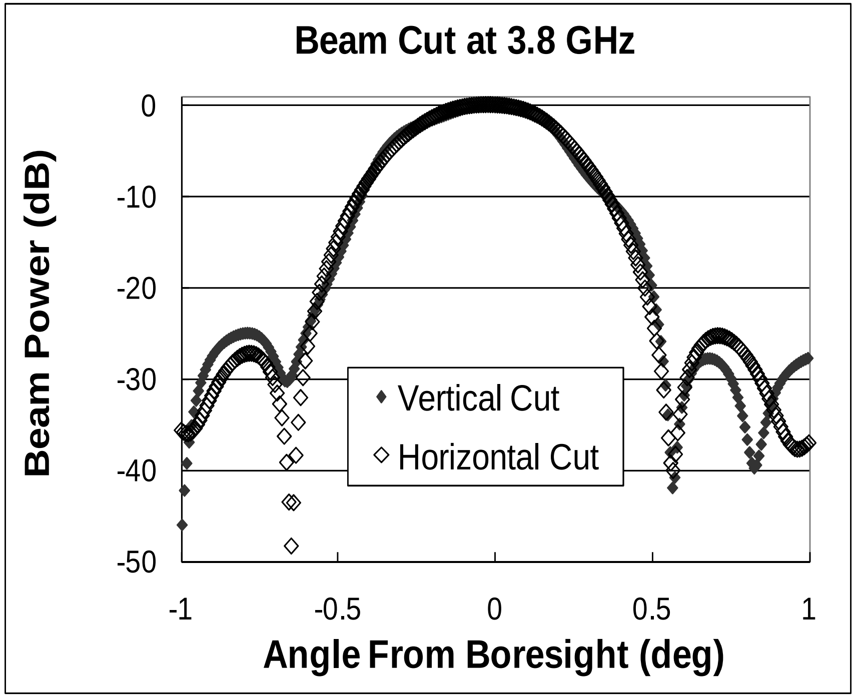


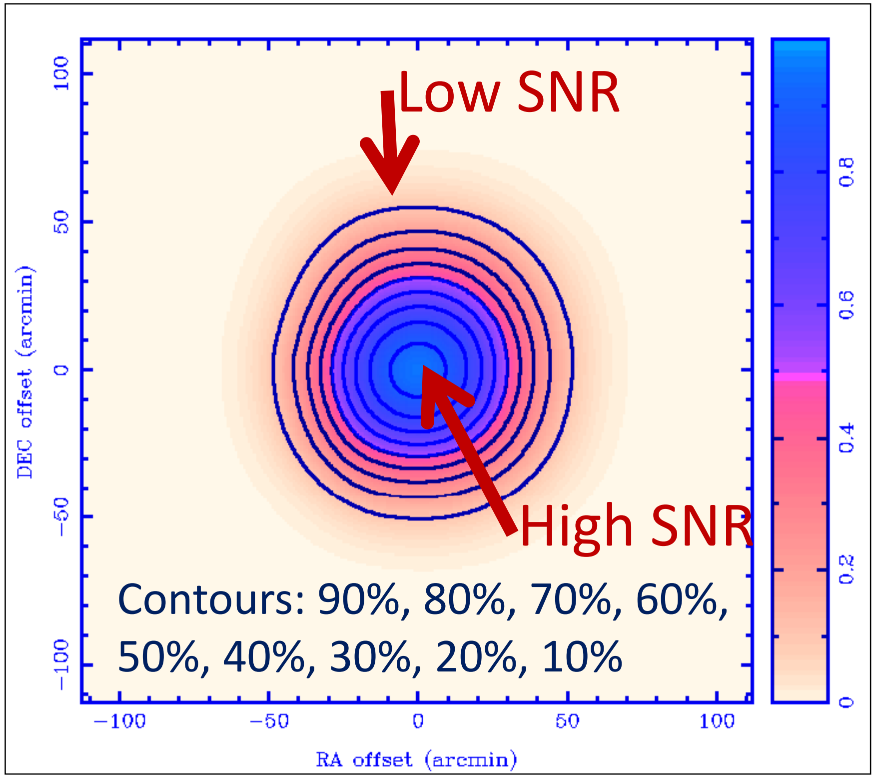
Primary Beam
FWHM = 2.5°
Spacing = 1.82°



Contours at 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%

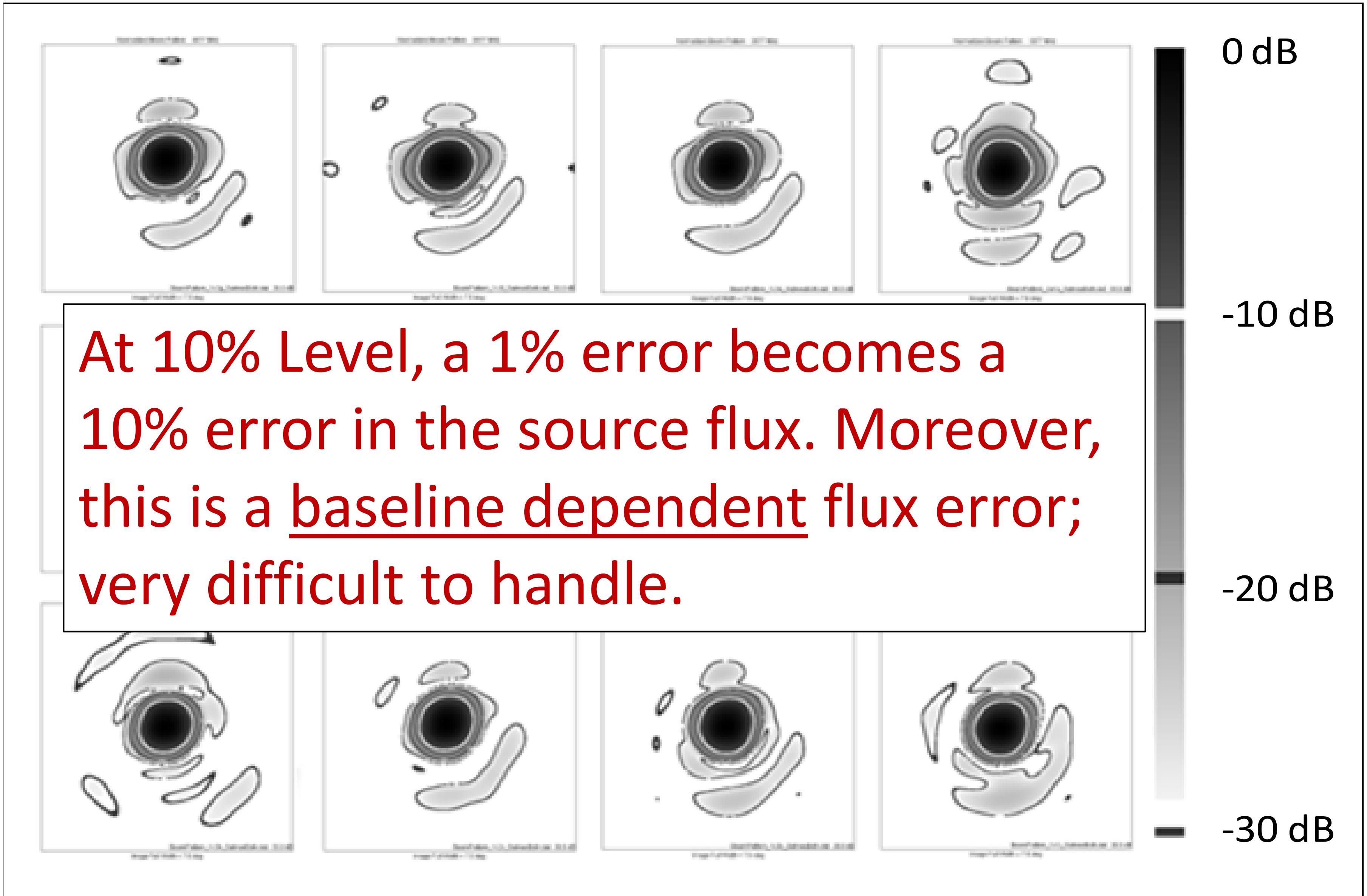
Primary Beams are not Gaussians





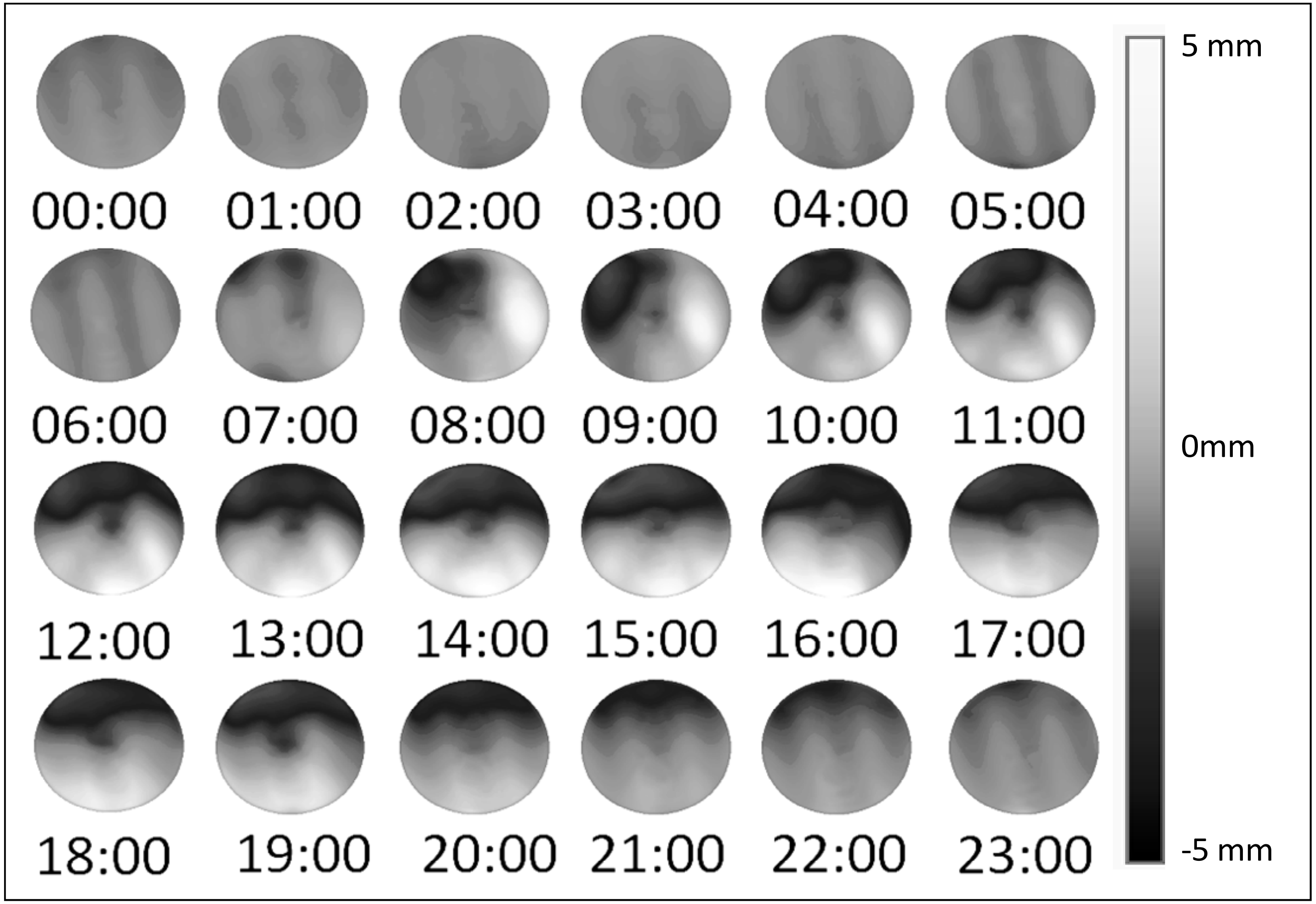
An image is made for each pointing. The image is cleaned, then corrected for circular Gaussian fit (not exact – note PB at 10% point). Images are stitched together to make mosaic map. Difference of PB from Gaussian introduces errors, esp. at edge of individual fields.

Not All PB's are Alike -- ~1% Max Error



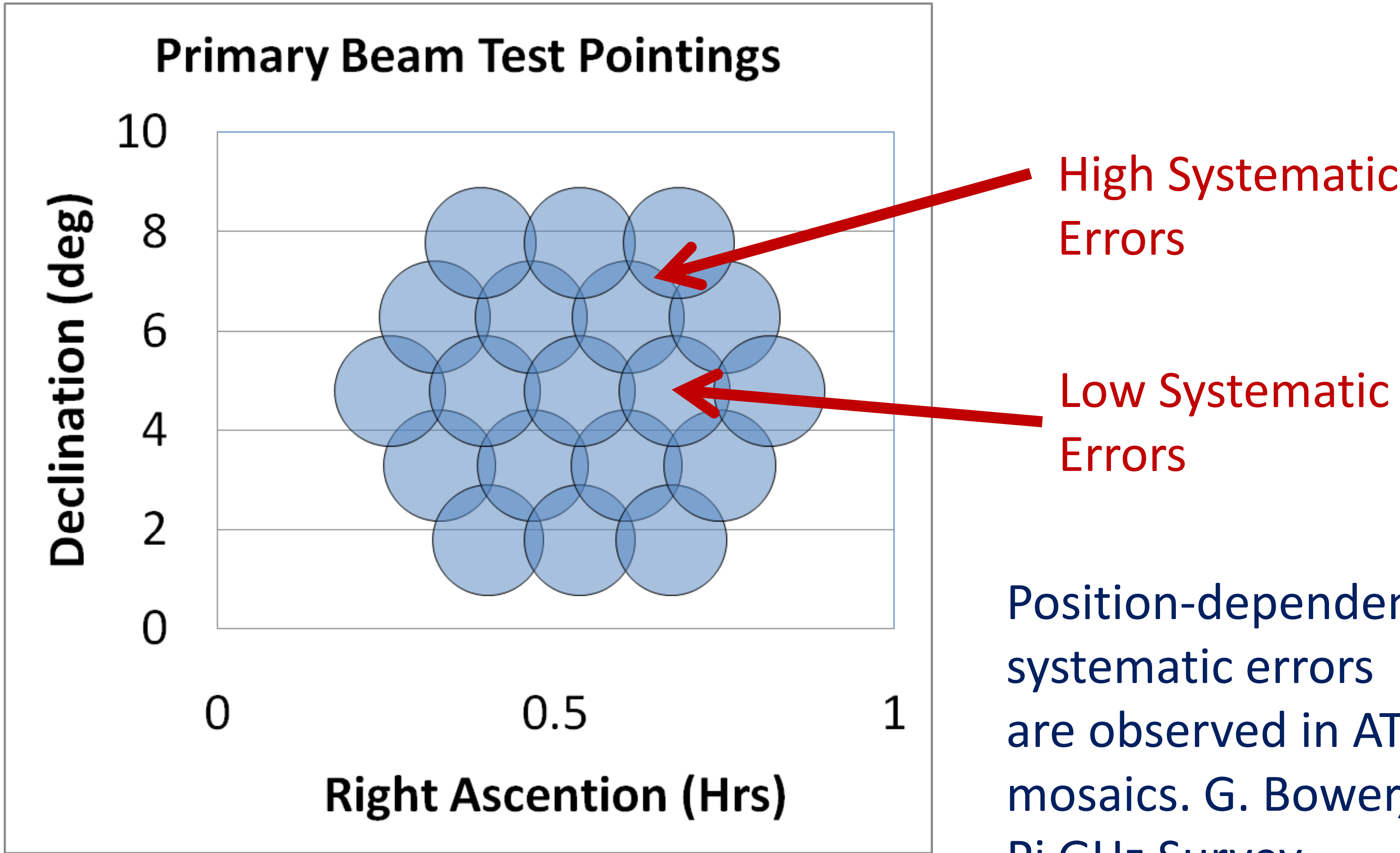
At 10% Level, a 1% error becomes a 10% error in the source flux. Moreover, this is a baseline dependent flux error; very difficult to handle.

Dish Surface's are Time Dependent!



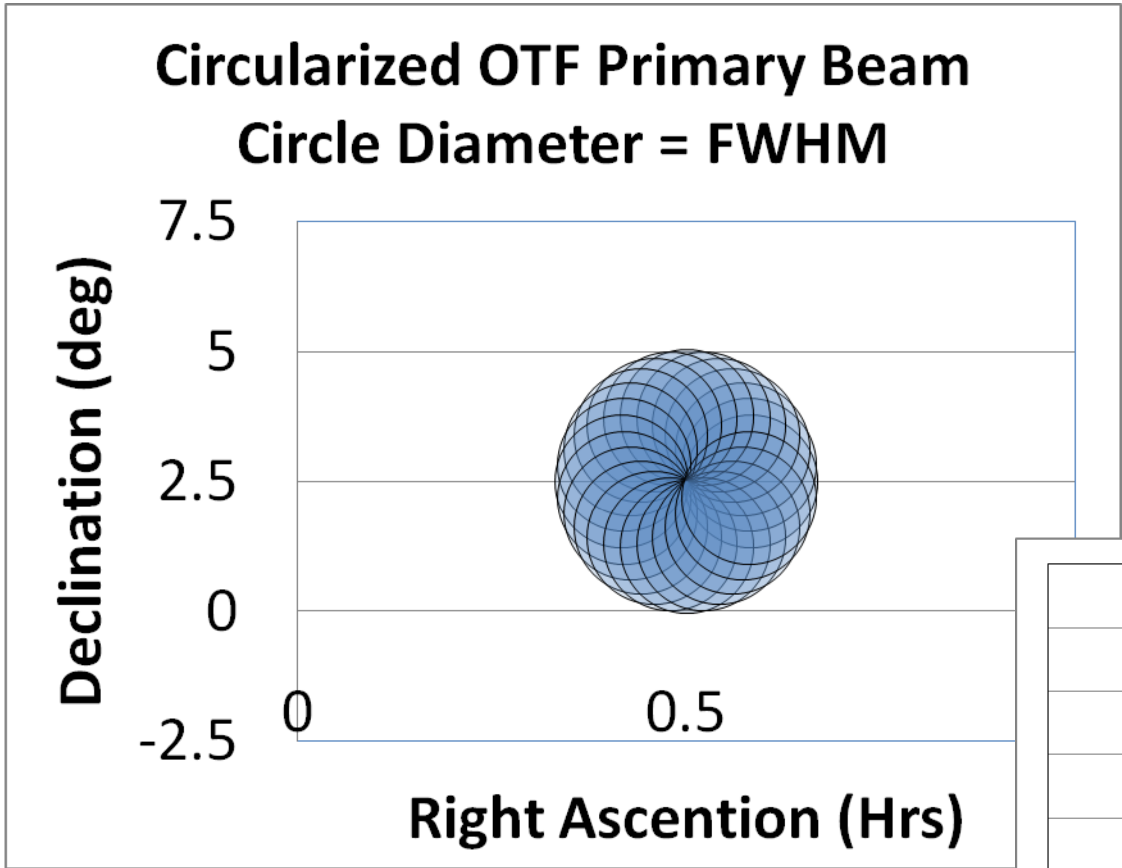
Naturally PB's are also Time / Temperature / Solar Angle Dependent. Pointing is too.

Traditional Mosaic

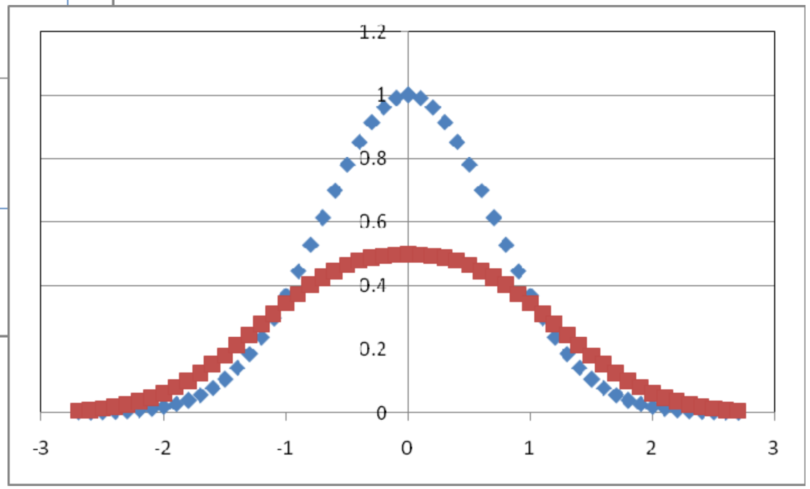


Position-dependent systematic errors are observed in ATA mosaics. G. Bower, Pi GHz Survey.

OTF Solution Prototype 1



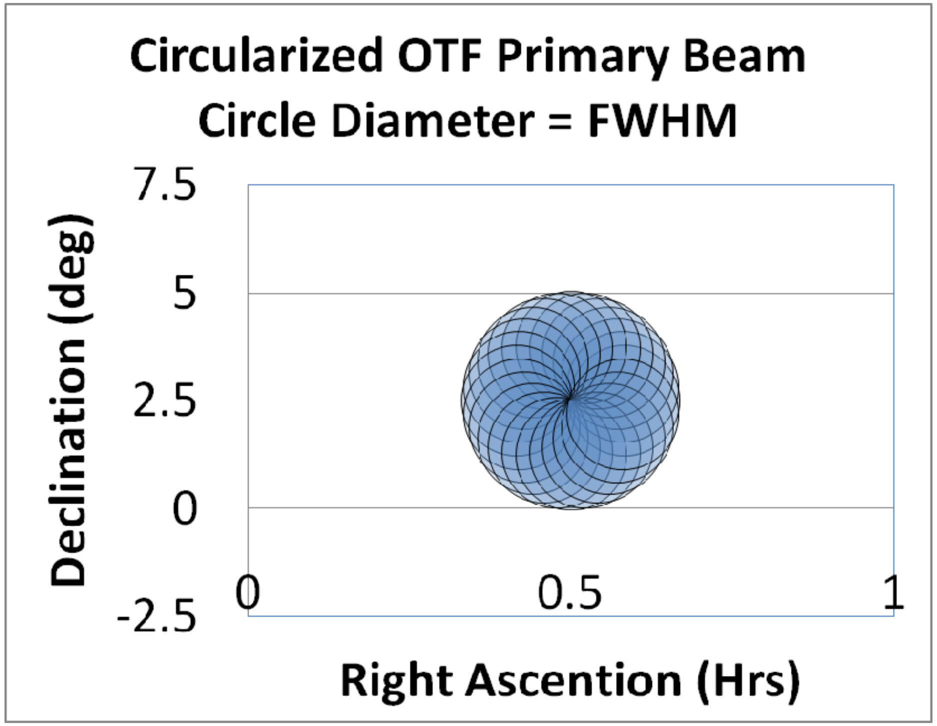
Rapidly circulate the PB of all antennas while keeping the same phase center in the correlator.



Primary Beam is broadened and with right parameters has a nearly flat top. More resistant to beam defects.

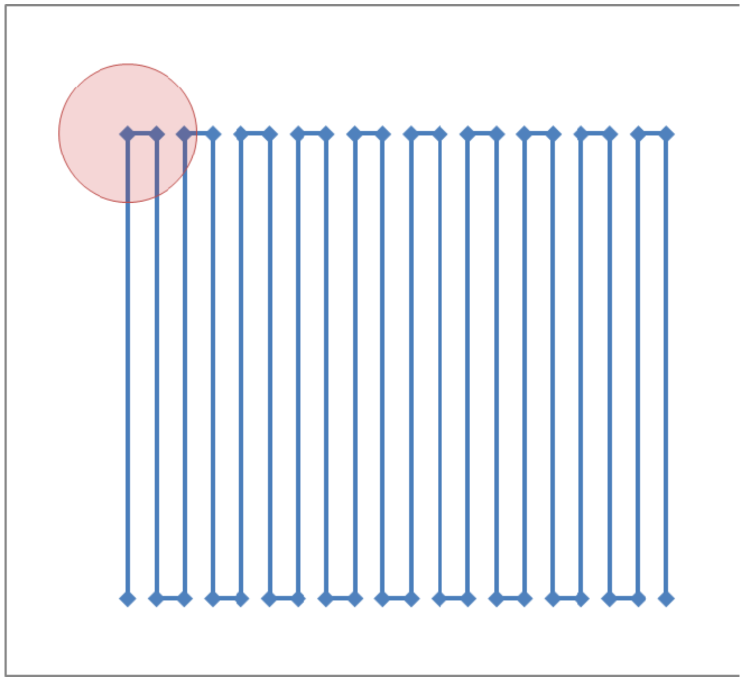
No Sensitivity Loss!
Its just moved around.

OTF Solution Prototype 1



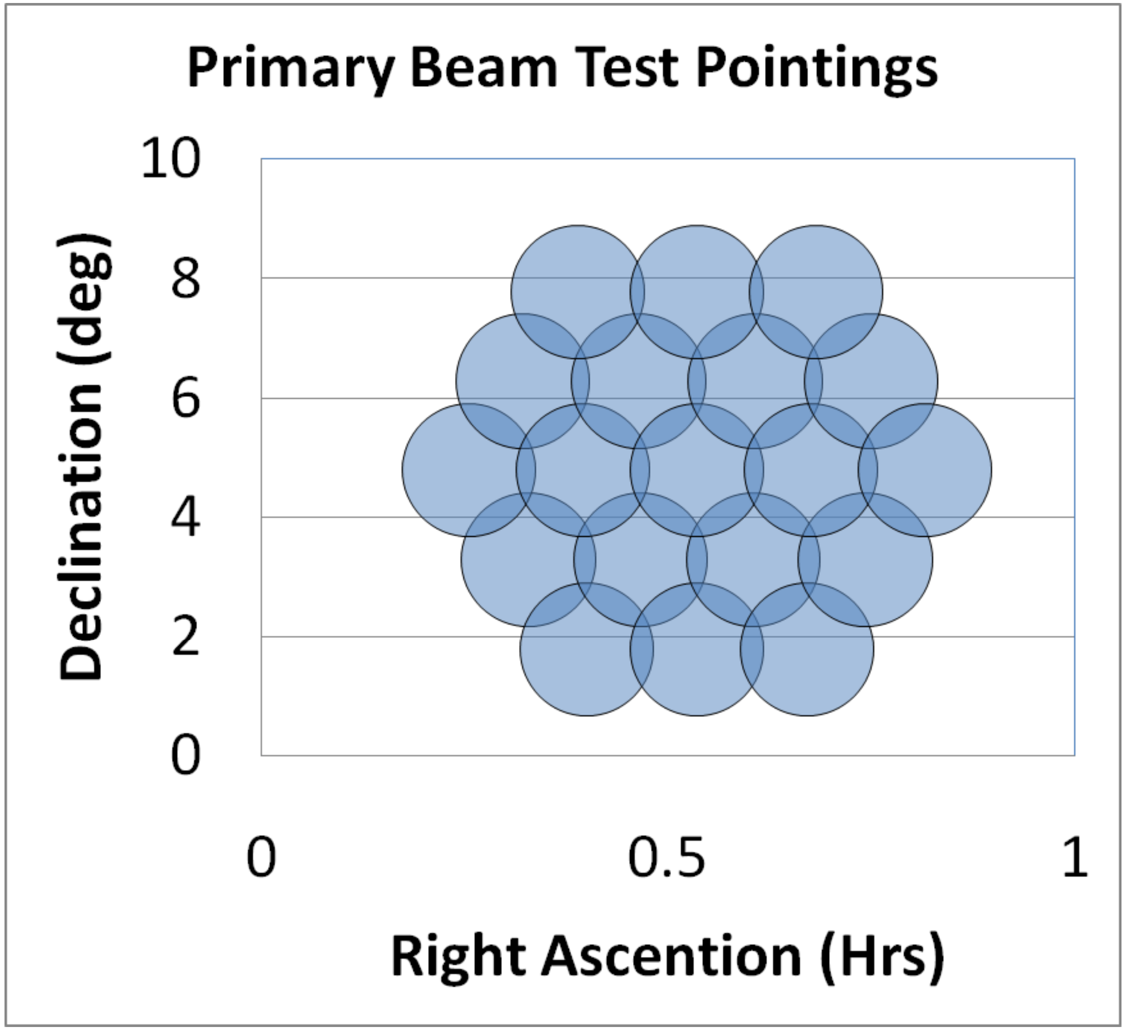
- ATA dishes move fast
- Can complete a cycle in single dump time = 10 s.
- Compound Ephemerides = Eph1 * Eph2 * Eph3 …
- Rotations implemented with Quaternions
- Eph1 = phase center, Eph2 = circle about zenith with 10 s period

OTF Solution Prototype 2



- Continuous motion on a fine grid, spacing << PB diameter
- Cannot complete cycle in 1 correlator dump, so…
- Attach RA, Dec of PB pointing to each dump.
- At image time, generate a super-Nyquist grid of pointings, using all data weighted by distance from pointing.
- Stitch pointings together as usual.
- Gives maximally uniform PB

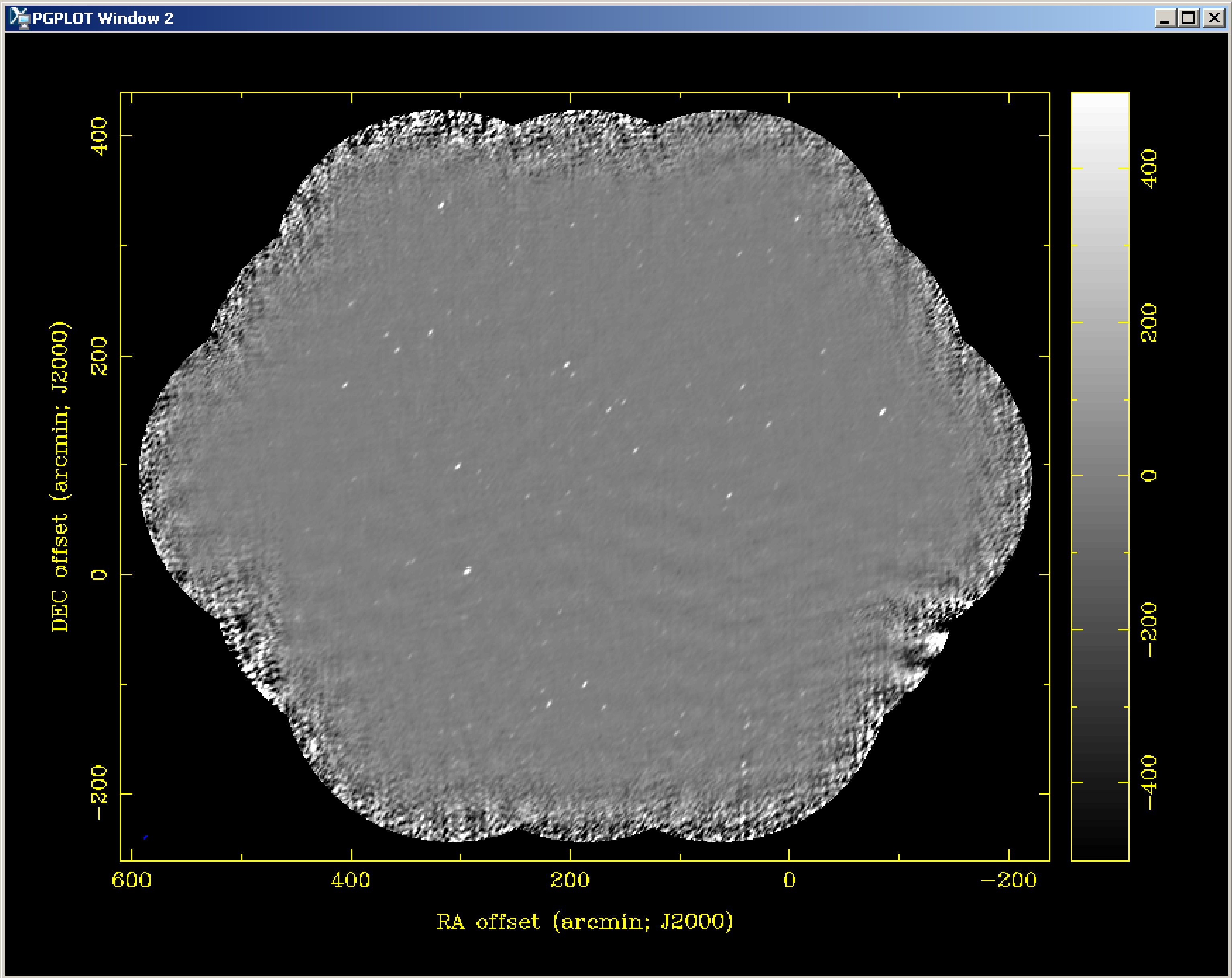
First Attempt



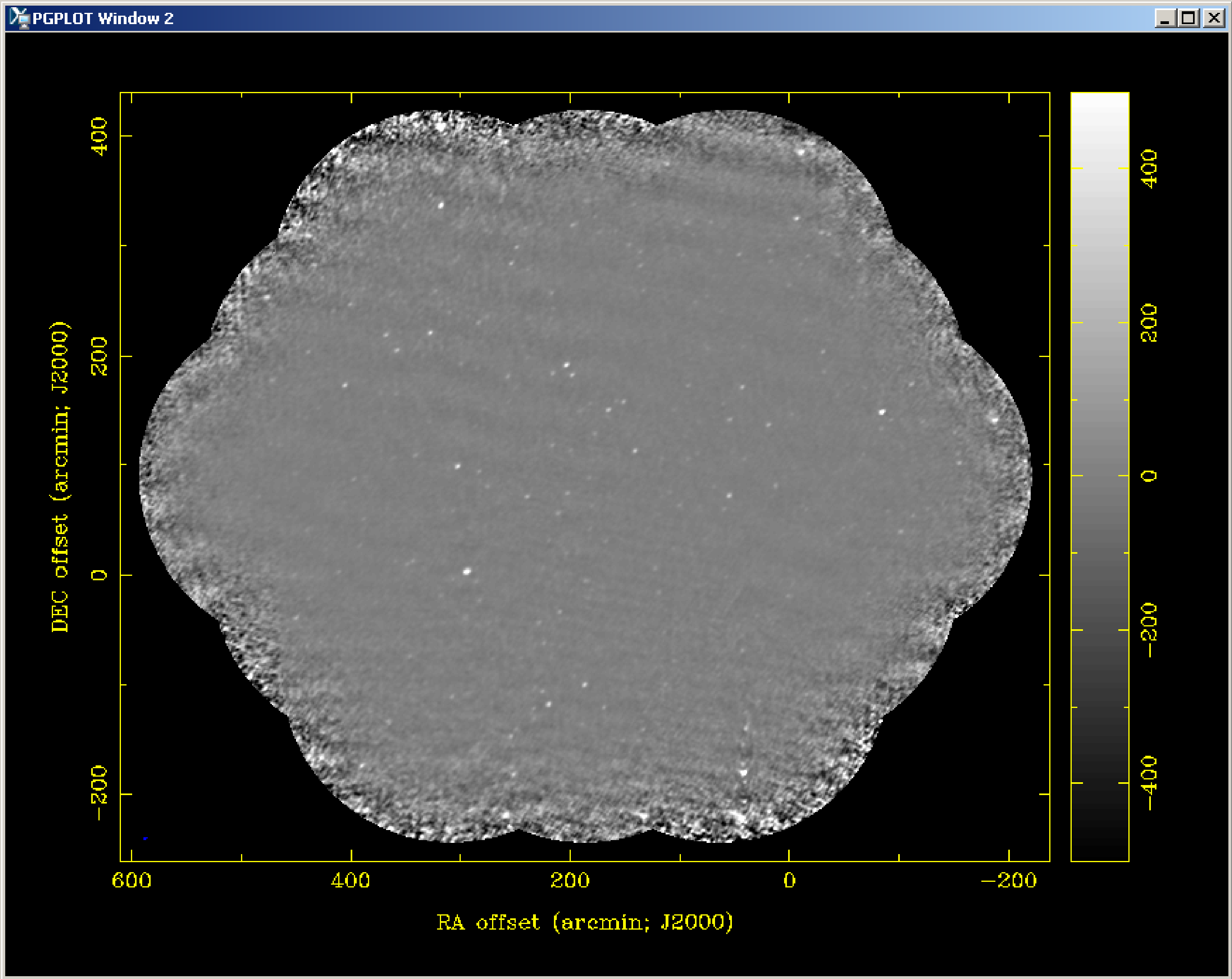
19 Pointings
4 Epochs
2 with static PB's
2 with circulating PB's

2 min/pointing
3-4 repeats per night

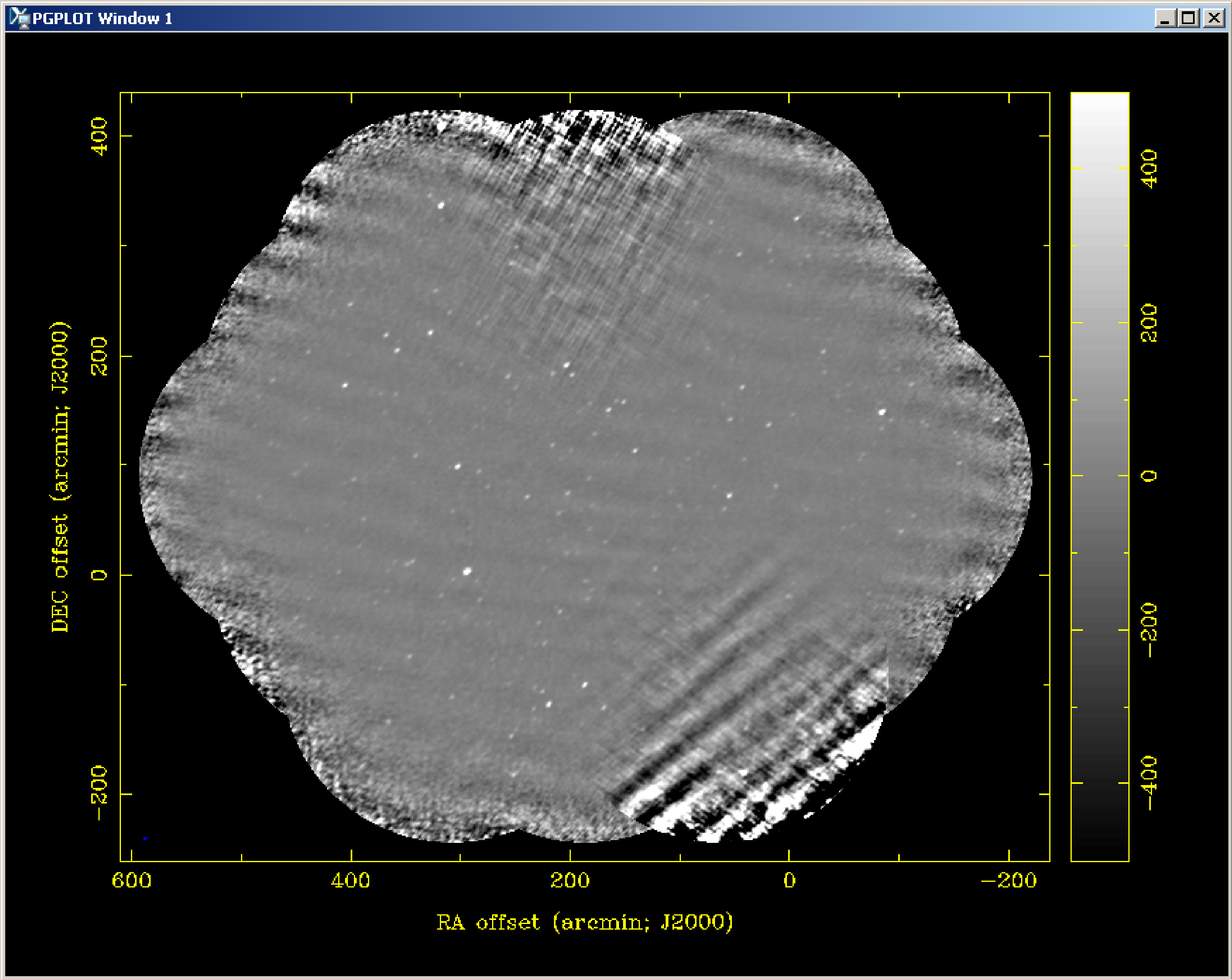
Normal Mosaic – July 25, 2010



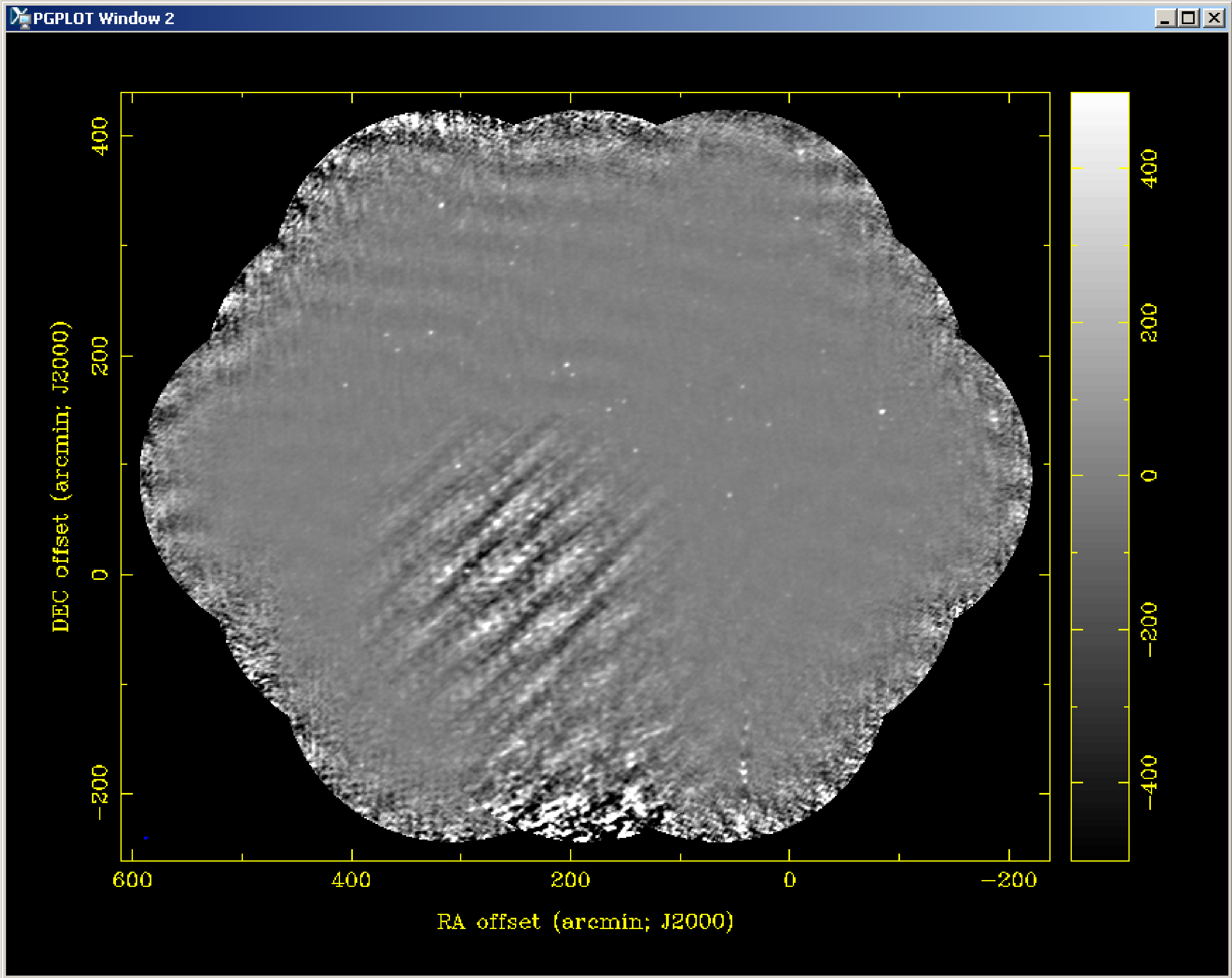
With Circulation – July 27, 2010



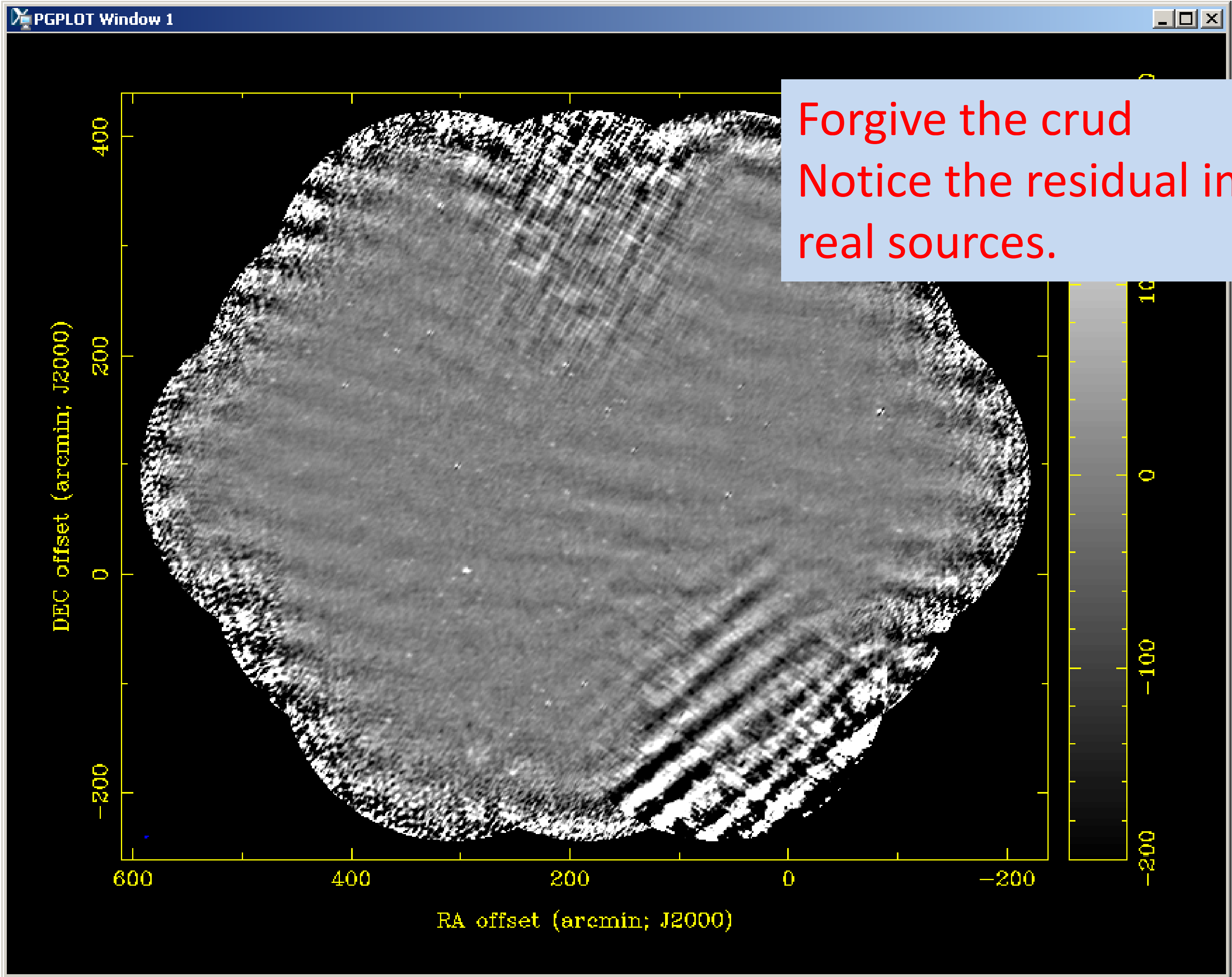
Normal Mosaic – July 28, 2010



With Circulation – July 26, 2010

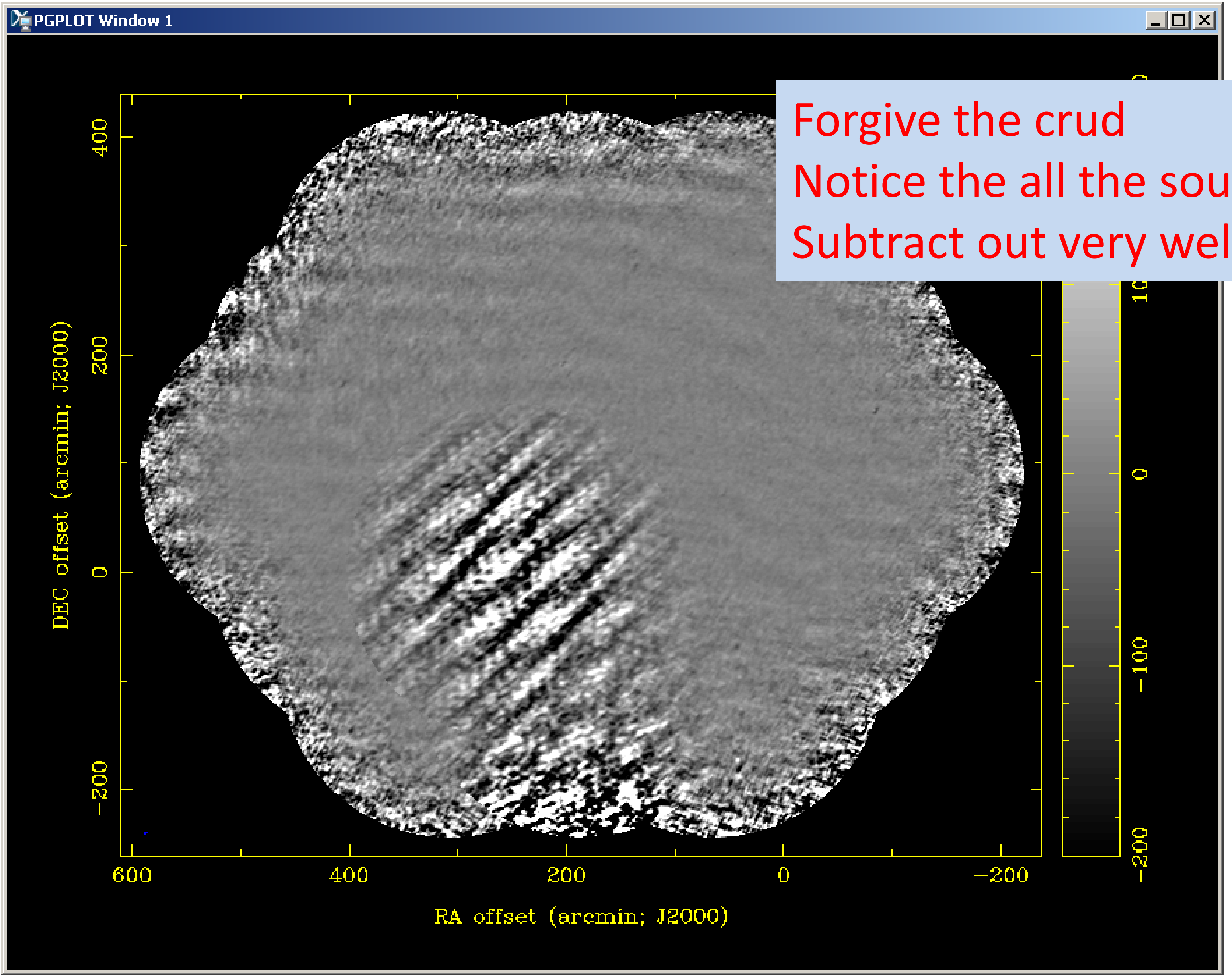


Plain-25-July – Plain-28-July



Forgive the crud
Notice the residual images of real sources.

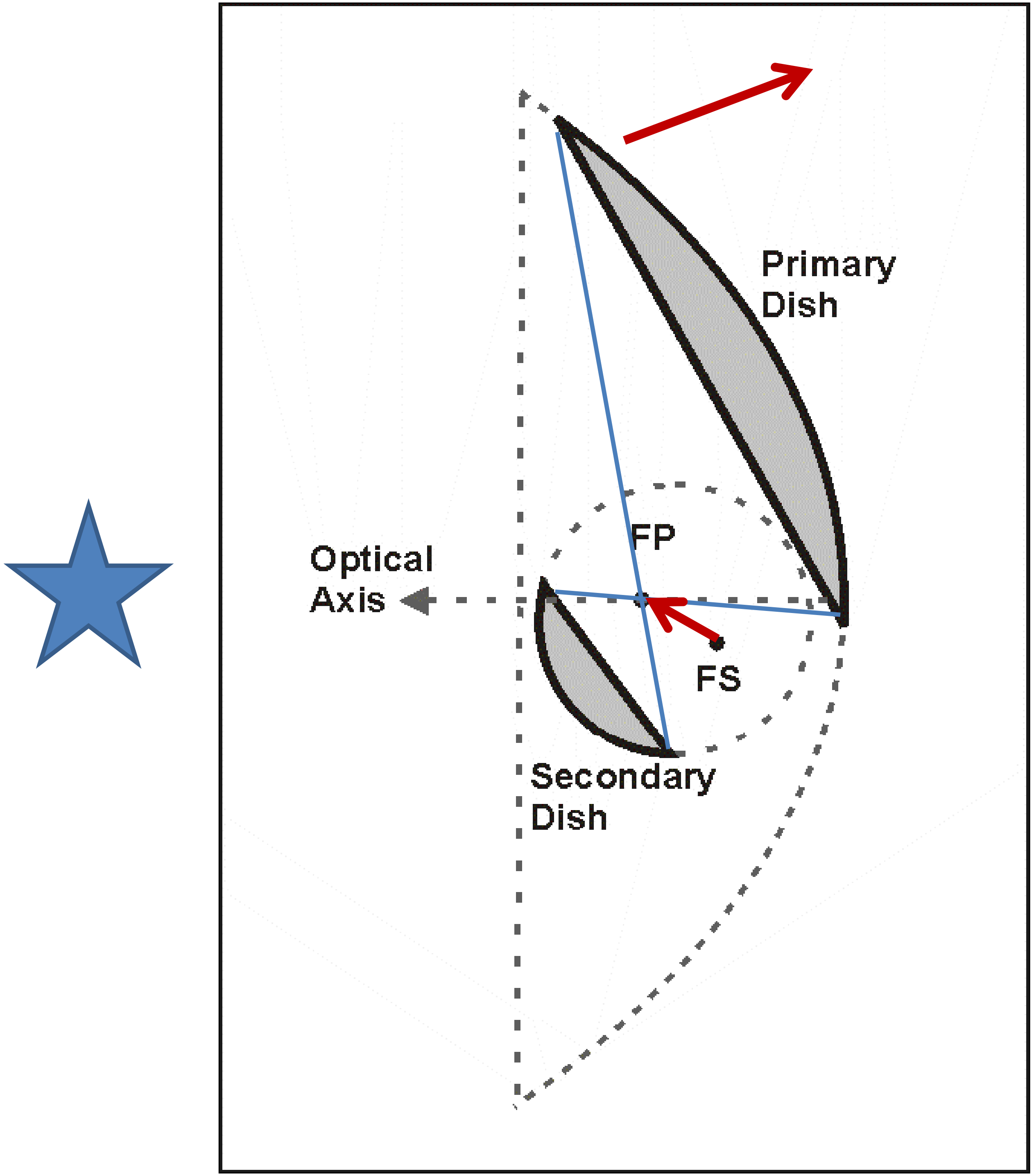
Circ-26-July – Circ-27-July

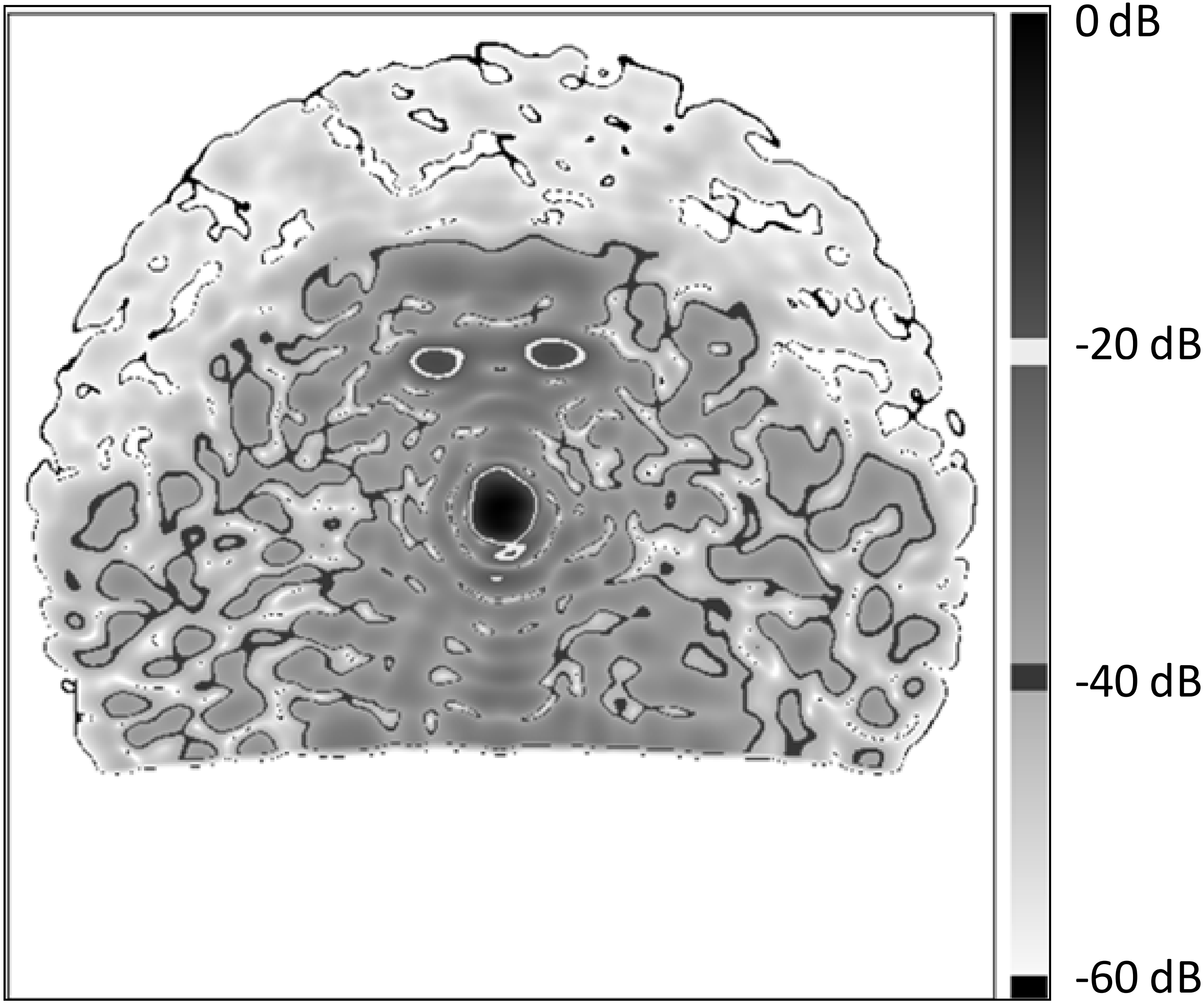


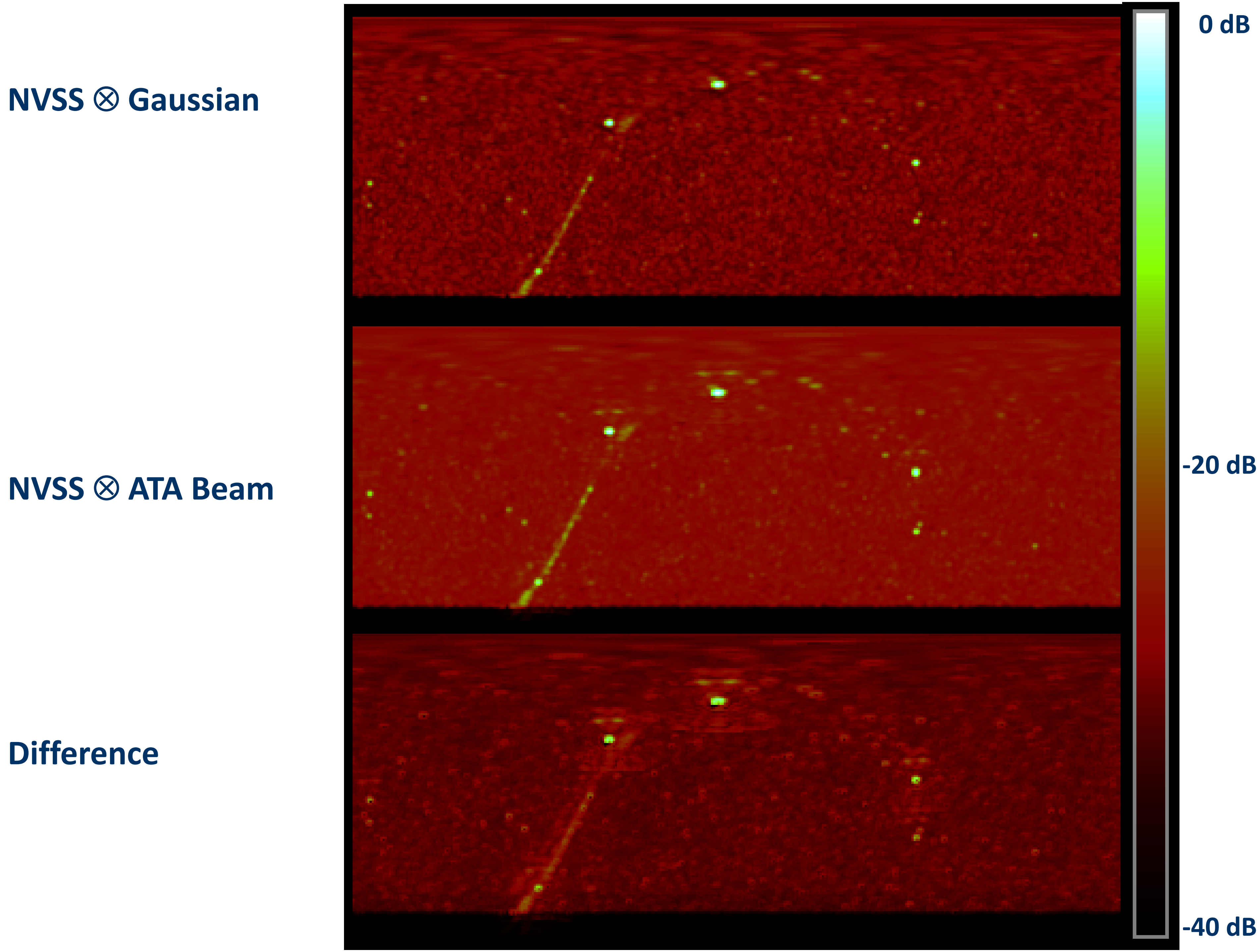
Forgive the crud
Notice the all the sources
Subtract out very well.

OTF Mapping doesn't cure all your PB problems

- If there is one or more very strong sidelobes that stand out above the rest, they're still going to show up in our data.


Primary
Dish
Optical
Axis
FP
FS
Secondary
Dish


0 dB
-20 dB
-40 dB
-60 dB


NVSS ⊗ Gaussian
NVSS ⊗ ATA Beam
Difference
0 dB
-20 dB
-40 dB

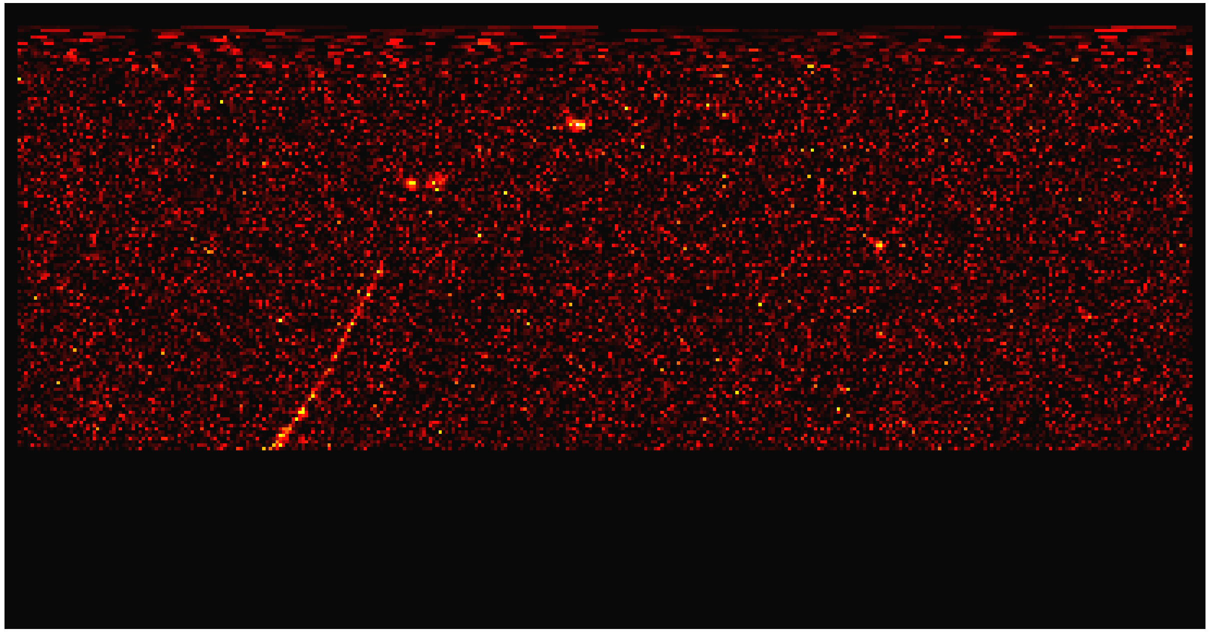
OTF Mapping doesn't cure all your PB problems

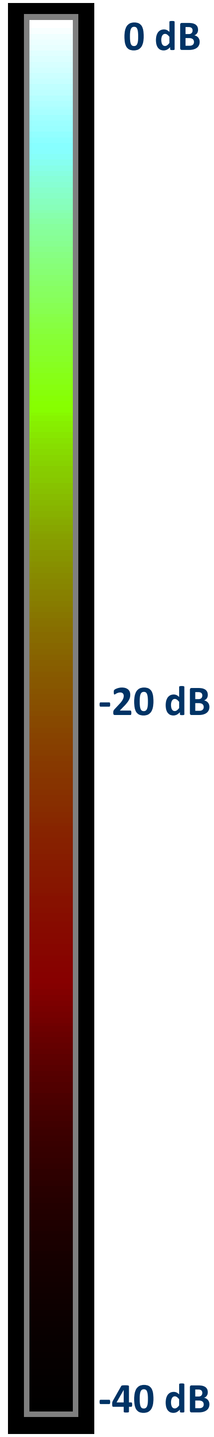
- If there is one or more very strong sidelobes that stand out above the rest, they're still going to show up in our data.

- If your primary beam is substantially different from what you claim it to be, you will have residual errors.

NVSS ⊗ Station Beam

Figure 9: Convolution of the NVSS survey with the perfect station beam pattern. The station beam is formed by multiplying Fig. 8 by the primary beam pattern of a 10 meter dish. The color scale is logarithmic and spans 40 dB with Cas A at 0 dB.





1° Phase Miscalibration Difference

Figure 10: Difference between the perfect station beam and error station beam convolutions. The color scale is logarithmic and spans -40 to -80 dB in intensity, relative to Fig. 9. That is, the brightest feature in this image is ~40 dB weaker than the brightest feature in Fig. 9.