University of Portsmouth

ICG

FILM: Fourier Inspection of Lensing Modes

A NEW METHOD FOR THE NEXT GENERATION OF RADIO TELESCOPES

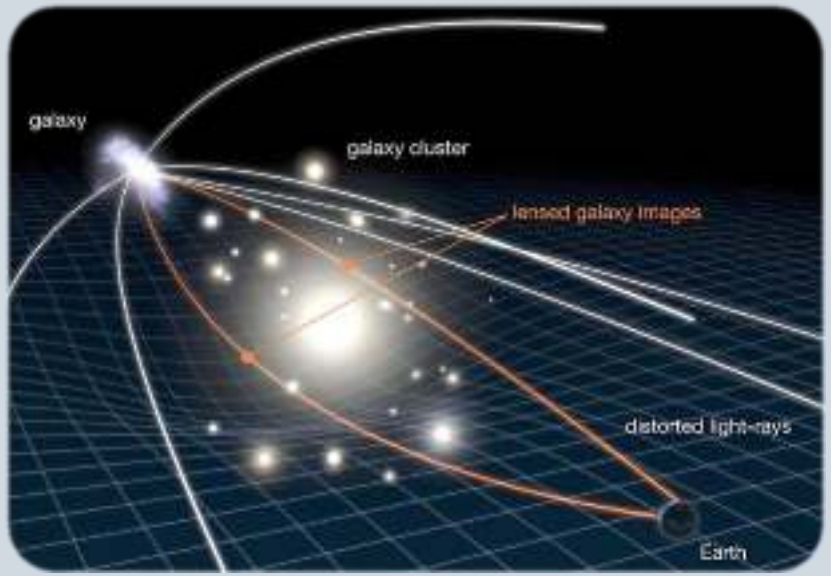
MICHAEL TARR: 2ND YEAR PHD STUDENT

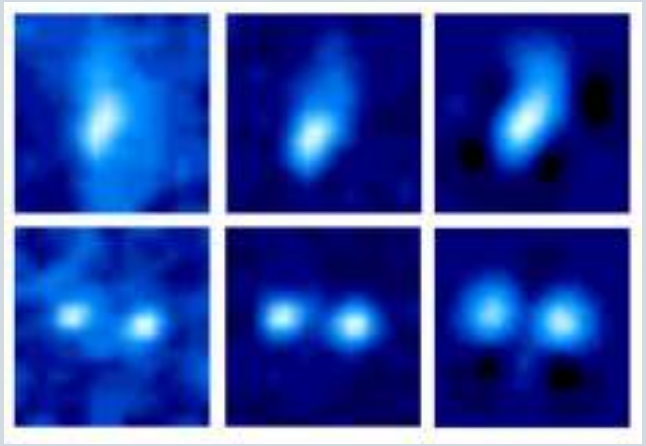
SUPERVISORS: DAVID BACON, BOB NICHOL

Why Bother with Lensing?

- **Direct** probe of matter;
- Constrains **parameters** of: Dark Matter,

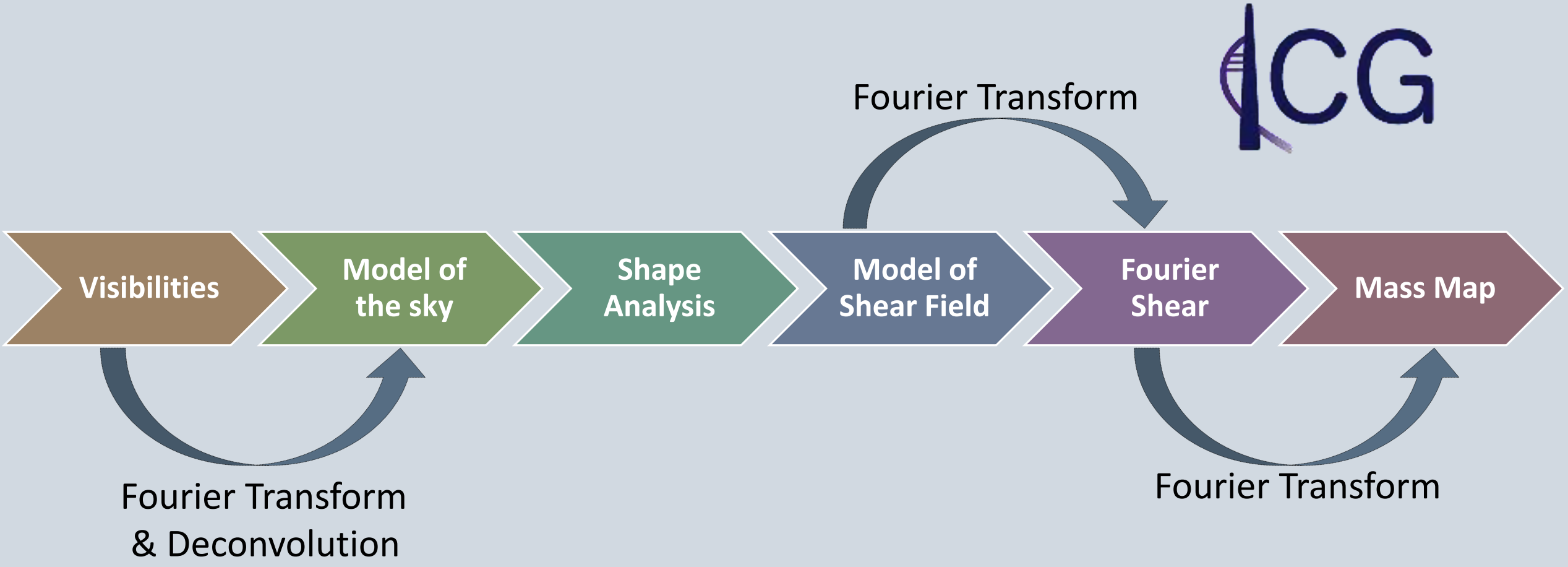
  Dark Energy and Cosmology.





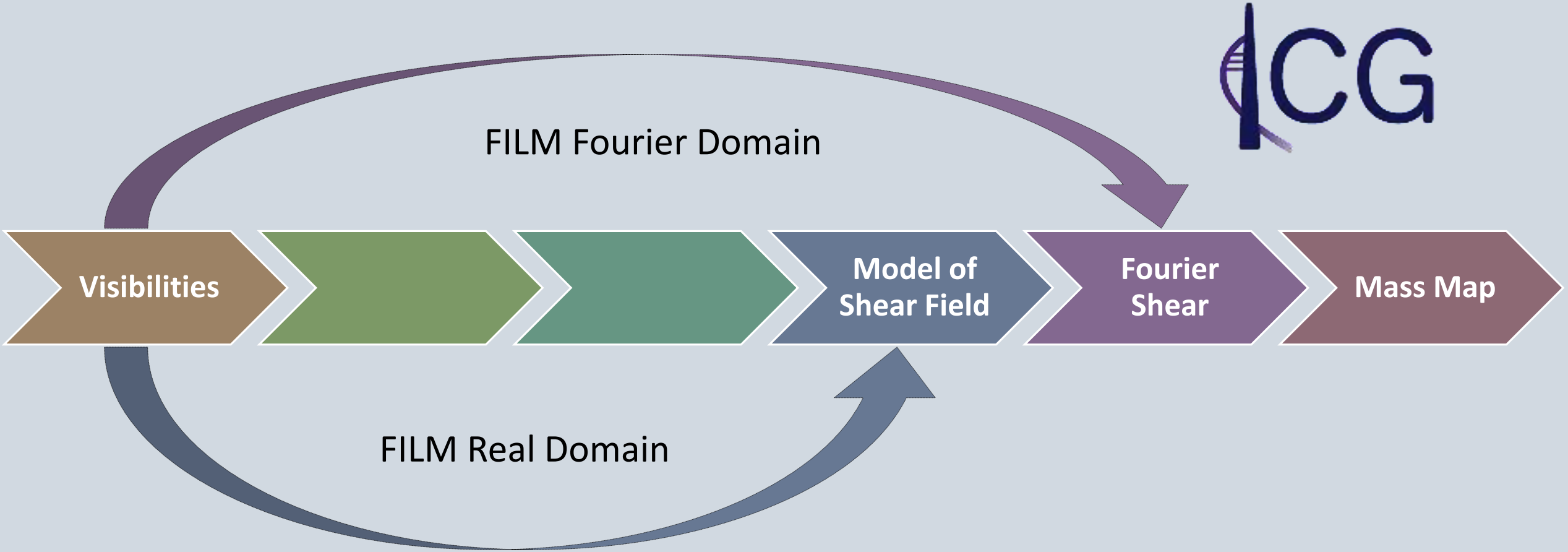
Chang et al 2002, **arXiv:astro-ph/0107085v2**

- Some **early work** on weak lensing in radio;
- Radio telescopes could offer deep and wide field data, **perfect for weak lensing**.



Radio lensing

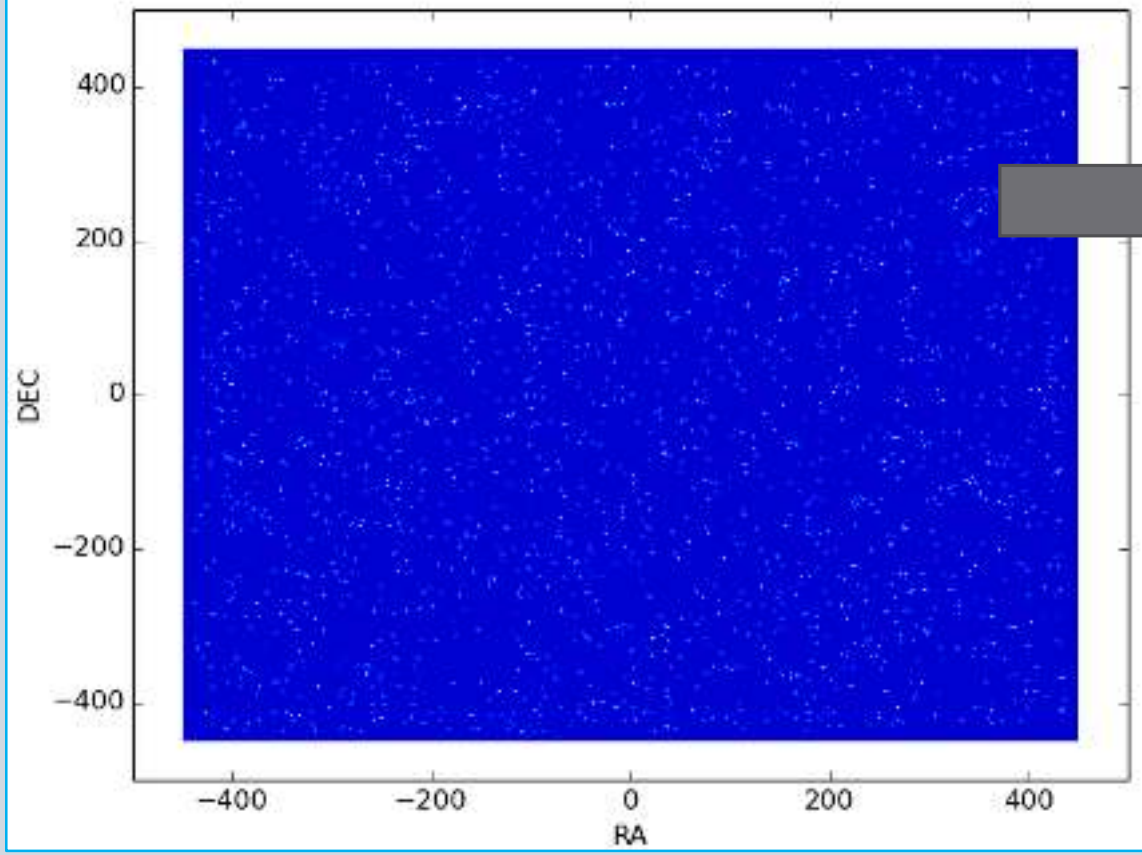
Using a '**traditional**' weak lensing method with radio data can **introduce biases** from the multiple Fourier transforms and models used.



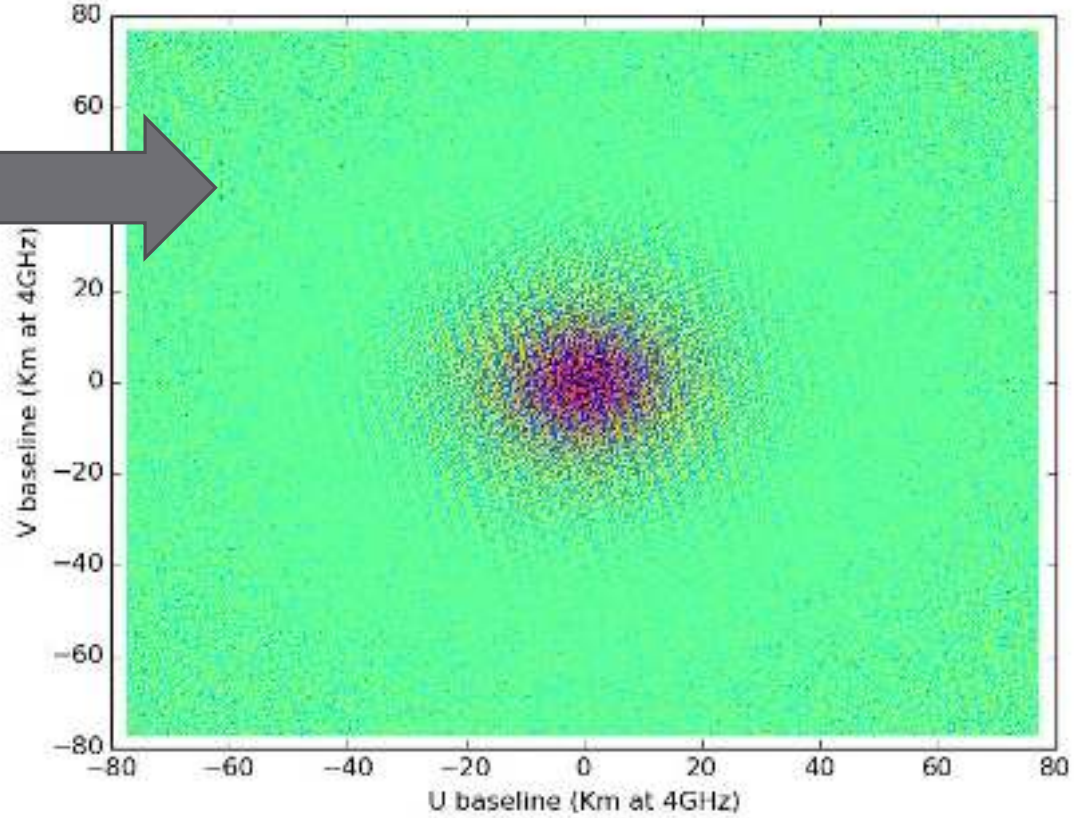
Radio lensing

Our method, **FILM** (Fourier Inspection of Lensing Modes) reconstructs Real space shear or its Fourier Transform **directly from the visibilities**.

True sky simulation

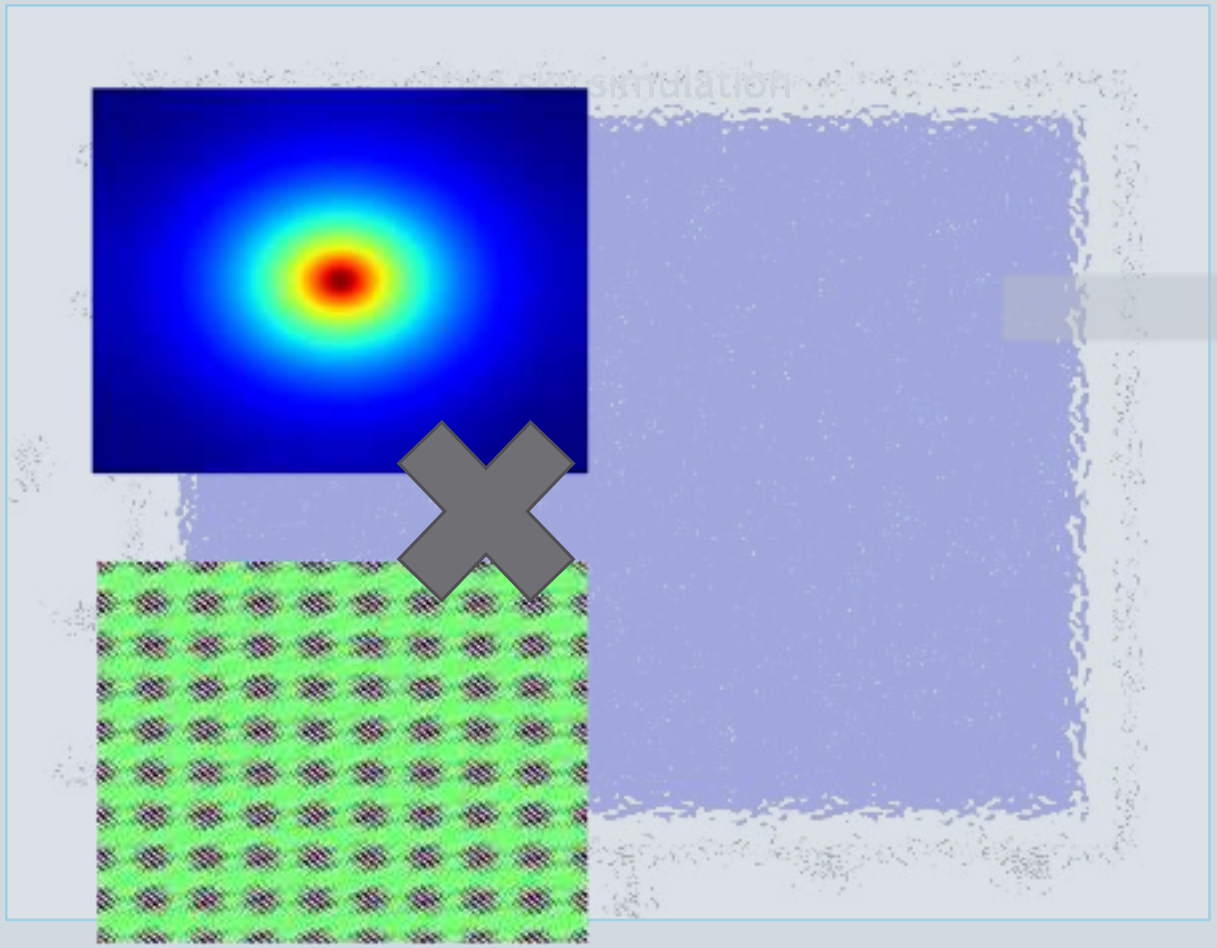


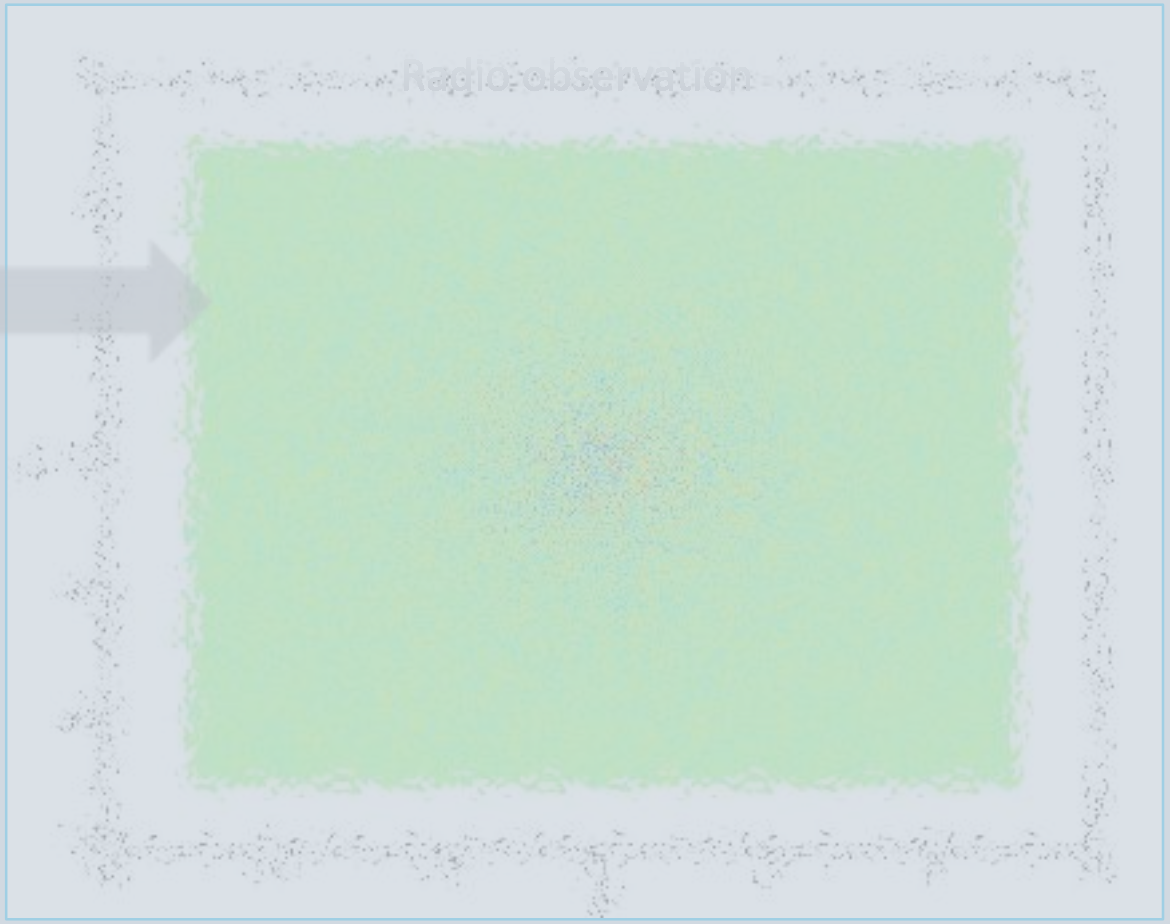
Radio observation



The contribution of shear to the Radio sky

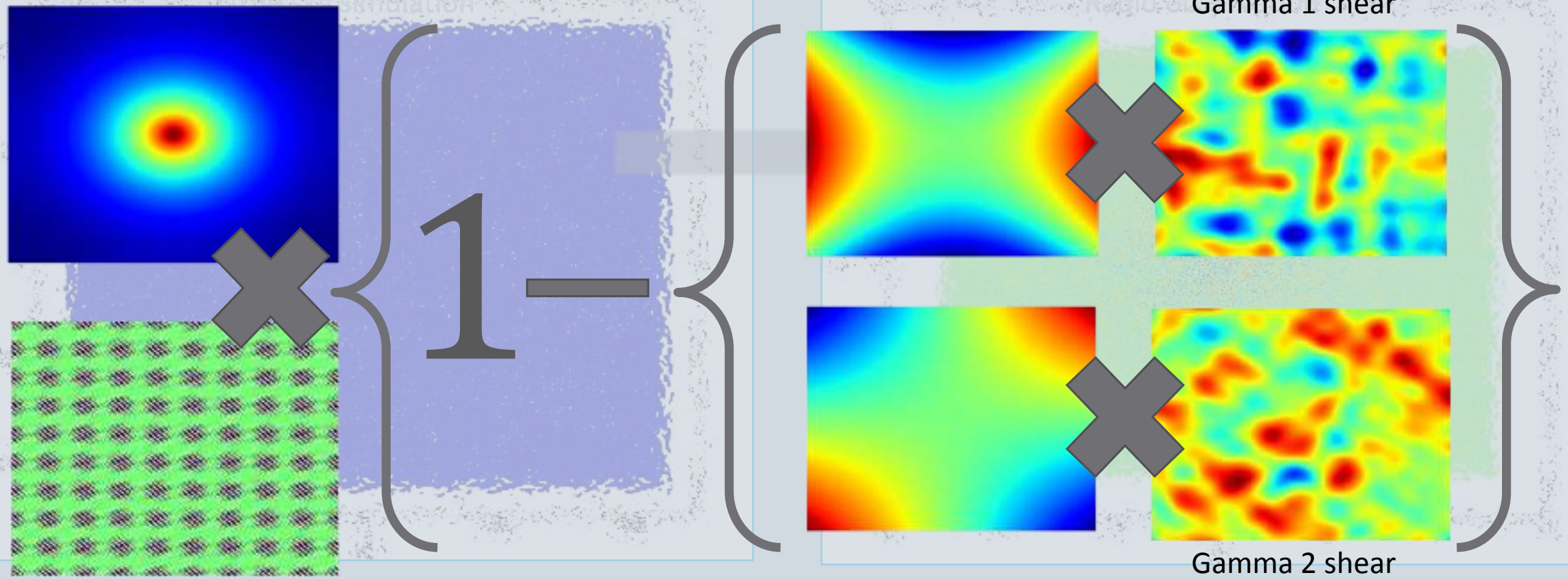
We make a simulation of sky brightness and create a radio observation using a Fourier transform.





The contribution of shear to the Radio sky

Fourier transforming the ‘true sky’ analytically, we find that effect of a **shear** field can be **simply represented** in the Fourier domain.



The contribution of shear to the Radio sky

Known positions of background galaxies provide a Fourier domain ‘comb’ to mask out unwanted sources.

Results

FOURIER AND REAL DOMAIN

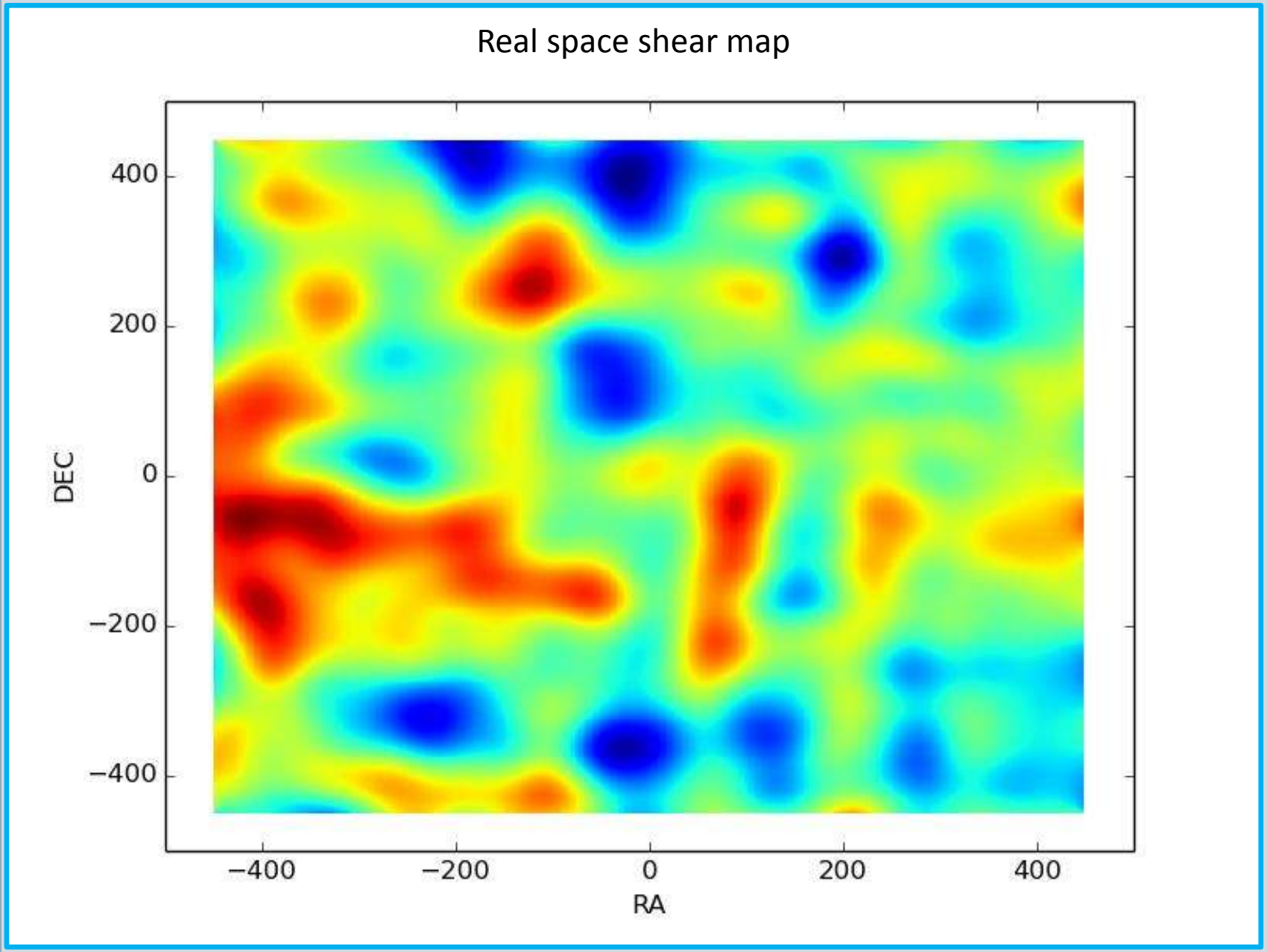
Results with ‘perfect’ data

Perfect Data

- A (very) well sampled UV plane;
- High resolution;
- Good source density;
- Small intrinsic ellipticities ≈10% .

Result

- Low noise reconstruction of the Fourier shear field.



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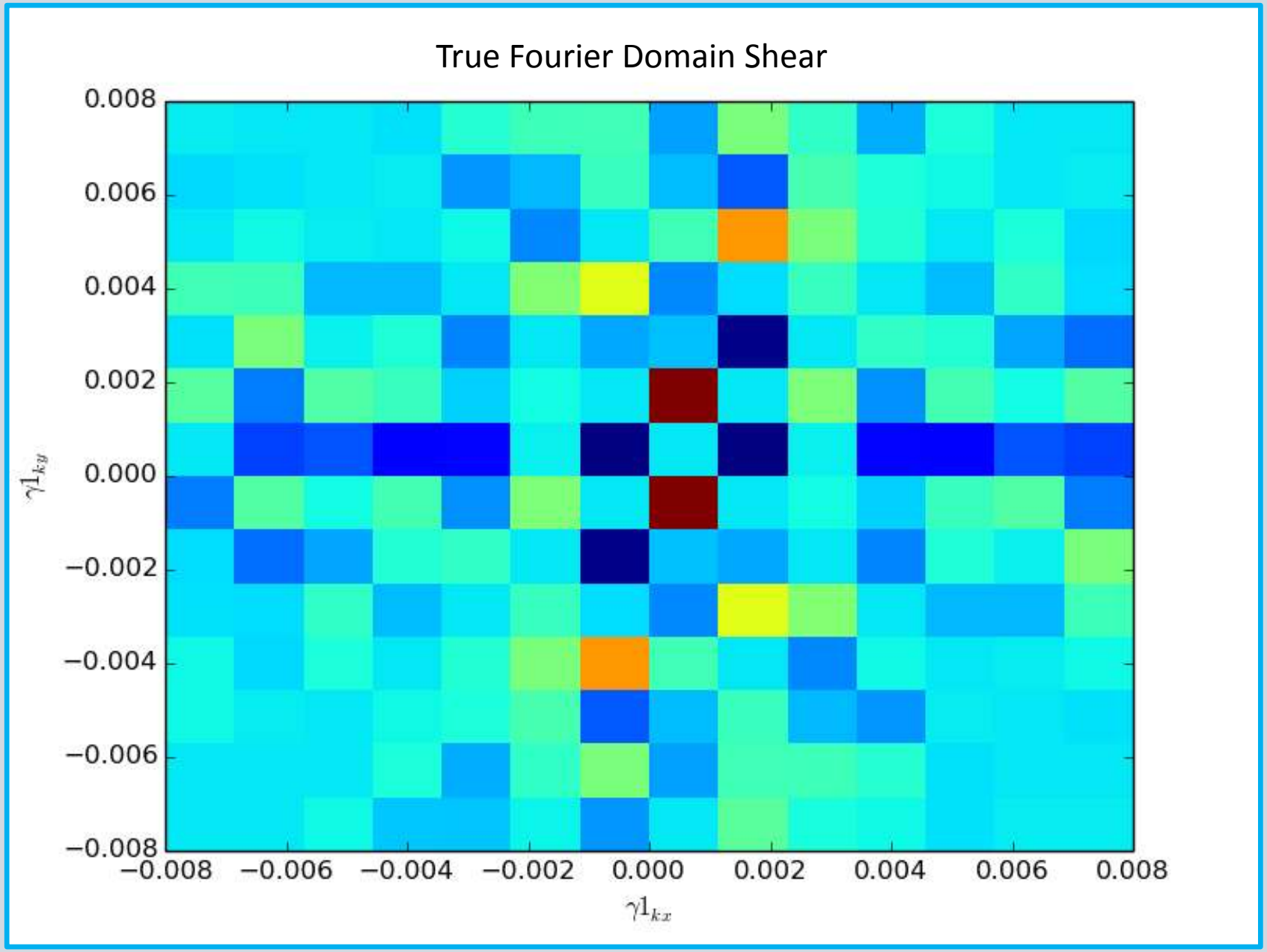

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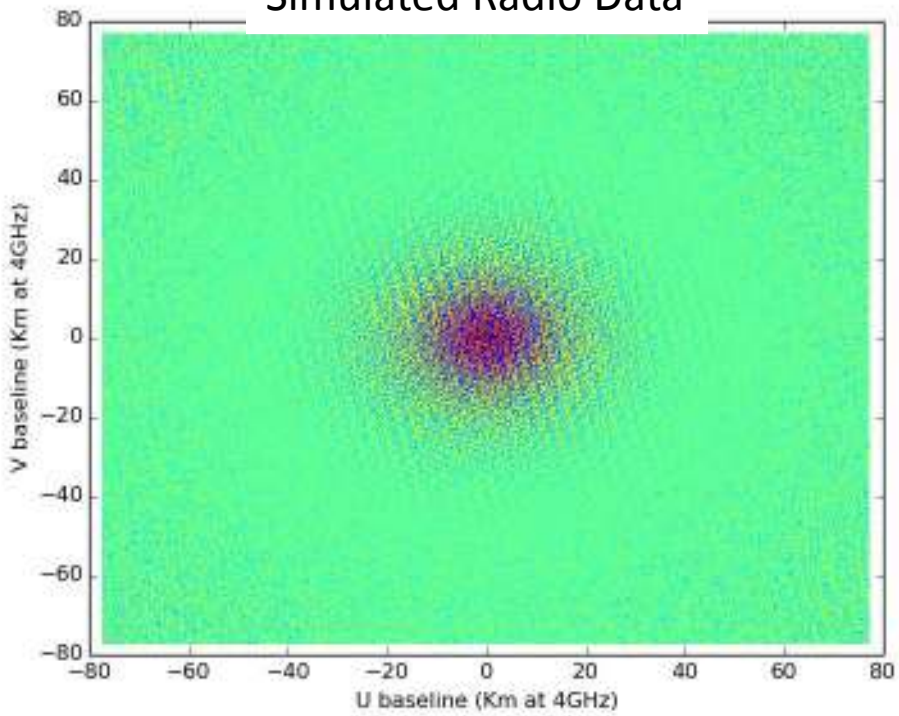
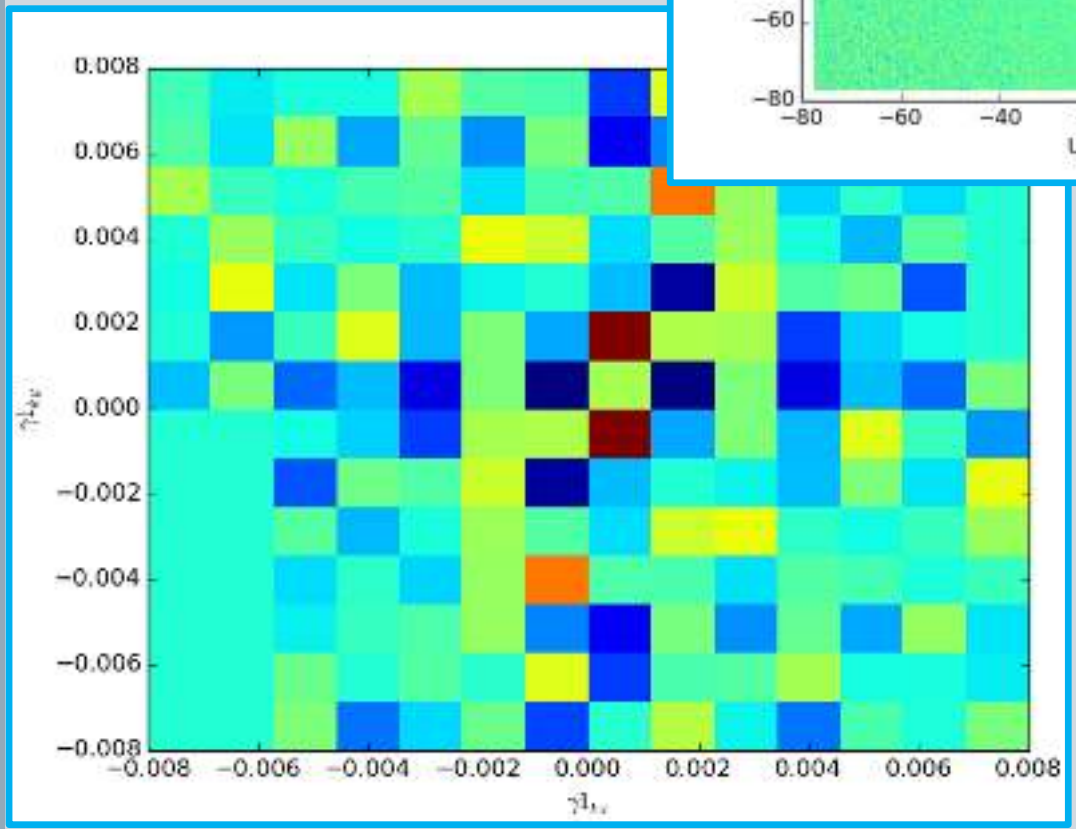
Simulated Radio Data



Fourier Domain Shear estimation



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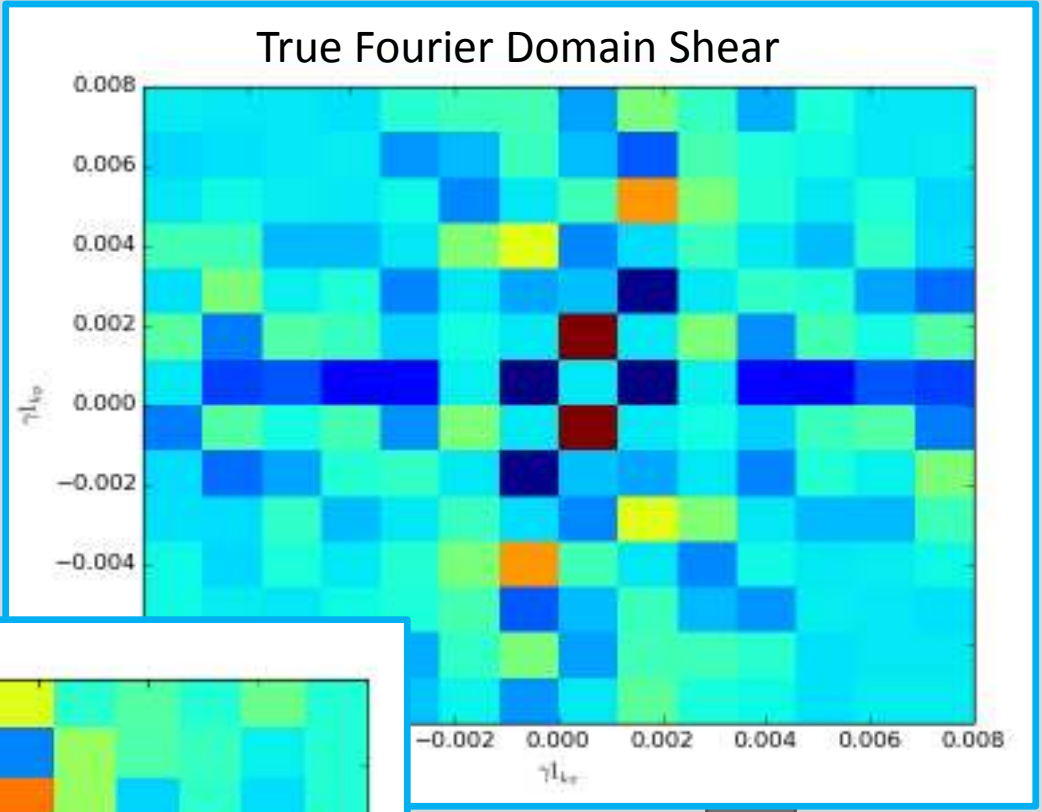
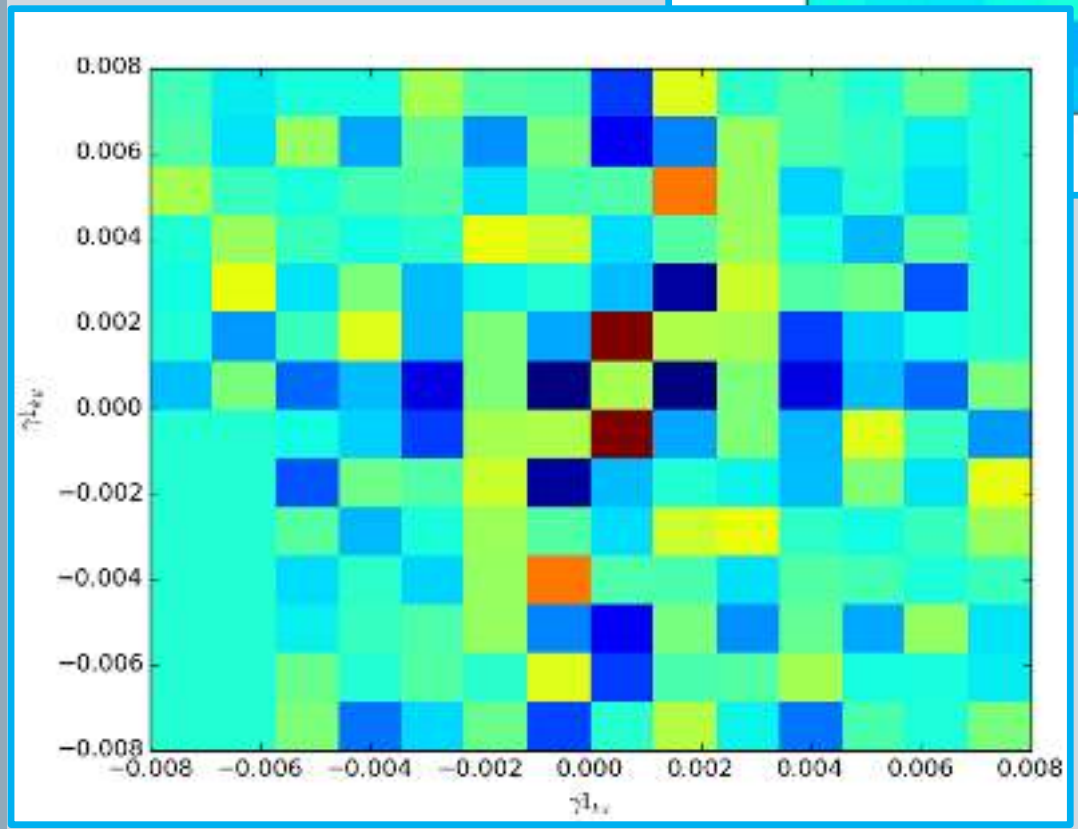
True Fourier Domain Shear



Fourier Domain Shear estimation



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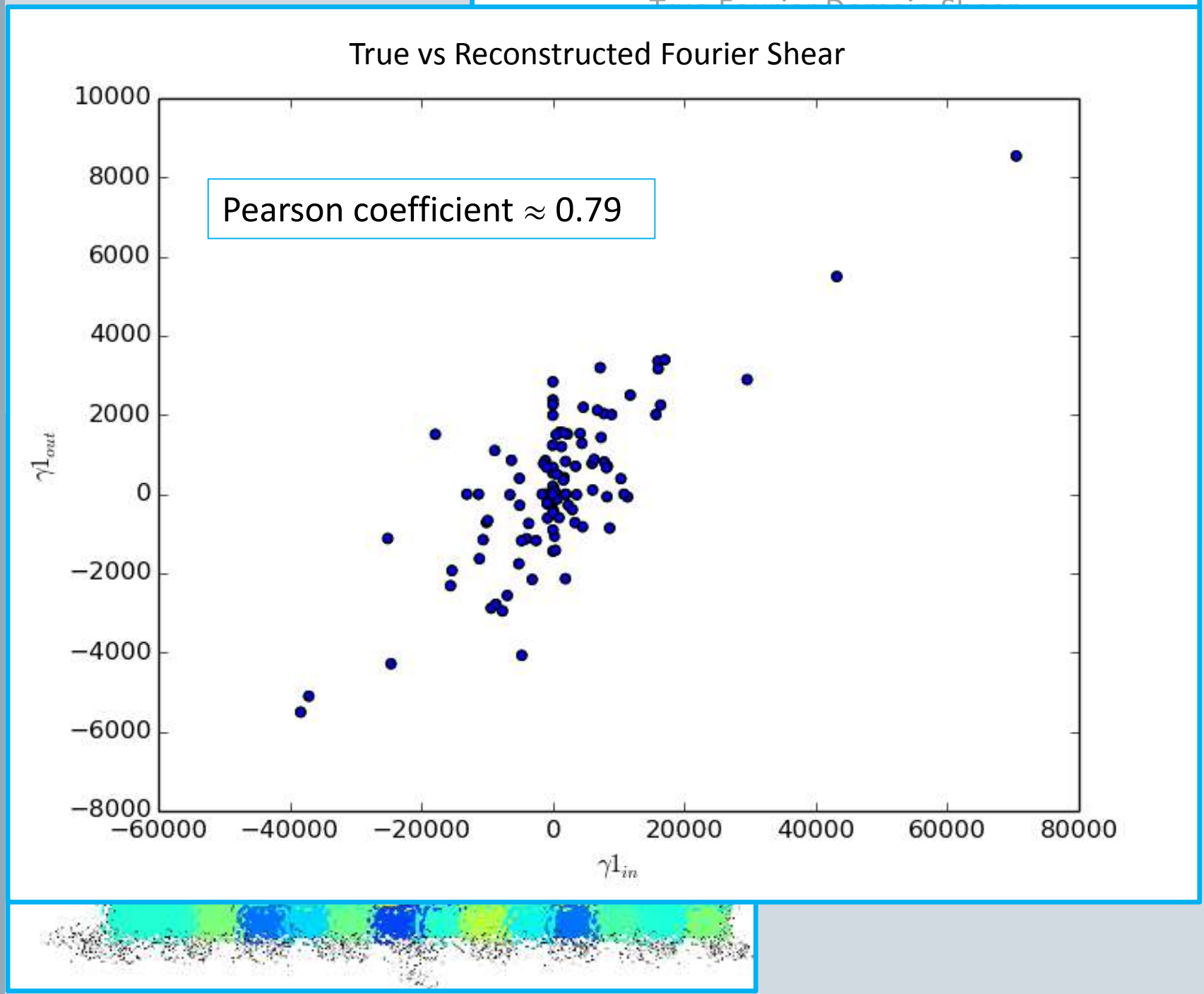

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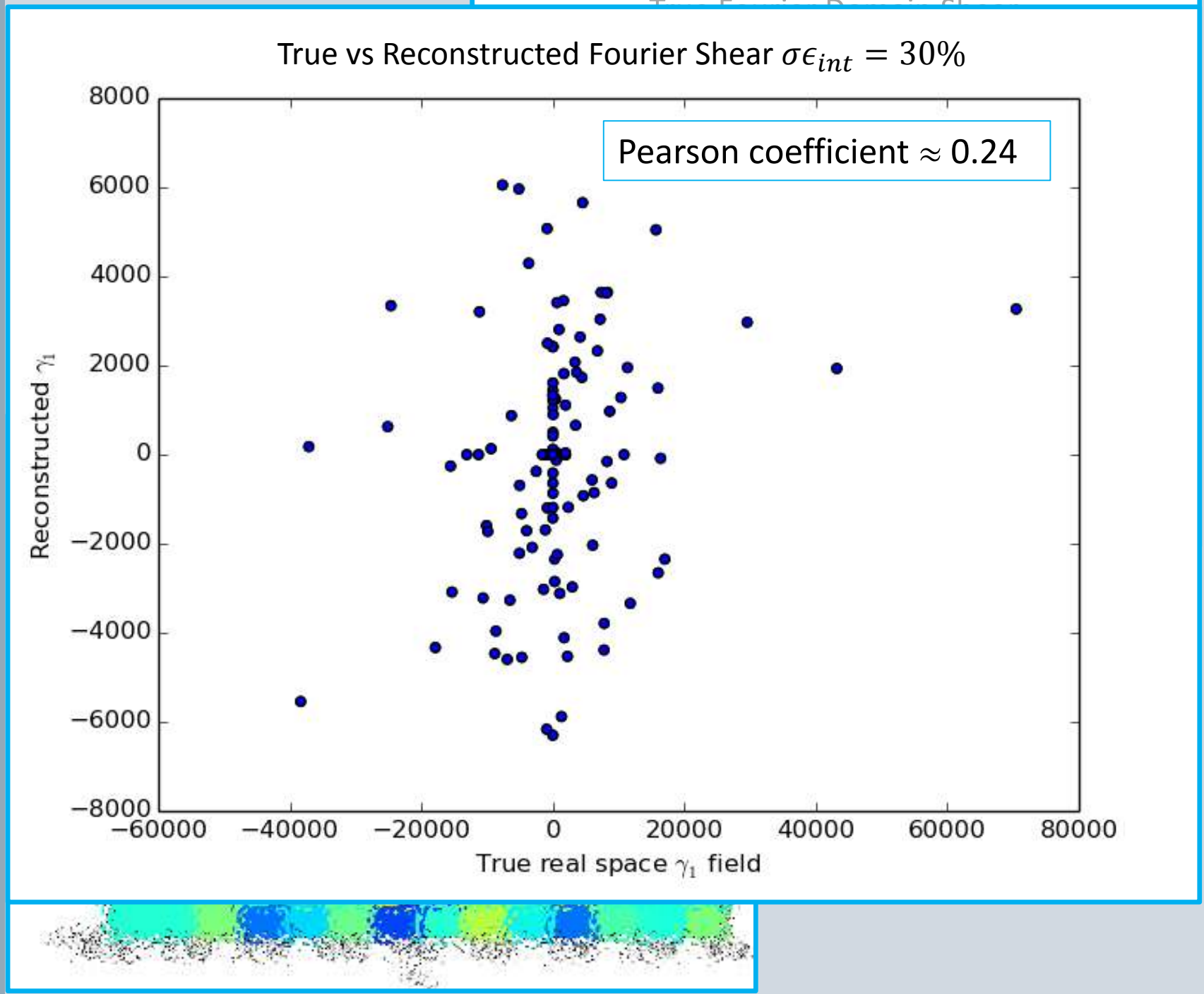

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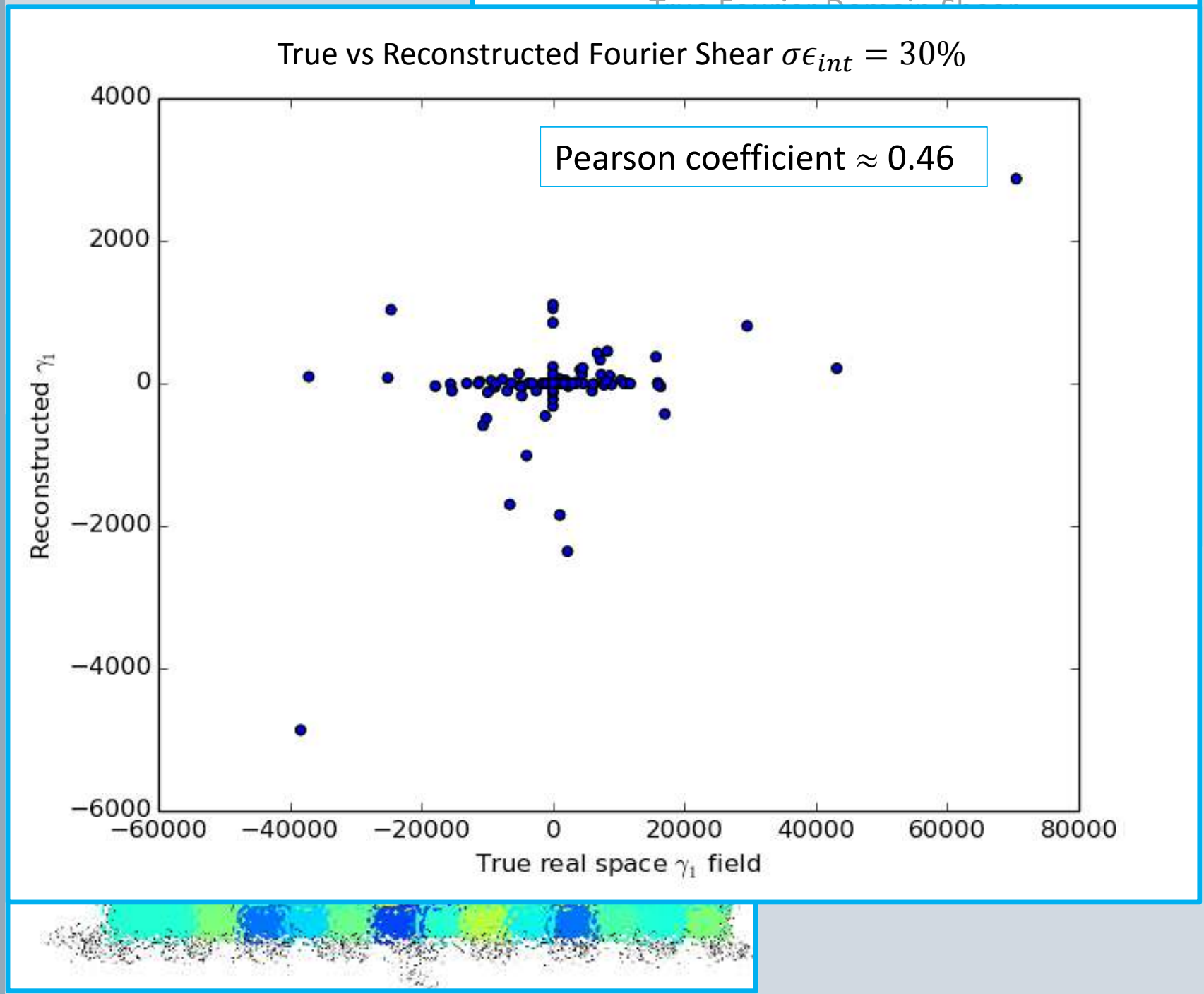
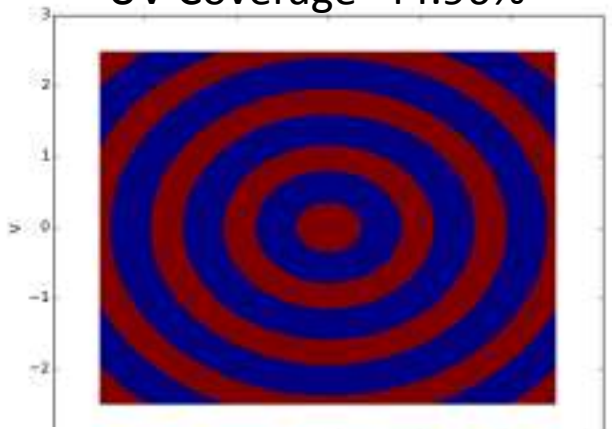
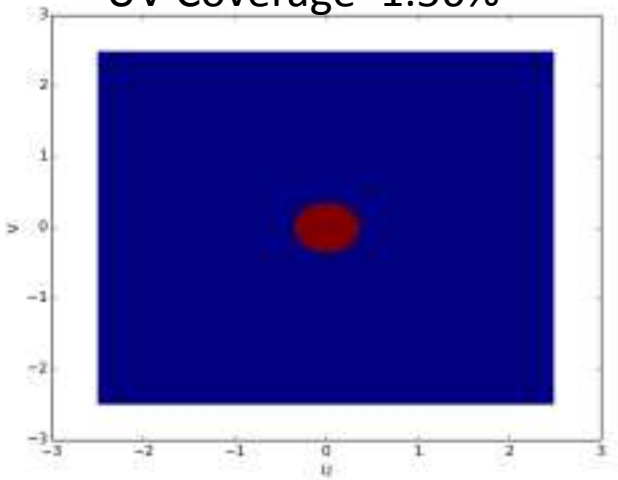


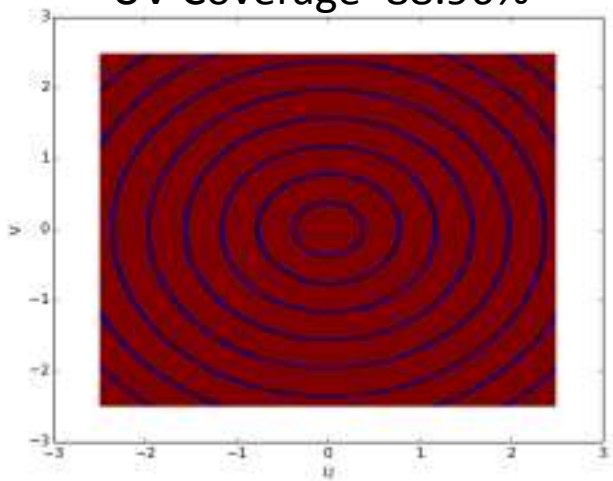
UV Coverage=44.96%

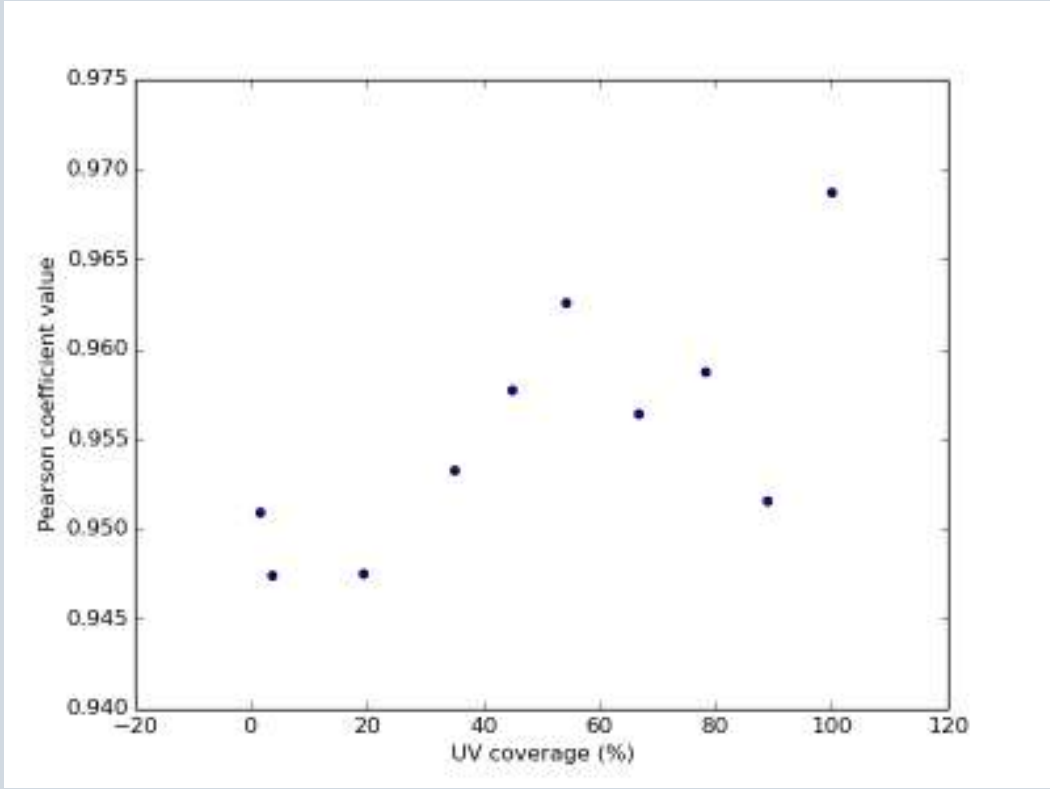


UV Coverage=1.56%



UV Coverage=88.96%



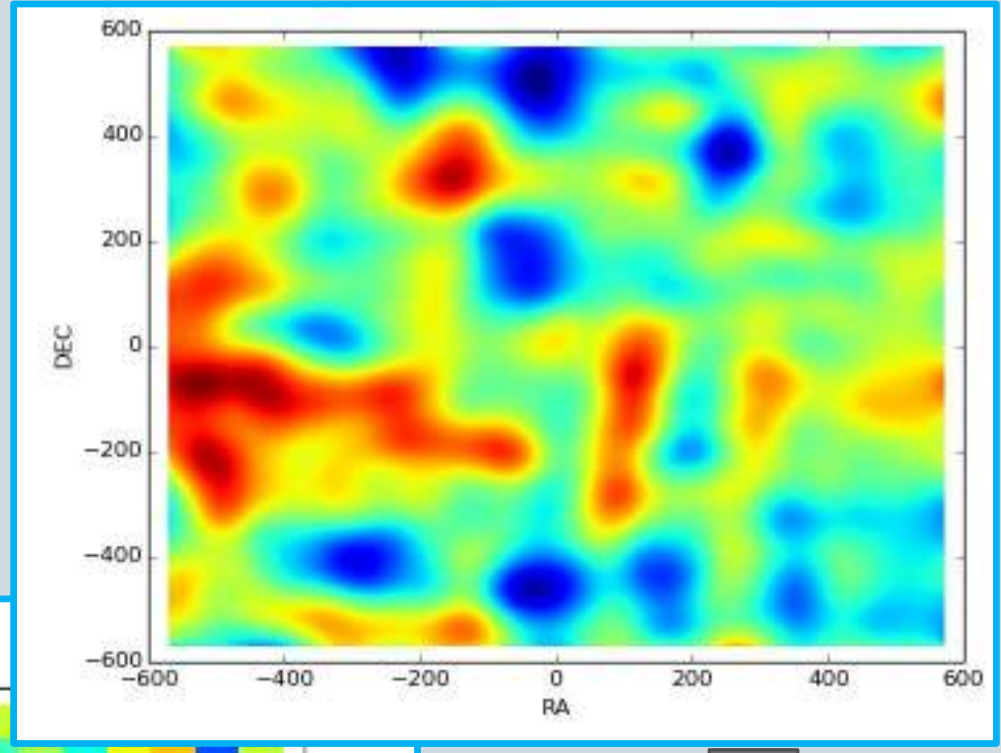


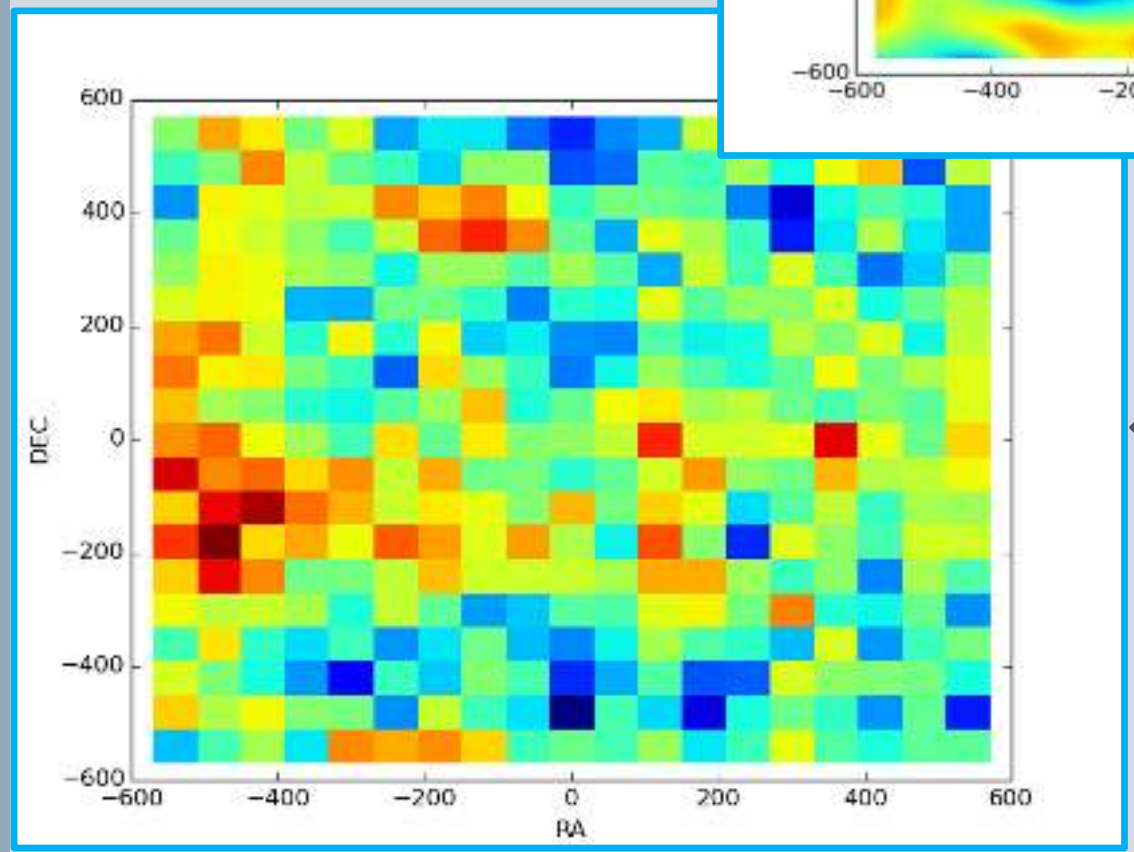
Effect of UV-Sampling

No severe decline in signal to noise, indicating measurement is robust against SKA UV sampling.

Real Space Results

- Same caveats as the Fourier space version;
- A good reconstruction with more stable noise properties;
- Noise should scale with source densities and smoothing scale;
- Cross correlation with optical surveys like LSST could improve this dramatically.





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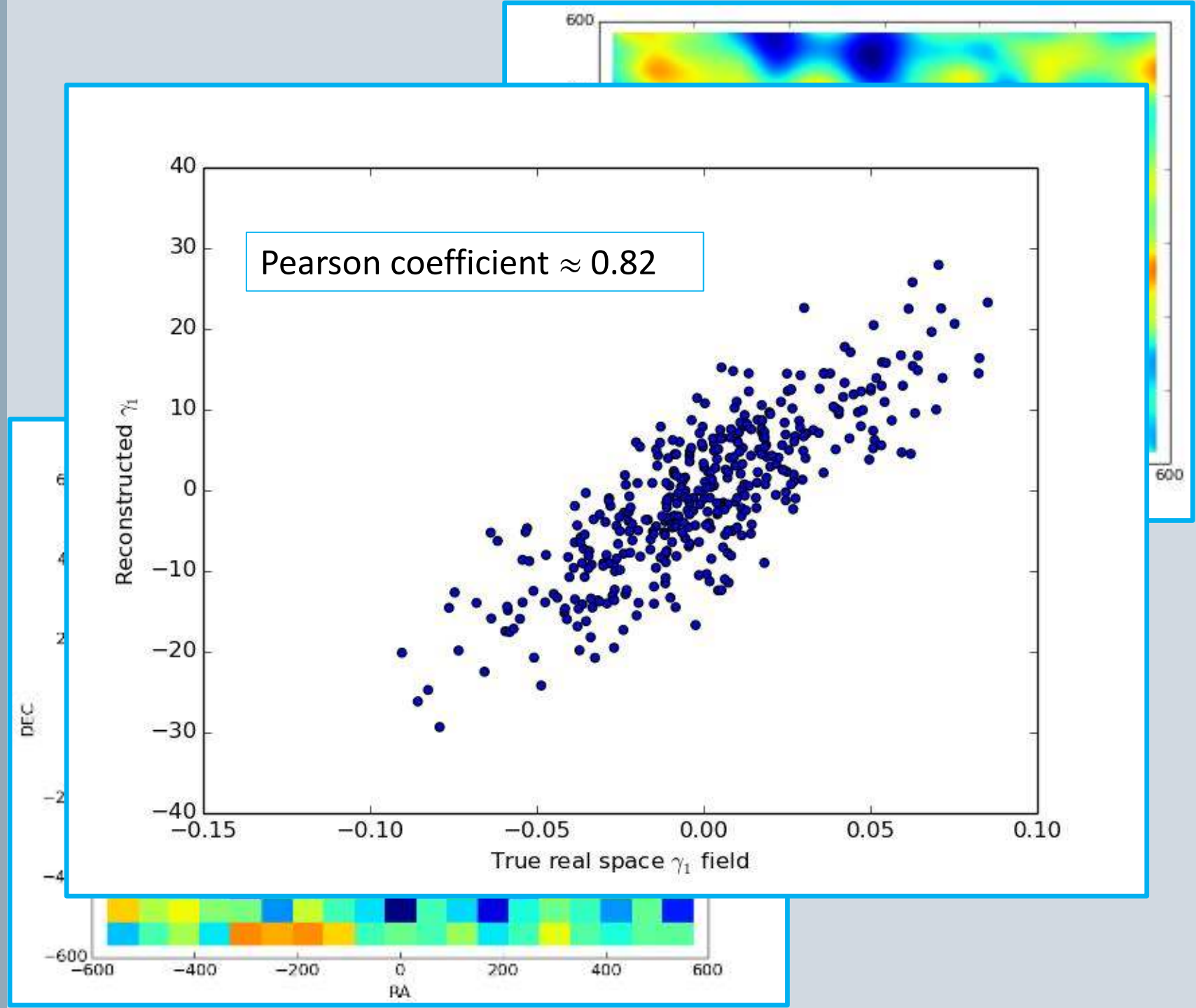

Conclusions

- Previous work has shown that weak lensing at radio frequencies is viable;
- We have shown that the reconstruction of a shear field, or its Fourier transform, from ‘perfect’ visibilities is possible;
- Modifications to the simulation to make it more realistic result in increased noise, but have not had an unreasonably large effect;
- Next steps:
  - Test on more realistic simulations and real data;
  - Compare FILM with other methods, KSB after using CLEAN for example.