Phased-ALMA and VLBI polarimetry

Ivan Martí-Vidal

Nordic Node of the European ALMA Regional Center

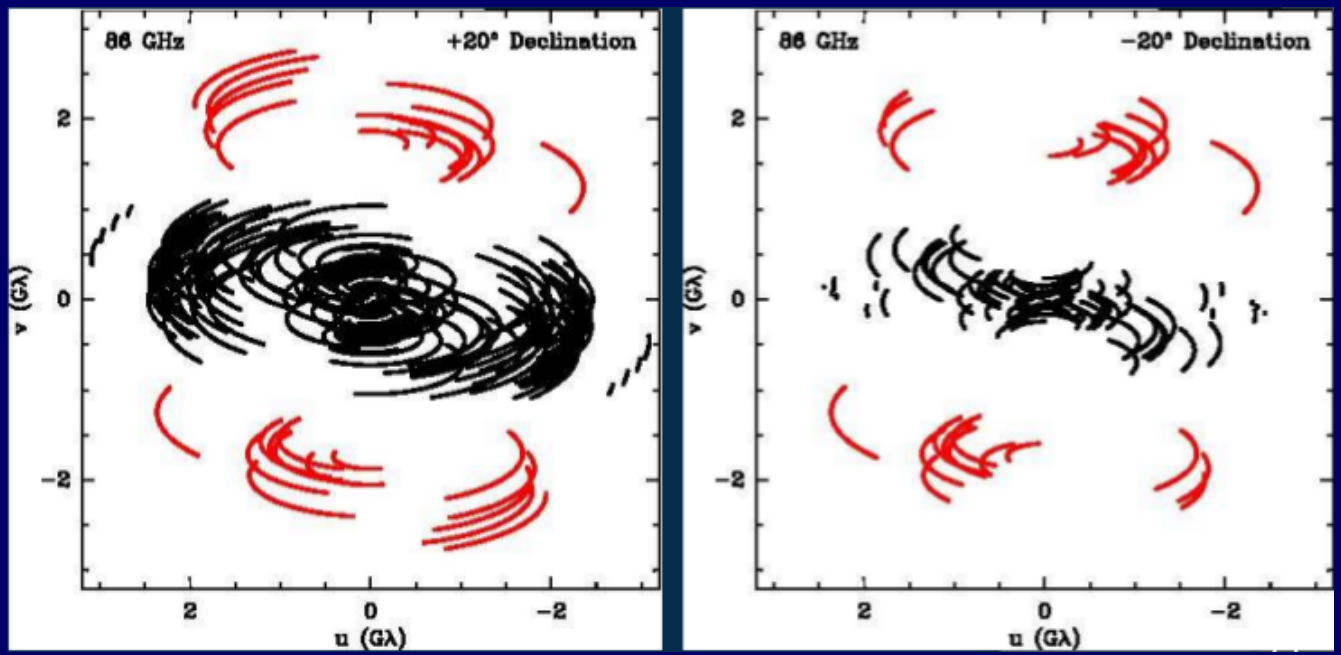
Swedish National Facility for Radio Astronomy

Onsala Space Observatory (Sweden)

Bologna mm-VLBI – 2015 January 22

The ALMA Phasing Project

- Use the whole ALMA as one single (VLBI) station.
- Large increase in sensitivity (and image fidelity) for mm-VLBI.
- Will reach a few 10s of μas resolution!
- Will improve sensitivity by a large factor.



UV Coverage of Global VLBI at 3mm (ALMA in red)

See Fish et al. (arXiv:1309.3519)

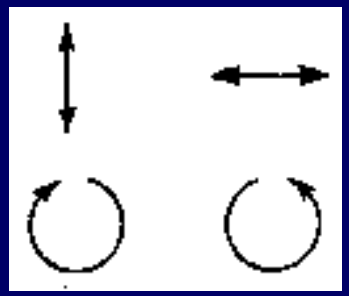
The ALMA Phasing Project (APP) Team

(Incomplete list)

- Haystack
  - Shep Doeleman (PI), Mike Hecht (PM), Geoff Crew, Vincent Fish, Victor Pankratius, Chet Ruszczyk, Chip Coldwell, ...
- NRAO
  - Rich Lacasse, Ray Escoffier, Joseph Greenberg, Bill Shillue, Bob Treacy, Rafael Hiriart, Matias Mora, ...
- MPIfR
  - Walter Alef, Alan Roy, Helge Rottman, ...
- Onsala
  - Iván Martí-Vidal, Tobia Carozzi, Michael Lindqvist, ...

..., Alan Baudry (ESO), Mareki Honma (NAOJ), Tomoaki Oyama (NAOJ), Makoto Inoue (ASIAA), Nicolas Pradel (ASIAA), Robert Lucas (UJF), Neil Nagar (UDEC), Alejandro Sáez (ALMA), Bernhard López (ALMA) Jonathan Weintroub (CfA), ...

Linear pol. vs. circular pol. feeds.



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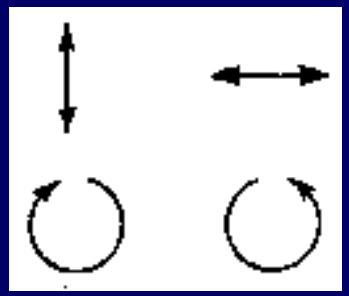

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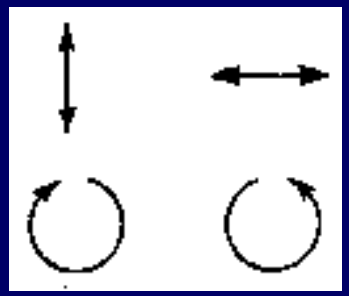

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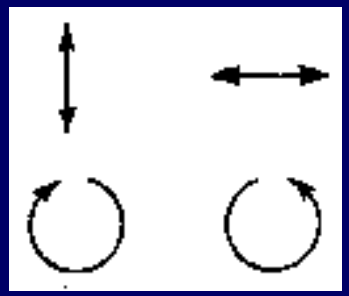

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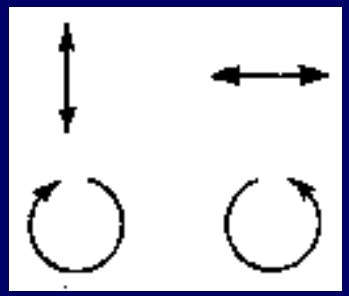

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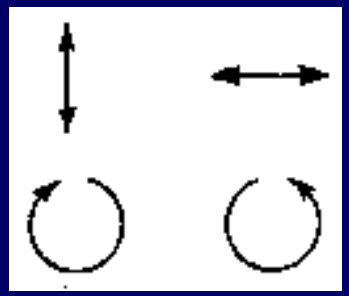

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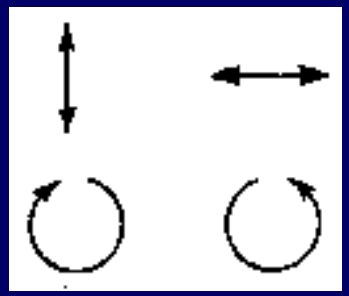

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ALMA antennas have LINEAR feeds!!

ALMA polarization for VLBI

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Final strategy is

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The main advantages are

- Minimum hardware implementation.
- Flexibility for post-processing.
- Easy adaptability for future X/Y-based stations.

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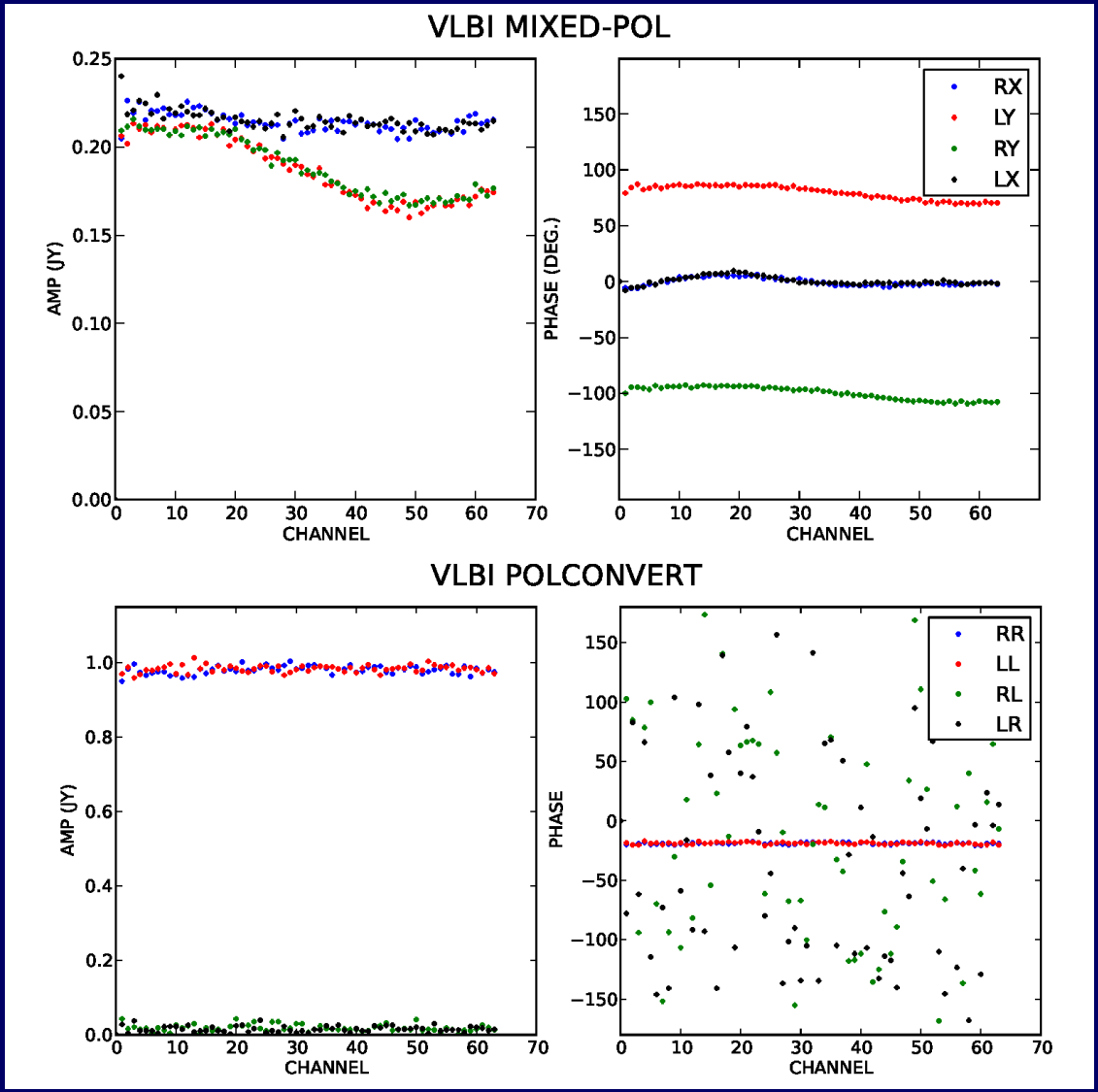
- Conversion fully implemented in our software, PolConvert.

Simulation results. Unpolarized source



- 10 ALMA antennas (XY basis).
- Different X/Y gains (BP, G, K, and D) in each ALMA antenna.
- 1 VLBI station (RL basis).
- Realistic simulation (thermal noise, signal quantization, etc.)
- Simulation output:
  - ALMA cross-products (MS).
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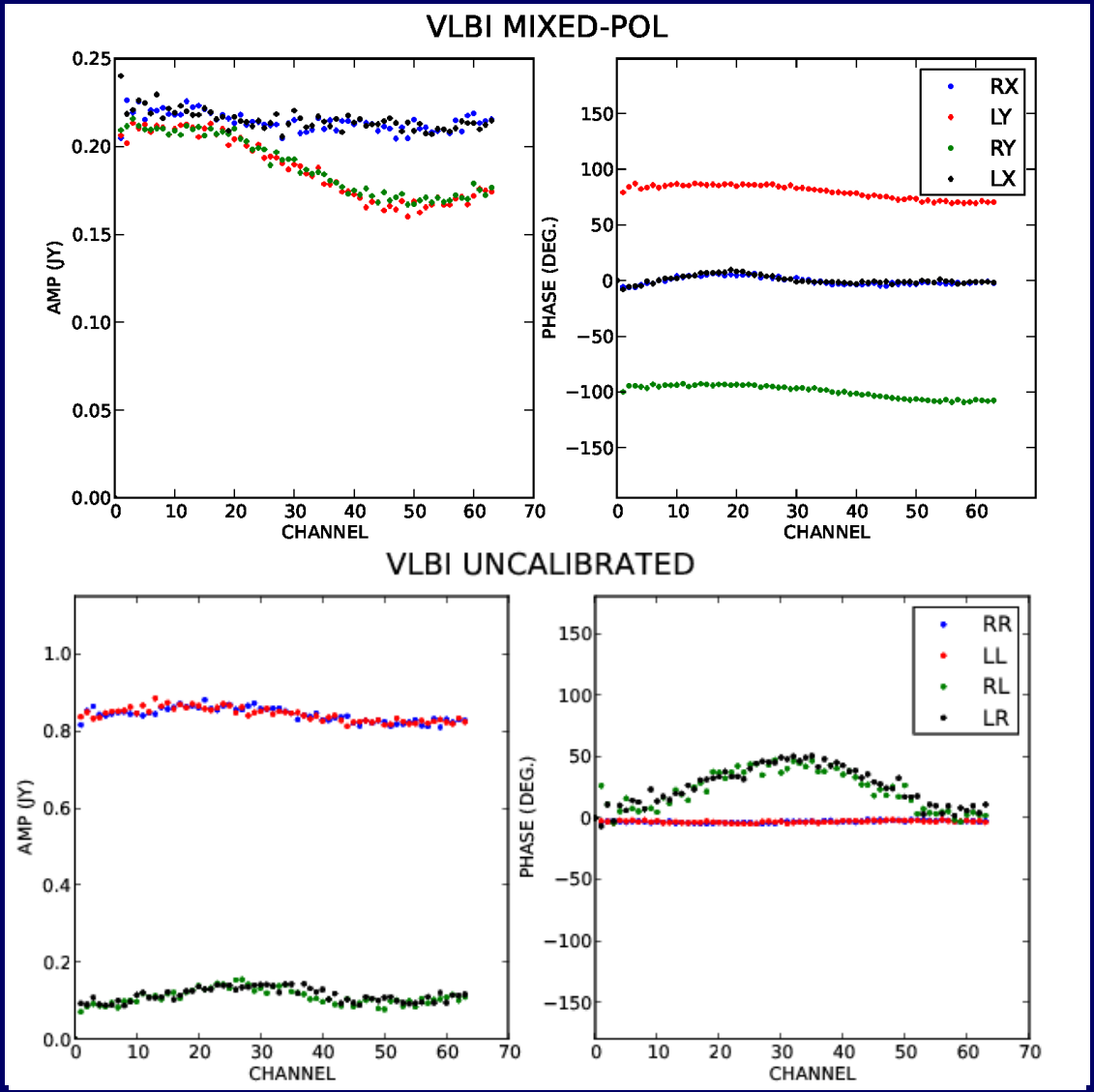

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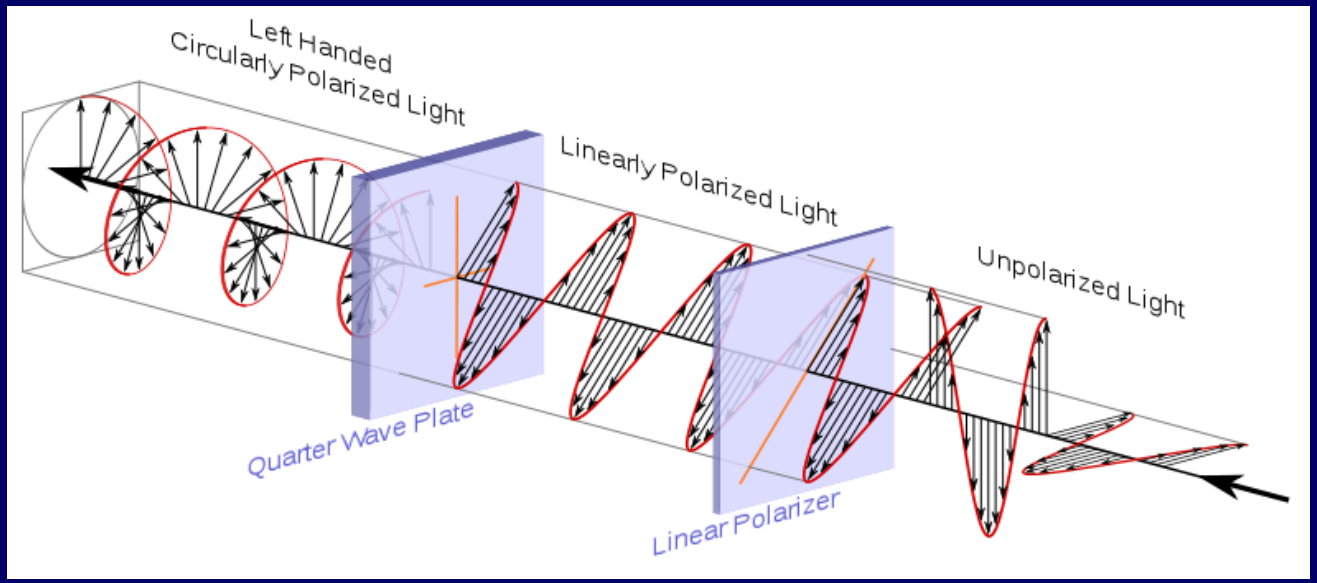

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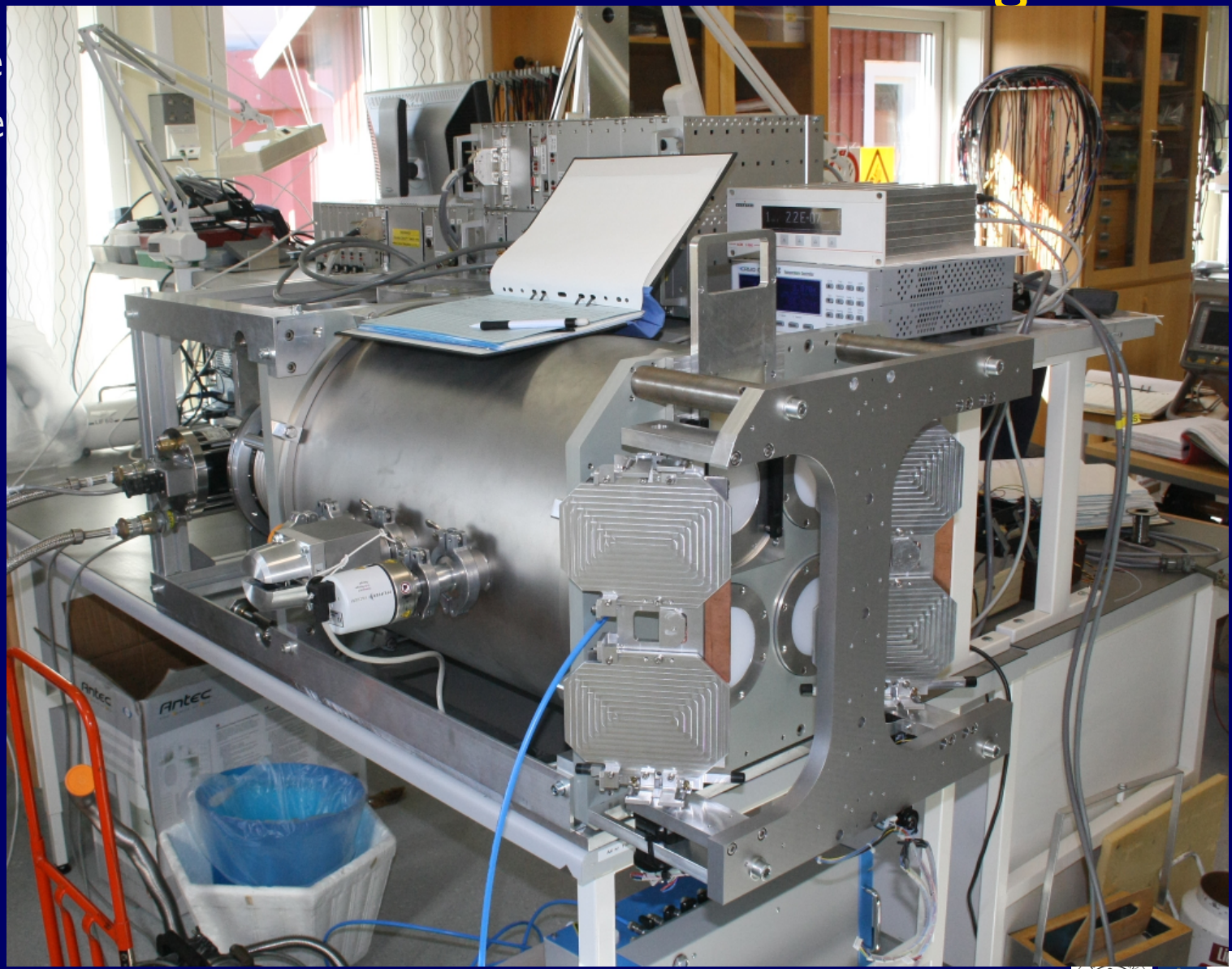

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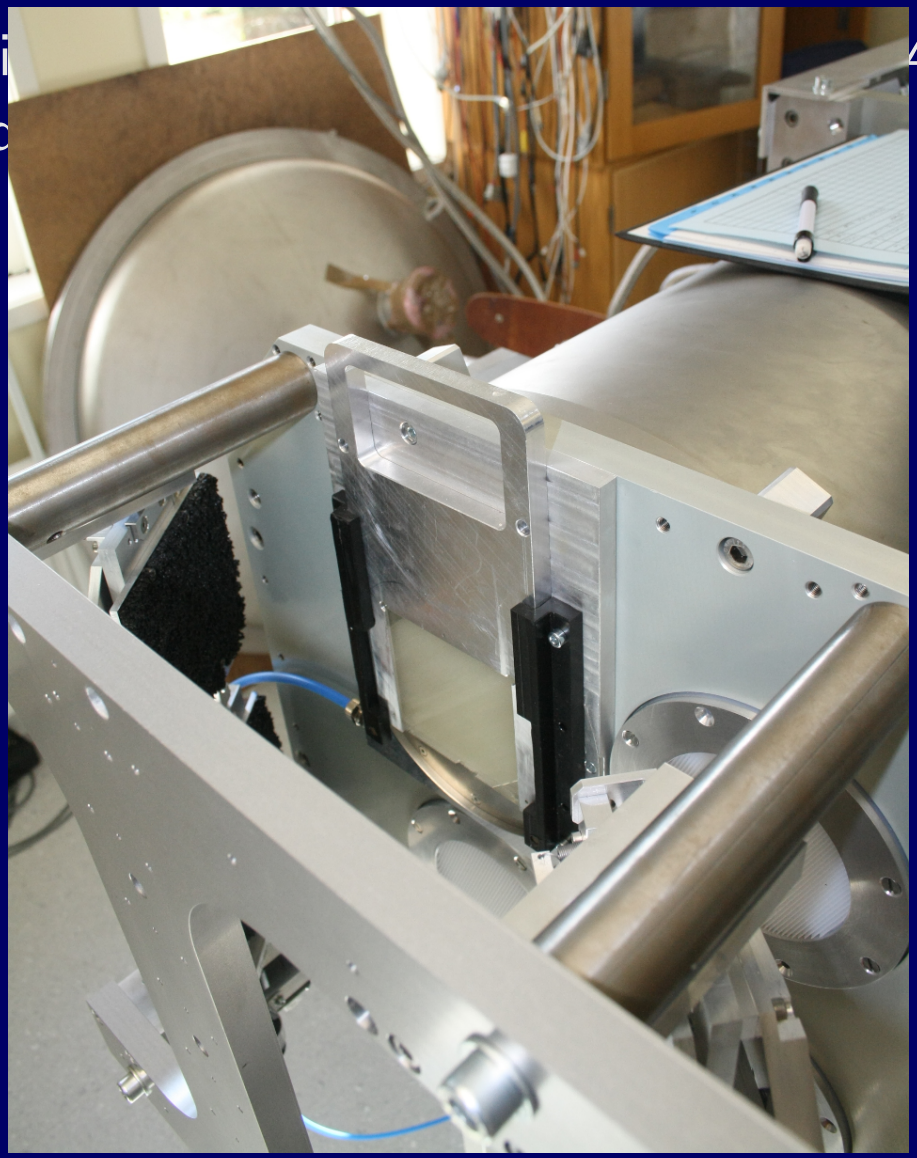

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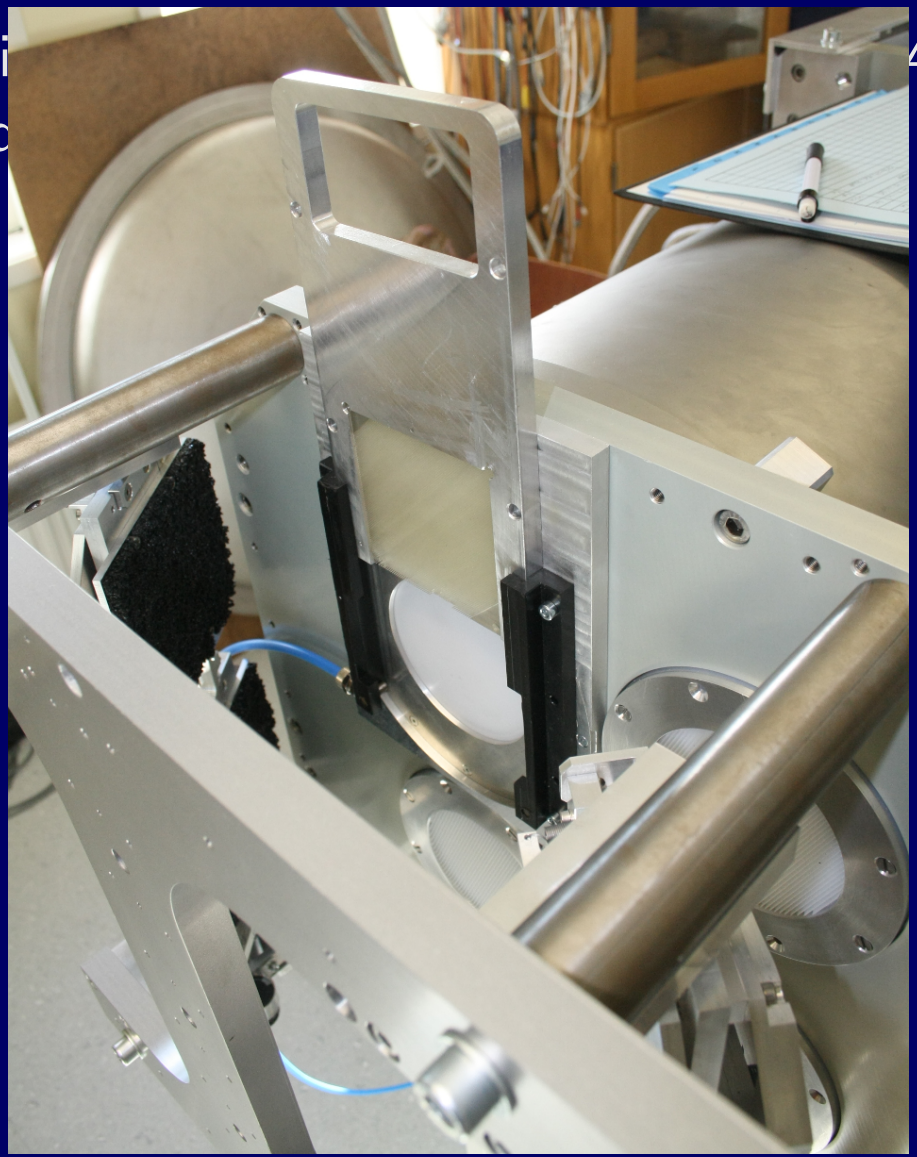

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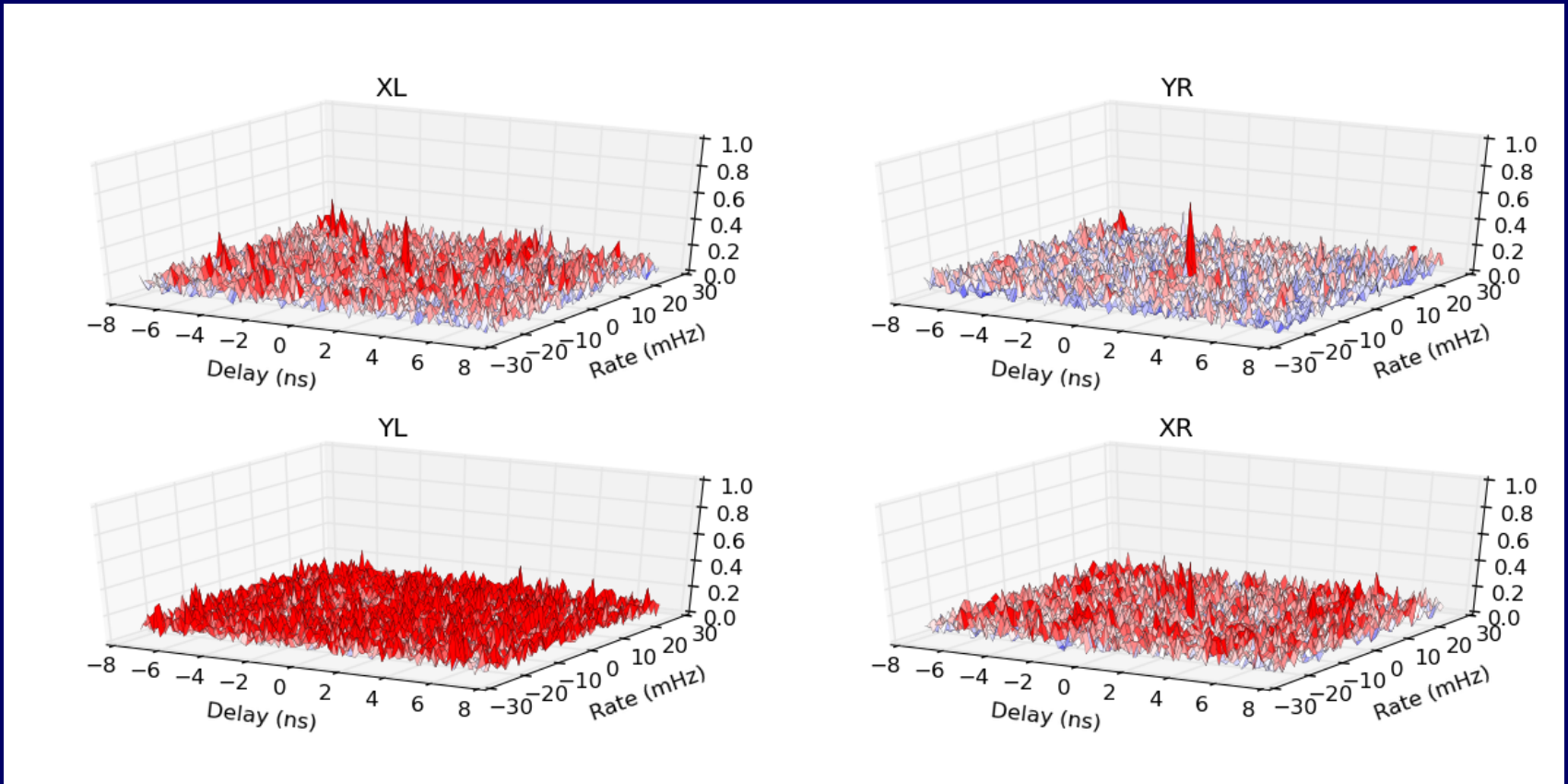
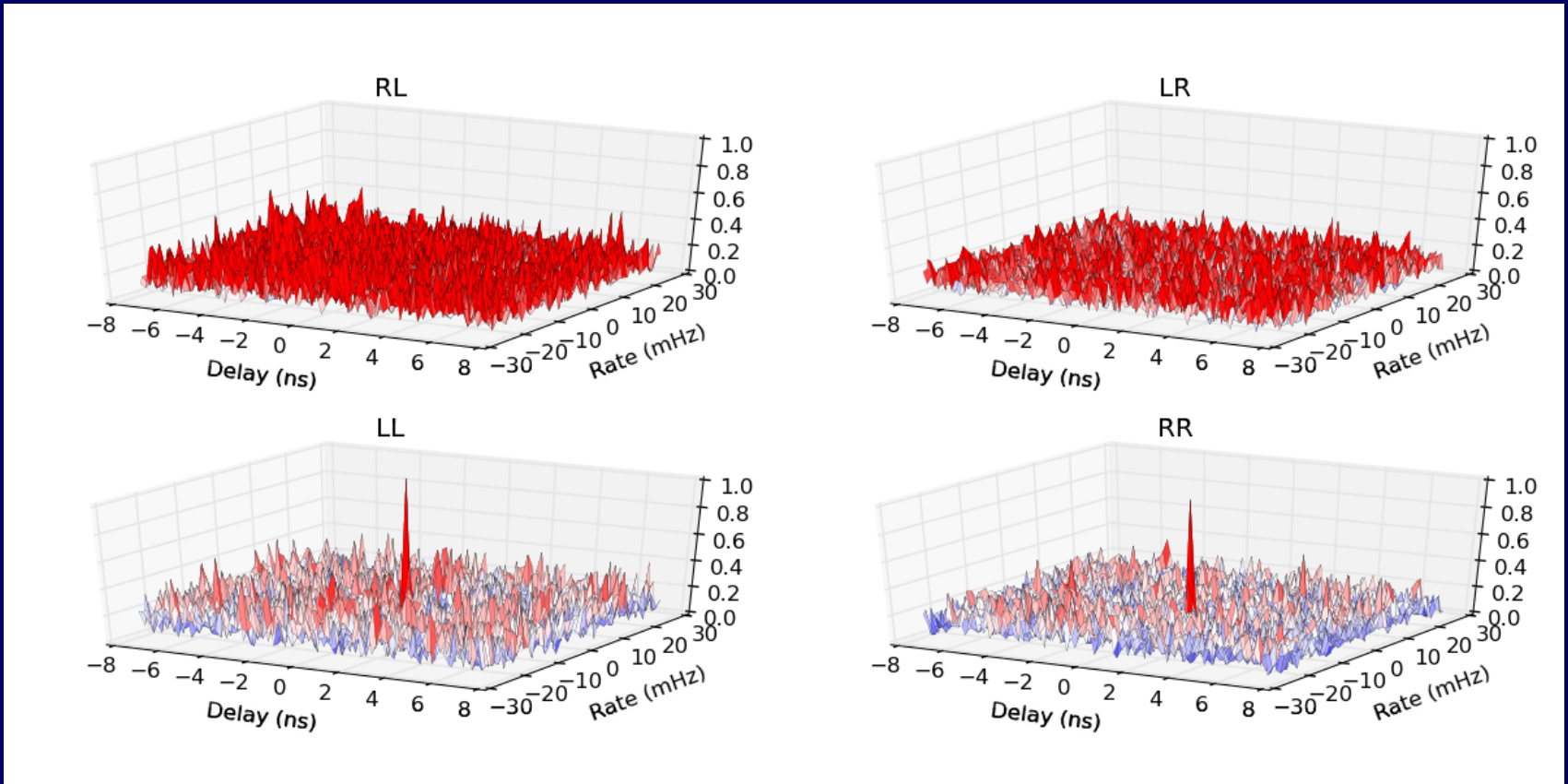


On-Eb final pol-converted fringes



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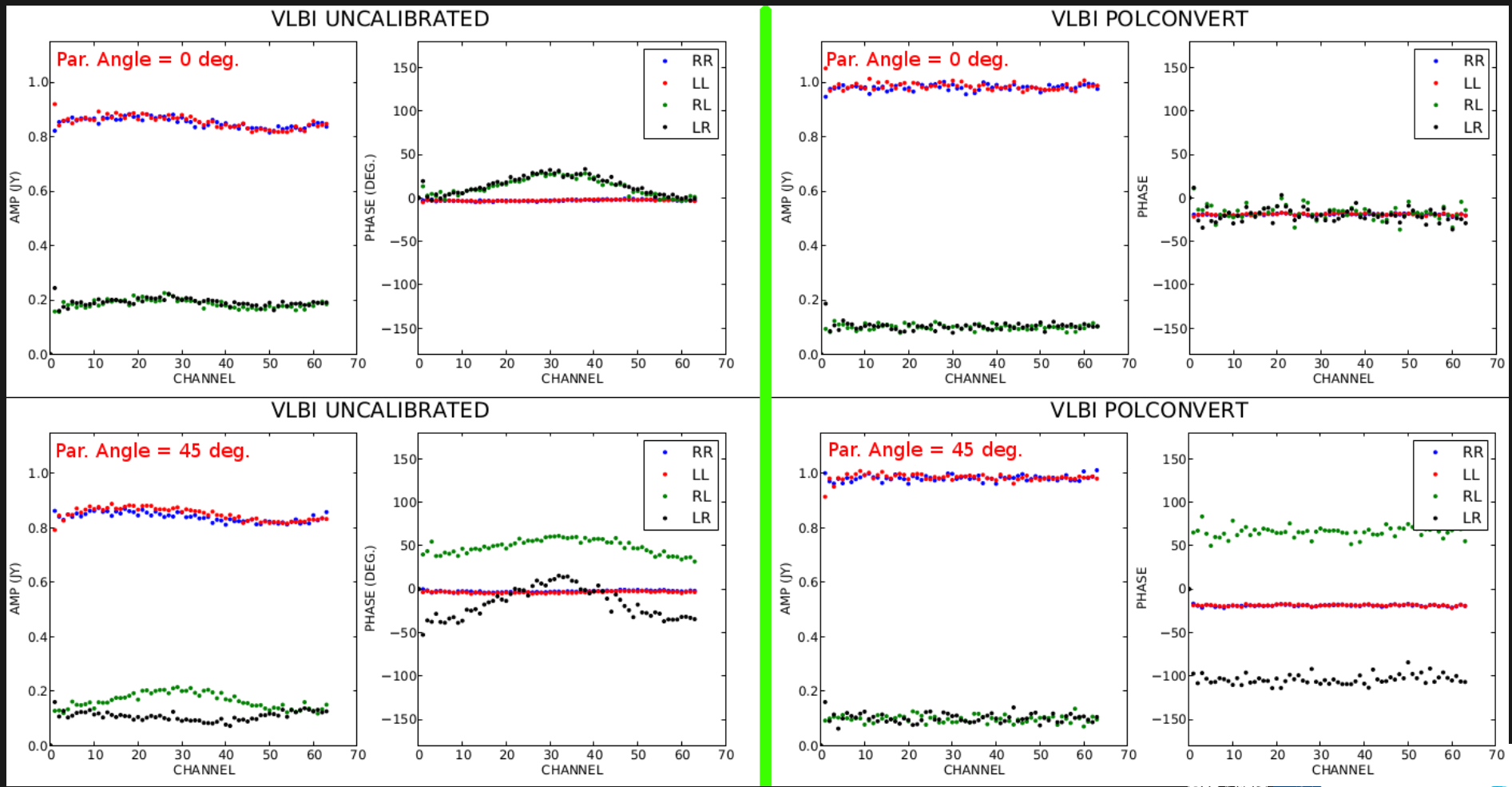

Simulation results III. Circularly polarized source

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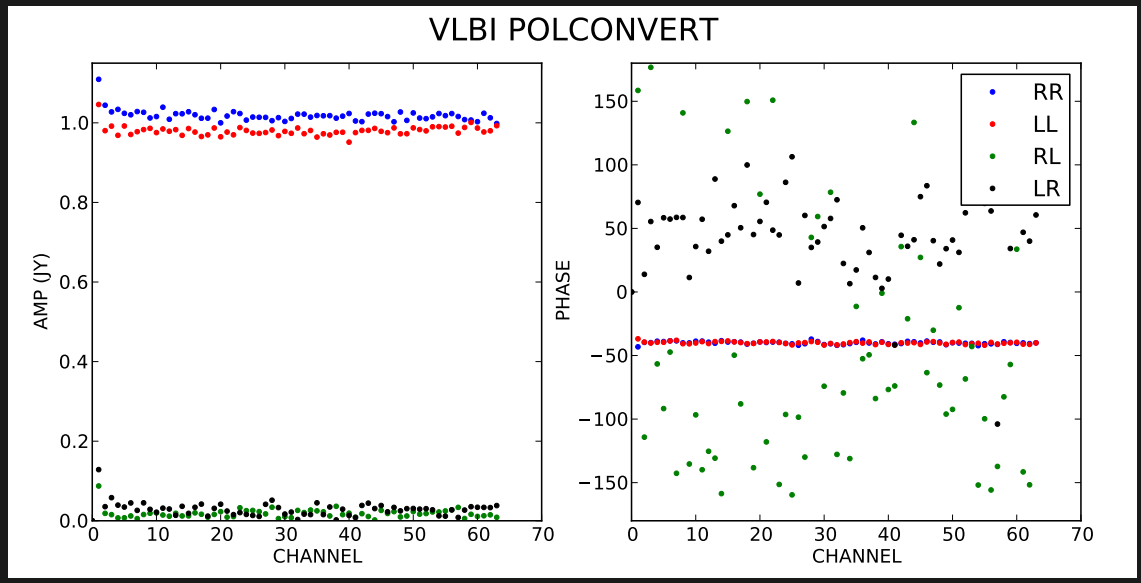
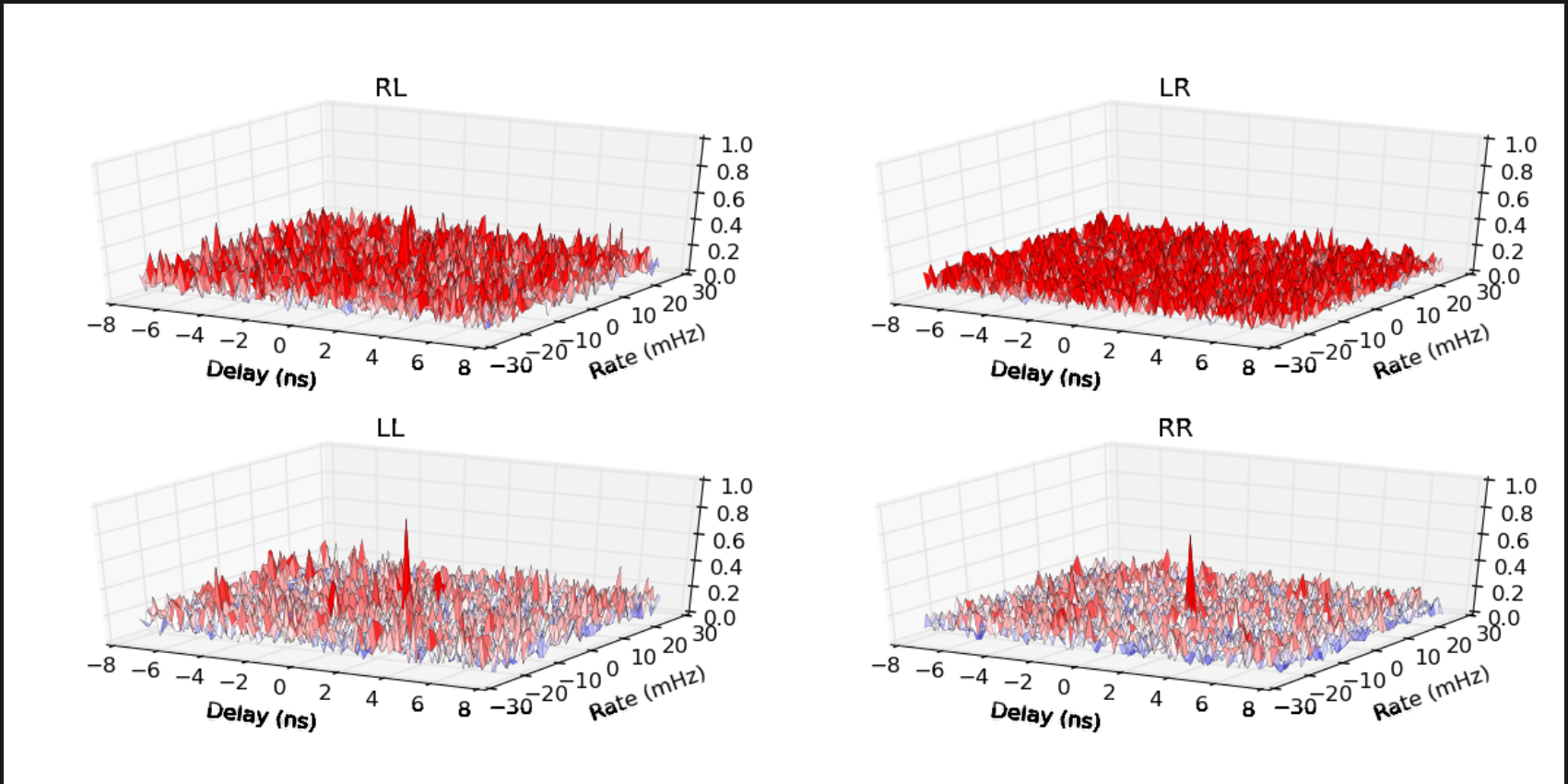


Small contamination from V into RL/LR, due to deviations in the estimates of the D-terms

On-Eb quick pol-converted fringes



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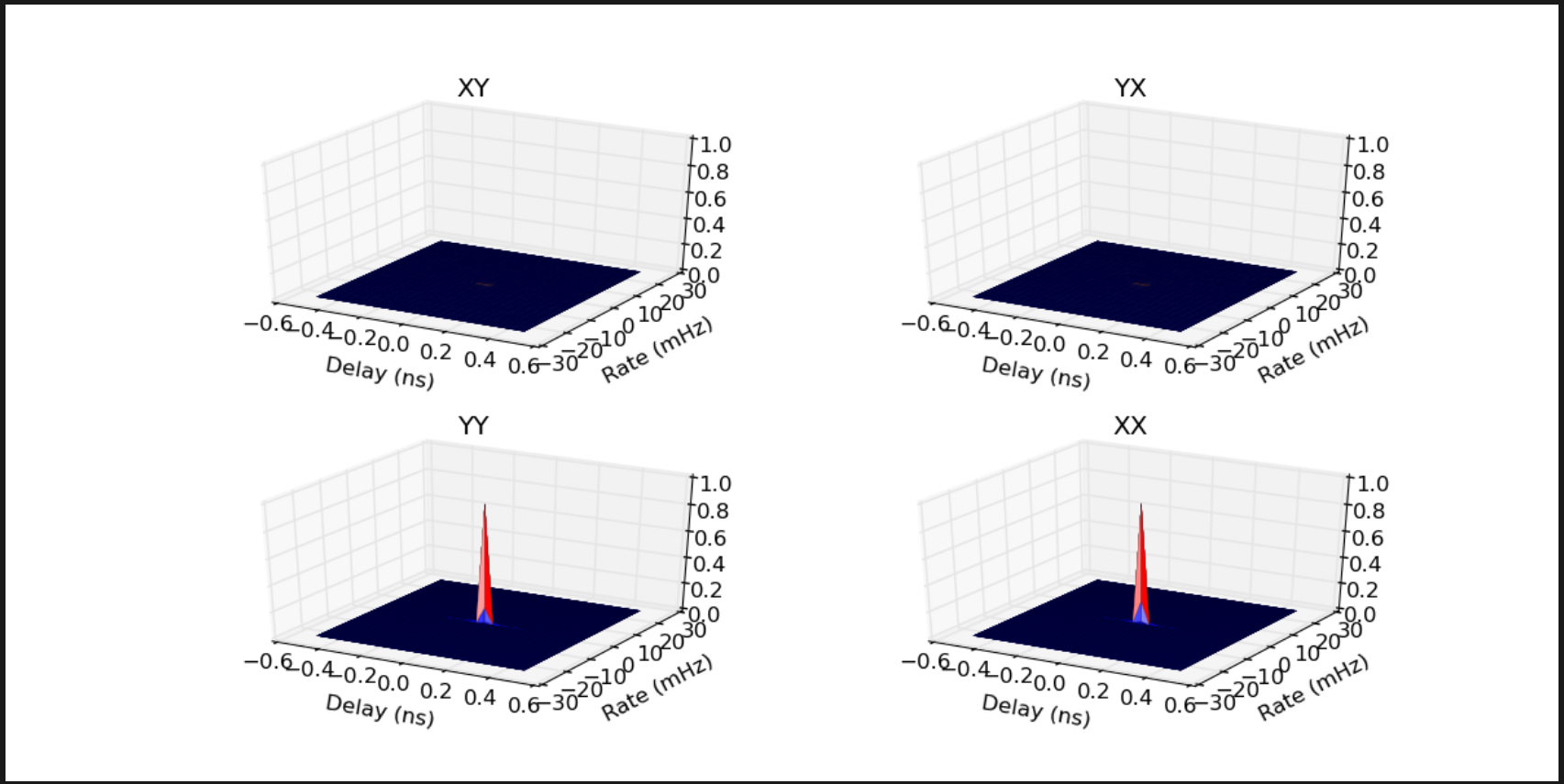

Phased vs. Antenna 1 - Linear

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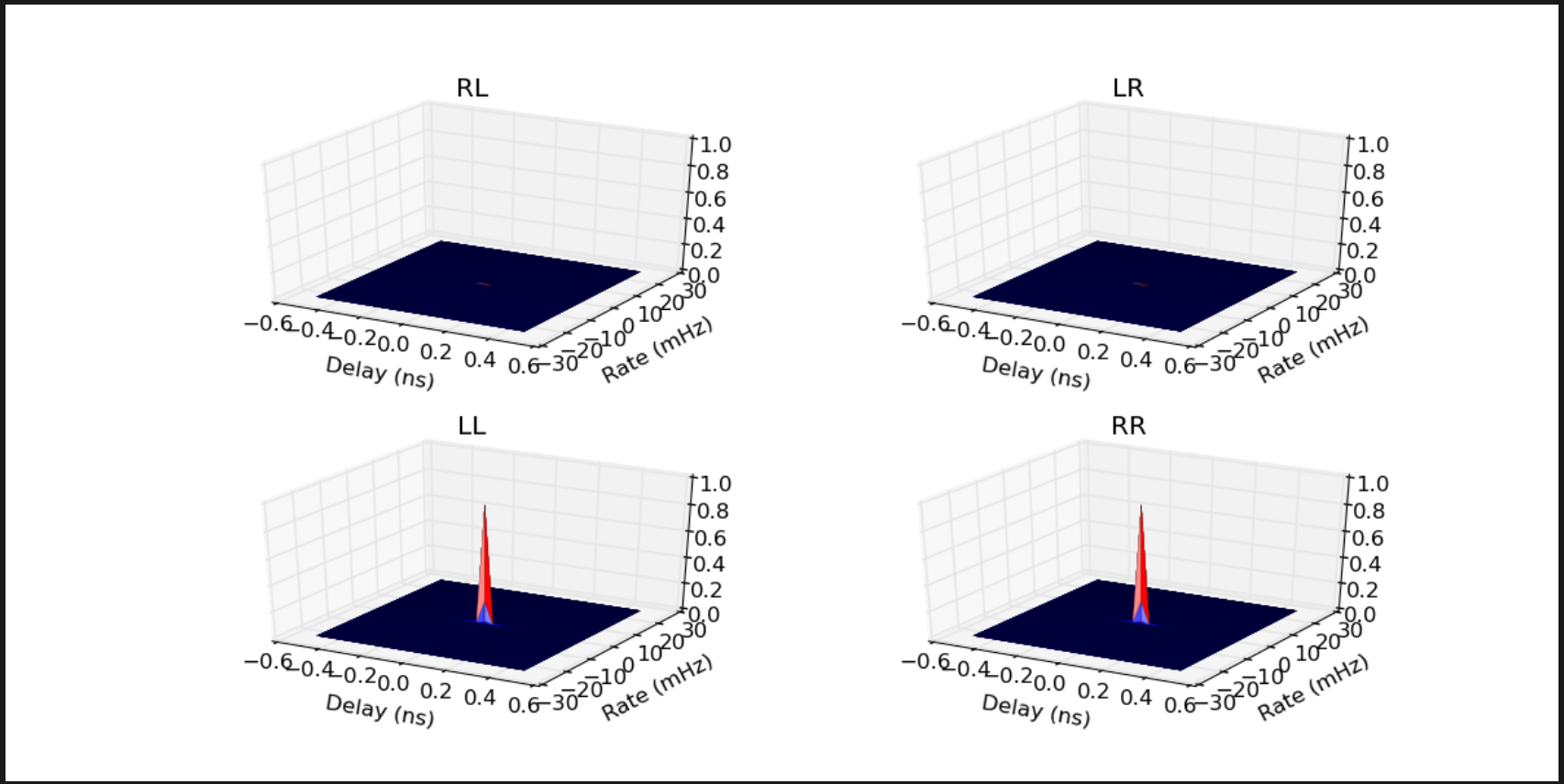
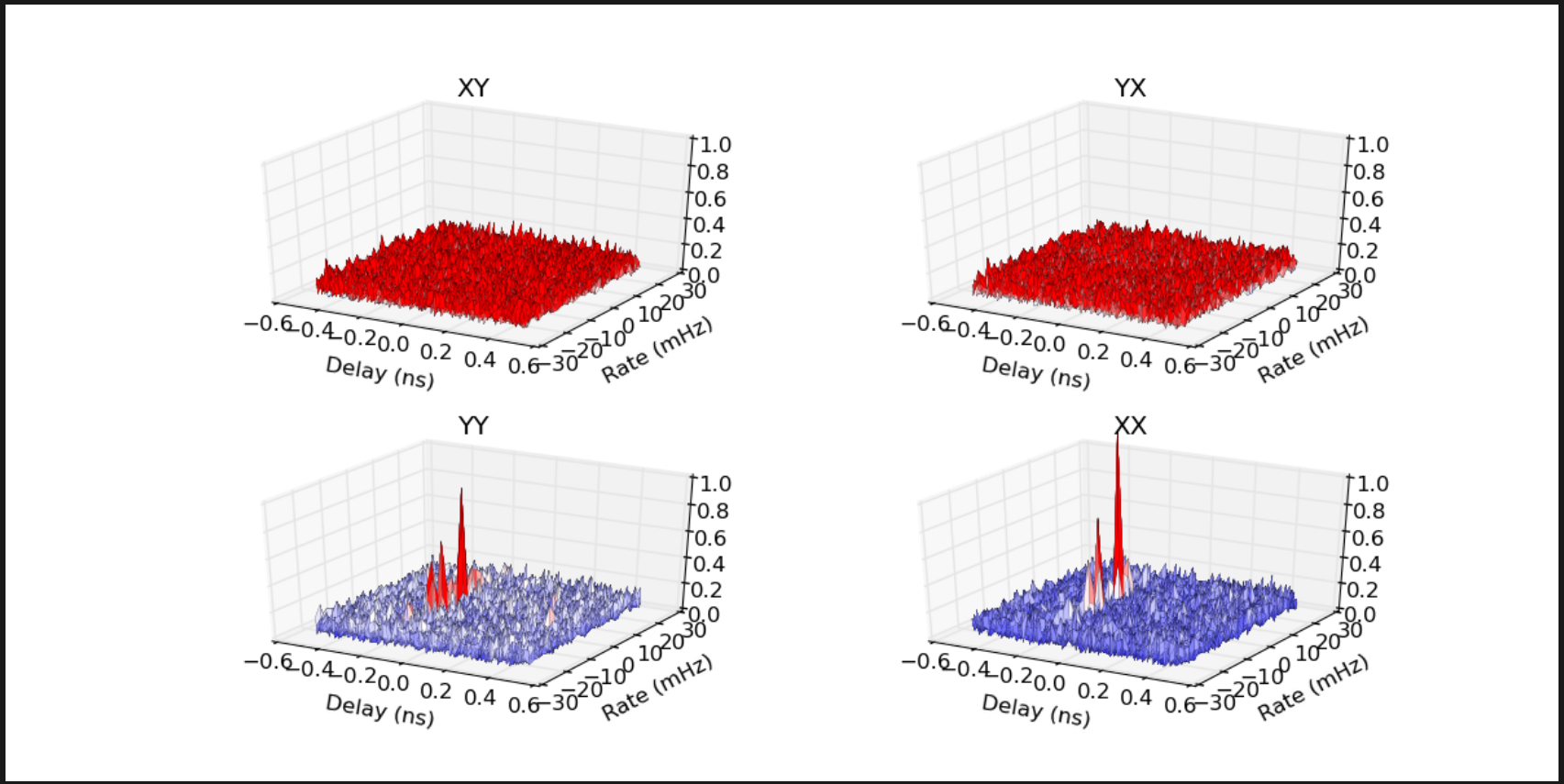


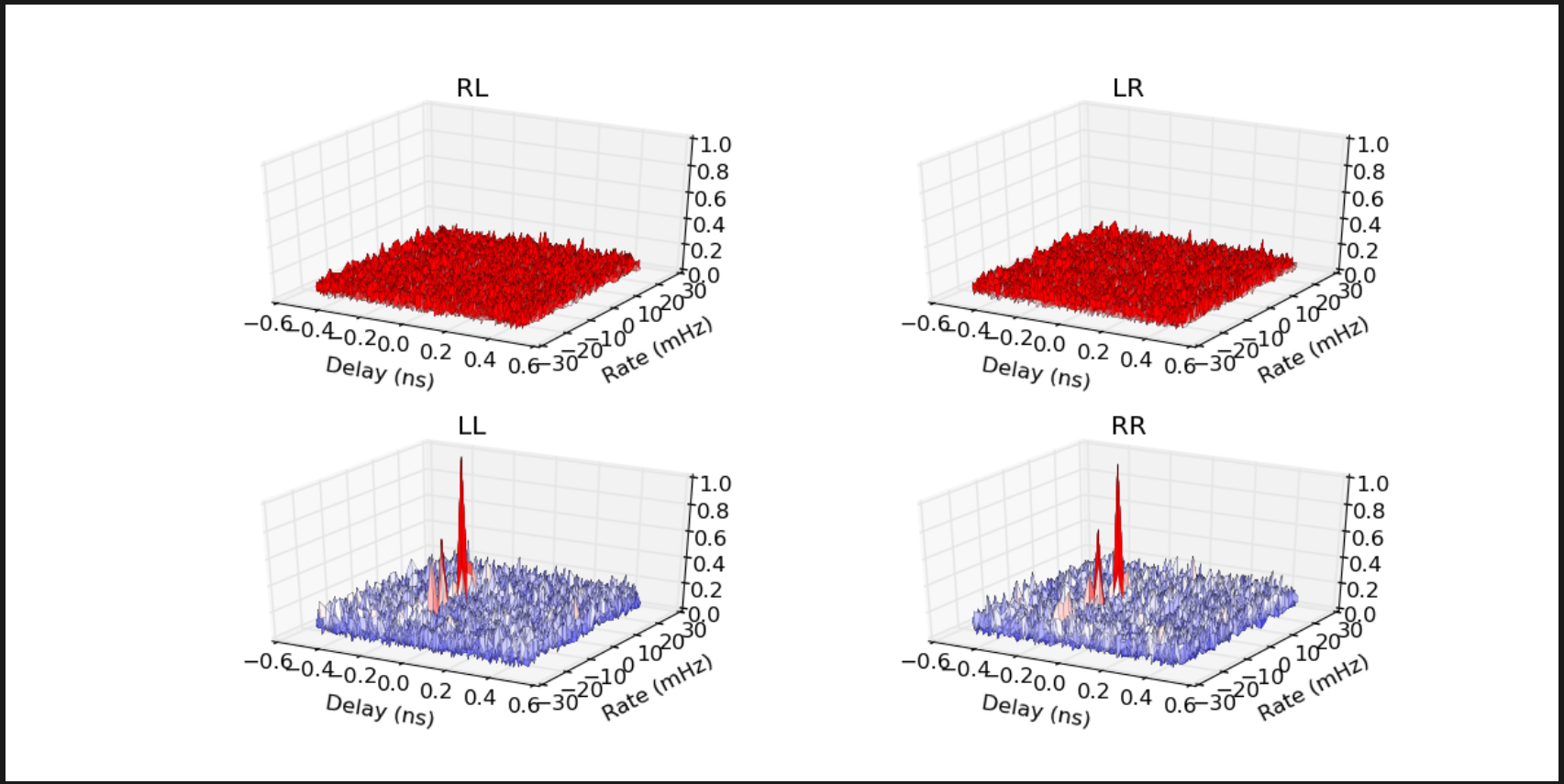
Phased vs. Antenna 1 - Circular

First Phased-ALMA fringes!



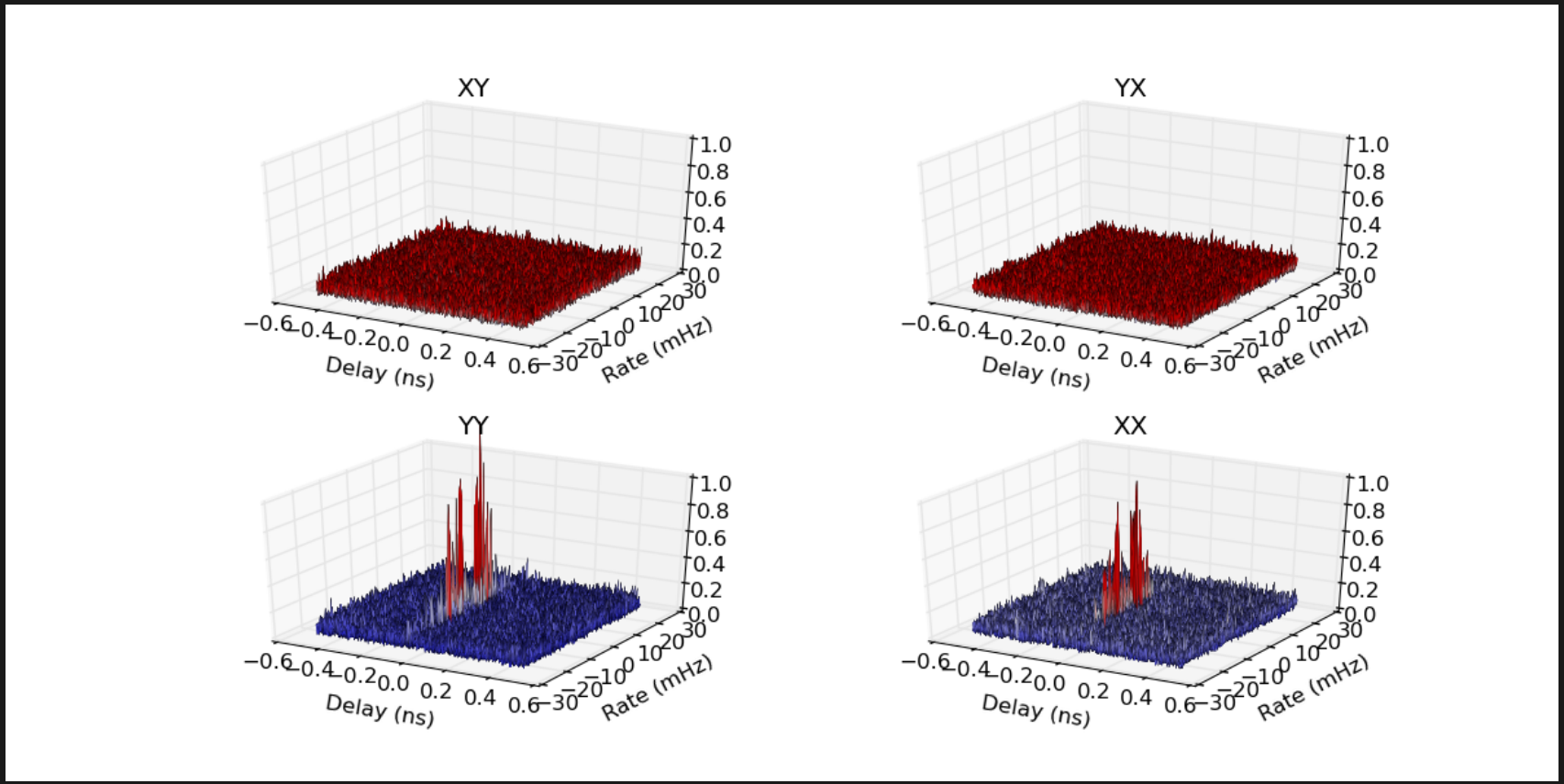
Antenna 1 vs. Antenna 2 - Linear

First Phased-ALMA fringes!



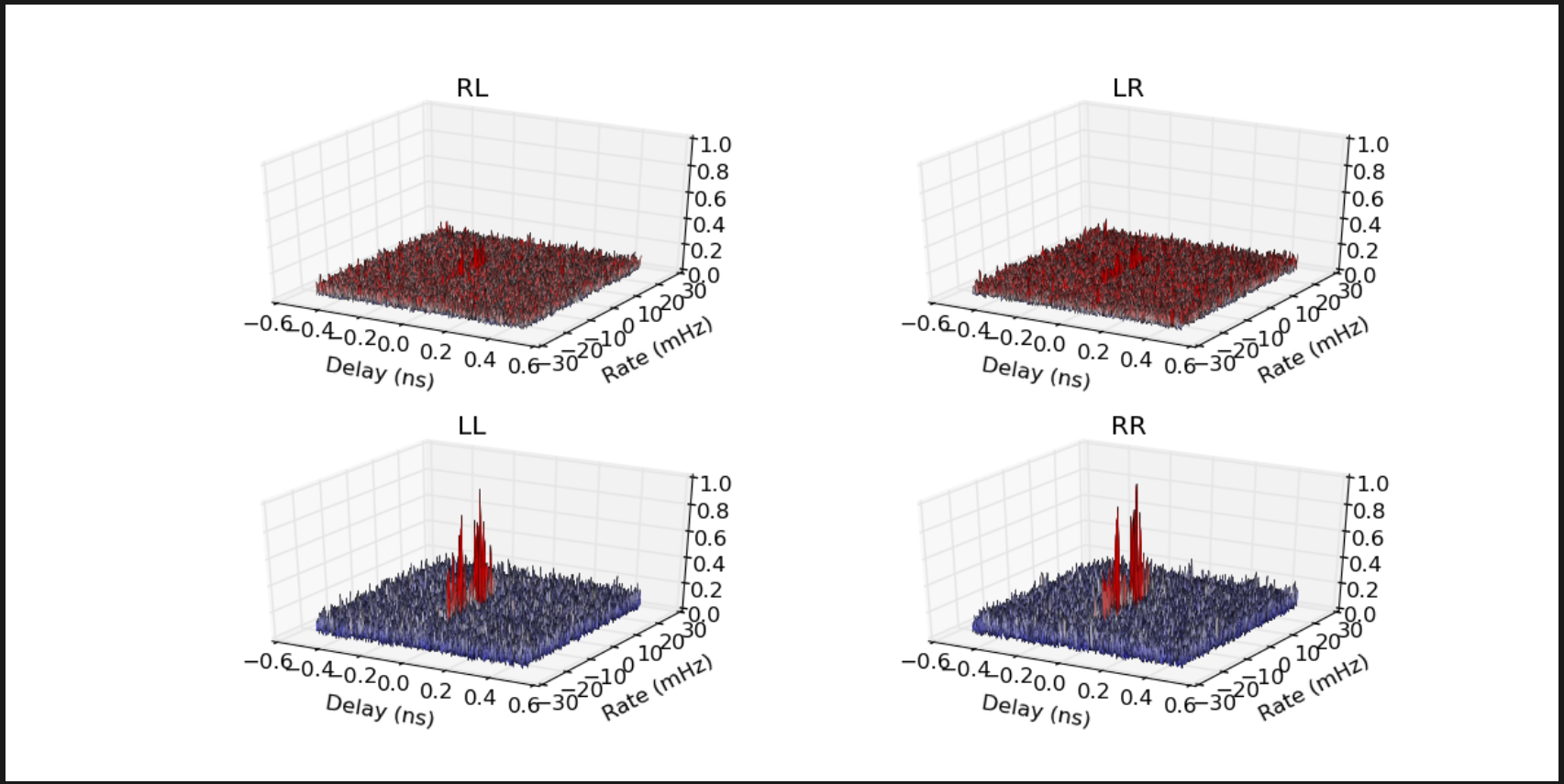
Antenna 1 vs. Antenna 2 - Circular

First Phased-ALMA fringes!



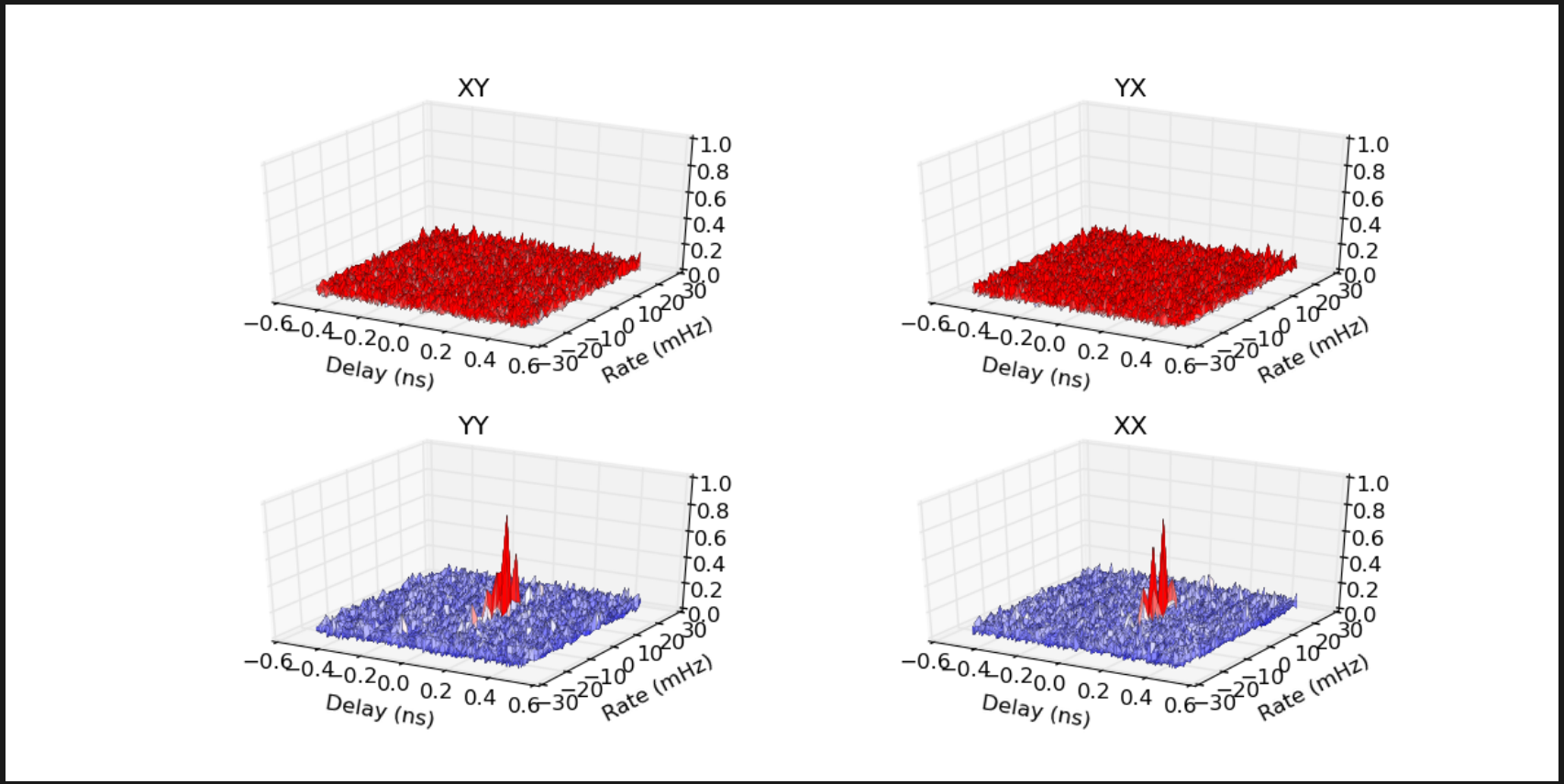
Antenna 1 vs. Antenna 3 - Linear

First Phased-ALMA fringes!



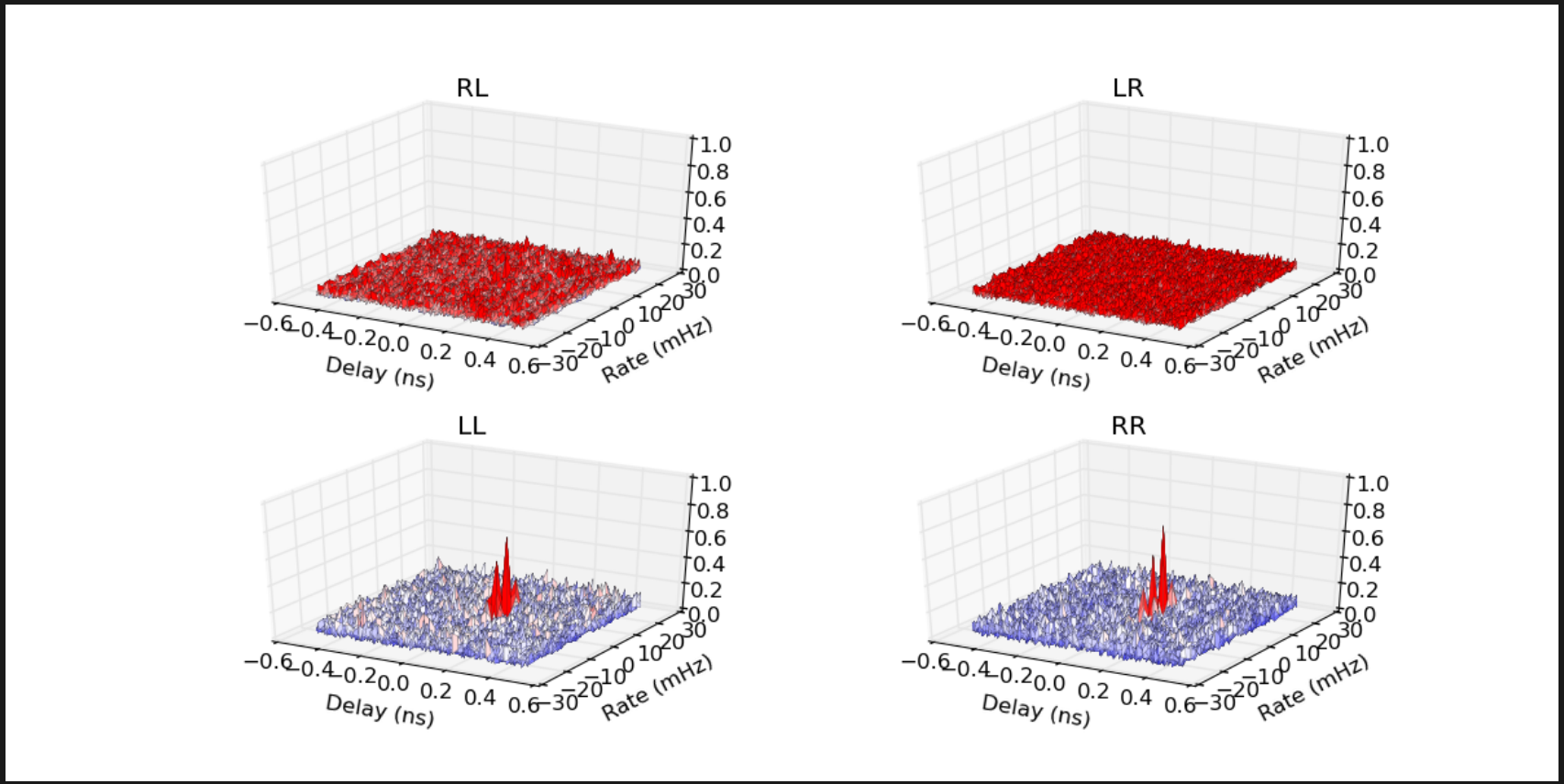
Antenna 1 vs. Antenna 3 - Circular

First Phased-ALMA fringes!



Antenna 2 vs. Antenna 3 - Linear

First Phased-ALMA fringes!



Antenna 2 vs. Antenna 3 - Circular