EHT Data: Overview and Challenges

Vincent L. Fish

Data: The Big Picture

Observe

Correlate

Reduce

Calibrate

Analyze and interpret

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Test and operate equipment, scheduling, telescope control, monitoring, logs, ...

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Fit models to data or produce image, compare with simulations
Generate science
Write papers

Challenge of high-frequency VLBI

In one word: Atmosphere

Two main issues

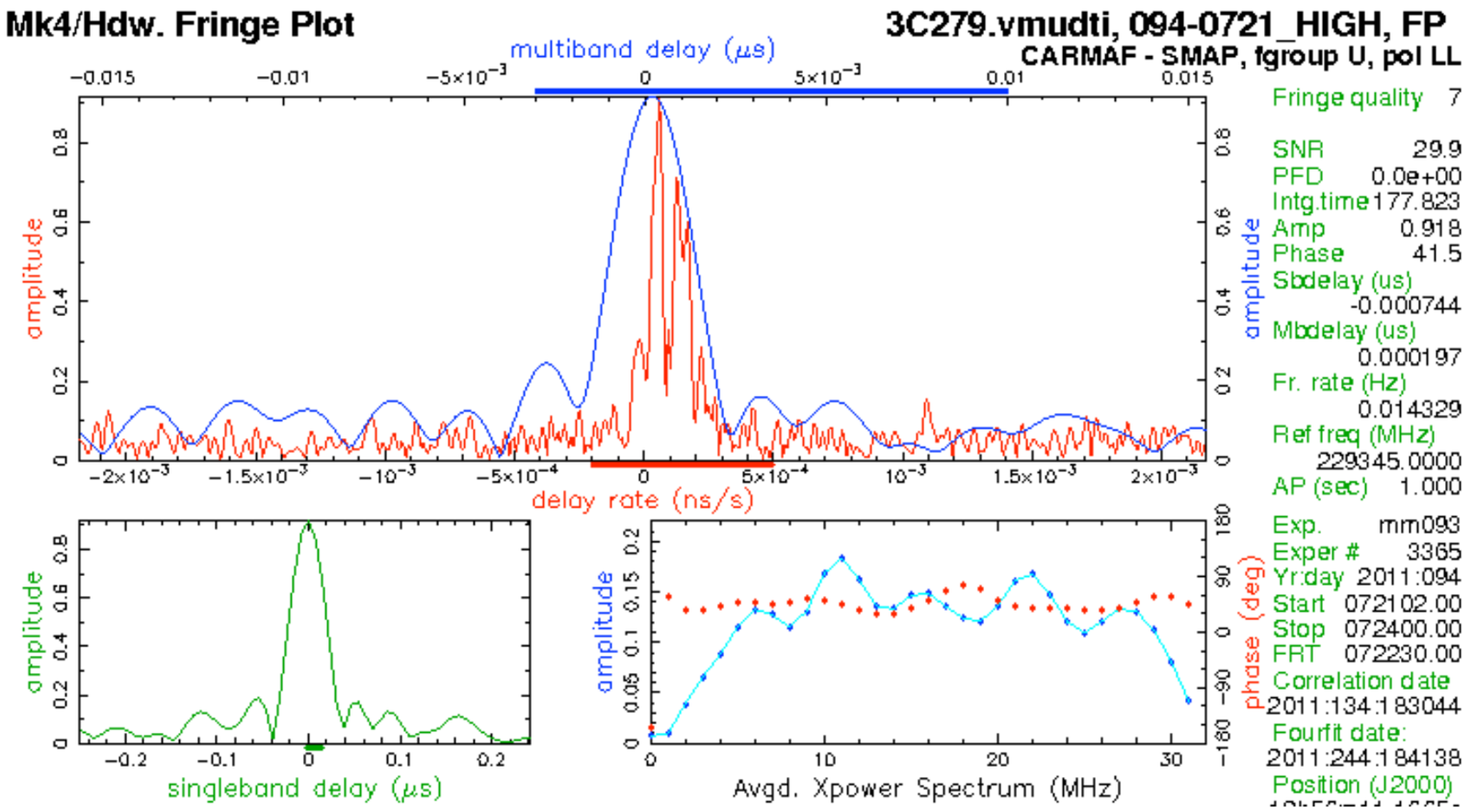
- Opacity
- Coherence

Rapidly changing tropospheric delays introduce phase variations

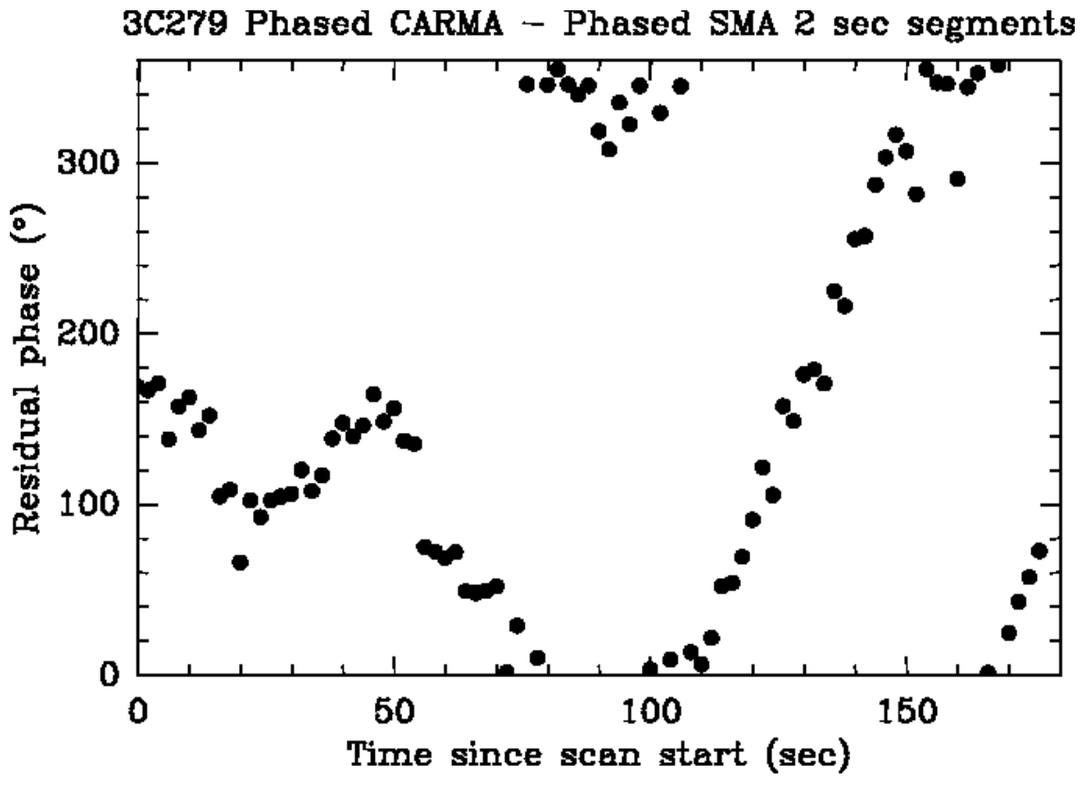
Effects on the data

- Sensitivity loss
- Amplitude loss
- Corruption of phase information

Example scan: Strong



Entire scan
amplitude = 0.918
(coherent fit, 180 seconds)



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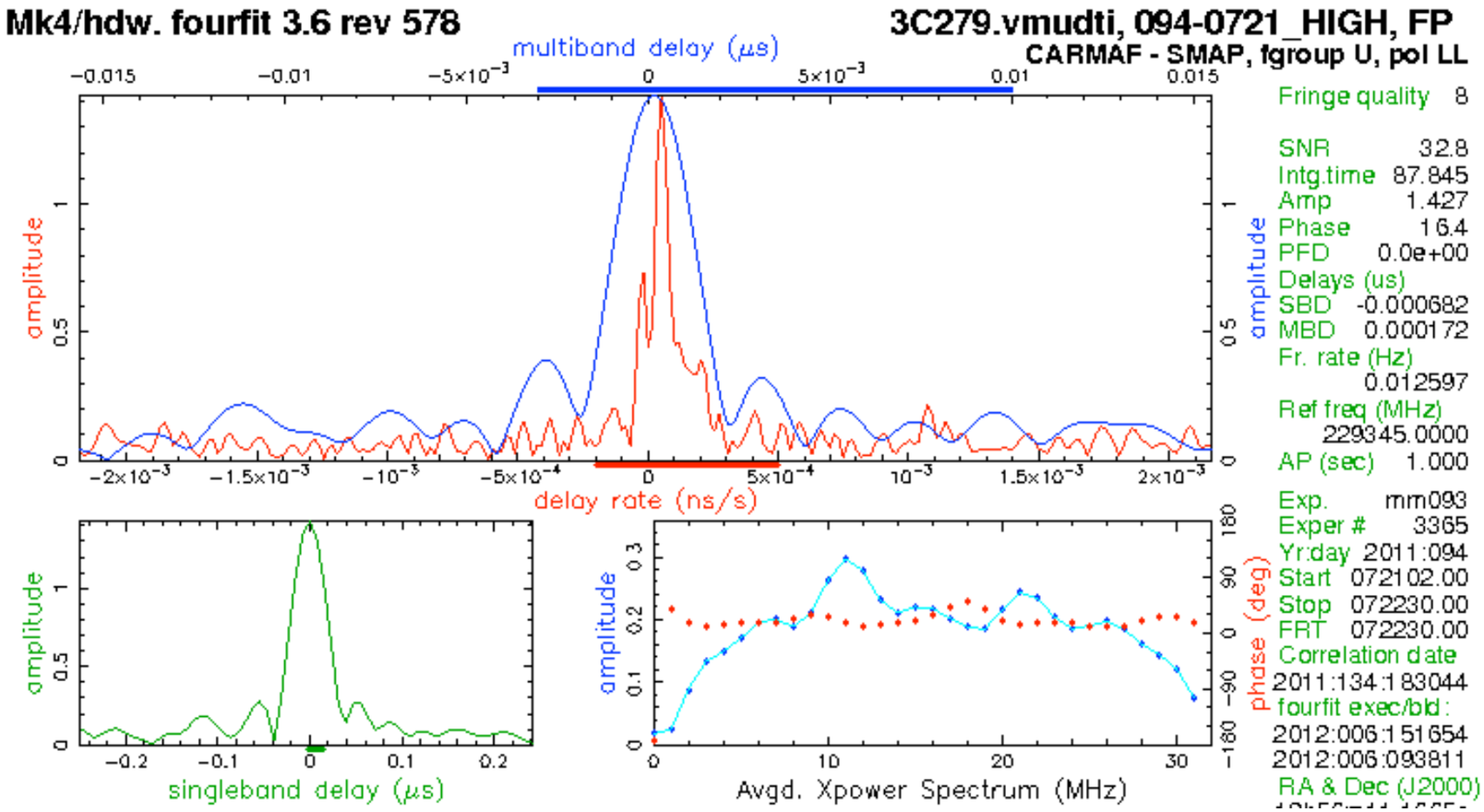
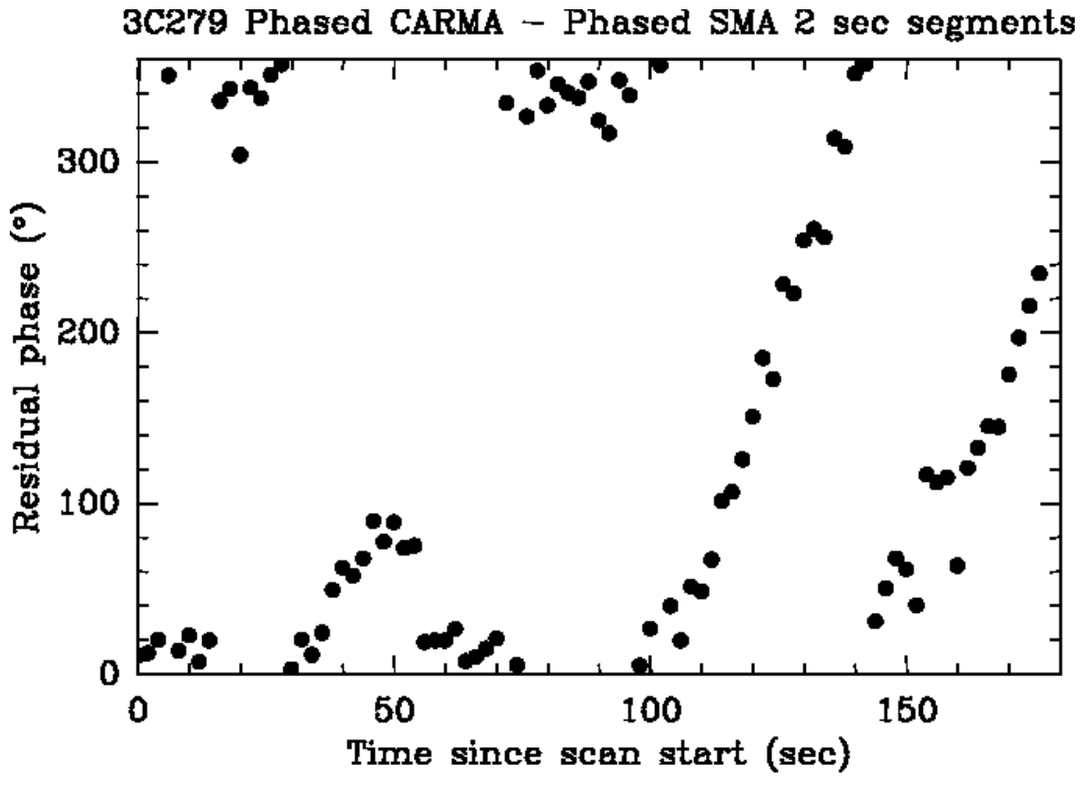


First half
amplitude = 1.427
(coherent fit, 90 seconds)



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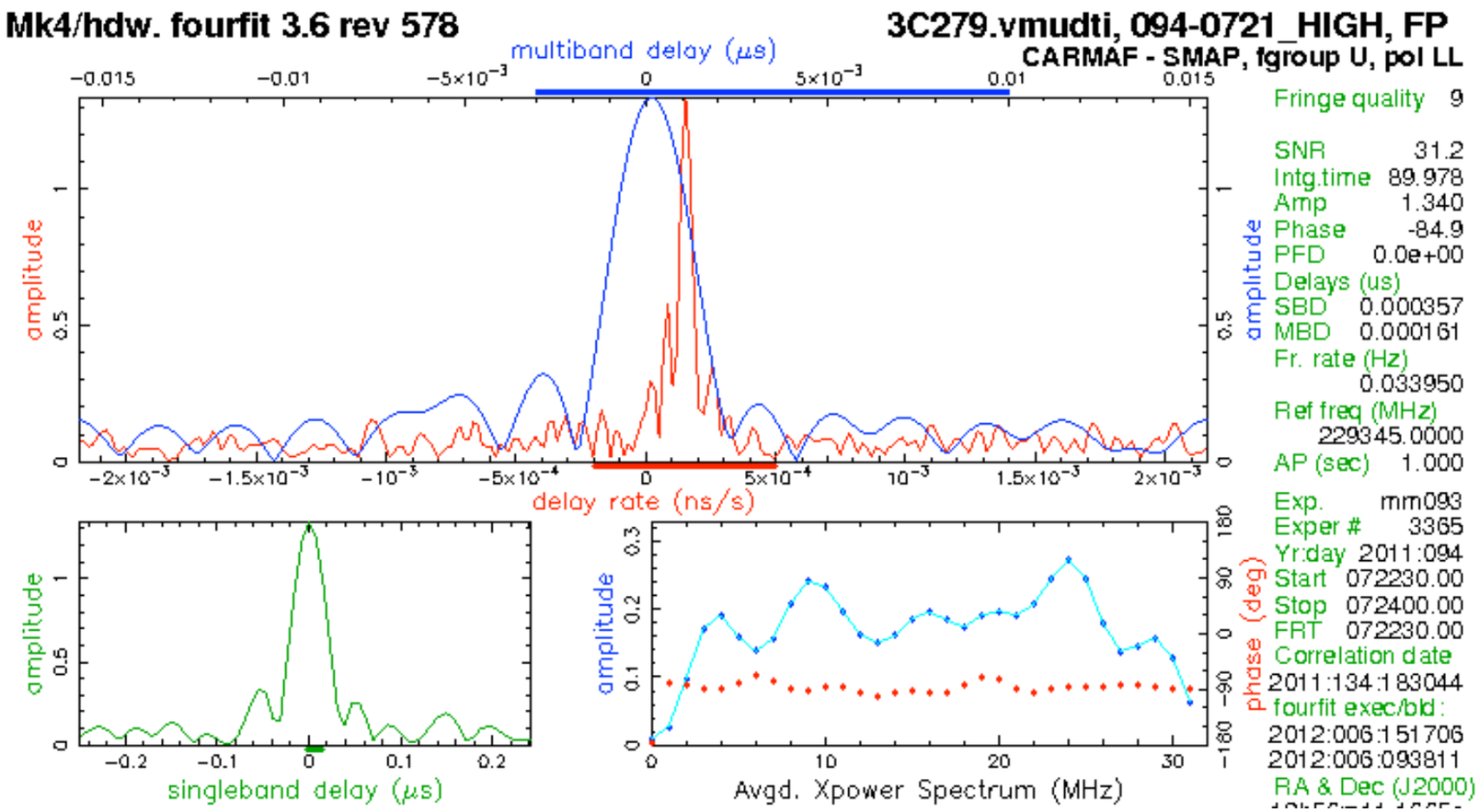
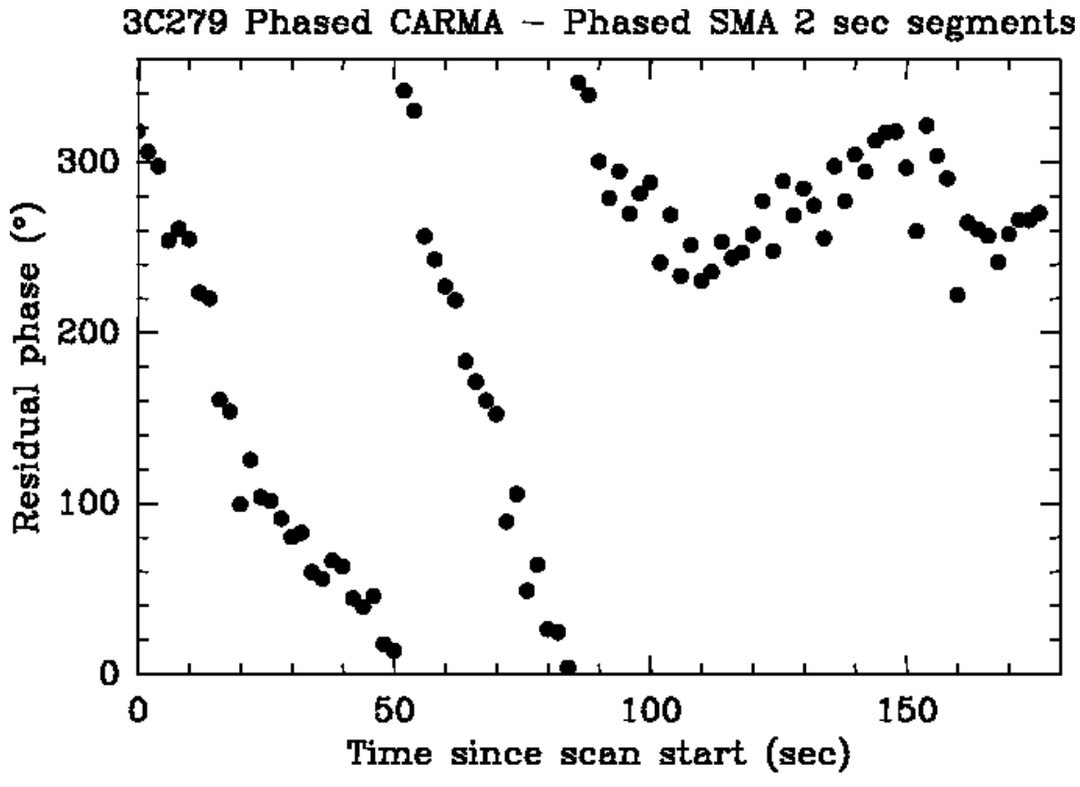


Second half
amplitude = 1.340
(coherent fit, 90 seconds)

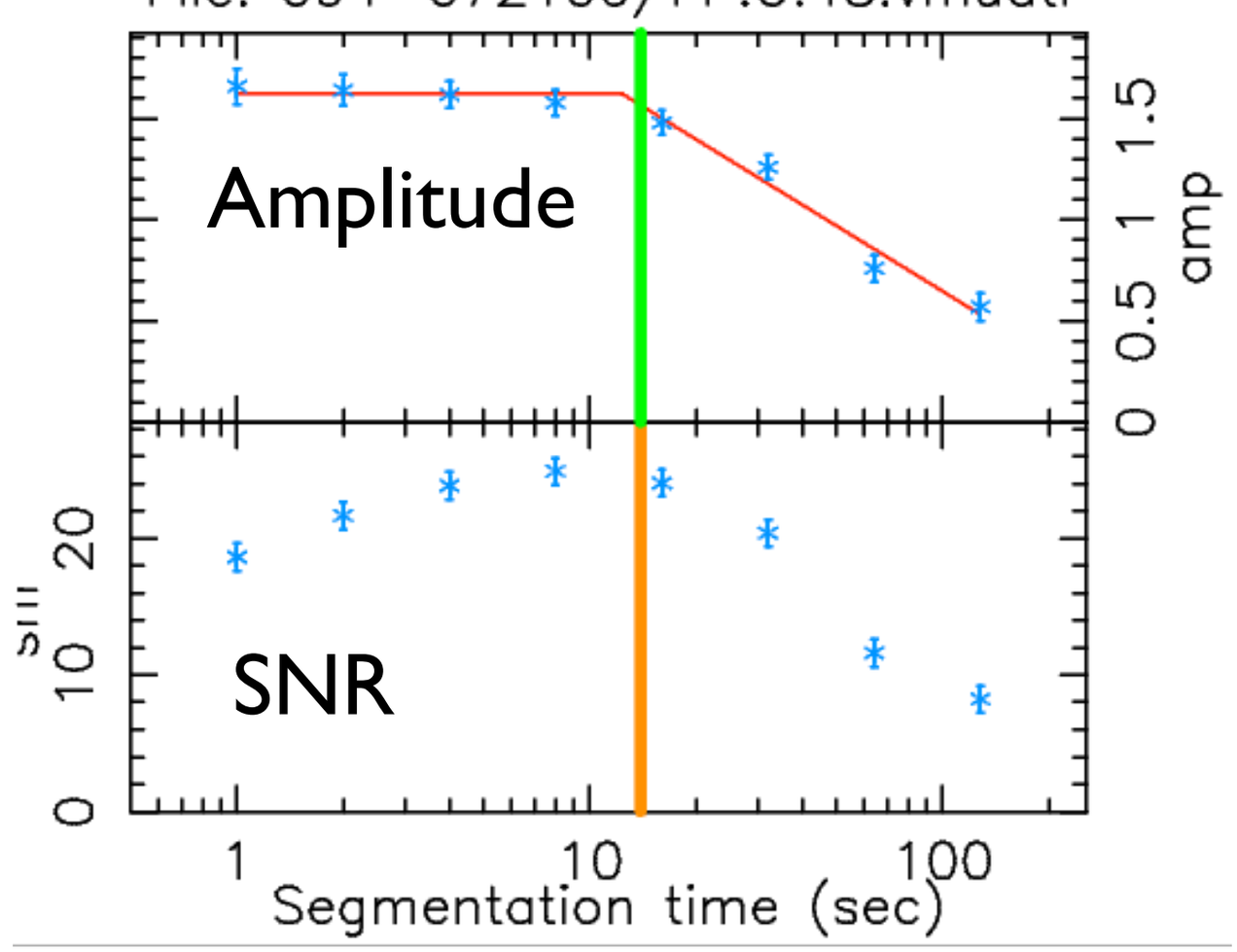


Atmosphere and coherence

The atmosphere introduces rapid phase fluctuations

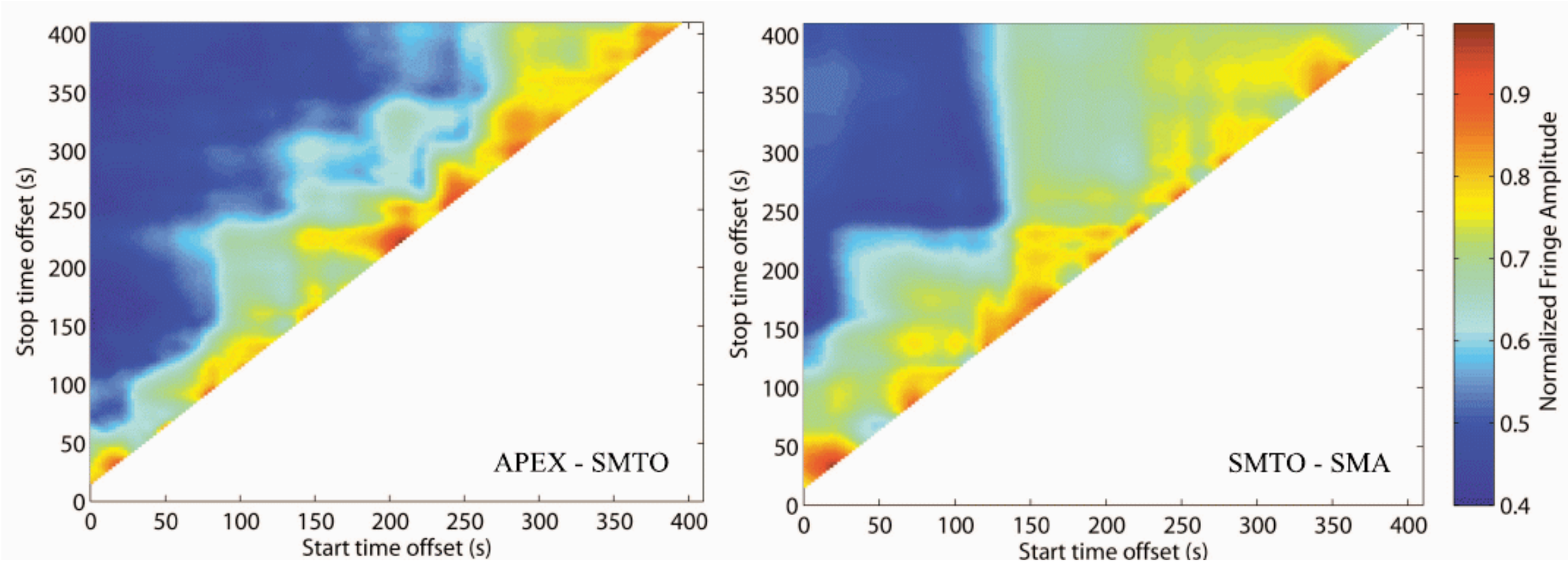
Must segment data and average incoherently to
optimize detection as well as to determine the
correlation coefficient

Corrected amplitude = 1.66
(incoherent averaging, 1 second)



Amplitude measurements

Not easy!



(Wagner et al submitted)

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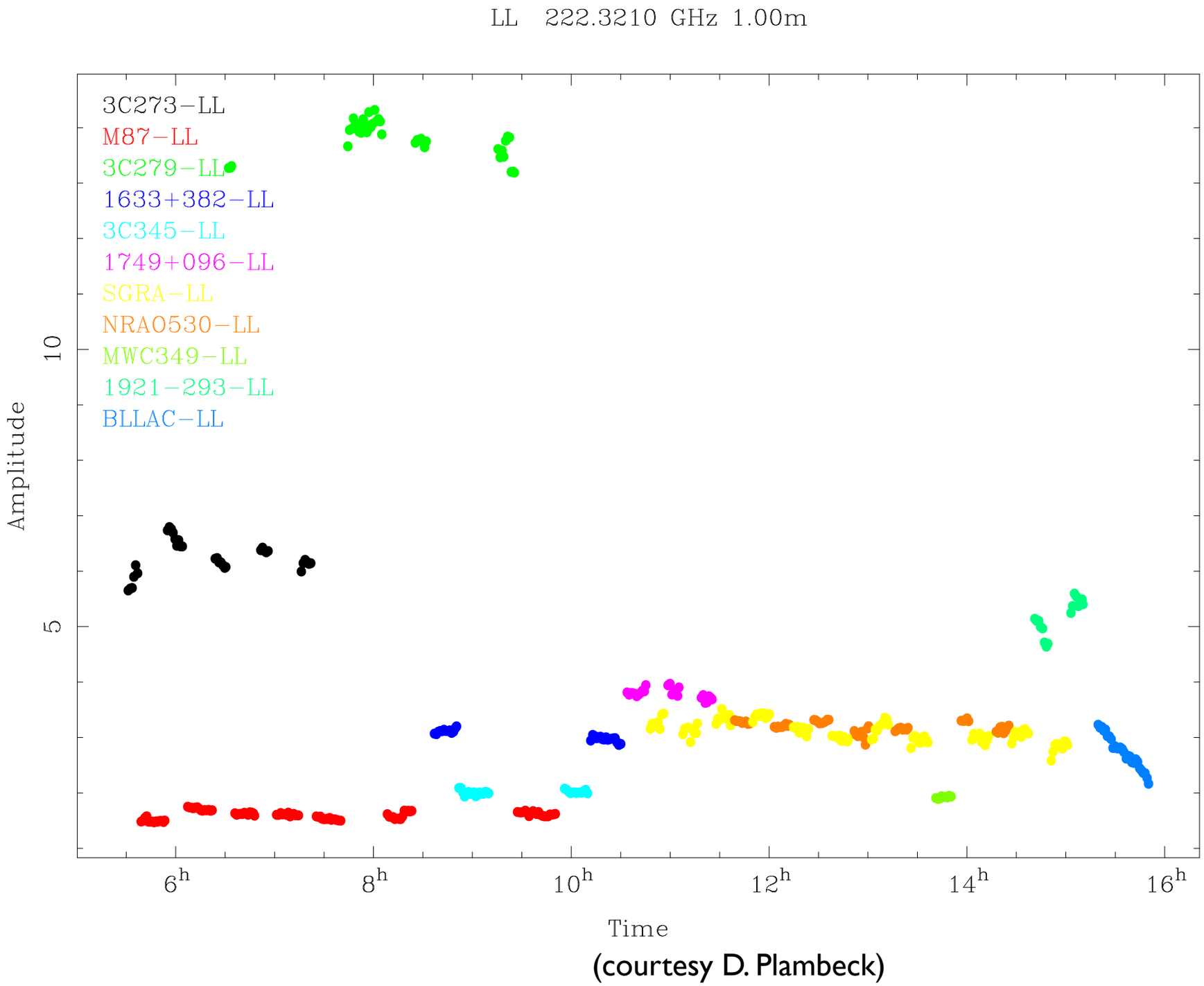

(courtesy D. Plambeck)

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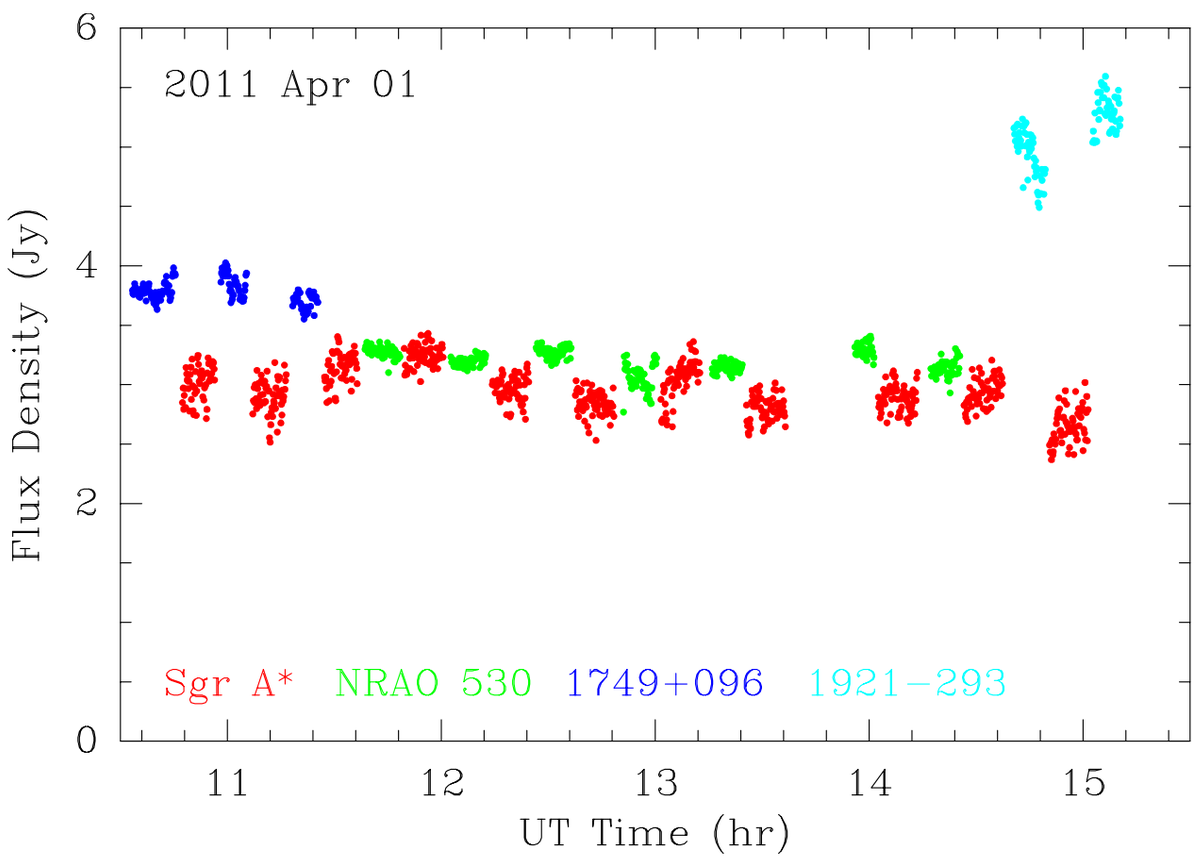

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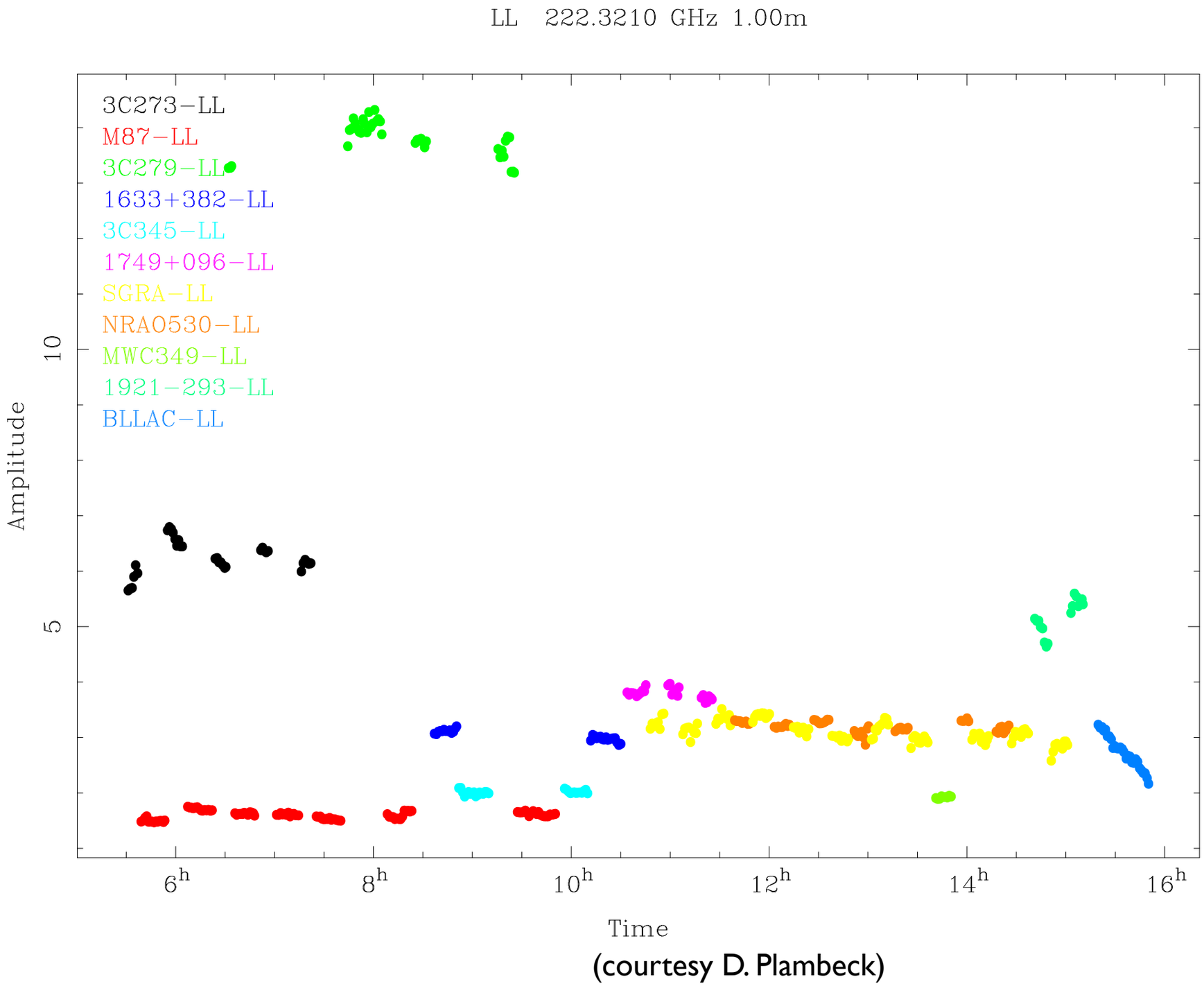

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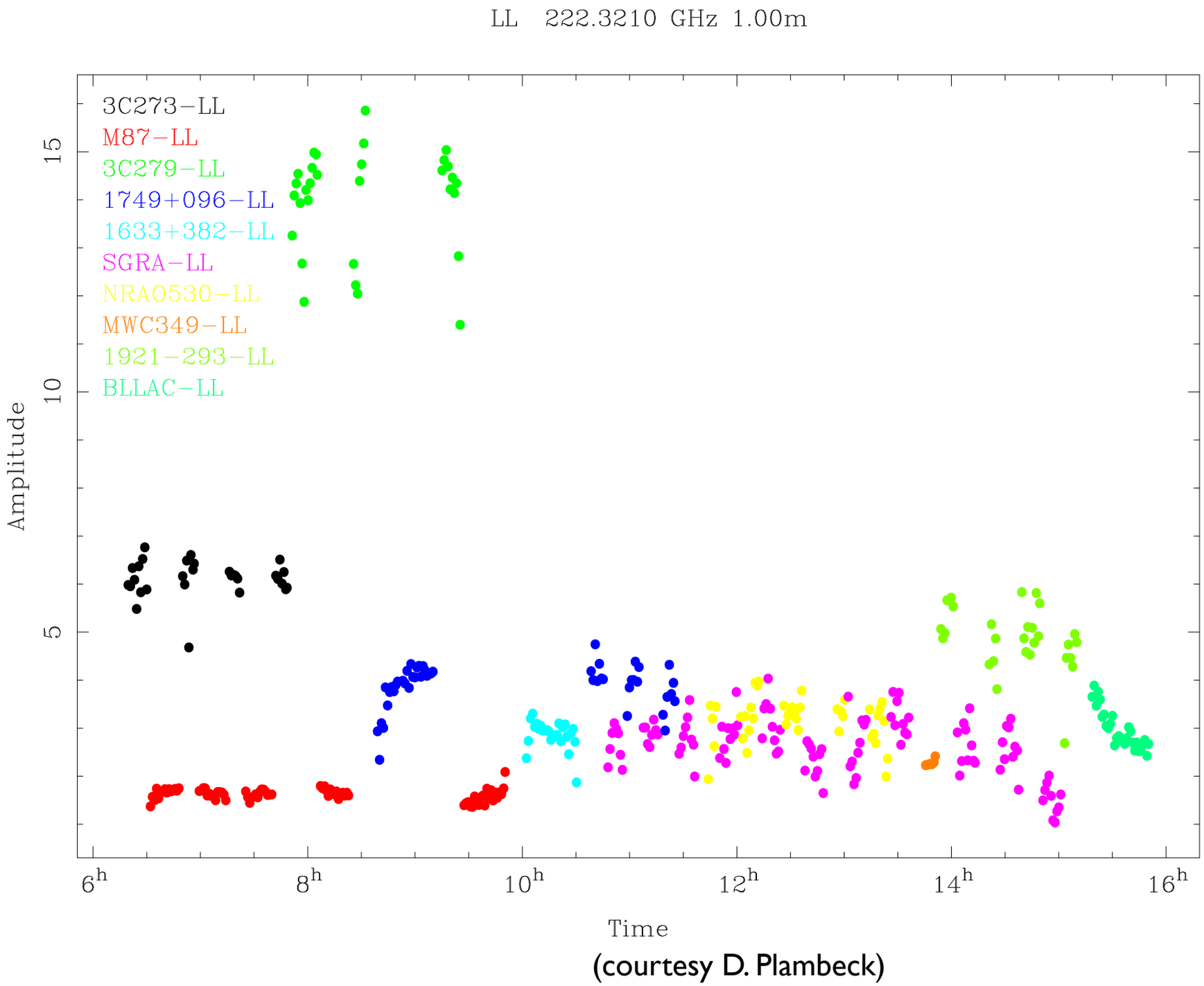

(courtesy D. Plambeck)

Amplitude measurements

Not easy!

Hard for connected-element and single-dish measurements too

Potential difficulties at several stages

- Determining correlation coefficients
- Getting high-quality calibration information (T_{sys}, tau, gain, ...)
- Measurement errors in these quantities too
- Infrequent measurements
- Directionality

Systematic errors

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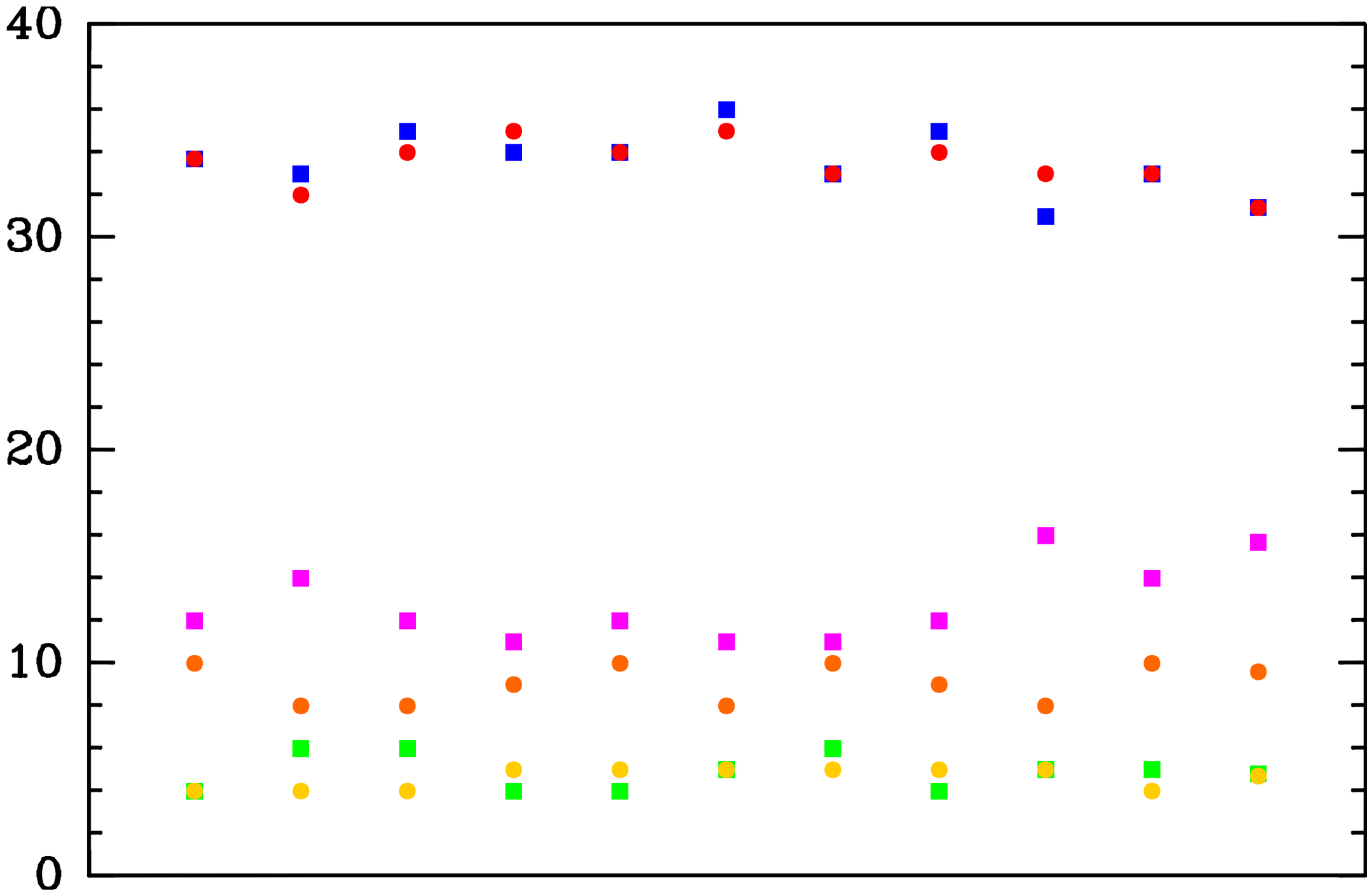
Insidious!



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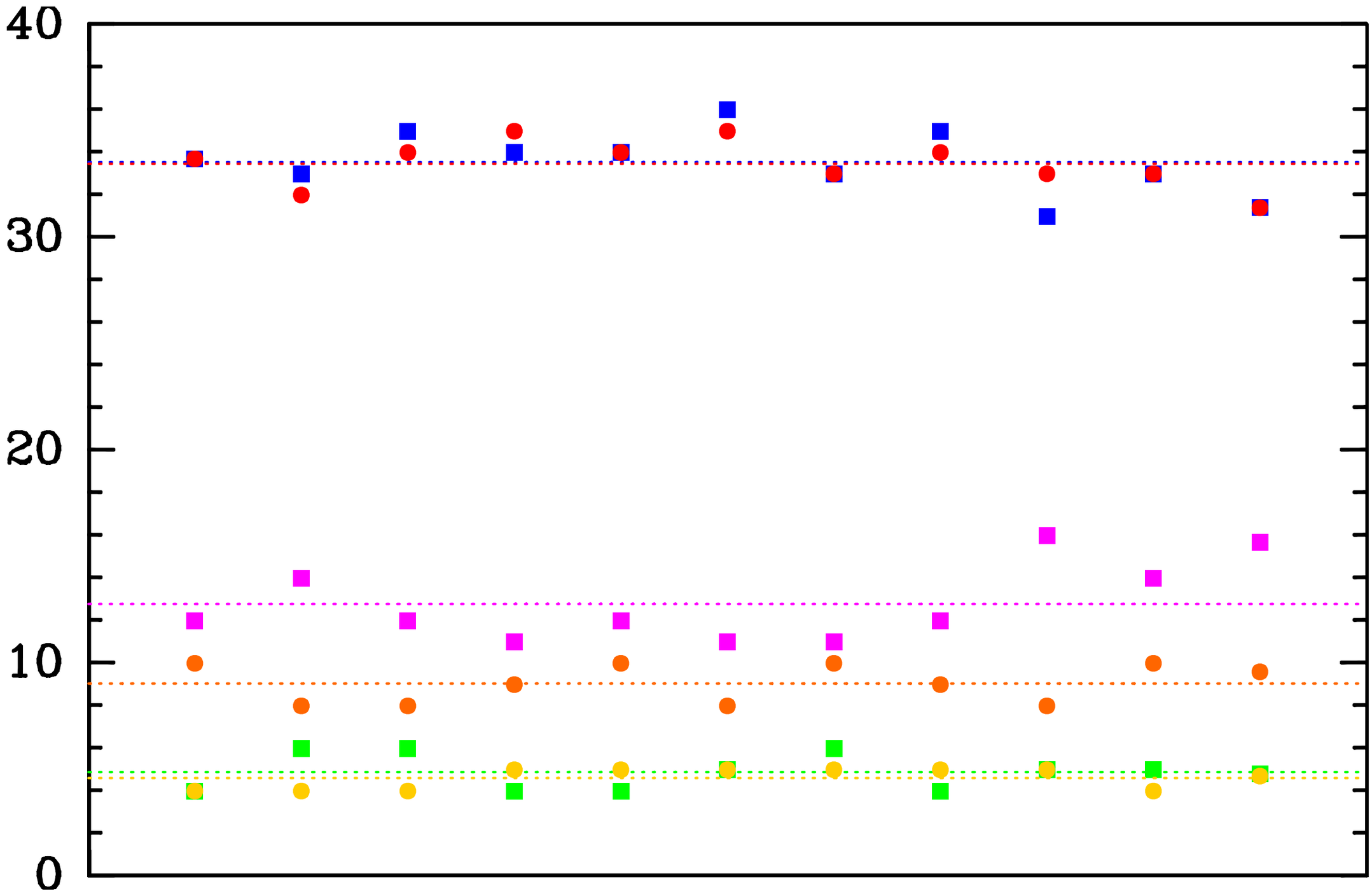

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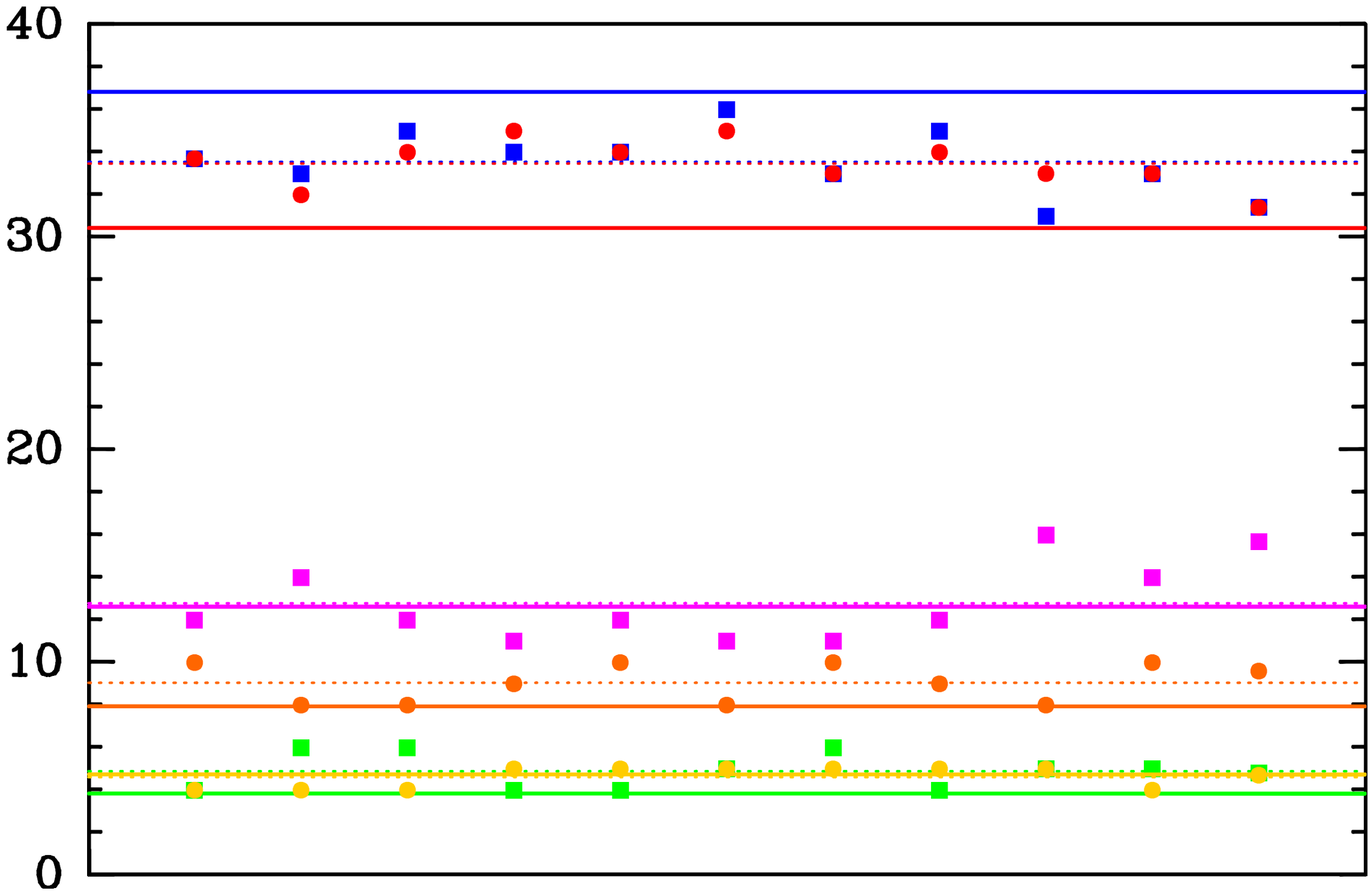

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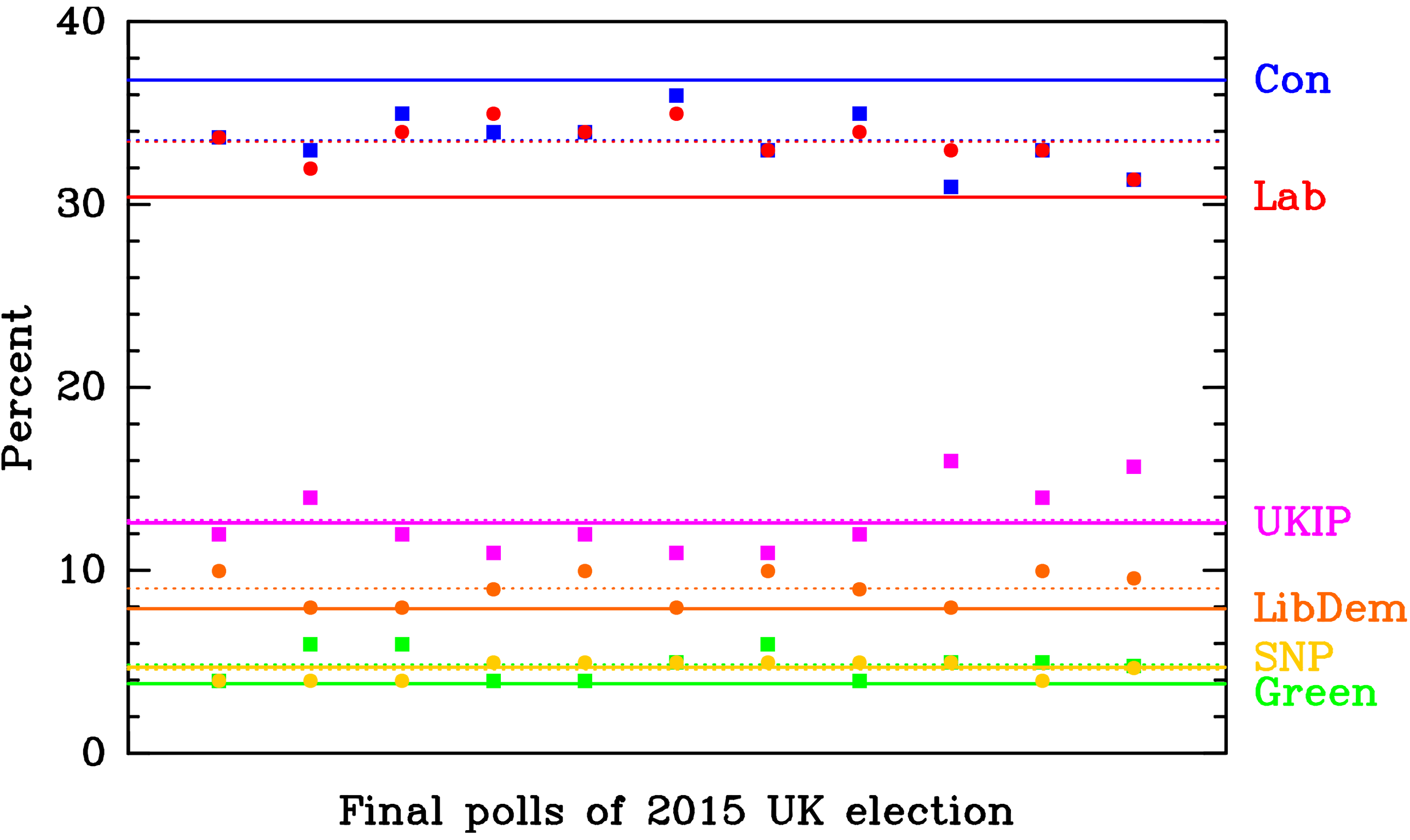

Systematic errors

Insidious!

Often neglected entirely

Treating systematic errors as random errors leads to high confidence in an erroneous result

Interpretation of data and comparison with models/simulations should take into account (possibly unknown) systematic errors

Haystack Observatory Postprocessing System (HOPS)

<u>What it is</u>

Specialized toolkit for mm VLBI processing

Highly flexible fringe finding with diagnostic plots

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More on HOPS in the tutorial