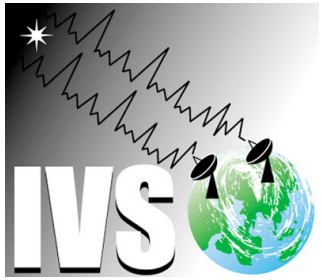

VLBI2010 imaging and structure corrections

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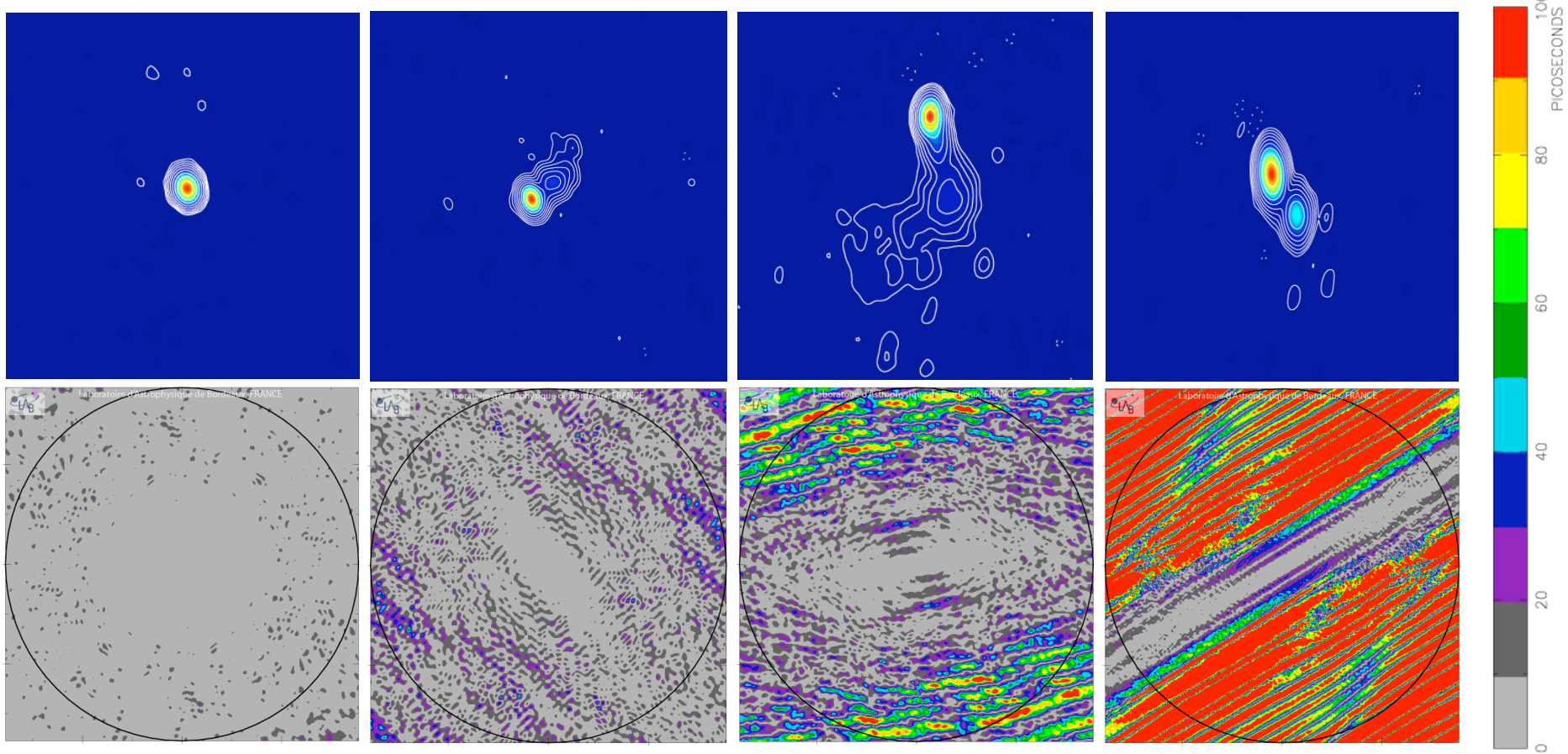
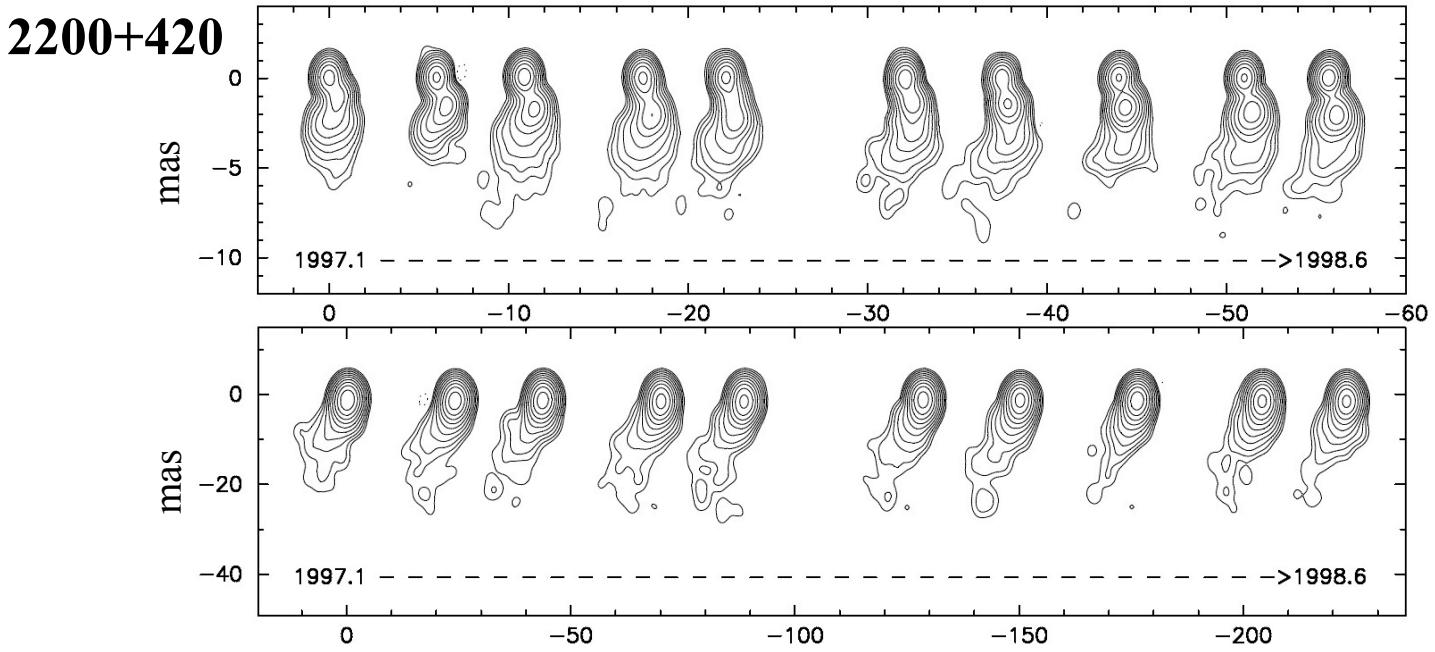
Source structure examples

- Most of the sources are not point-like
  ⟶ add a "structural delay" to the group delay

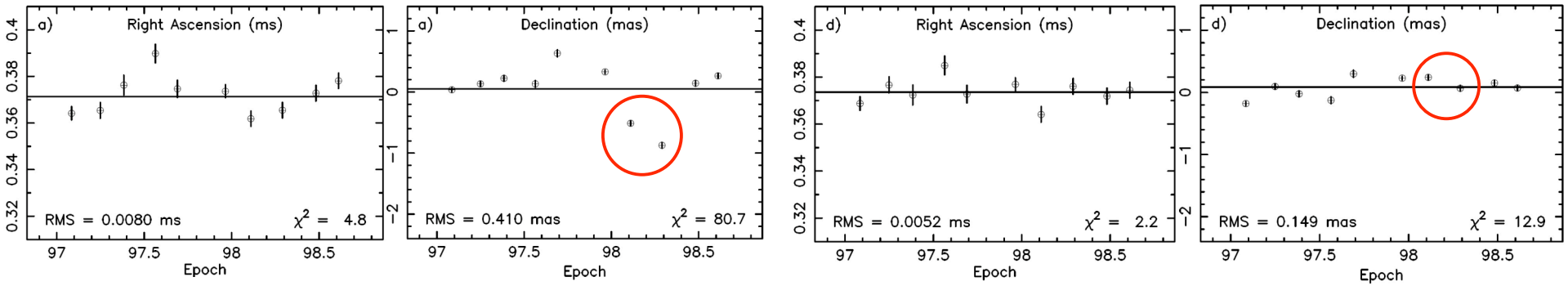


Images from the Bordeaux VLBI Image Database http://www.obs.u-bordeaux1.fr/BVID/

Source structure motion



Coordinates

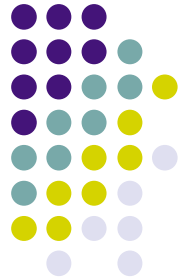


Structure not corrected

Structure corrected

[Charlot 2002]

Motivations



- Until now ⟶ selecting sources with minimal structure

  Ex: "Definition" sources of the ICRF2 (August 2009)

- With the VLBI2010 system ⟶ routinely determining and correcting for source structure

  What is needed ?

  - High quality images

    For VLBI2010, simulated images

  - Structure corrections based on these images

    First study with a traditional S/X frequency setup

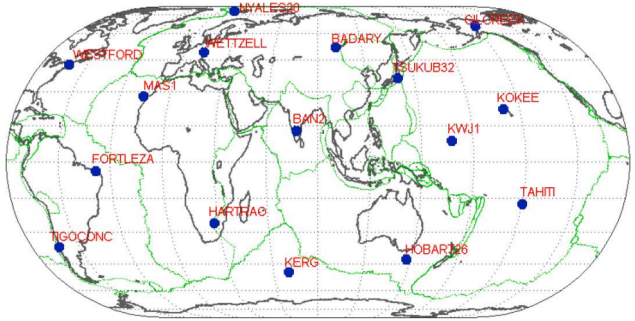
Imaging procedure

VLBI2010 schedule

Maximizing the number of observations or Uniform sky coverage

Network configuration

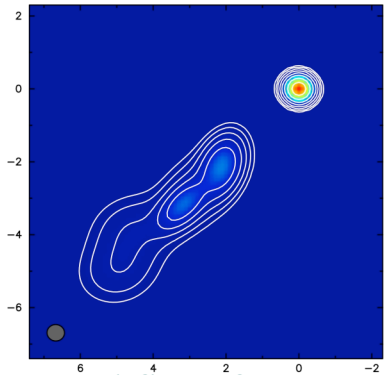
16 or 32 stations



Frequency setup

X-band setup with a total bandwidth of 1 GHz

Theoretical source model



Total flux of 25 mJy

First contour level at 0.5% of the peak brightness

UV data SIMULATION → Automatic IMAGING → **Image** → Structure corrections

Random noise

SNR=20

Additive noise 2% of the total flux

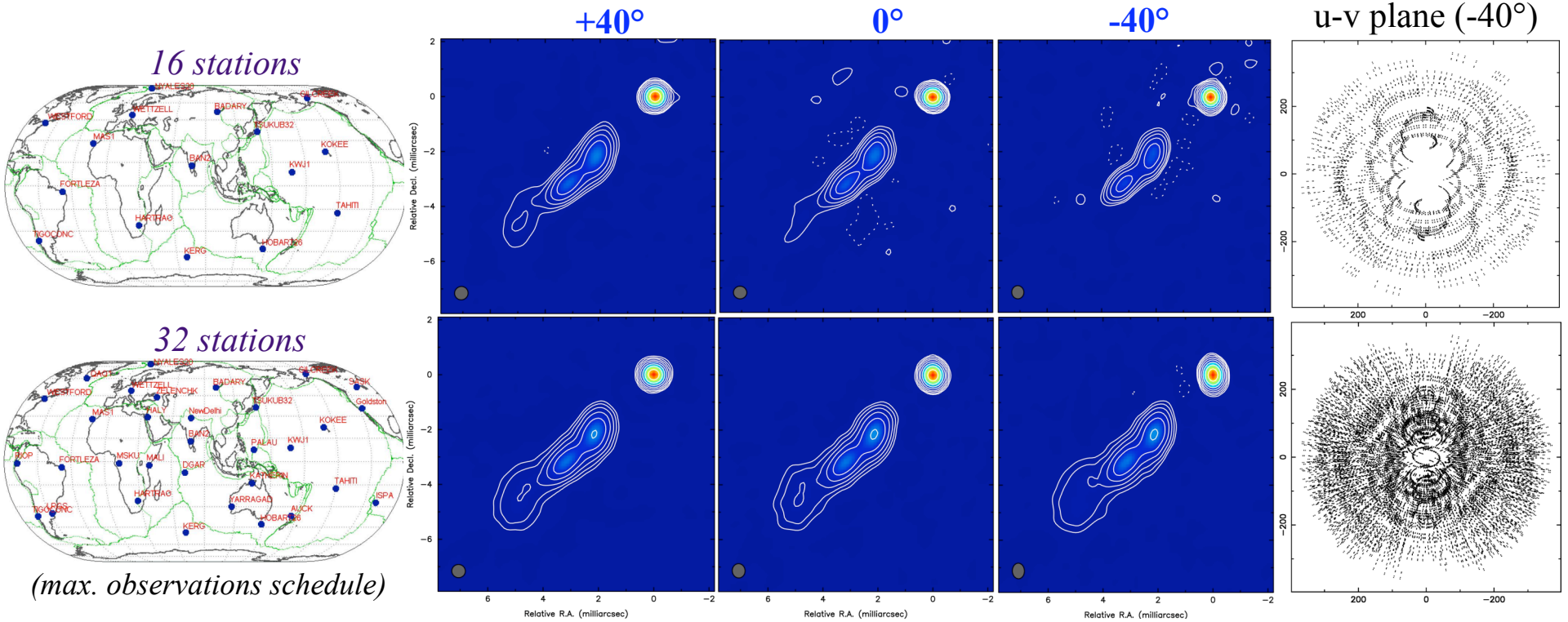
Amplitude multiplicative noise of 5% of expected visibility and phase noise of 3°

+ Calibration errors up to 6%

Monte-Carlo simulations

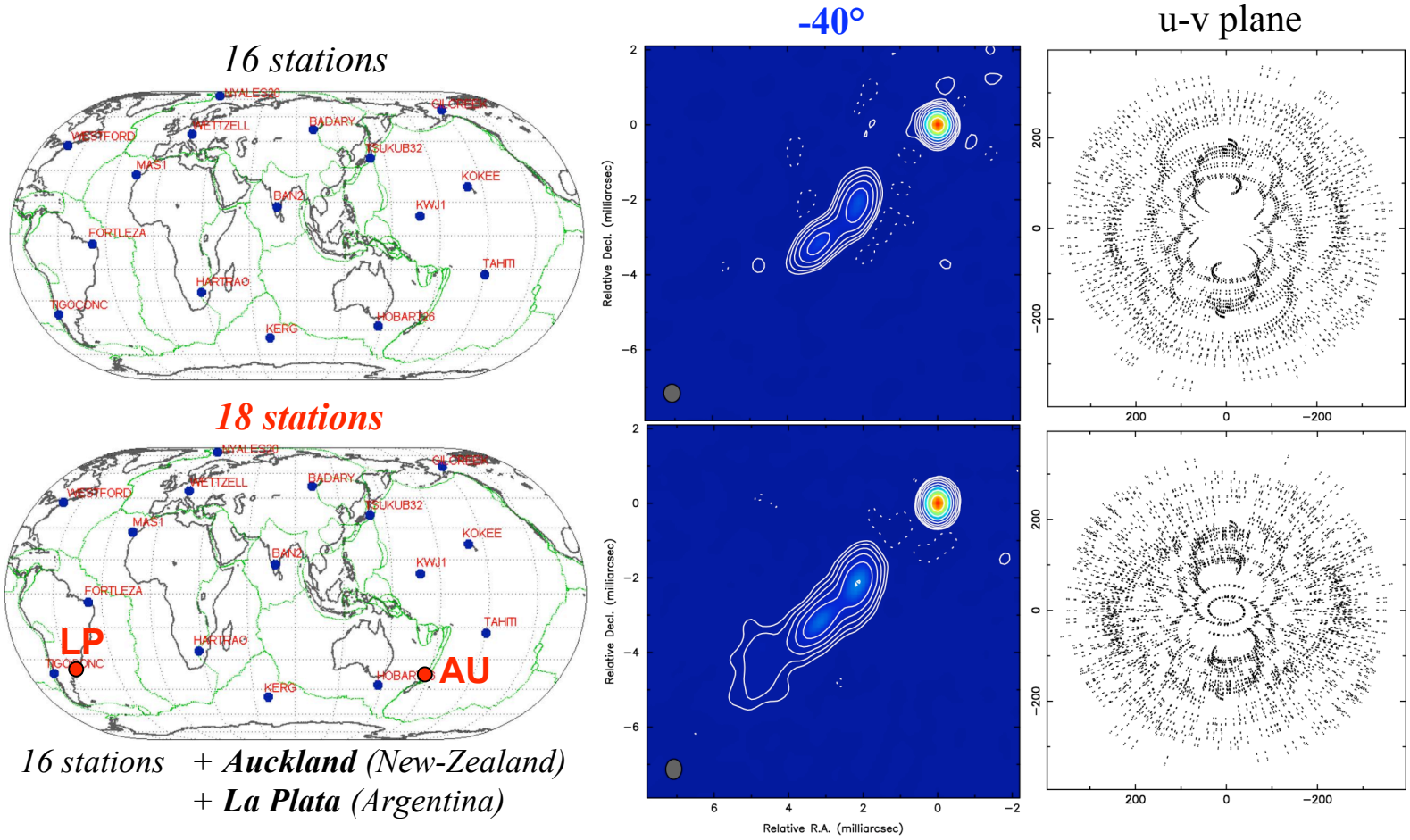
→ *Statistics about images and structure corrections*

Resulting simulated images



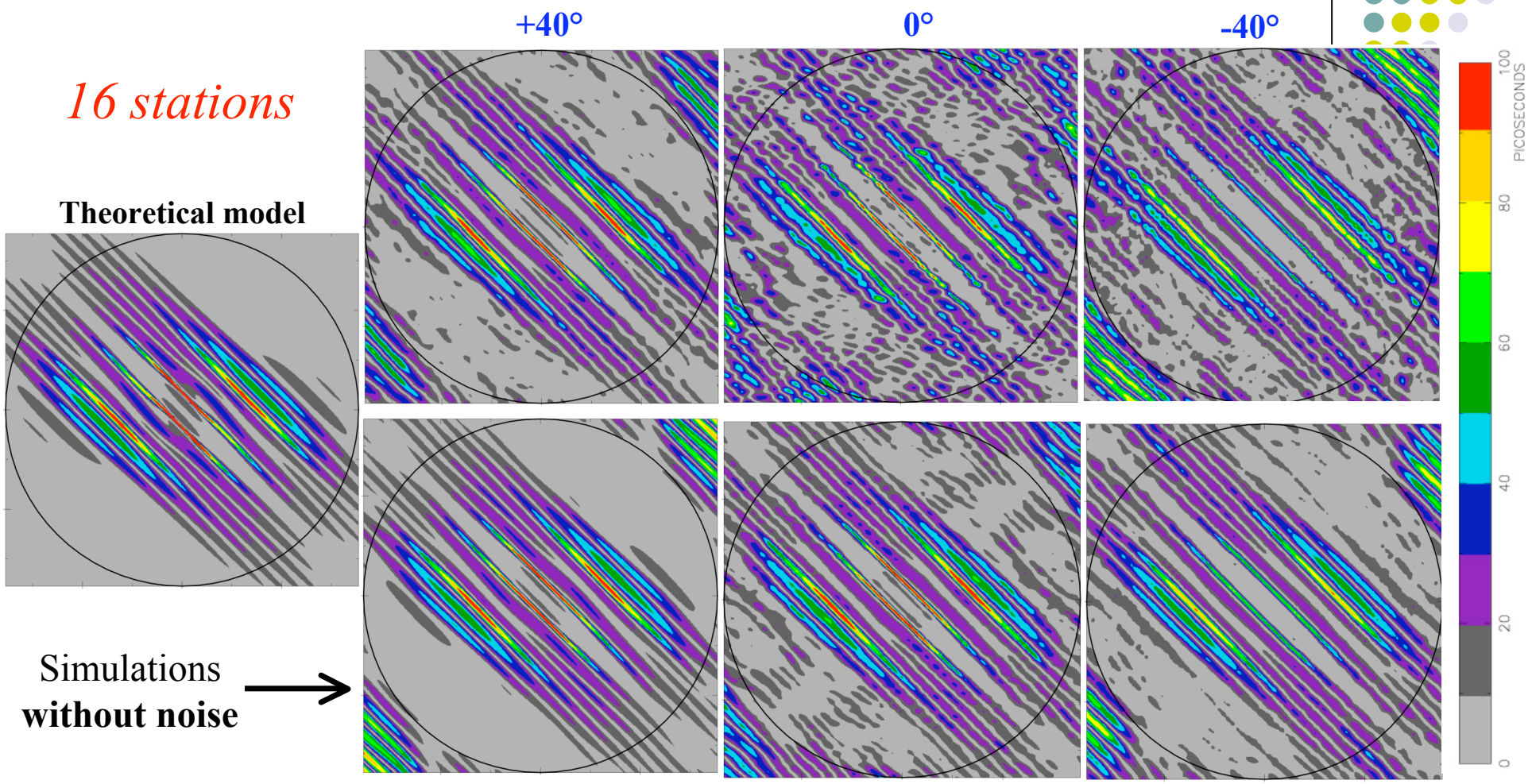
- VLBI2010 schedules & networks will achieve a better u-v coverage than current geodetic sessions
- Images with a good dynamic range *(from 1:200 to 1:1000)*
- With 16 stations, problem of reconstruction of extended structure for sources at low declination due to the lack of short baselines

18-station network



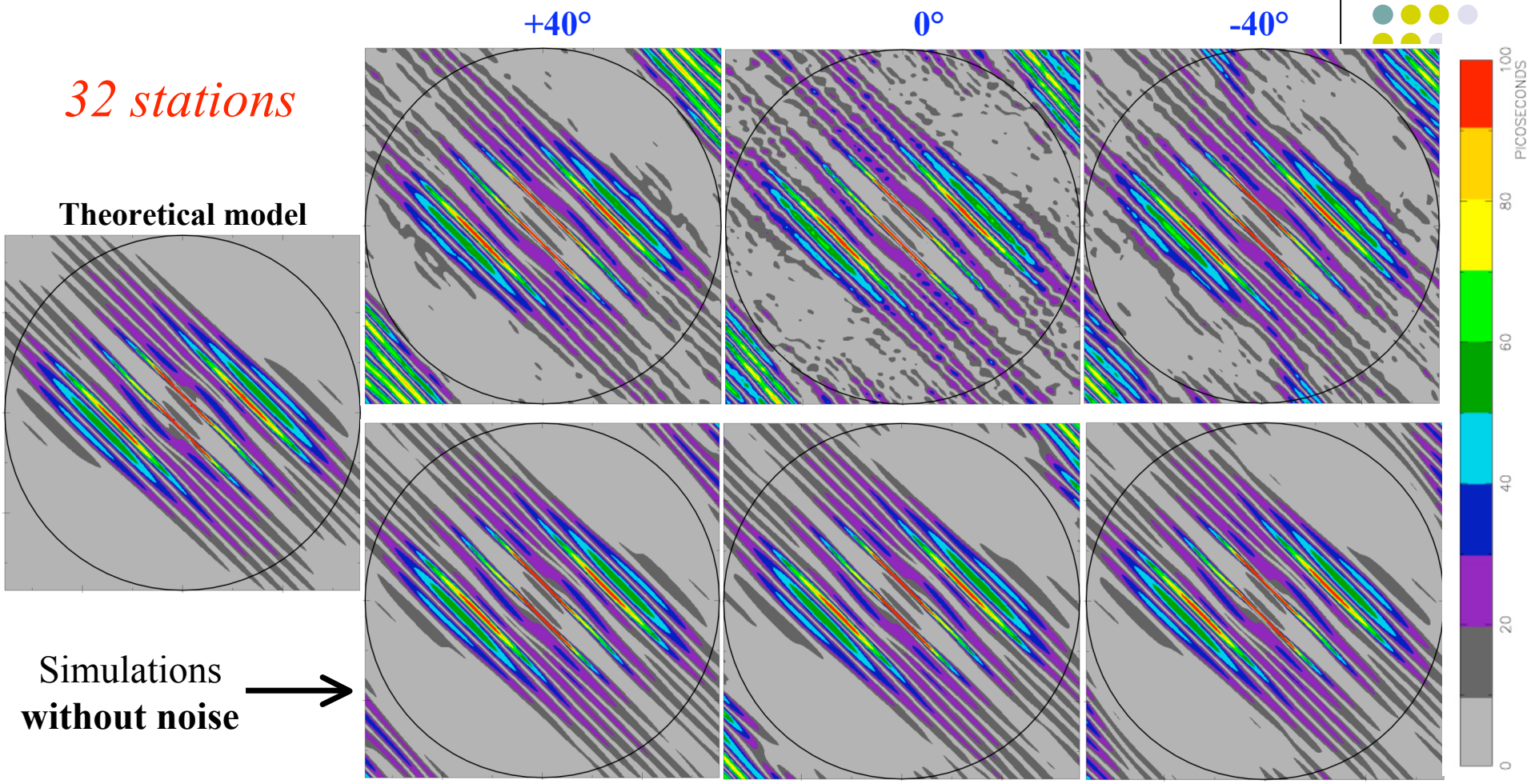
- With 18 stations, this problem of reconstruction of extended structure for sources at low declination is mitigated

Structure corrections: 16 stations



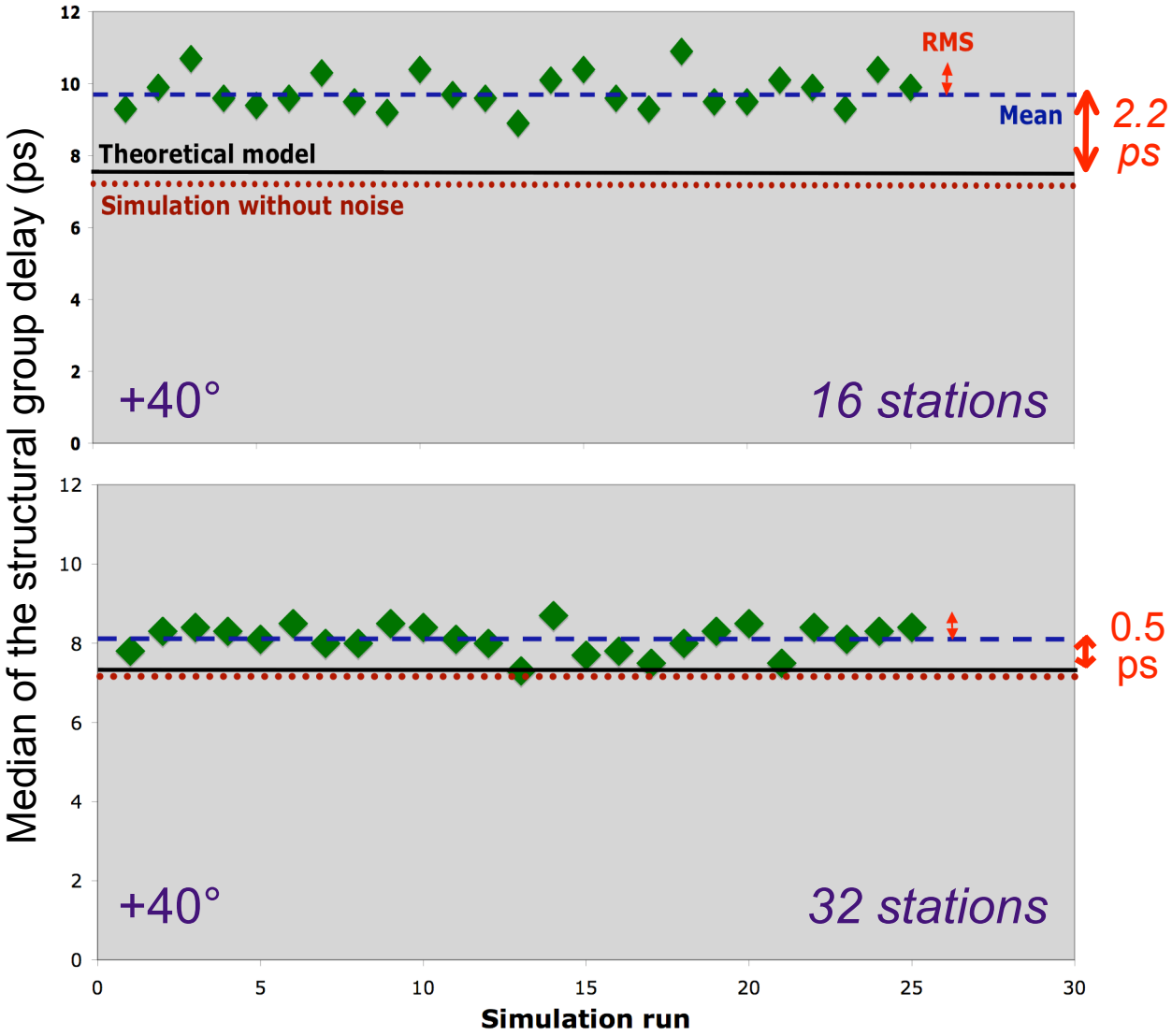
- **25** simulations + **1** simulation without noise for each declination
- Not fully recovered structure → less accurate structure corrections

Structure corrections: 32 stations



- Less noise in structure corrections
  Visually closer to the theoretical model corrections

Simulation set examples



- RMS
  → Impact of noise

- Difference between the Mean and the Theoretical model
  → Systematic error due to imperfect u-v coverage

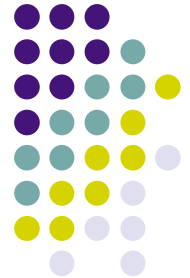
Statistics summary

(Statistics in picoseconds)		- 40°	0°	+ 40°
16 stations	Median diff.	4.2	6.0	2.2
	RMS	0.404	0.792	0.493
32 stations	Median diff.	1.9	2.1	0.5
	RMS	0.447	0.399	0.352

- For the most favorable case (source at +40°)
  Statistically very close to the theoretical model (to less than 1 ps)

- As for imaging, 32 stations is better than 16 stations

Conclusion and prospects



- Group delay should be corrected from structural effects since its part in the VLBI2010 error budget will be significant
  - VLBI2010 will produce high-quality images
  - Structure corrections (in traditional X/S mode) statistically close to the theoretical model
  - 32-station network is recommended
- Next steps ?
  - Compare individual corrections of u-v points actually observed
  - Studies for the "broadband delay system"

    Some problems need to be solved…
    - Change of source structure with frequency
    - Position dependency with frequency ("Core-shift")


Thank you !