Atomic hydrogen at z>5

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Project goal (*originating from VLBI studies*)

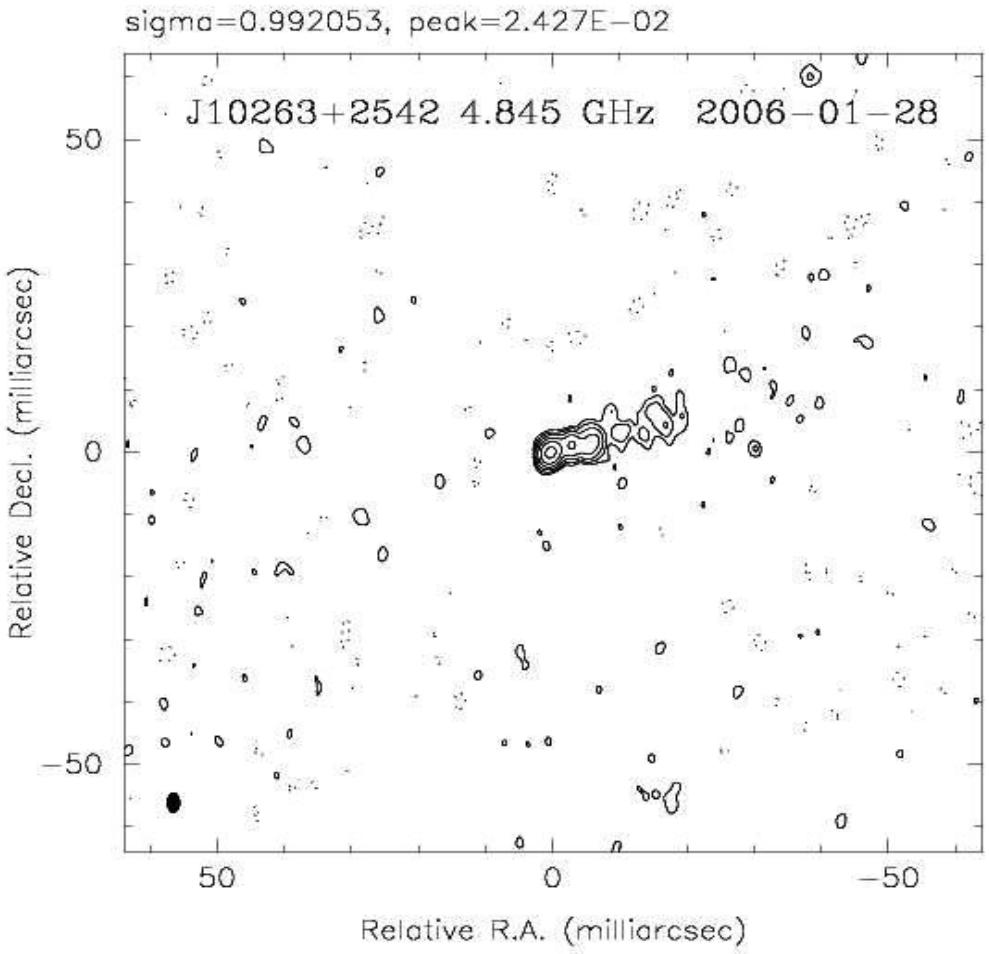
- Detection of HI absorption close to z_{em} = 5.28 toward J1026+2542

Source No.	Source name	z	$S_{1.4}$	$\alpha_{L\text{-}C}$	f_{HI}	S_{HBA}
			mJy		MHz	mJy
1	J0836+0054	5,77	1,11	-0,80	209,80945	5,1
2	J0906+6930	5,47	93,40	0,00	219,53787	93,0
3	J1026+2542	5,28	230,00	-0.41	226,03596	500,0
4	J1427+3312	6,12	1,70	-0,60	199,49579	5,5
5	J1429+5447	6,21	2,95	-1,00	197,00555	21,3
6	J2228+0110	5,95	0,31	no data	204,37554	-

- Must HI be there? If so, powerful diagnostic instrument for
  - *Formation of inner structures in host galaxies at 10-1000 pc*
  - *Inner edge of EoR?*
  - *Cosmological evolution of the fine structure constant, α*
- Not the best chance in the z>5 sample (others more likely CSS)
  - *too a flat spectrum*
- Opportunistic approach

J1026+2542: a typical core-jet (sadly…)

VIPS VLBA, 5 GHz, Helmboldt et ql. 2007



- Does not appear to be CSO/CSS
  - *Not too confined by medium?*
- But prominent jet – pol-on geometry
  - *Favourable for large HI depth?*
- HI optical depth of 0.01– 0.05

S_{abs} ~ 5 –25 mJy for 500 mJy source

S_{230} ~ 500 mJy, interpolation from Waldram et al., 1996

Observation setup

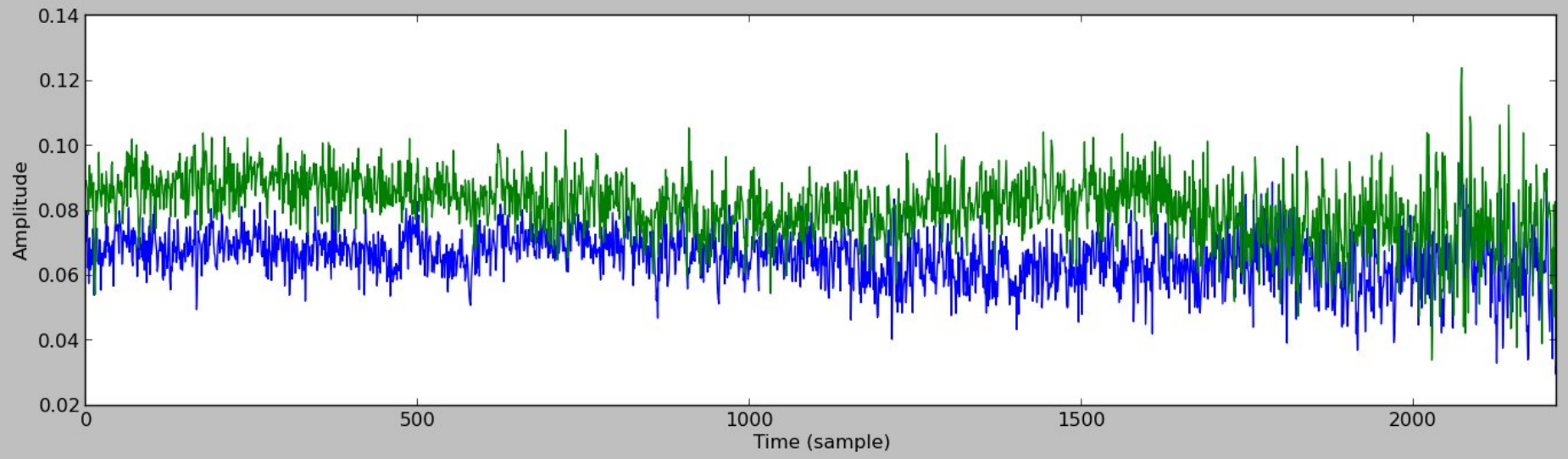
- Two sessions, ~4 hrs of usable data each *(of 13 hrs requested)*
  - *8 April and 26 June 2013 (some "night time")*
  - *Additional ~0.5 hrs on 3C196 for test RFI mitigation*
- Calibrator: 3C241 (instead of 3C196 proposed) – sky position advantage (closer to target)
- Dutch LOFAR stations only
- HBA, expected absorption at 226 MHz (*210 – 250 MHz requested*)
  - *Continuum imaging as well*
  - *Deepest LOFAR observation at these frequencies so far?*
- Dual beam (calibrator & target)
  - *100 sub-bands on target, 100 sub-bands on calibrator*
  - *64 spectral channels per sub-band, 3 kHz resolution*
- "Zero-order" flagging (*by Observatory/Carmen*)
  - *RFI not as bad as feared*

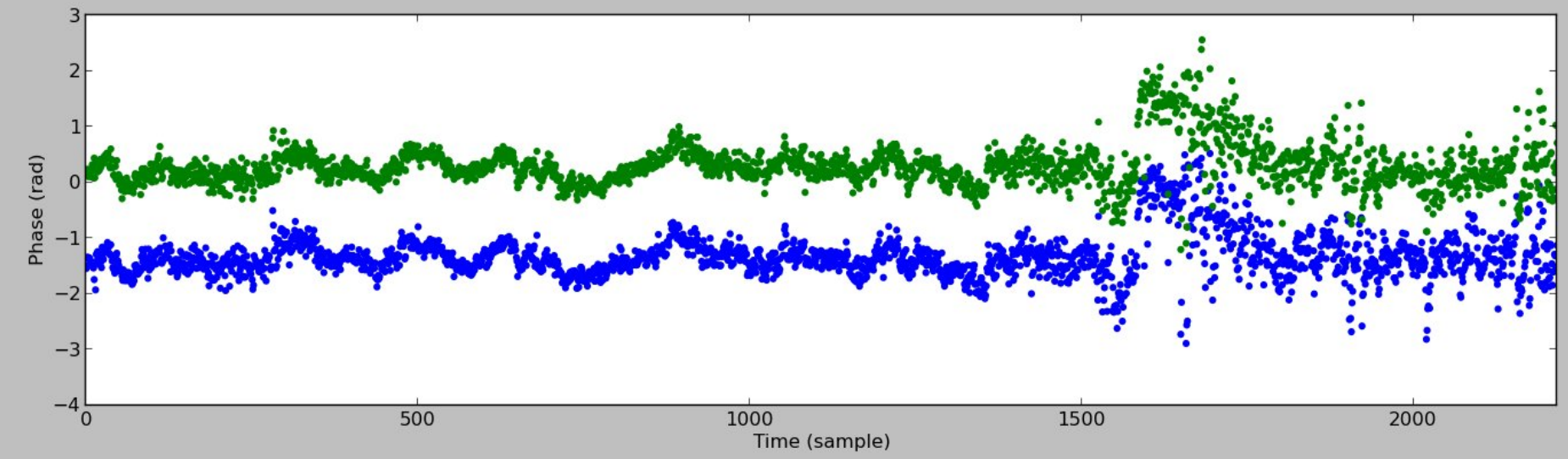
Data processing (so far)

- Averaging over 10 s
- Second round of flagging
- BBC calibration (on 3C241)
- Model-fitting the calibrator (from point-source model)
  - *Noisy calibration tables (instrumental effects only, "no RFI any more")*
  - *"Smoothing" filter; solutions – back to un-averaged data*
- Continuum imaging of both calibrator and target
- Noise:
  - *~ twice of expected for 3C241*
  - *close to expected for target*

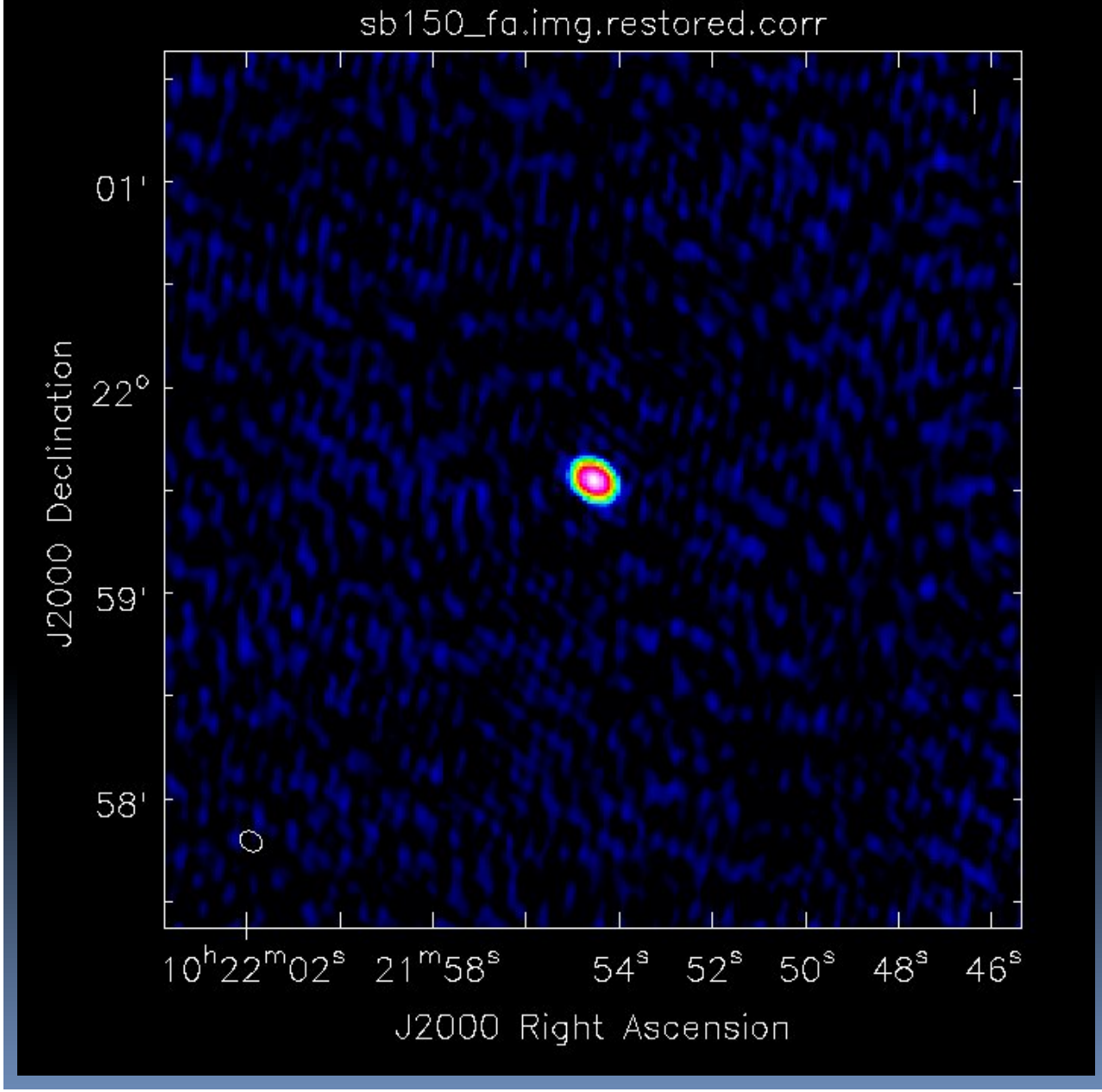
- *Efforts to continue…*

The data: superterp, CS2-CS3, central SB





3C241 @ 226 MHz (*continuum*)



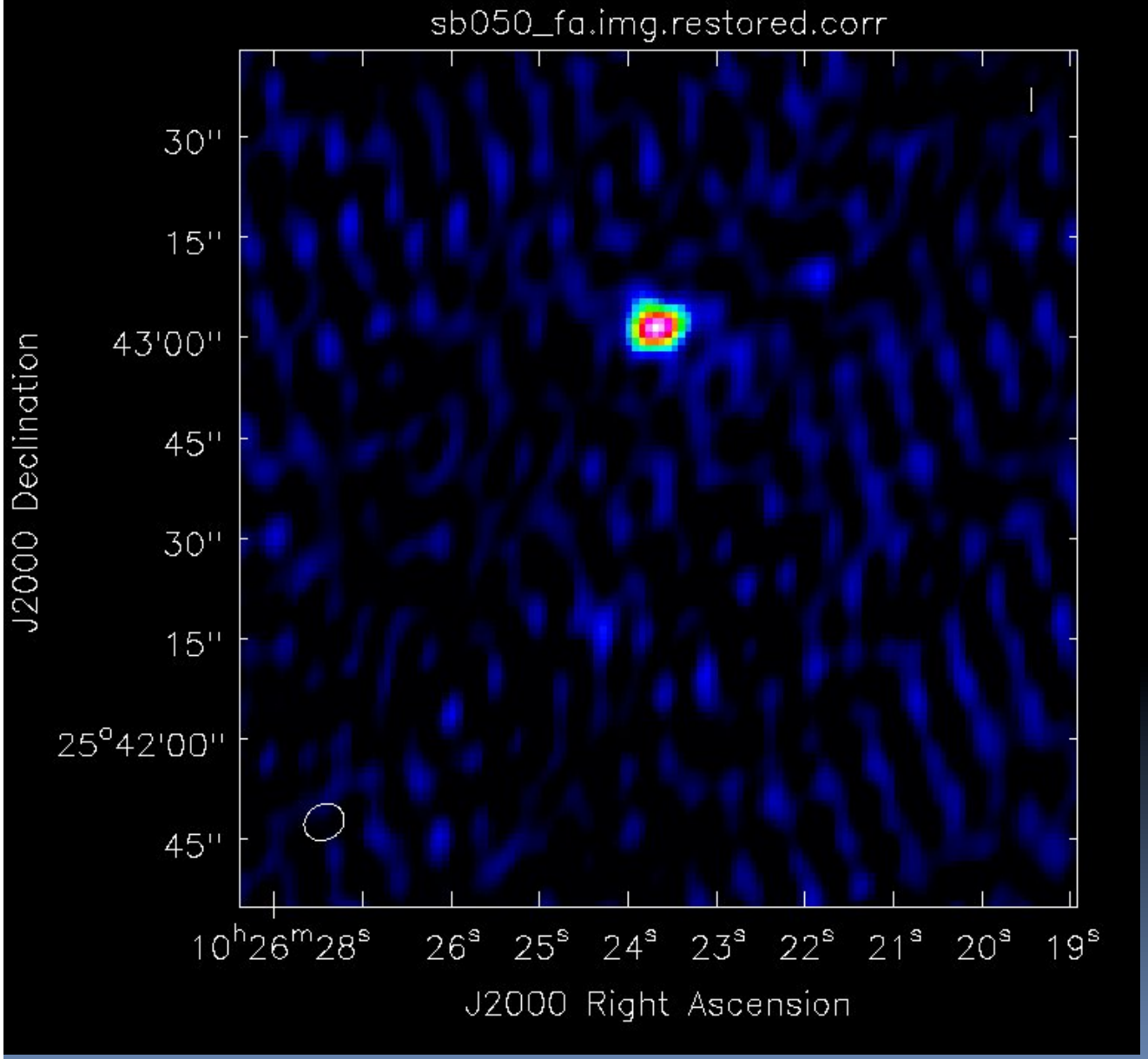
Single sub-band

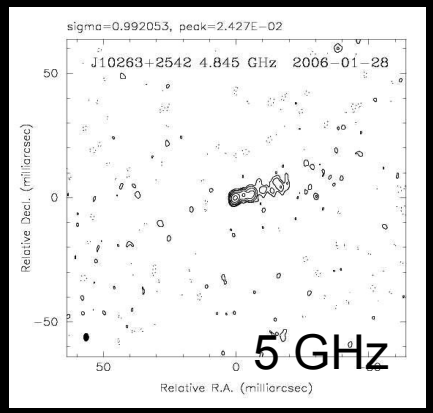
Beam: ~6 arcsec

Peak: ~7.2 Jy/beam

σ = 14 mJy/beam
(*but no smoothing?*)

J1026+2542 @ 226 MHz, continuum





Single sub-band

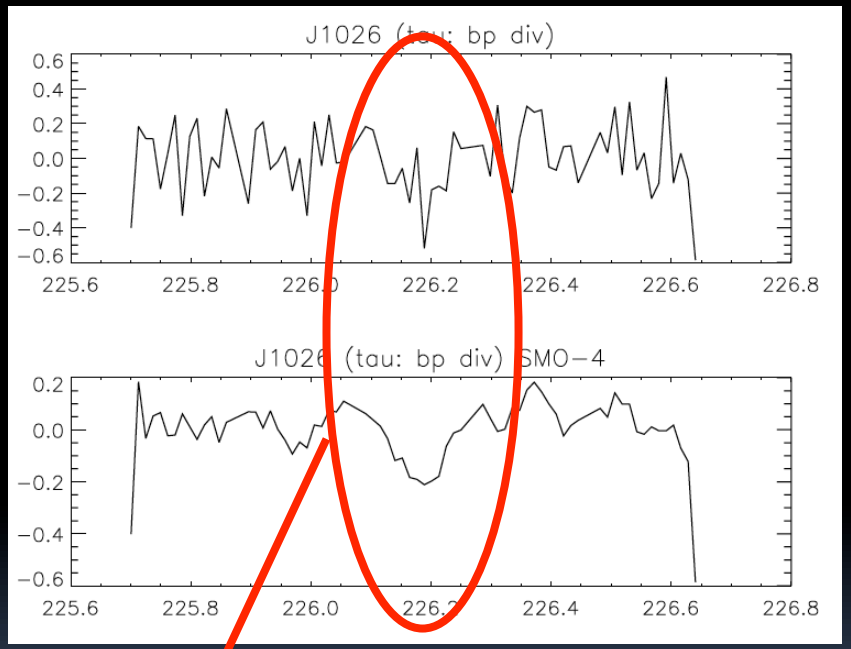
Beam: ~6 arcsec

Peak: ~0.2 Jy/beam
Total: ~0.3 Jy

σ = 7 mJy/beam

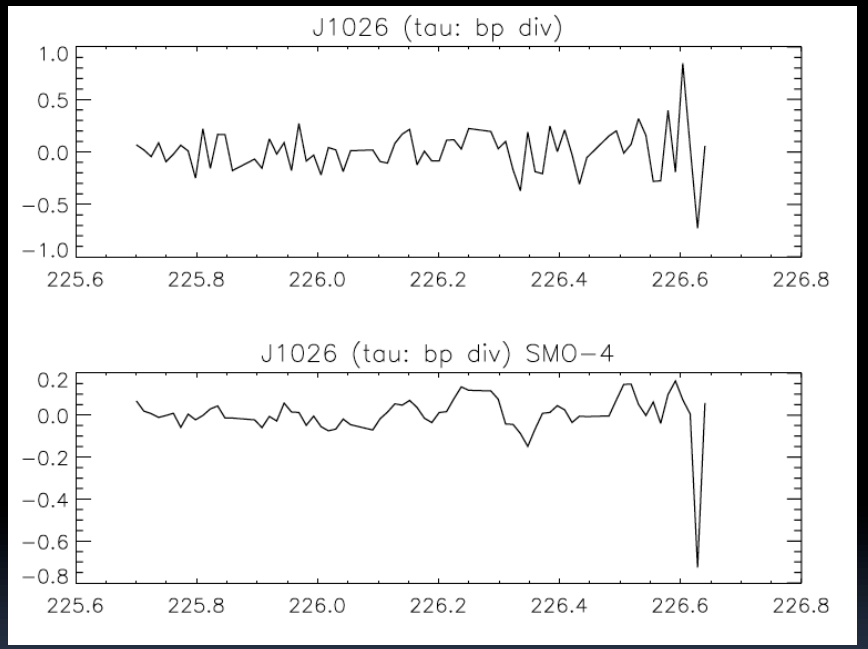
J1026+2542 spectra, ~ 4 hrs integration each

08.04.2013



2.5 *sigma* hint?

26.06.2013



Conclusions & way forward

- Main goal: so far – inconclusive
  - *But total integration so far ~70% of requested*
  - *Difference in spectra of April and June?*
    - *…but target's total flux density is 50% of expected (interpolated)*
- Continuum imaging – can be pushed further
- Additional ~4-5 hours to complete/verify?