Effelsberg's UBB and LOFAR

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Max-Planck-Institut für Radioastronomie

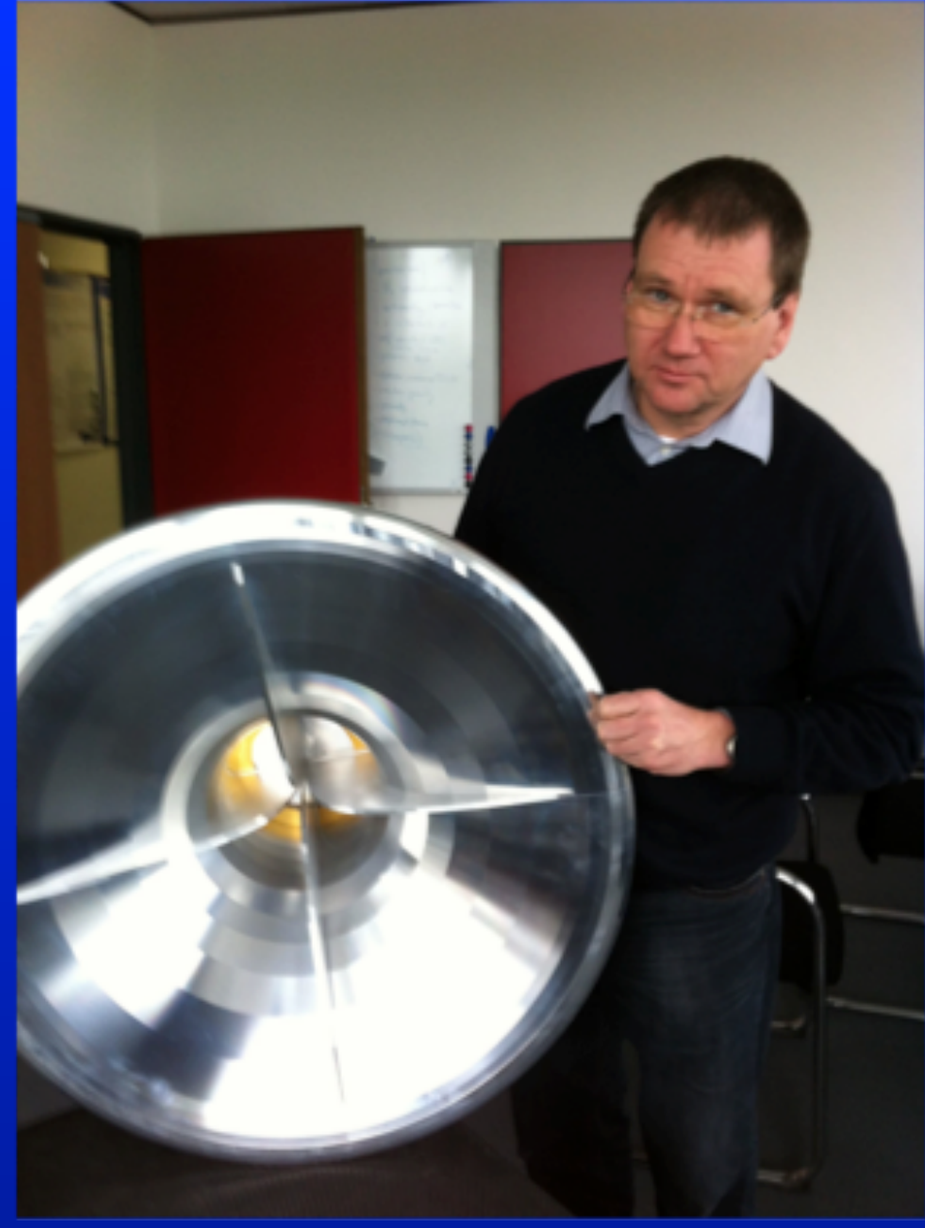
and P. Freire, R. Karuppusamy, MPIfR receiver group
and J. Hessels, B. Stappers and LOFAR pulsar working group

IPTA Meeting, Kiama, 29 June 2012

Contents

- Short Status Update on the Ultra-BroadBand Receiver and Backend (mostly “pretty” pictures)
- Update on LOFAR Timing
  - What is LOFAR
  - MSP observations with LOFAR
  - MSP timing with LOFAR

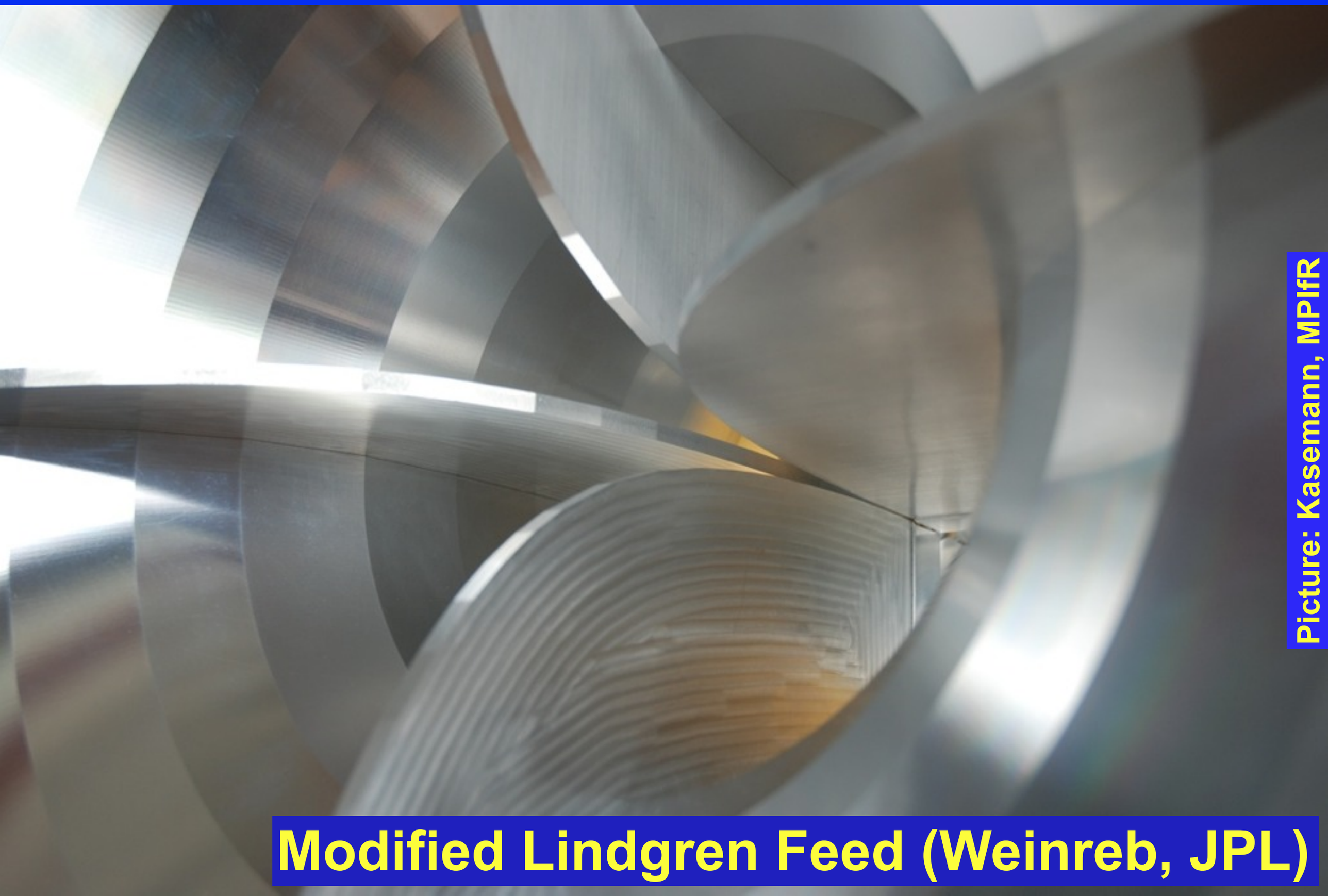
UBB Status



- **Frontend:**
  - **All components finished**
  - **Assembly complete**
  - **On telescope by July 2012 (!!)**
  - **T_{sys} < 49 K (includes sky temperature)**
  - **Most sensitive receiver ever (?!)**

Picture: Michael Kramer

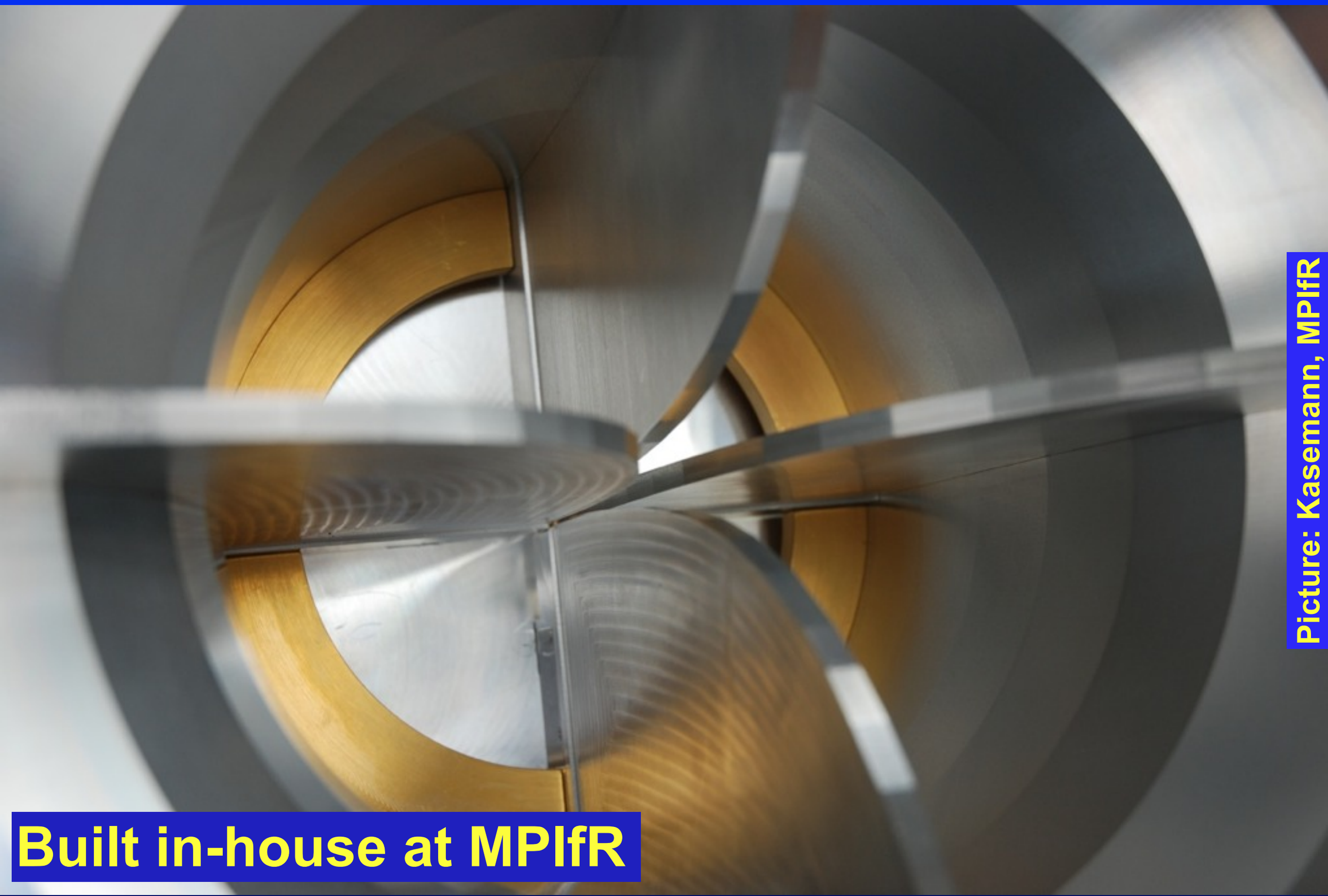
Introducing the UBB



Picture: Kasemann, MPIfR

Modified Lindgren Feed (Weinreb, JPL)

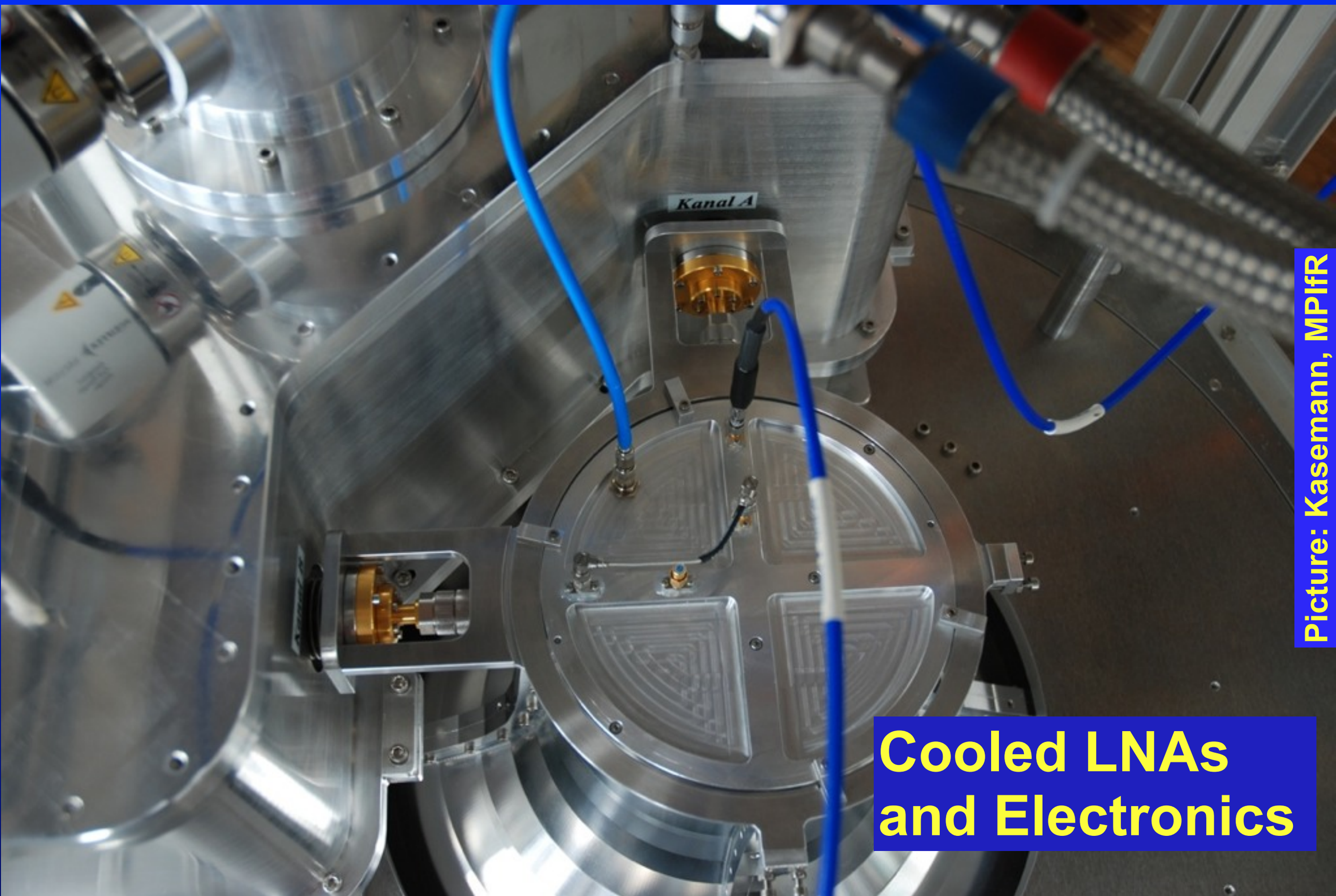
Introducing the UBB



Picture: Kasemann, MPIfR

Built in-house at MPIfR

Introducing the UBB



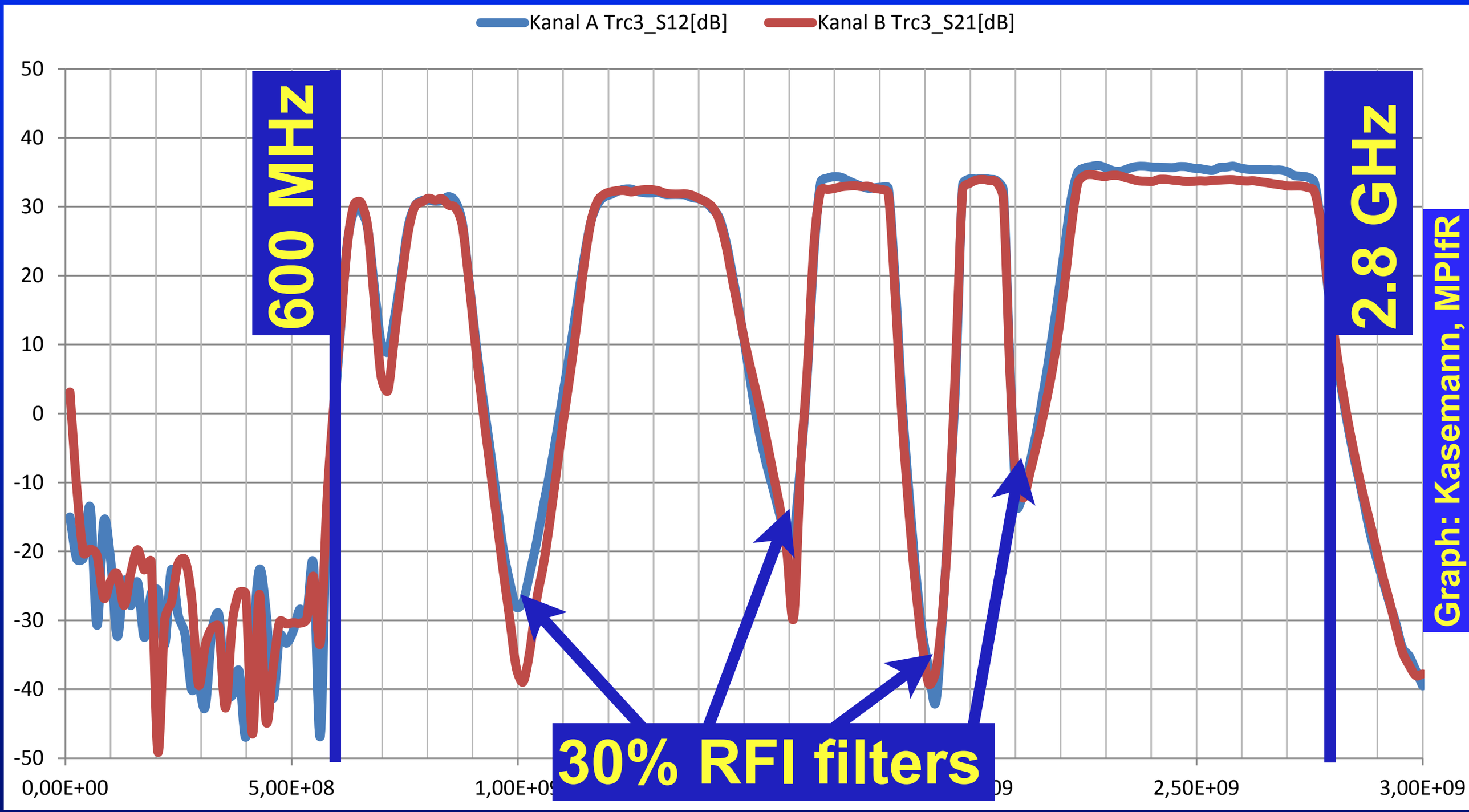
Picture: Kasemann, MPIfR

Cooled LNAs and Electronics

Pictures: Kasemann, MPIfR

Funded by €1.9M ERC grant to Paulo Freire

Introducing the UBB



UBB Status

Version: 1
Datum: 21. Jun. 2012
Zeiterfassung

Beobachtungsplan A
MPIfR 100-m-RT
3. Jul. 2012 bis 16. Jul. 2012

DATUM		---- MESZ ---- 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	Frontend	Back-end
DI	3.7.	Test 9cm • **SFK** >---------- 95-11 * ----------> W >--- Europe 118 = 02-12 ----	P90, S36, SX	A,B,E
MI	4.7.	---------- Europe 118 = 02-12 ----------> Test RDBE Pointing	SX, S36, S28	E
DO	5.7.	Pointing • >---------- 95-11 * ----------> W **P170** >---------- Test UBB ----------	S28, S36, P170	A
FR	6.7.	---------- Test UBB ----------> W **P210-7** >---------- 18-12 (Timing 21cm) ----------	P170, P210-7	A,C
SA	7.7.	---------- 18-12 (Timing 21cm) ----------> **SFK** >---------- BM352 = 130-10 ----------> >--------- 18-12 (Timing 11cm) ---------	P210-7, S36, S110	C,E
SO	8.7.	---------- 18-12 (Timing 11cm) ----------> **P210-7** >---------- 92-11 ----------	S110, P210-7	C
MO	9.7.	---------- 92-11 ----------> >---- BM359c1 = 70-11 ----	P210-7, S20	C,E
DI	10.7.	------ BM359c1 = 70-11 -----> >- Test, Poi., Kal. -> W >------- BM359a2 = 70-11 -------	S20	E
MI	11.7.	------ BM359a2 = 70-11 -----> >- Test, Poi., Kal. -> W • >---------- 27-12 * ----------	S20, S60	E,A,B
DO	12.7.	---------- 27-12 ----------> W • >---------- 27-12 * ----------	S60	B
FR	13.7.	---------- 27-12 ----------> W • >---------- 94-11 * ----------> >------- BM359b1 = 70-11 -------	S60, S36, S20	B,A,E
SA	14.7.	---- BM359b1 = 70-11 ---> >---------- BS219 = 40-12 ---------- • ---> >---------- 94-11 * ----------> >- Test, Poi., Kal. -	S20, S60, S36	A,E
SO	15.7.	---> >---------- 95-11 * ----------> >---------- 94-11 * ----------> >- Test, Poi., Kal. -	S36	A
MO	16.7.	---> >---------- 95-11 * ----------> W **P90** >---------- 90-11 ----------	S36, P90	A,B
UT		22 23 24 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22		
LST		18:04 01:05 11:07 17:08		

14.-16.7.: Flexible scheduling: weather decision possible every 6 hours.

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95-11:	Giessübel, Beck et al.
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Europe 118 = 02-12:	Geo-VLBI (Nothnagel, Müskens et al.)
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BM359 = 70-11:	Mutel et al.
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Test Observations Starting Next Week!!

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BS219 = 40-12:	Salter et al.

UBB Status

- **Backend:**
  - **Temporarily:**
    - **an Asterix/Obelix clone**
    - **~1GHz bandwidth**
    - **ready pretty much *now***
  - **Final solution:**
    - **Uniboard-based**
    - **~ 2 GHz bandwidth**
    - **ready in winter 2013 (?!)**

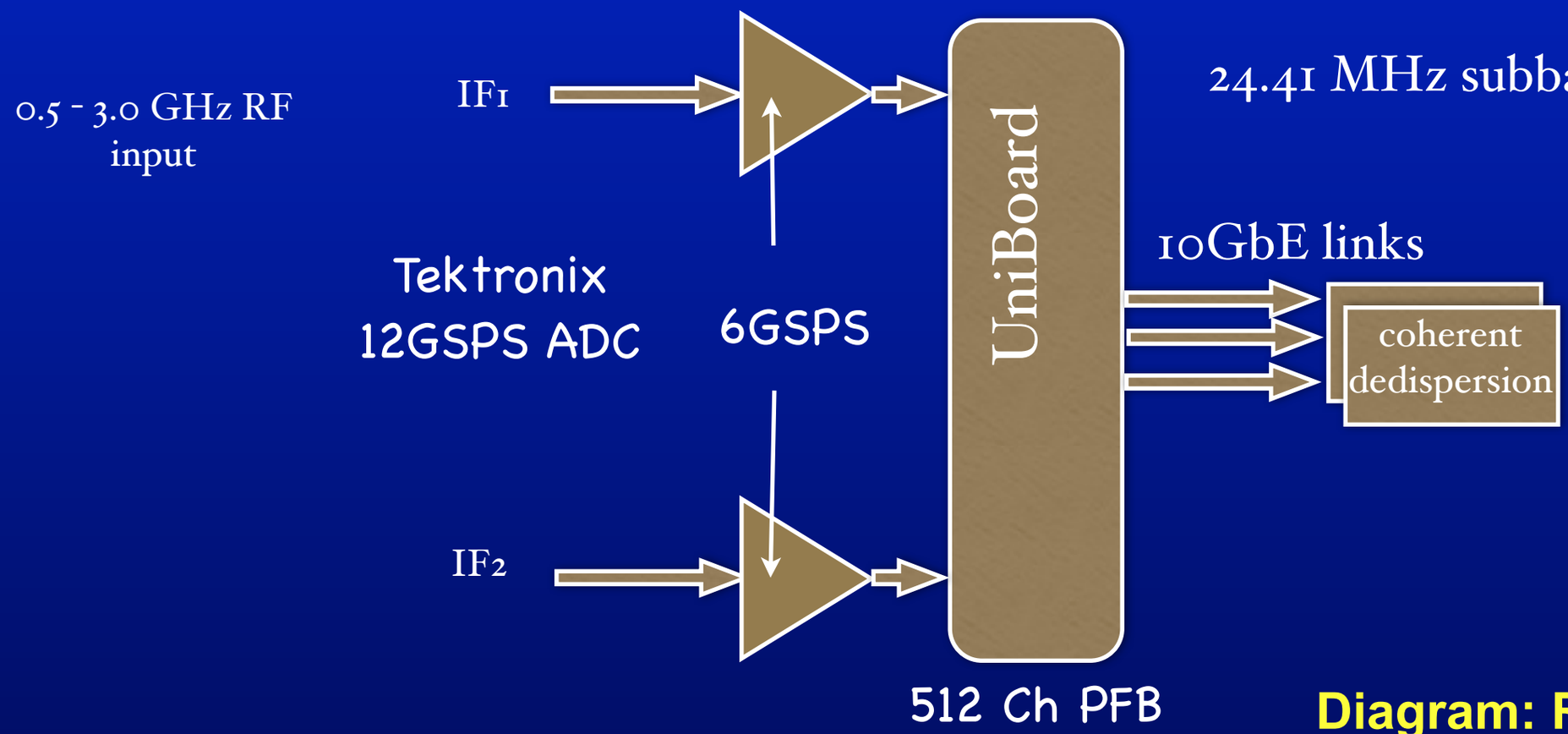
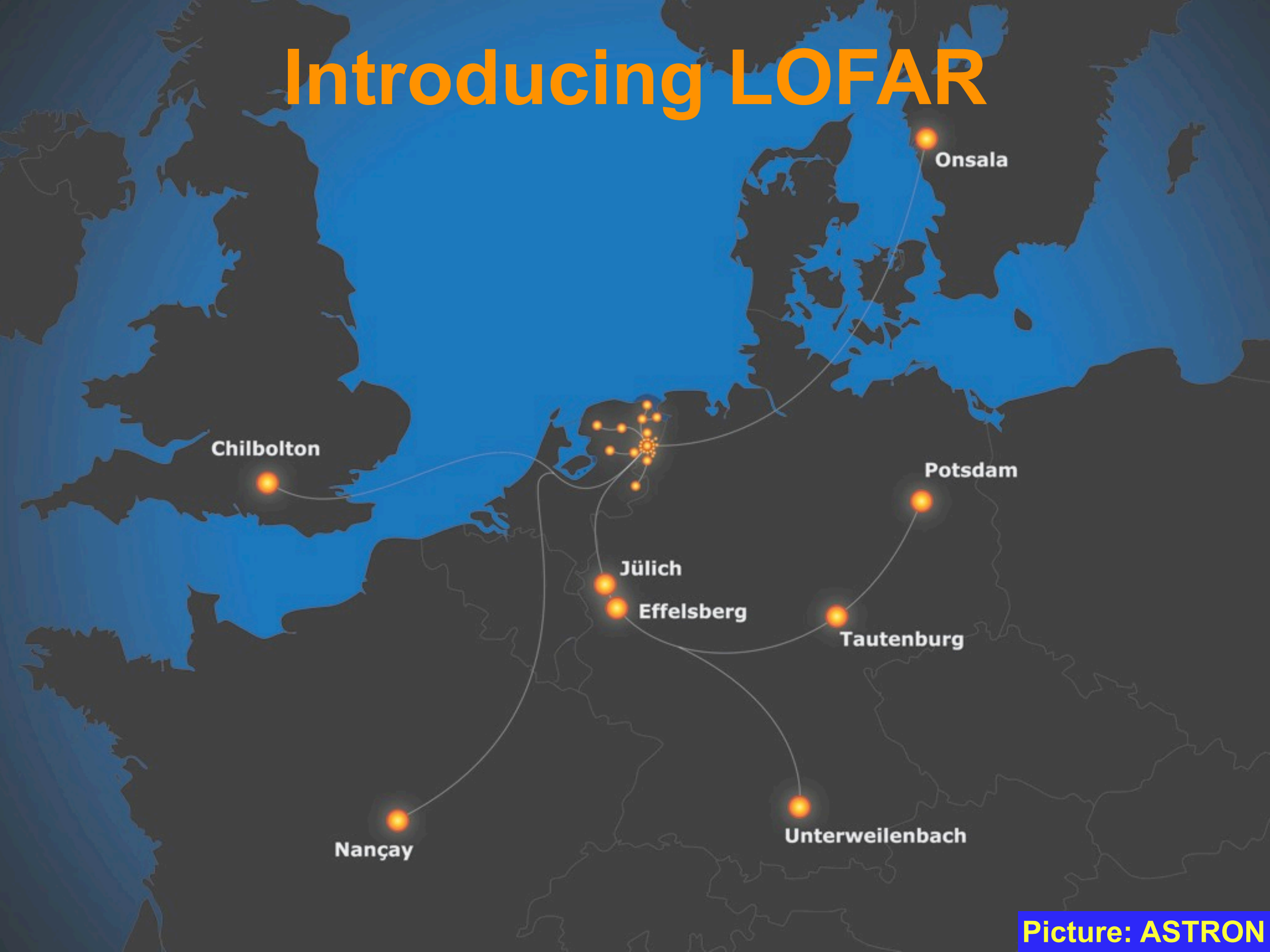


Diagram: Ramesh Karuppusamy

Introducing LOFAR



Picture: ASTRON

Introducing LOFAR

Picture: Anderson, MPIfR

Picture: ASTRON

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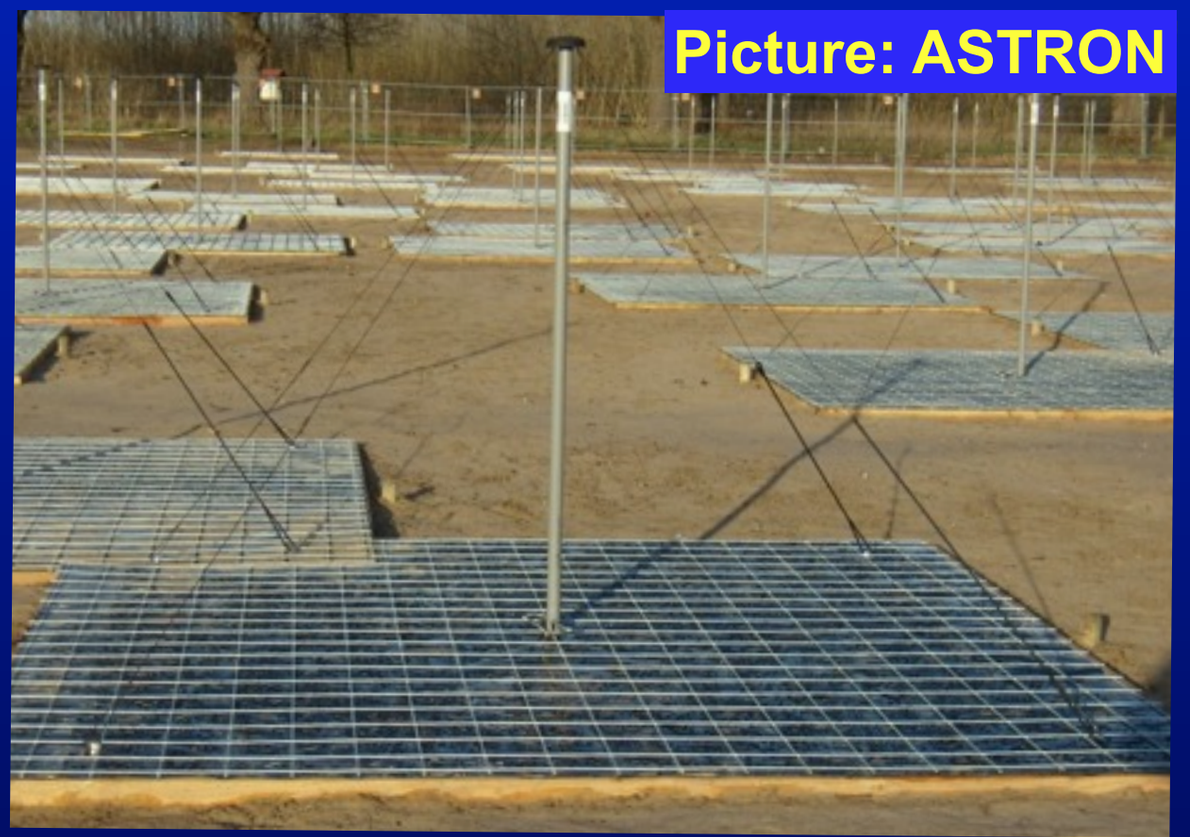

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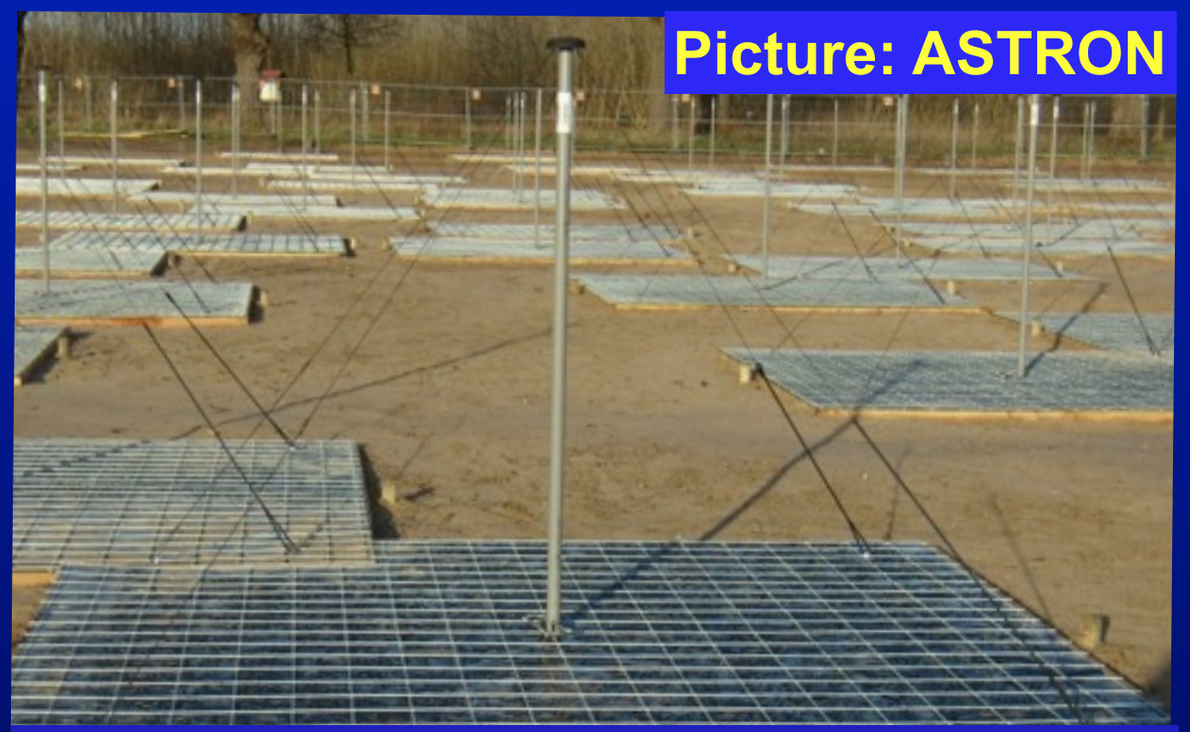


Picture: ASTRON

Low Band (10-90 MHz)

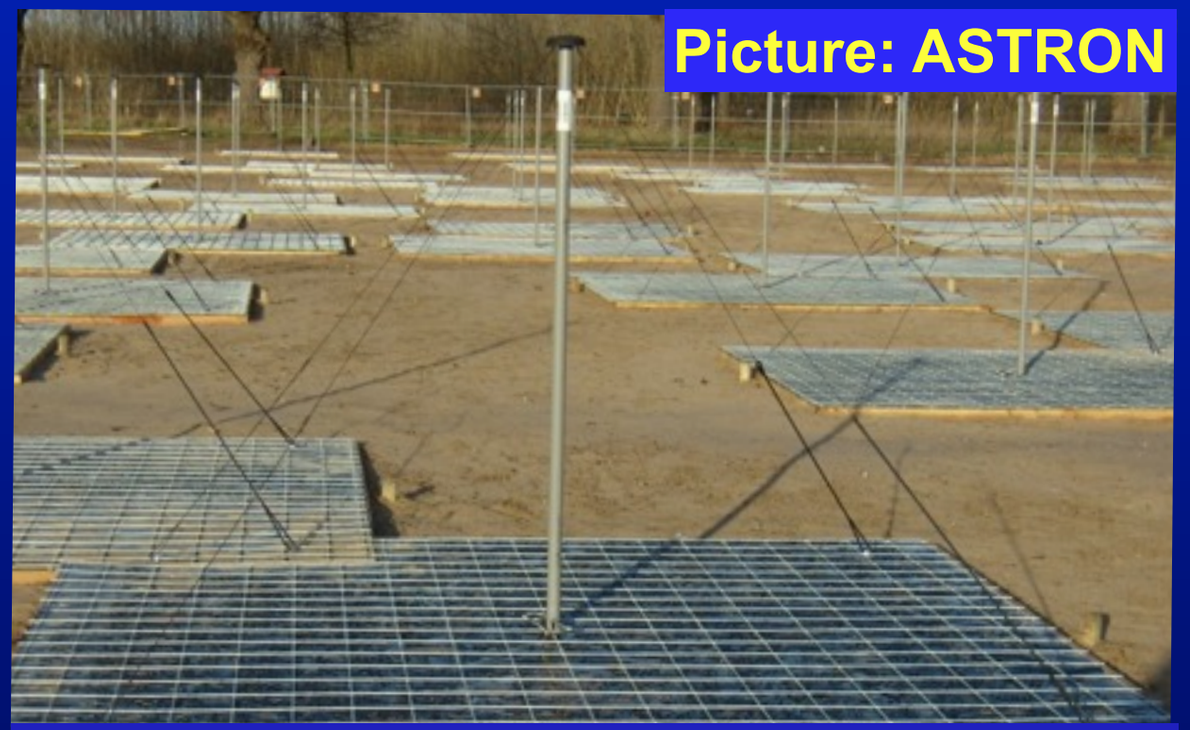
Introducing LOFAR

Picture: Anderson, MPIfR

Picture: ASTRON

High Band (110-240 MHz)

Picture: ASTRON



Low Band (10-90 MHz)

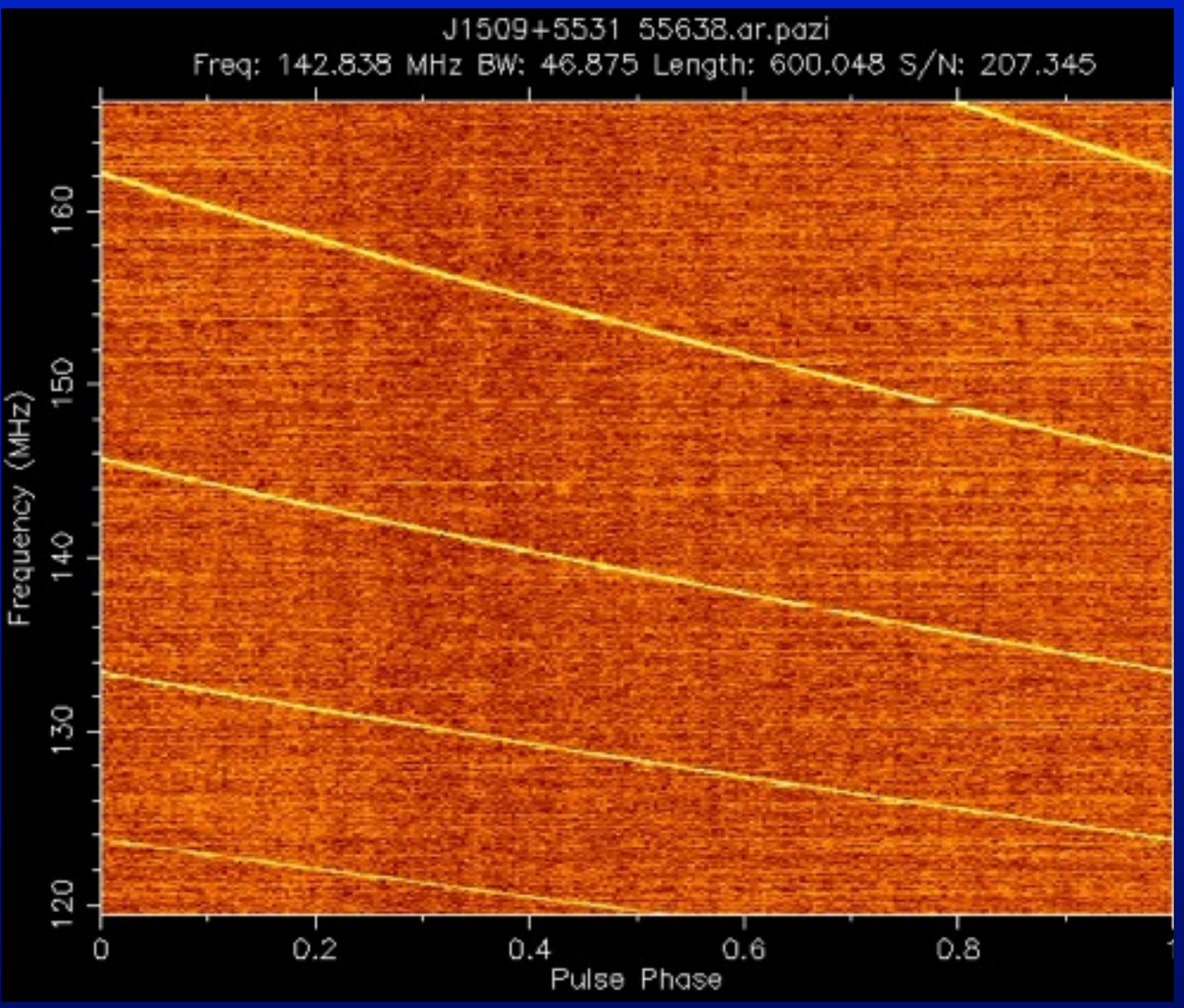
Introducing LOFAR

48 MHz Bandwidth,
80 MHz by end of year

Picture: ASTRON

(*Potential*) Problems for LOFAR

- Dispersion can smear out the pulse
- Dispersion *very strong* at these low freqs.
- Coherent Dedispersion to the rescue!



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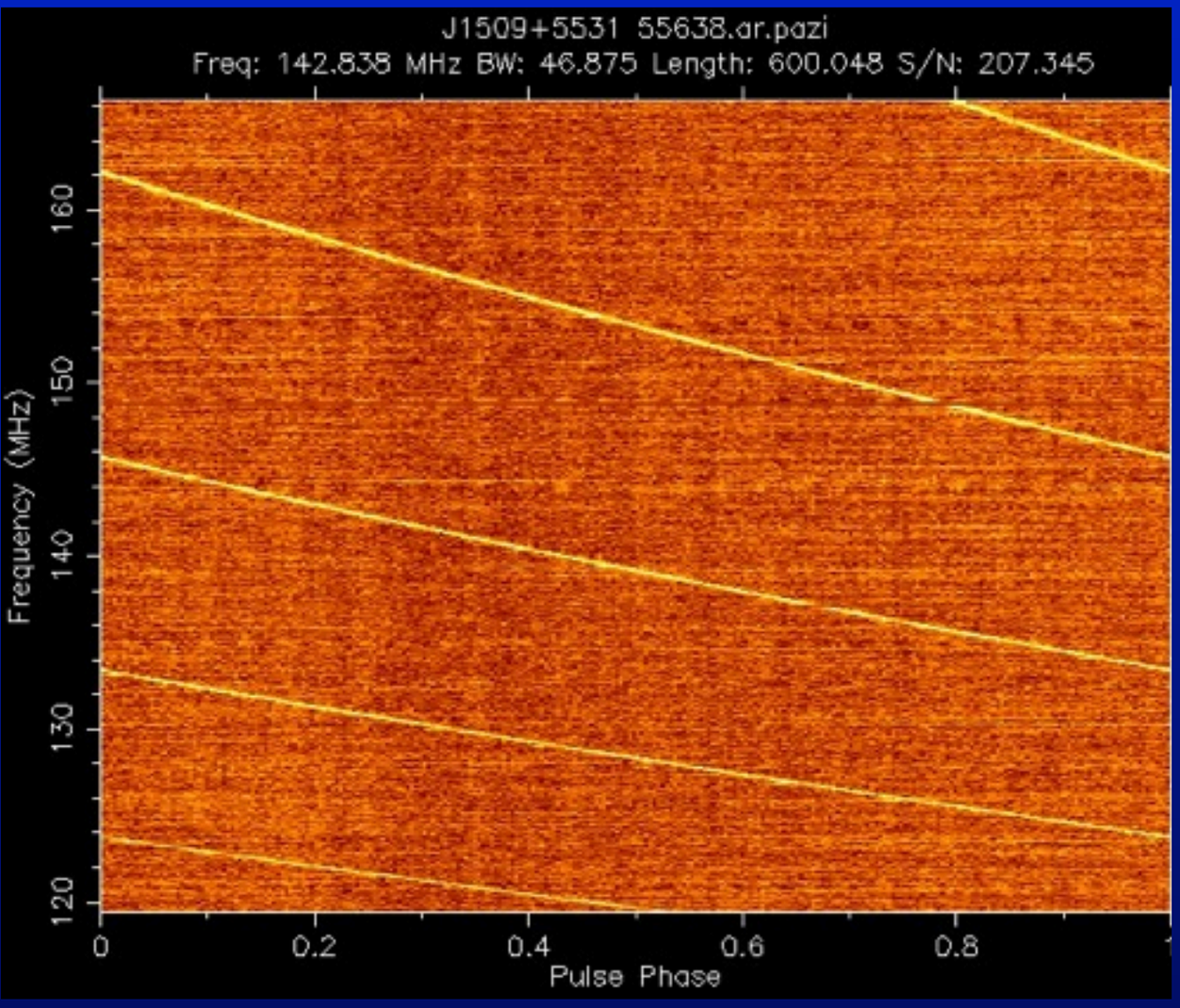
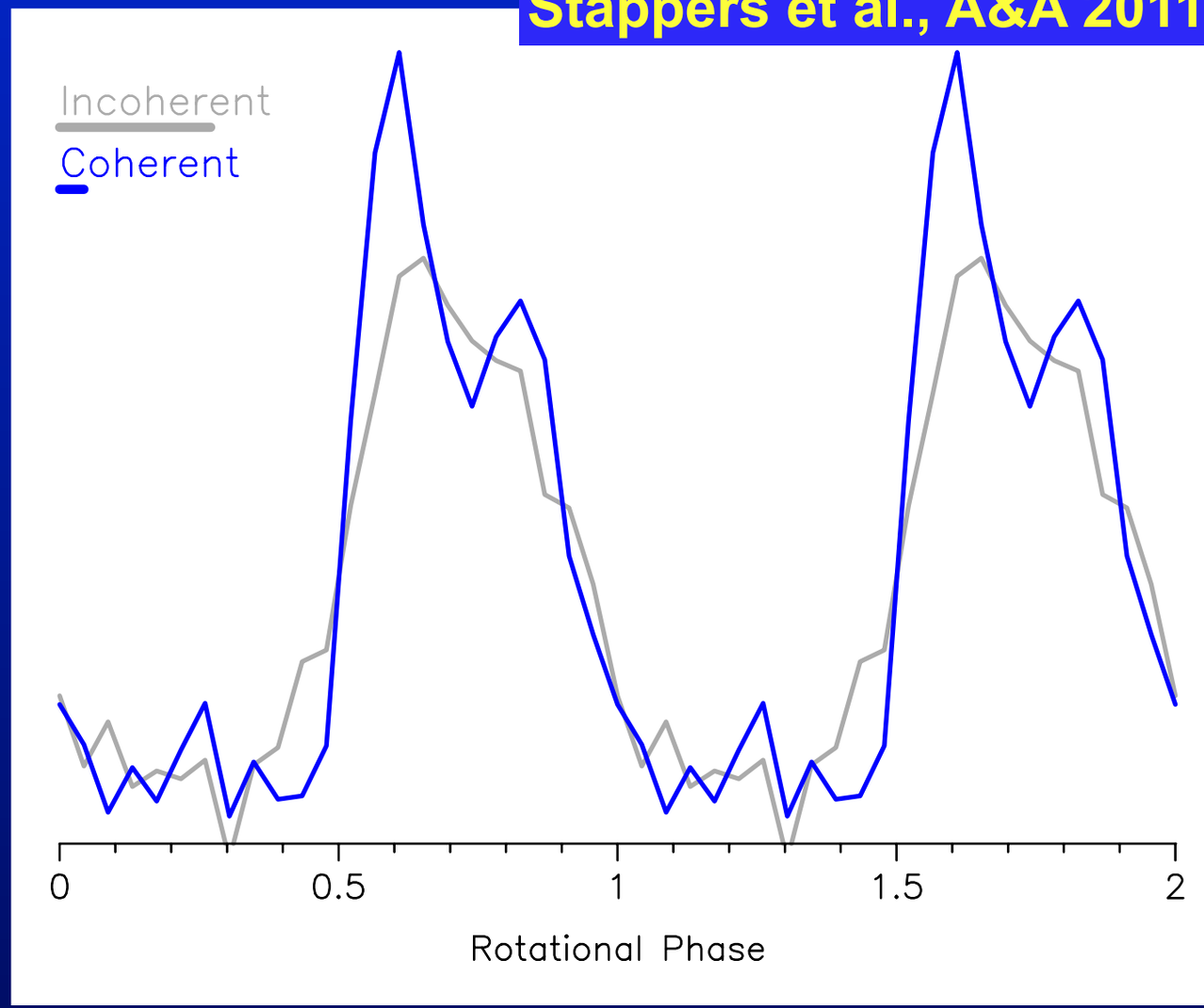
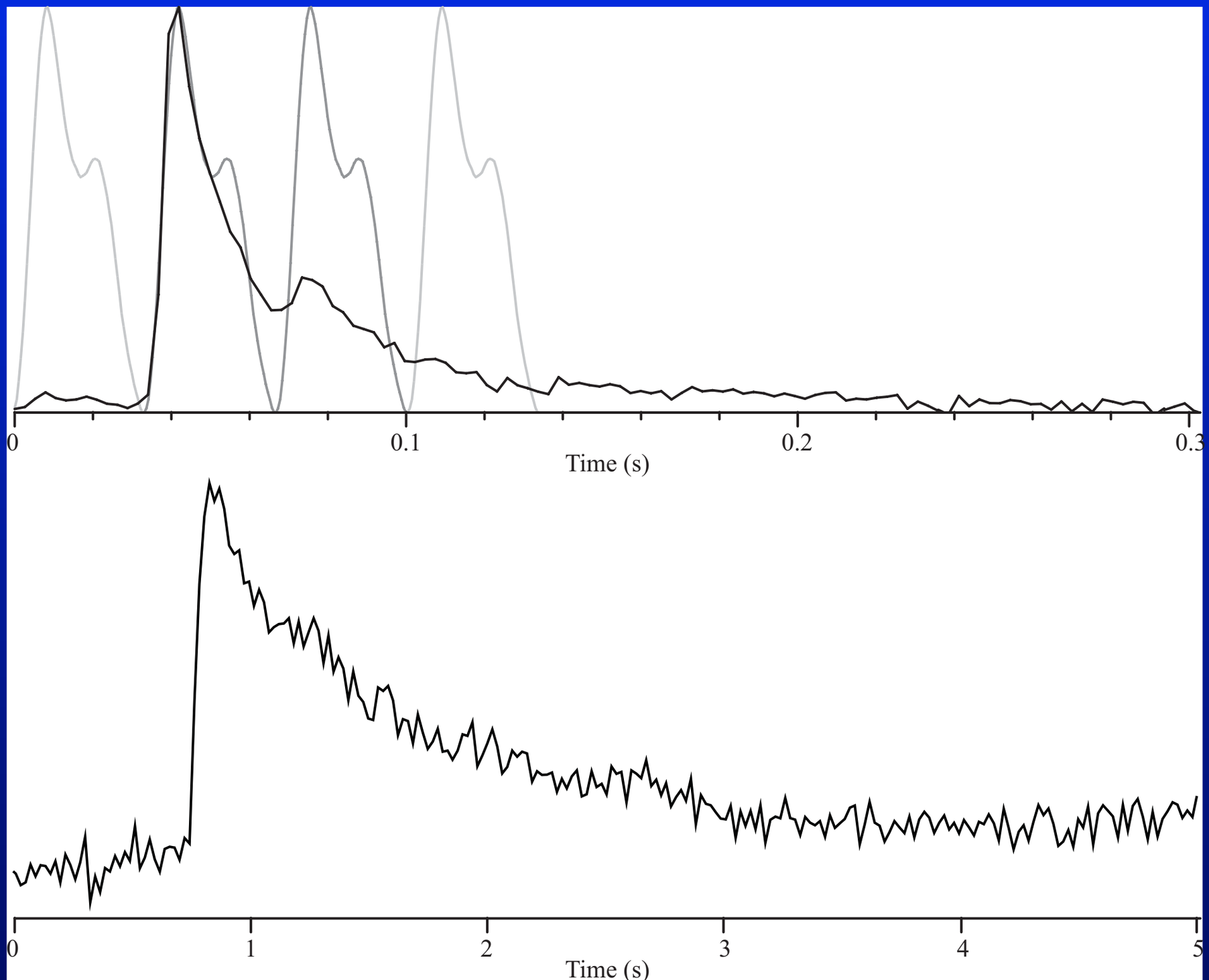


Stappers et al., A&A 2011



(*Potential*) Problems for LOFAR

- **Scattering can obliterate anything.**



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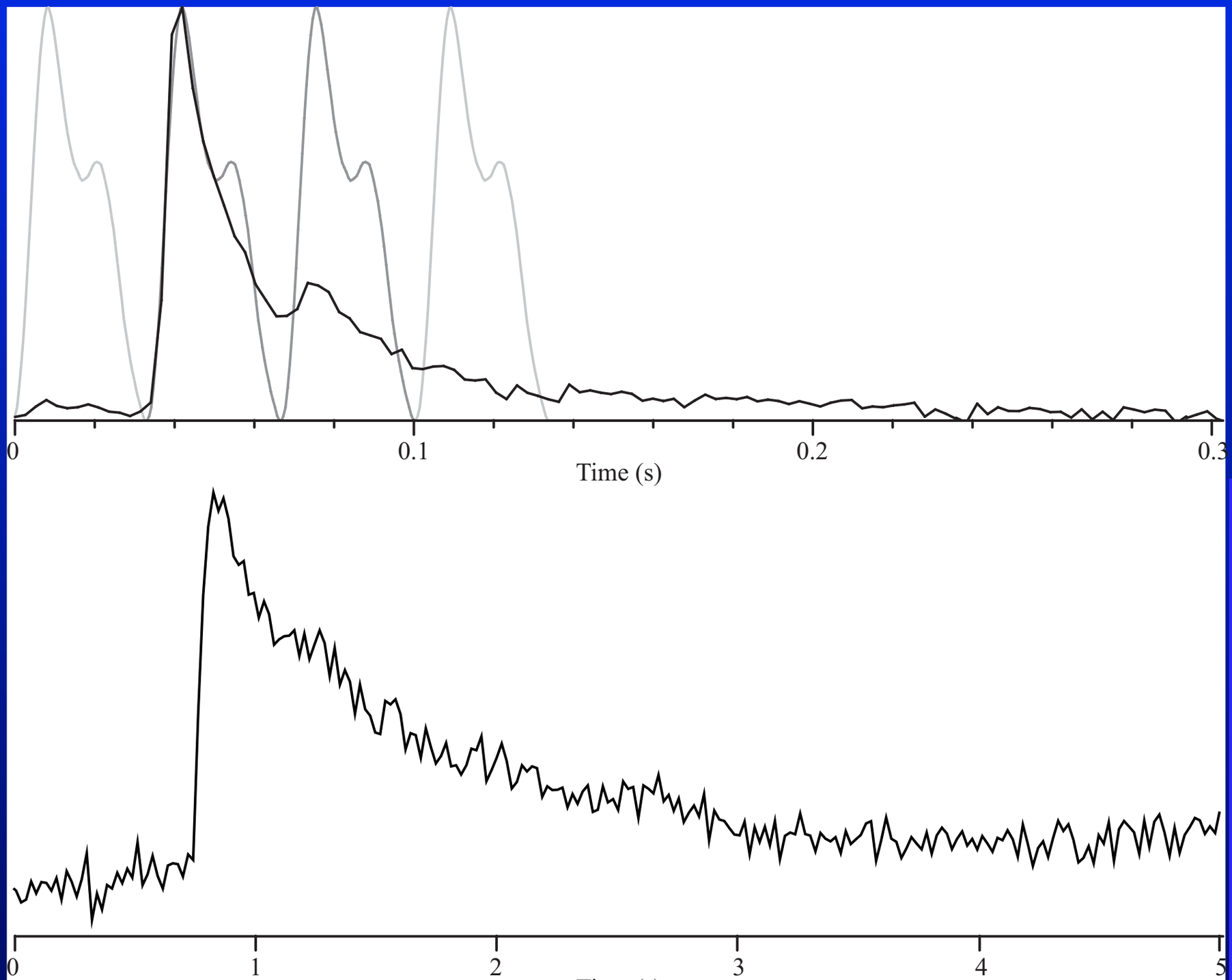

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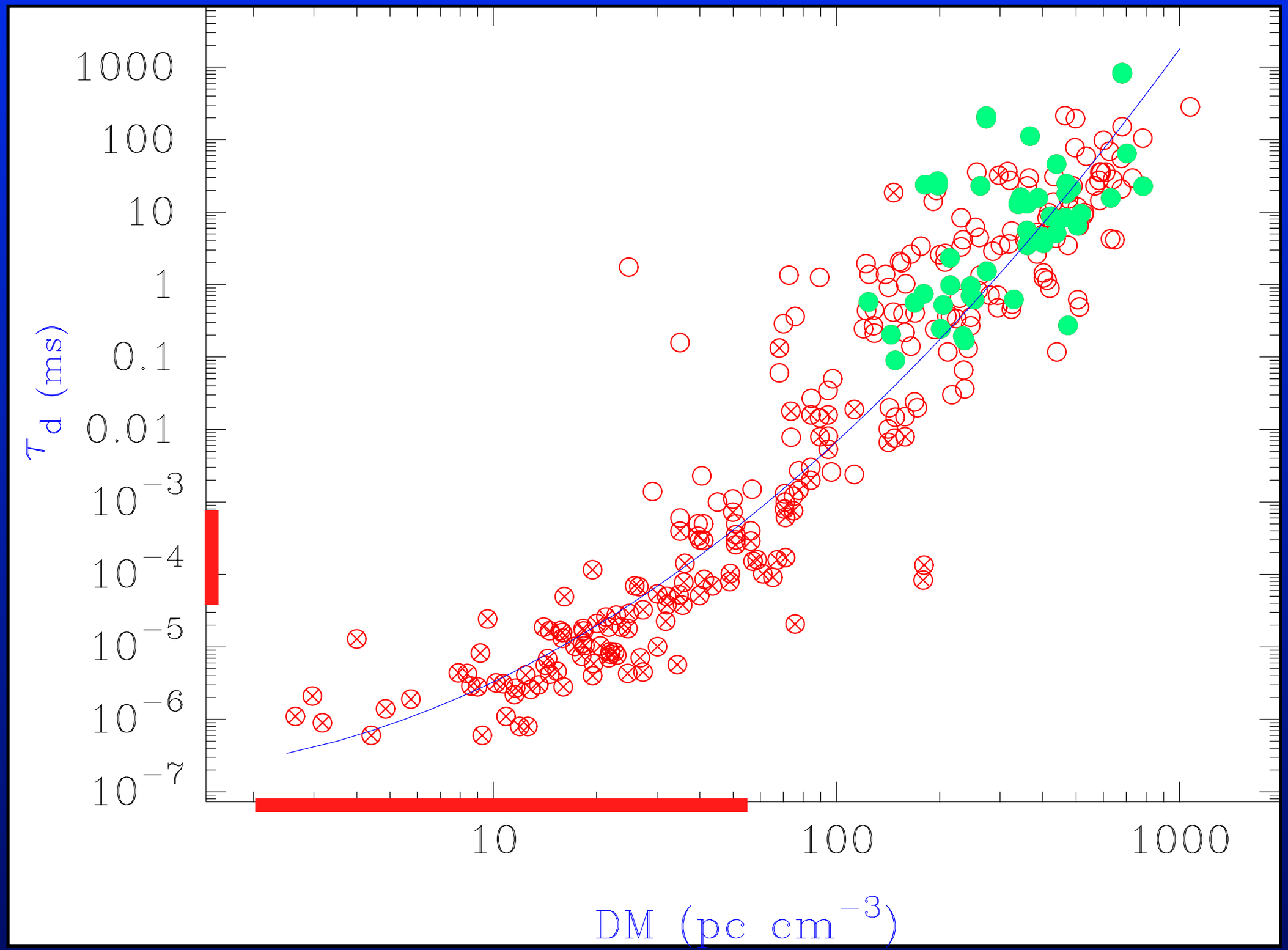
(*Potential*) Problems for LOFAR

- **Luckily scattering seems rather random**



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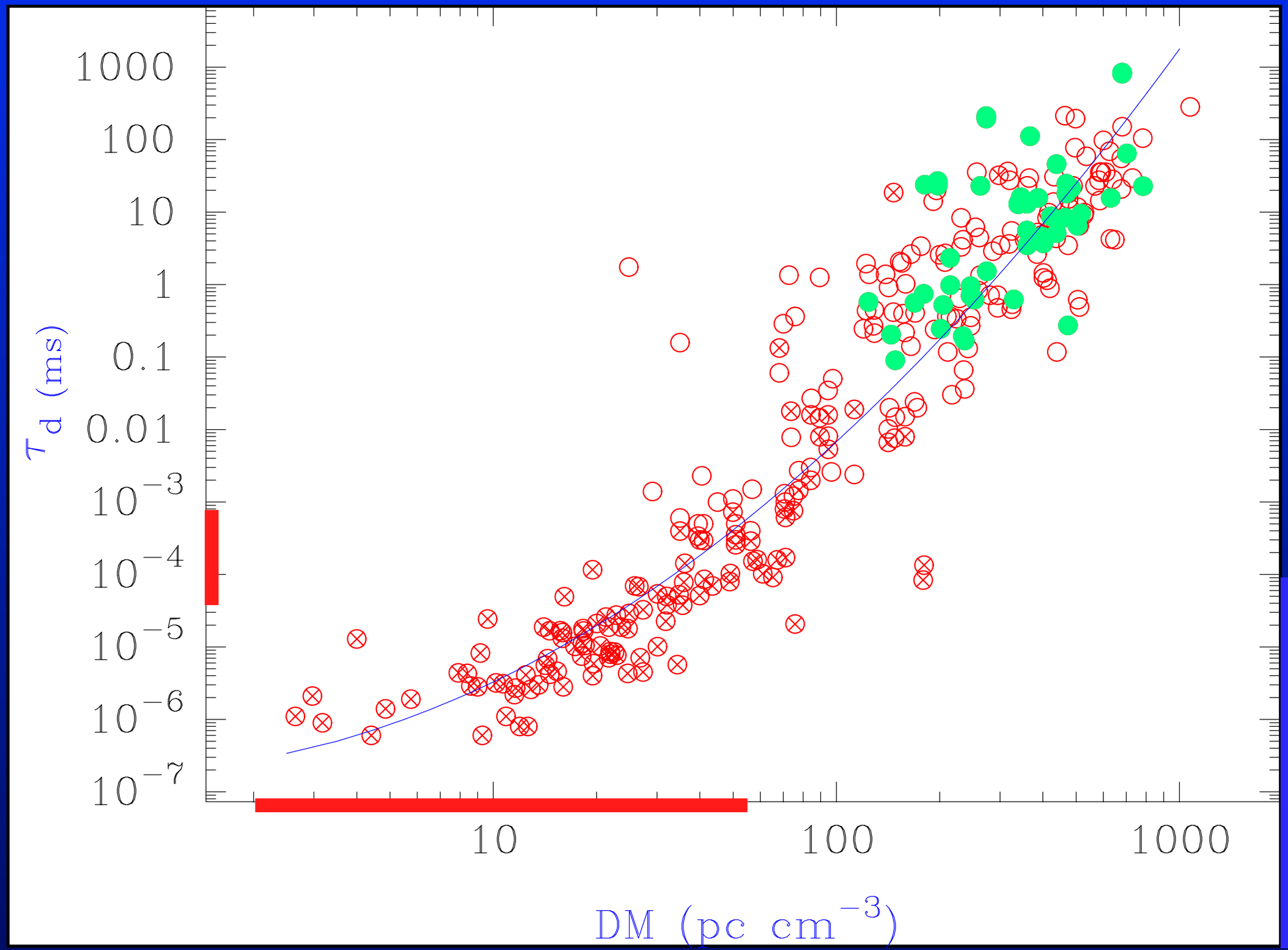
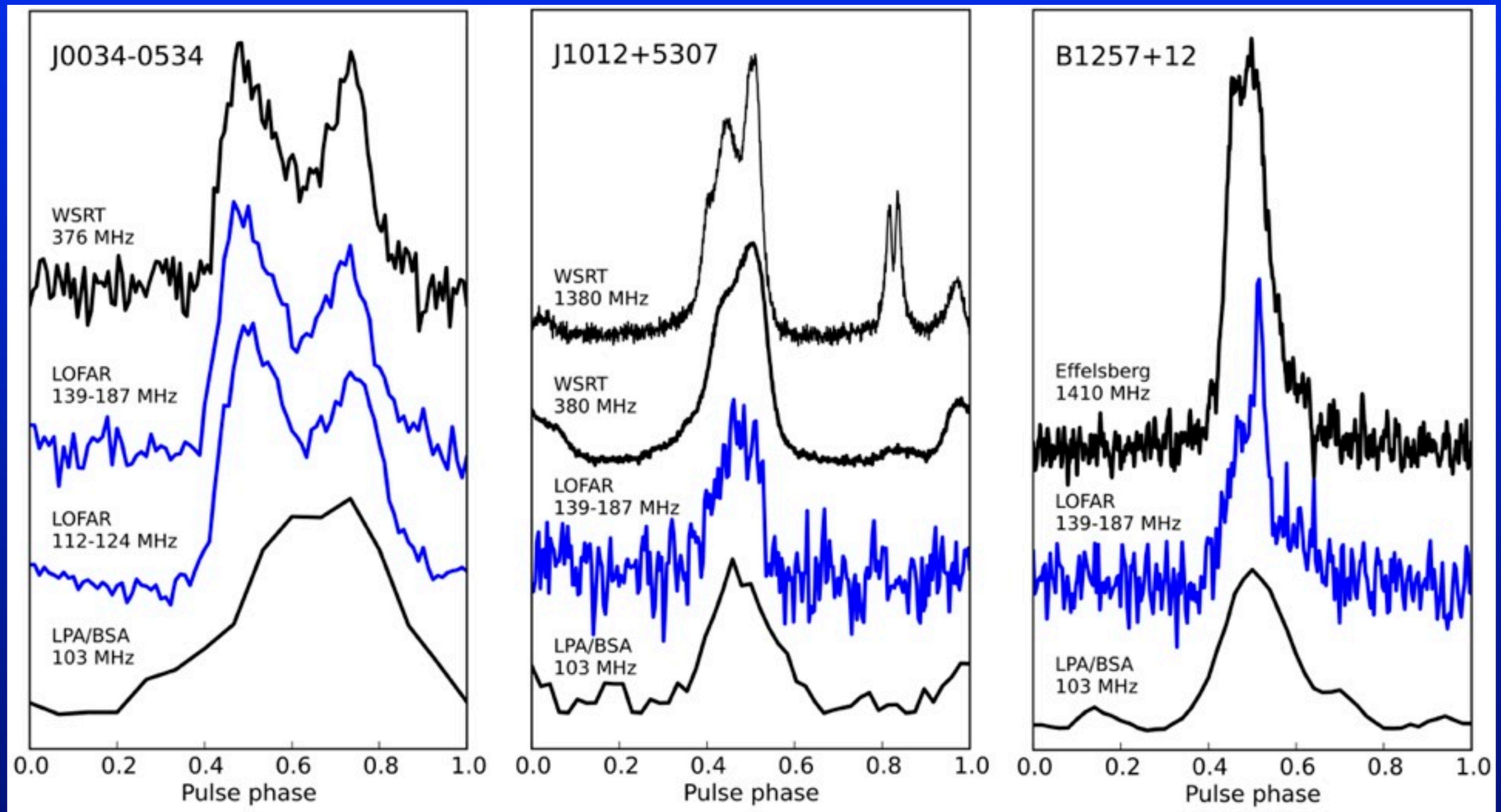


Bhat et al., ApJ 2004

MSPs with LOFAR



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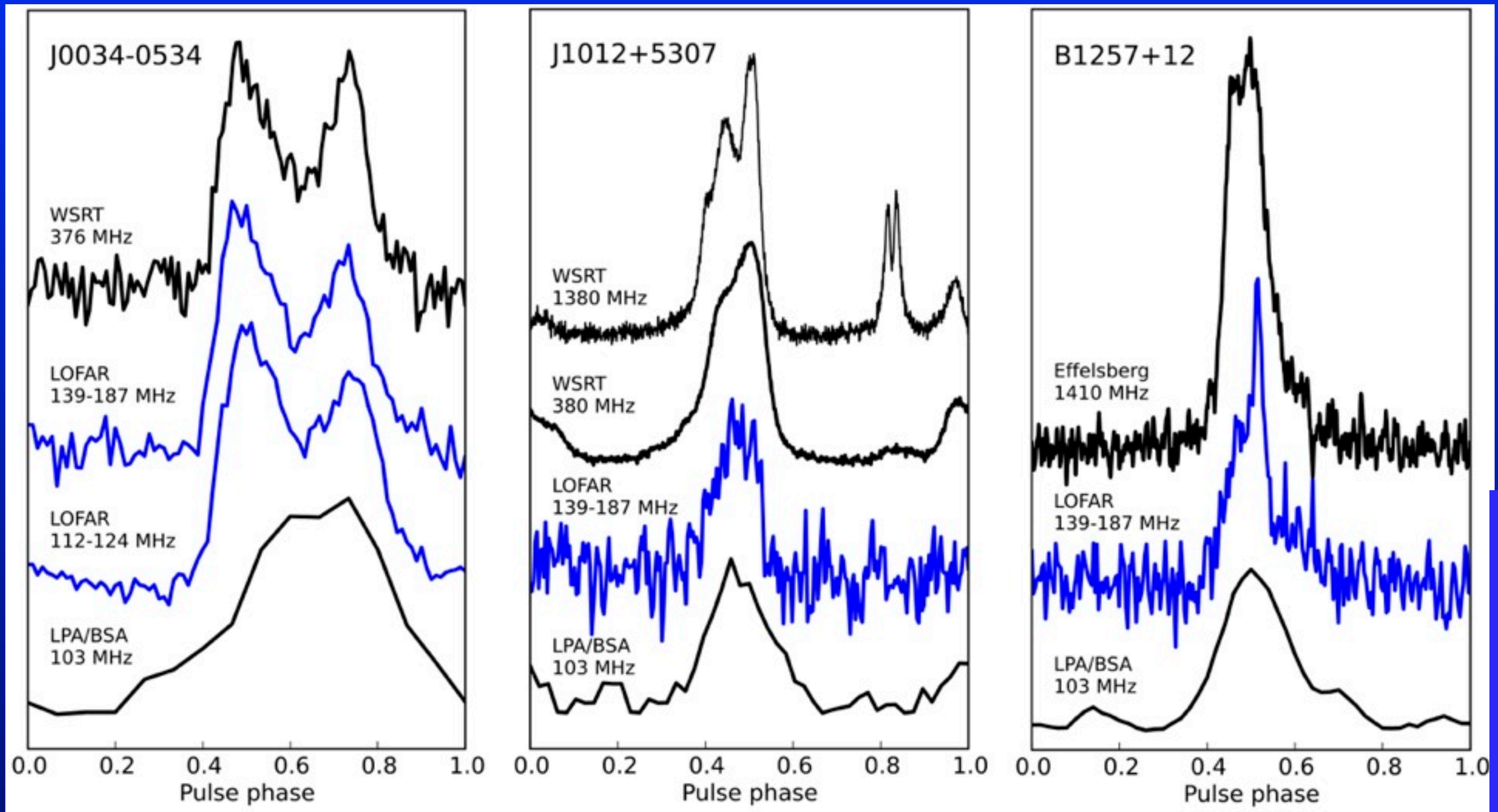
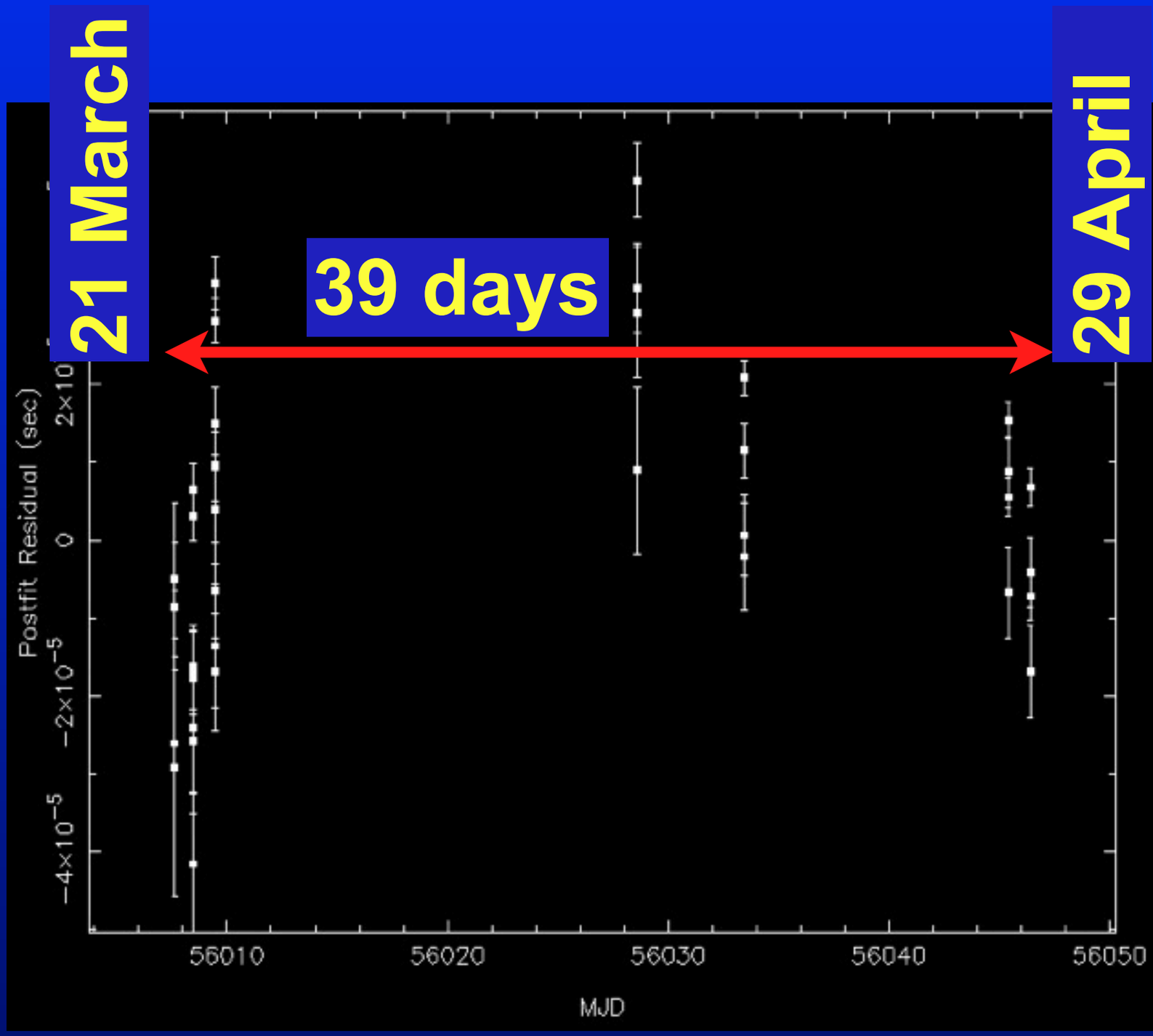


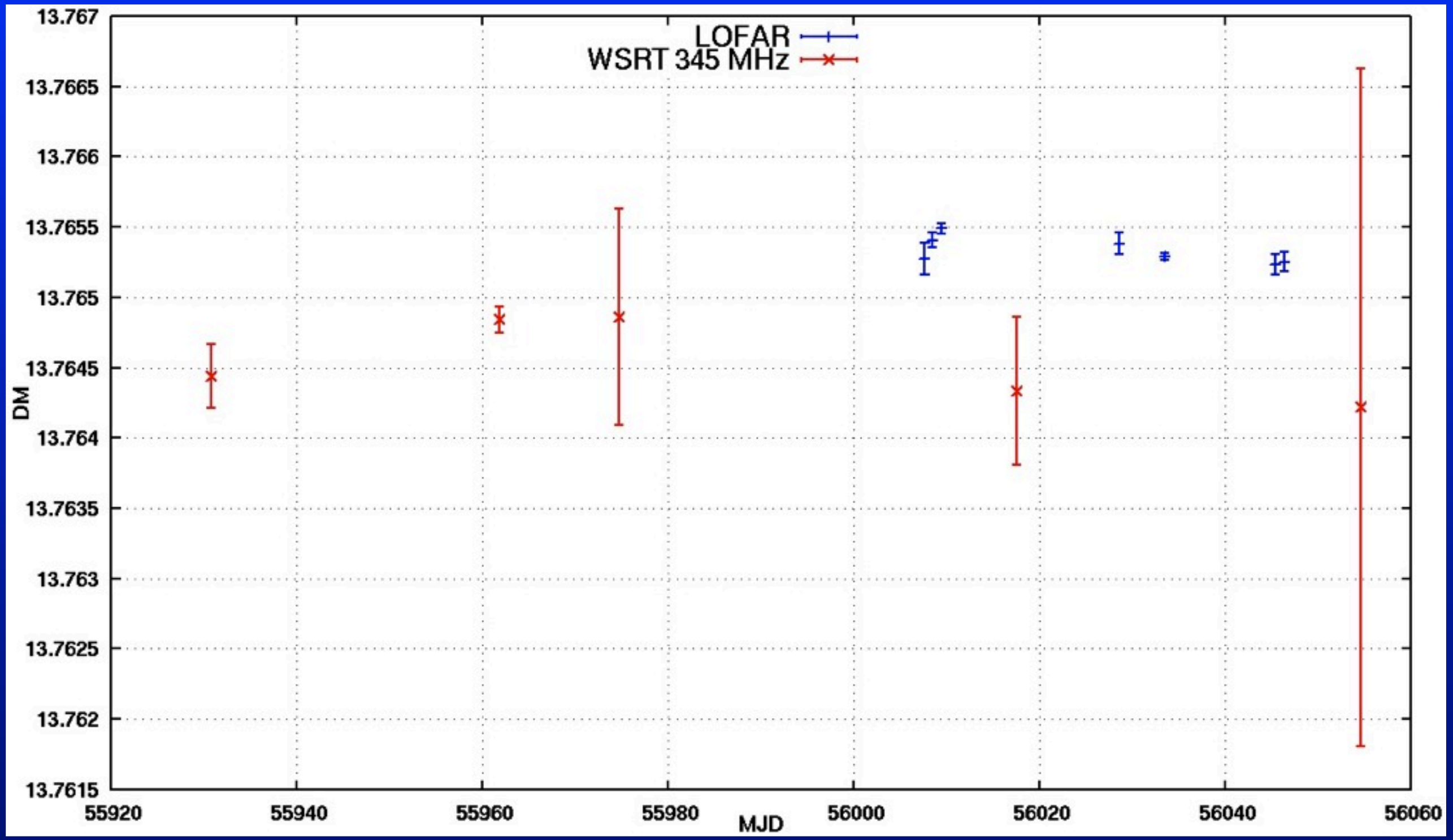
Pictures: Hessels

Core Timing of PSR J0034-0534

- P0 = 1.9 ms
- 36 TOAs (nothing fitted)
- Nothing fitted! (WSRT par)
- 143 MHz; BW: 48MHz (4x12)
- 15-min integrations
- TOA Unc: ≥2.3 μs
- Residual RMS: 16 μs
- Reduced chi-sq.: 8.2
- 31 May / 1 June obs failed



Dispersion with WSRT and LOFAR



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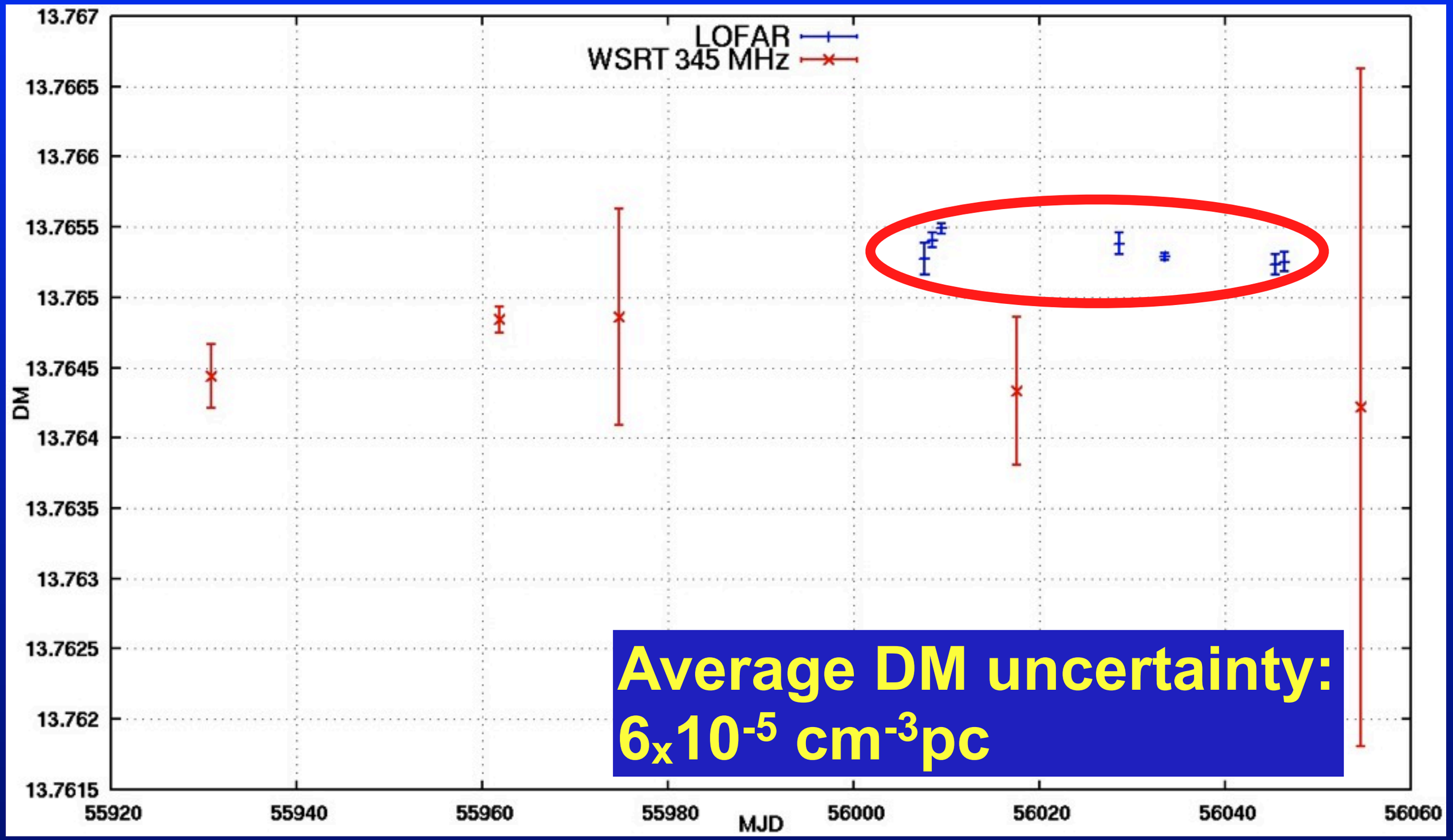

Core MSP Timing

- High sensitivity to dispersion variations demonstrated
- Would like:
  - Higher cadence
  - More sources

Dedicated LOFAR Post-doc

- **Goals:**
  - **Observe ≥30 MSPs (≥15 PTA sources)**
  - **To investigate evolution & variability of scattering, dispersion & profile morphology as a function of time and frequency.**
- **3-year position; to start later this year**
- **PI: Hessels (Co-Is: Ben, Rutger, Joris,...)**

Summary/Conclusions

- **UBB on EFF 100-m next week.**
  Expect first results in half a year.

- **LOFAR also well on track.**
  Expect MSP timing and detailed DM investigations soon.

- **Lots of work left --**
  Postdoc position available!

- **Expect many results in the next year!!**

Supplementary Slides

125 MHz
137 MHz
149 MHz
161 MHz
Relative amplitude
Phase bin No.
1
0.8
0.6
0.4
0.2
0
-0.2
0
10
20
30
40
50
60
70

Single-Station Timing of 0329

- PSR B0329+54 (P0 = 0.7s)
- 113 TOAs
- 285 days (0.78 years) Eff
- 1 Nançay TOA (aligned!)
- 153 MHz (Eff); 149 MHz (Ncy)
- 1-min (Eff); 5-min (Ncy)
- TOA Unc: ≥16μs
- Strongly affected by jitter
- Post-fit RMS: 621 μs
- Wgt-RMS: 381 μs

Nançay TOA!

Post-fit Residuals