

DGFI part of project PN 5: status report

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DFG Research Unit FOR1503
Bonn, 13.06.2016

VLBI processing software DOGS-RI

- participation in the "**VLBI Analysis Software Comparison Campaign 2015**" organized by the Chalmers University of Technology with OCCAM and DOGS-RI
- submission of DOGS-RI **test solutions** (one year of data?) to the IVS Combination Center for validation
- **parallel submission** of OCCAM and DOGS-RI solutions for the routine R1 and R4 sessions
- switch from OCCAM to DOGS-RI
- reprocessing with DOGS-RI using the OCCAM preprocessing options

VLBI Analysis Software Comparison Campaign (1)

- initiated by the Chalmers University of Technology (Sweden)
- comparison of theoretical delays computed by different software packages:

$$\tau_{\text{computed}} = \tau_{\text{geometric}} + \tau_{\text{grav}} + \tau_{\text{trop}} + \tau_{\text{AO}} + \tau_{\text{therm_def}}$$

- 11 institutions with 11 different software packages participated
- first results were presented at the IVS General Meeting in March 2016

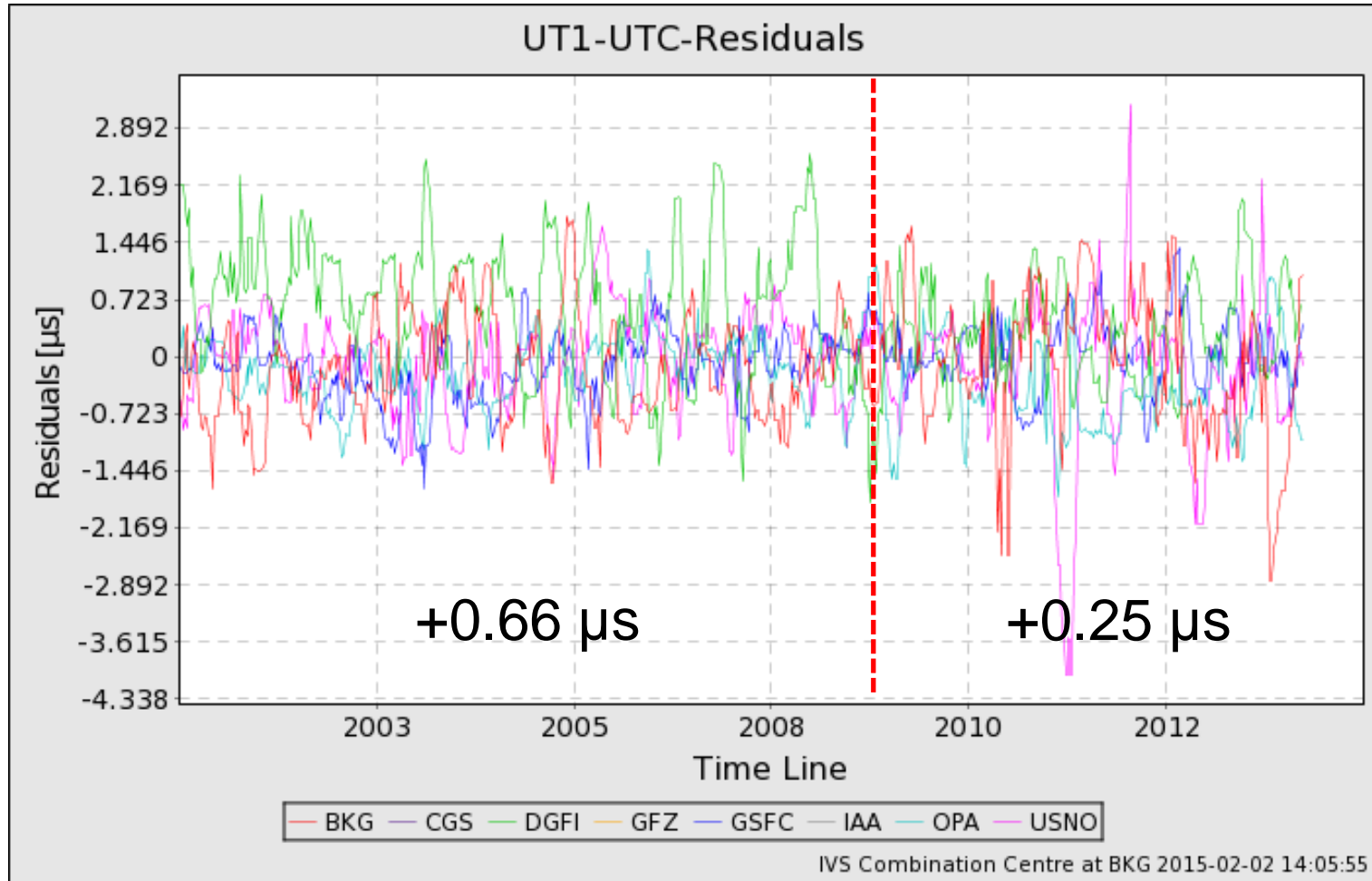
VLBI Analysis Software Comparison Campaign (2)

RMS [mm]	Calc11(GSFC)	c5++	DOGS-RI	ivg::ASCOT	SCORR	VieVS
Calc11(GSFC)	x	0.43	-	0.38	0.57	0.44
c5++	-	x	0.61	0.17	0.44	0.22
DOGS-RI	-	-	x	0.59	0.71	0.59
ivg::ASCOT	-	-	-	x	0.41	0.17
SCORR	-	-	-	-	x	0.44
VieVS	-	-	-	-	-	x

0.0 - 1.0 mm RMS

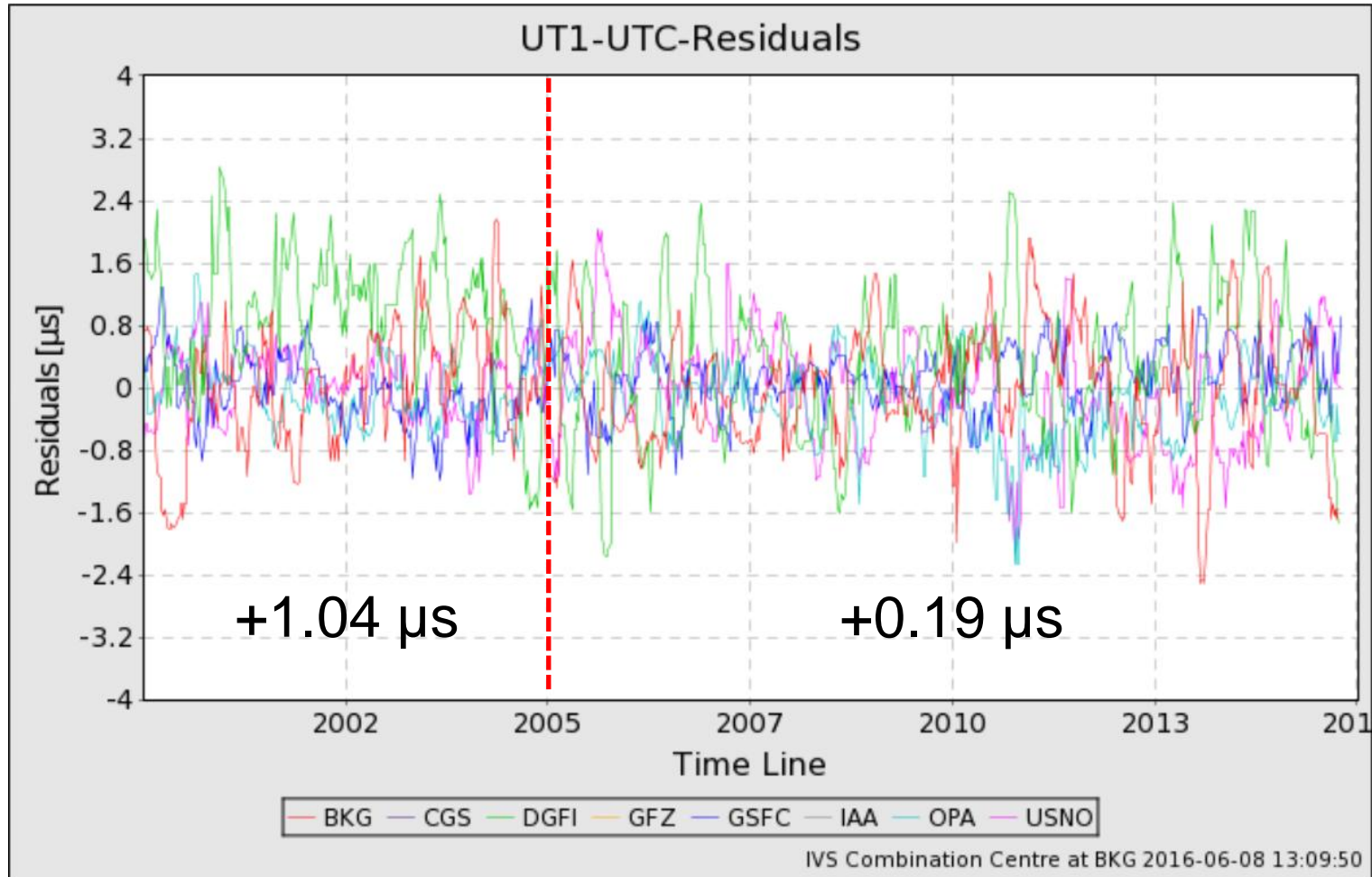
RMS of residuals between delays from different software packages for a fictitious 2-week campaign (Klopotek et al. 2016)

OCCAM reprocessing (1)



significant DGFI bias (green) prior to 2009 (Hannover meeting, Feb 2015)

OCCAM reprocessing (2)



reduced bias after reprocessing (2005-2009)

Combined multi-year reference frame

	GNSS	SLR	VLBI
Institution	CODE	DGFI-TUM	DGFI-TUM
Software	Bernese	DOGS-OC	OCCAM
Resolution	daily	weekly	session-wise
Time span	January 2005 - December 2015		
Datum conditions (station coord.)	NNR/NNT/NNS	NNR	NNR/NNT
Coord. jumps	according to DTRF2014 processing		

Solution characteristics

GNSS:

- CODE contribution to repro2/ITRF2014 ("cf2"), complemented by operational solutions ("cof") for the latest months

SLR:

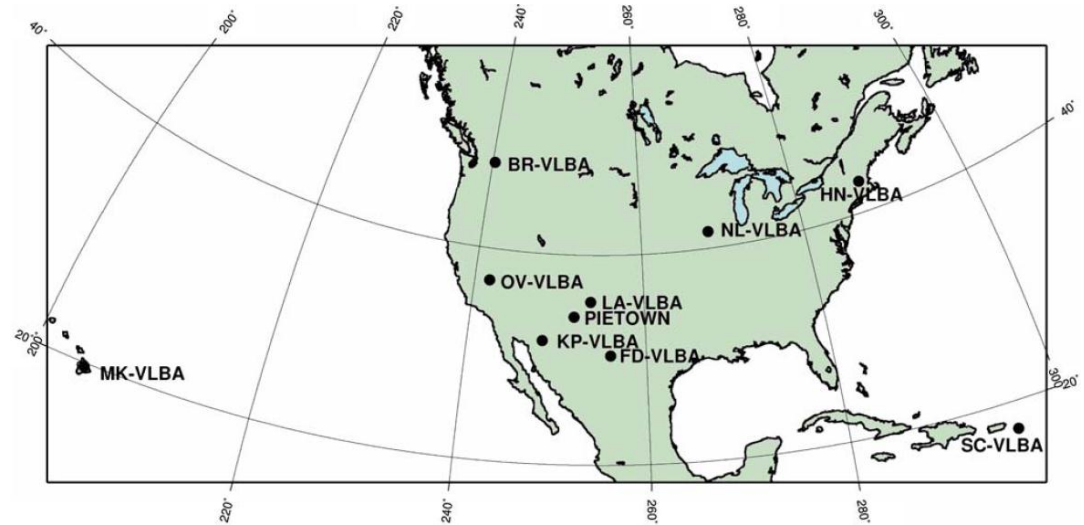
- DGFI-TUM solution based on LAGEOS-1/2
- 7-day orbits
- stations with less than 10 normal points excluded

VLBI:

- DGFI-TUM solution considering more than 1550 24-hour sessions (all types of sessions)
- stations contained in less than 10 sessions excluded
- NNR condition w.r.t. ICRF2 defining sources
- special handling sources treated as arc parameters

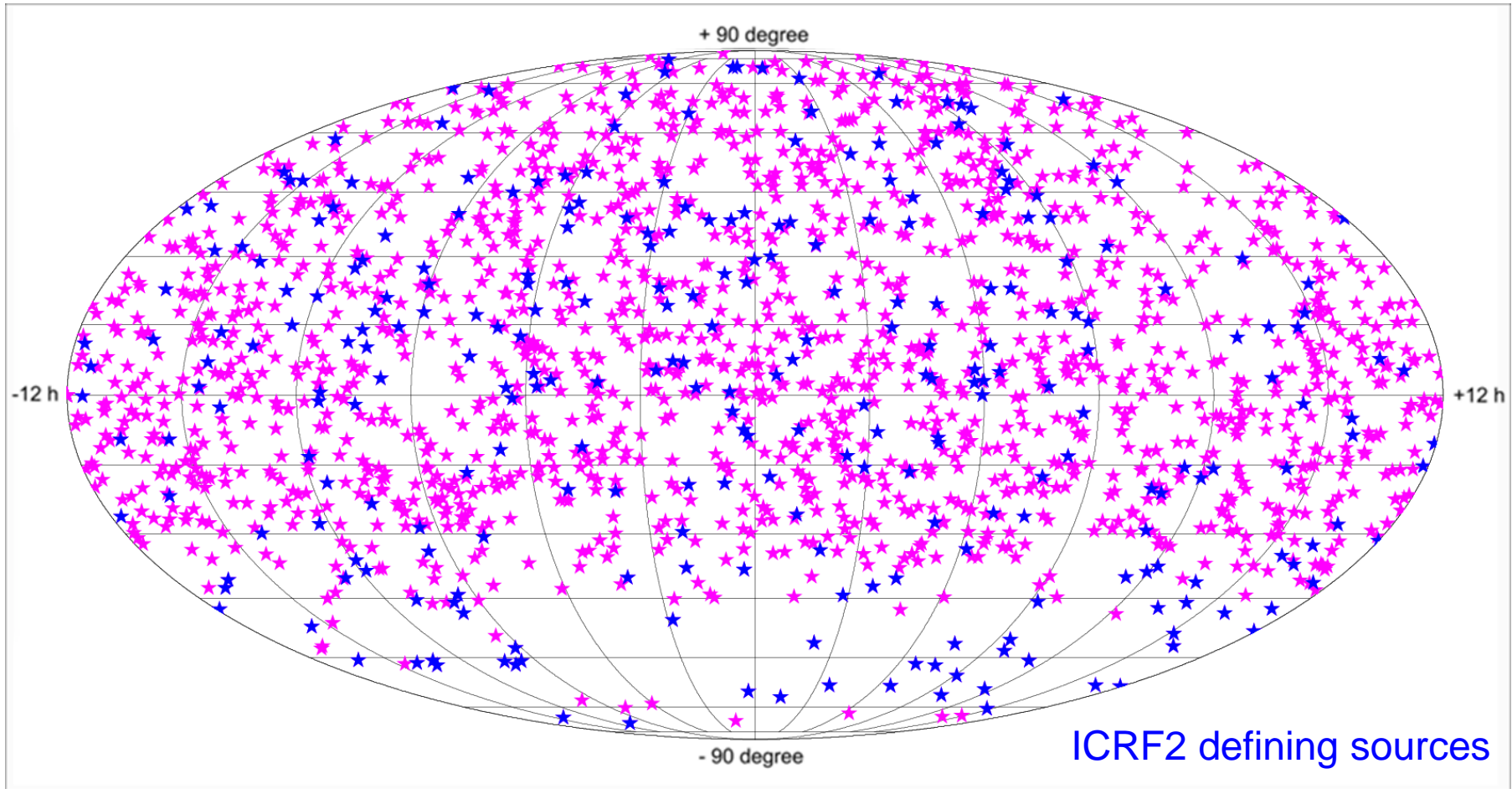
Second epoch VLBA Calibrator Survey (VCS-II)

- 8 Very Long Baseline Array (VLBA) sessions observed between January 2014 and March 2015
- data made available in March 2016
- about 2400 VCS-only sources reobserved (> 300 sources per session)
- position uncertainties reduced by a factor of about 5 compared to VCS-I (Gordon et al. 2016)



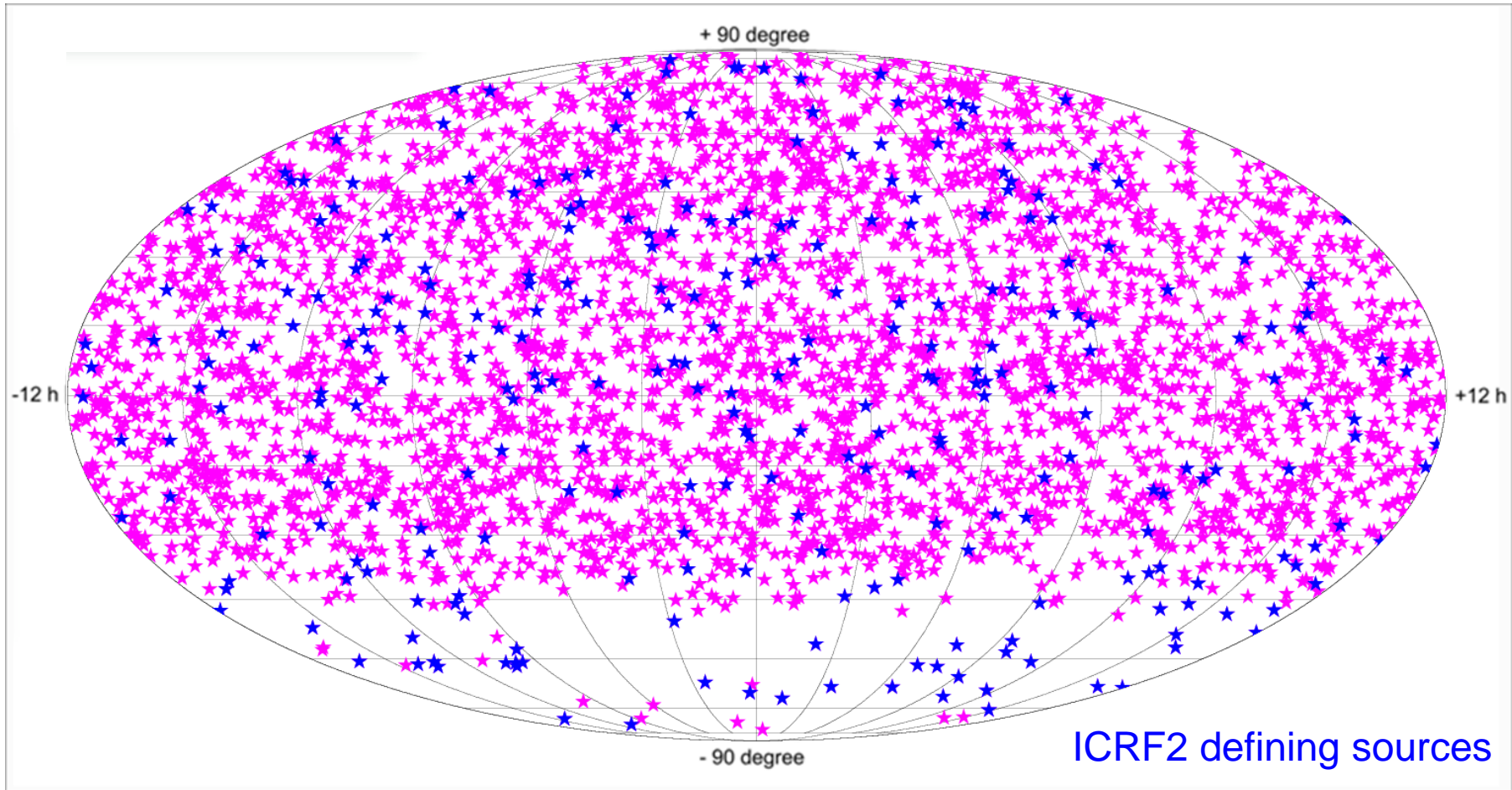
Petrov et al. (2009)

Radio sources (1)



Frankfurt meeting: 1851 sources

Radio sources (2)

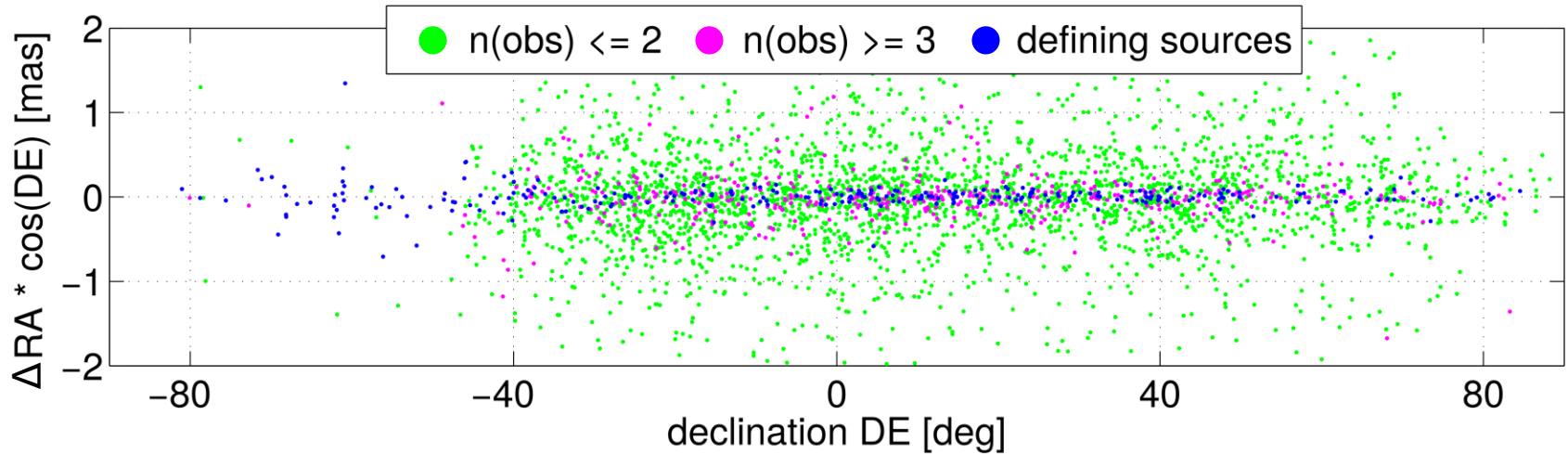
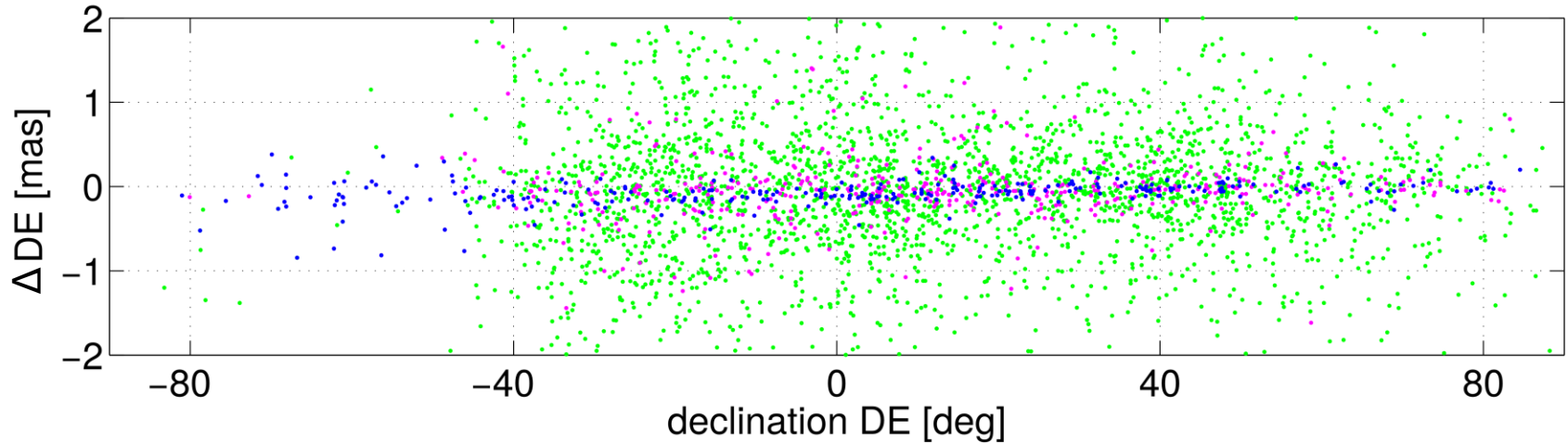


Frankfurt meeting: 1851 sources

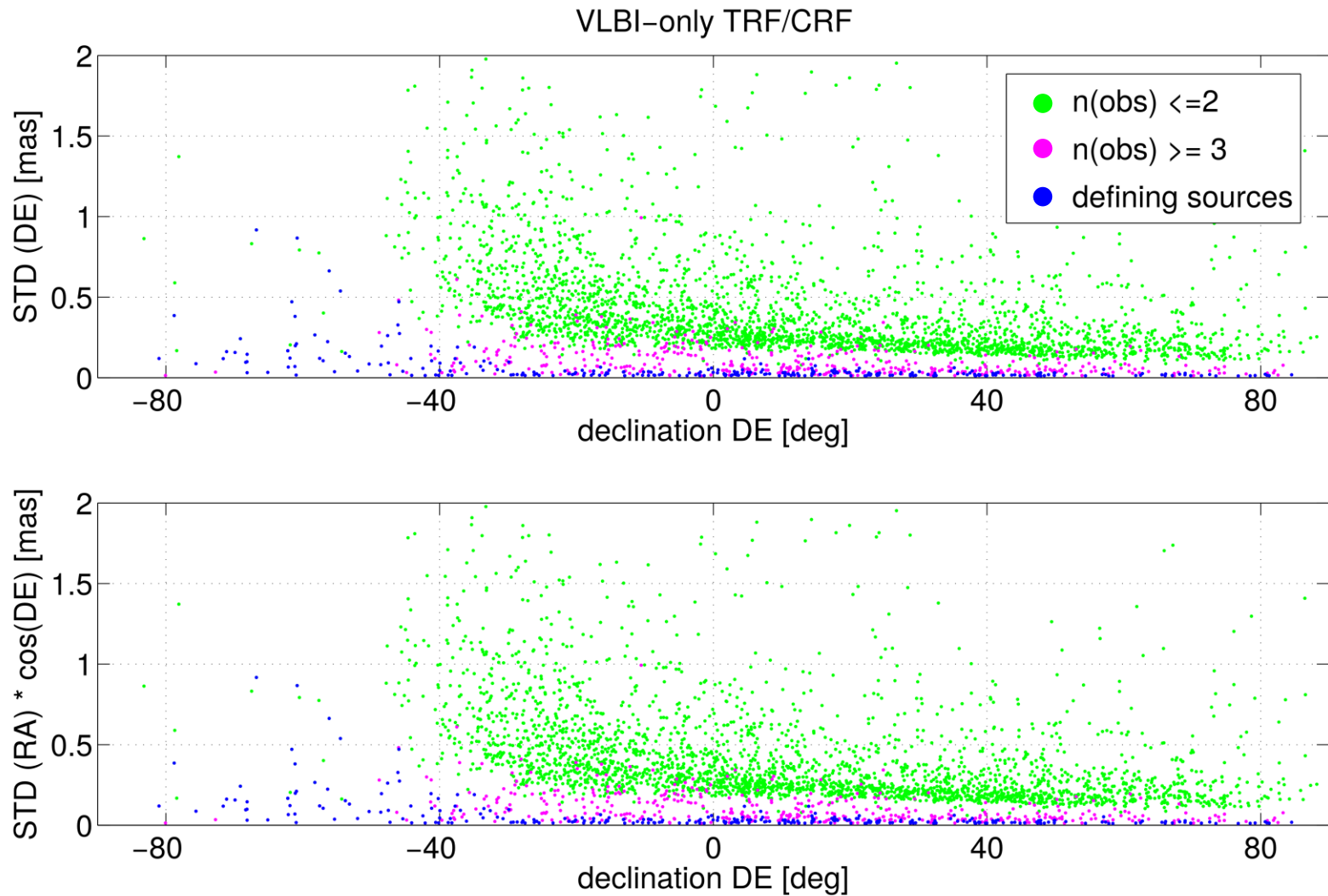
Bonn meeting: 3518 sources

Coordinate corrections (compared to a priori values)

VLBI-only



Standard deviations



Local tie (LT) selection (1)

	$\Delta LT < 3 \text{ cm}$	$\Delta LT < 5 \text{ cm}$	$\Delta LT < 10 \text{ cm}$	$\Delta LT < 100 \text{ cm}$
Intra-technique	34	40	44	50
GPS/VLBI	20	44	51	116
GPS/SLR	21	46	53	81
SLR/VLBI	4	6	7	14
Total	79	136	155	261

Local tie (LT) selection (1)

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Solution A



Solution B

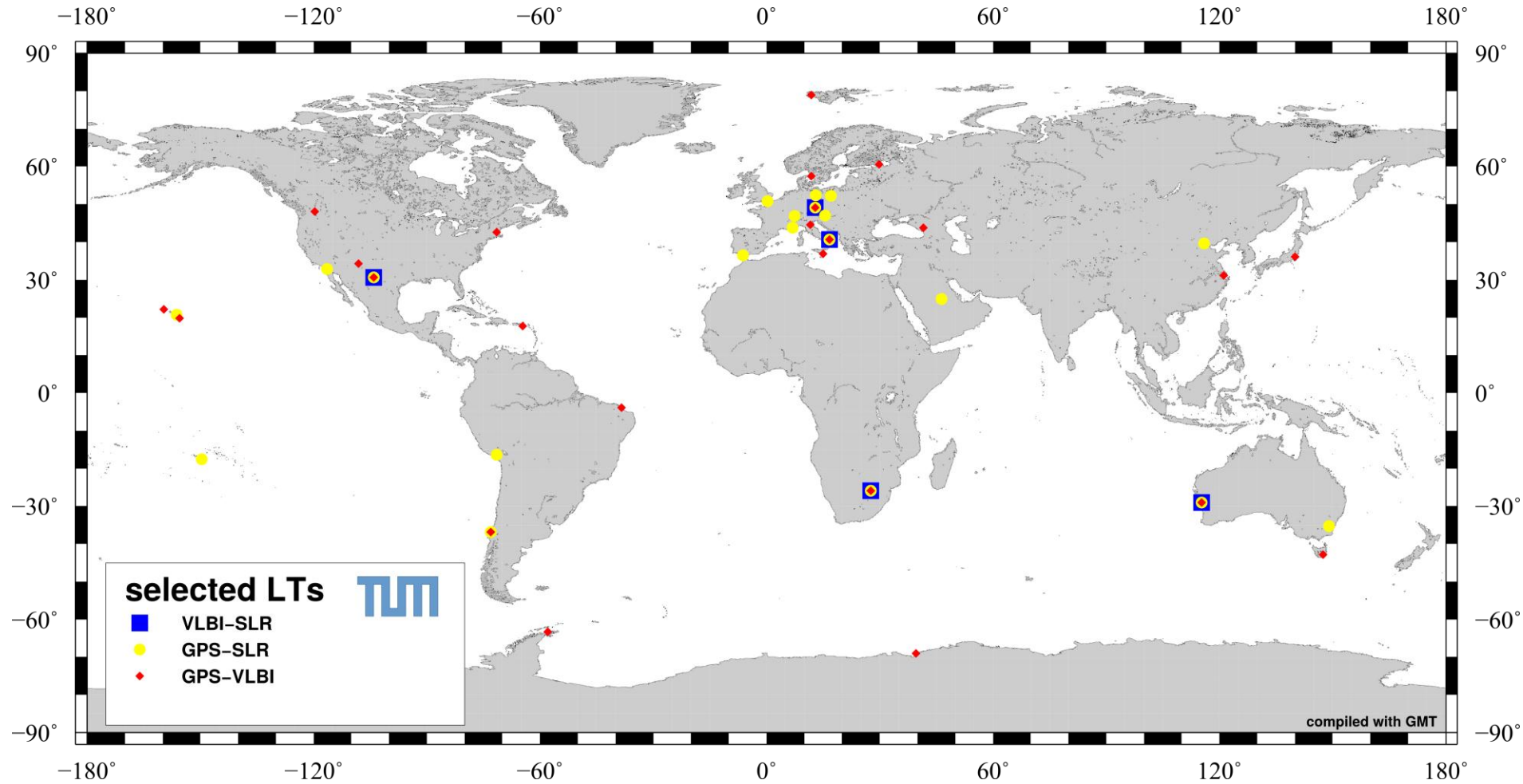
Weighting:

$$\sigma_{LT} = 0.2 \cdot \Delta LT$$

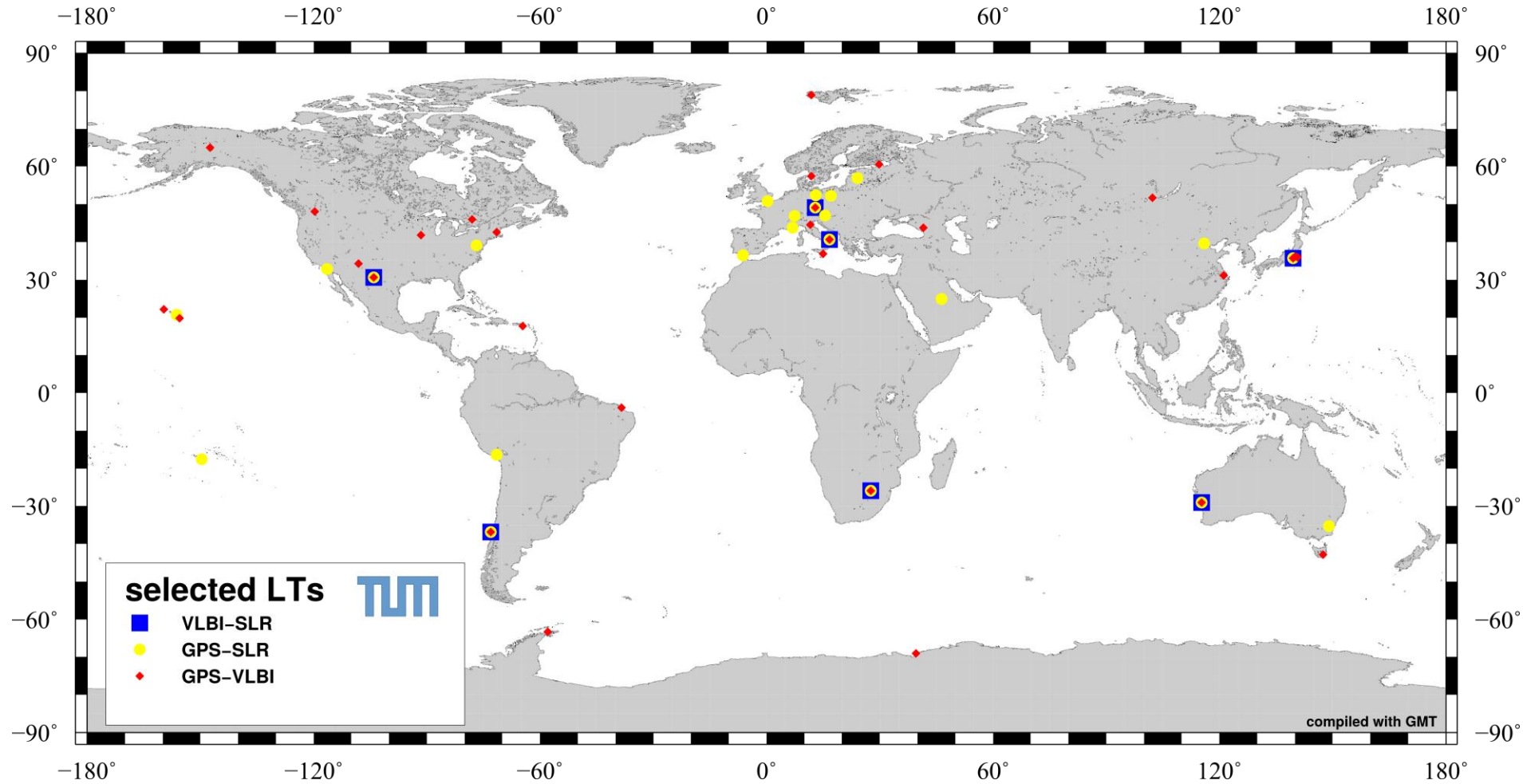
$$\lambda_{GPS} = 0.34$$

$$\lambda_{VLBI} = \lambda_{SLR} = 1.0$$

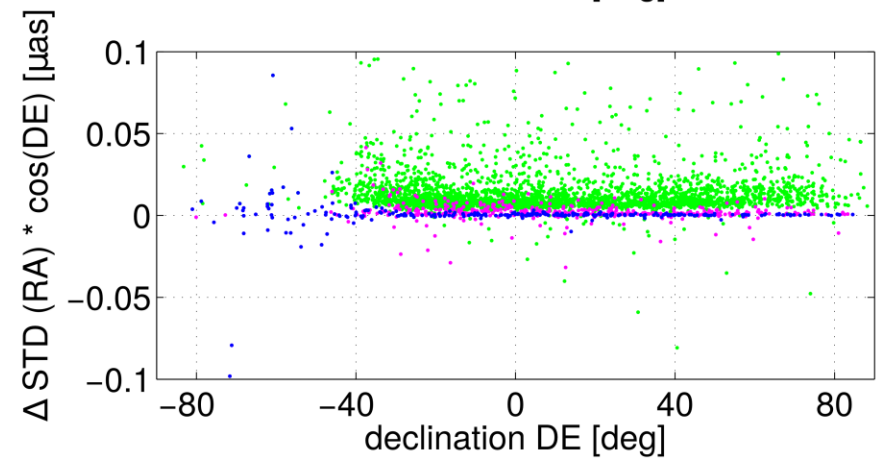
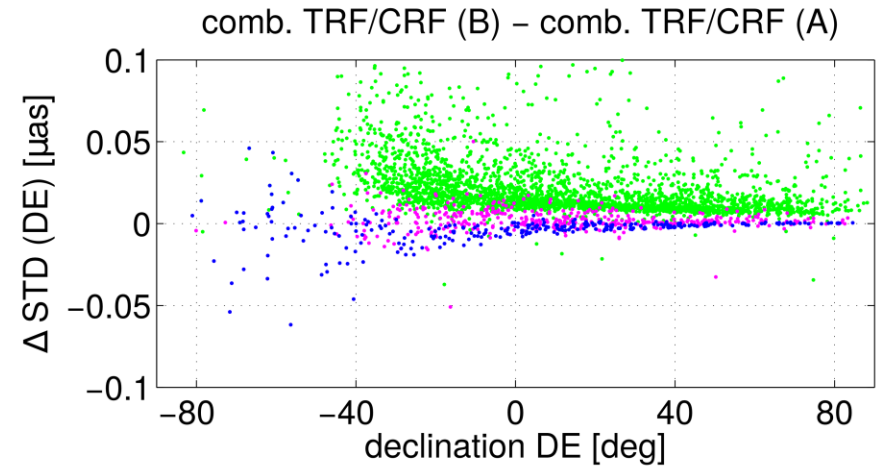
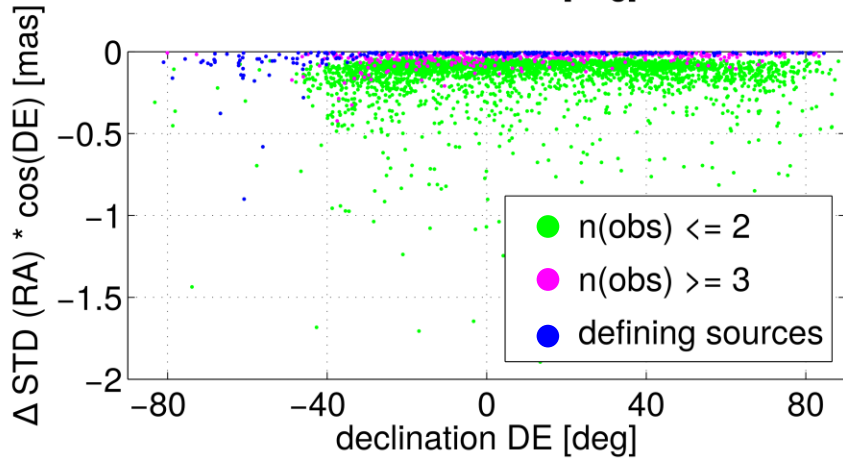
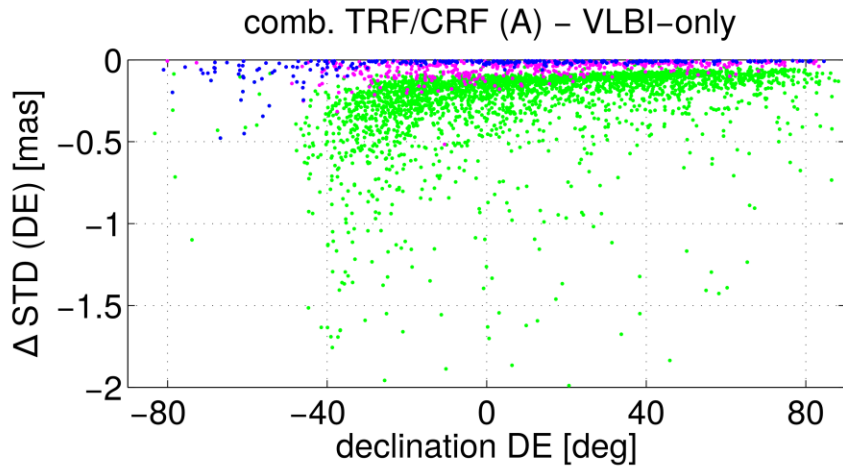
Local tie (LT) selection (2): $\Delta LT < 5$ cm



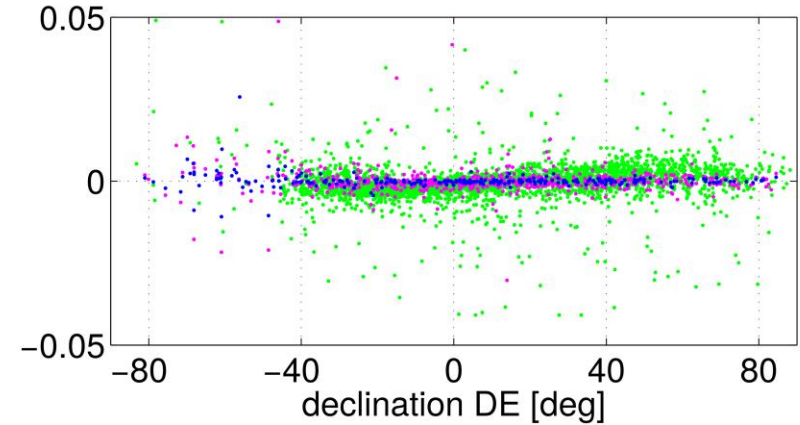
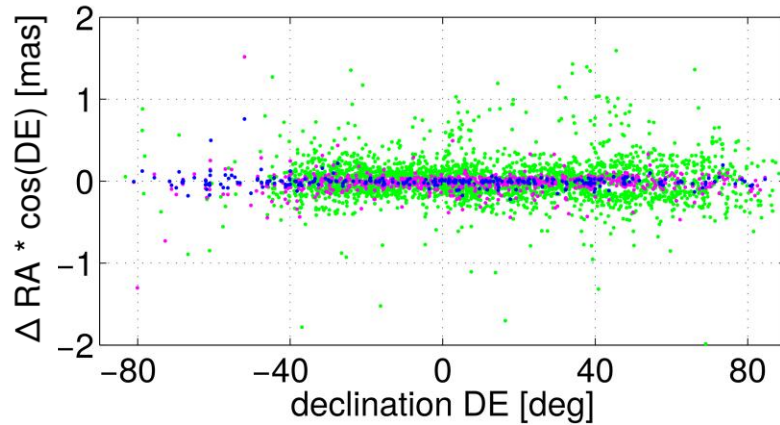
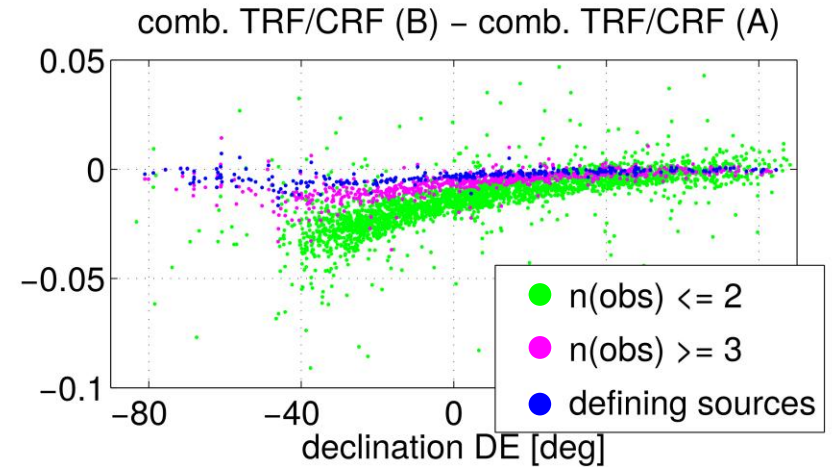
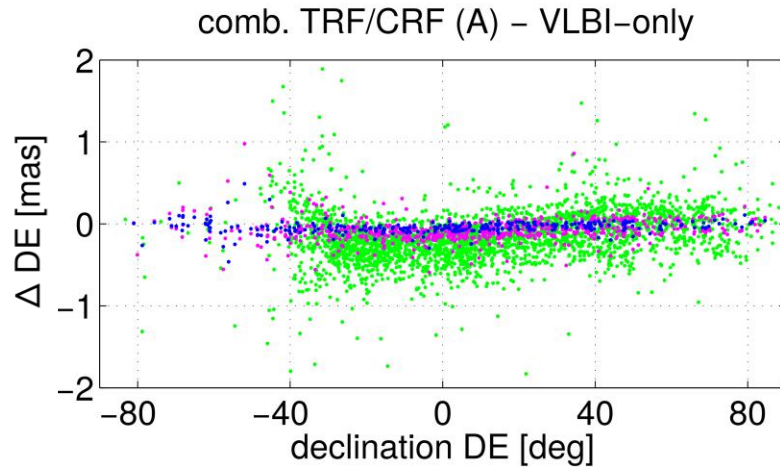
Local tie (LT) selection (3): $\Delta LT < 100$ cm



Combination: impact on standard deviations



Combination: impact on source positions



Conclusions

- DOGS-RI ready for validation by the IVS Combination Center
- reduced biases for the reprocessed VLBI solution (back to August 2004) in the IVS combination
- combined 11-year TRF/CRF solution available (including > 3500 sources)
- inter-technique combination results in reduced standard deviations for the source positions
- combination has biggest impact on poorly observed sources
- further studies: impact of local tie selection/weighting; impact of combining Earth rotation parameters; impact of seasonal station motions; etc.