

# Automatic processing INT sessions with nuSolve software

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# Script mode of vSolve

## Script support

- Qt library provides an engine for ECMAScript (standardized Java script).
- vSolve exports its types, objects and functions to make them accessible to the script engine.
- A script is a plain ASCII file that vSolve reads and executes line by line.
- In a script a user can read a session, change models, parameterization, obtain a solution, save a report, store a new version of the session, and so on.

# Script mode of vSolve

## Applications of script mode

Using the script mode allows to automate many operations.

- Arthur Niell (Haystack Observatory) used the script mode to process VGOS sessions and KOKEE mixed mode observations.
- Eskil Varenius (Onsala Observatory) processed ONTIE19 (9 databases), ONTIE20 (16 databases), VGOS-B (16 databases) sessions using the script mode. Later, he adjusted the script to analyze phase delays from these sessions.
- Nicole Geiger (USNO) developed a script to process INT type sessions.
- At Goddard we use the script mode for various purposes.

# Script autoINT.js

## Script

Initially, when the script mode appeared in vSolve, a script pia4INT.js has been created and included in a distribution. Script autoINT.js is derived form script pia4INT.js.

## Operations

- Read a database. If version greater than 3, reset all editings.
- Set parameters for estimation: clocks offset and rates only. Get single band delay solution for S-band.
- Check group delay ambiguity in S-band. Get solution, check outliers.
- Check group delay ambiguity in X-band. Get solution, check outliers.
- Evaluate ionosphere corrections.
- Set parameters for estimation: clocks, zenith delays, dUT1 or baseline vector.
- Perform reweighting/outlier processing loop.
- Obtain a final solution.
- Save a report in spool file format.

Script process one database at a time. A spool file and additional output are stored in predefined directories.

## Verification of a solution

To compare results of running `autoINT.js` script with a human solution, a simple script was created. The script reads a database, set up parameters and obtain a final solution using editings stored in the database. Then, a spool file and similar addition output are stored.

To compare two versions of editings, the following results of a final solution were used:

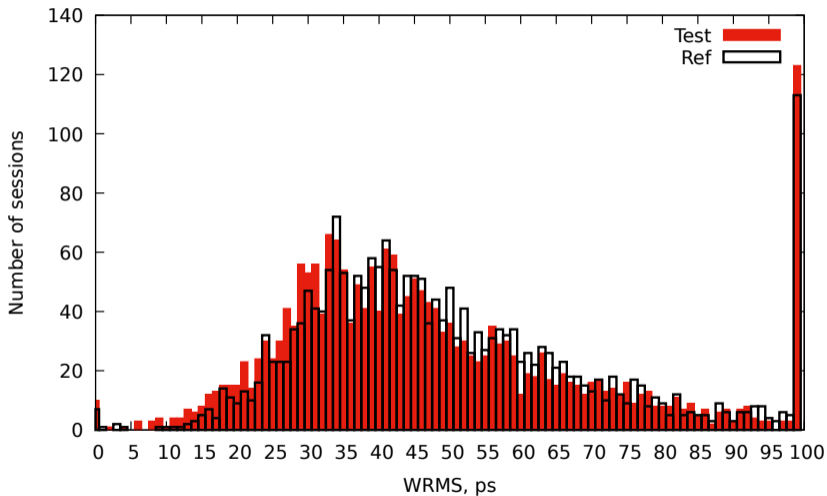
- Numbers of observations: total, usable and processed.
- WRMS of the solution.
- dUT1: a posteriori value, adjustment and standard deviation.

Comparison of script and operator solution: 2183 INT sessions from January 2017 – March 2022 (S/X and VGOS). Solutions for 1091 sessions are identical, 1092 sessions are different.

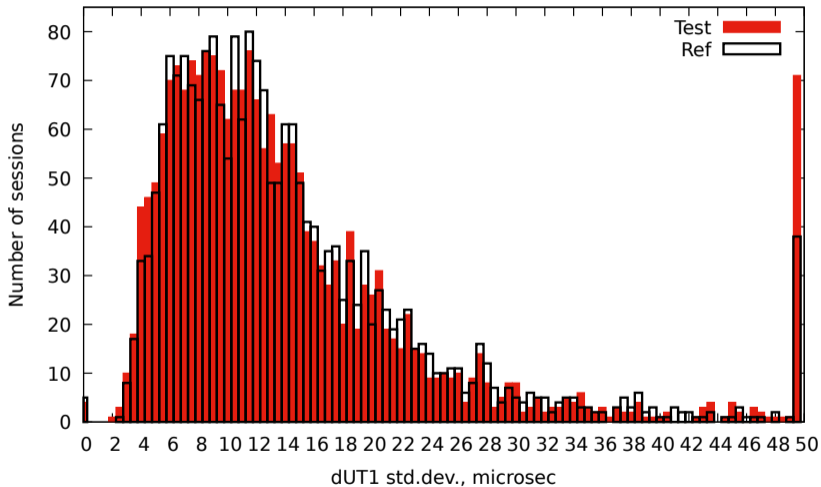
## Differences between solutions

Database	Reference solution								autoINT script							
	Number of obs			WRMS	dUT1, $\mu$ s				Number of obs			WRMS	dUT1, $\mu$ s			
	tot	good	used	ps	val	adj	$\sigma$	tot	good	used	ps	val	adj	$\sigma$		
21JAN03XK	48	46	45	30.9	-37174381.1	-5.8	5.0	48	46	45	30.9	-37174381.1	-5.8	5.0		
21JAN04VI	41	41	39	34.4	-37174423.4	-35.7	5.3	41	41	39	34.4	-37174423.4	-35.7	5.3		
21JAN04XK	40	40	39	22.5	-37174295.0	18.3	4.5	40	40	39	22.5	-37174295.0	18.3	4.5		
21JAN04XU	19	17	17	32.6	-37174390.6	-3.0	8.1	19	17	17	32.6	-37174390.6	-3.0	8.1		
21JAN05XU	19	16	16	47.4	-37174552.7	-8.0	13.5	19	16	16	47.4	-37174552.7	-8.0	13.5		
21JAN07XU	19	15	15	23.9	-37175001.6	4.5	11.7	19	15	15	23.9	-37175001.6	4.5	11.7		
21JAN08XU	20	18	18	61.4	-37175071.6	-0.5	16.4	20	18	18	61.4	-37175071.6	-0.5	16.4		
21JAN09XK	53	48	45	36.8	-37175096.6	-22.2	6.0	53	48	45	36.8	-37175096.6	-22.2	6.0		
21JAN10XK	53	49	49	40.5	-37174788.7	-20.5	6.3	53	49	48	35.7	-37174787.1	-18.9	5.6		
21JAN11VI	38	38	34	26.1	-37174059.7	9.8	4.7	38	38	38	57.6	-37174053.7	16.3	9.3		
21JAN11XK	135	134	110	33.2	-37174288.5	18.1	5.0	135	134	108	26.9	-37174290.3	16.3	4.2		
21JAN11XU	19	17	17	19.2	-37174065.0	-8.9	7.4	19	17	17	19.2	-37174065.0	-8.9	7.4		
21JAN12XU	20	16	16	47.3	-37173554.0	-23.4	14.1	20	16	16	47.3	-37173554.0	-23.4	14.1		
21JAN13XU	19	17	17	50.6	-37172987.1	8.0	14.2	19	17	17	50.6	-37172987.1	8.0	14.2		
21JAN14XU	43	40	40	70.4	-37172587.7	-11.3	11.0	43	40	39	60.5	-37172583.5	-7.2	10.0		
21JAN15XU	19	16	16	47.6	-37172136.5	2.0	11.8	19	16	16	47.6	-37172136.5	2.0	11.8		
21JAN16XK	52	49	46	45.6	-37171933.0	-31.3	6.8	52	49	46	45.6	-37171933.0	-31.3	6.8		

## Distribution of WRMS for all INT sessions 2017–2022

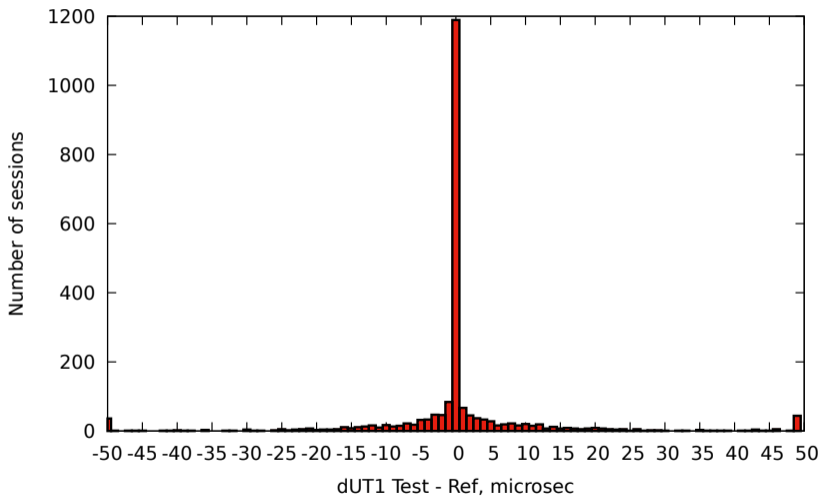


## Distribution of dUT1 std.devs, all INT sessions

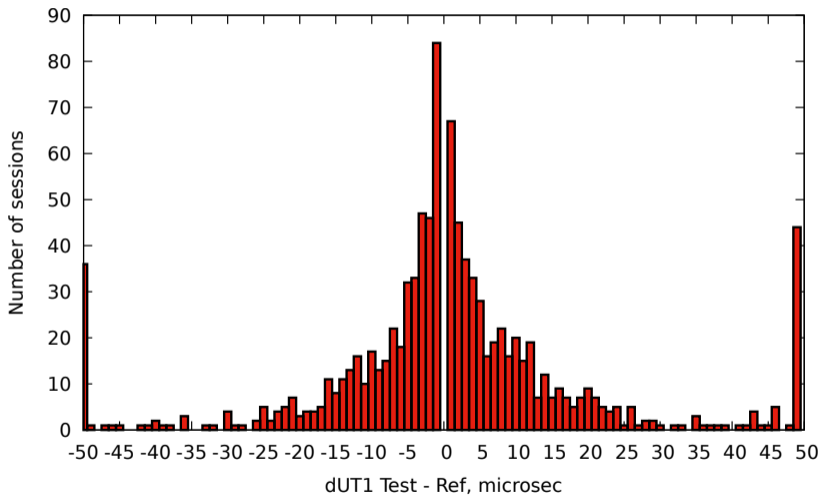




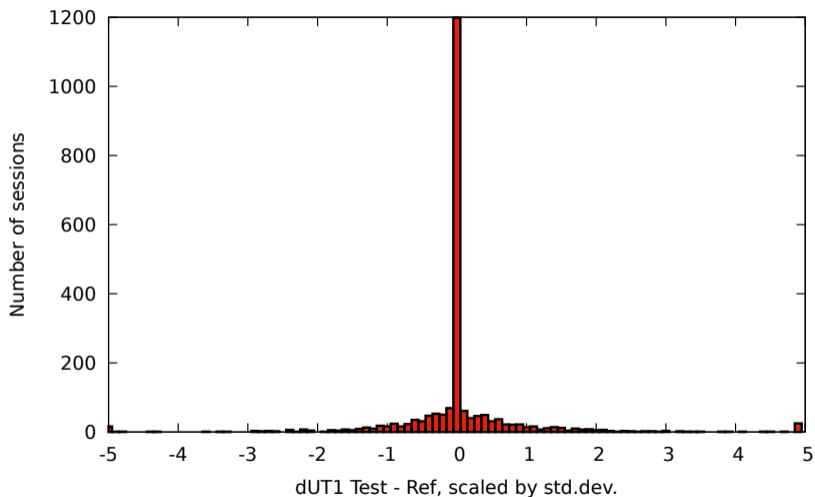
## Distribution of dUT1 differences, all INT sessions



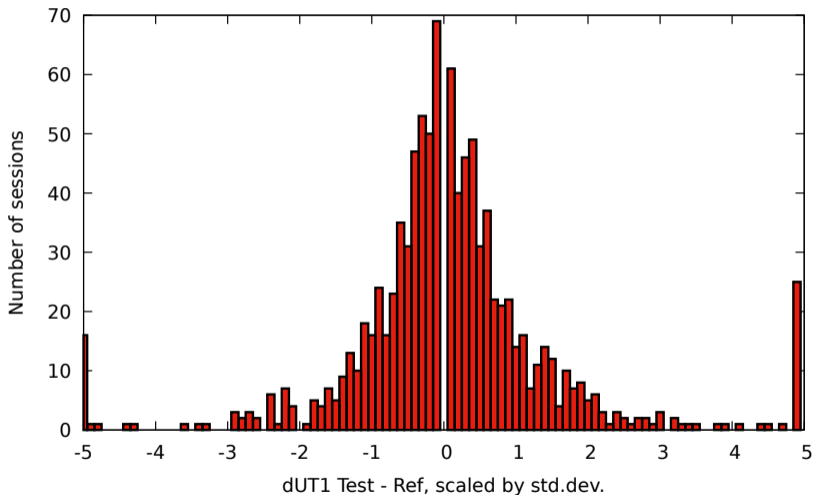
## Distribution of dUT1 differences, all INT sessions



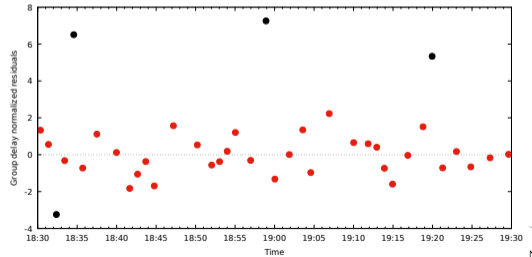
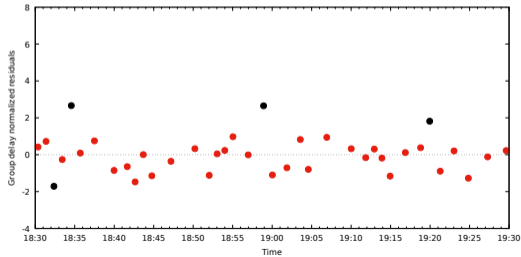
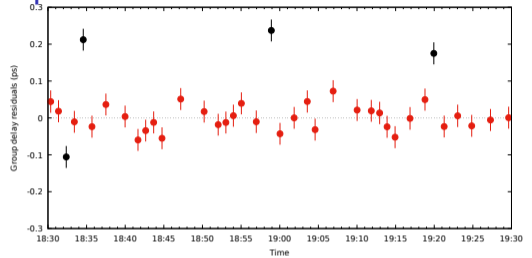
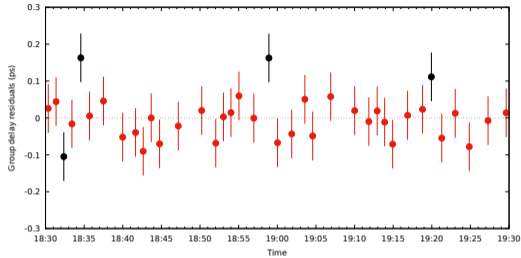
## Distribution of scaled dUT1 differences, all INT sessions



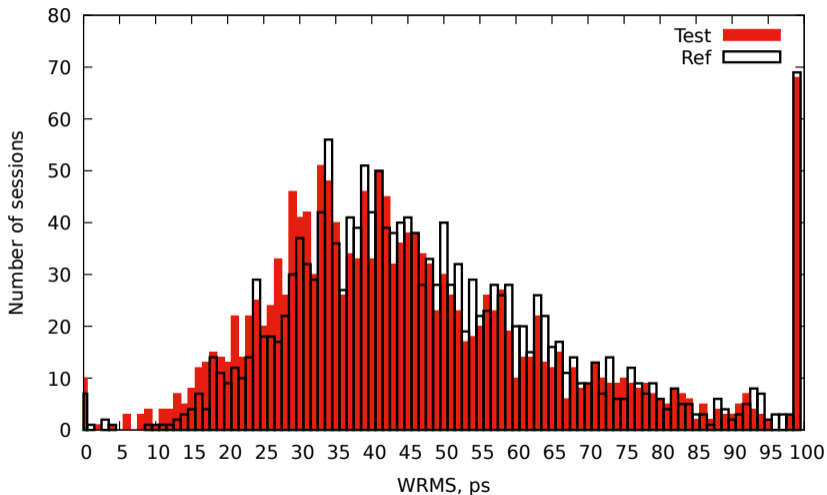
## Distribution of scaled dUT1 differences, all INT sessions



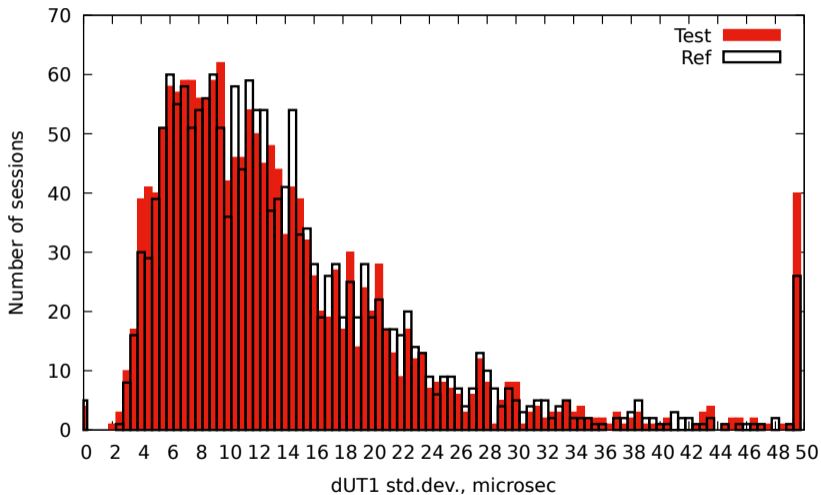
# Script vs human: 21JAN11VI



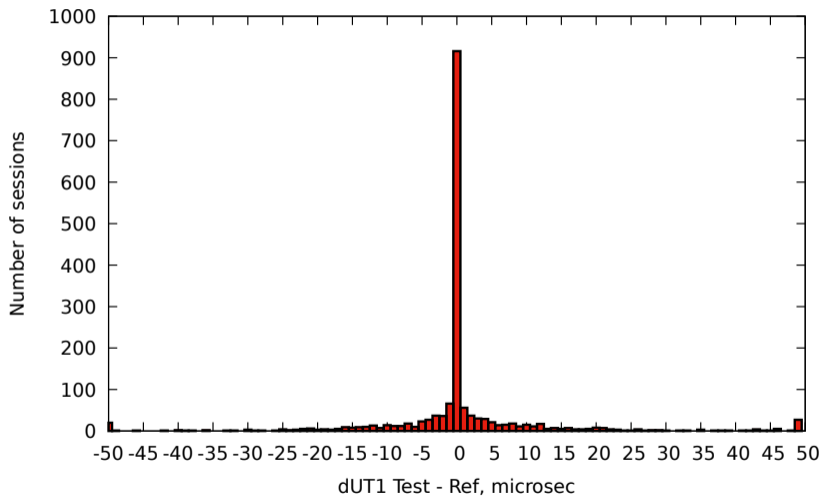
## Distribution of WRMS, non-GSI INT sessions



## Distribution of dUT1 std.devs, non-GSI

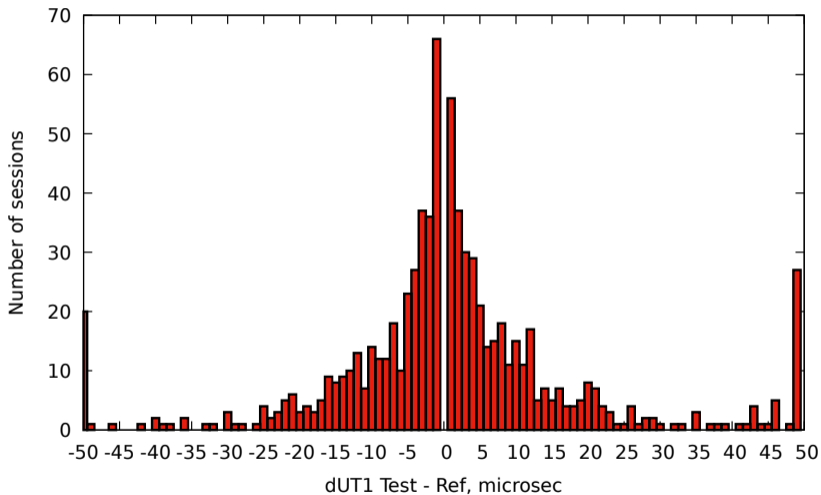


## Distribution of dUT1 differences, non-GSI

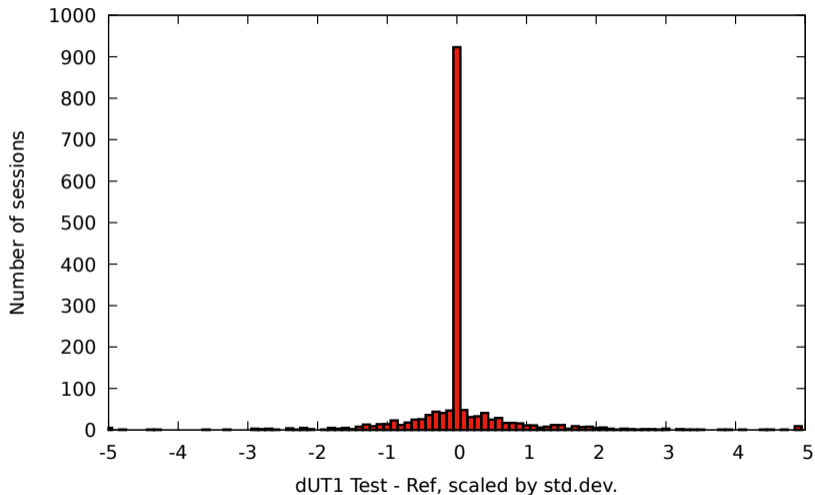




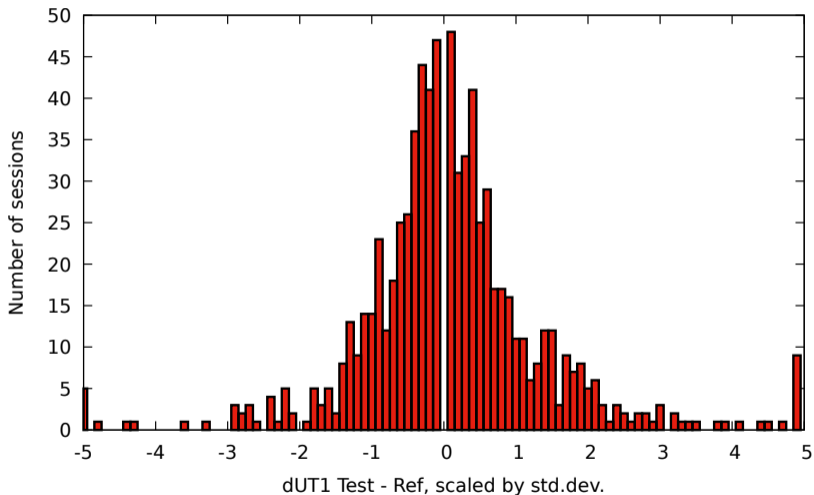
## Distribution of dUT1 differences, non-GSI



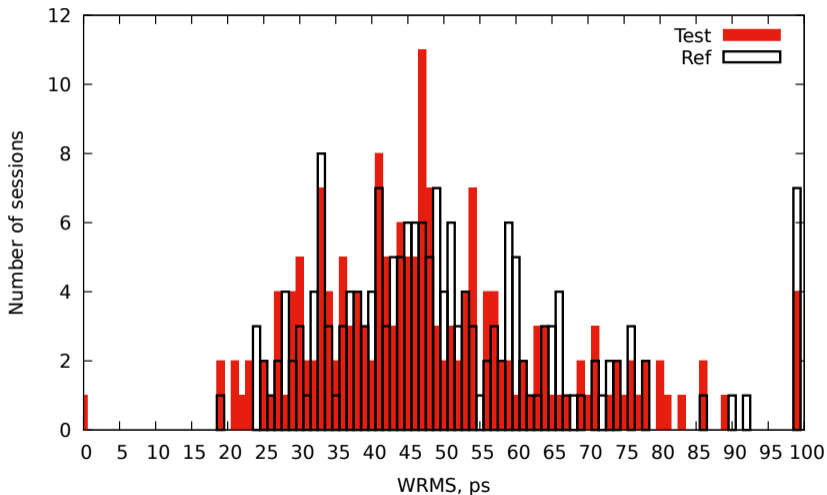
## Distribution of scaled dUT1 differences, non-GSI



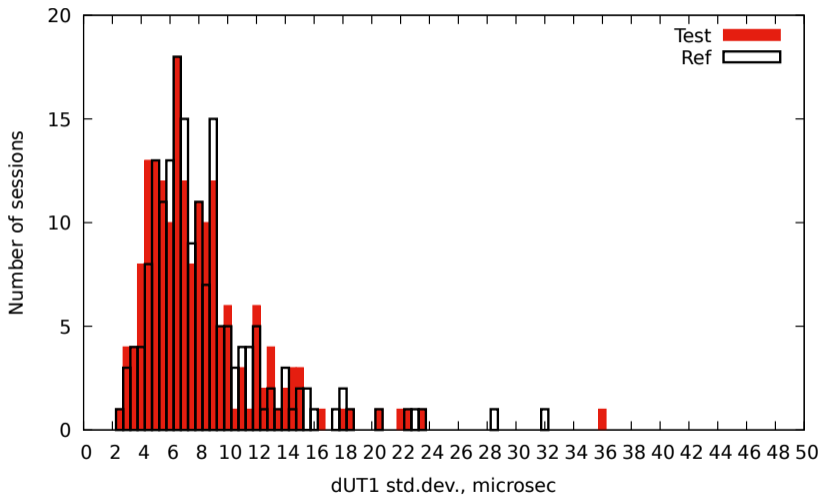
## Distribution of scaled dUT1 differences, non-GSI



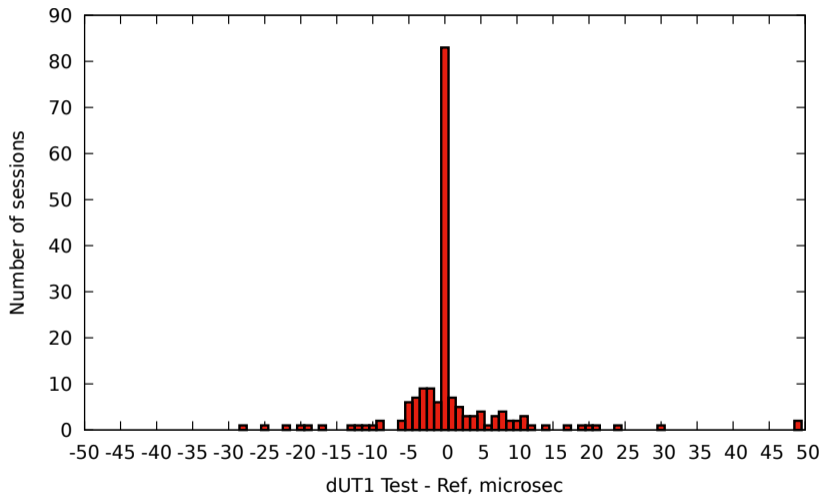
## Distribution of WRMS, VGOS INT sessions



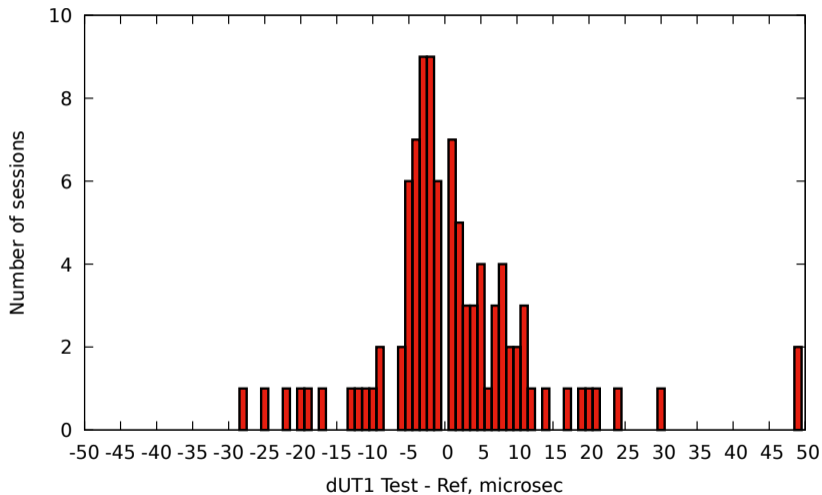
## Distribution of dUT1 std.devs, VGOS



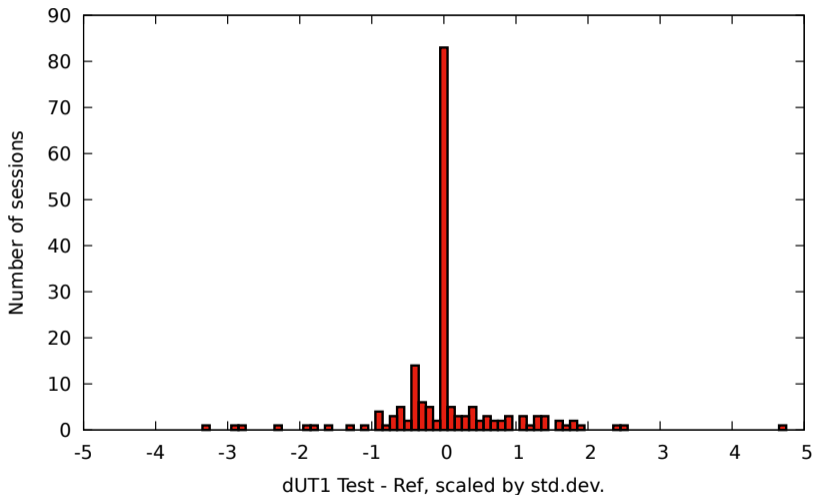
## Distribution of dUT1 differences, VGOS



## Distribution of dUT1 differences, VGOS

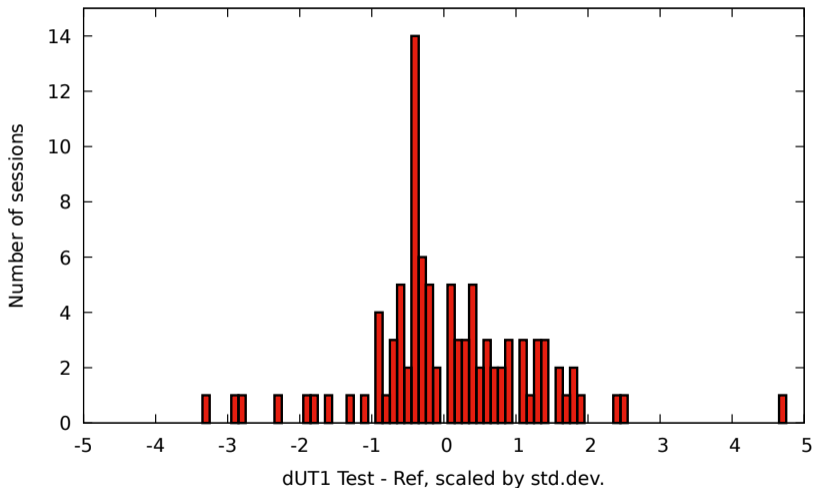


## Distribution of scaled dUT1 differences, VGOS





## Distribution of scaled dUT1 differences, VGOS



## Summary

- The automatic script is capable to process INT sessions.
- Special treatment of outliers are required when a session with small number of observations is processed.
- The work on the script is continuing.
- We plan to include it in nuSolve distribution as well as update in the future releases.

Thank you for your time!