

MPIfR/BKG correlator report

**19th European VLBI for Geodesy and Astrometry
Bordeaux, 2009**



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MK IV correlator status

- Shutdown expected 2009/2010
- 8 Mark 5A
- 4 Mark 5B (1 used for e-VLBI transfer)
- 4 Mark 5s in the lab
- Controlled by a mixture of HP-UX – Linux
- E-VLBI transfers regularly for some telescopes



Geodetic correlation (IVS)

- 60% of correlator time for geodesy
- R1 ~ 50 exps / year (eVLBI: Ts, Ny, On)
 - Data-base in 10 days
- INT3 ~ 50 exps / year (eVLBI-only)
 - Data-base in 7 hours
- OHIG ~ 6 exps / year (eVLBI: Ts, Sy)
- Europe ~ 6 exps / year (eVLBI: Mh, Ny, On, Wz)
- T2 ~ 3 exps / year (eVLBI: Ts, Ch, Aa, Ka)

More woman power required due to e-VLBI +



DiFX Collaboration

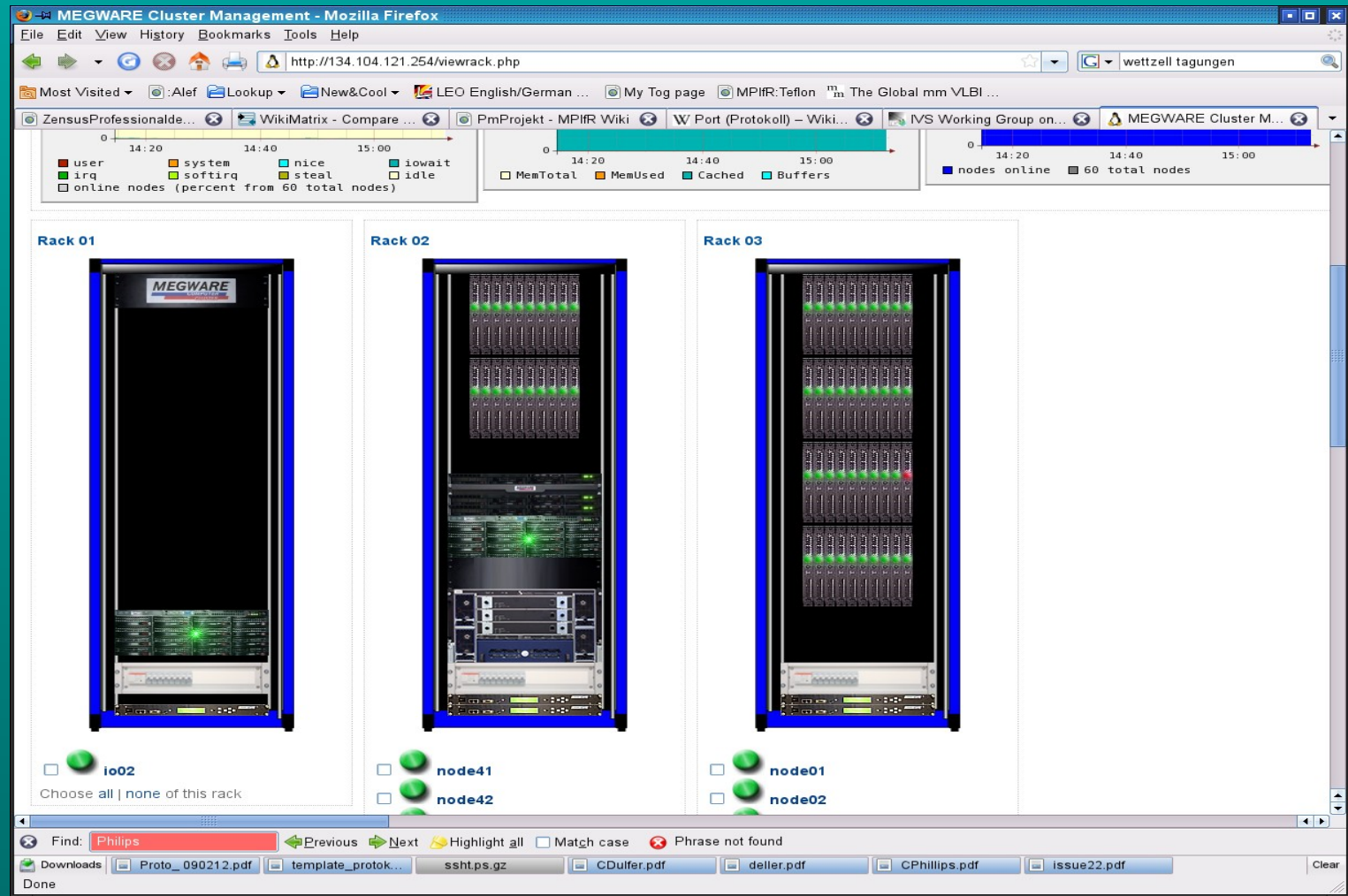
- BKG is financial partner in MPIfR's DiFX project
- IGG of University of Bonn supports the project
 - Open postdoc position
- Standard DiFX collaboration: NRAO, Swinburne, ATNF, Curtin, IRA-INAF...
- 50% programmer at Bonn starting 03/09



Hardware

- Compute Cluster with 60 Nodes + 1 FXmanager
= 488 compute cores
 - Linpack: 4 TFlops
 - 2 Raids with total 40 TB disk space
 - Infiniband and 1 GE interconnect
 - Mark 5 to Cluster 1 GE (later 10 GE?)
 - Closed cool loop
 - Power consumption ~4 – 24 kW (+ cooling)
- 16 Mark 5A/B/C









Initial (geodetic) Installation

- Installation during A. Deller visit in 2006
- Scan-based correlation
 - vex2delayuvw_scanbased.pl
 - scancorrelate.pl
 - R1240 (~3000 files)
 - ParselTongue script → AIPS



1st geodetic verification

MK IV – DiFX comparison

- Data from BM261 – subset of 4 antennas, 1 min
 - 4 freq sub-bands: 1358.49 – 1406.49 (USB +LSB)
 - 8 MHz per sub-band (128 MHz total)
 - LCP & RCP
 - 2-bit sampling
- For the comparison
 - LSB of 1358.49 MHz



1st geodetic verification correlation

- MK IV and DiFX driven from VEX
- CALC versions different ! (UT1, pol xy)
- No phase-cal for DiFX
- 128 lags, 2 s integration
- MK IV standard post-processing
 - Fourfit (fringe fitting)
 - MK4IN (export to AIPS)
 - Stores correlator model → CL table
 - Adds sidebands → had to be disabled



1st geodetic verification

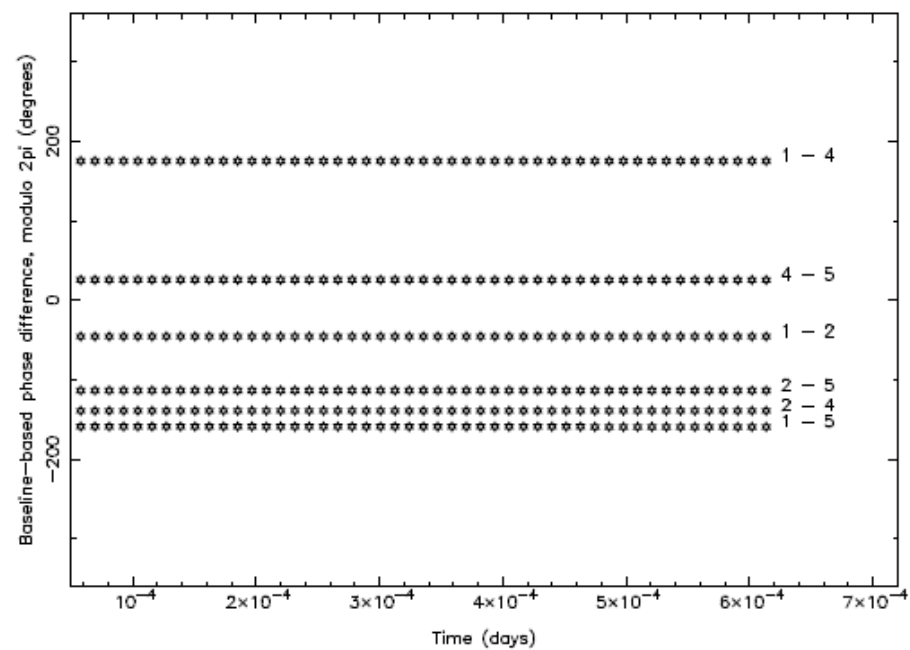
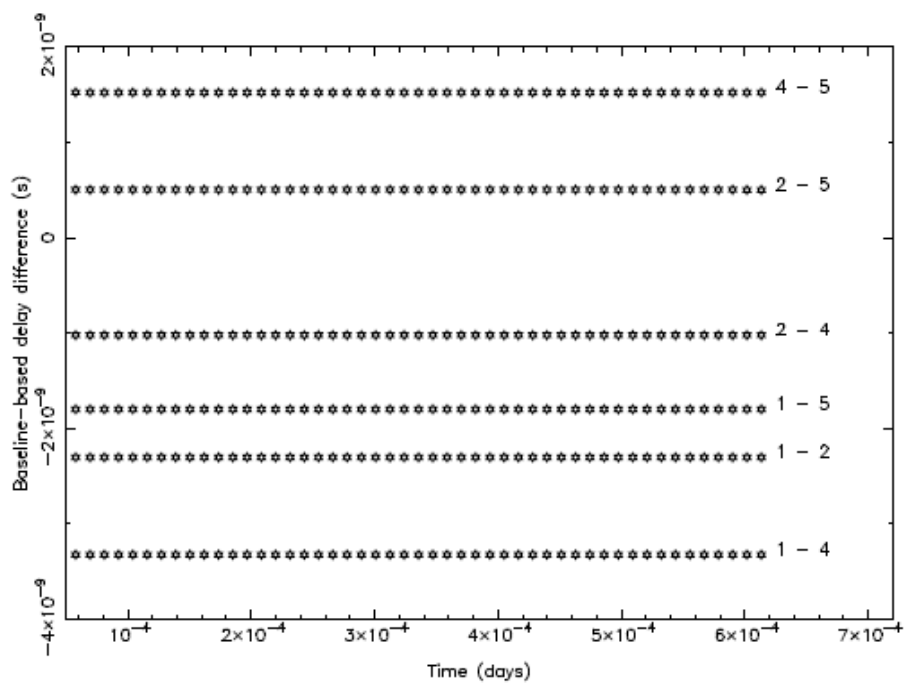
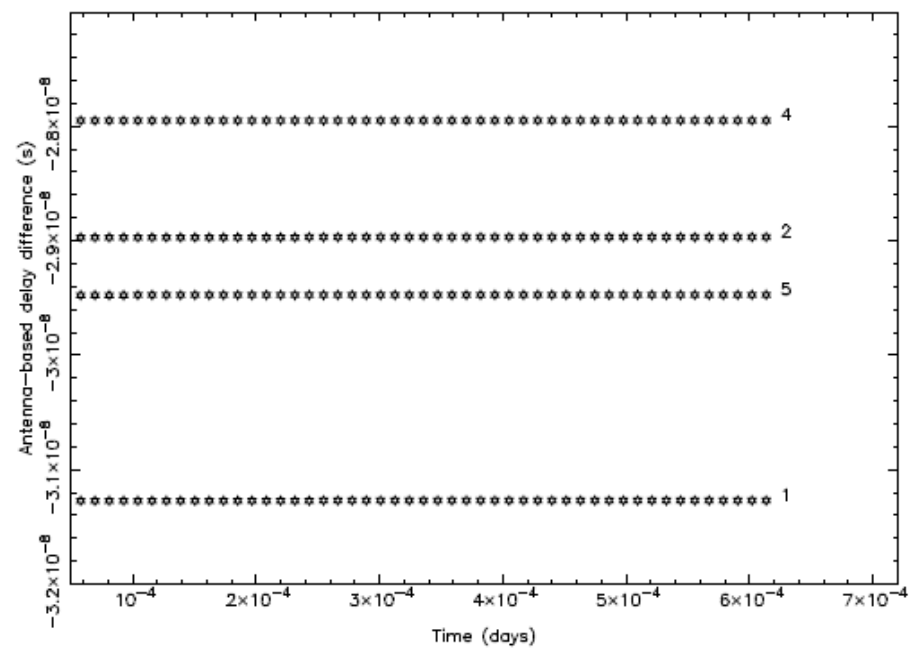
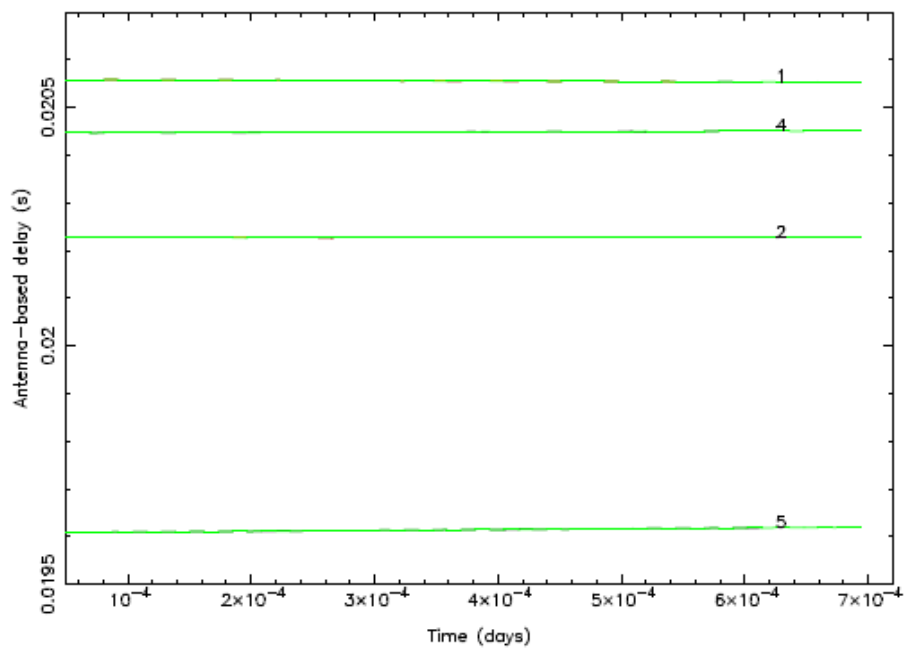
DiFX correlation

- Clocks and rates different sign
- Output RPFITS
- Export to AIPS with ATLOD
- Export to FITS (same for MK IV data)



1st geodetic comparison

- Comparison done in MIRIAD using plotting routines UVPLT and UVSPEC
- Differencing delay model of MK IV and DiFX
 - Convert to phase difference
 - Over 8 MHz e.g. $\sim 10^\circ$ (FD – KP)

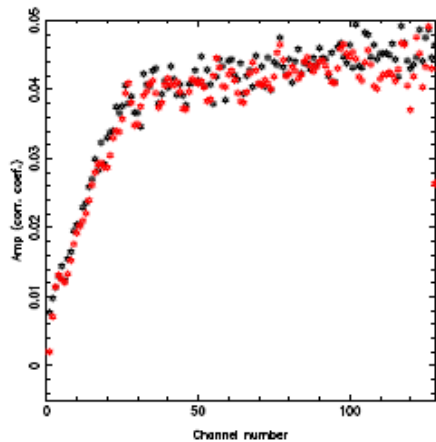




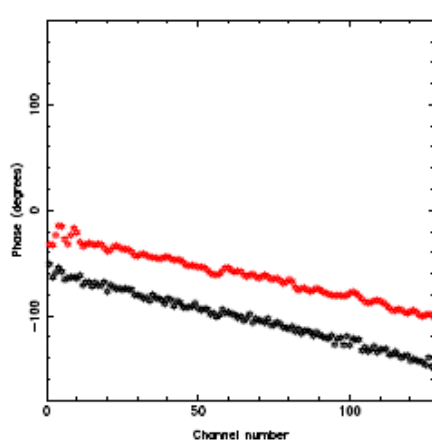
1st geodetic comparison

- Amplitude agrees within a few percent
 - Differences in how corrections are calculated and applied
- The mean phase difference as a function of time and of frequency is well within 1σ of zero

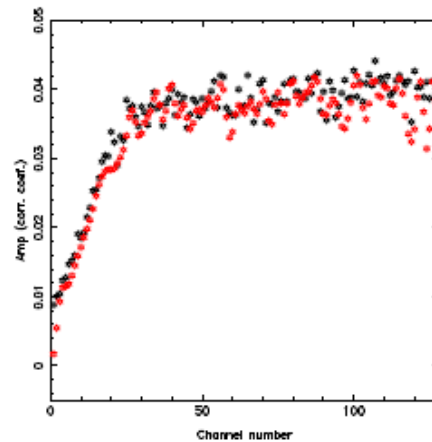
Baseline: FD - PT



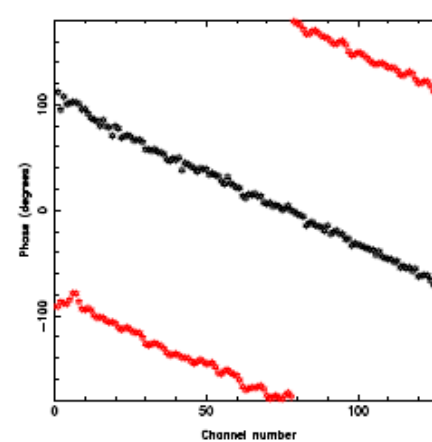
Baseline: FD - PT



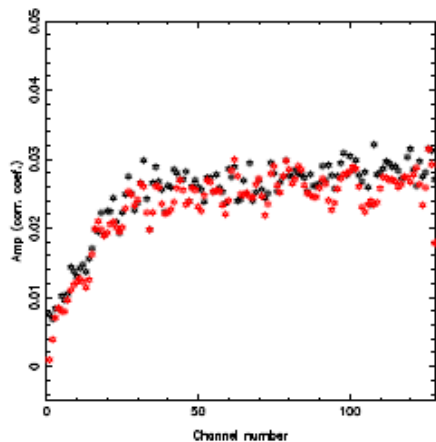
Baseline: FD - KP



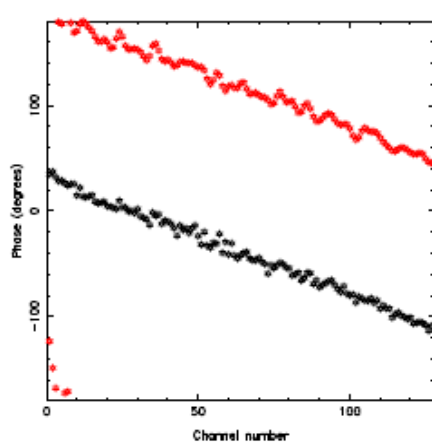
Baseline: FD - KP



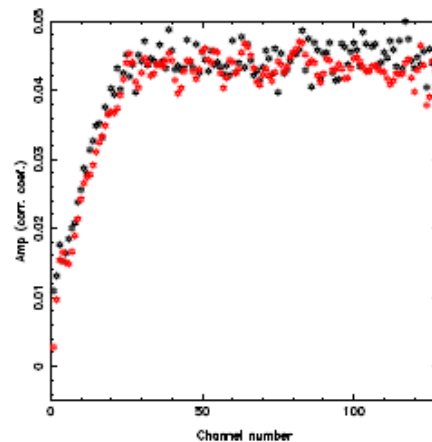
Baseline: FD - OV



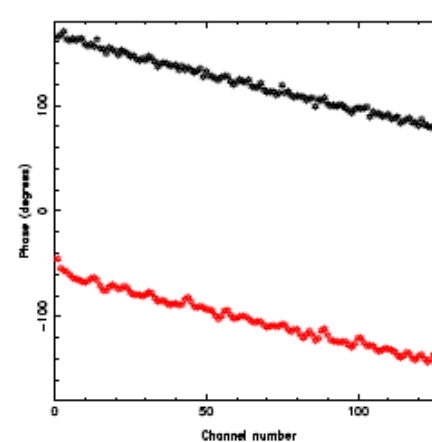
Baseline: FD - OV



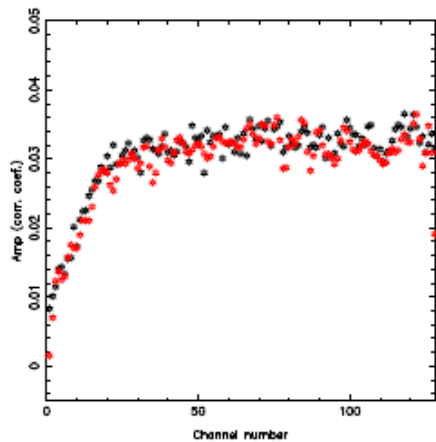
Baseline: PT - KP



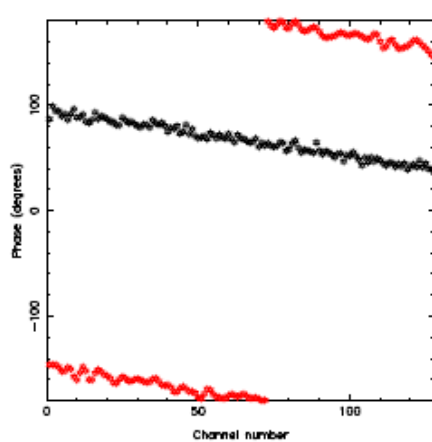
Baseline: PT - KP



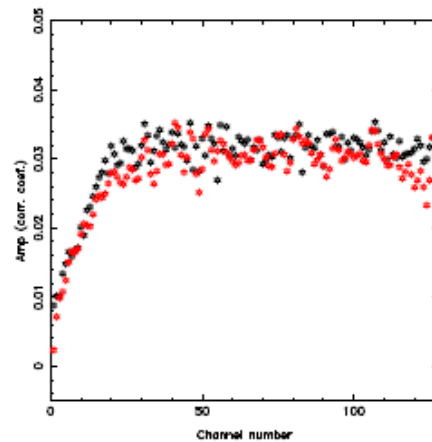
Baseline: PT - OV



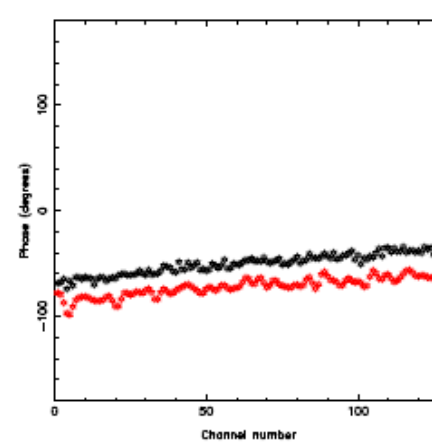
Baseline: PT - OV

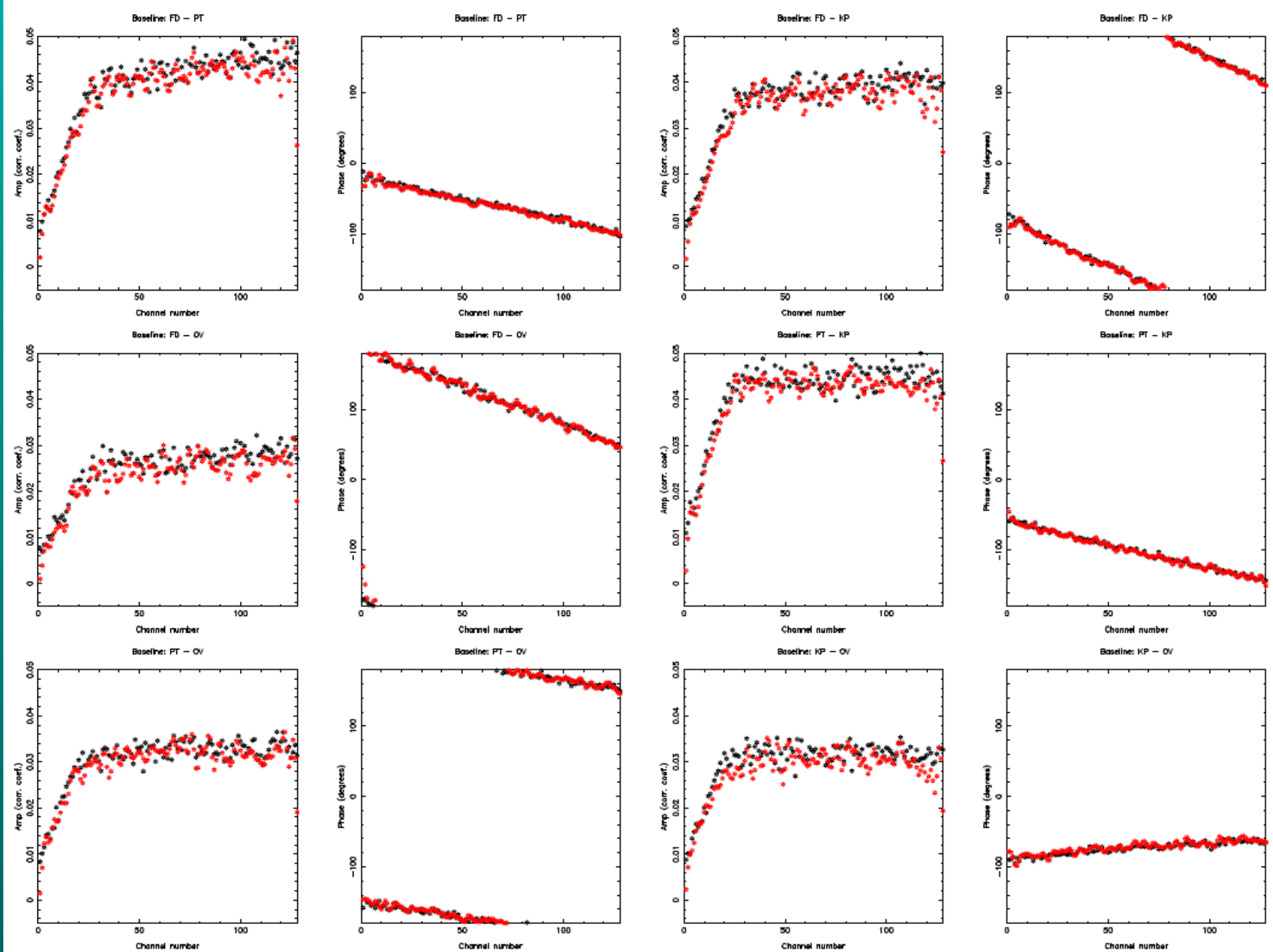


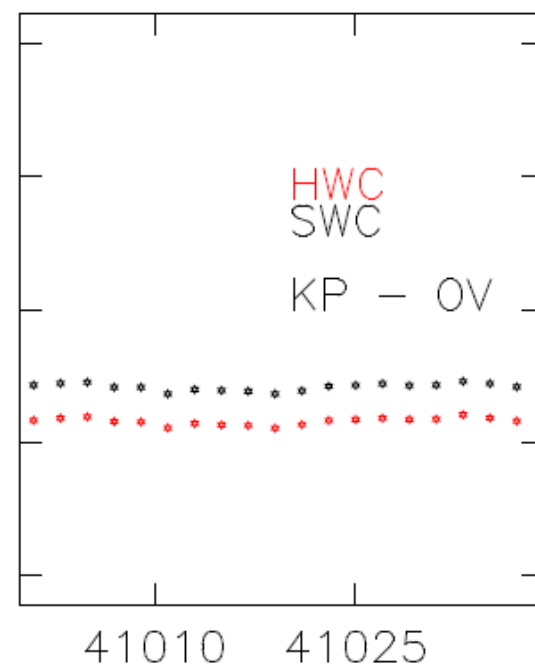
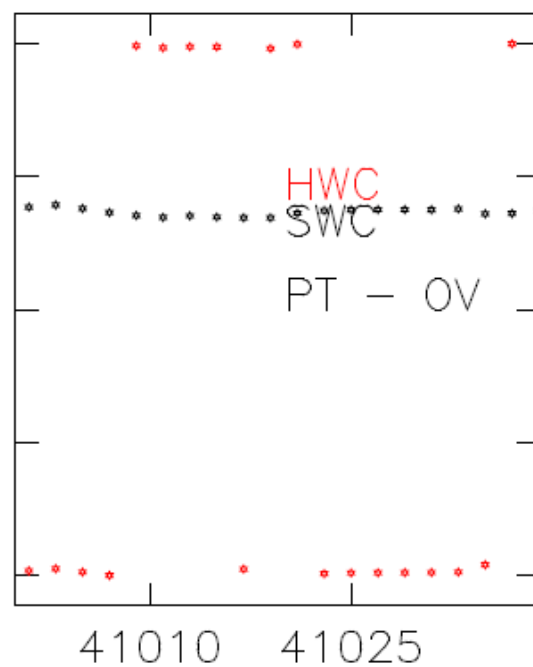
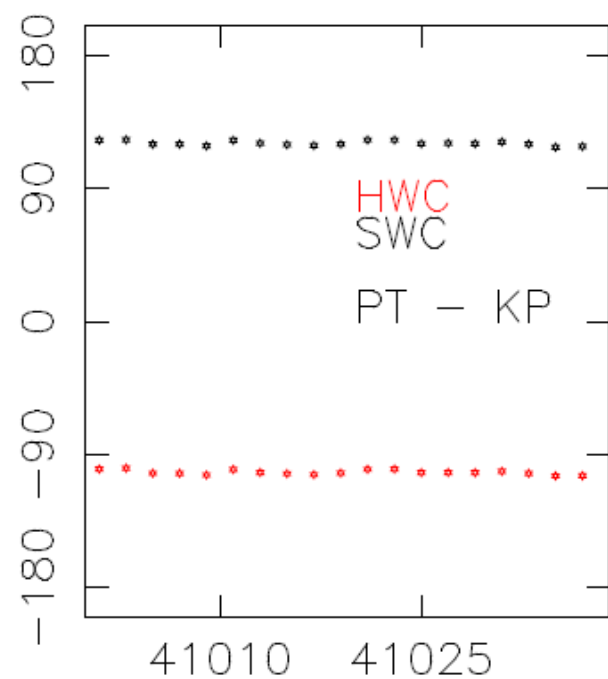
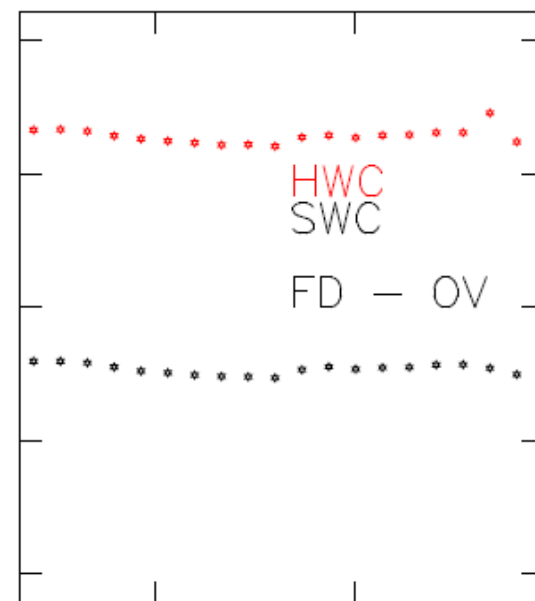
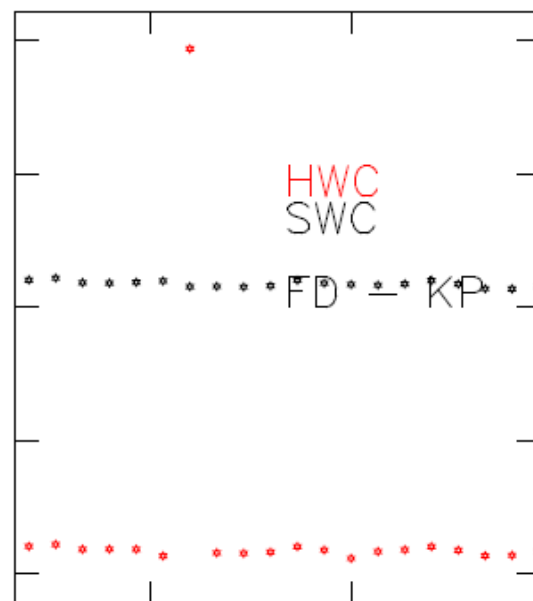
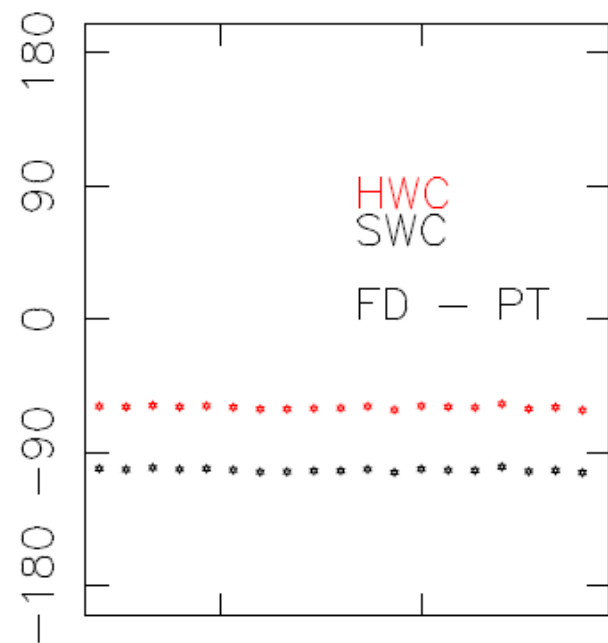
Baseline: KP - OV

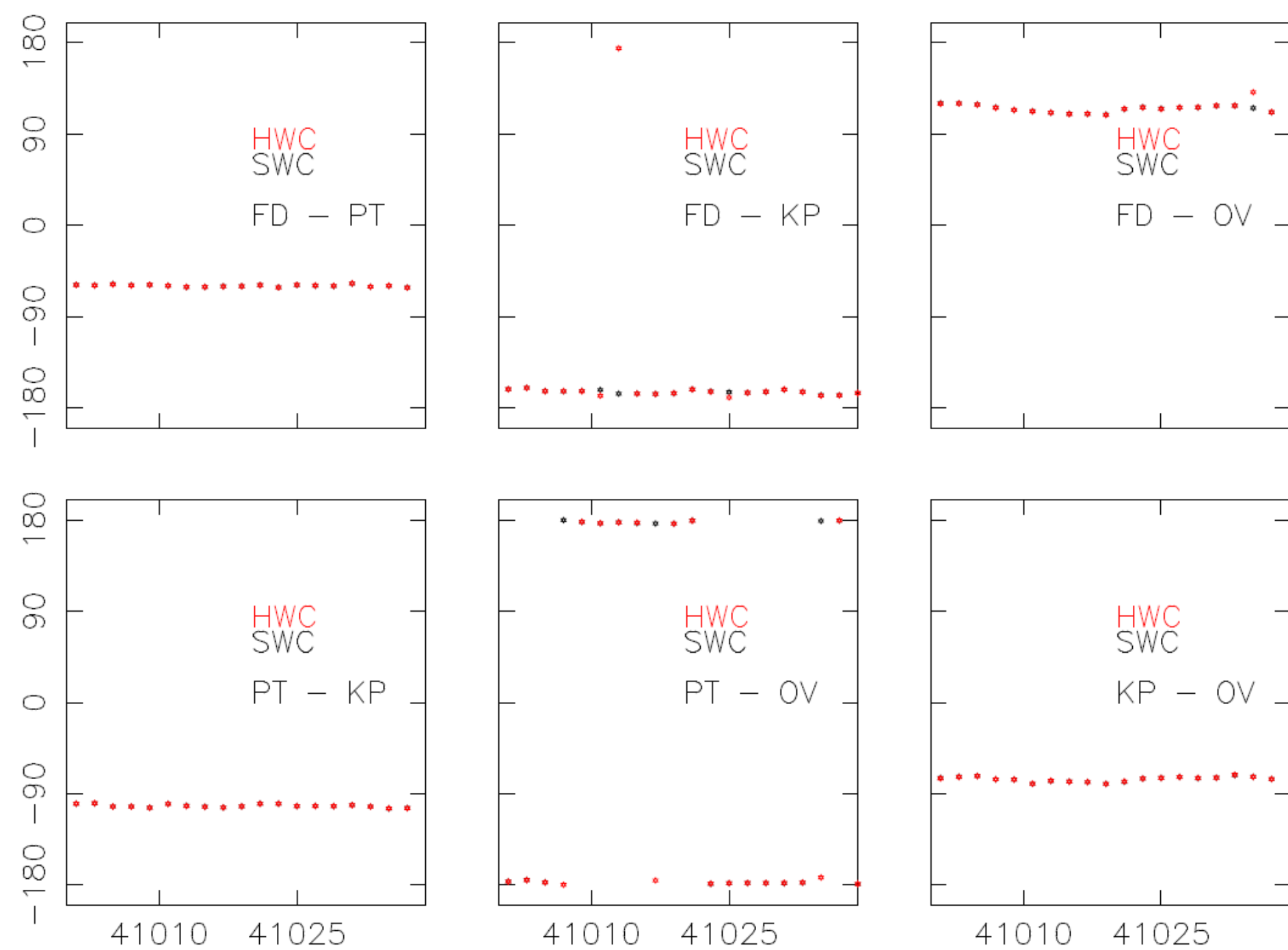


Baseline: KP - OV











1st geodetic comparison

Results of differenced phase

The mean phase difference is well within
1 σ of zero

R^2 indicates less than 1% due to linear
regression $\Rightarrow$ no significant difference

Baseline r^2	Mean of phase differences ($^\circ$)	Standard deviation of phase differences ($^\circ$)
FD - PT 1×10^{-4}	-1.60	2.46
FD - OV	0.56	1.22



1st geodetic comparison differenced phase vs. time

Excellent agreement,
though MK IV for some time samples deviates

Baseline	Mean of phase differences (°)	Standard deviation of phase differences (°)	r ²
FD - PT	-0.234	1.700	
	4.7×10^{-2}		
FD - OV	-0.663	1.676	
	1.03×10^{-1}		

Second Verification (Last Week)

- Mark IV Correlator
 - Phase cal tone extraction
 - MarkIV output (lags)
- Fourfit (fringe fitting)
- AEdit (data inspection)
- Fourfit
- Further Data inspection
- Export to Database
- DiFX Correlator
 - fits-idi output
- AIPS¹
 - Initial fringe fit on strongest source to replace Phase Calibration from Phase tones
 - Fringe fit
 - Output to Mark III
- DBEdit

¹following “explain ASTROMET” recipe

Further Development

High Priority

Phase Cal tone extraction

- Master's Project (Frédéric Jaron)
- Parallel code will be added to DiFX

Medium Priority

Mark IV output

- Not a simple format conversion
 - Have to transform to lag space

Lower Priority

Native K5

Further Testing and development

Testing with all back-ends

- Lots of broadband formats
- Out of order channels
- Experience so far is encouraging

Reading Directly from Mark5 units

- VLBA

eVLBI

- ATNF

Performance and Benchmarking

Multiple Subnets

- Currently need to launch a separate correlation job for each subnet
- Some overhead involved with this but shouldn't be prohibitive



DiFX for geodesy: plans

- Phase-cal extraction
- INT3 correlation (export via AIPS)
- 24 h full geodetic run ~ 8 stations
- output to MK IV format
 - Fourfit
 - Standard geodetic export with DBEDIT