

# Simulation of VGOS observations at the raw data level with VieRDS

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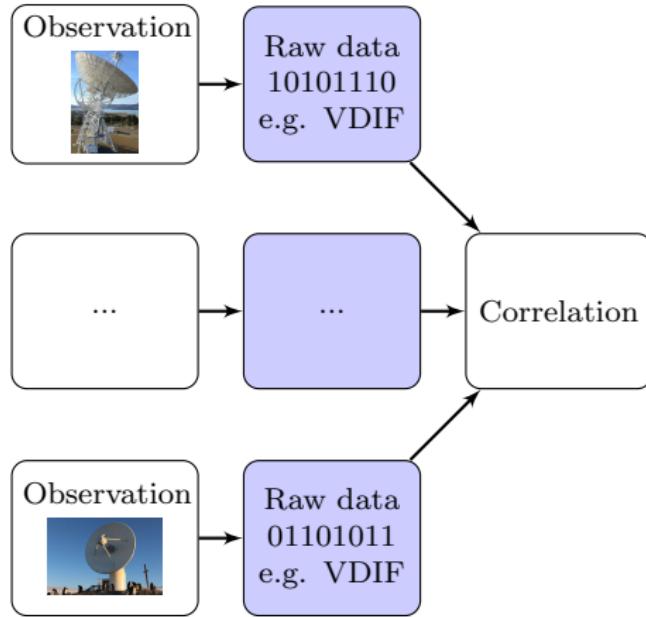
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**EVGA**

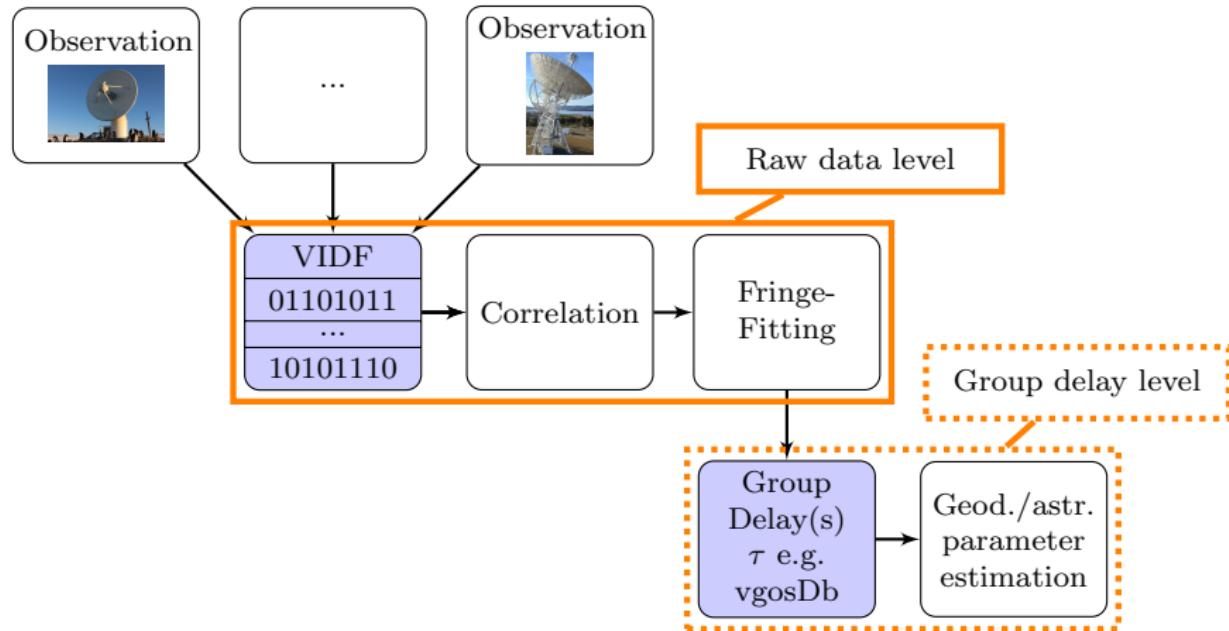
March 16, 2021

# Definition: Raw data



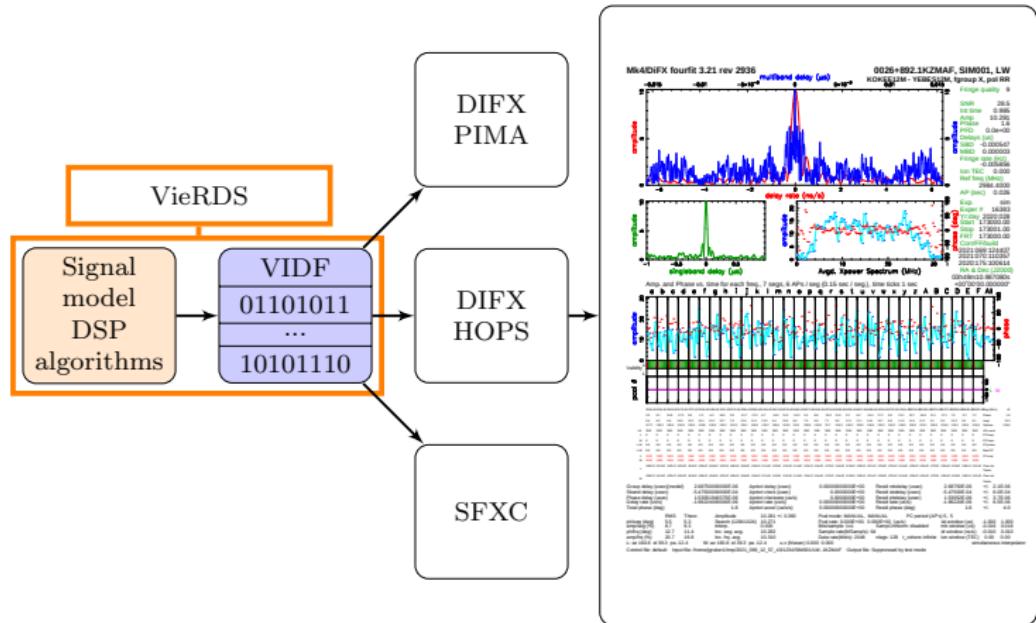
**Raw data** is referred to as the filtered, down-converted, sampled, and quantised electric field strength measurements generated at each station.

# Why simulating at the raw data level?



**Direct accessibility** of systematic (and random) effects at the observation and raw data level, which are vanished at the group delay level.

# VieRDS: A novel software to simulate raw VLBI data



**Released 2021:** <https://github.com/TUW-VieVS/VieRDS>

**Reference:** Gruber et. al (2021), accepted by PASP

## Studies

- ① Power of the phase calibration signal (PCAL)
- ② Characteristic VGOS station frequency response
- ③ New VGOS frequency setups

# PCAL power: Real fourfit PCAL amplitude values, VO1021, Oe,Wf

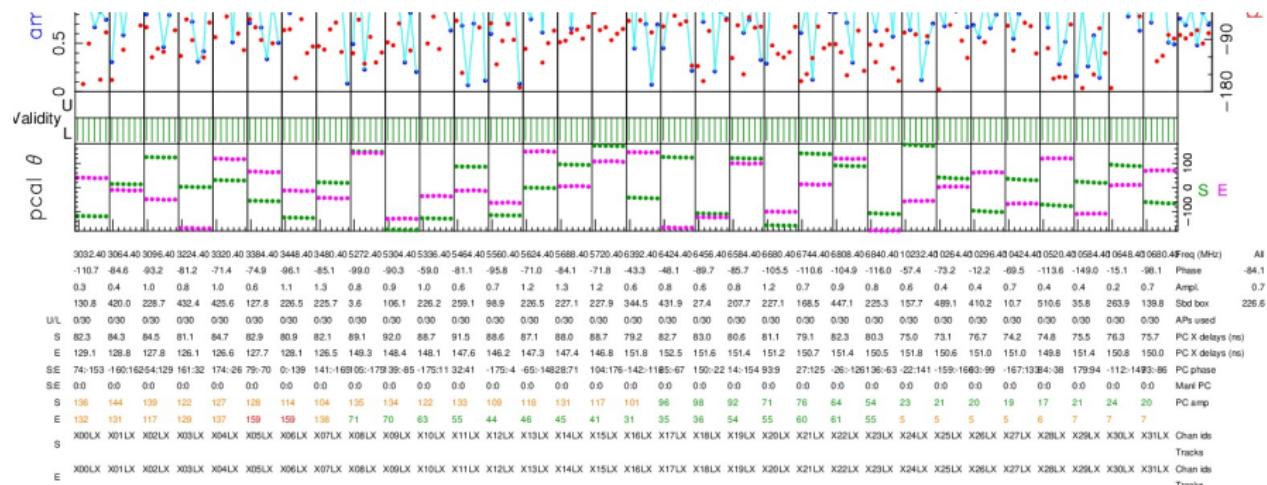
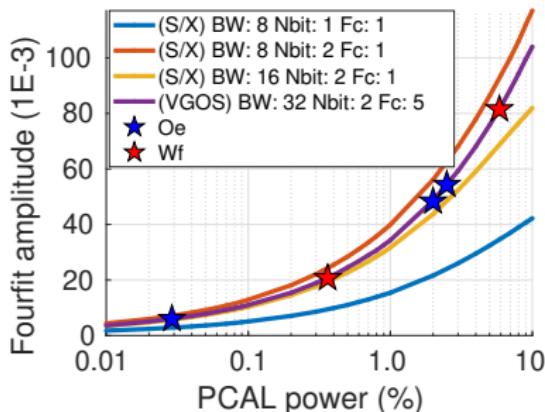


Table: Mean Fourfit PCAL amplitudes per VGOS band from plot above

	A	B	C	D
Oe	126.7	124.9	81.5	20.7
Wf	137.7	54.3	48.3	6.0

# PCAL power: Simulated and real PCAL amplitudes

VieRDS (**PCAL**) → DIFX → HOPS (PCAL phase, SNR)



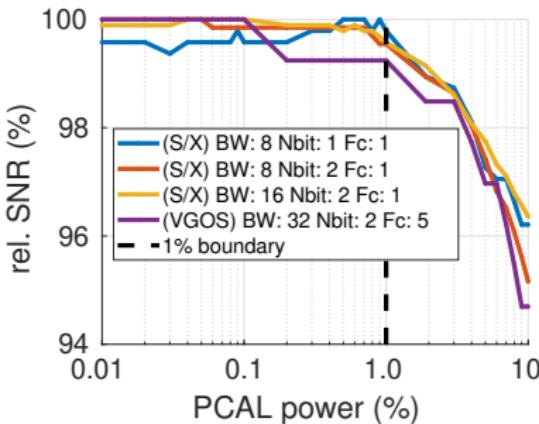
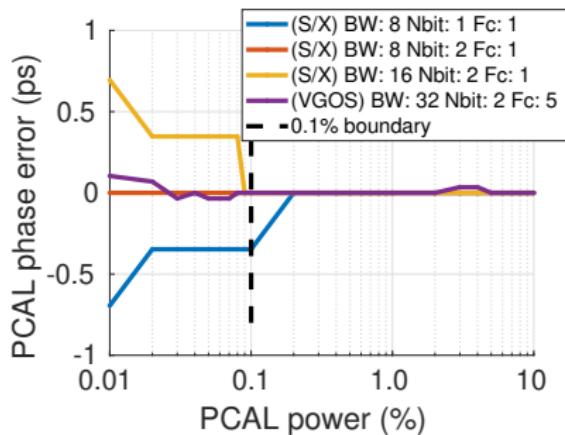
- ① PCAL amplitude can be parameterized by relative power  $p_{cal,rel}$  (%)
- ②  $p_{cal,rel} = \frac{P_{pcal}}{(P_{src} + P_{sys})}$
- ③ Simulation of  $p_{cal,rel}$  from 0.01 to 10 %
- ④ **Goal:**  $A_{PCAL,fourfit}(p_{cal,rel})$

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# PCAL power: 'sweet area'

VieRDS (**PCAL**) → DIFX → HOPS (PCAL phase, SNR)



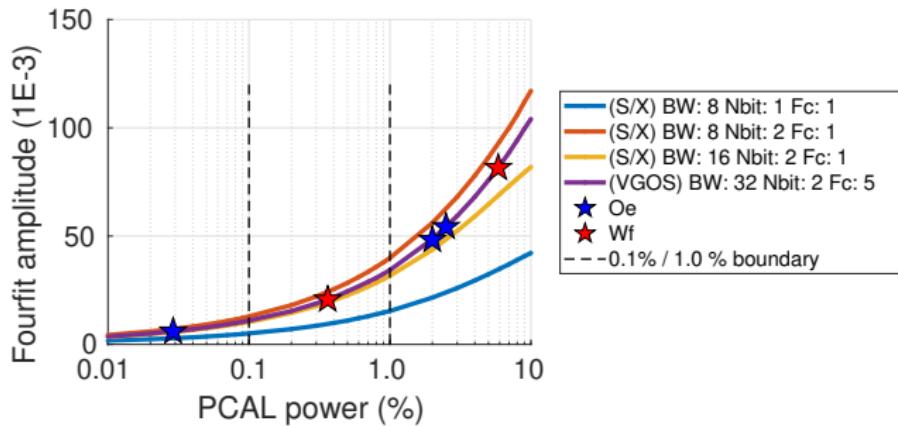
Interesting PCAL power thresholds: 0.1 % and 1.0 %

Below 0.1 %: the PCAL phase measurements show significant errors.

Above 1.0 %: SNR of the quasar noise signal is decreased.

# PCAL power: 'sweet area' and real data

VieRDS (**PCAL**) → DIFX → HOPS (PCAL phase, SNR)

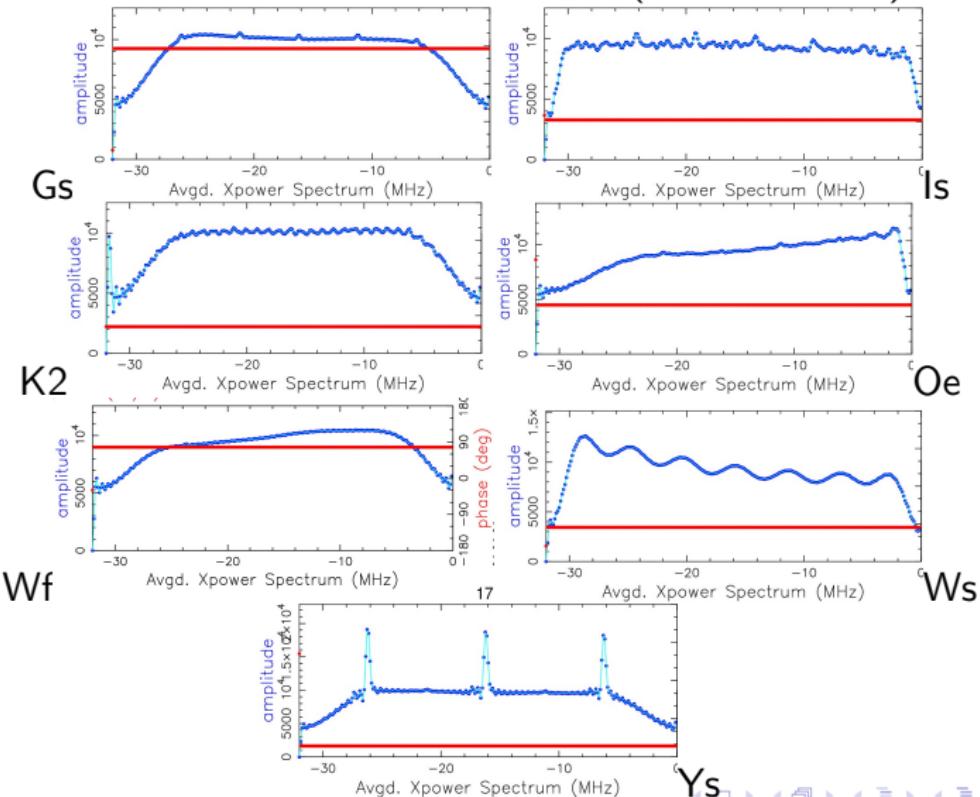


Interesting PCAL power thresholds: 0.1 % and 1.0 %

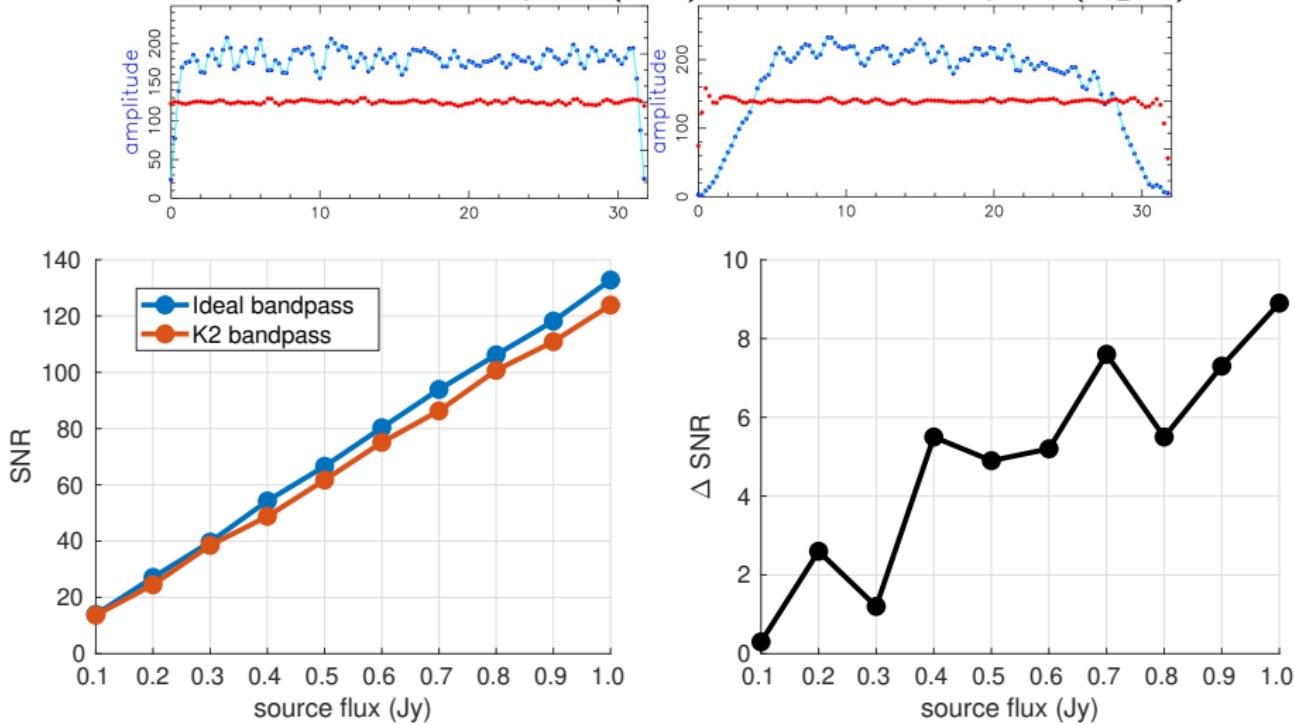
With the current real PCAL power setup it seems to be difficult to get into the sweet area.

# VGOS station frequency response

Real data: VO1021, channel 26 (10.26440 GHz)

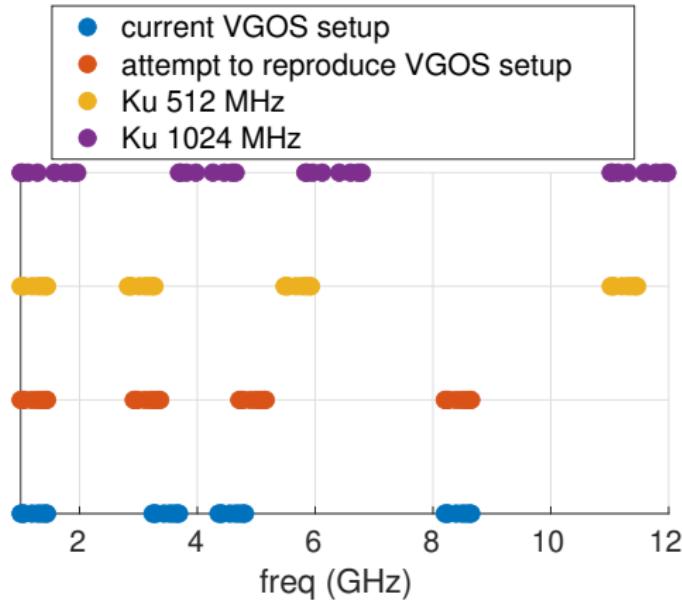


## Simulation of ideal bandpass (**left**) and of K2 bandpass (**right**)



Some SNR is lost due to the station characteristic frequency response.

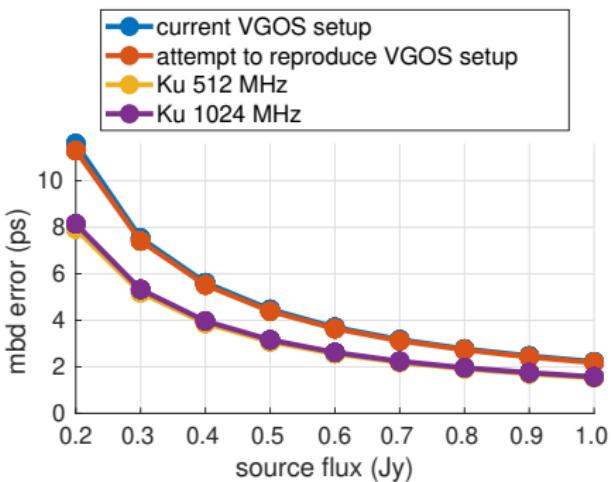
# New VGOS frequency setups by B. Petrachenko



Provided by **Bill Petrachenko** (Mail: [IVS-vtc] VTC meeting, Feb 2021).

# New VGOS frequency setups: MBD error performance

VieRDS (**multi-channel**) → DIFX → HOPS (mbd error)



The fourfit multiband (mbd) error shows a significant improvement for frequency setups going up to Ku band.

# Take-home messages and outlook

- VieRDS: Novel software to simulate raw VLBI data.  
(<https://github.com/TUW-VieVS/VieRDS>)
- Generates VDIF data which can be used in standard VLBI pipelines  
(e.g. DiFX-HOPS).
- PCAL power shows a 'sweet' area between 0.1 % and 1.0 % of rel. power.
- Not surprisingly, some SNR is lost due to the station characteristic frequency response.
- Significant improvement of fourfit mbd error for new frequency setups going up to Ku band.
- **Outlook: Simulation of linear polarized feeds and source structure.**

Thank you very much  
for your kind attention!