Universität Rostock

Traditio et Innovatio

Status of design of HOM coupler

(Beam positions from diode-downmixed HOM-signals?)

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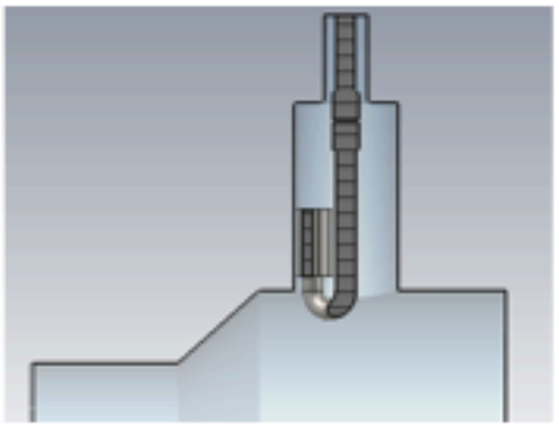
Status end of last Nov:

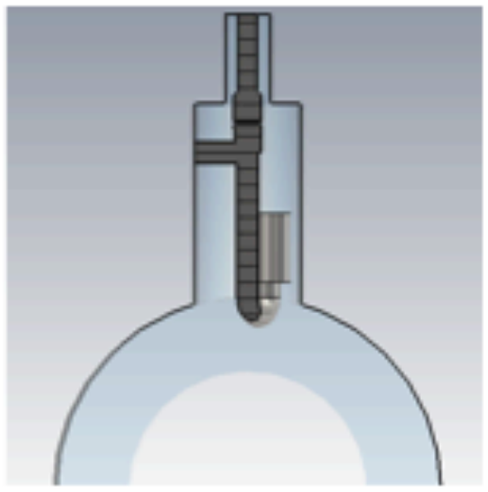
Some geometrical details

Penetration depth of the antenna/loop in the beam pipe could be increased, but:
- risc of dark current heating,
- impedance

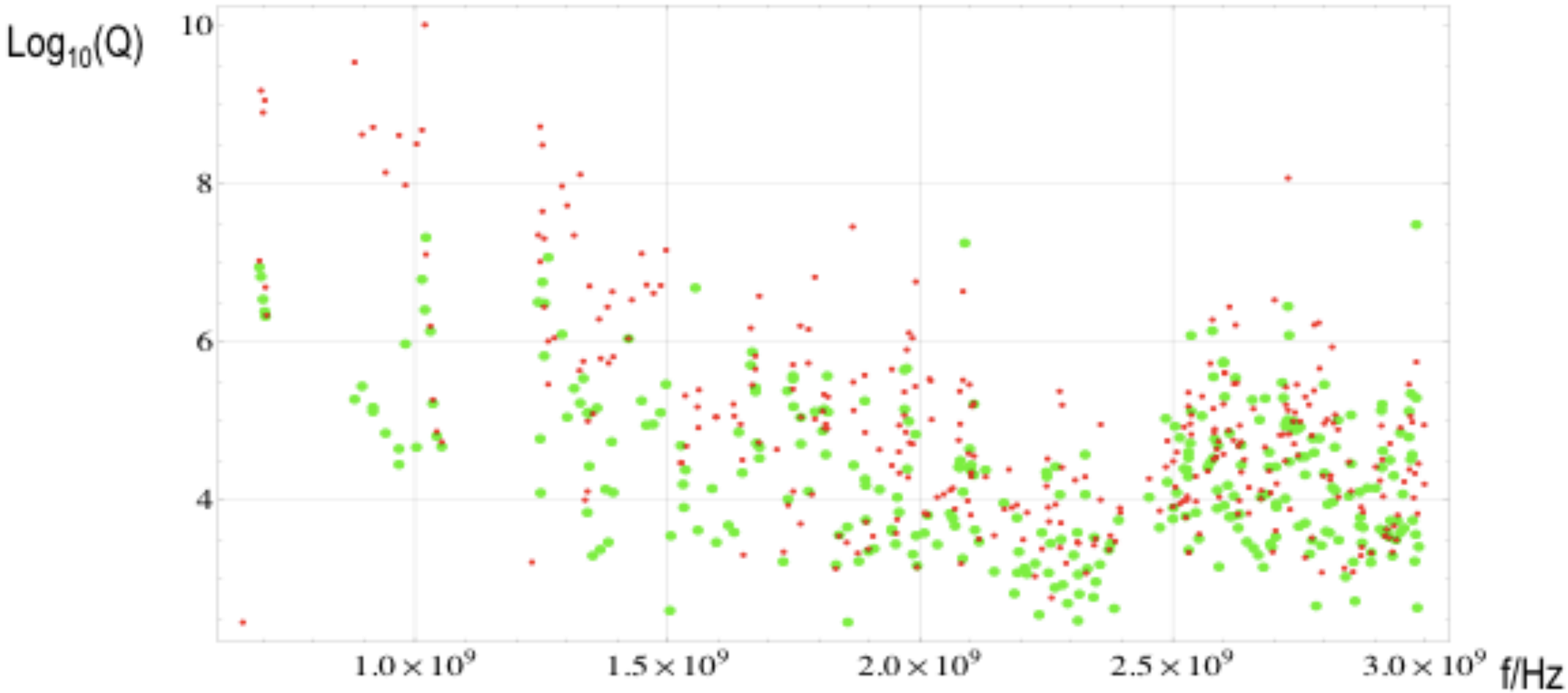
Mechanical stability, esp. against oscillations, may be an issue.

But: LHC cavs. use similar concept (courtesy W.W.)



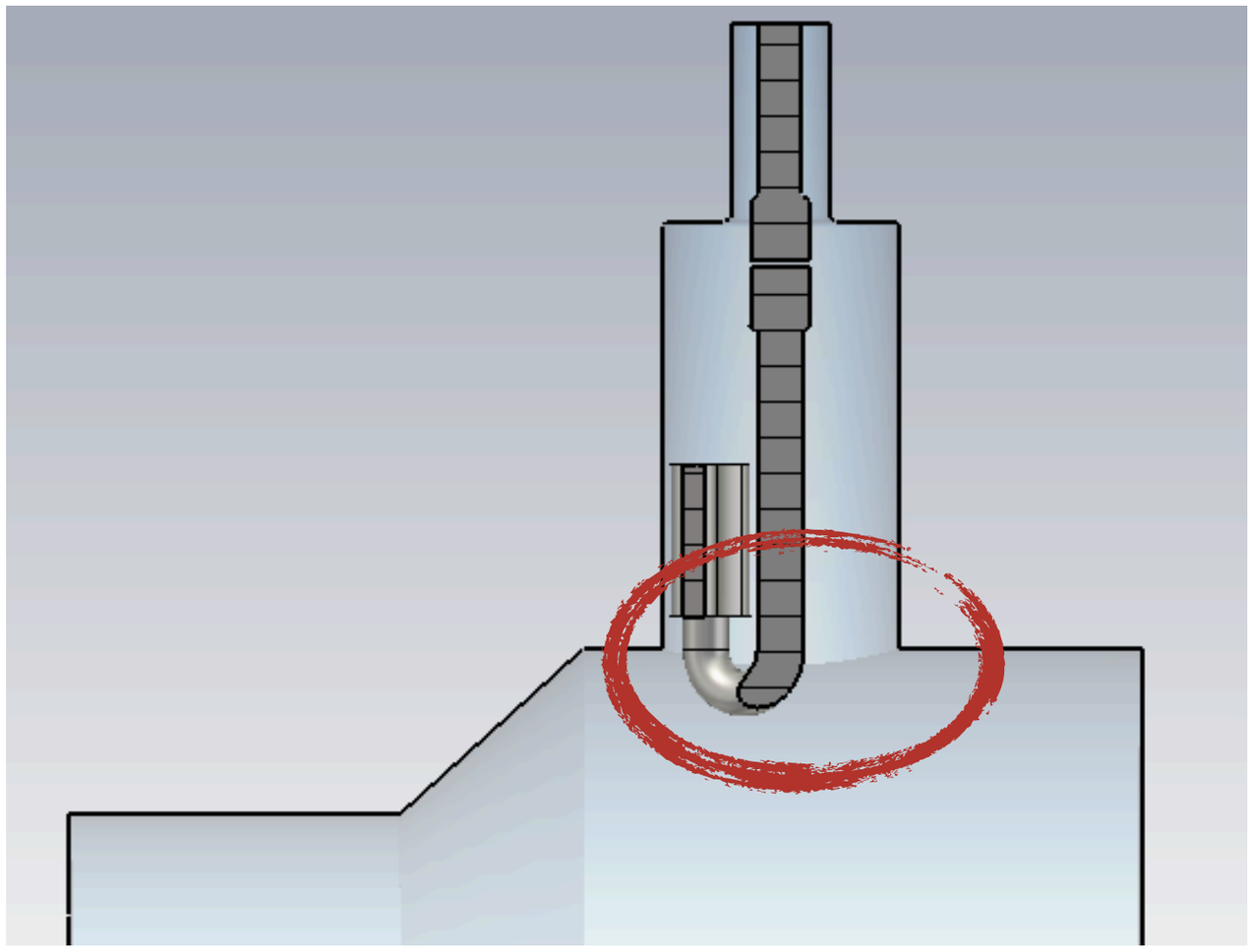


Status end of last Nov:



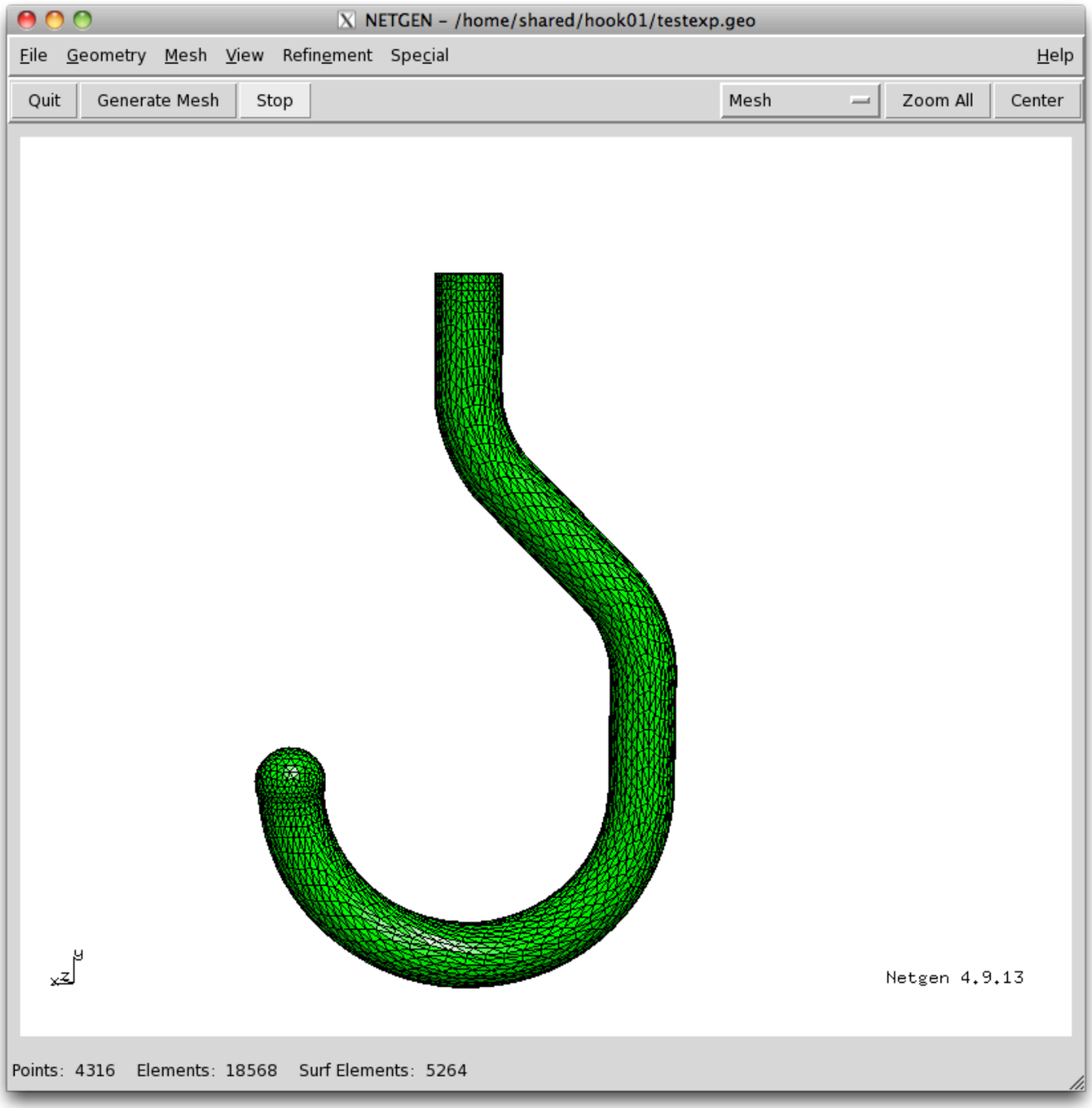
- red: HOM coupler only, green with matched power coupler
- main power coupler helps significantly below 2 GHz; still Qs > 10^6 found

Conclusion end of last Nov:



increase penetration depth and " coupling area"

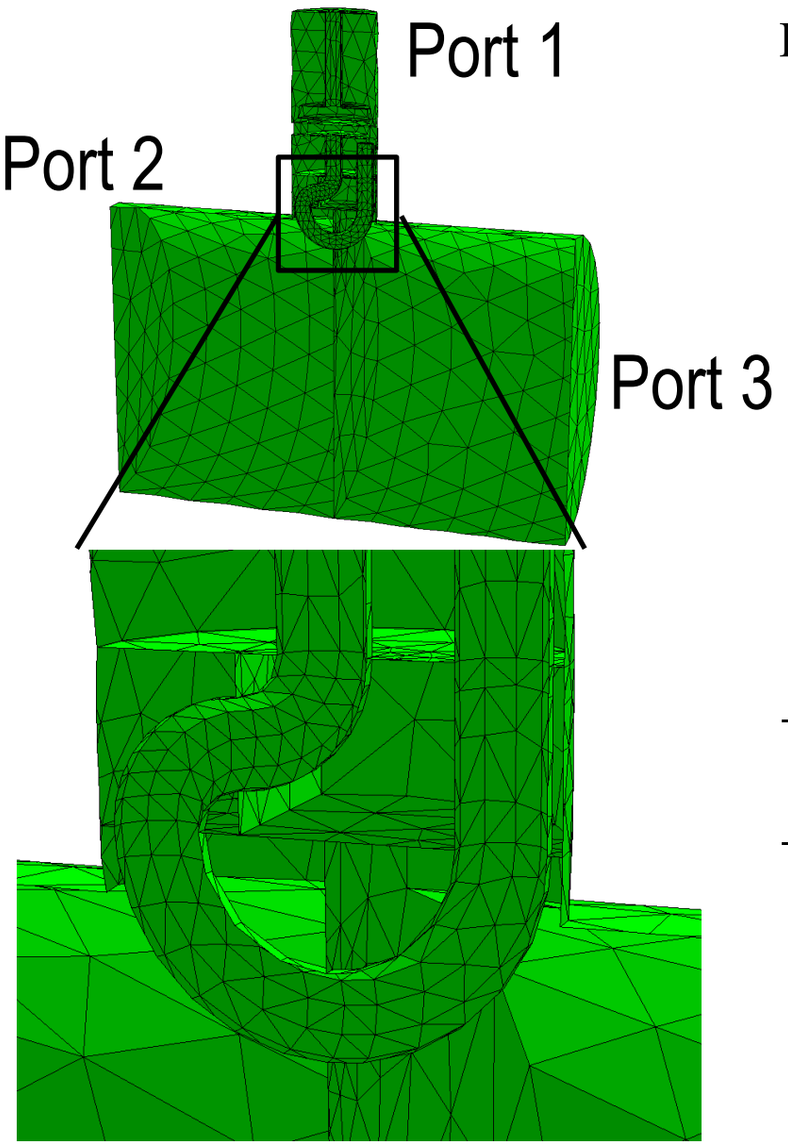
So we would like to have something like this

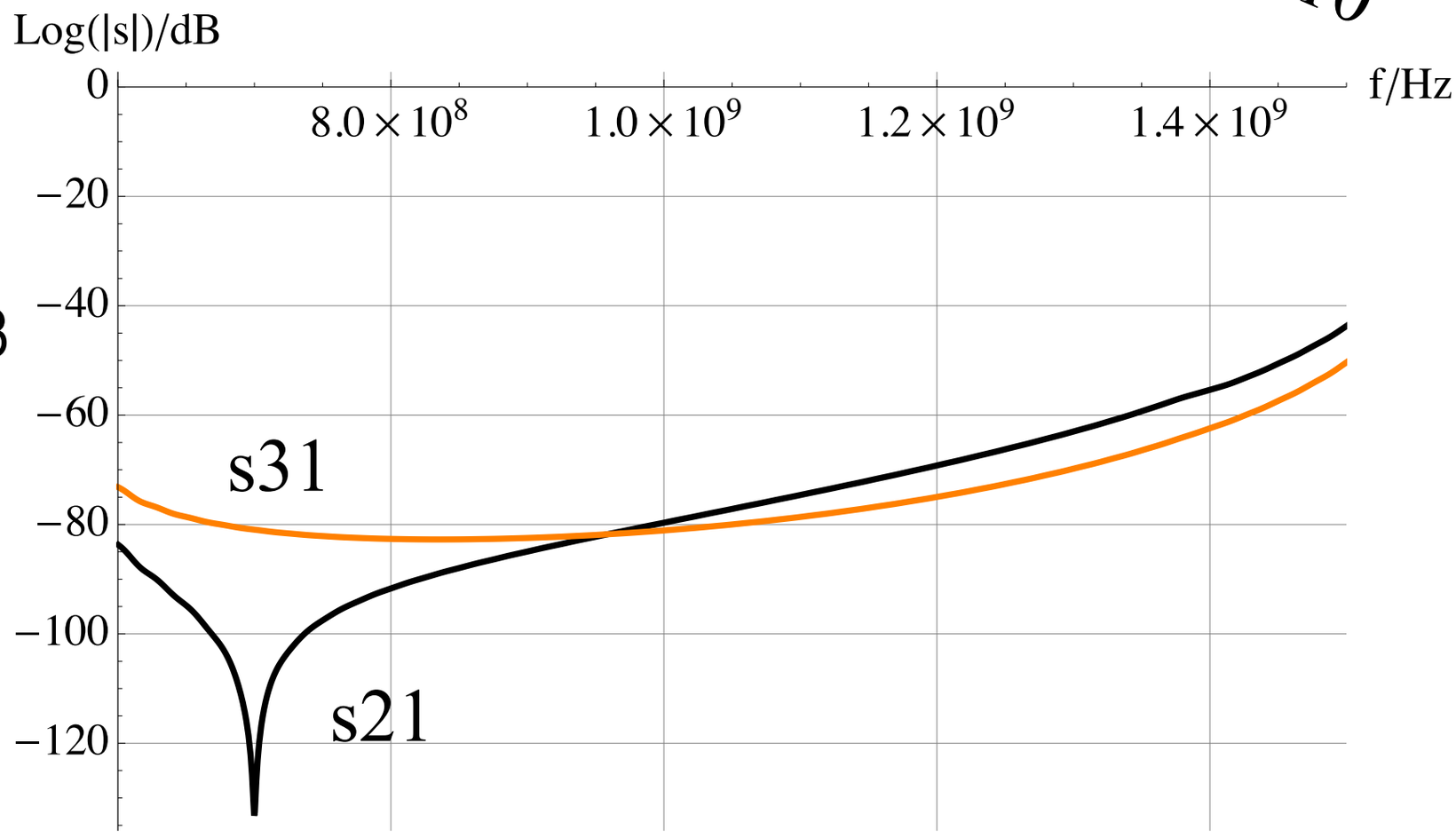


... taking profit from our freshly installed GPU-based ...

shown @ HOM10, Cornell, Oct10

Then - GPU Accelerated DG-FEM (NUDG*)



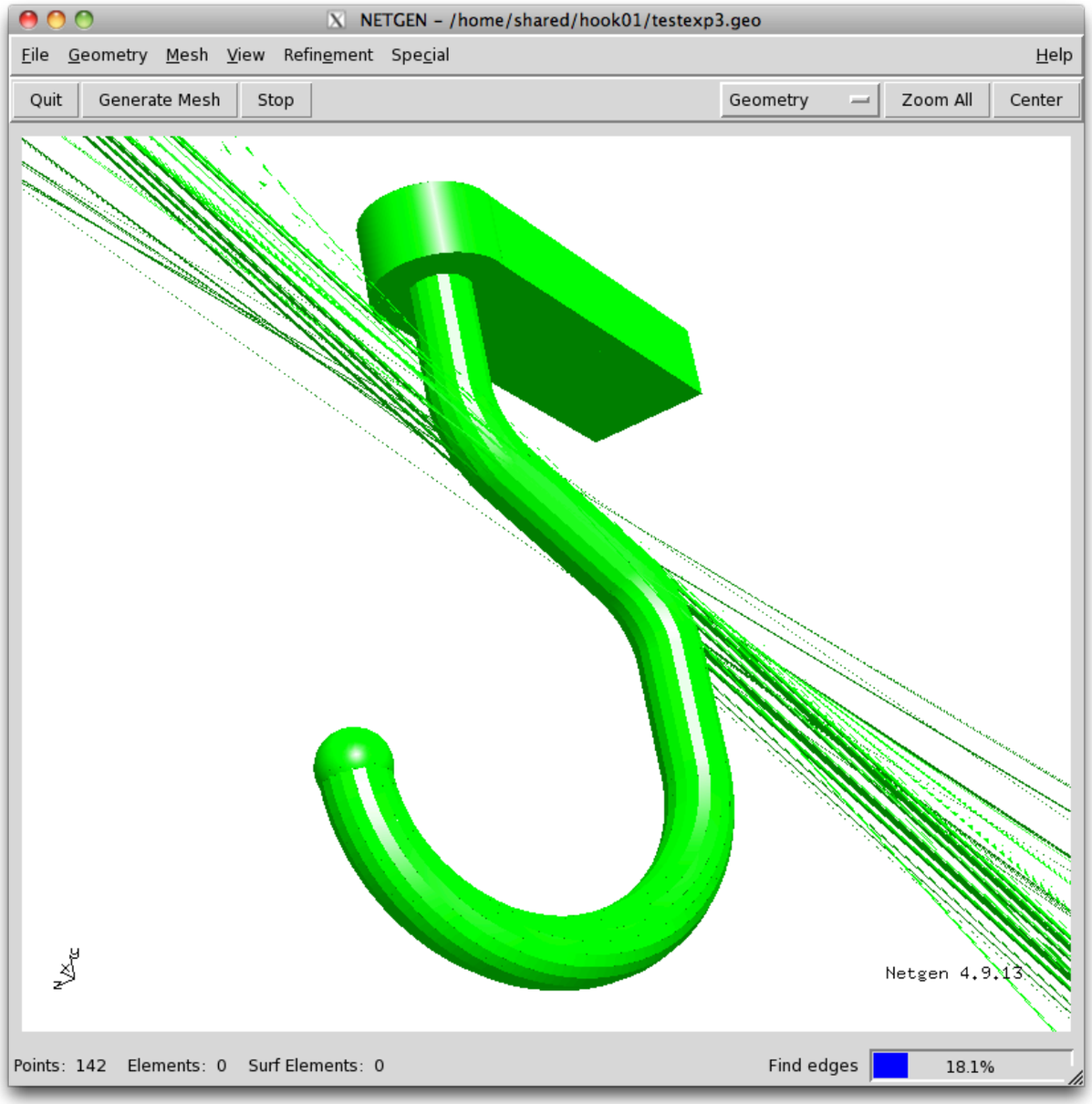


Transmission of TM01 to TEM, Computational Time ~400s on GPU GTX 470

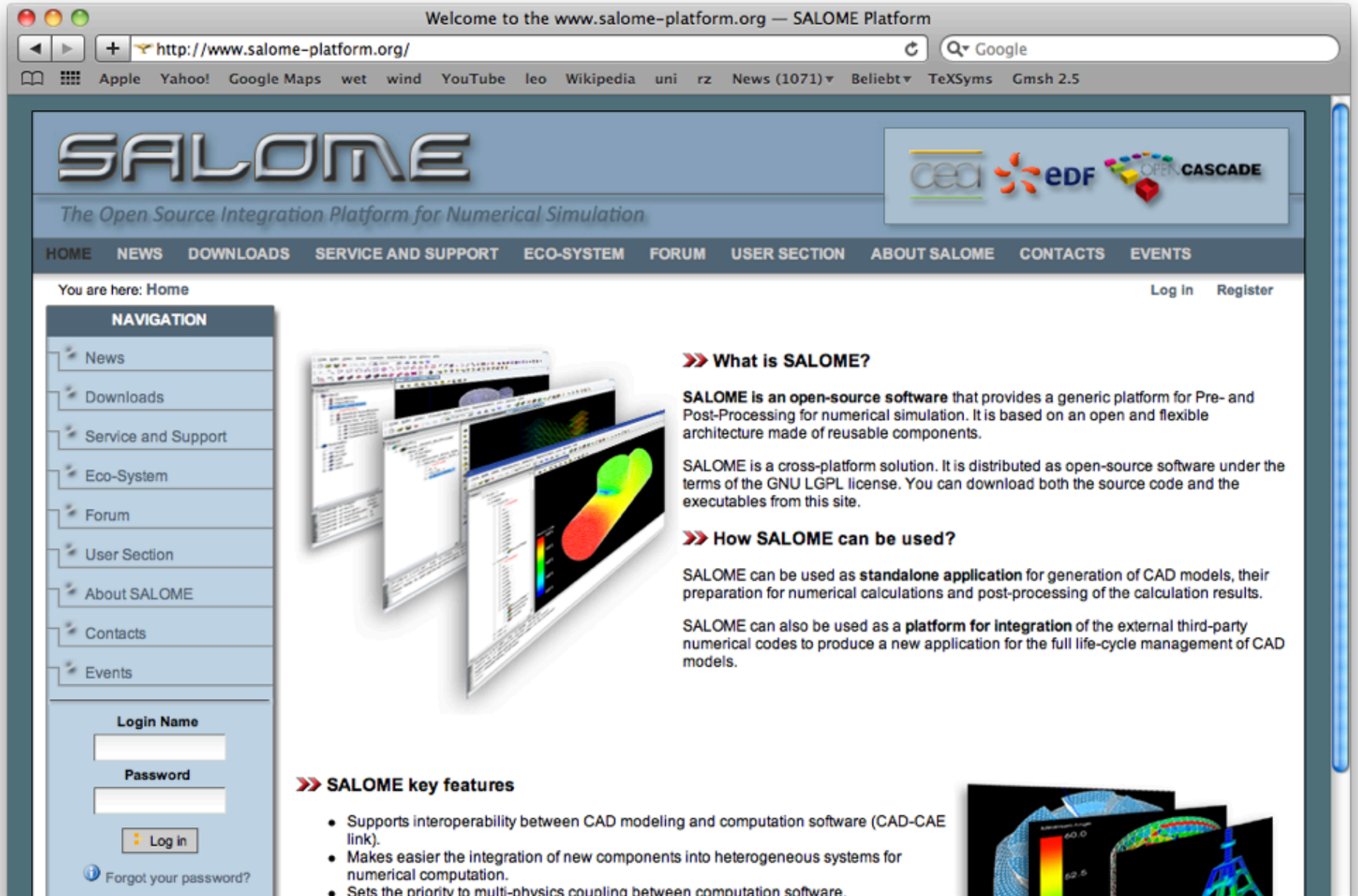
HOM section discretized (12k elements)

*www.nudg.org

... well ..., NETGEN introduced some troubles:



Current decision to delegate geometry and meshing to French product:



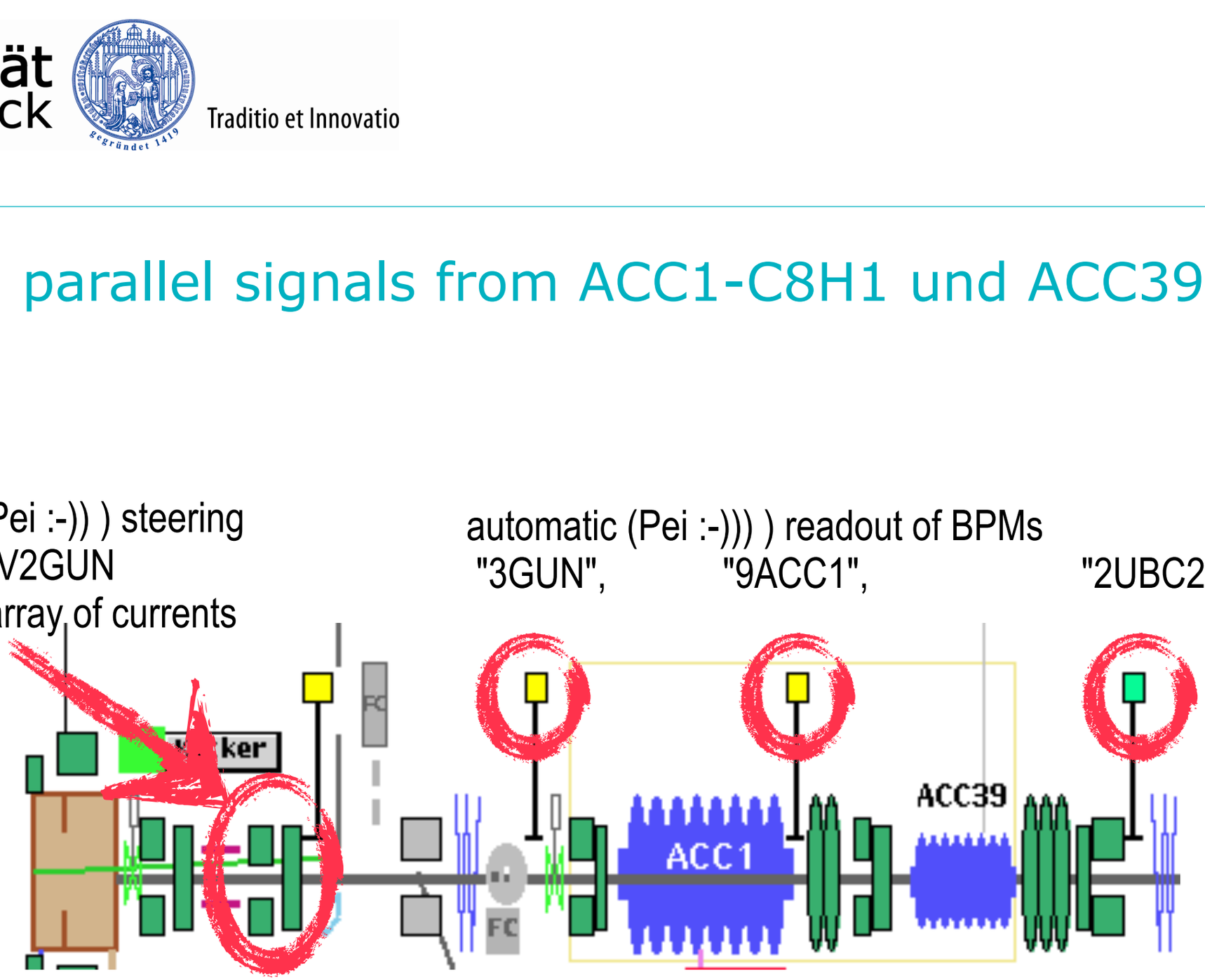
Mainly occupied by something, that could be of some interest for SPL:

HOM-based beam position monitoring using diode detectors ...

Taking in parallel signals from ACC1-C8H1 und ACC39-C4H2

manually (Pei :-))) steering
of H2GUN/V2GUN
using 5x5 array of currents

automatic (Pei :-)))) readout of BPMs
"3GUN", "9ACC1", "2UBC2"



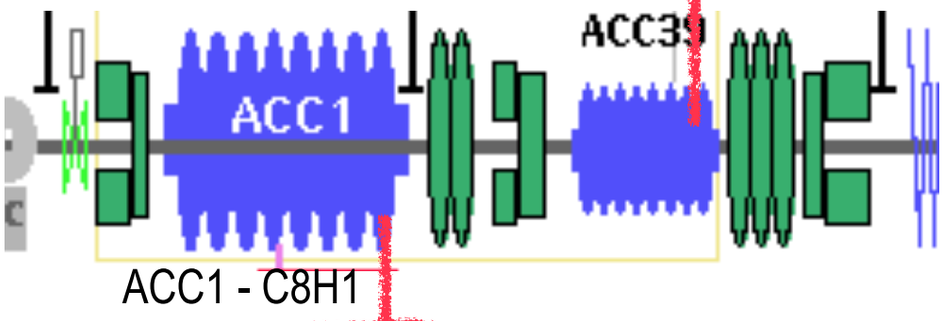
~0.6 nC, single bunch, quads on

3 dB, filter, diode, scope

ACC39 - C4H2

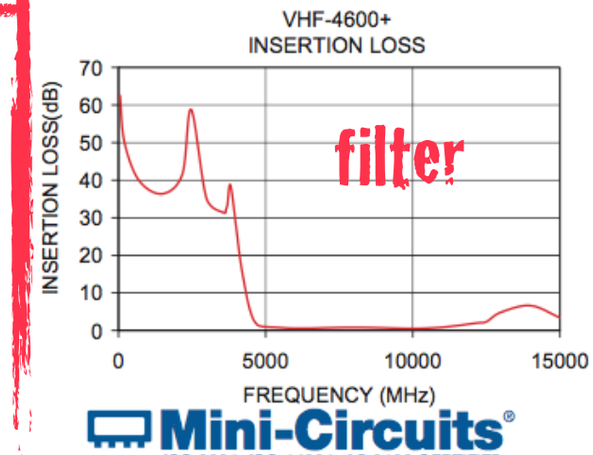
-3dB

-6dB split



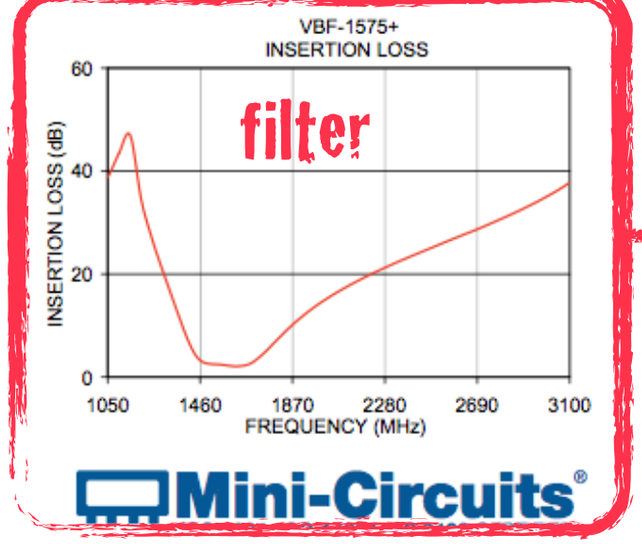
ACC1 - C8H1

to Pei's RSA



Agilent 423B low-barrier-Schottky diode

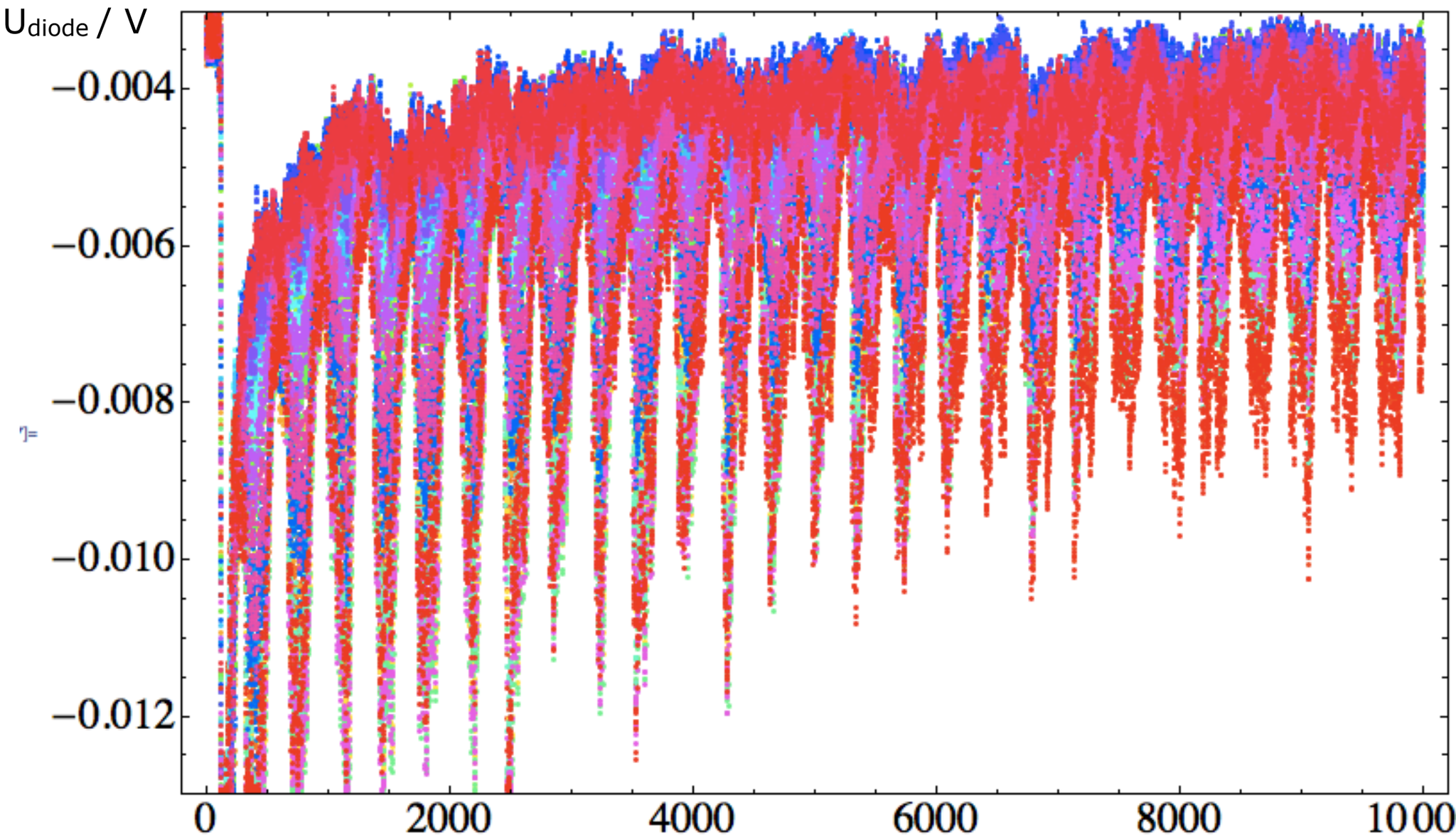
-3dB



Agilent 423B low-barrier-Schottky diode

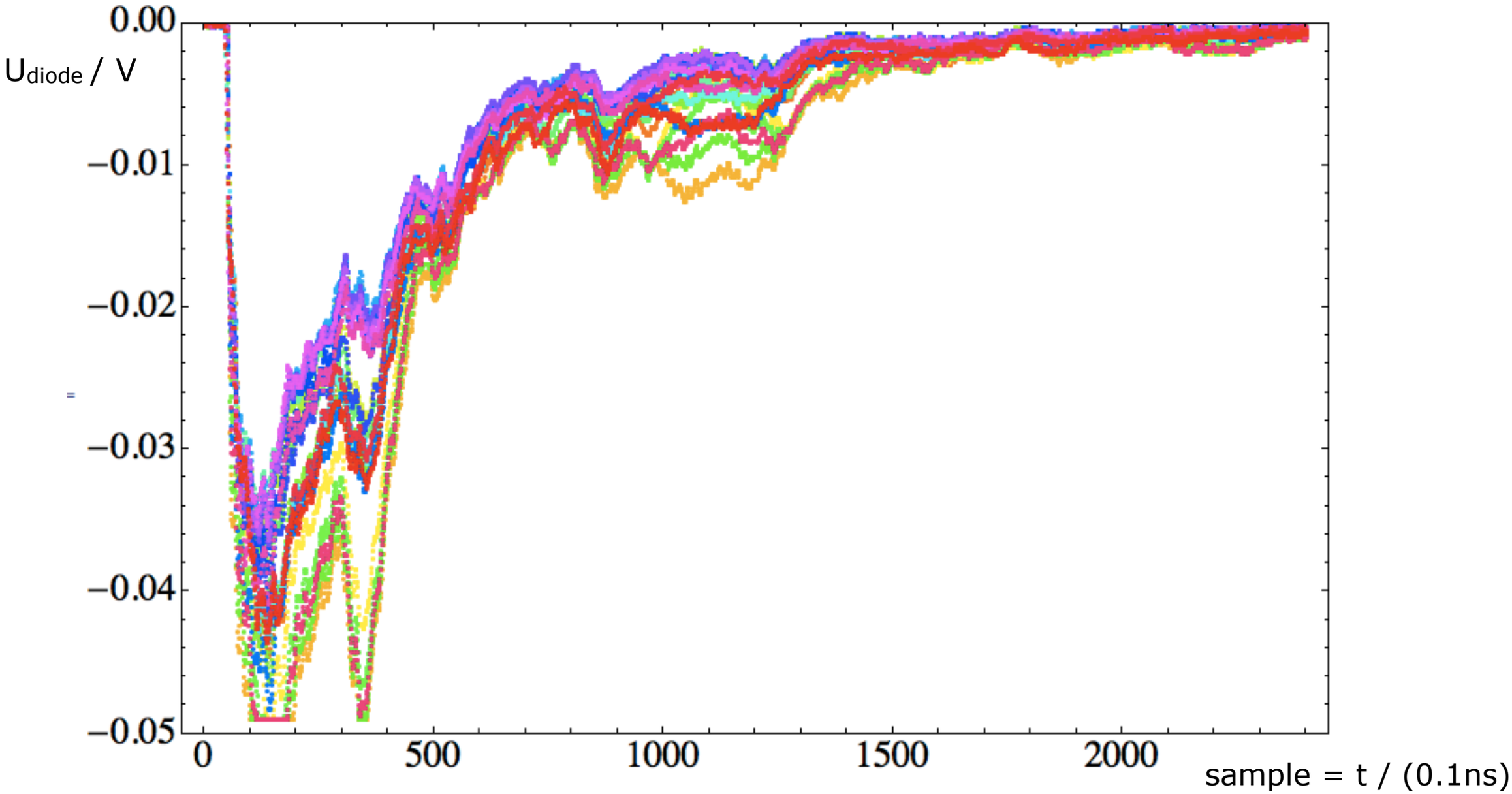
RuS RTO1014, 1 GHz nominal bandwidth, 10 GS/s,
10kS = 1µs (each channel),
Ch1: ACC1, 2mV/div, trig,
Ch3: ACC39, 5mV/div
waveforms manually (Helge :-))saved

ACC1: All 25 (+1)* raw diode voltage signals vs. time



*: last position repeated first

ACC39: All 24* (+1) raw diode voltage signals vs. time**



*: one position accidentally not stored
**: signal clipped in time covering only "interesting" range = 2400 samples = 0.24 µs

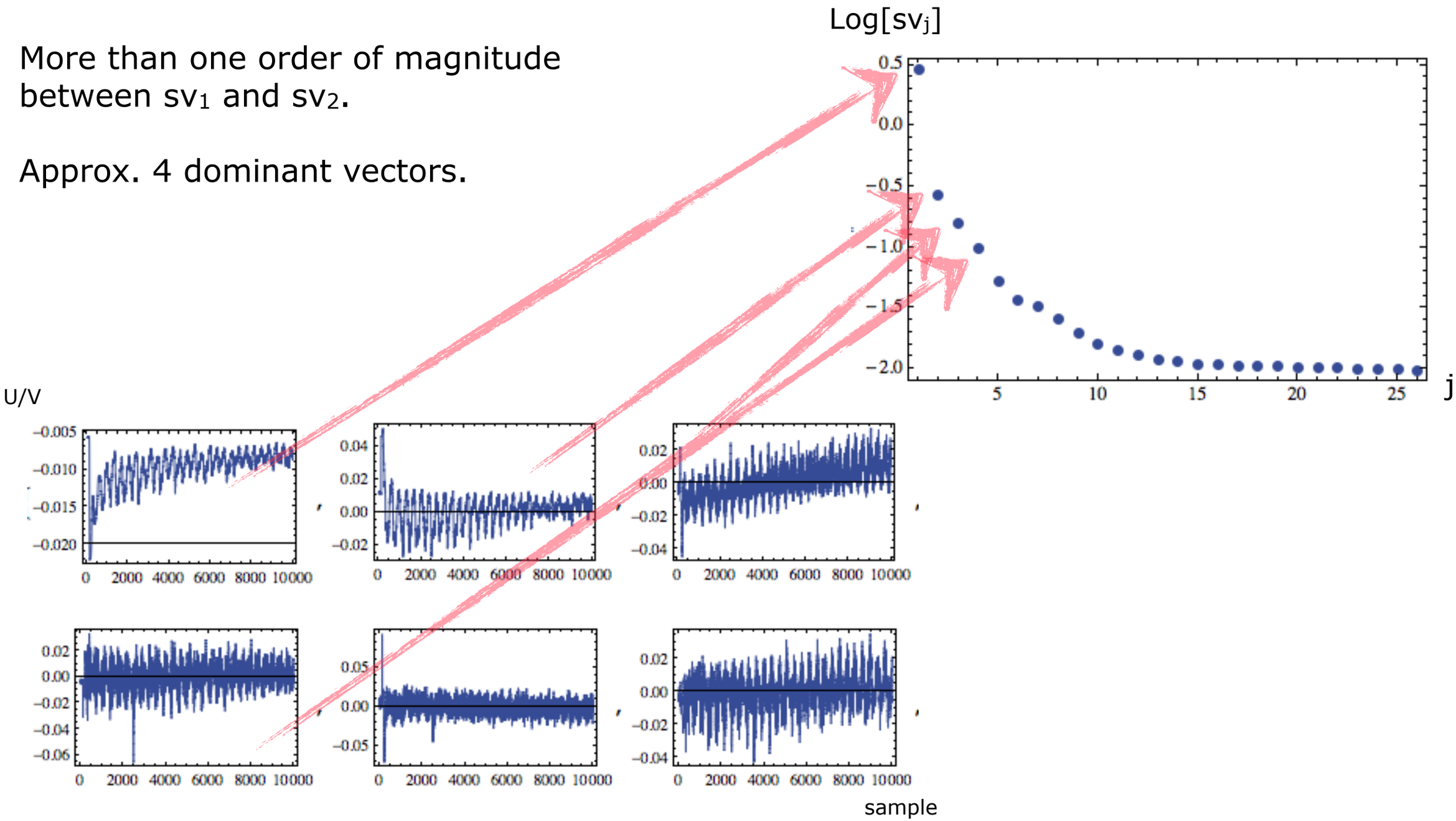
Singular Value Decomposition

- Analyses set of N signal curves (of equal length n = no. of sample points), ...
- ... considering each data set as a vector in n-dimensional space, ...
- ... whether and which dominant directions = svd-basis vectors are apparent in the N vectors.
- Weight ("prominence") of each svd-basis vector is expressed as it's singular value.
- Large differences of the singular values indicate dependence of the signal curves on few parameters.
- SVD does NOT correlate to any parameter.
- Available as fast (<1s) black-box-algorithm eg. in Mathematica©

SVD basis vectors and weights for ACC1 signals:

More than one order of magnitude between sv_1 and sv_2.

Approx. 4 dominant vectors.



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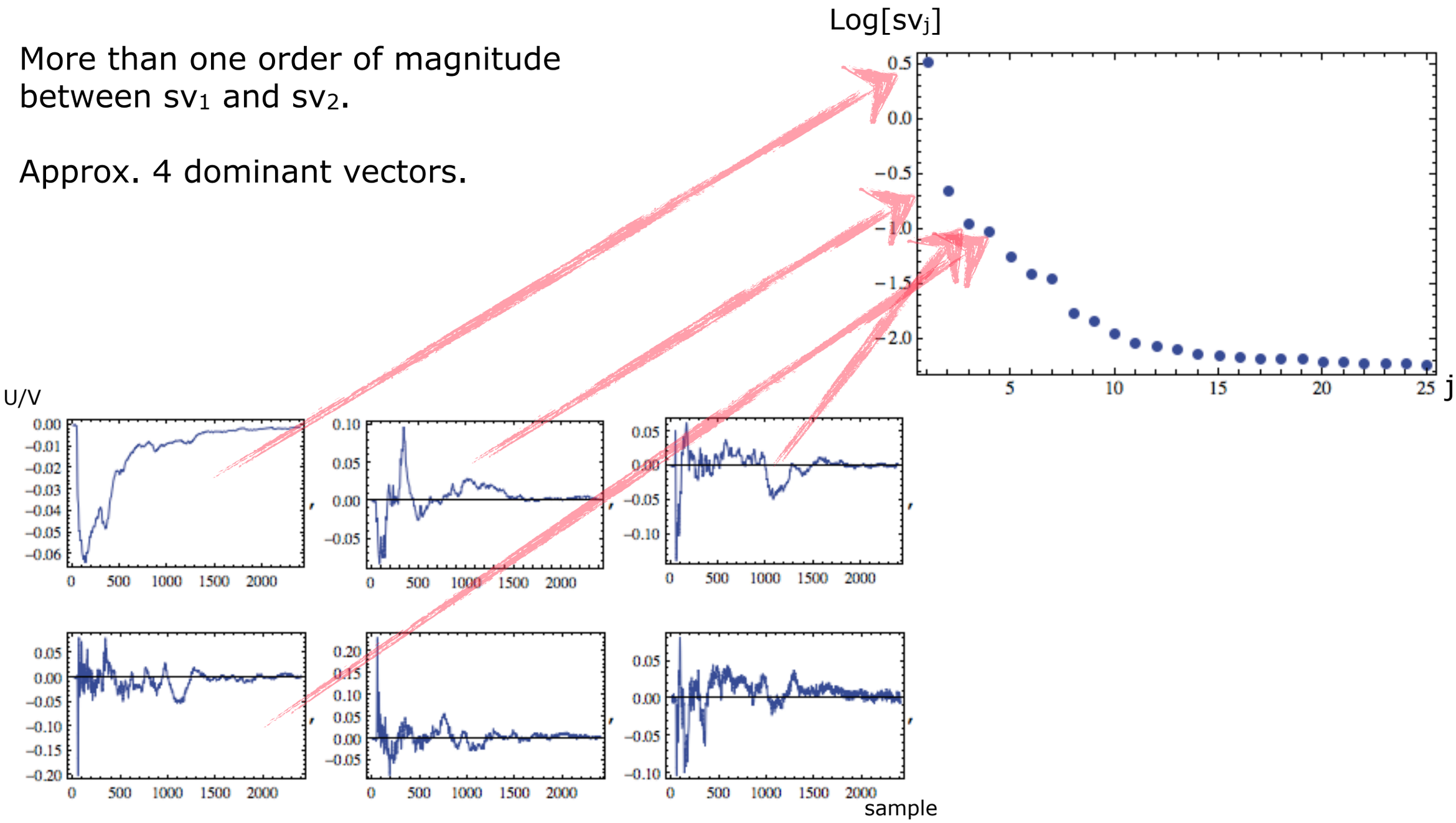
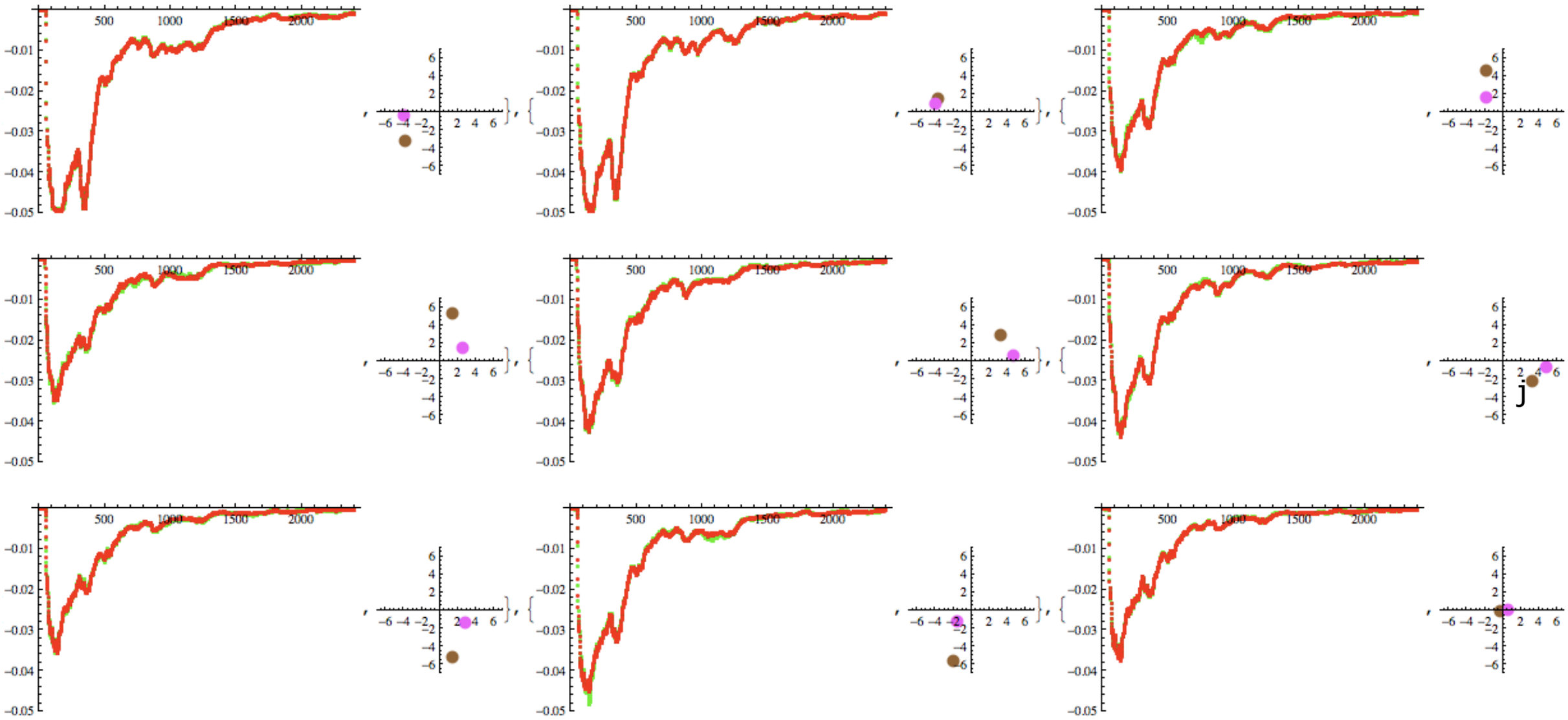
SVD basis vectors and weights for ACC39 signals:

More than one order of magnitude between sv_1 and sv_2.

Approx. 4 dominant vectors.



Check SVD for ACC39 signals (shown 9 of 25) - works very well:



green: original - (almost impossible to see)
red: reconstructed out of **4 first svd basis vectors**

magenta: BPM 2UBC2/mm
brown: BPM 9ACC1/mm

all graphs U/V vs. sample

Use amplitudes a of prominent svd vectors instead of entire signals

$$\underline{\underline{a}} := \begin{pmatrix} a_{v1,meas1} & \cdots & a_{v4,meas1} \\ \vdots & & \vdots \\ a_{v1,meas25} & \cdots & a_{v4,meas25} \end{pmatrix}$$

$$\underline{\underline{k}} := \begin{pmatrix} x_{bpm1,meas1} & \cdots & y_{bpm2,meas1} \\ \vdots & & \\ x_{bpm1,meas25} & \cdots & y_{bpm2,meas25} \end{pmatrix}$$

exist $\underline{\underline{D}}_{4\times4} \cdot \underline{\underline{a}} \overset{??}{=} \underline{\underline{k}}$

with good coincidence

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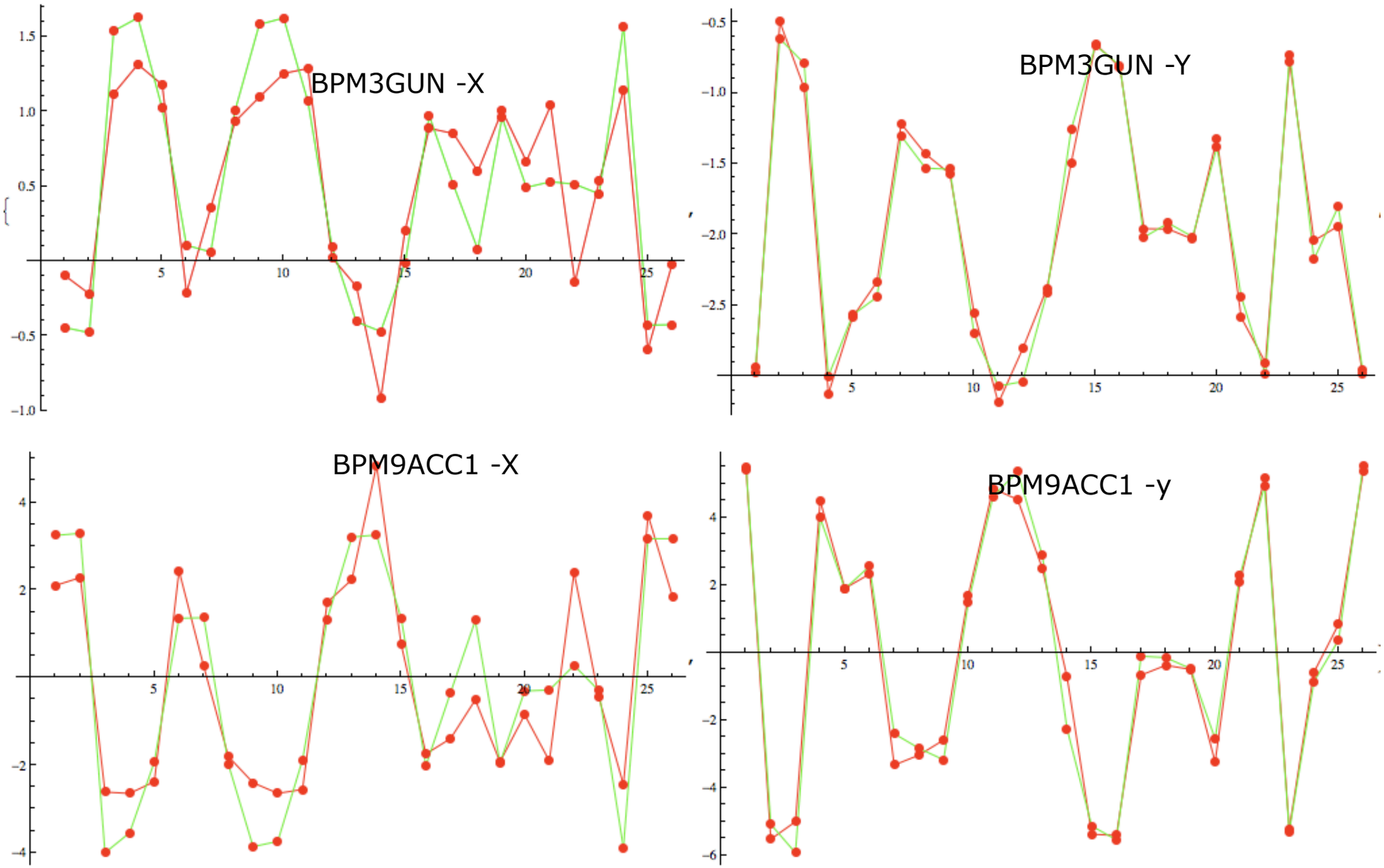
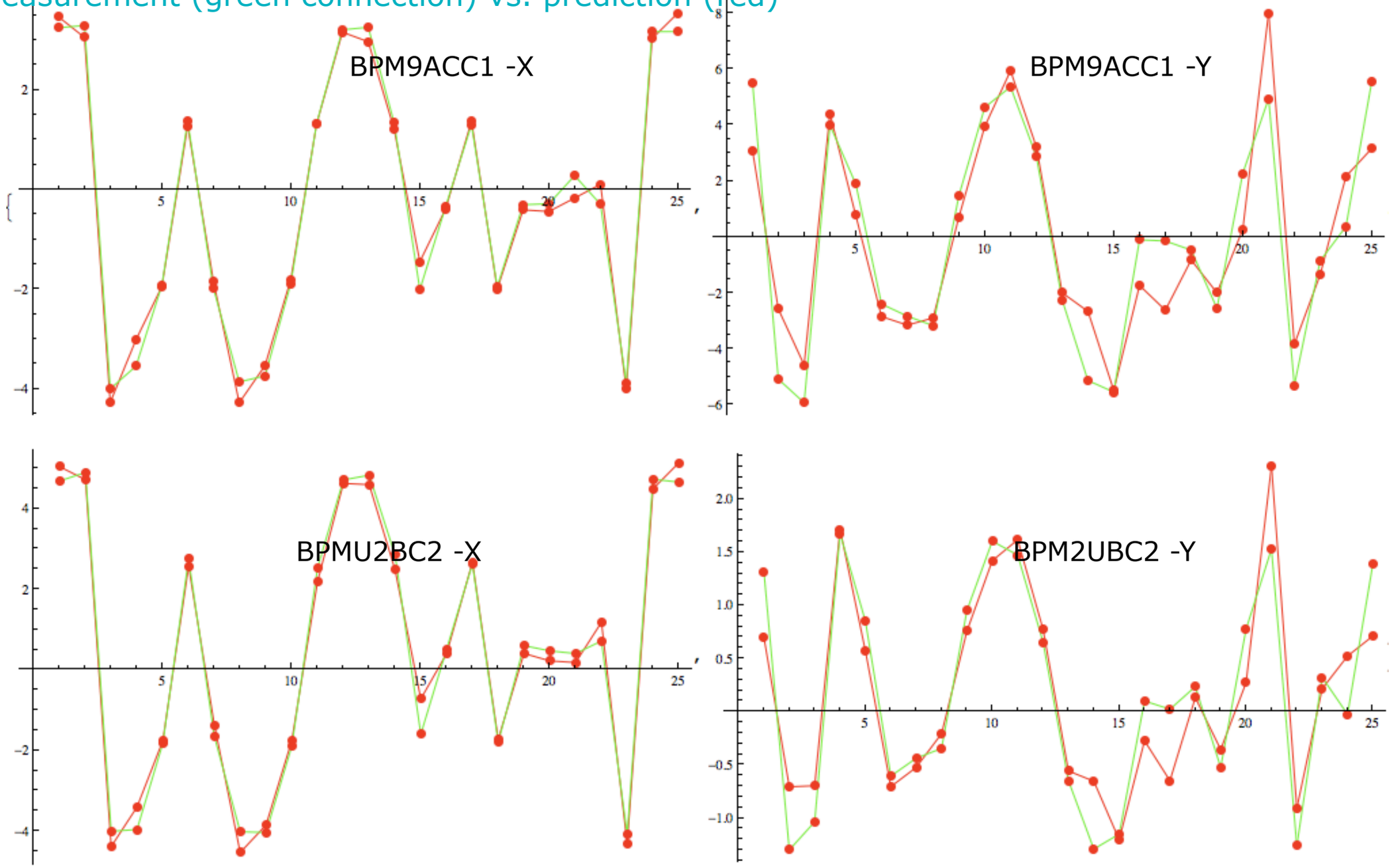
ACC1: take SVD-vecs 2-5 and introduce bpm/signal offset* ☺

Measurement (green connection) vs. prediction (red); * courtesy to Rob/Steve for suggestion



ACC39: svd-vecs 2-5 and using an bpm/signal offset ☺☺

Measurement (green connection) vs. prediction (red)



Conclusions

- try to release hold of HOM coupler design a.s.a.p
- switch back to CST one possibility; preference for own solution (but geometry input some issue)
- spent almost all available manpower to beam measurement @ FLASH Jan/Feb
- achieved promising results for HOM-based beam position monitoring using SIMPLE and UNSPECIFIC components