CZ – Prague
SiPM measurement

2021/03/16

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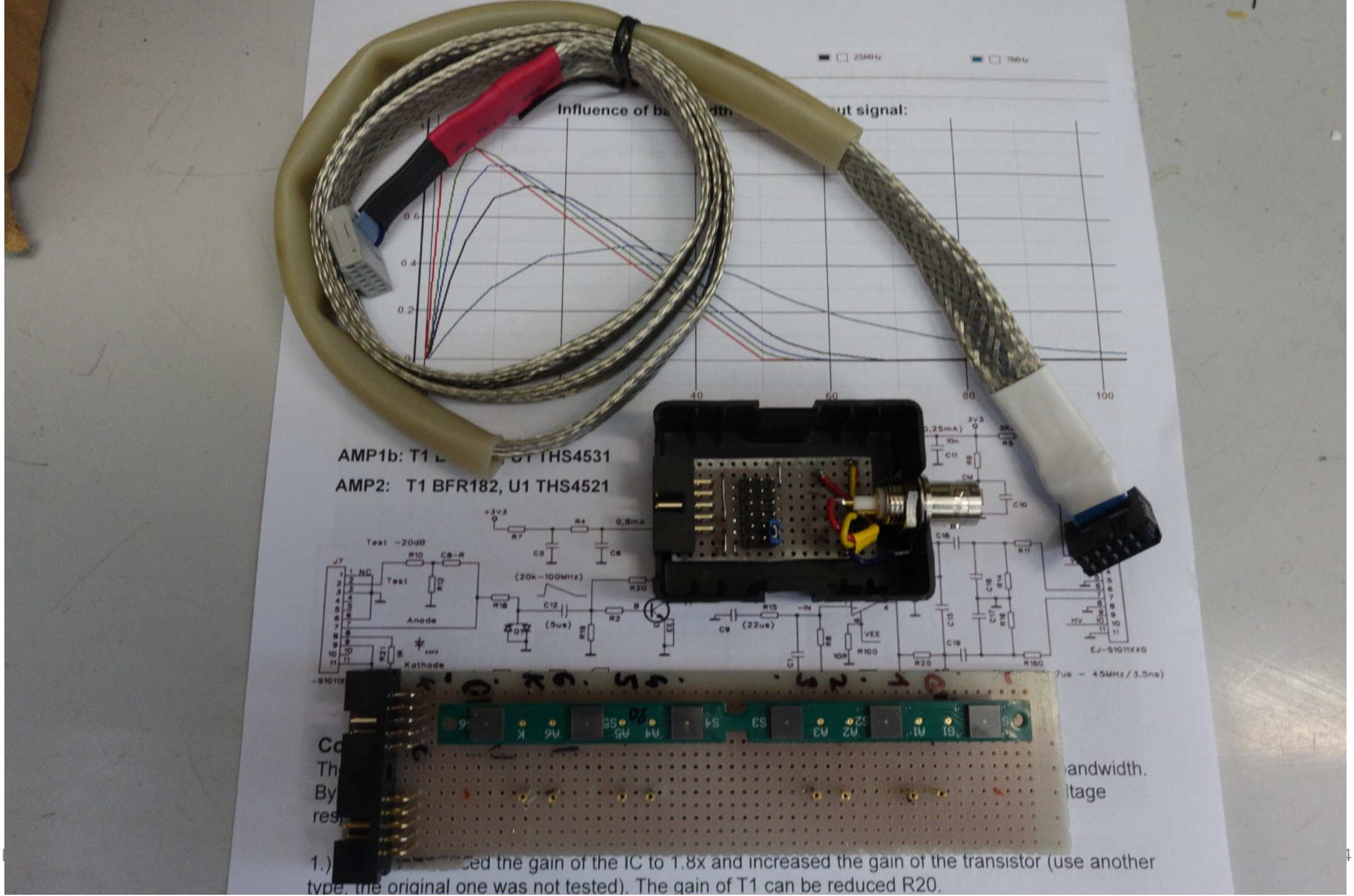
CZ – Prague
250-SiPM-split status

2021/03/16

A start

- Got the package on Thursday, unpacked and thinking about
- Full lockdown in CZ, exception (weekly tested essential workers) going to work (this includes us ☺, still many restrictions)
- Today have tried a set up for the warm IV measurement
- Have made a decision to produced a new single carry boards for the IV measurements
  - Much less materials to immerse and thermo-cycling
  - Needed connectors and cables anyway
  - Worry about the 6-SiPM-board pins during many (re-)insertion
  - Probably preferring one board warm&cold at once than all in warm, than cold


25MHz
7MHz
Influence of ba dth ut signal:
AMP1b: T1 THS4531
AMP2: T1 BFR182, U1 THS4521
andwidth.
ltage
1.) ced the gain of the IC to 1.8x and increased the gain of the transistor (use another
type, the original one was not tested). The gain of T1 can be reduced R20.

CZ – Prague
Cold Amp modification

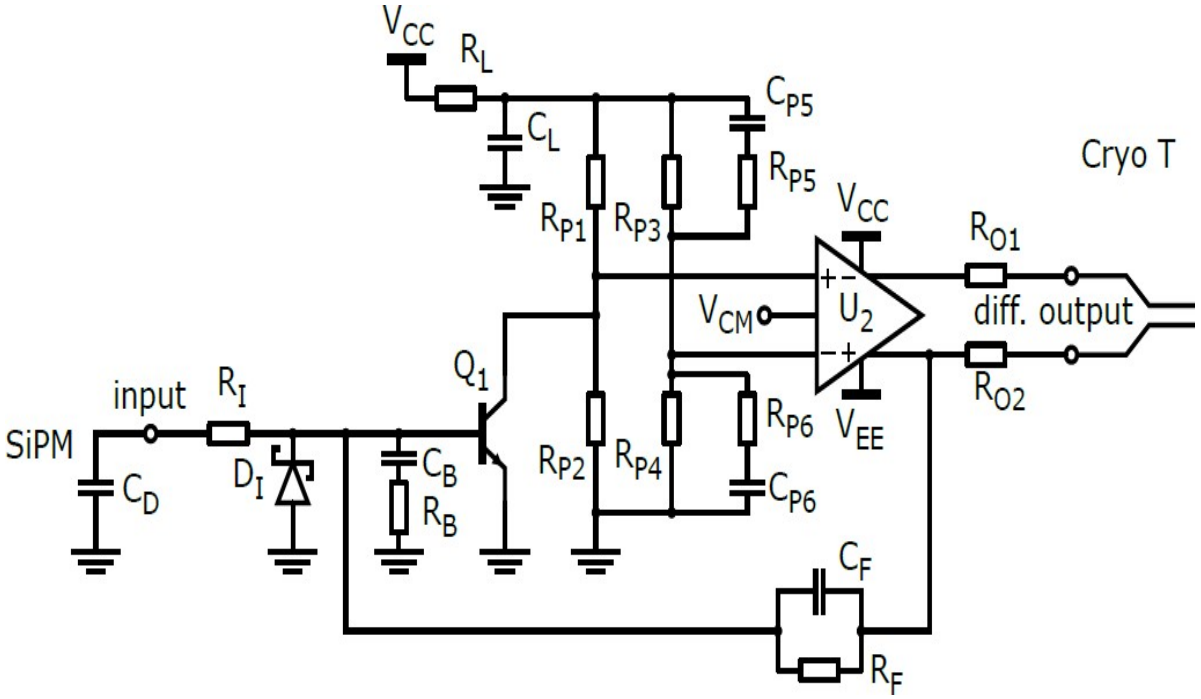
2021/03/16

performed by Josef Zuklin (zuklin@fzu.cz)

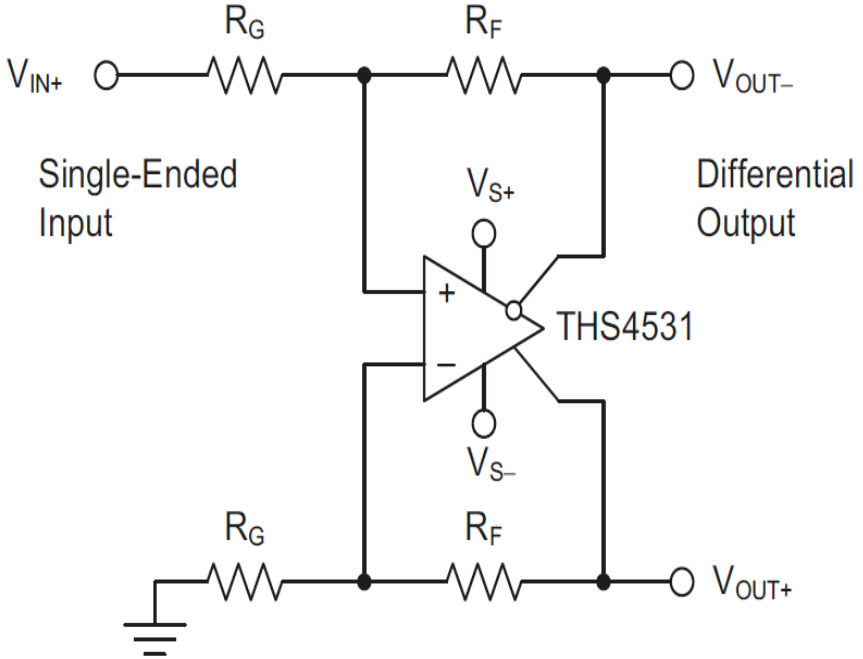
Measurement of a low energy cryogenic amplifier

- **Basic measurement of frequency and amplitude response AMP1 [1] and AMP1b, AMP2 (changed by JZu)**
- used instruments: Oscilloscope DPO4104 and generator (oscilloscope MDO3054)

Schematic of the amplifier AMP1



Recommended circuit for used THS4531

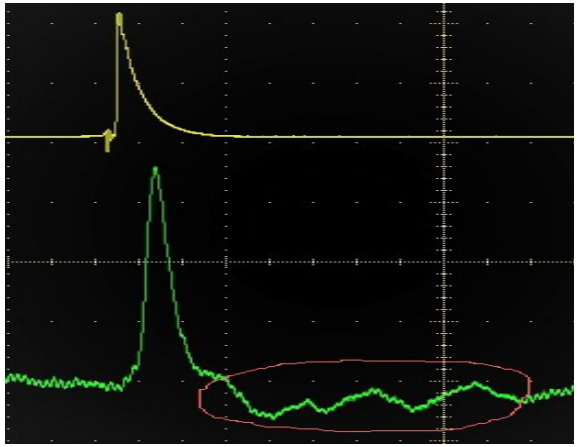


output AMP1
(with Q1 BFP640 and U2 THS4531)

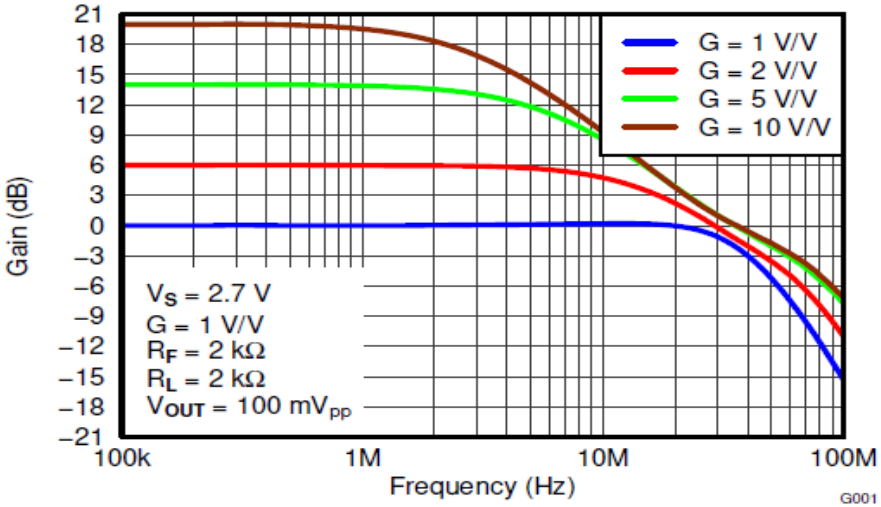
The circuit AMP1 is quite unstable at room temperature (only one Rf is used).

In LN2 it is slightly unstable (red), yellow input, green output.

The measured AMP1 in LN2 (IC with added transistor) is very similar to THS5431 [2] with a gain of 2-5.

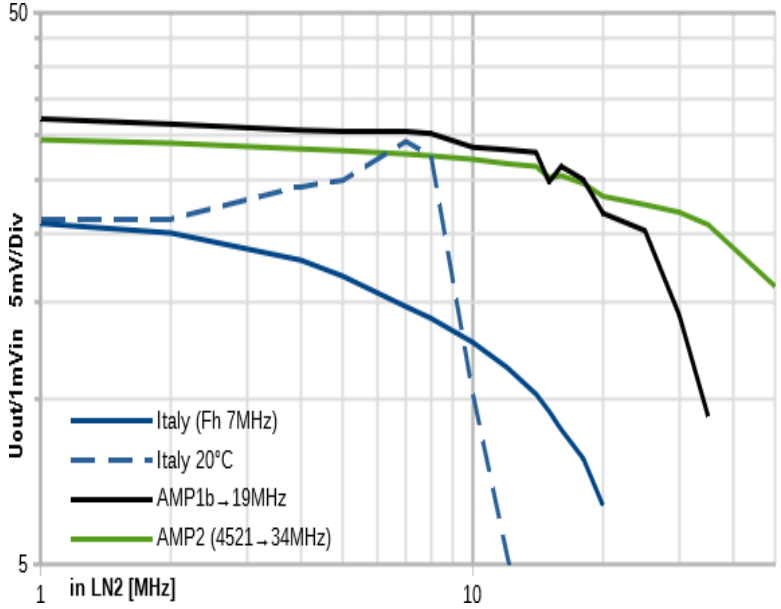


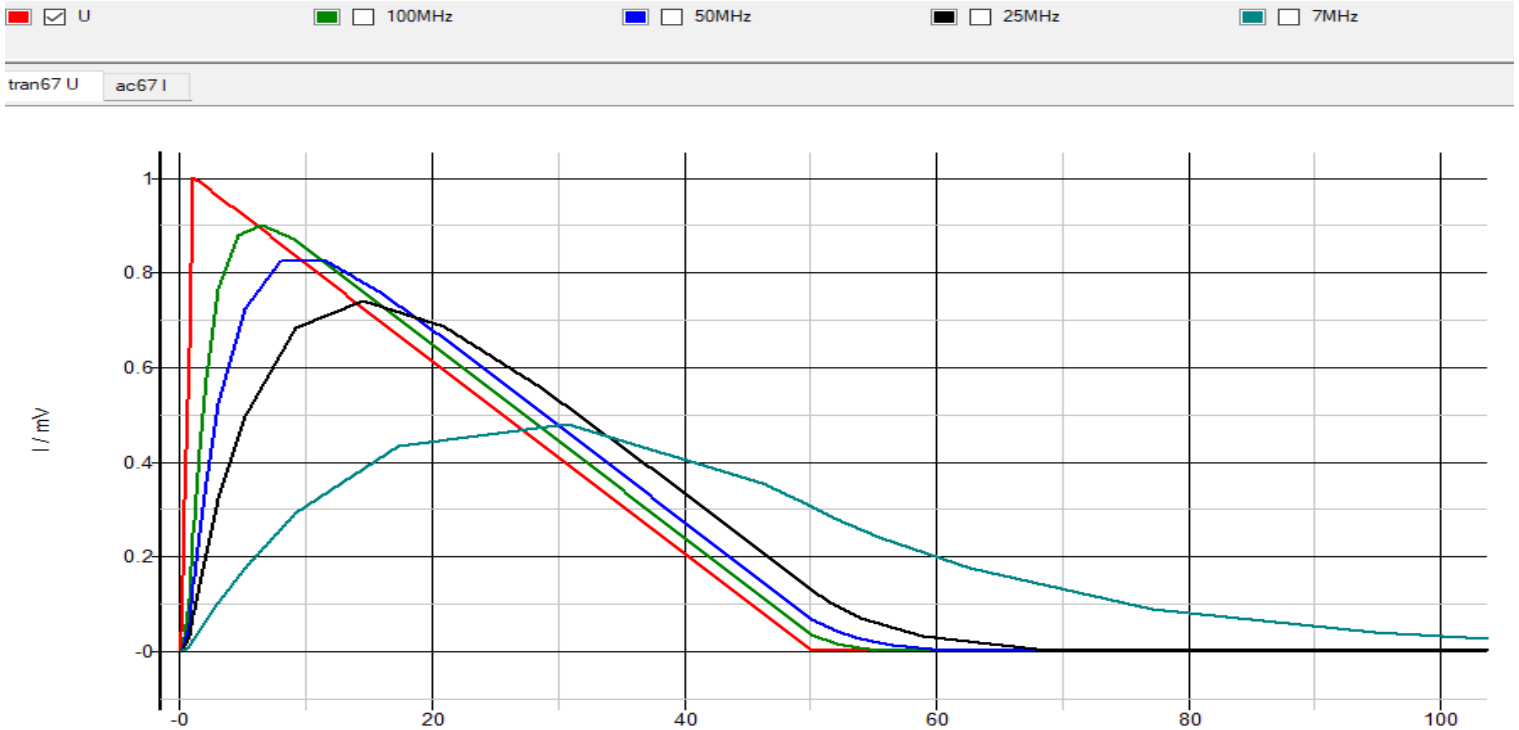
frequency response THS4531 [2]



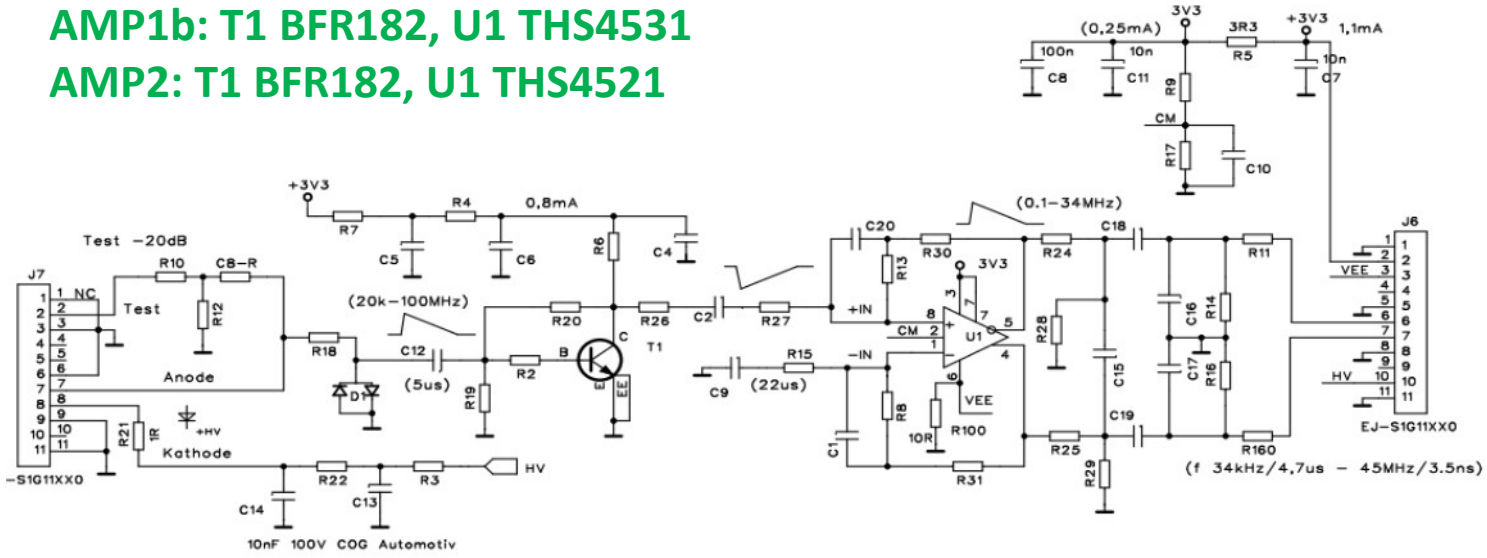
Modification of the circuit with THS4531 to increase the bandwidth from 7MHz to 19MHz (AMP1b) and reduce the current consumption.

To improve the parameters even more, it is possible to use 2.5x faster IC THS4521 (AMP2). In both cases the current consumption is less than 1.5 mA (original approx. 2.2mA).





AMP1b: T1 BFR182, U1 THS4531
AMP2: T1 BFR182, U1 THS4521



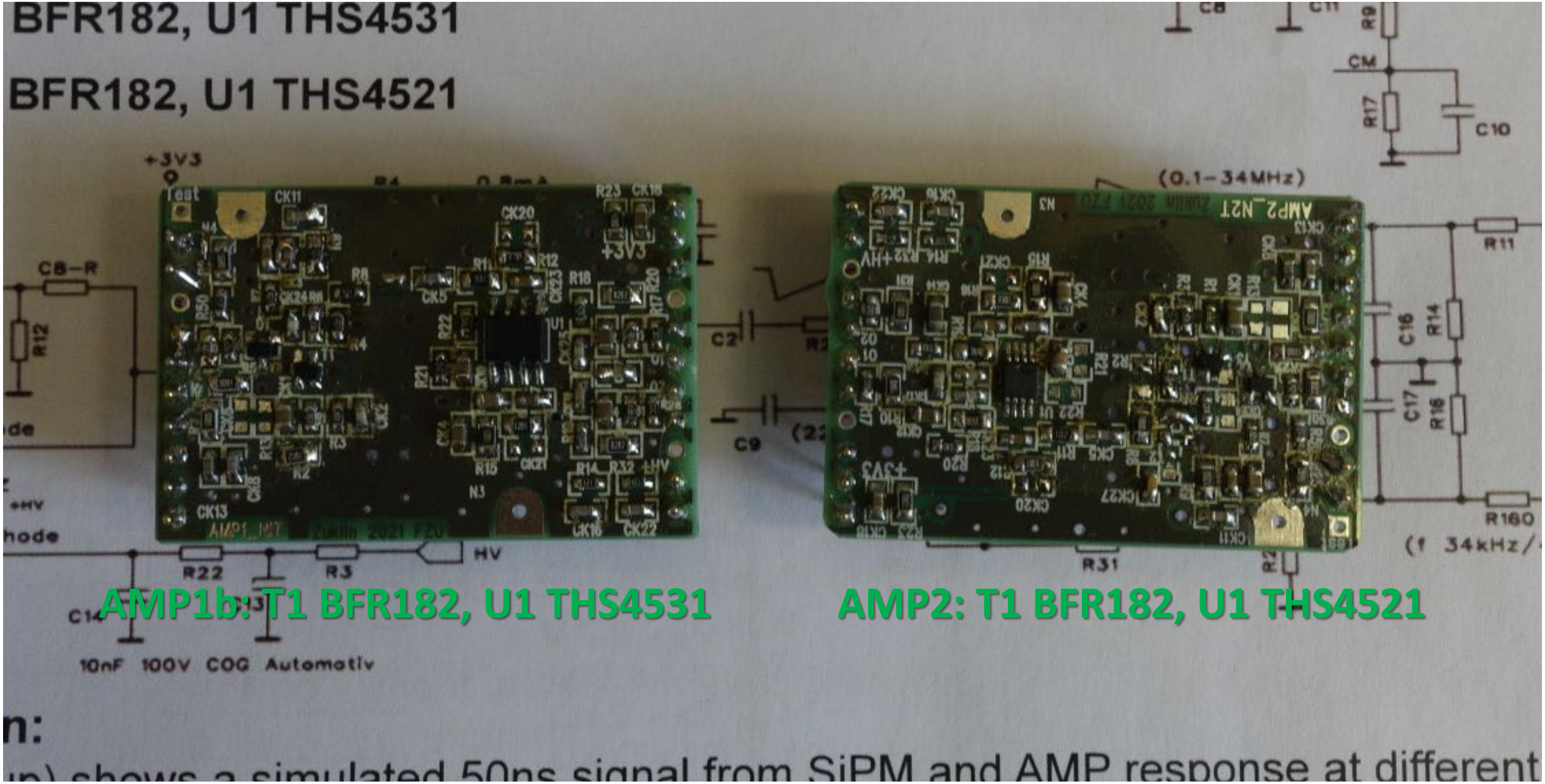
Conclusion:

The figure (left) shows a simulated 50ns signal from SiPM and AMP response at different bandwidth. By increasing the frequency range of AMP from 7MHz to 20-50MHz, we obtain a better voltage response and thus a better distance from noise and interference.

1. **AMP1b:** reduced the gain of the IC to 1.8x and increased the gain of the transistor (use another type, the original one was not tested). The gain of T1 can be reduced R20.
2. **AMP2**: used faster IC THS4521 (THS4561 didn't work OK). With THS4521 it is possible to select gain up to 3-5 (for 35--19 MHz).

References:

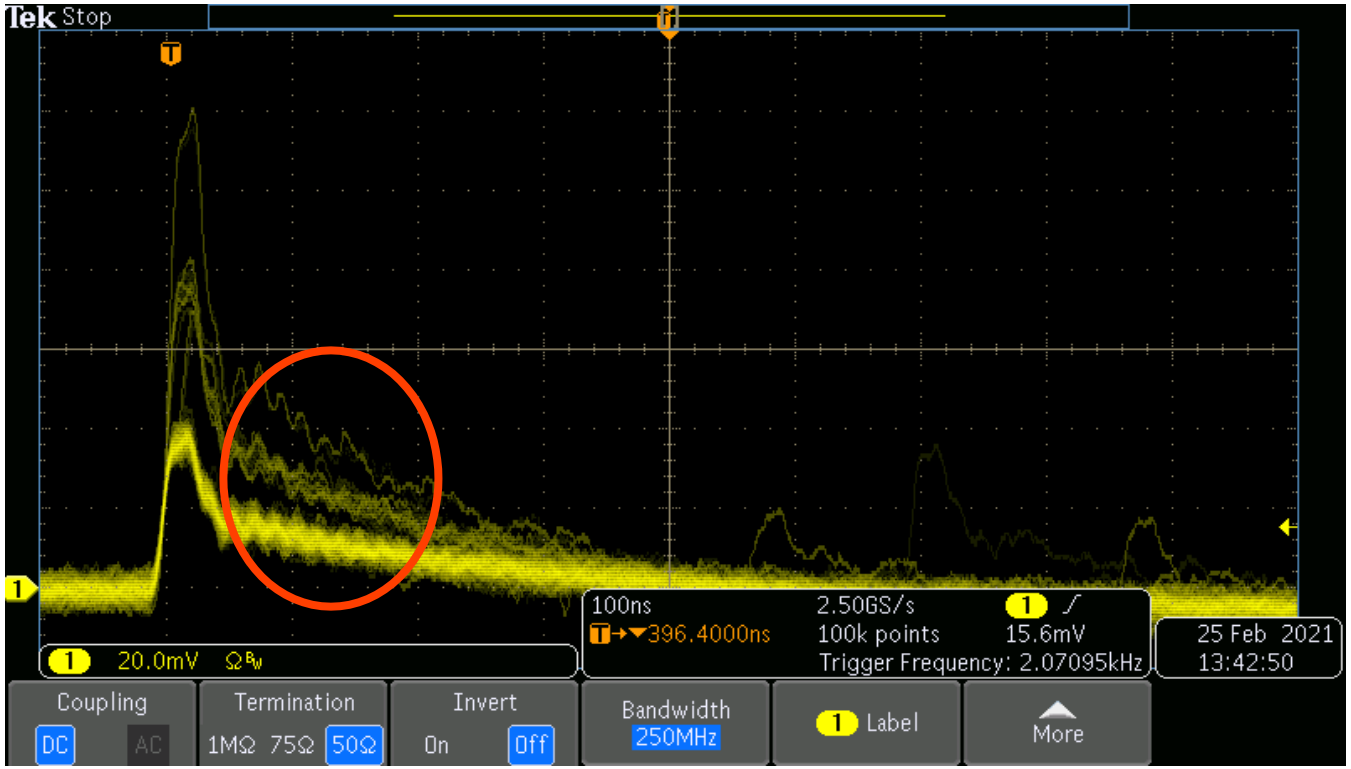
[1] A low noise and low power cryogenic amplifier for single photoelectron sensitivity with large arrays of SiPMs
P. Carniti,a A. Falcone,a C. Gotti,a A. Lucchini,b G. Pessina,a S. Riboldib and F. Terranovaa, Milano Italy
[2] THS4531.pdf (www.ti.com)



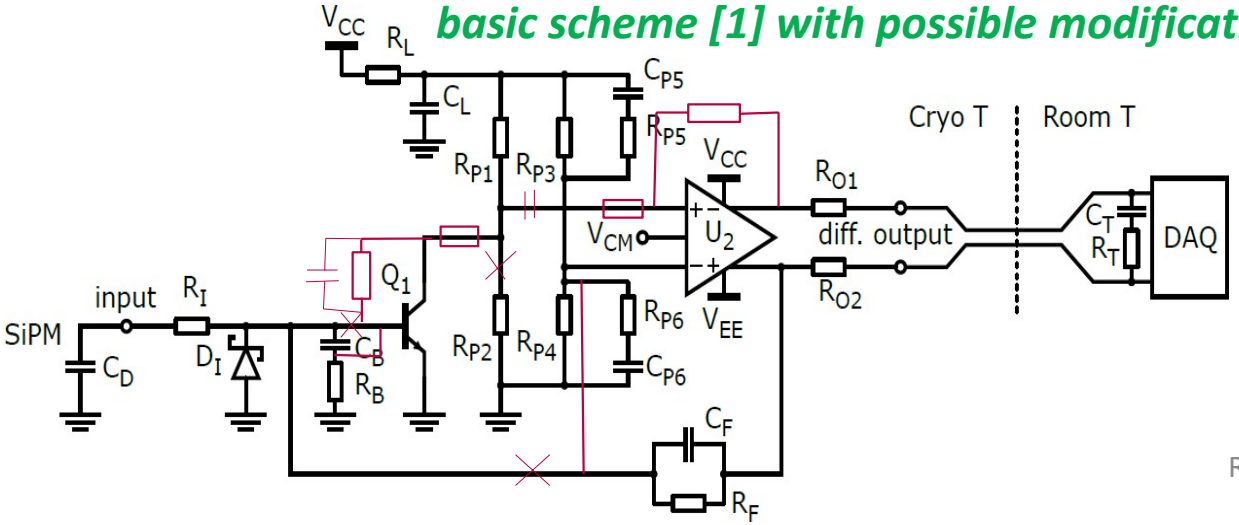
n:

up) shows a simulated 50ns signal from SiPM and AMP response at different

figure AMP1 in LN2 *- marked in red - probably small oscillations IC THS4531.*



basic scheme [1] with possible modifications [1b], [1c]

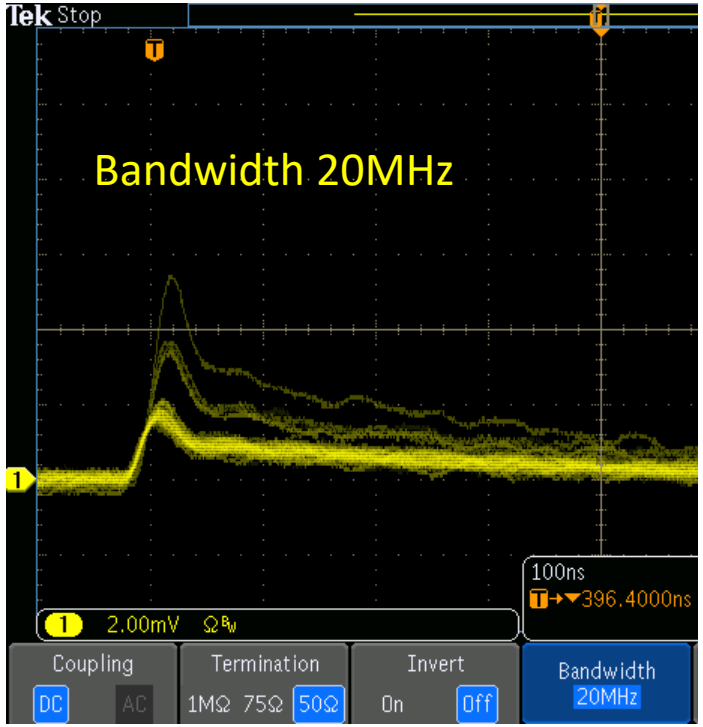


Design notes:

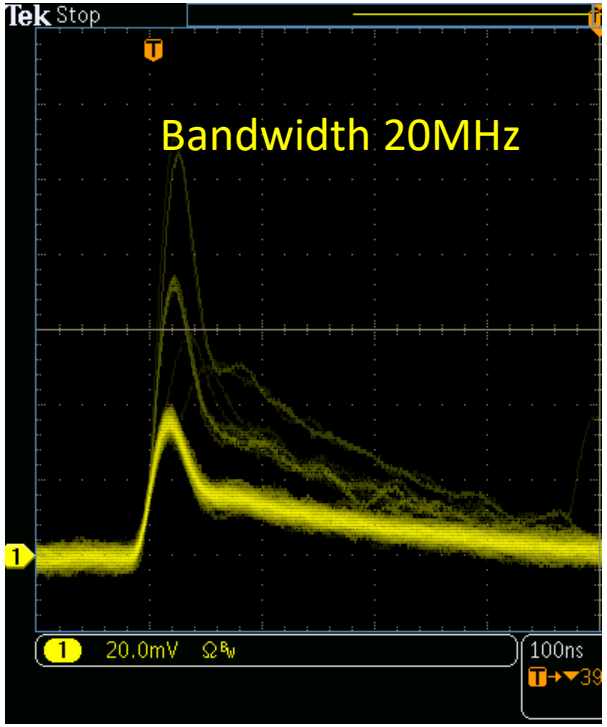
- So far I have not been able to modify the circuit with THS4531 [1] for a completely stable function at room temperature and also in LN2. Occasionally (after switching on at 20 ° C) oscillations with large amplitude occurred. Then, the correct operation of the IC cannot be guaranteed.
- IC THS4321 is more stable and it is possible to design the circuit [2] so, that the current consumption is the same or smaller than the original design [1].
- It is good to close the Q1 feedback (RC) and insert a small R at Q1 collector (3-10R limits UHF oscillations). RC values selects gain and bandwidth. And also define the gain in +In IC (as shown below). This corresponds to circuits [1b] and [1c] with the parameters at the attachment heading.

Recommendation *for components R, C, … (standards):*
MIL-STD-202 Method 107G (300x Thermal Shock -55/+125°C) or (and) Automotiv AEC-Q200 Test 16
https://www.vishay.com/docs/34497/qualapgind.pdf (Yageo, Panasonic...)

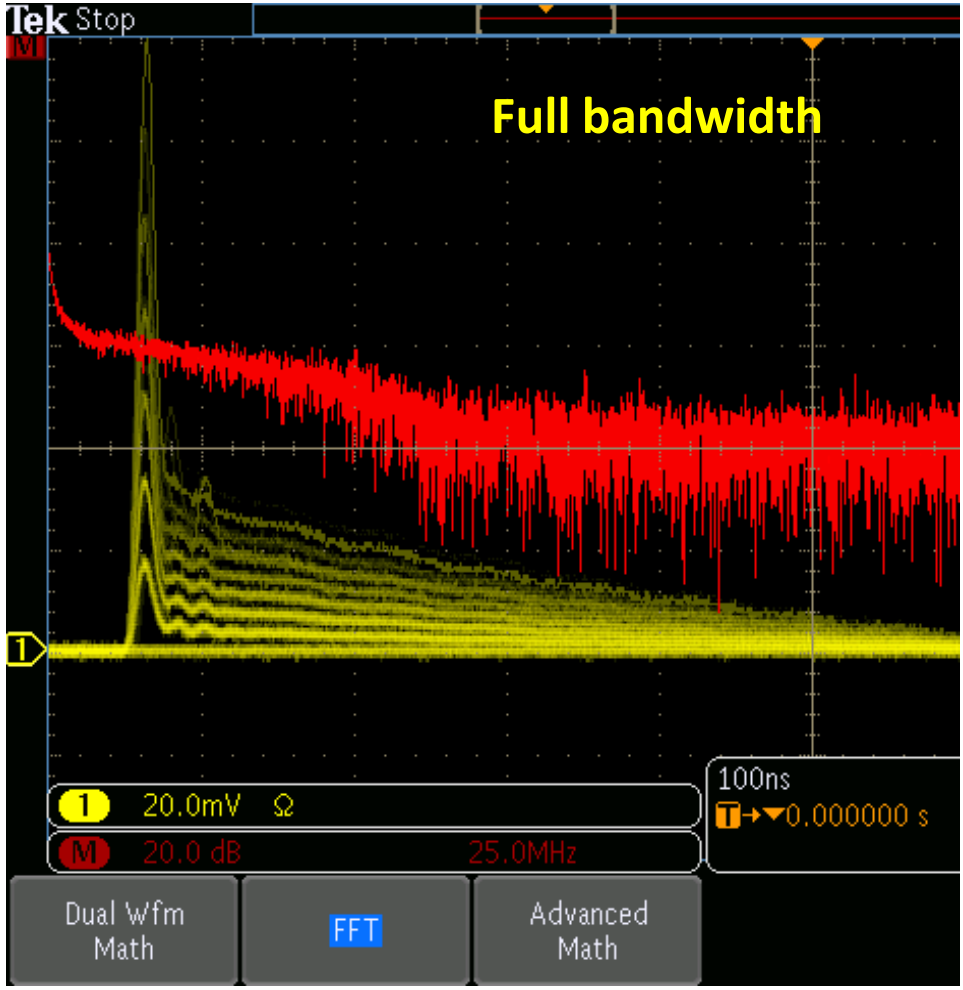
AMP1 directly to the oscilloscope (1,8mVp...)



AMP1 with „warm“ Amplifier 20x (36mVp...)



AMP2 - directly to the oscilloscope (18mVp...) + FFT

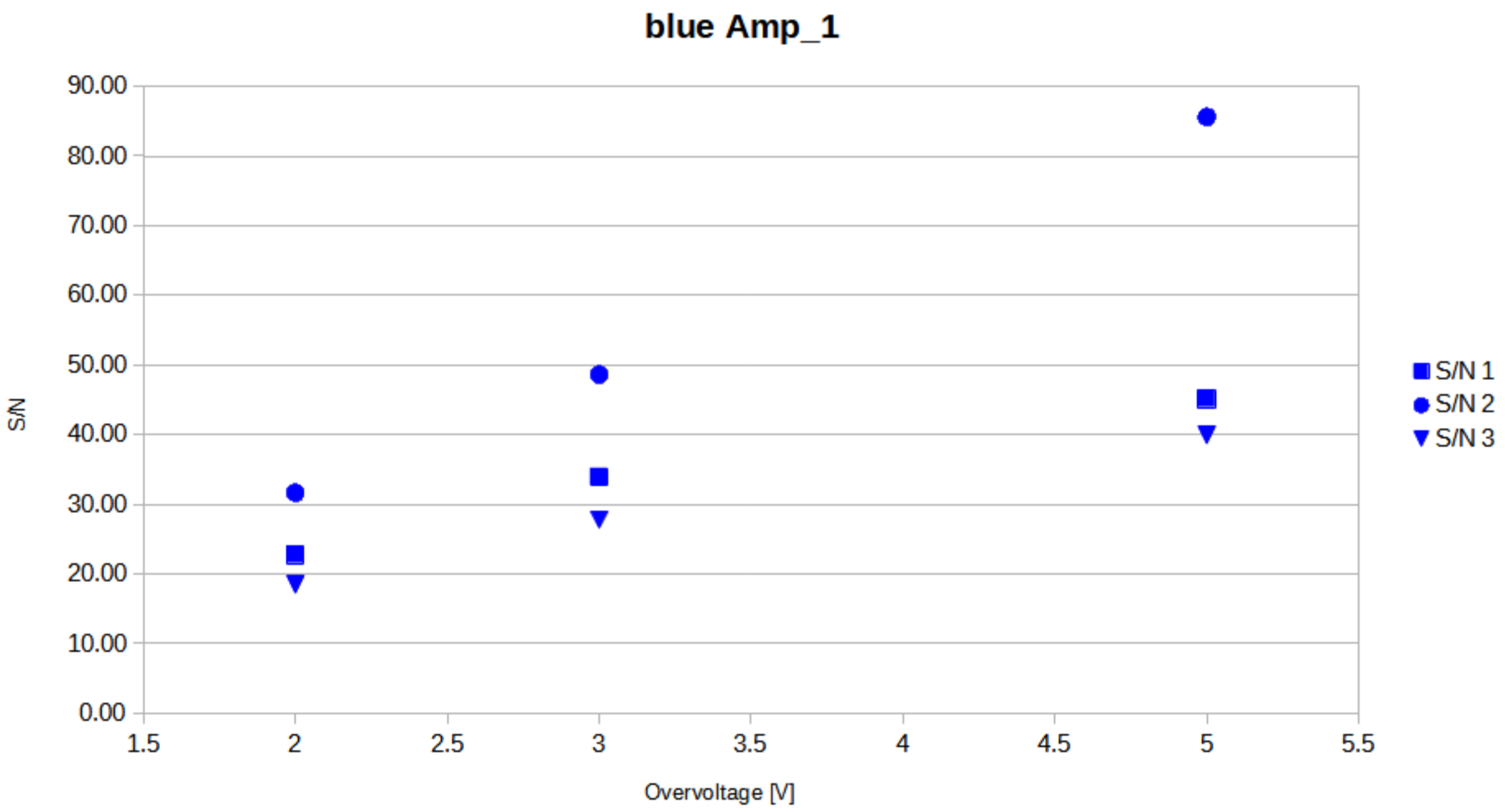


Tested:
original [1] (AMP1) -> Icc = 2,2mA, Fh = 7MHz,
AMP1b -> [1] with modifications, Fh = 19MHz, Icc = 0,9mA
AMP1c -> gain as [1], integration constant 50ns, Fh = 9MHz,Icc = 0,65mA
AMP2 -> IC THS4521, Fh 34MHz, Icc = 1,5mA

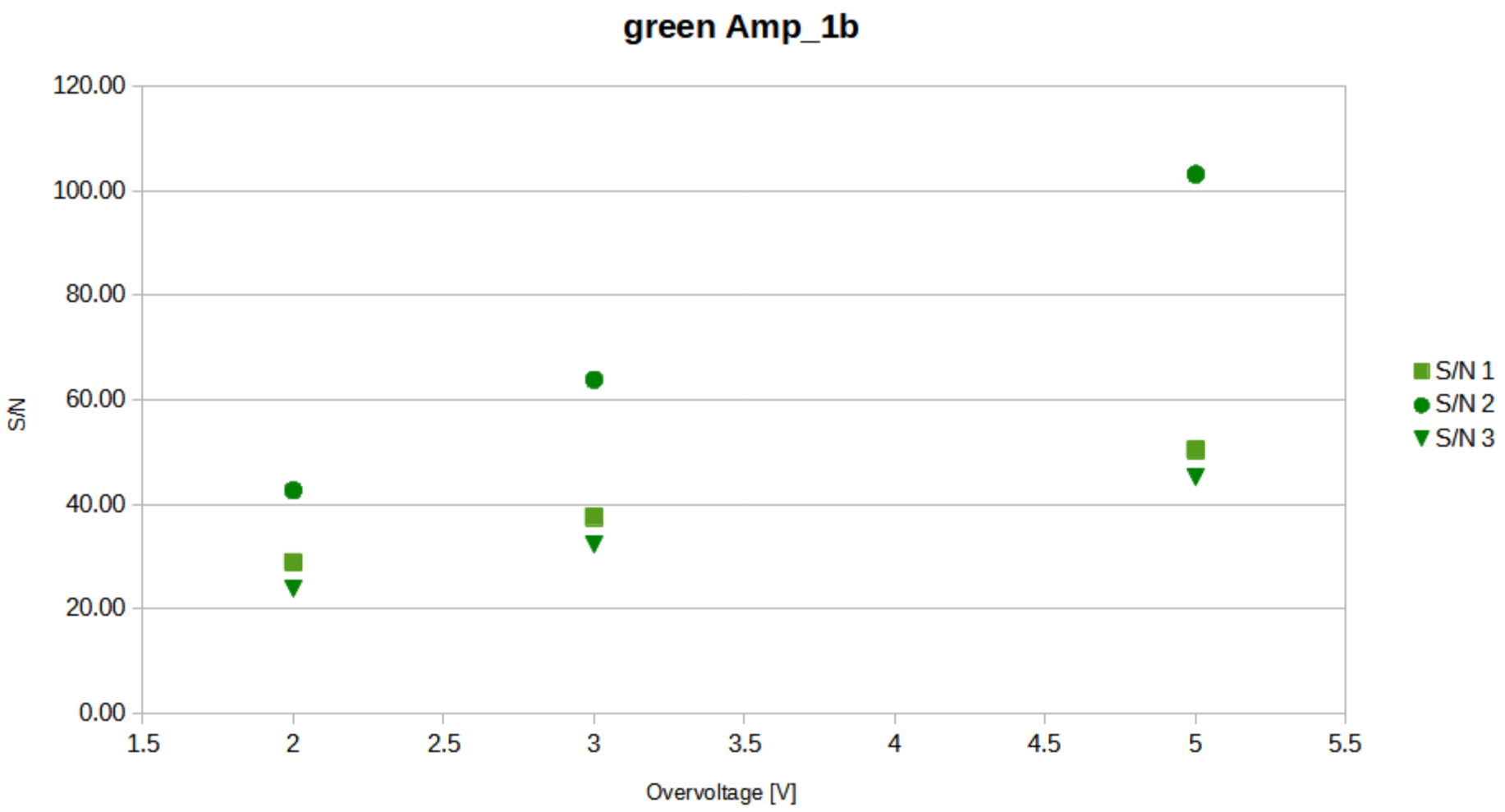
Preamp modification measurements

gain & S/N measurement

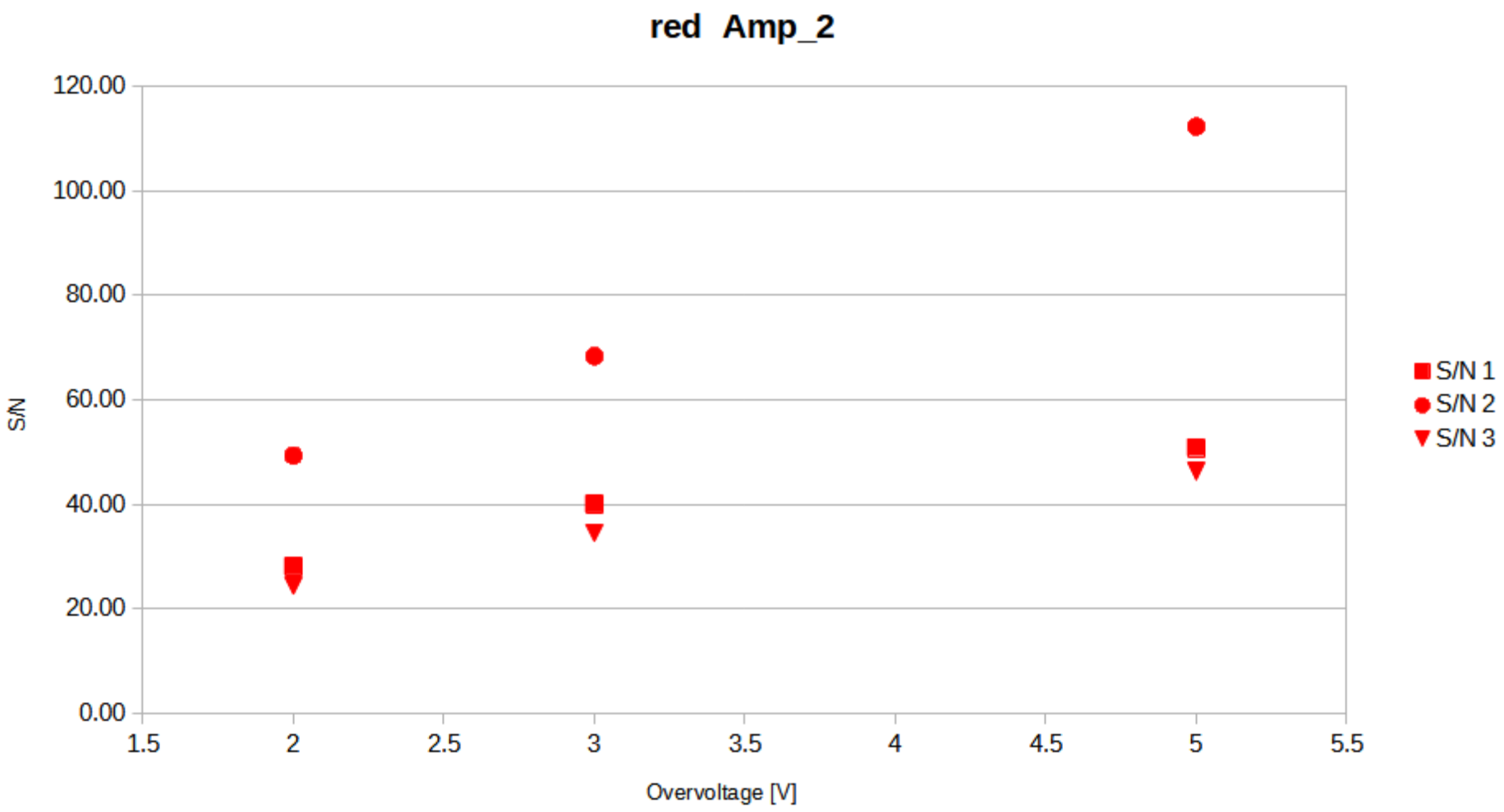
Signal to Noise – Amp_1, all calculations



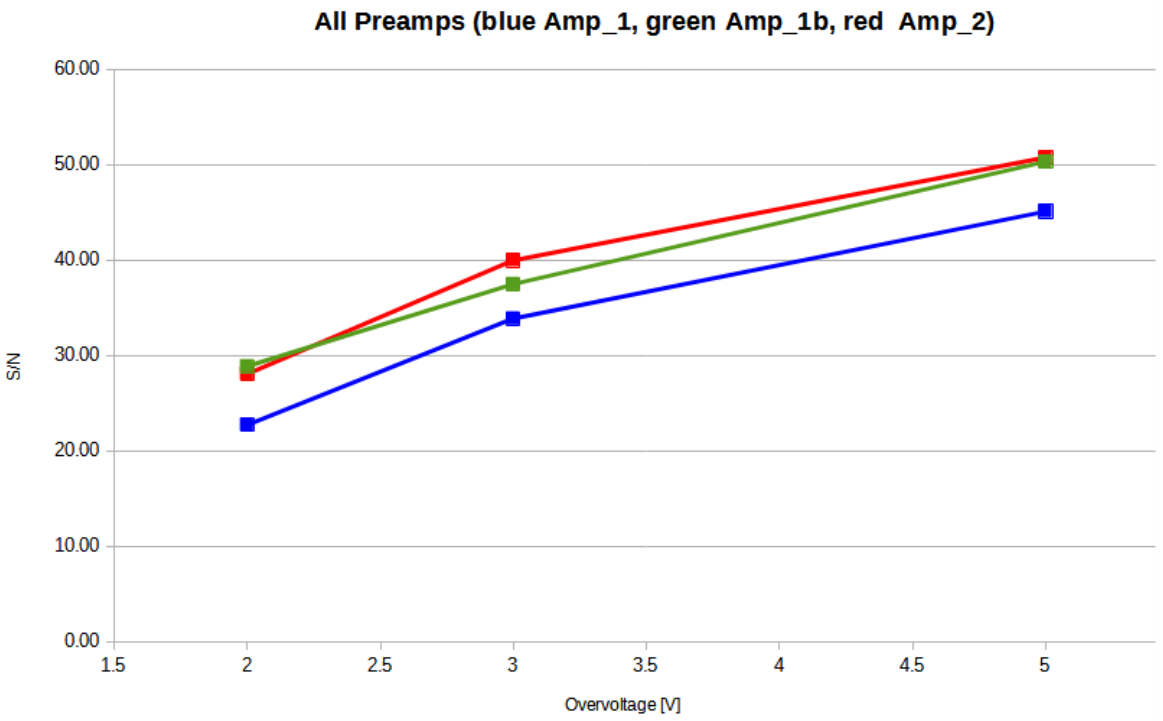
Signal to Noise – Amp_1b, all calculations

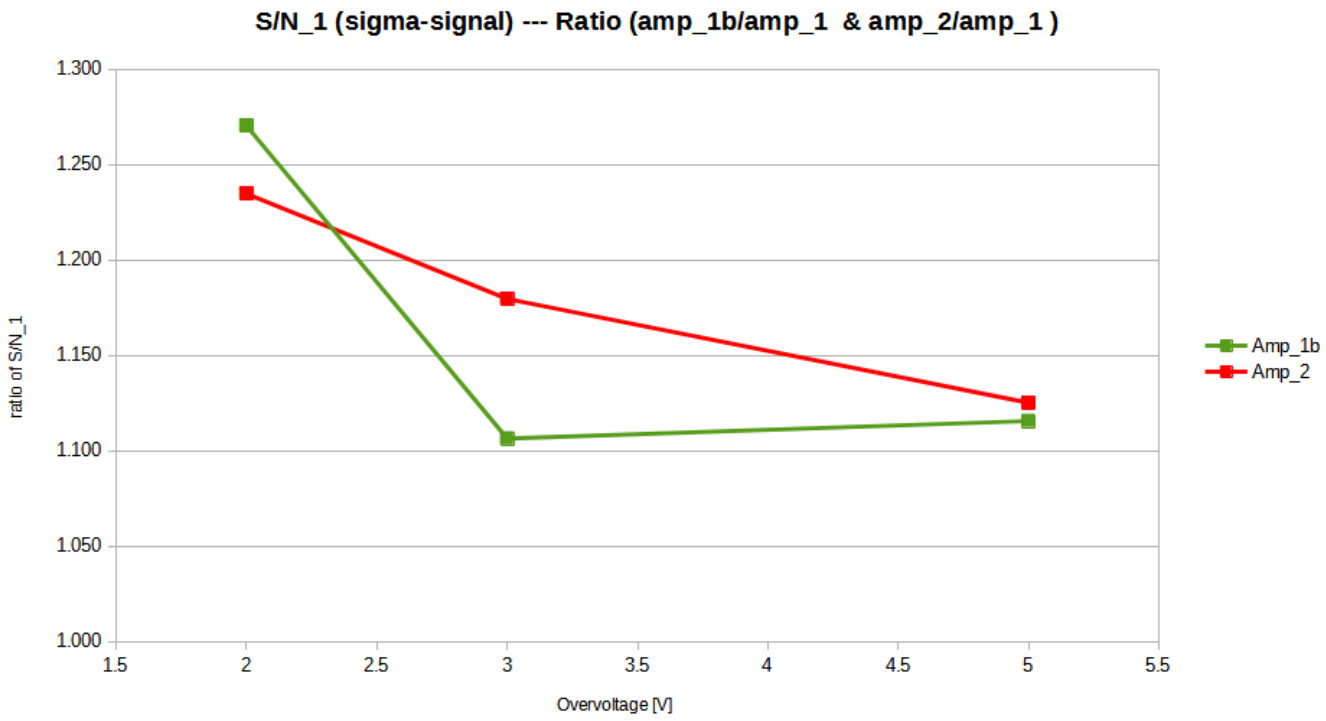


Signal to Noise – Amp_2, all calculations

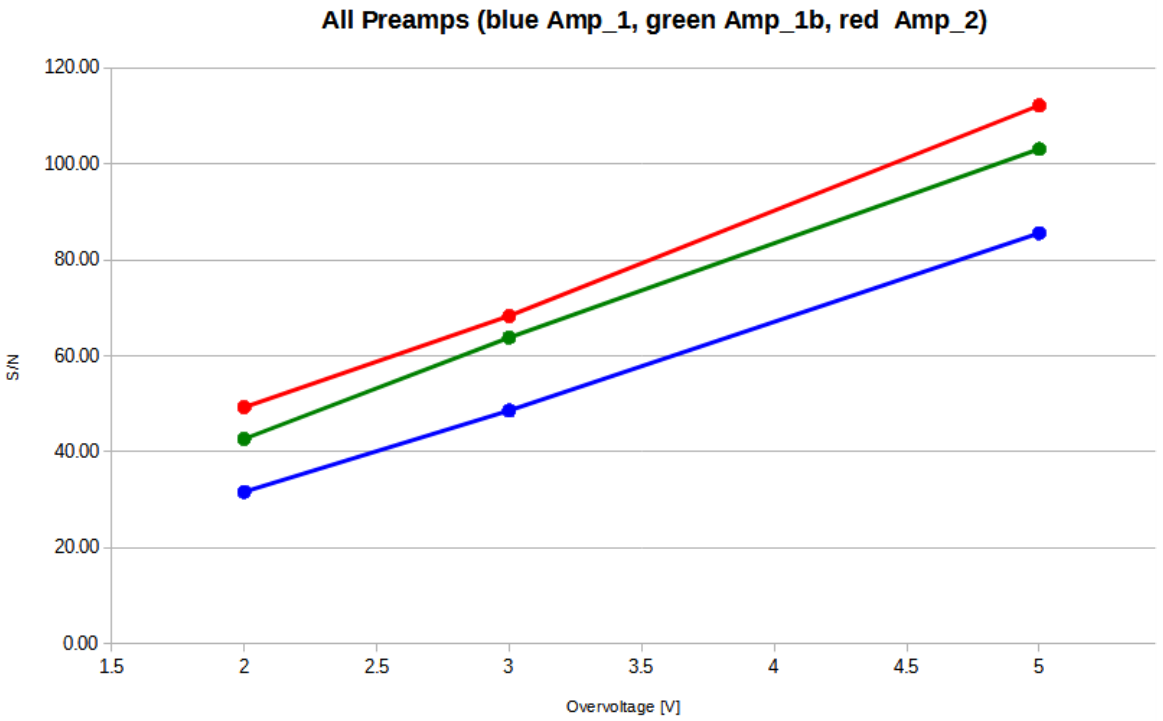


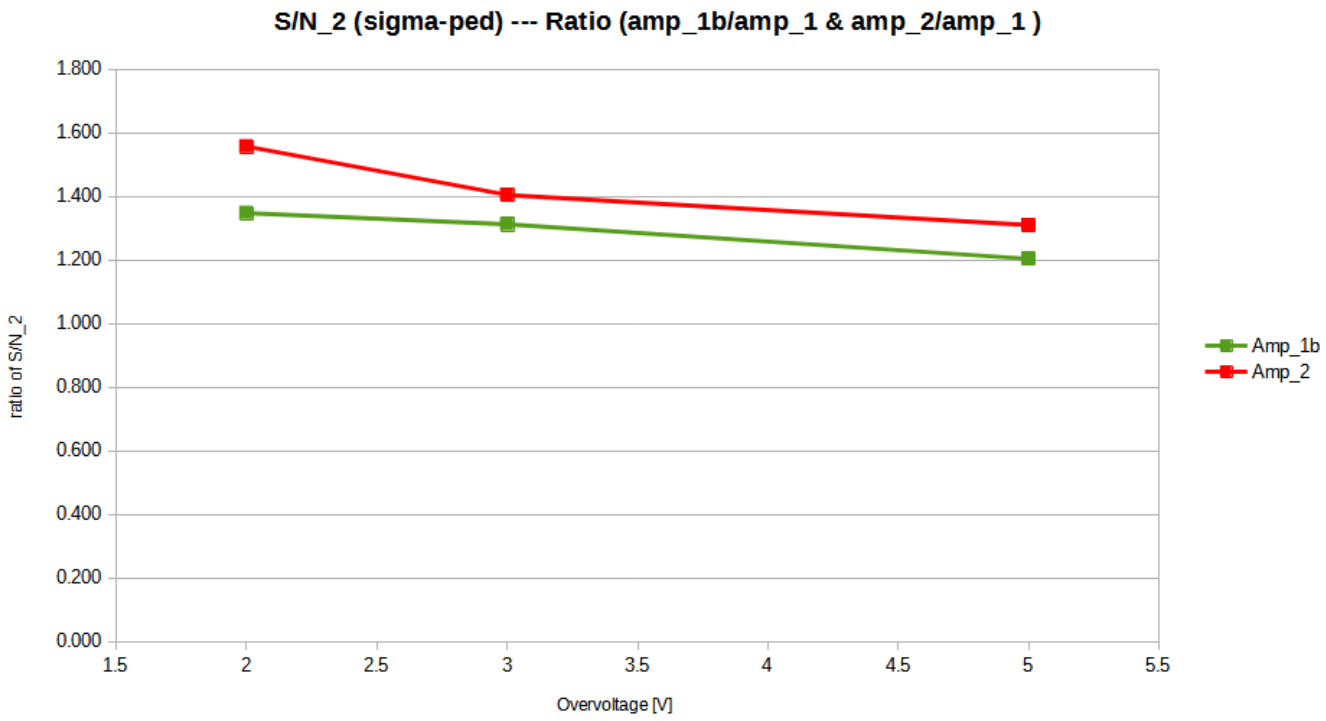
Signal to Noise – all Amps, Sig to Noise (1pe sigma)



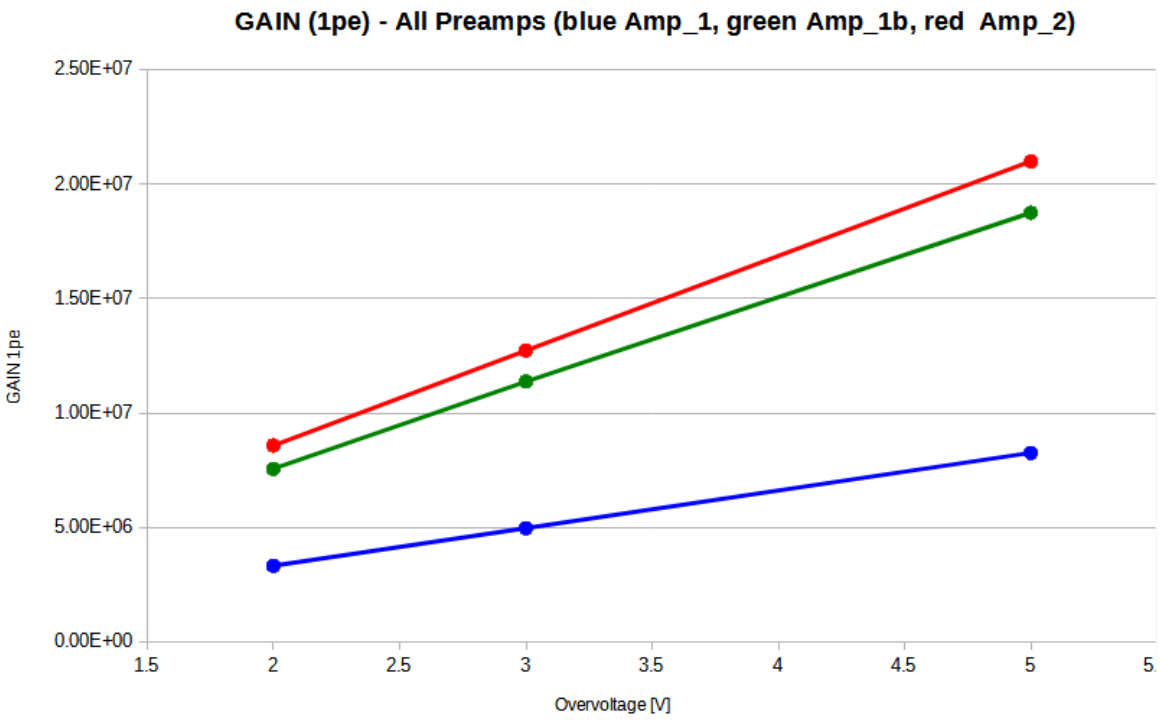


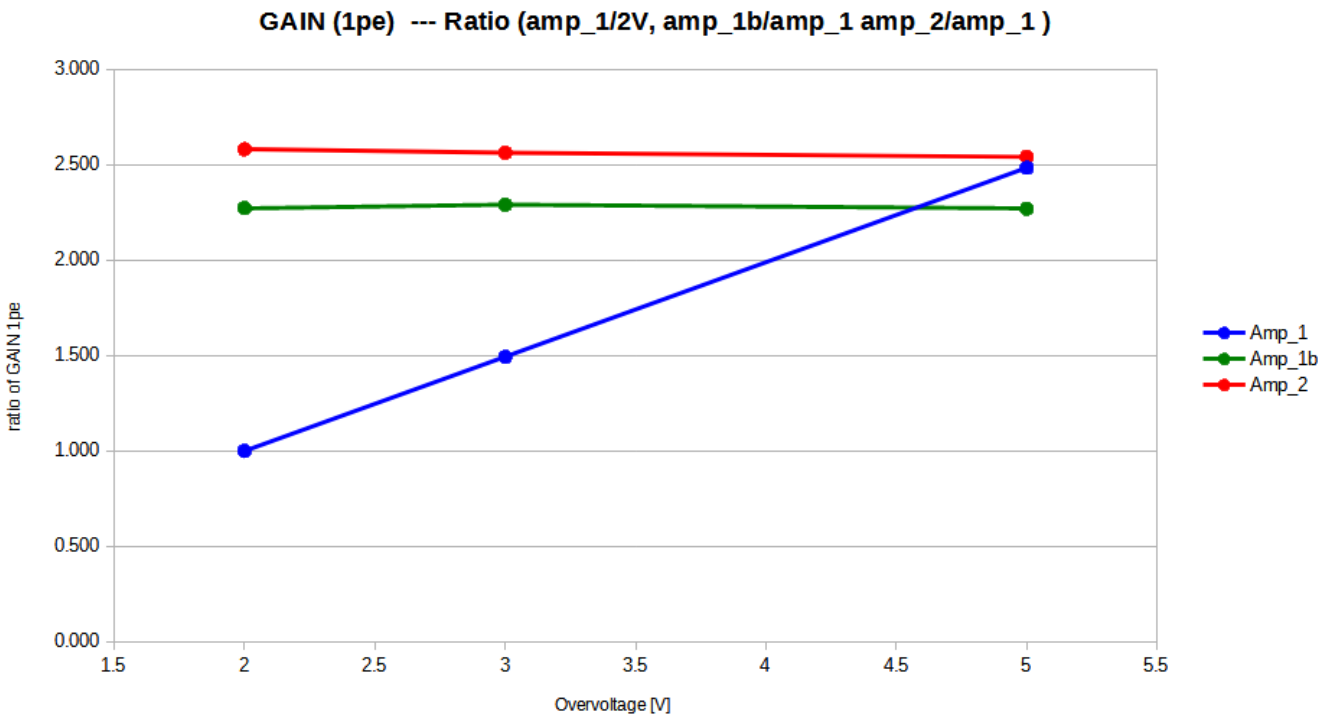
Signal to Noise – all Amps, Sig to Noise (pedestal sigma)



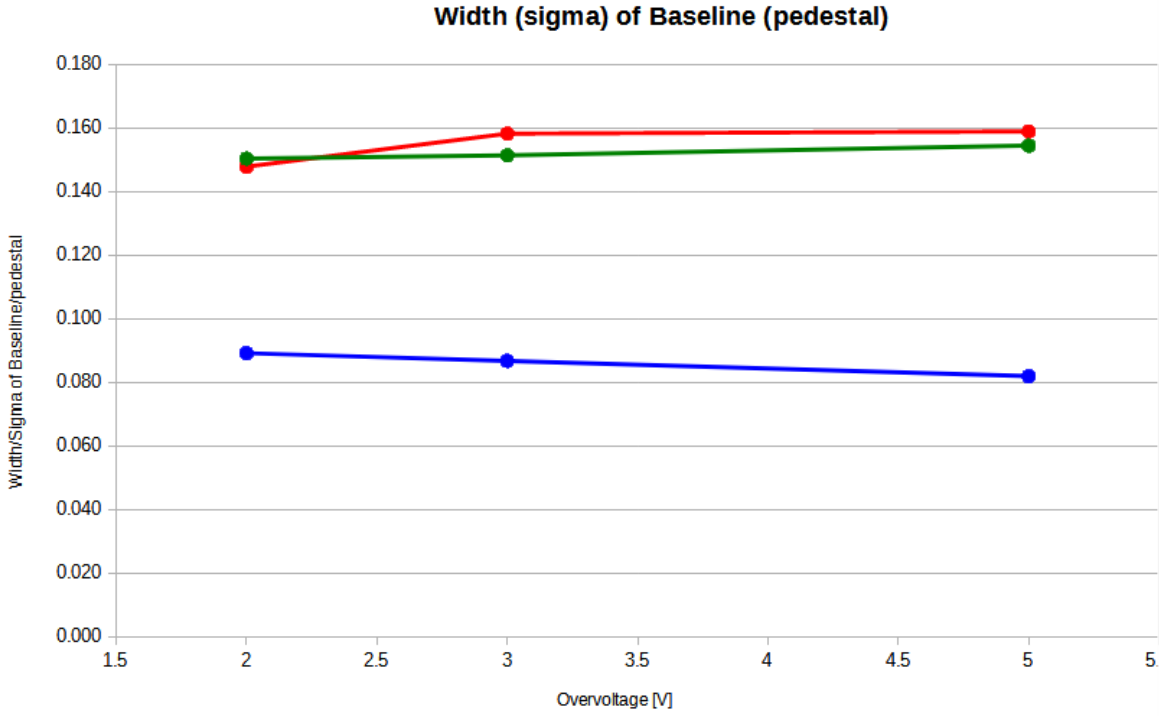


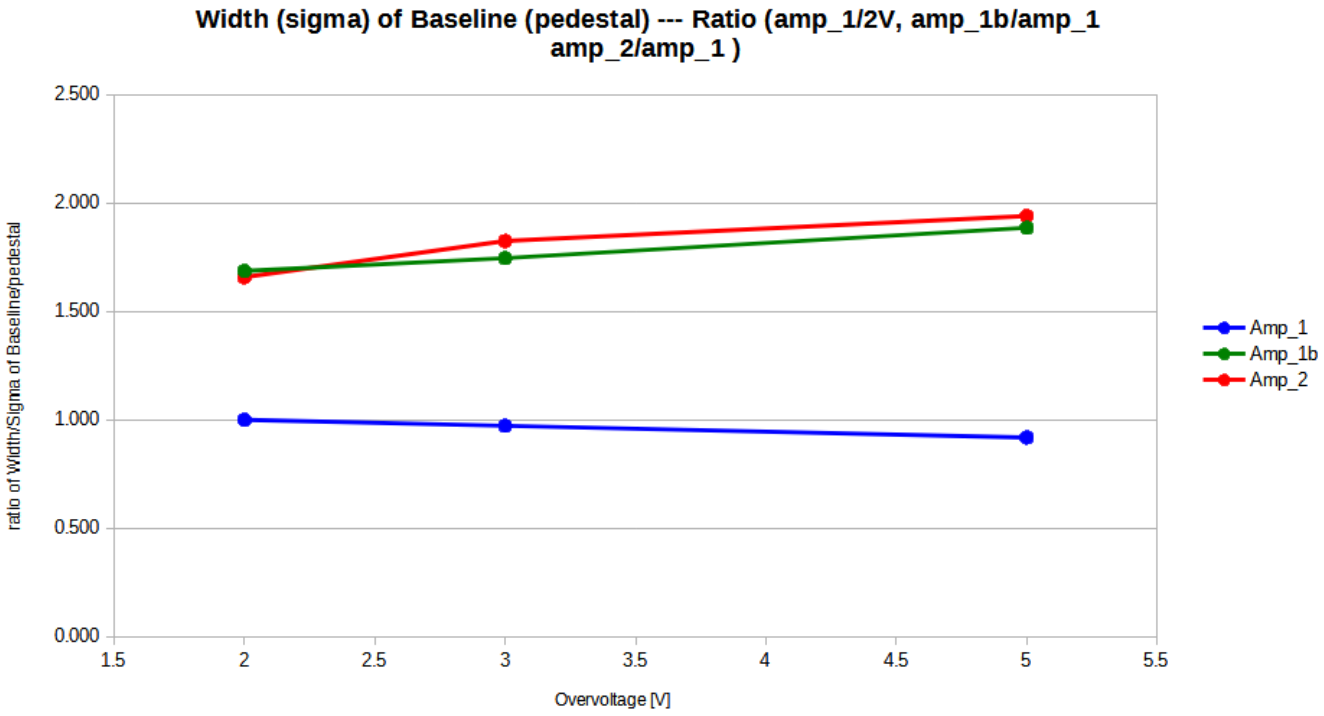
GAIN (1pe)


GAIN (1pe) - All Preamps (blue Amp_1, green Amp_1b, red Amp_2)
GAIN 1pe
2.50E+07
2.00E+07
1.50E+07
1.00E+07
5.00E+06
0.00E+00
1.5
2
2.5
3
3.5
4
4.5
5
Overvoltage [V]

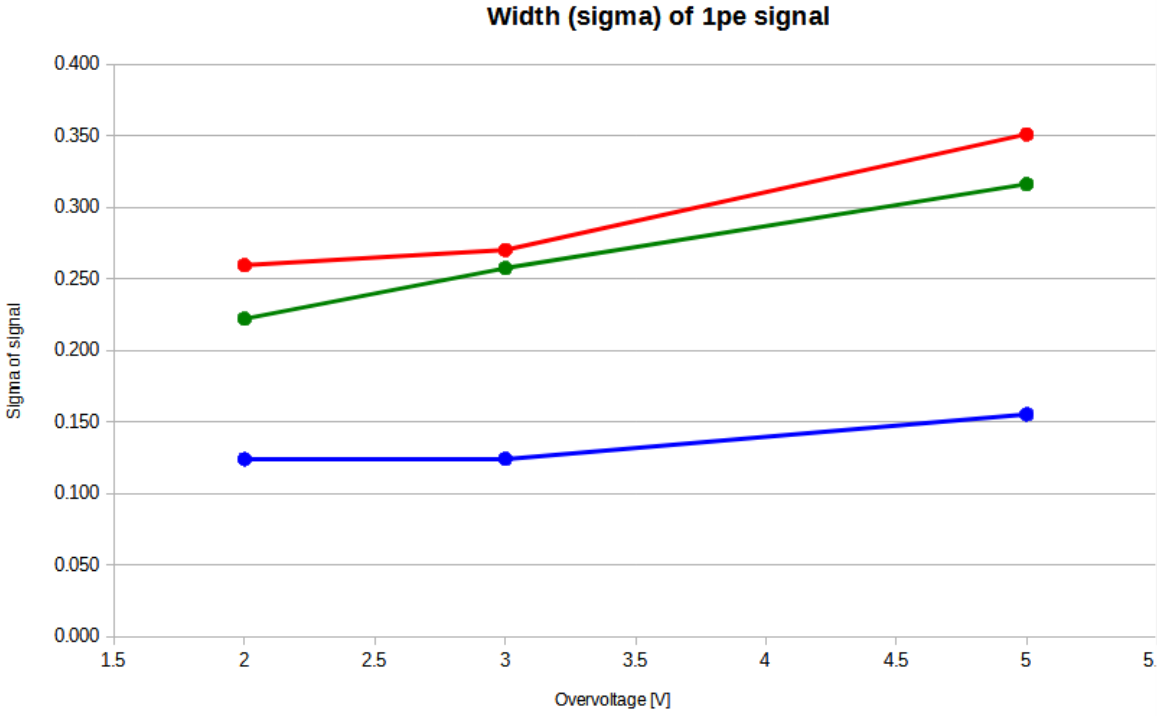

GAIN (1pe) --- Ratio (amp_1/2V, amp_1b/amp_1 amp_2/amp_1)
ratio of GAIN 1pe
3.000
2.500
2.000
1.500
1.000
0.500
0.000
1.5
2
2.5
3
3.5
4
4.5
5
5.5
Overvoltage [V]
Amp_1
Amp_1b
Amp_2

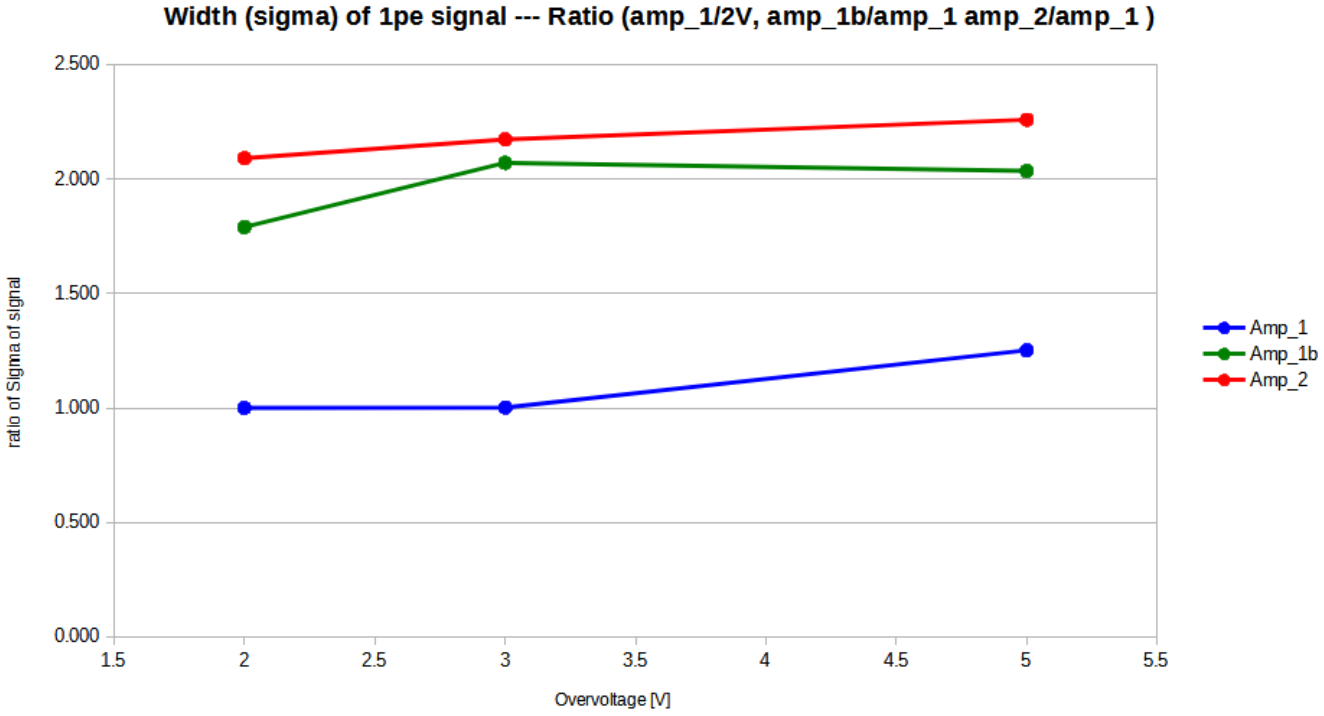
Width (sigma) of pedestal/baseline





Width (sigma) of signal (1pe)





Any further info, question, interest:

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