

LMU München - Excellence Cluster Universe

PS & Services

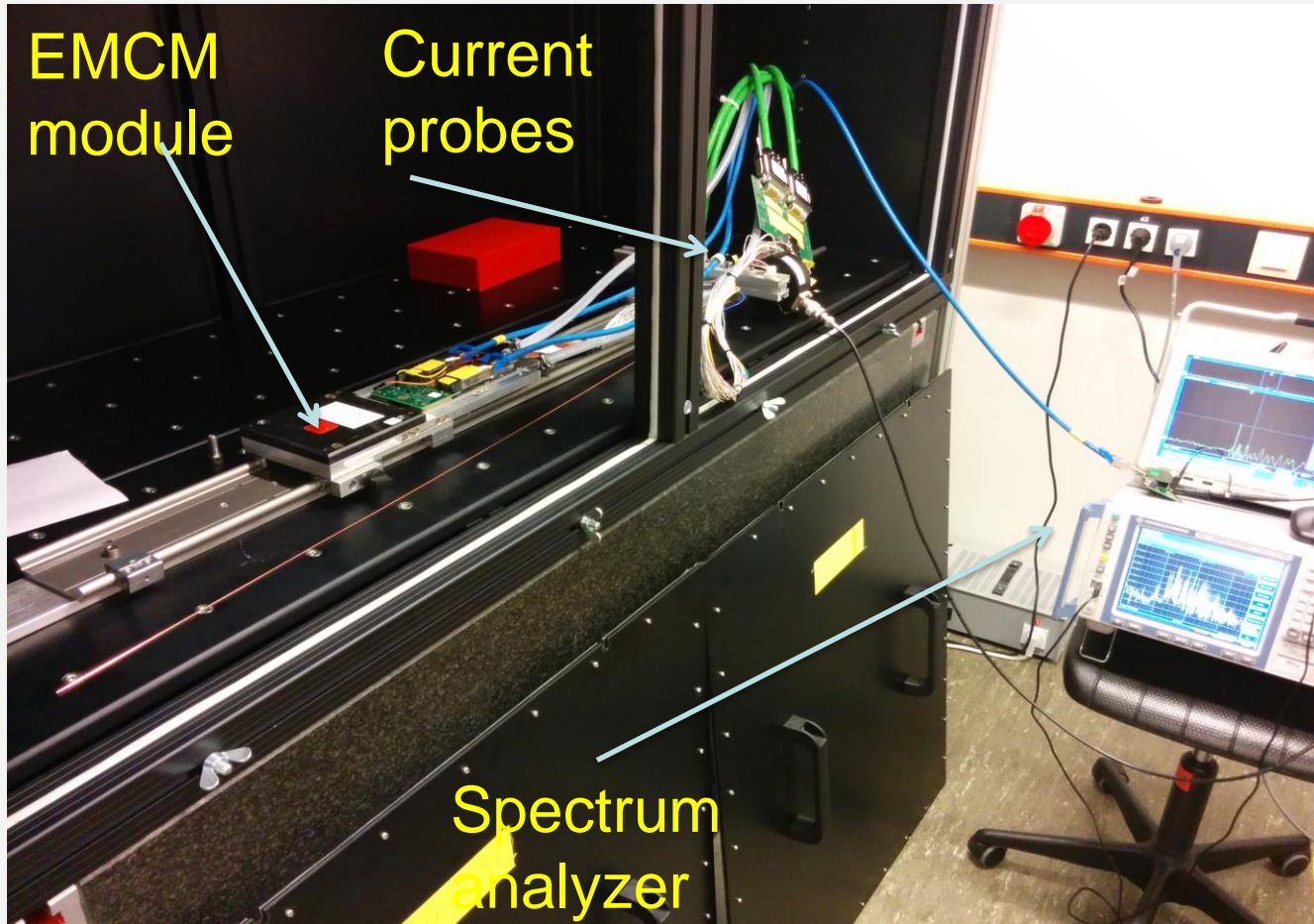
Stefan Rummel

**PXD SVD Meeting Prague
21.01.15-23.01.15**





- Noise measurements
- Noise of Step Down converter
- Load regulation and optimization
- Services:
 - Kapton development





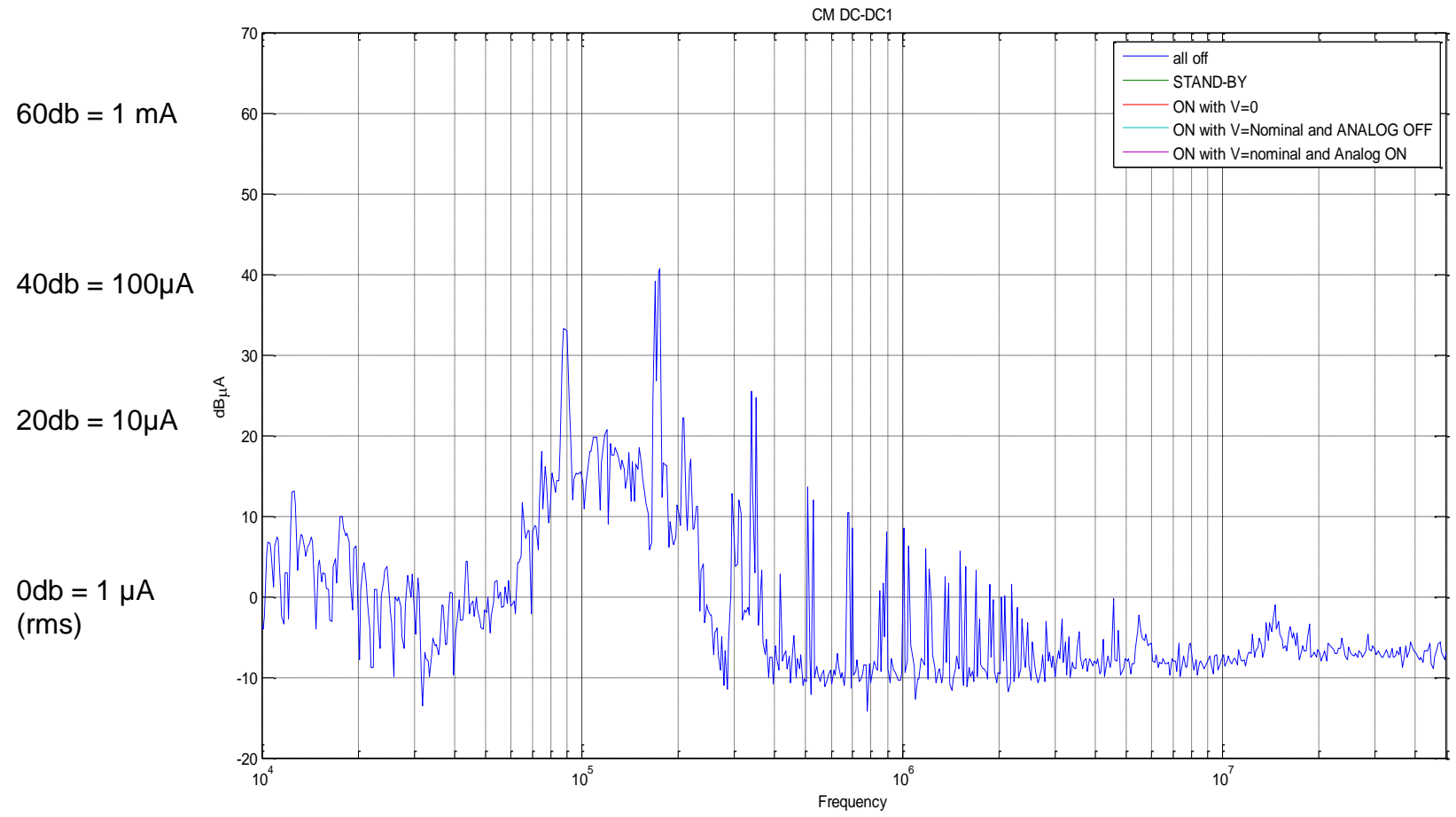
- A year ago the noise emission of PS units of PXD system was measured (Demonstrator PS)
 - PS unit loaded by a set of resistances.
 - Noise emission spectra totally characterized
- A new noise test campaign was carried out first week of December in order to continue the characterization of the PXD noise (Preproduction PS)
- The main goal of this test was to characterize:
 - System noise level of PXD system.
 - PS units + power cables + EMCM
 - The effects of ASIC operation on noise emission level.



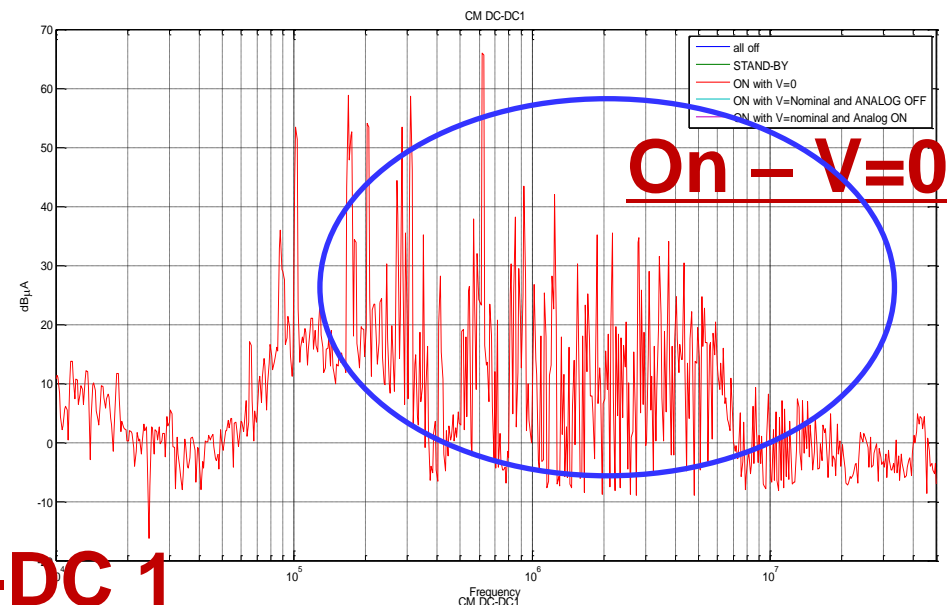
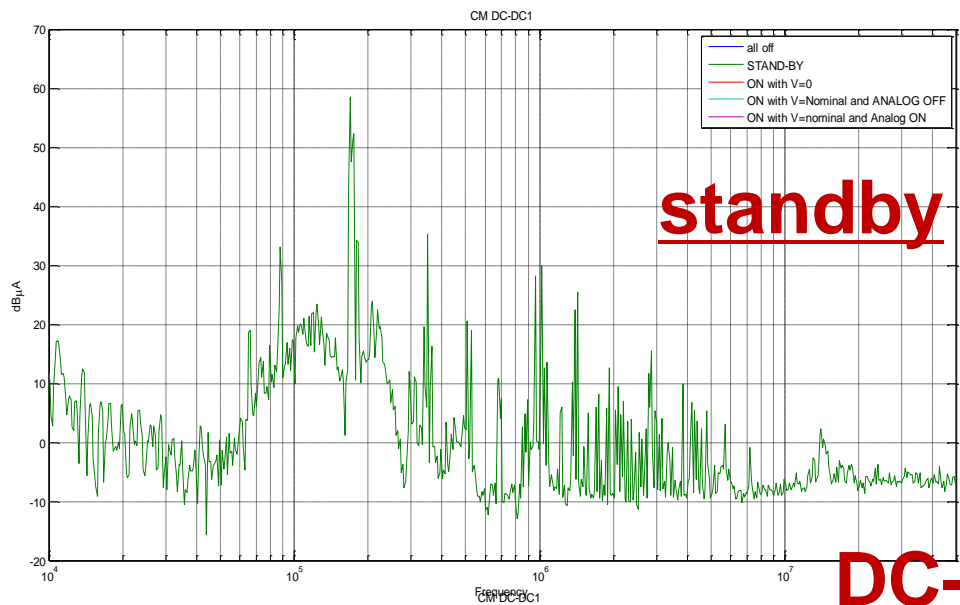
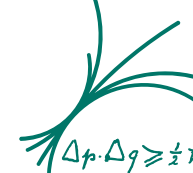
- The noise current in the power cables has been measured under four different conditions :
 - PS standby (Power DC-DC converters off)
 - PS on - Voltage set to 0V (DC-DC converters on)
 - PS on - Voltage set to nominal values: Analogue ASICs OFF
 - PS on - Voltage set to nominal values: Analogue ASICs ON
- Frequency range :
 - 10 kHz up to 50 MHz
 - BW : 1kHz.
- Common Mode from 3 DC-DC converters has been measured as well as noise level in other conductors (CM+DM)



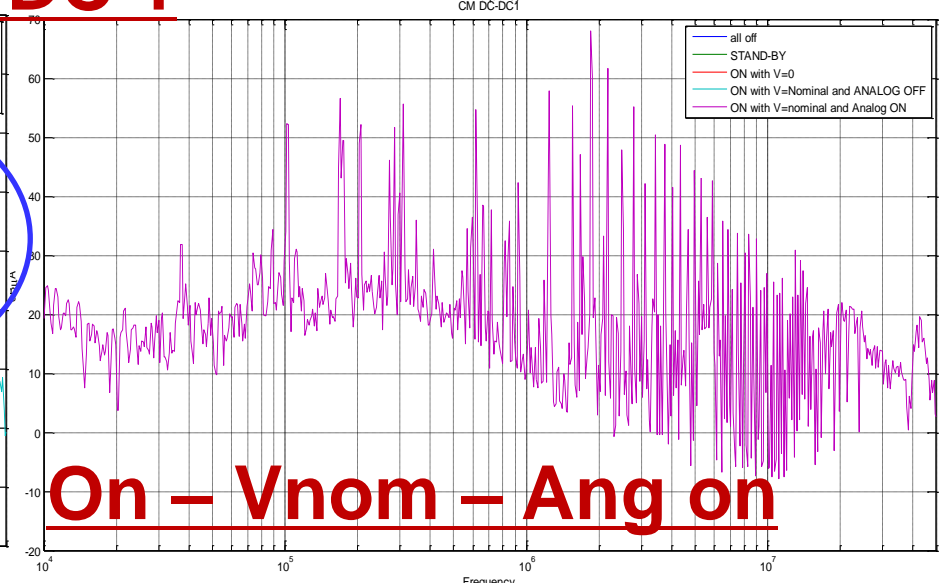
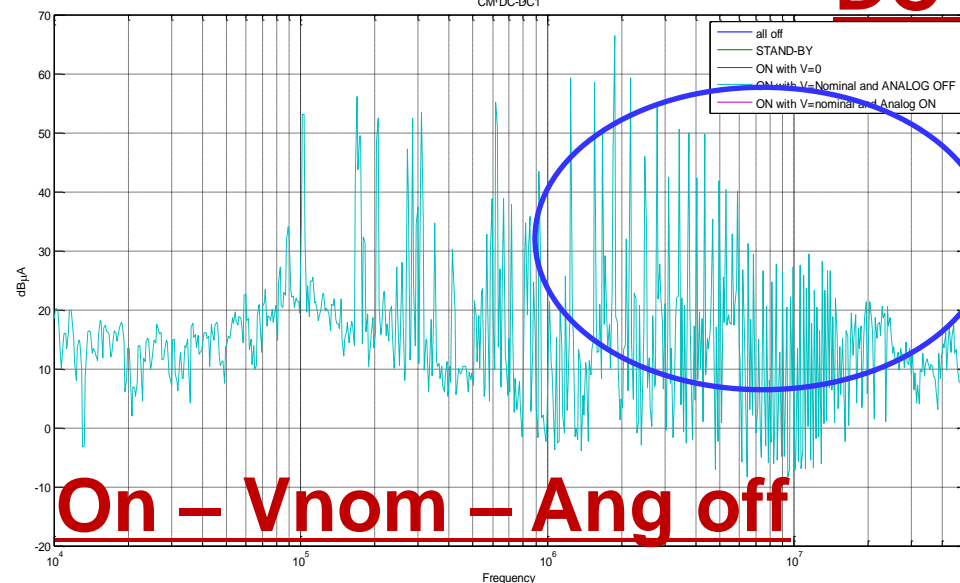
- » All OFF - Background noise – CM DC-DC1
 - CM : (DCD_AVDD+Refin +Source+ ANG_GND)

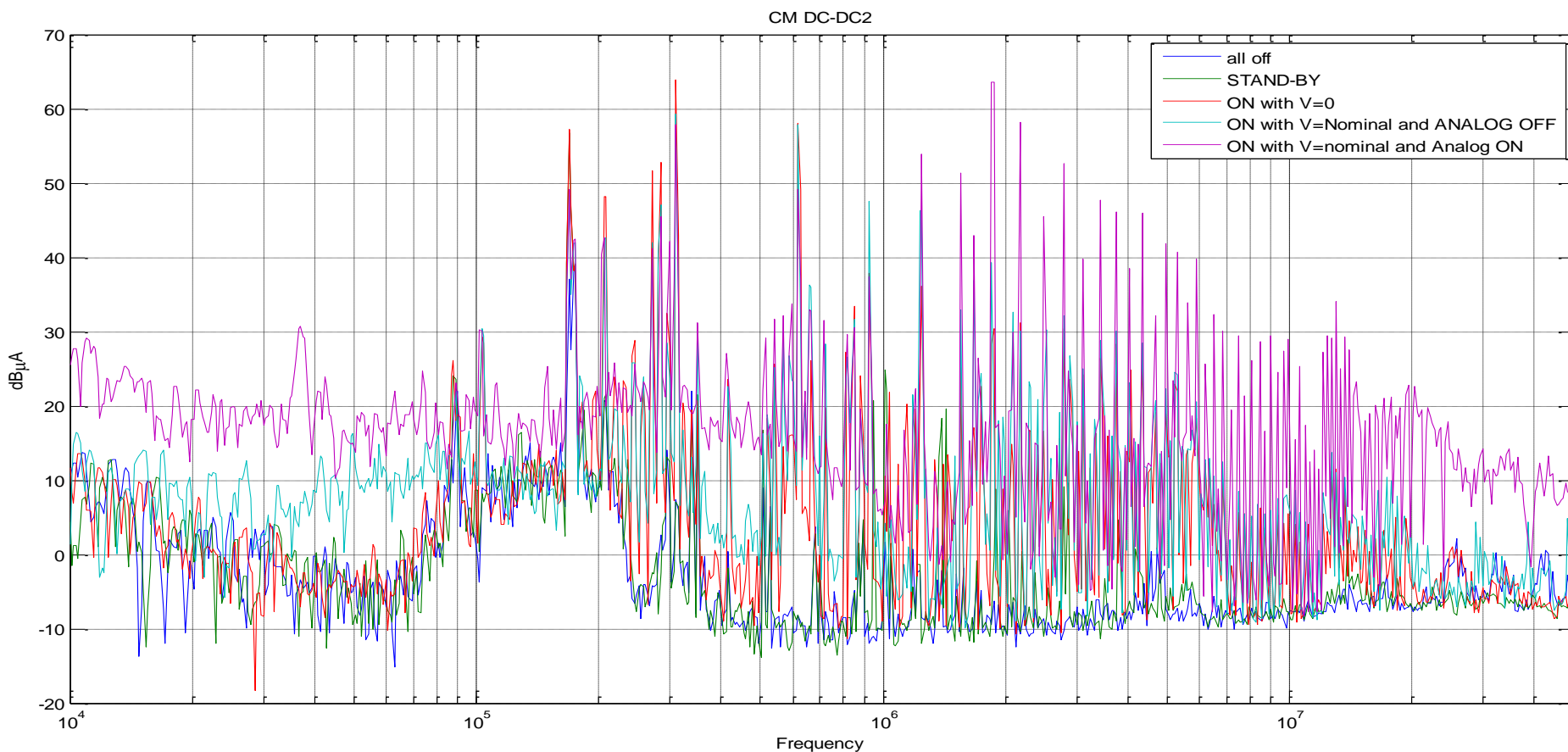


PXD system noise emission test



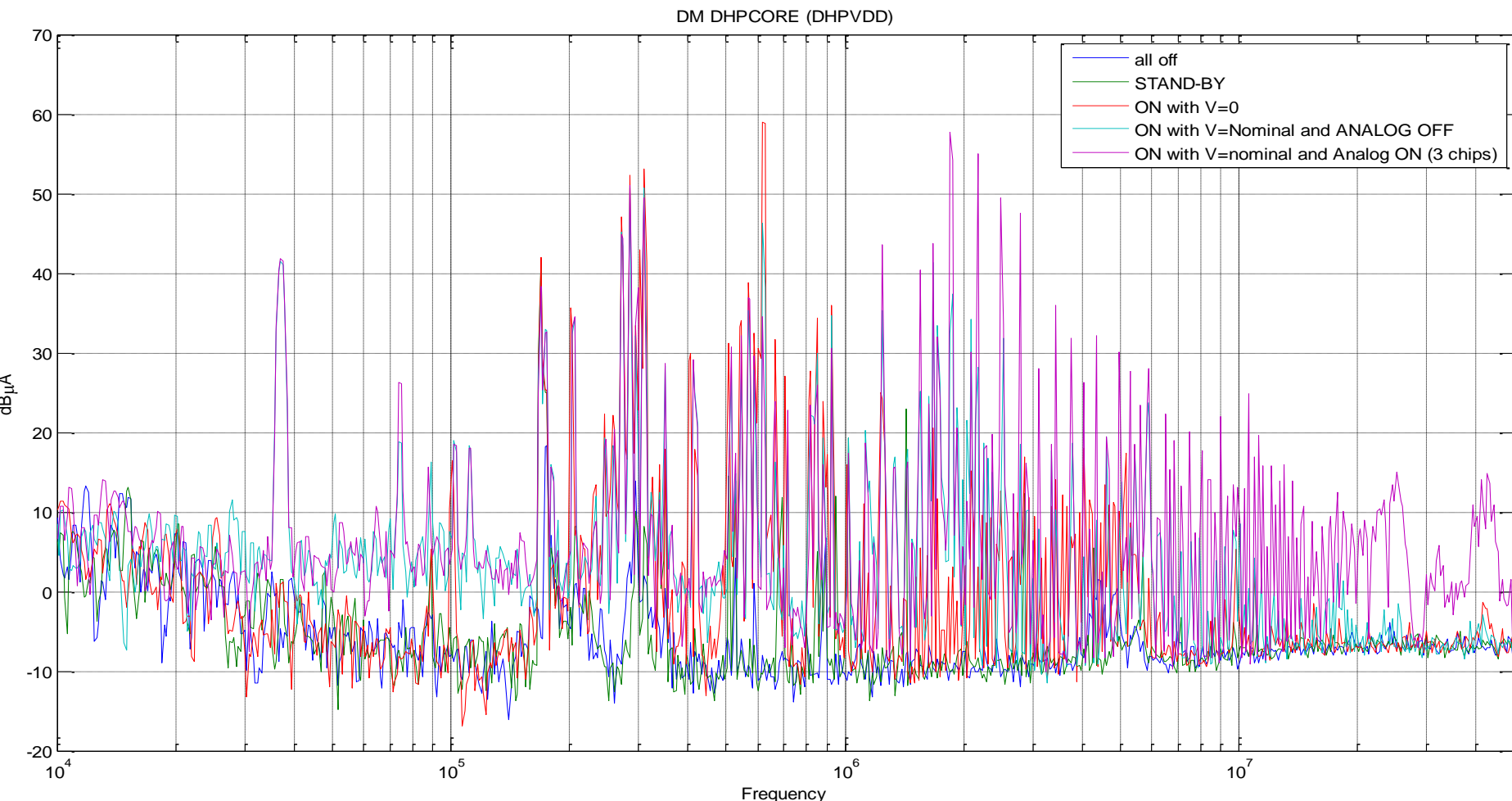
DC-DC 1





» CM DC-DC 2

Again, new noise components show up, even with V=0
(but DC-DC converters on)

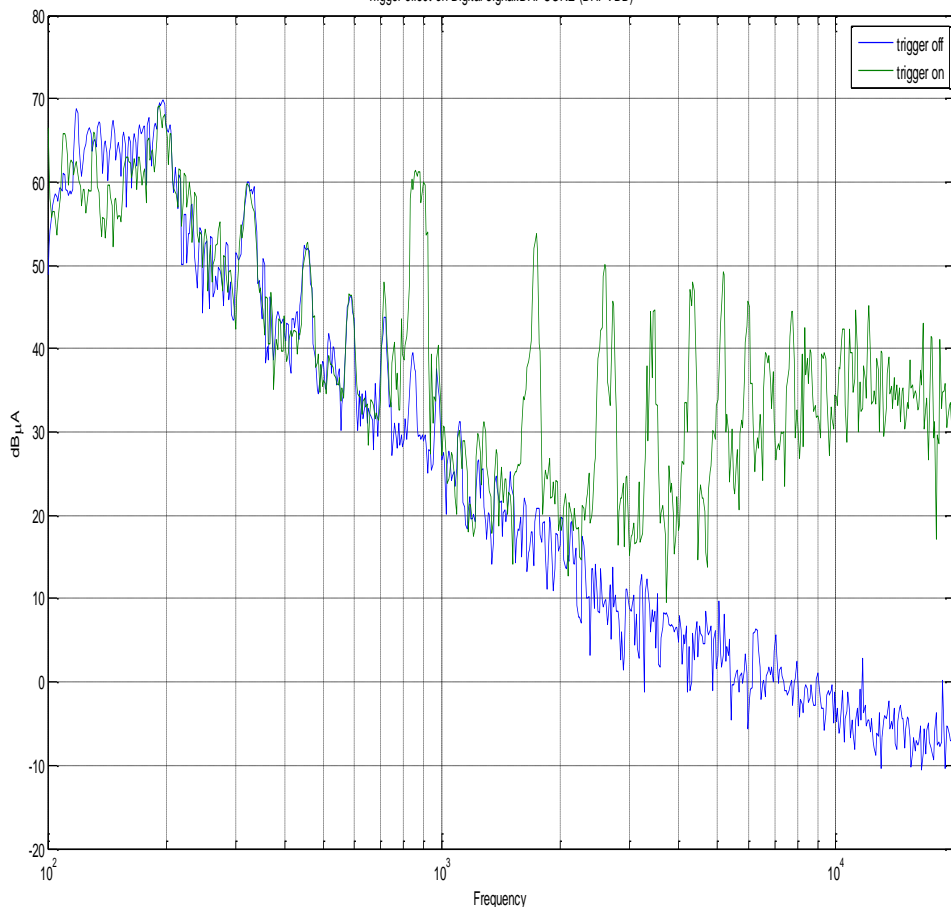


» CM+DM (DC-DC 3) : DHP_VDD

Again, new noise components show up, even with V=0
(but DC-DC converters on)

- » The noise current in the power cables was measured with and without trigger
 - Without: only ADC in DCD active, no data processing in DHP
 - With: in addition: Data processing in DHP, data transfer
 - » Frequency range
 - 100Hz – 20 kHz
 - » Four lines were measured :
 - 2 digital lines: DHP_VDD & DCD_VDDD (DHP and DCD supply)
 - 2 analogue lines: DCD_VDDA & SOURCE (DCD supply & sensor)
- The largest effect is expected on DHP_VDD (activity due to trigger)

Trigger effect on Digital signal: DHPCORE (DHPVDD)



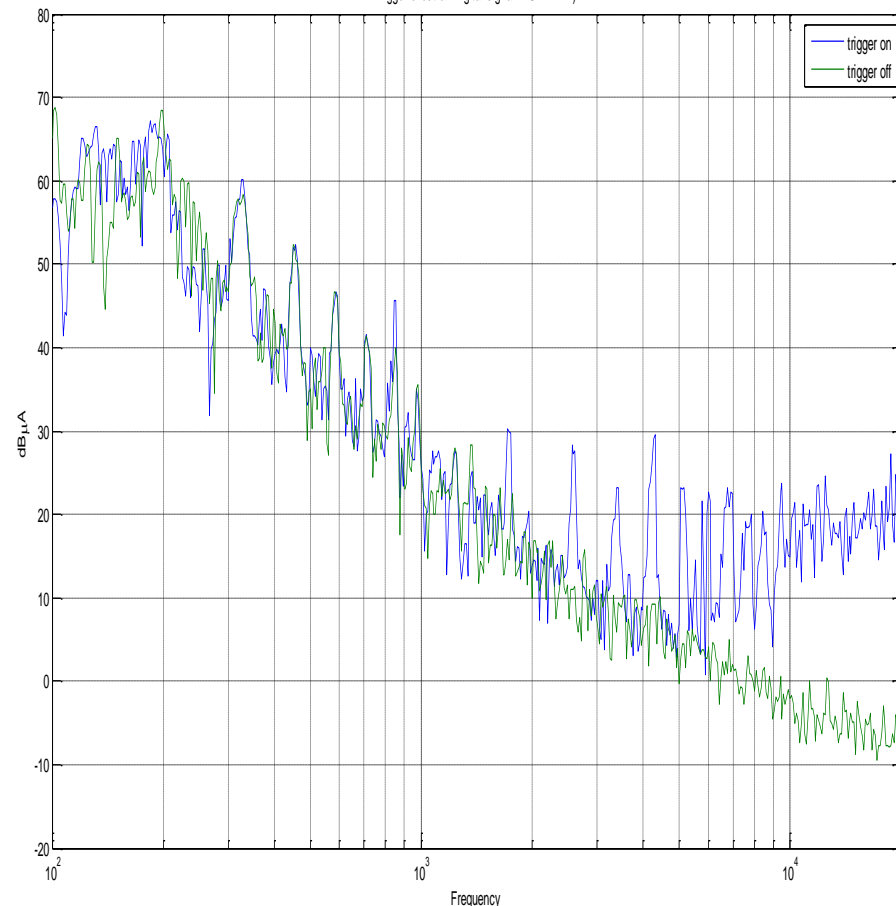
DHP_VDD

Trigger On - green

Trigger Off - blue

Digital activity
of DHP
clearly visible

Trigger effect on Digital signal: DCDVDD

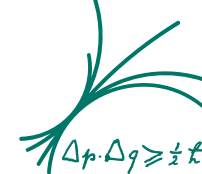


DCD_VDD

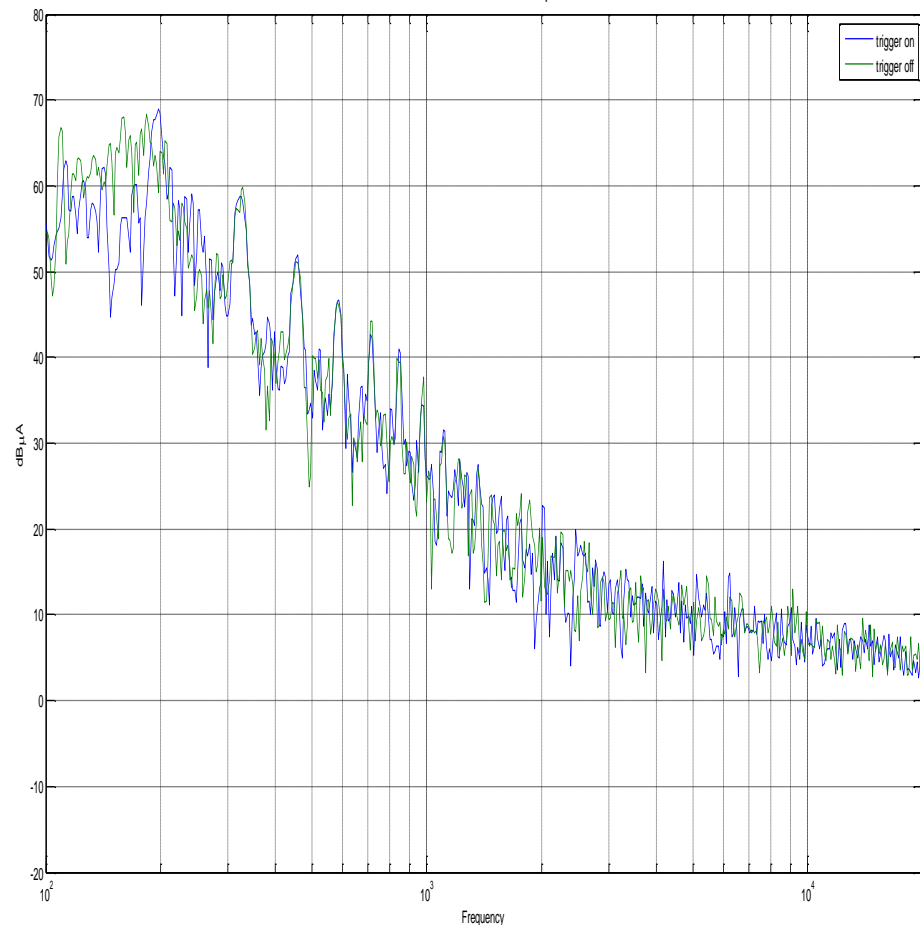
Trigger Off - green

Trigger On - blue

Triggering effects: Analogue lines



Trigger effect on Analog signal: DCD, DDA)



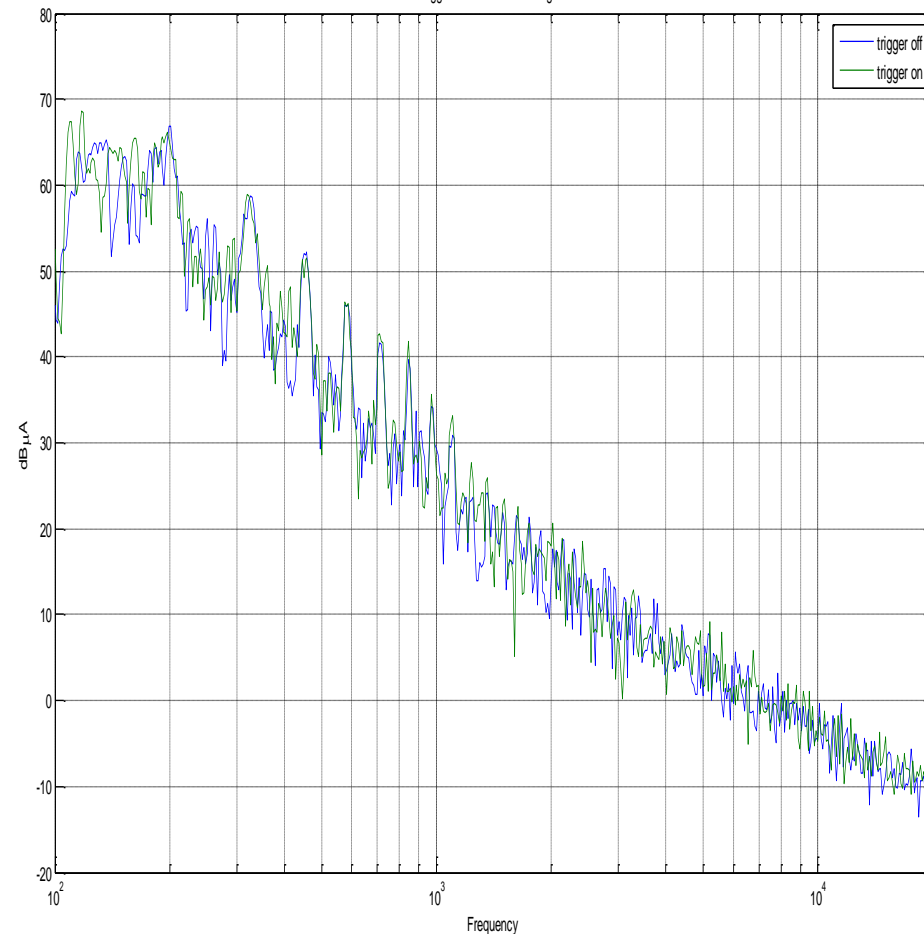
DC DVDDA

Trigger on - green

Trigger Off - blue

No cross talk on
analogue
supplies!

Trigger effect on Source signal



SOURCE

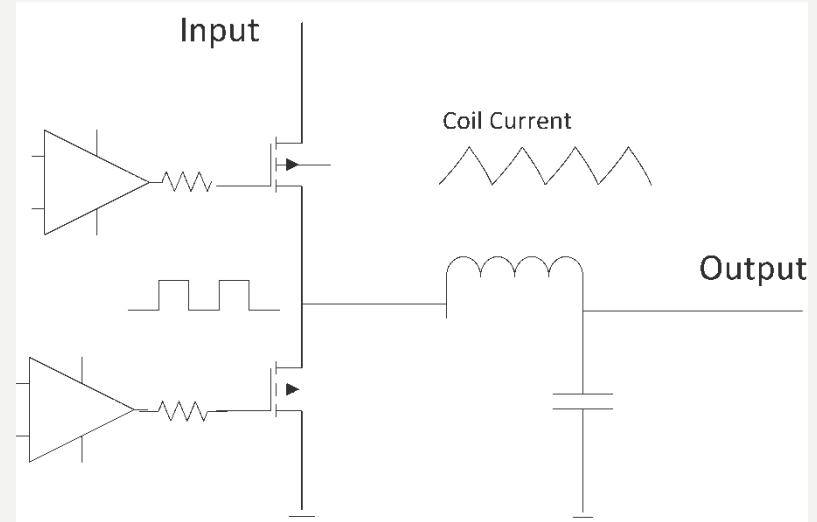
Trigger on - green

Trigger Off - blue



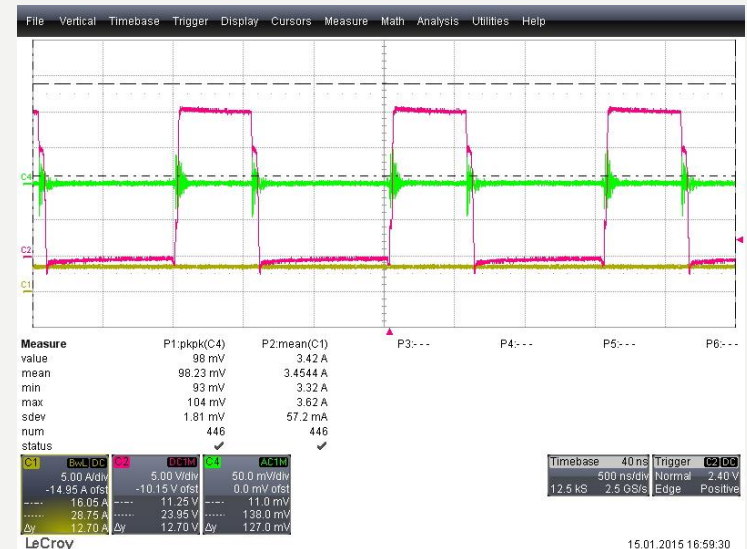
- Noise measurement revealed an increased noise of “Preproduction” units vs. “Demonstrator”
- Main differences:
 - More powerful DC/DC converter
 - More DC/DC converter in “Preproduction” units to feed the bipolar regulators
 - Additional step converter for analog and digital supply voltages
 - More noise which distributes in the unit
- New DC/DC converter card for Main production comprise additional filtering at input and output of DC/DC converters
- Form this measurements one cannot judge the performance of the module
- Either sensitivity analysis of the module required → Fernando is working on that
- Or comparative measurement with different PS's
 - Felix showed promising measurements

- Noise sources in converter:
 - Ripple due to current through inductor @ switching freq.
 - Switching noise – HF, due to fast switching of FET's and resulting ringing



Strategy for mitigation:

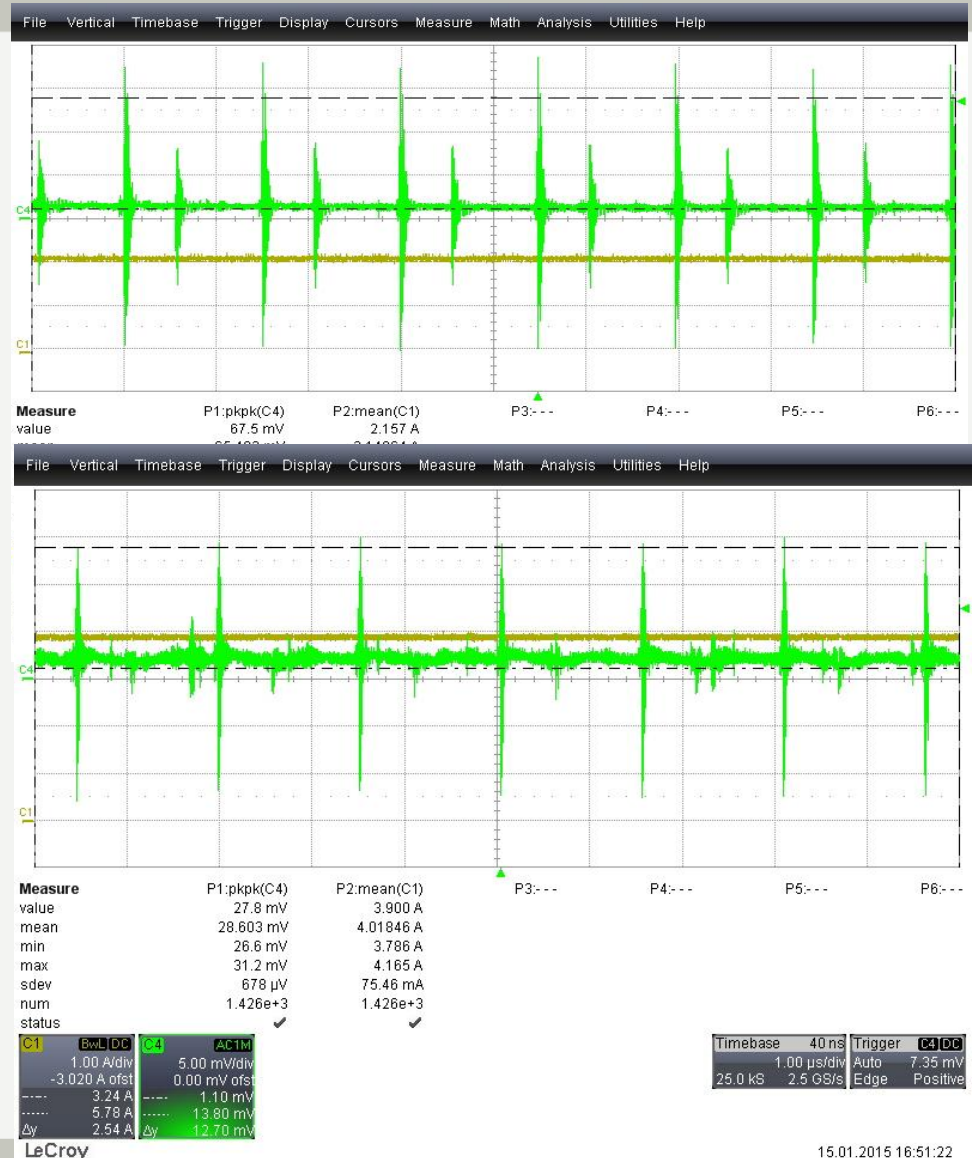
- Filtering
- Controlling the slope of the edge
 - Active circuitry
 - Ferrite beads, Resistors in gate drive circuitry



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- Mitigation using Ferrite beads and resistors in Gate drive improve Peak to Peak noise by factor 2

→ Given design can be significantly improved





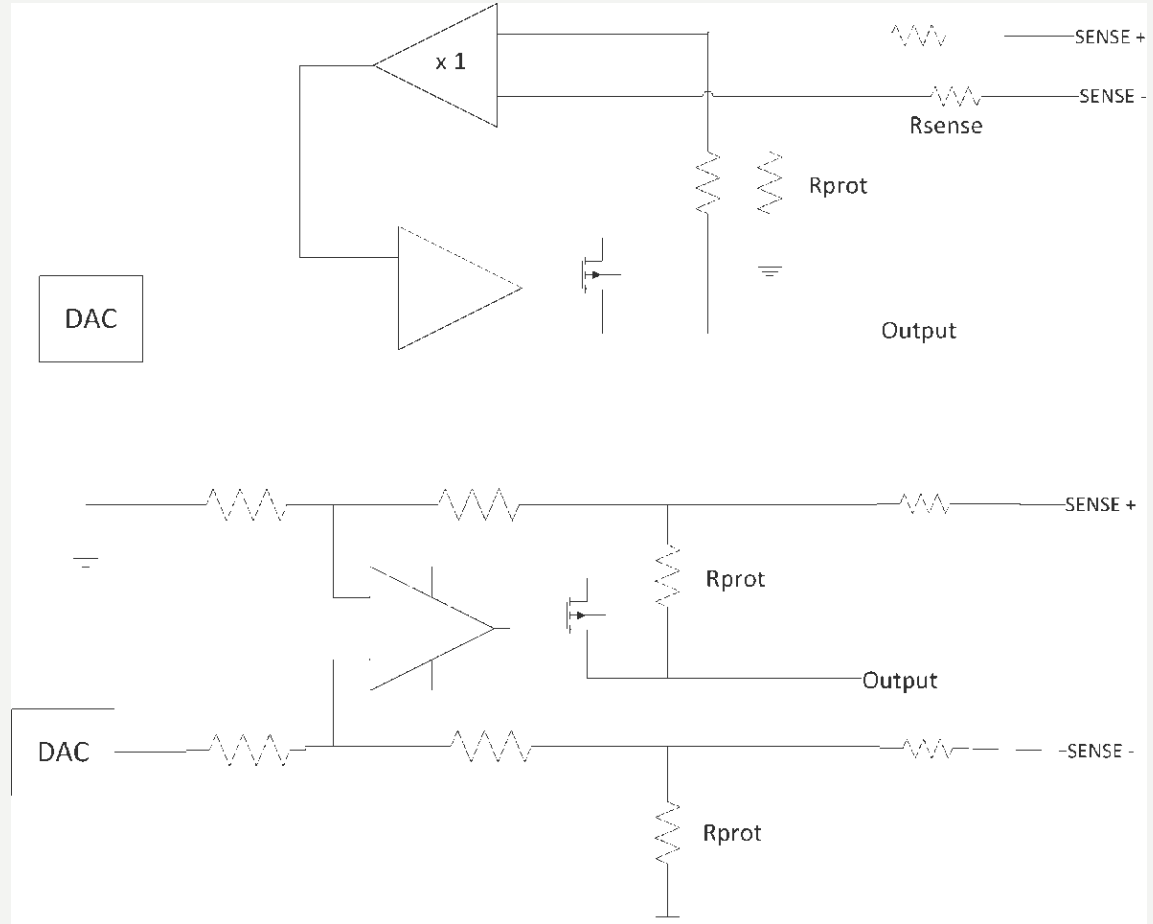
- Current generation of DHP is very sensitive to deviation of supply voltage
 - Load regulation might be an issue
 - High sense wire resistance is known to deteriorate load regulation

Design goals of sense wire input stage:

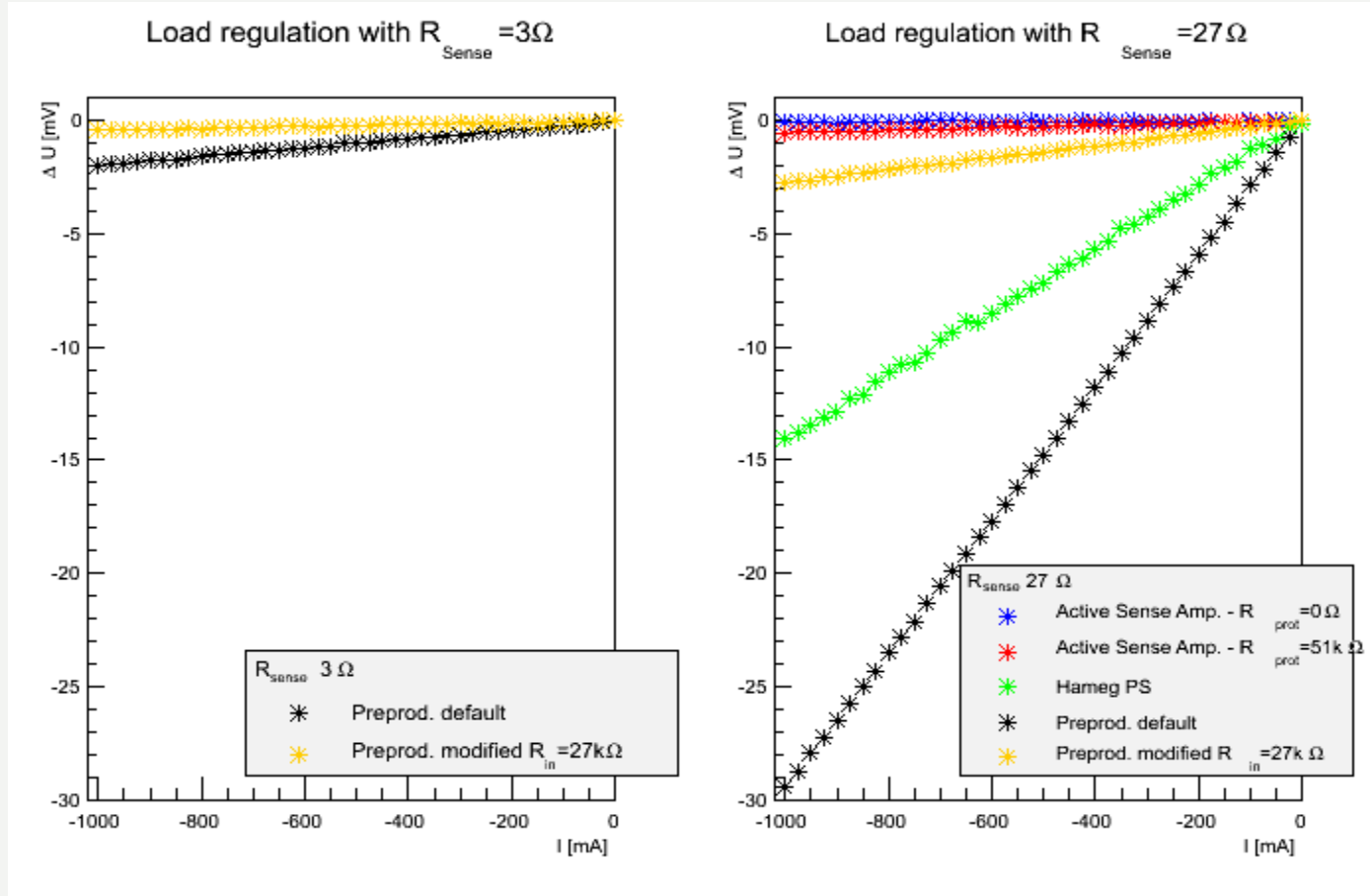
- High input resistance
- Voltage limitation in case of broken sense wire

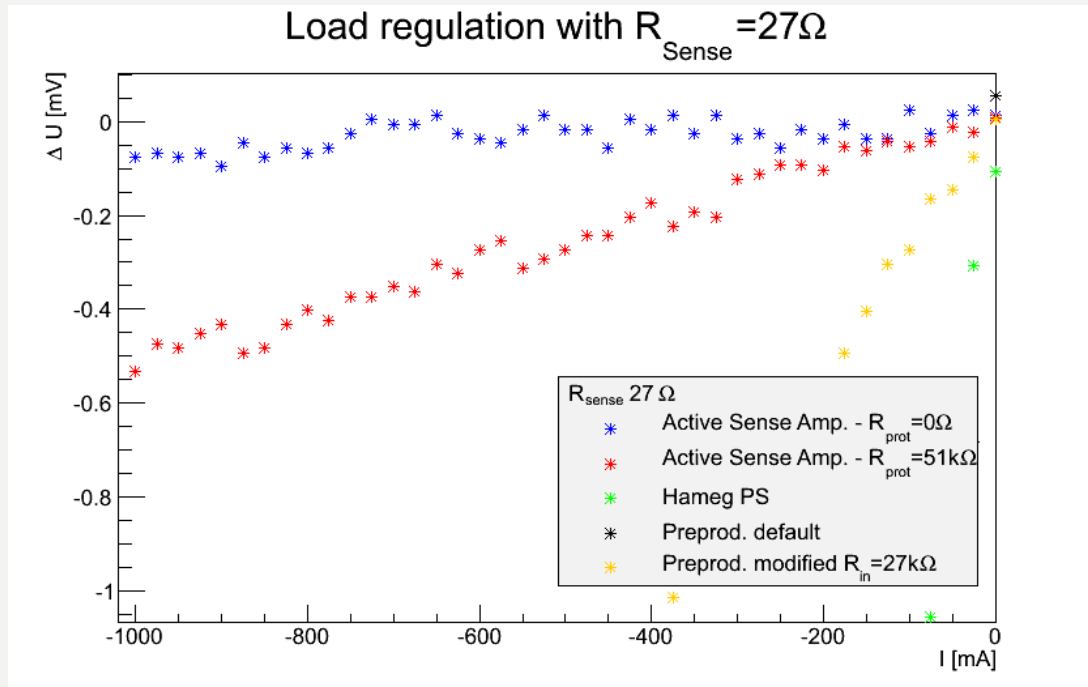


- Two variants in Preproduction Unit:
 - Regulator with active sense amplifier
 - Error amplifier in differential configuration



- Investigation of two scenarios:
 - Long power cable + intermediate cable → $R_{sense} = 3\Omega$
 - Long power cable + intermediate cable + 24 W to simulate module / Kapton resistance





- Preproduction in modified configuration significantly improves output DC impedance to 2.5mW significantly better than commercial unit
- Baseline for main production: Active sense amplifier with 51k protection resistor



- Lessons learned from recent test efforts:
 - Improving noise of Step Down converter
 - Improve filtering of DC/DC converter cards
 - Added CMC filter and converter inputs
 - Improved DM on outputs
 - Load regulation:
 - Active sense input for analog and digital channels
 - Higher input resistivity for circuitry connected to sense wires in the OVP card



- First Kapton layout has been finished
 - Documentation of interfaces available
 - Bond scheme
 - Assignment of connectors
 - Current load on bond wires and connector pins
- PXD9 EOM – Kapton interface correct
- Current load has been conservatively chosen
- Minor modifications will be done within this week
- Start of production within Jan. 2015



Noise Measurements:

- New noise components visible compared to prev. measurement
 - Additional currents visible while triggering and analog section in operation
 - No crosstalk between analog and digital voltage visible
 - Most significant change in hardware are the step down converter and some additional low power converter
 - Measures improve the noise of the step down converter have been demonstrated
 - In addition filtering of DC/DC converter cards improved
 - Load regulation in presence of sense resistance can be improve from 30mW to 2.5mW for the preproduction PS's and finally towards .5mW for the Main production
- Recent test effort gave valuable input for the main production
- First Kapton Design finished, after fixing some minor issues production will be started