AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Setup of multilayer detector modules for FCAL test-beams

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Agenda

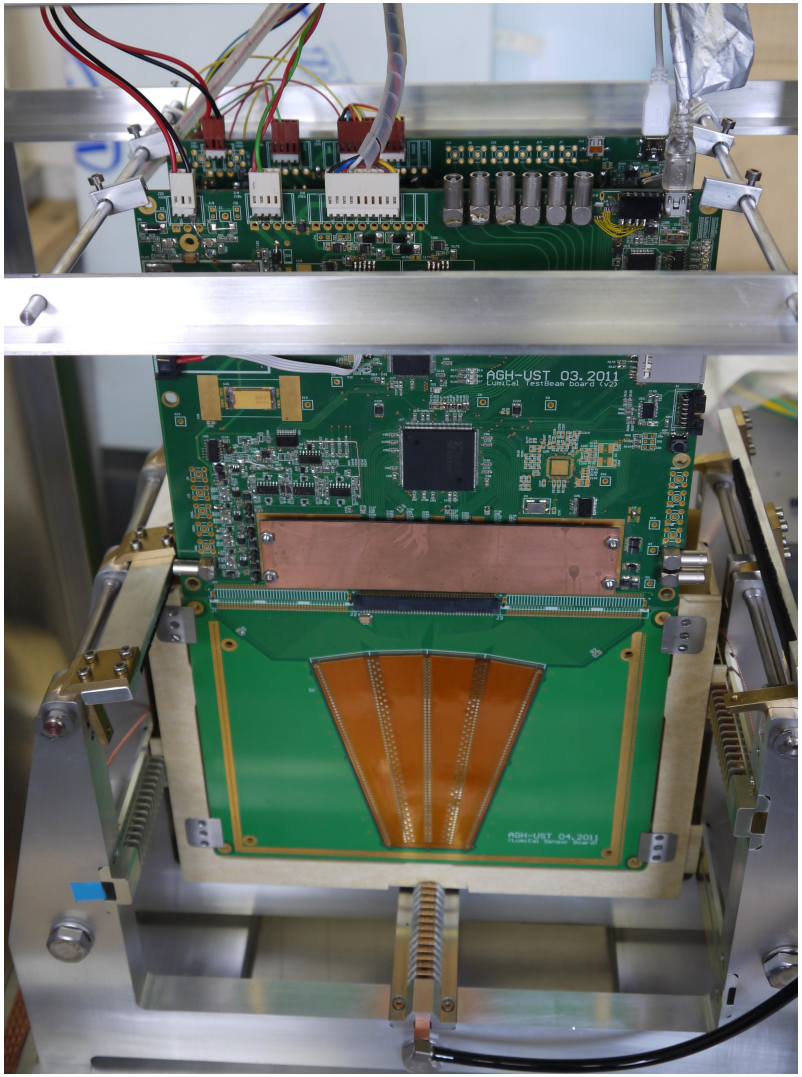
- **Status found**
- **Present works**
  - **HV filtering**
  - **Voltage regulator**
  - **Decoupling**
  - **Multiboard integration**
- **Present status and plans**

LumiCal readout boards status
Before my work...

- Currently we have four readout boards and three sensors (**we are still missing one...**)
- Status of the boards:

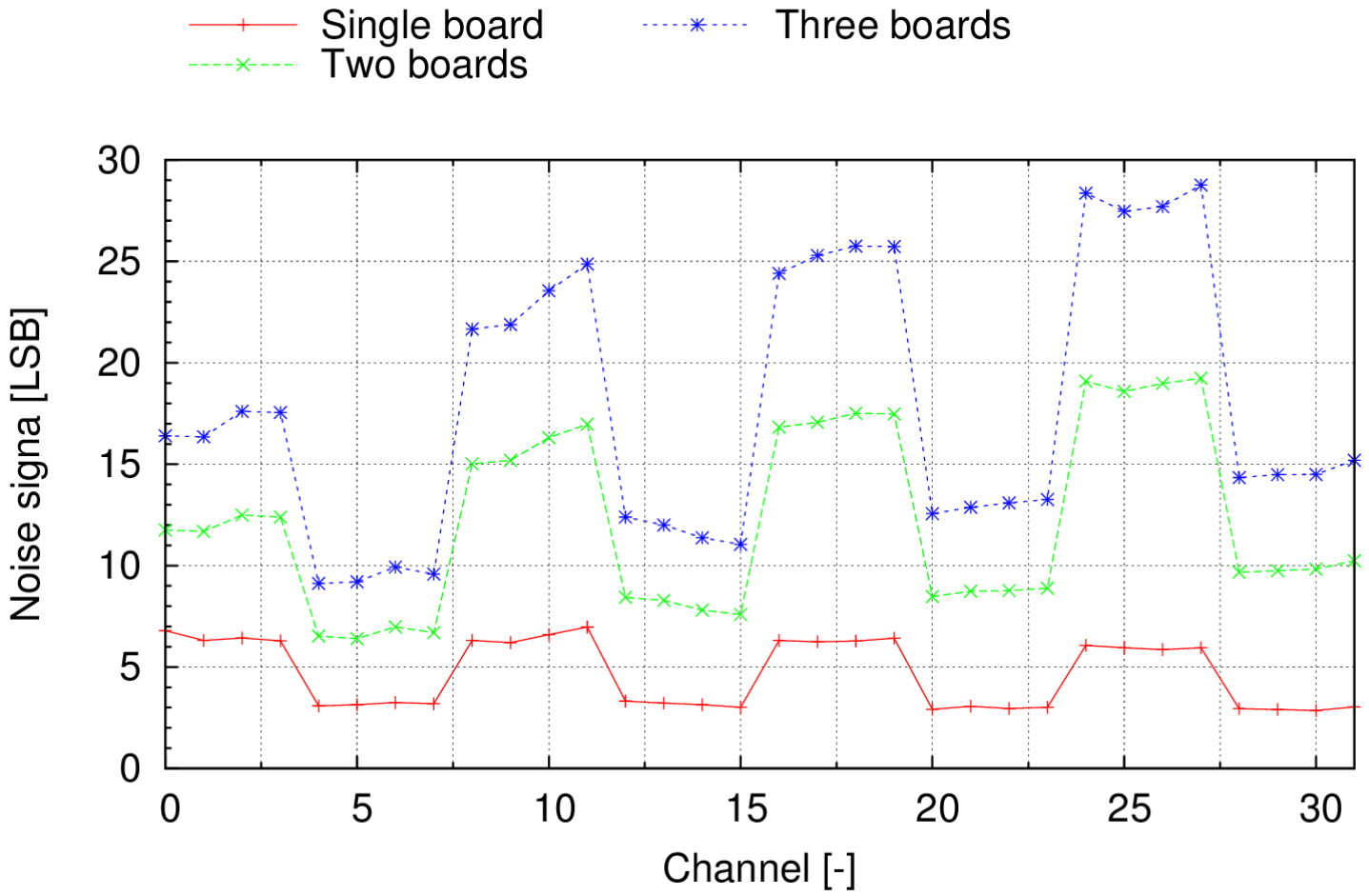
Board ID	Owner	PCB version	Assembly version	HV filter	Noise (active feedback)	Noise (resistive feedback)	CERN tests
63	**Krakow**	**2.0**	**1**	**OK**	**6**	**3**	*****
67	DESY	2.1	1	OK	6	3	
76	Tel-Aviv	2.1	2	NO	32	16	*
64	Krakow (second)	2.1	2	Wrong	32	16	*

Integration of multi-plane readout at CERN
First try in November 2013...



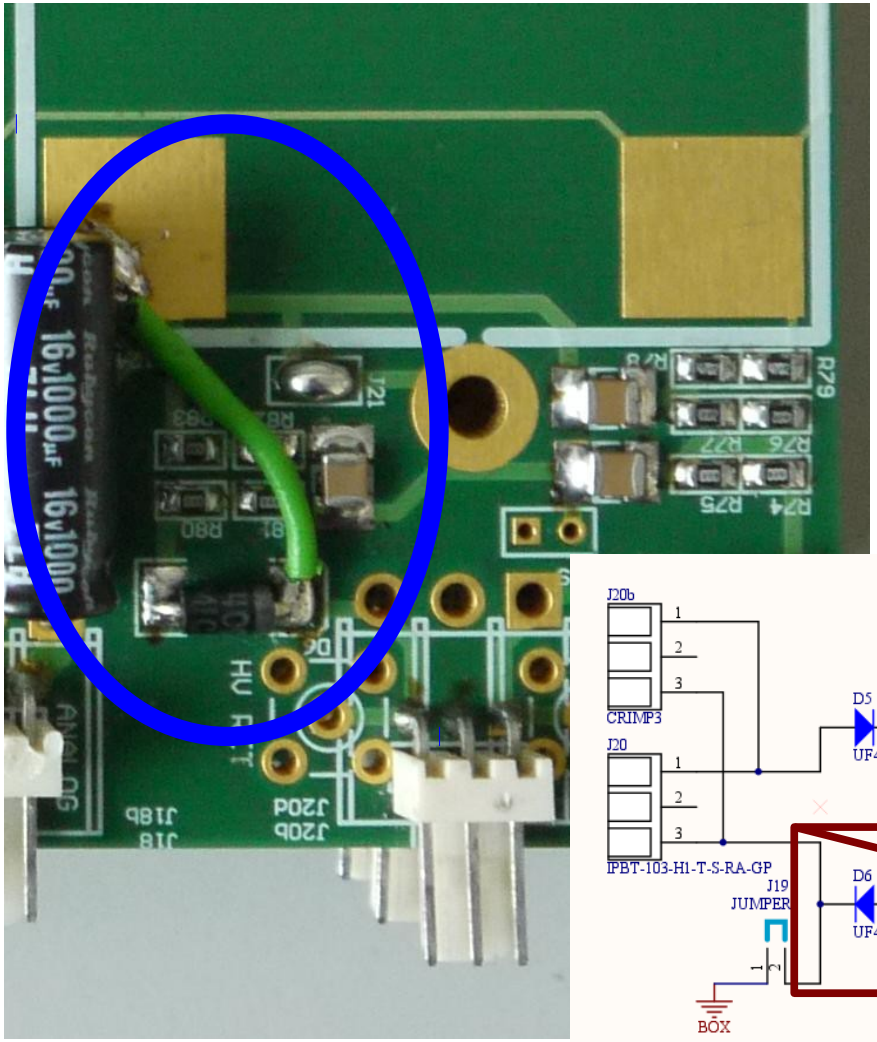
- Tested configuration:
  - Three readout boards with three sensors
- Main problem: **a large increase in noise** with two or more boards connected togeather

Integration of multi-plane readout at CERN
First try in November 2013...

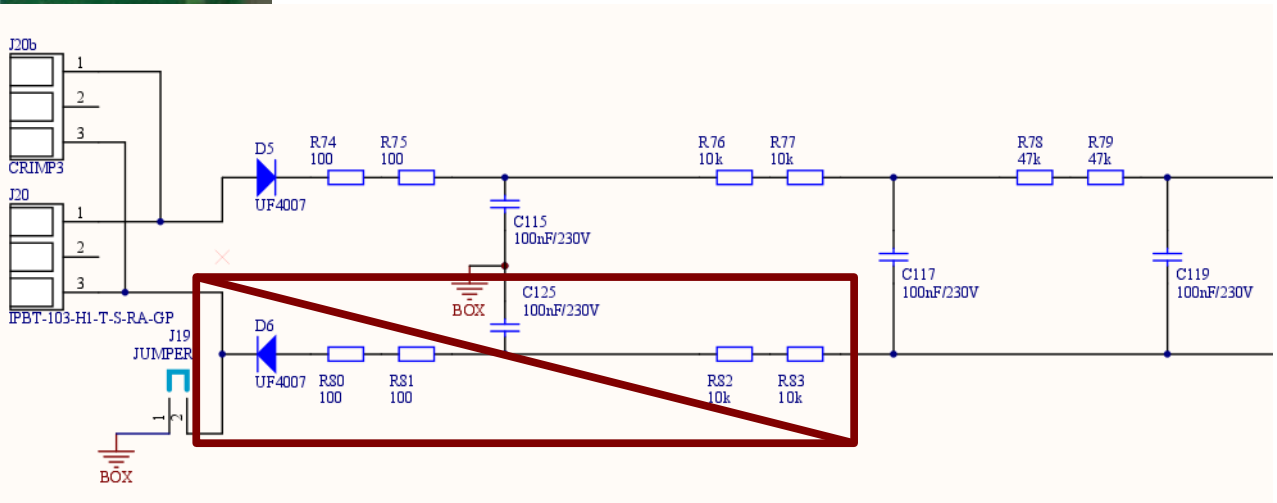


Not acceptable increase of noise for more than one board !!!

Present works in Krakow
HV filter modification on boards 64 and 76

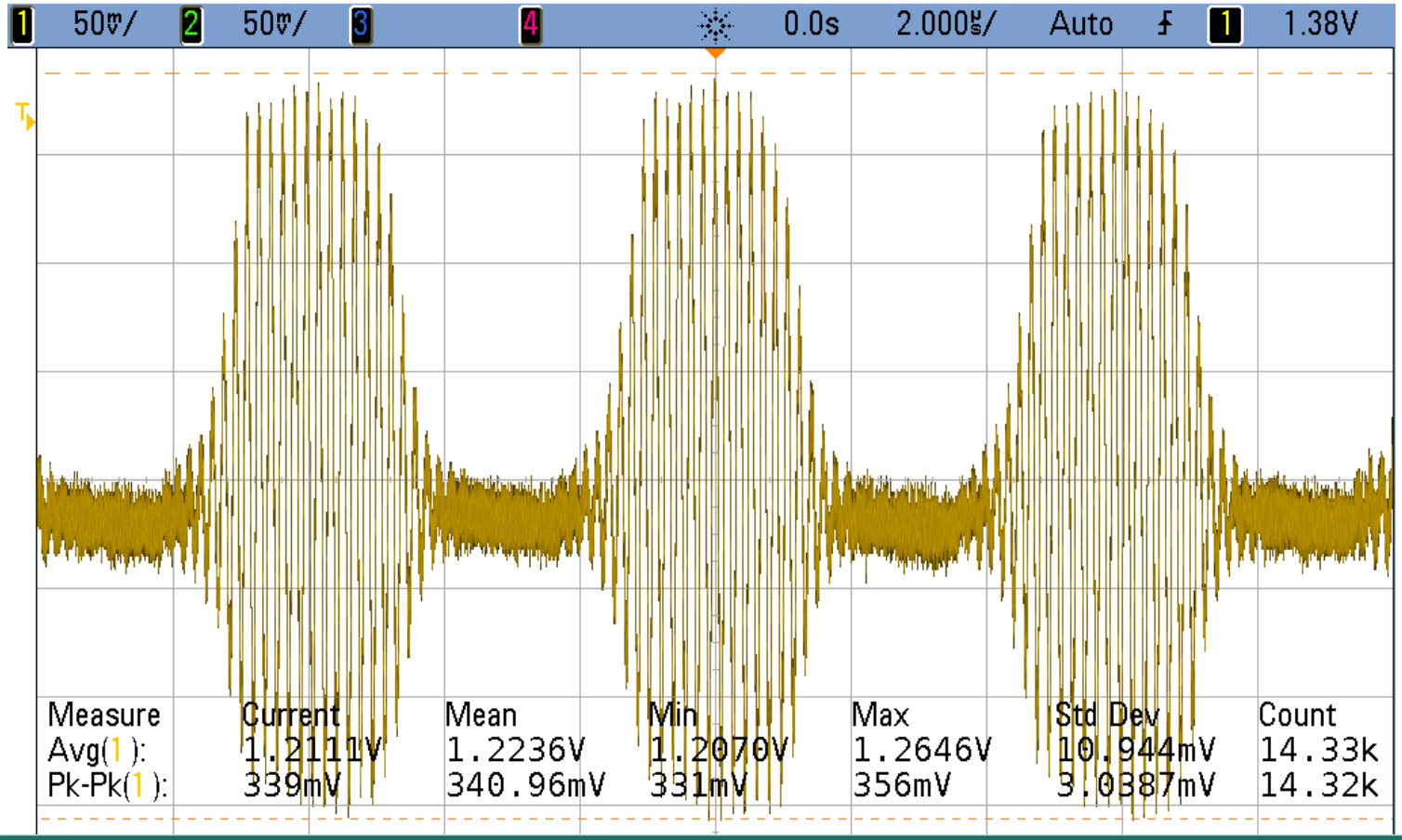


- **Noise reduction not achieved** by HV filter modification...

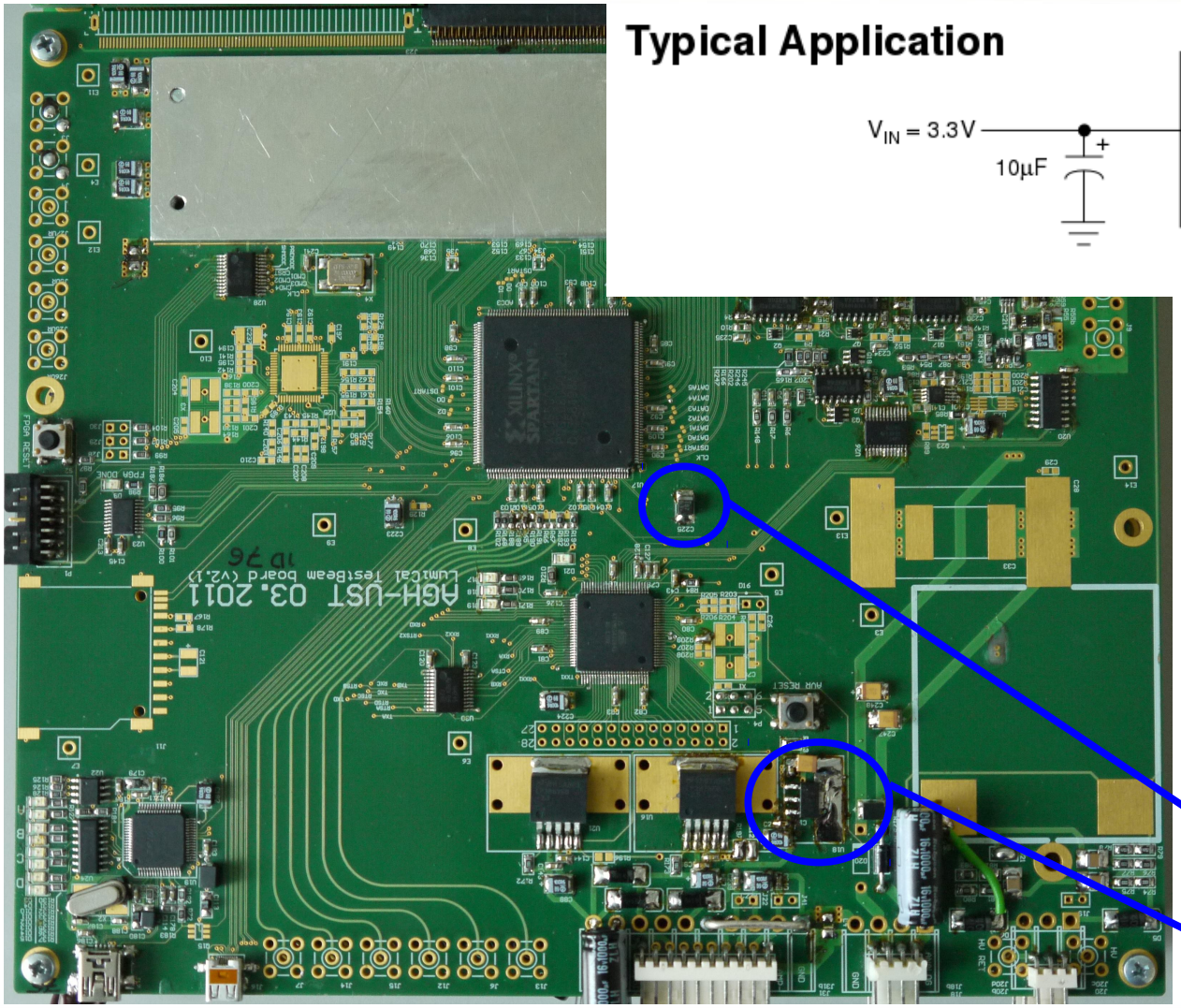


Present works in Krakow
FPGA core voltage regulator oscillations

- FPGA core voltage regulator oscillations founded on boards 76 and 64 (second assembly version)



Present works in Krakow
Wrong decoupling causes FPGA voltage regulator oscillations



- Output capacitor to far from regulator
- Only 100nF directly at regulator output

Output 100uF capacitor

Regulator

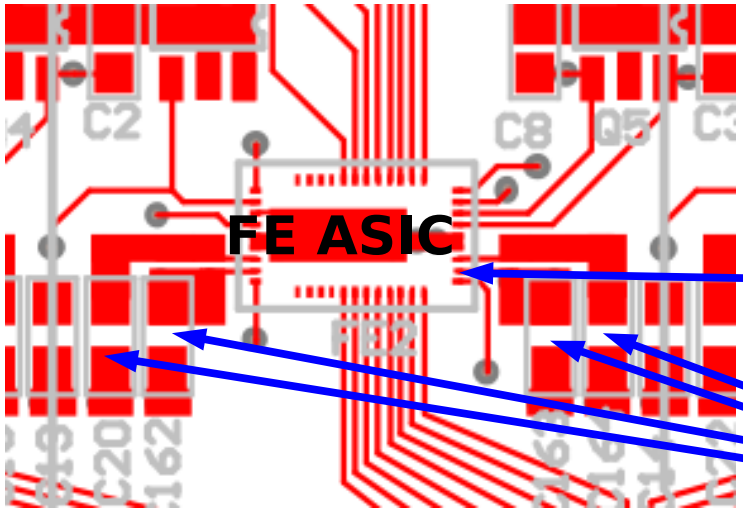
Present works in Krakow
FPGA core voltage regulator oscillations

- 100uF capacitance added to regulator output
- Noise reduced to **12/6 LSB –** to times higher than reference level

Board ID	Owner	PCB version	Assembly version	Noise (active feedback)	Noise (resistive feedback)	Modifications
63	**Krakow**	**2.0**	**1**	**6**	**3**	-
67	DESY	2.1	1	6	3	-
76	Tel-Aviv	2.1	2	12	6	HV filter, FPGA regulator
64	Krakow (second)	2.1	2	12	6	HV filter, FPGA regulator

Present works in Krakow
FrondEnd decoupling capacitaces

- FrontEnd power supply 100nF decoupling capacitances used in two assembly runs differs – probably have different ESR (Equivalent Series Resistance)
- Capacitaces located very close to the wirebonds (around 1mm)

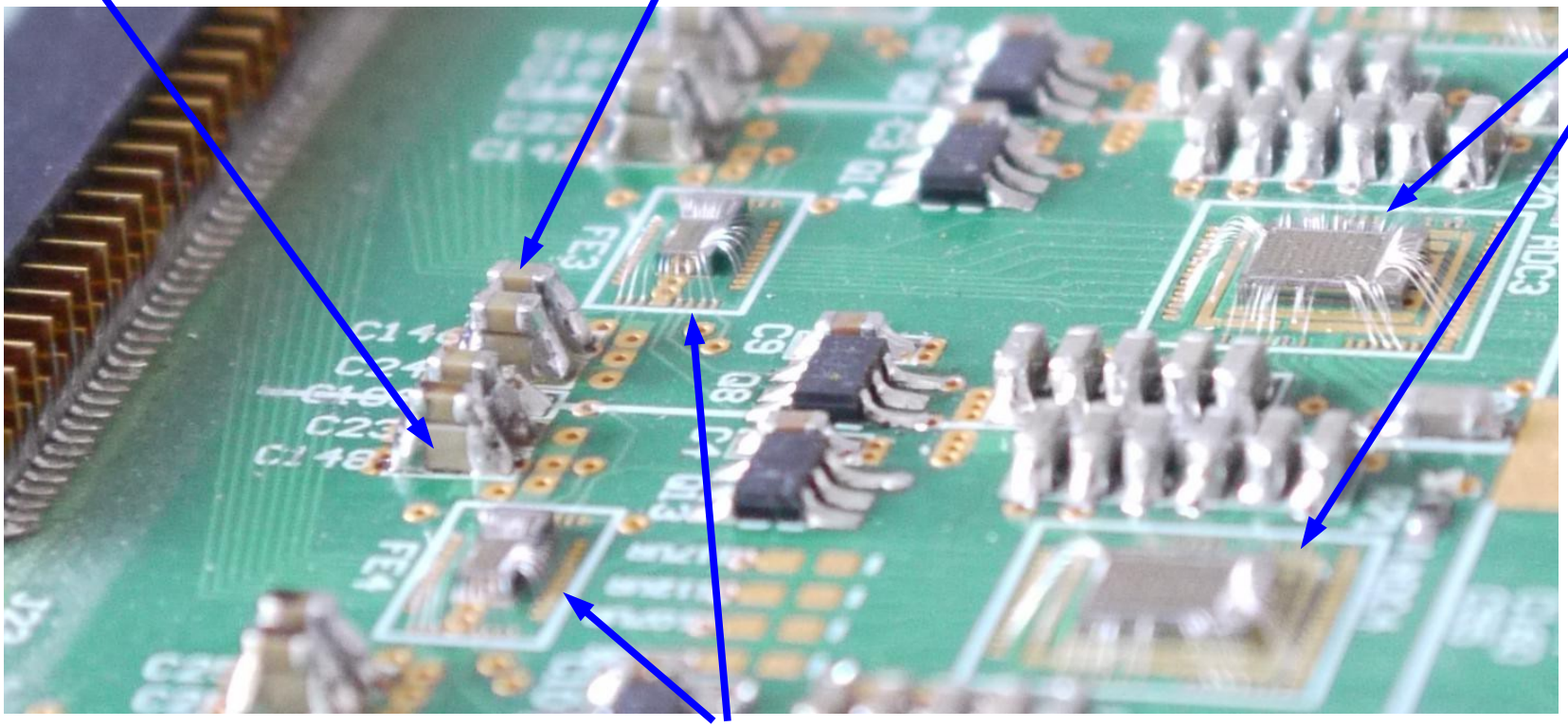


Wirebonds

FrontEnd power supply decoupling capacitors

Present works in Krakow
FrondEnd decoupling capacitaces

- Low ESR 1uF decoupling capacitors added paralelly to existing 100nF capacitances

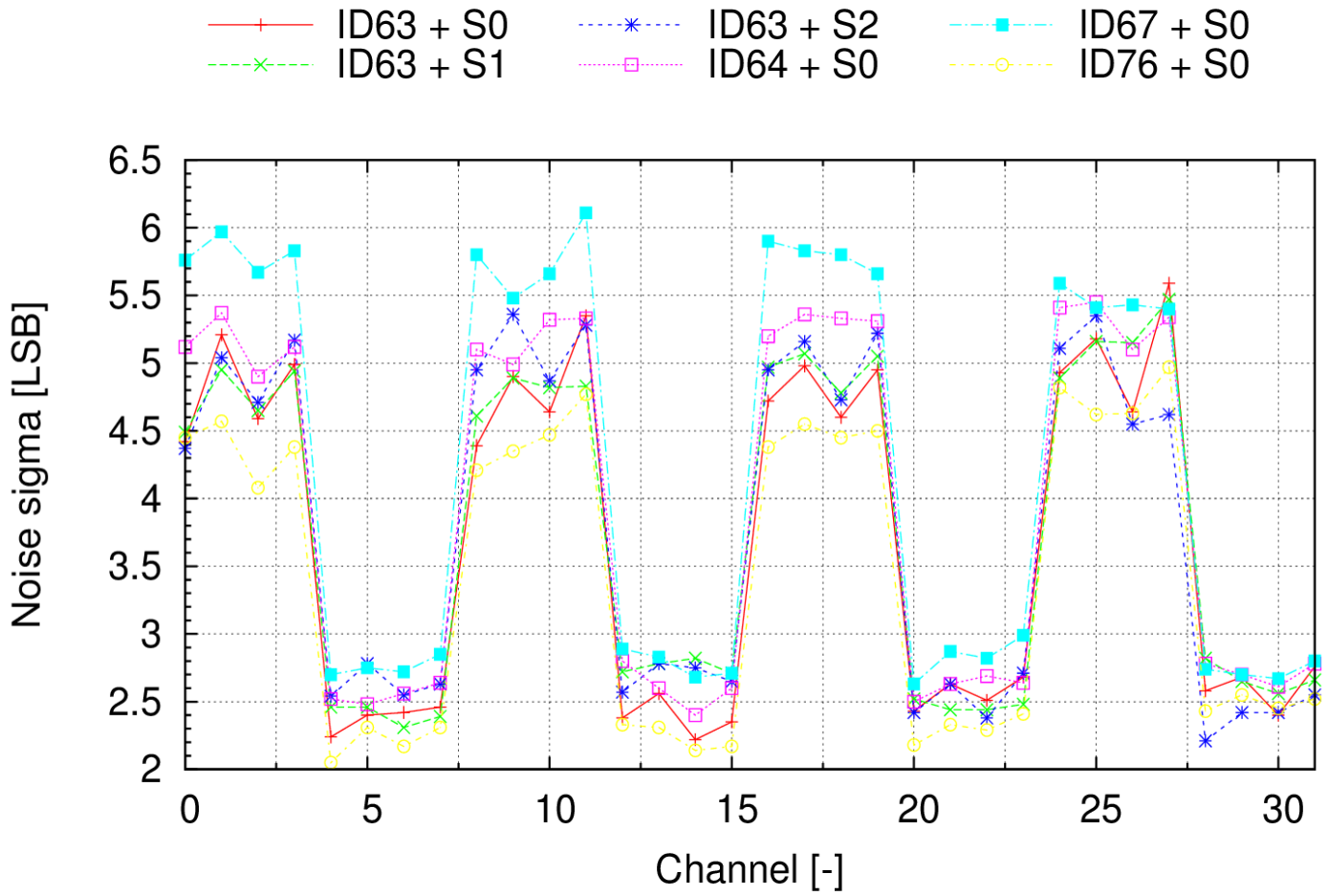


Present works in Krakow
FrondEnd decoupling capacitaces

- Noise reduced to 5.5/2.5 LSB – **below** reference level
- Decoupling capacitances added to all boards

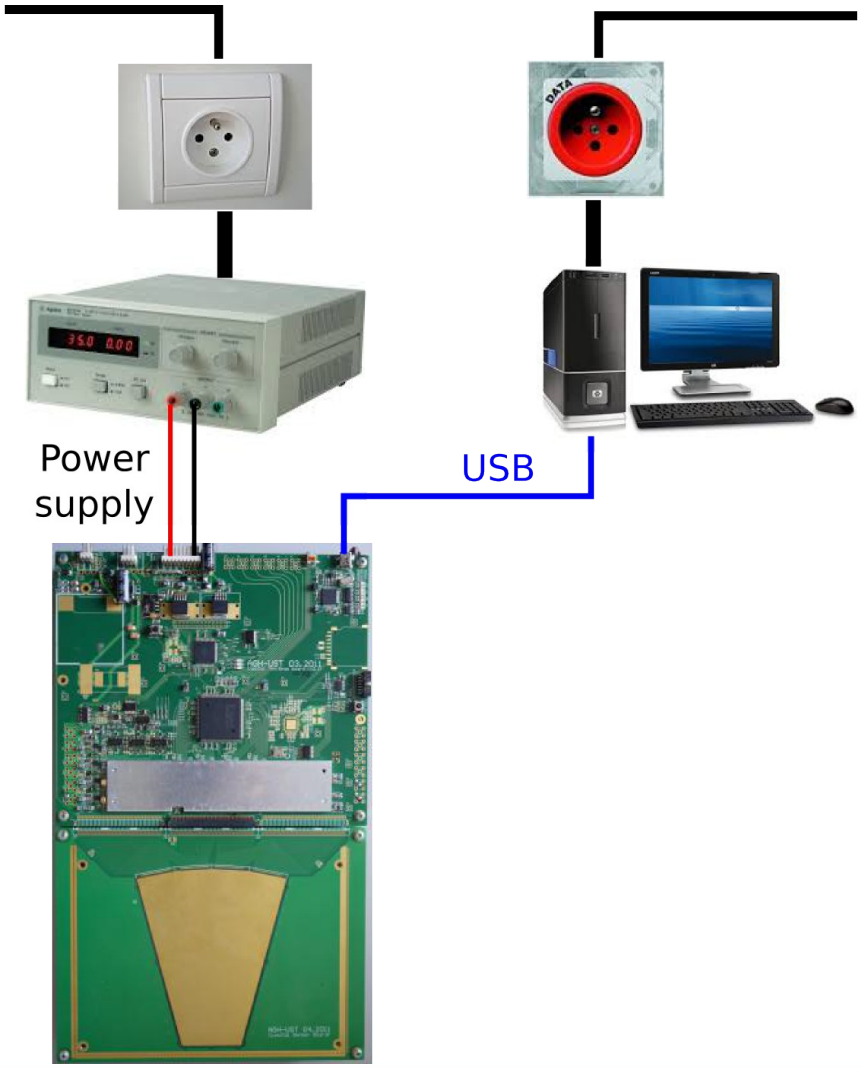
Board ID	Owner	PCB version	Assembly version	Noise (active feedback)	Noise (resistive feedback)	Modifications
63	**Krakow**	**2.0**	**1**	**6**	**3**	-
67	DESY	2.1	1	6	3	-
76	Tel-Aviv	2.1	2	**5.5**	**2.5**	HV filter, FPGA regulator **FE decoupling**
64	Krakow (second)	2.1	2	**5.5**	**2.5**	HV filter, FPGA regulator **FE decoupling**

Present works in Krakow
Single boards noise



After all modifications four boards have the same noise

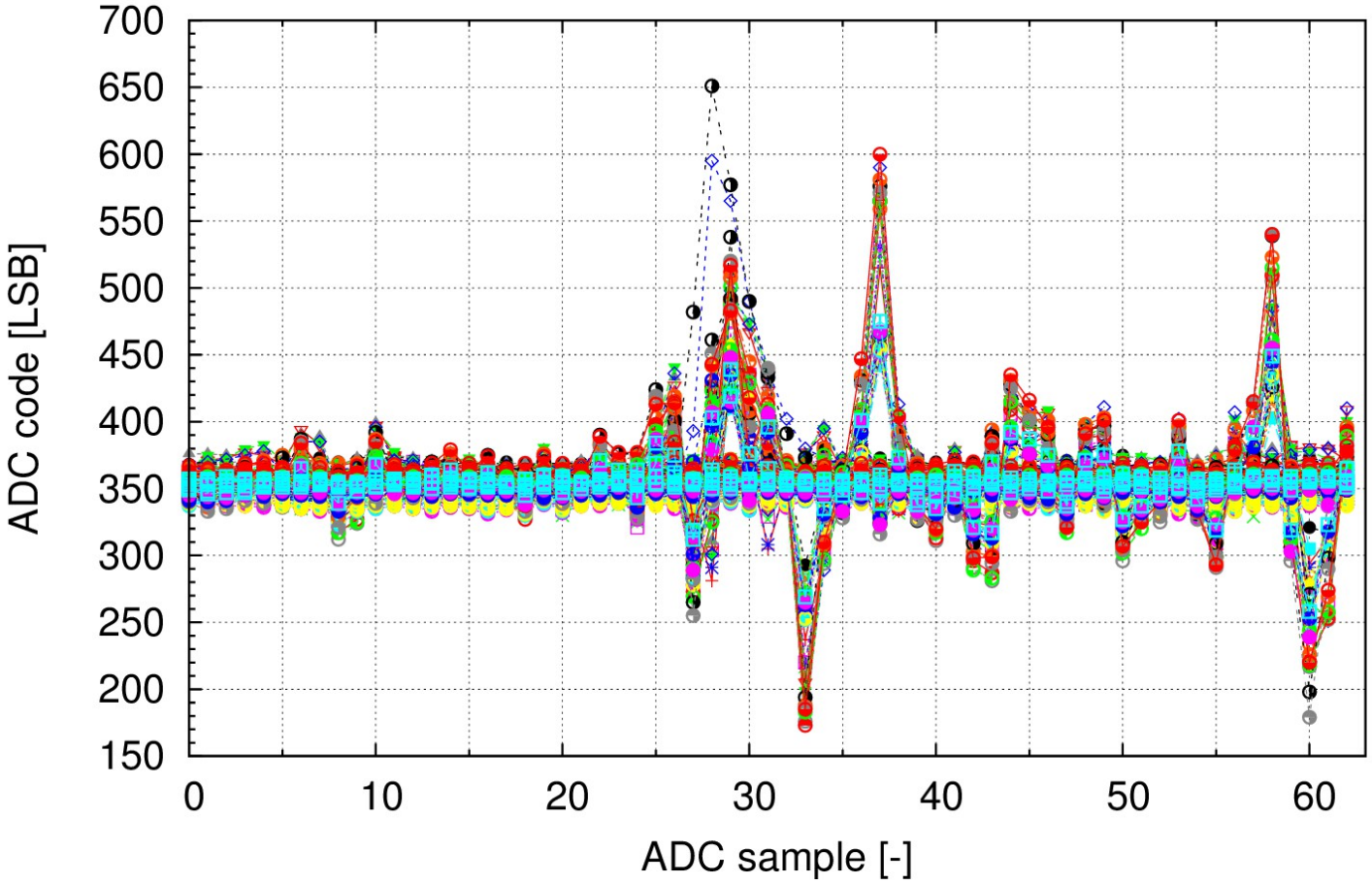
Present works in Krakow
Single board readout – USB ground loop problem



- Two separated power supply networks – one for equipment (ie. power supply) and second for computer
- Bad ground loop created by USB to PC connection

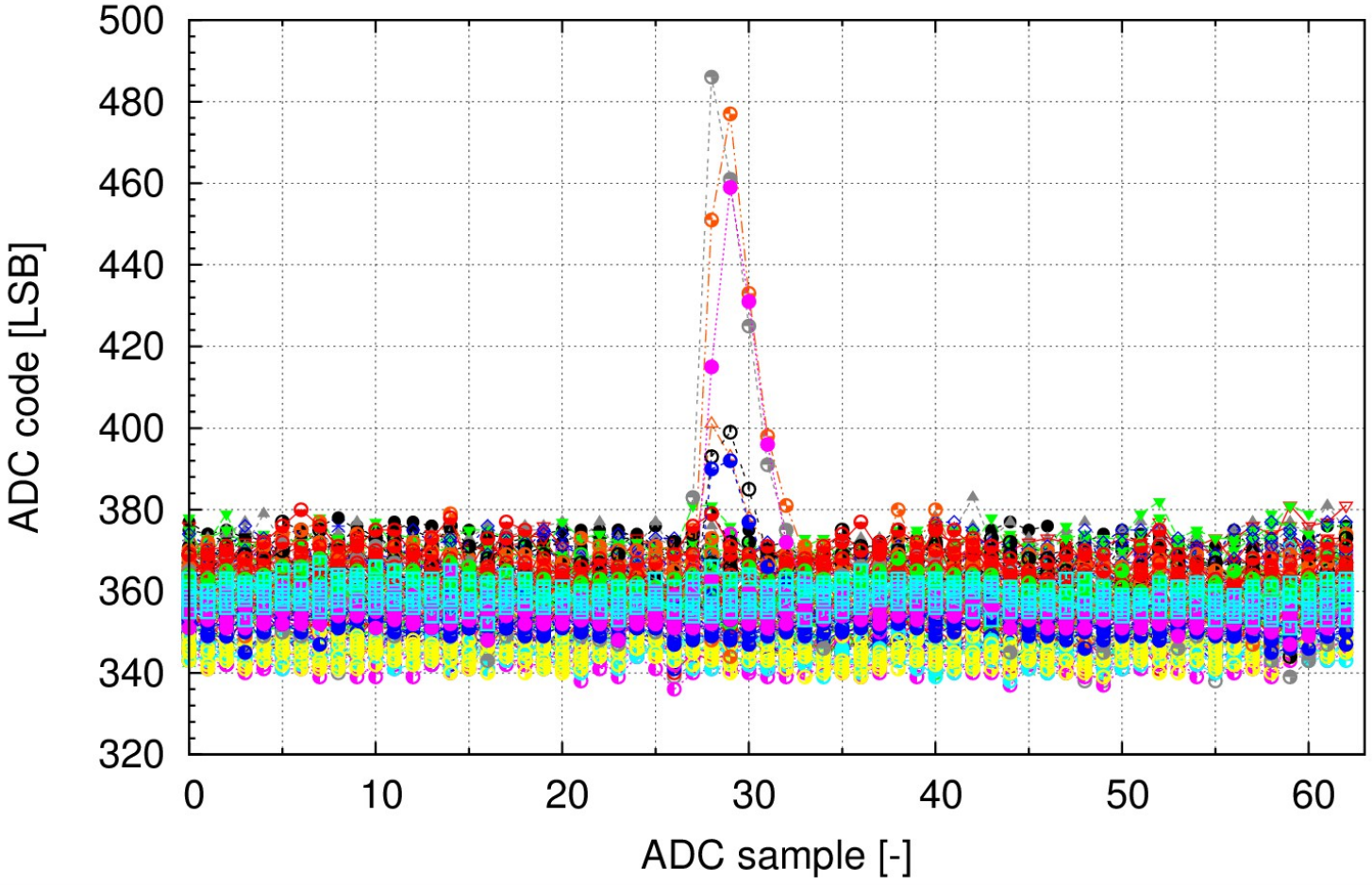
Present works in Krakow
Single board readout – USB ground loop problem

Disturbances caused by the connection of PC to separate power network

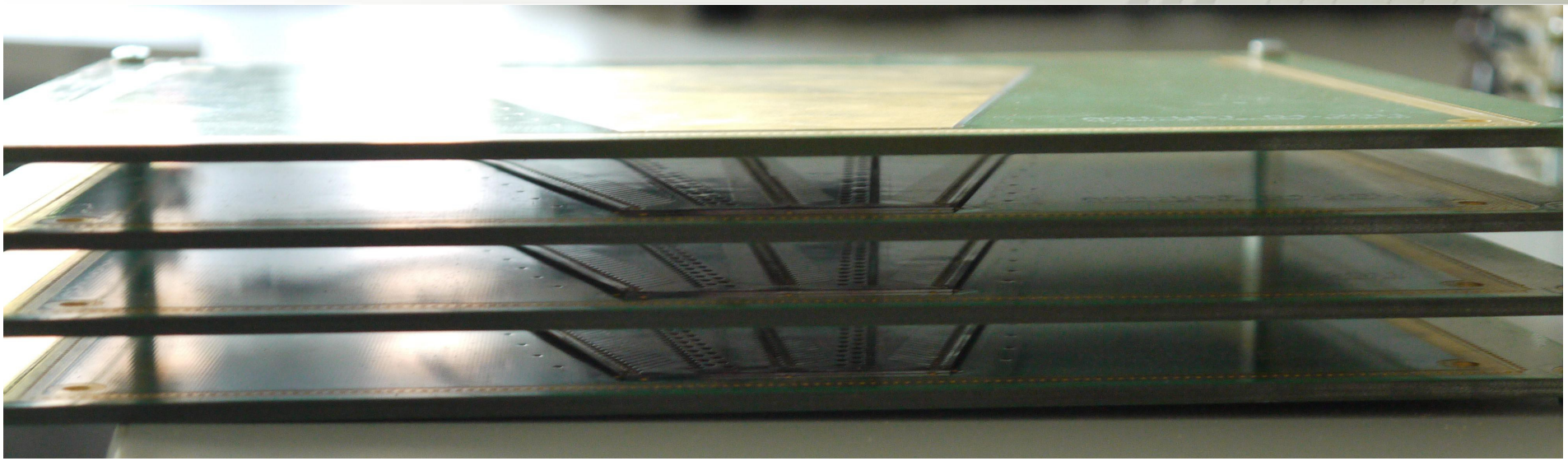


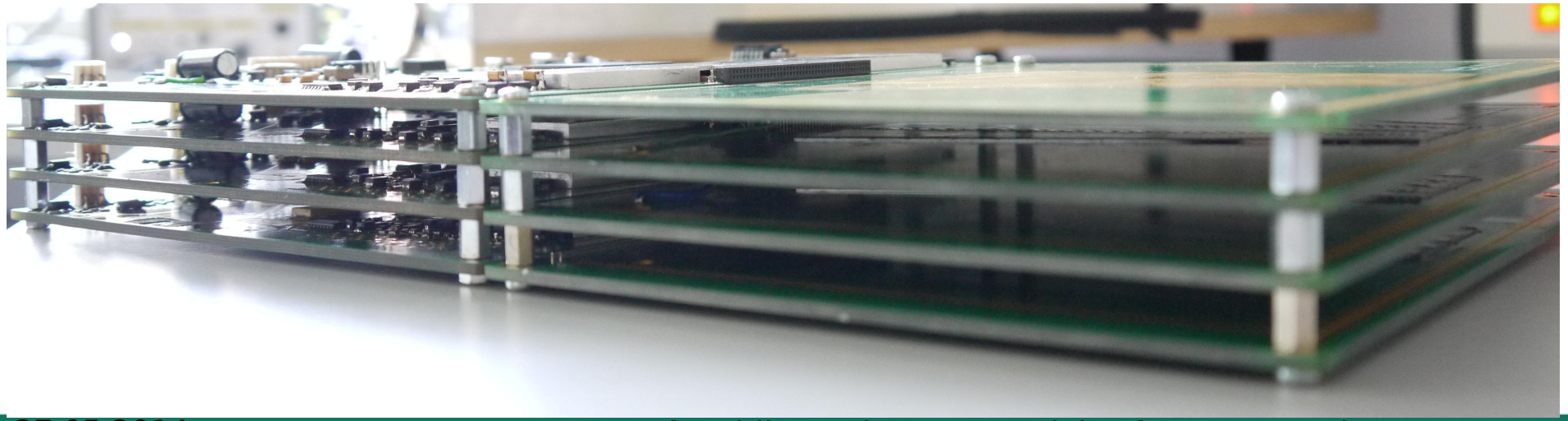
Present works in Krakow
Single board readout – USB ground loop problem

PC and power supplies connected to the same power

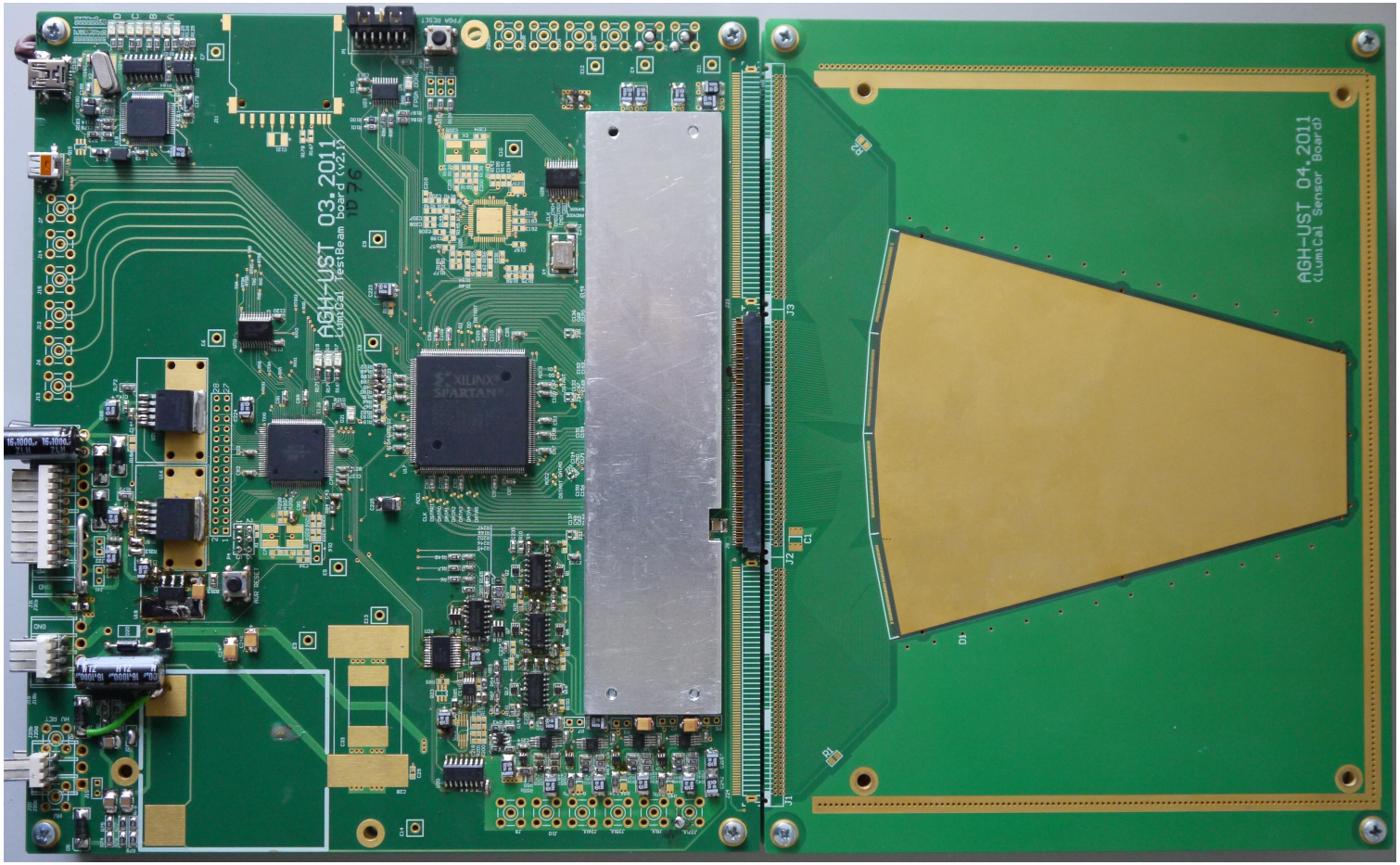


Present works in Krakow
Multiboard readout integration



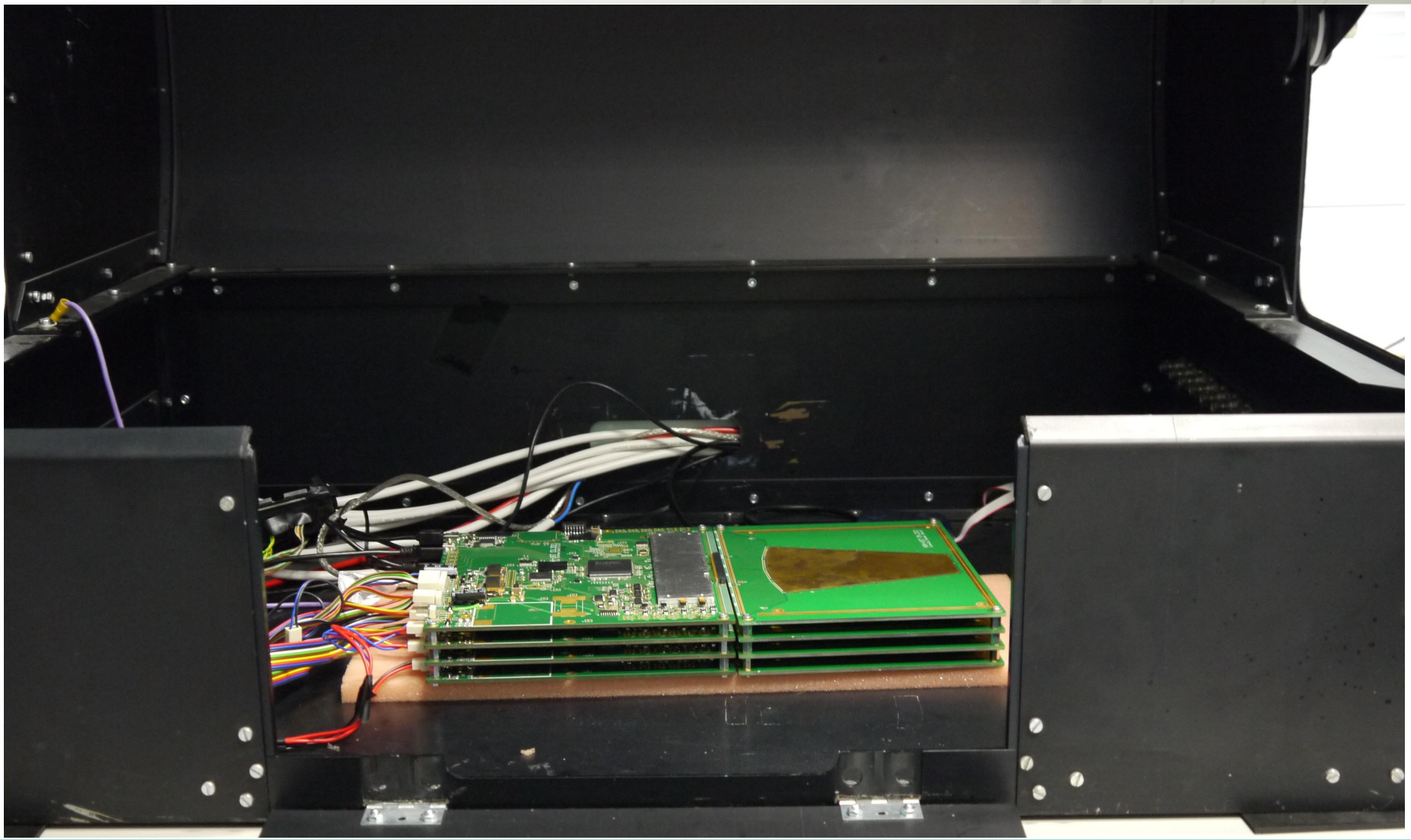


Present works in Krakow
Multiboard readout integration

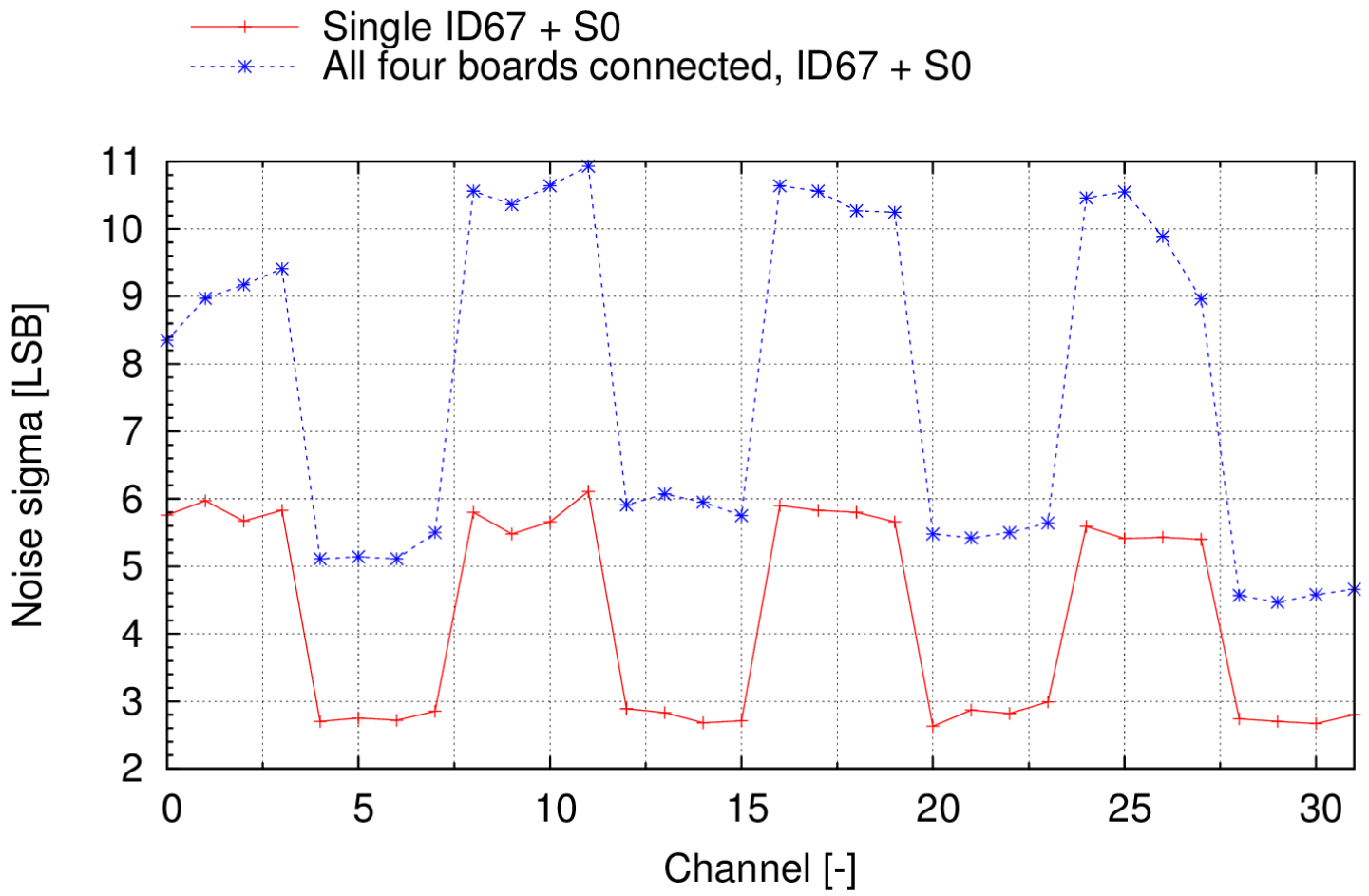


The fourth sensor is still missing !!!

Present works in Krakow
Multiboard readout integration



Present works in Krakow
Multiboard readout integration – power supply decoupling

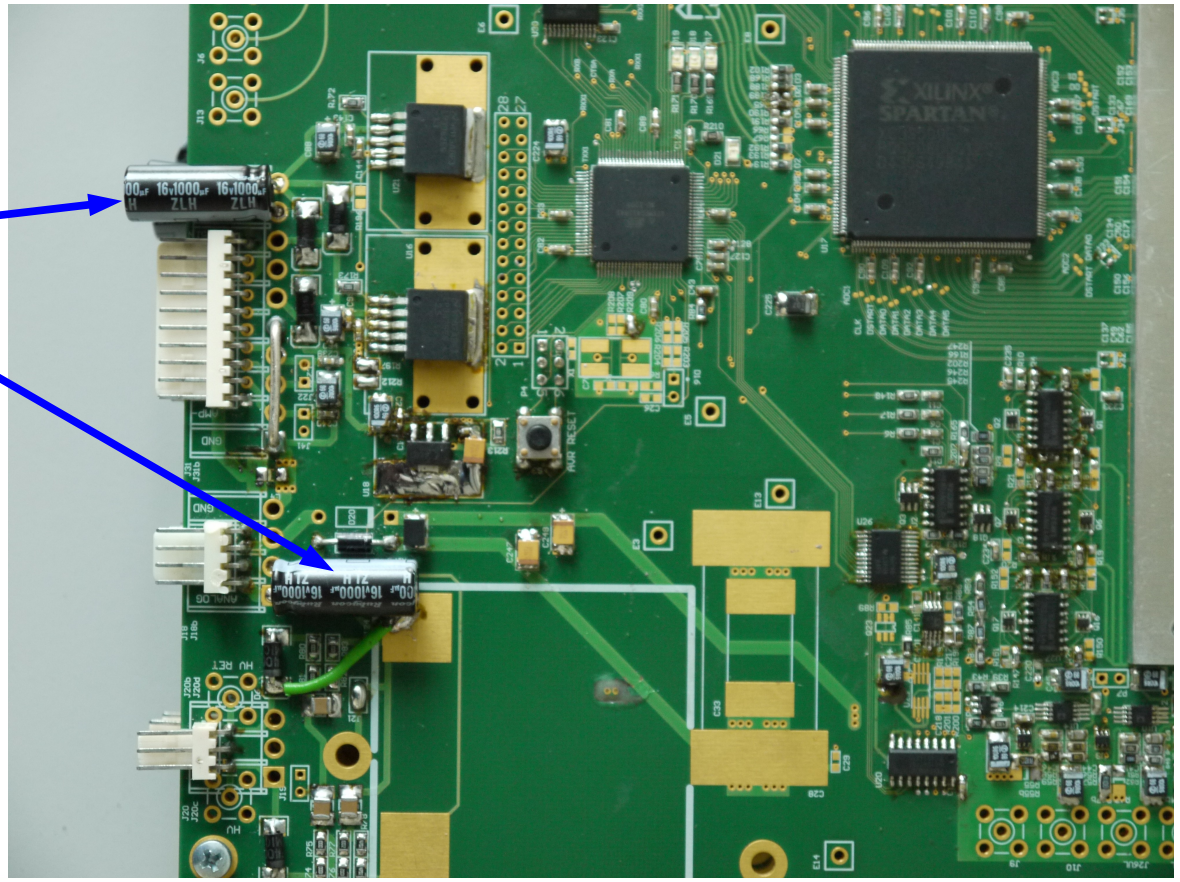


Again, the noise increases, but much less than at CERN

Present works in Krakow
Multiboard readout integration – power supply decoupling

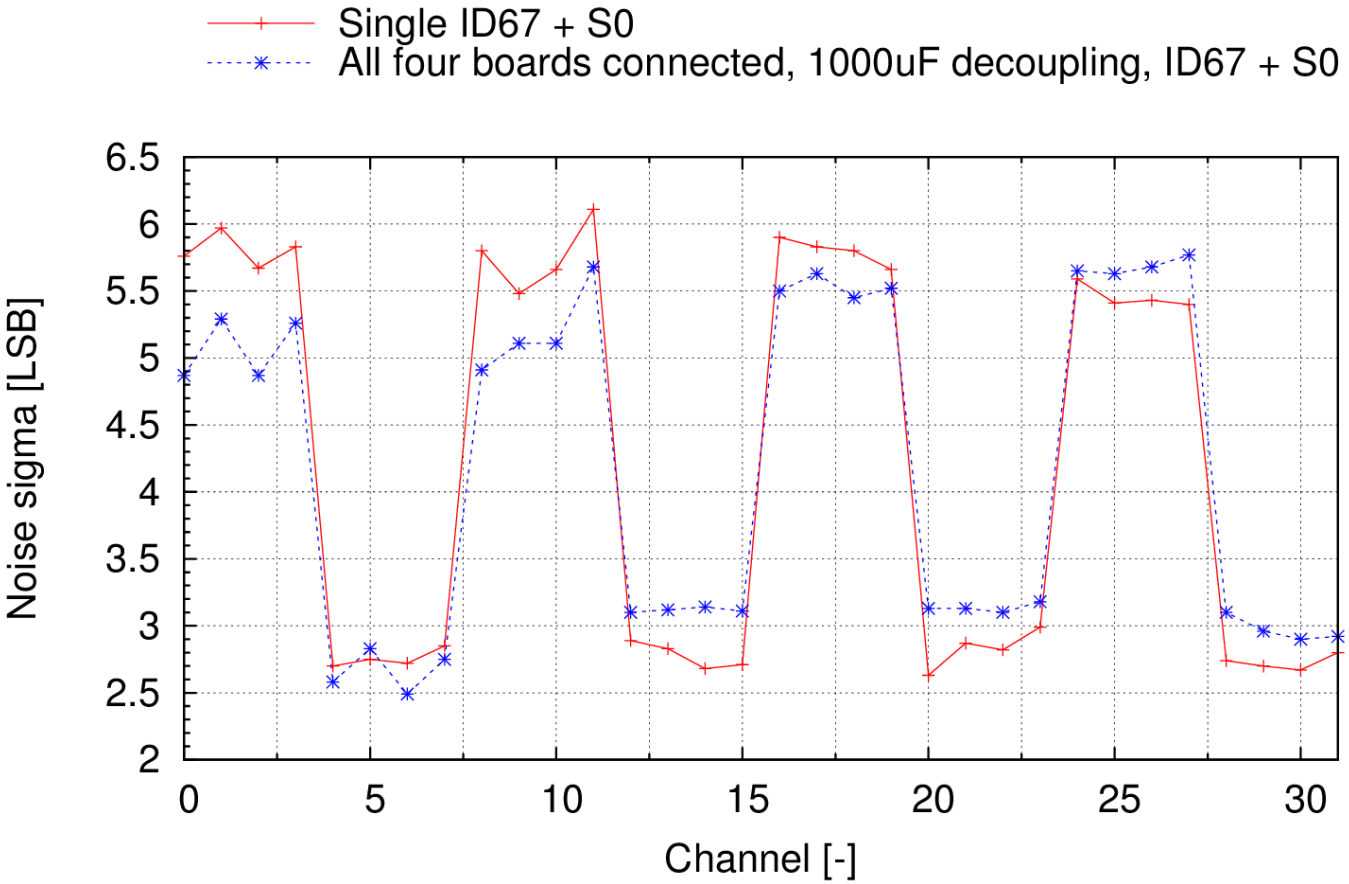
- Low ESR, 1000uF decouplig capacitors added on each board at power supply inputs

1000uF added



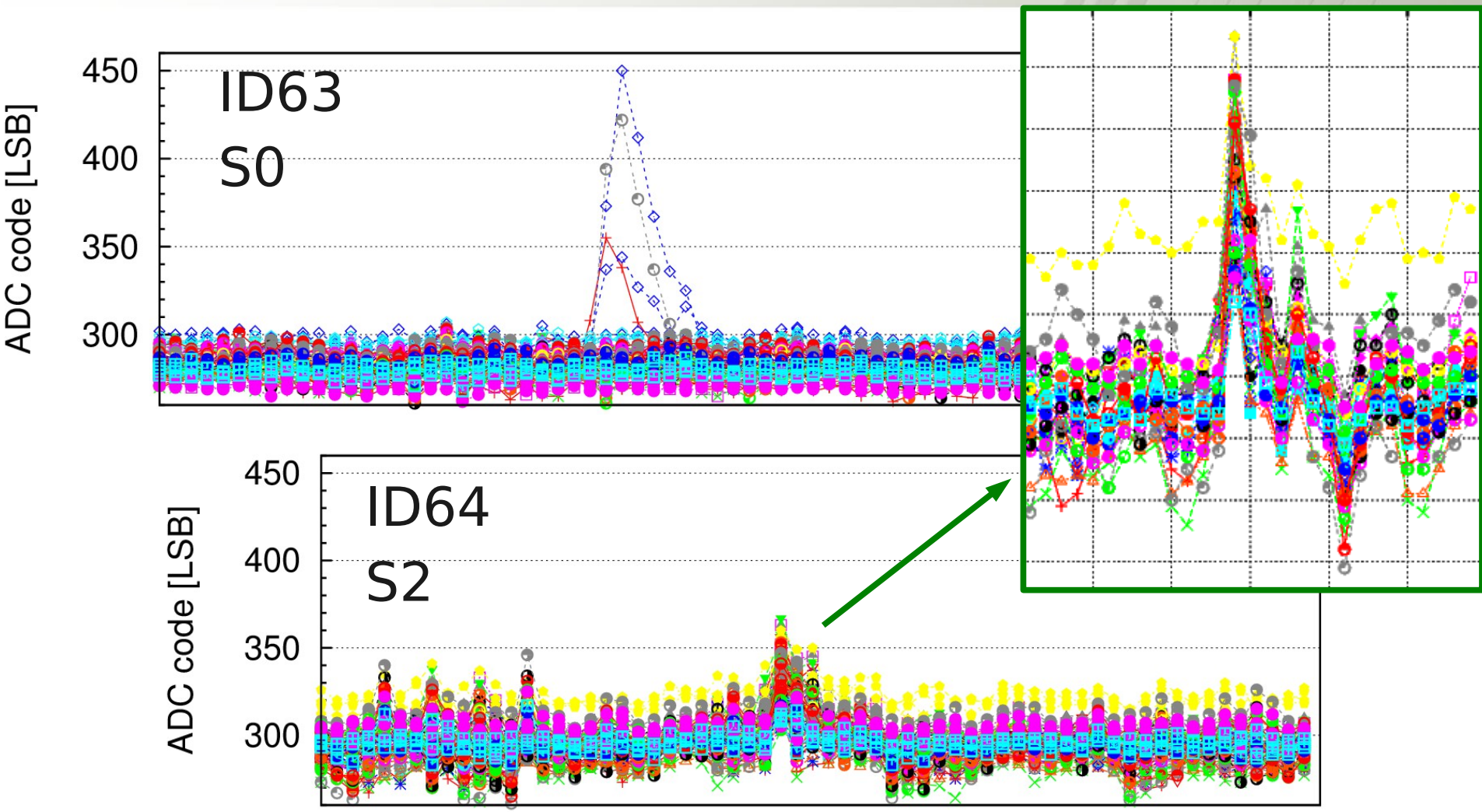
- Smaller tantalum capacitors needed

Present works in Krakow
Multiboard readout integration – power supply decoupling



Four boards together have the same noise as the single board, but … see next slide

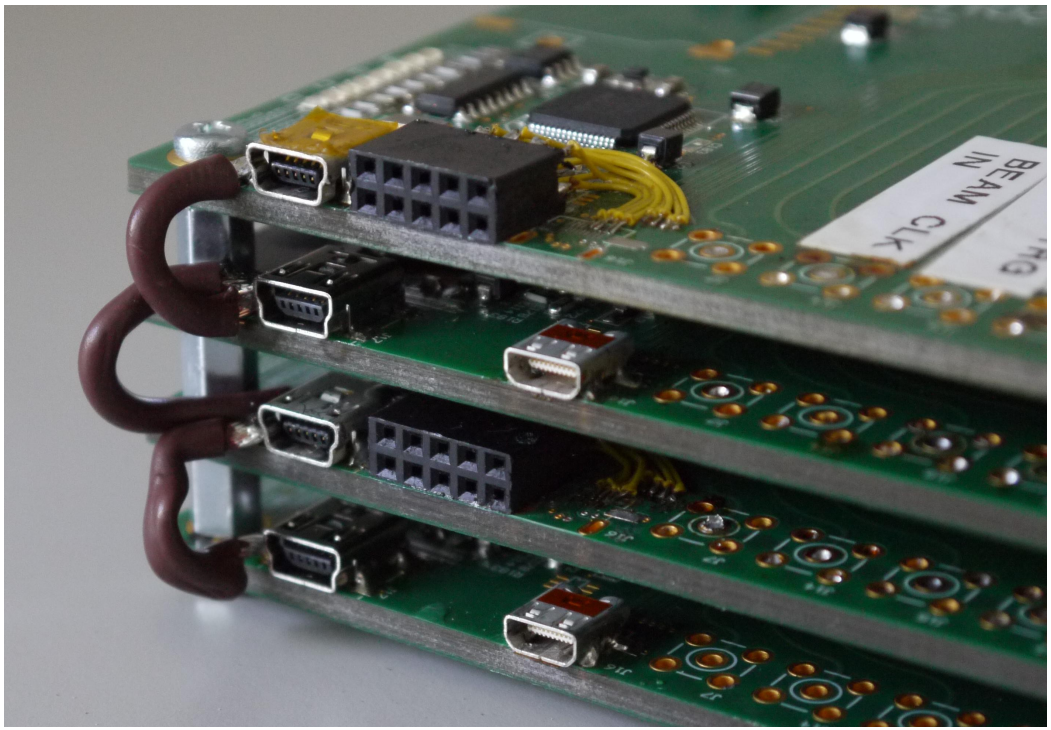
Present works in Krakow
Multiboard readout – USB ground loop problem (?)



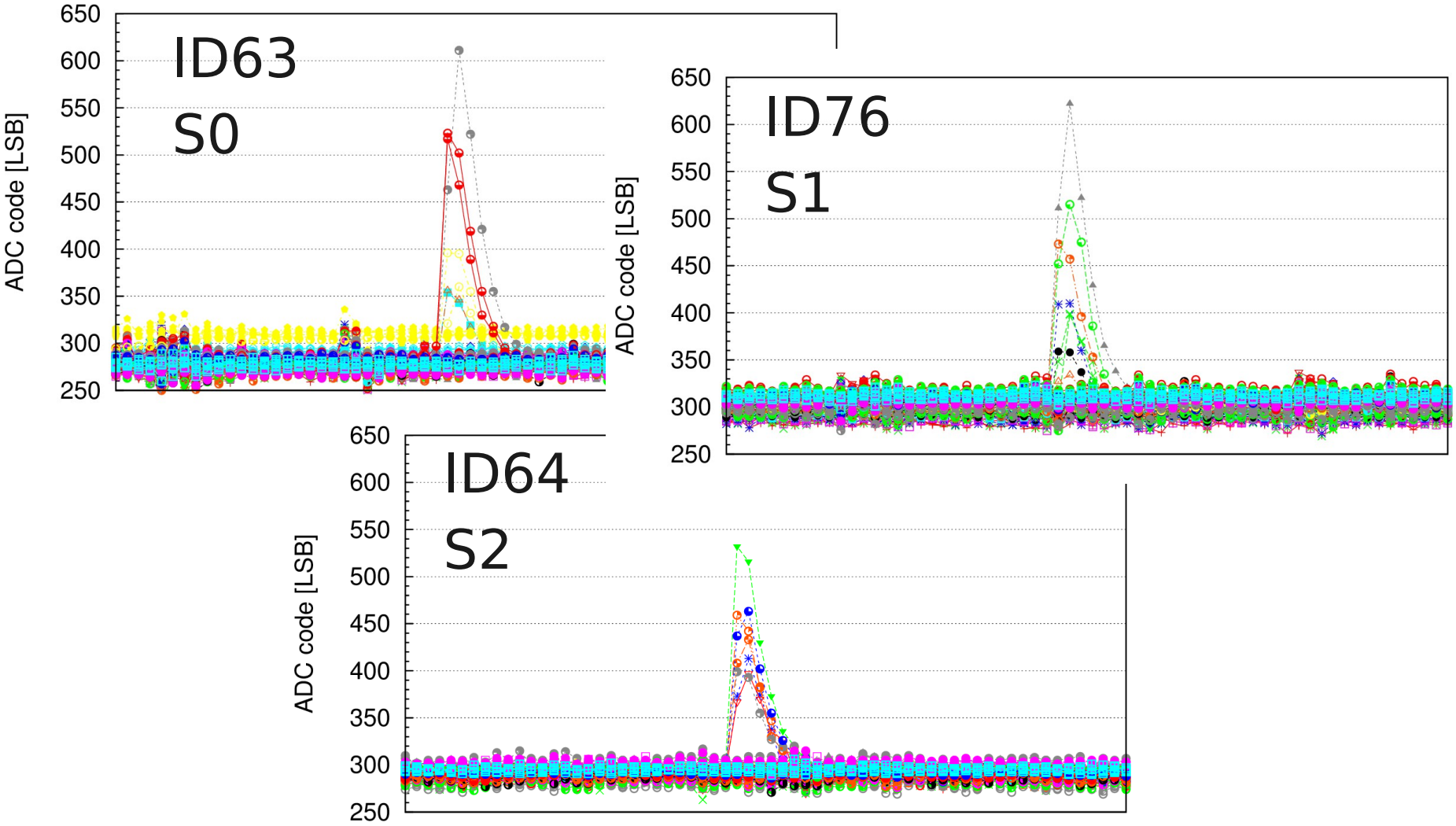
Present works in Krakow
Multiboard readout – USB ground loop problem (?)

- Each board connected via USB cable to PC – ground multiloop created

- USB ground shorted between boards – baseline variations reduced but not eliminated...
- FPGA core voltage unstability found on friday evening – probably better regulator needed...



Present works in Krakow
Multiboard readout – USB ground loop problem – high trigger treshold



Summary and Plans

- All four boards uniformed and noise reduced
  - HV filter modifications
  - FPGA core voltage oscilation eliminated
  - FrontEnd decoupling improved
  - Ground loop through PC connnection reduced
- Multiboard integration still in progress...
  - Noise reduced by power supply decoupling
  - Baseline variations still require some work...
  - TLU-like trigger system for cosmic measurements needs to be developed...