Extending the Sensitivity Range by Charge Sharing - Proof of Principle with an APV FE system

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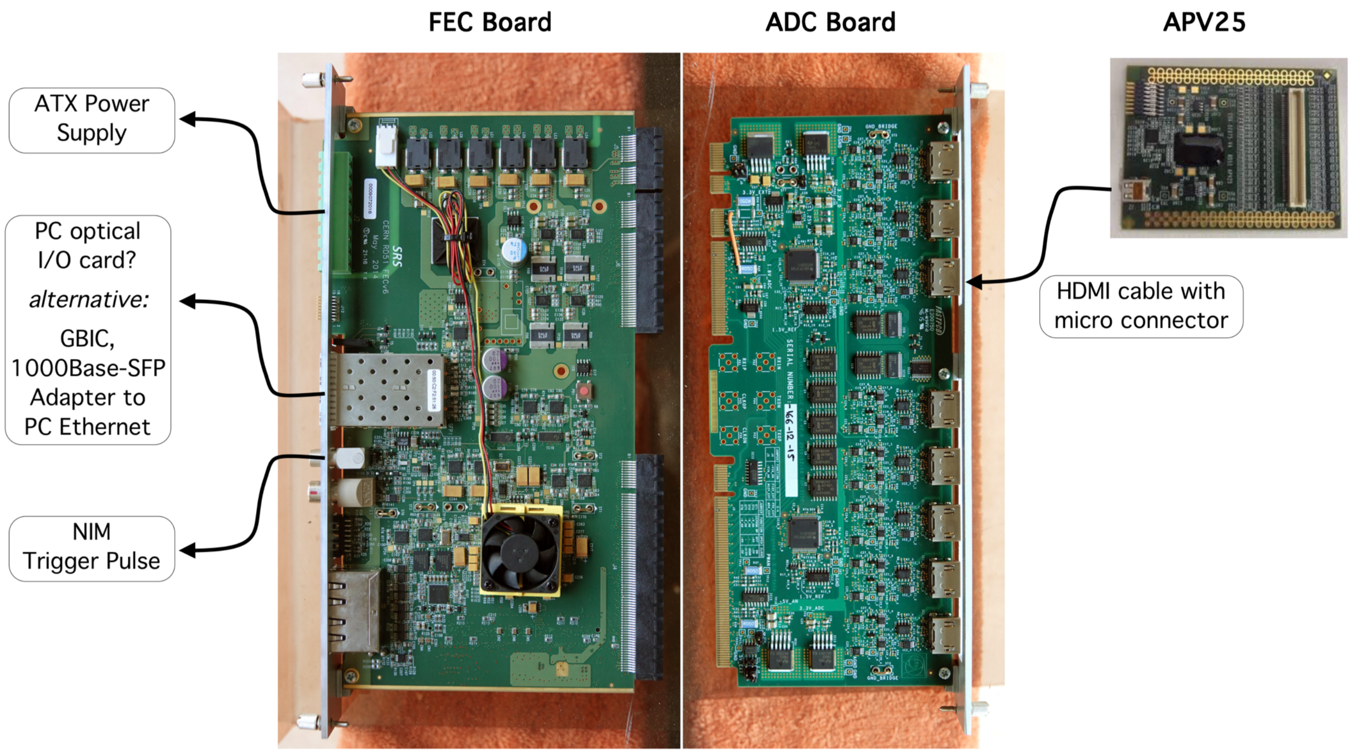
SRS - APV F/E System

Components

FE Board
- XILINX Virtex FPGA
- Fibre or Ethernet cable to PC
- Power Connector
- Clock & Trigger (NIM)

ADC Board
- 16x 12-bit ADCs, 40MHz
- 8 HDMI connectors to frontend

APV25 Board
- 128 channels
- PreAmp
- 50ns Shaper
- Analog pipeline
  - 192 slots = 4.8μs
- R/O by HDMI cable
- up to 2 APV per cable



SRS - APV F/E System

Setup Zeuthen

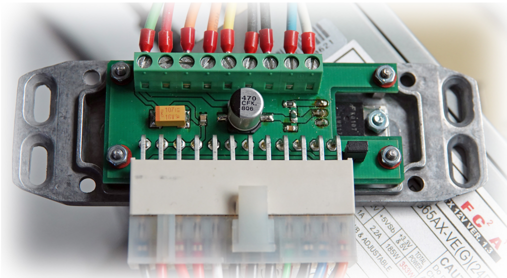
FEC + ADC Boards

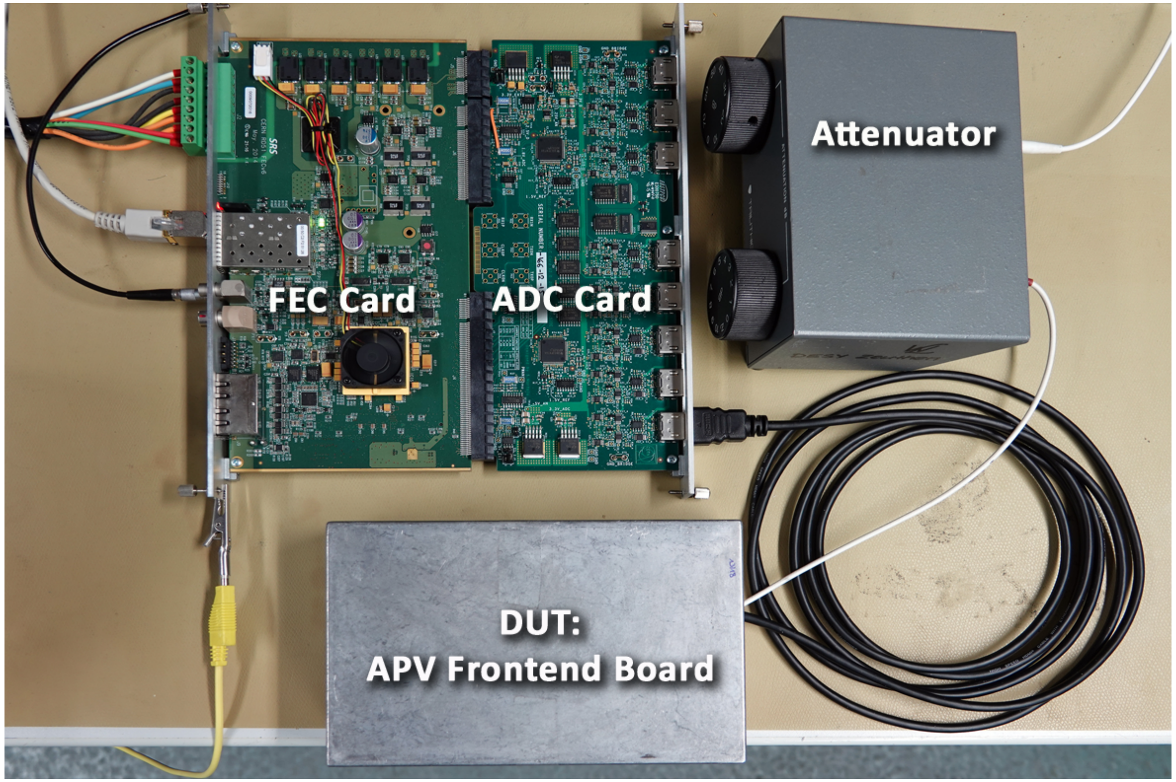
Readout PC

ATX Power Supply

+ DIY Voltage Converter 2.0V

MANY THANKS TO YAN & MENY for sending the modules to Zeuthen!





Device Under Test (APV25)

with charge injection circuit

NIM Pulser

for Trigger

TTL Pulser (synchronized)

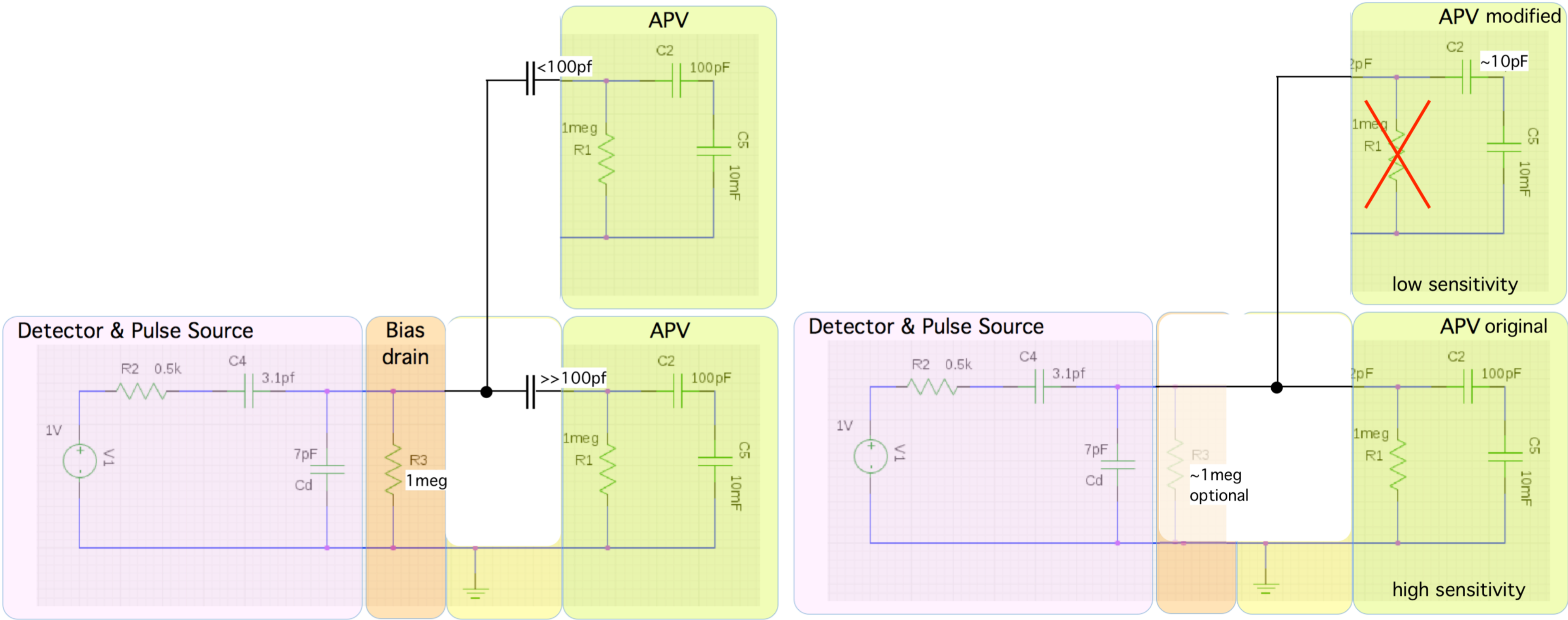
with Attenuator & Delay

for charge injection

Charge Sharing Proposal

Basic Idea (Sasha, Yan): Share charge between neighboring channels by insertion of two coupling capacitors of different value

Refined Idea (Wolfgang): Use existing coupling capacitors of the APV board (and change their value) → no adapter board needed!



APV Board Modifications (1)

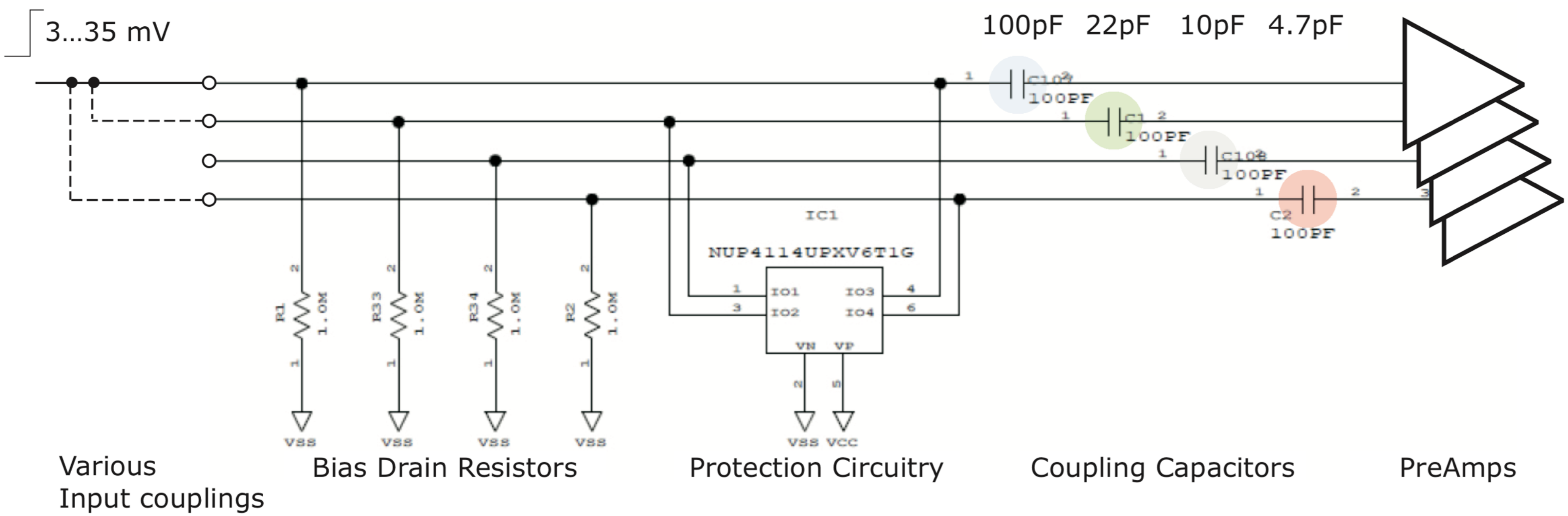
exchange coupling capacitors in 4 groups of channels (8-16-24-32 & 105-106-107-108)

standard: 4x100pF

new: 100pF - 22pF - 10pF - 4.7pF *remark: channel 24 (10pF) †*

inject input charge (1V step function) attenuated from -44dB to -26dB (3 … 35mV)

APV Frontend Circuit



SRS - APV F/E System

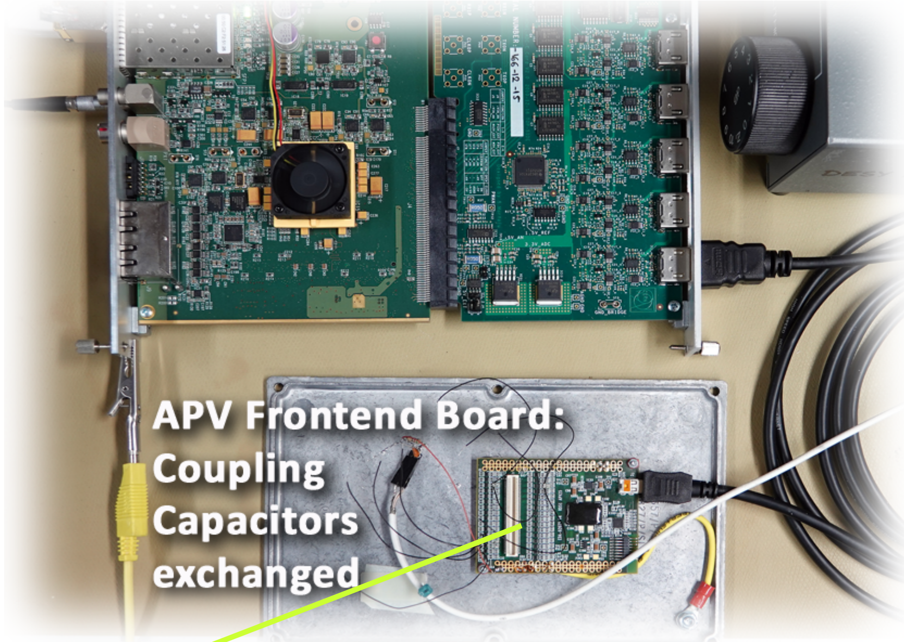
APV Board Modifications (2)

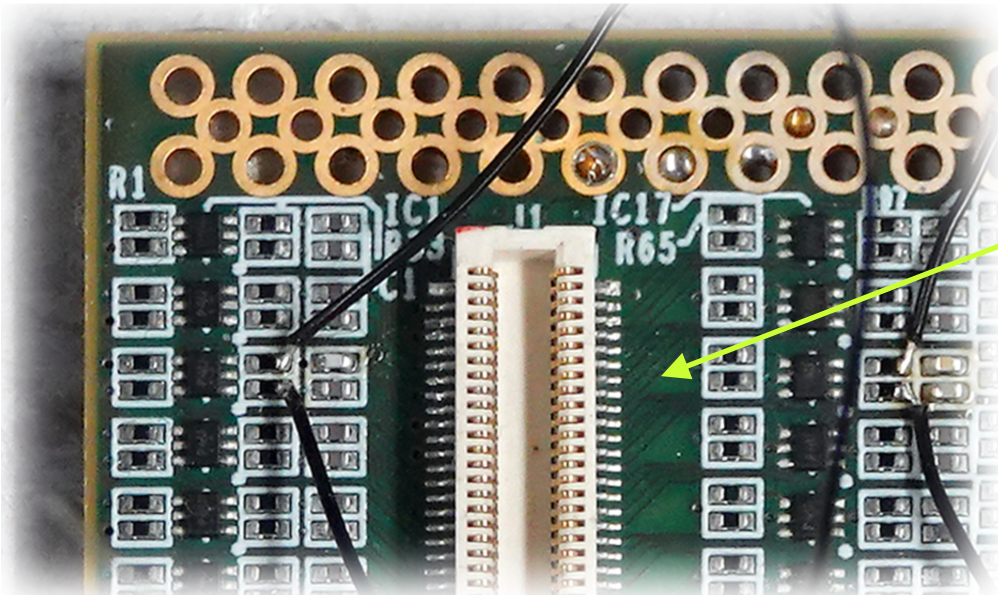
electronic circuit data not available!

→ reverse engineering of the pcb layout

exchange 6 SMD capacitors

solder 8 injection wires





MY THANKS TO WOLFGANG
for discussions and suggestions!

DAQ System

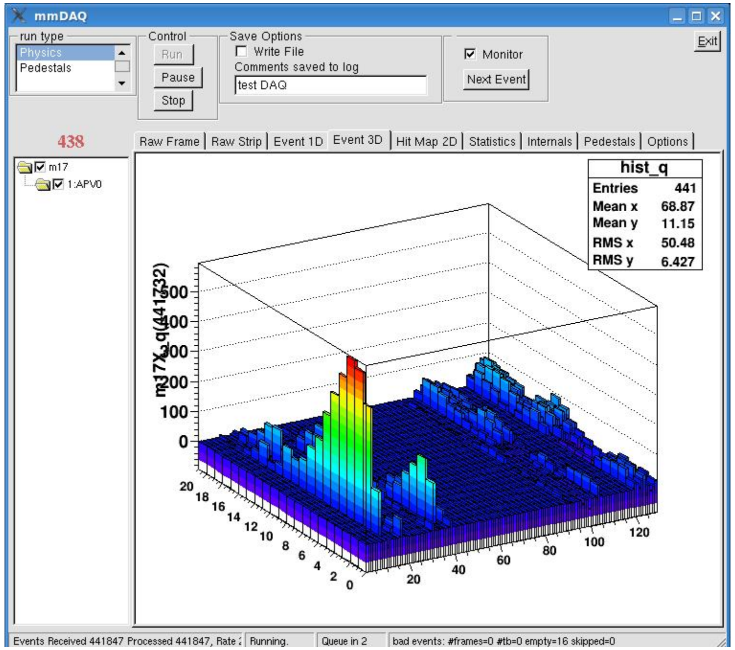
use Testbeam 2015 DAQ system

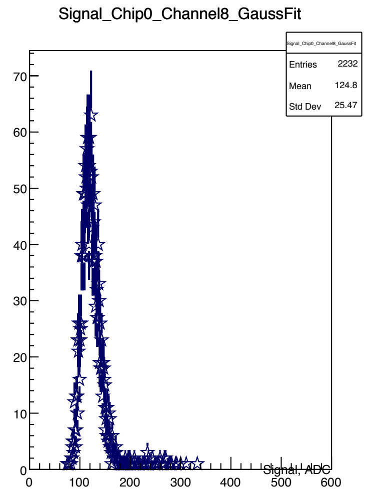
MANY THANKS TO SASHA
for helping us to bring the system up and running!

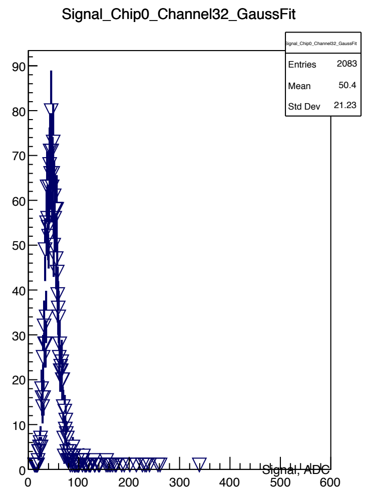
write nTuples Root files
confine the analysis to modified channels

A LOT OF THANKS TO INGO BLOCH
(ATLAS group Zeuthen)
for writing a quick-and-dirty Root procedure!

compare the mean values



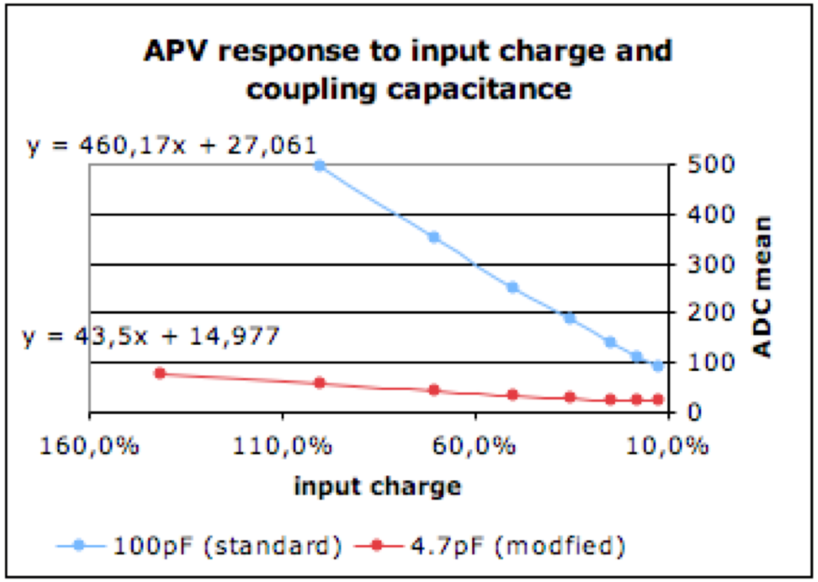


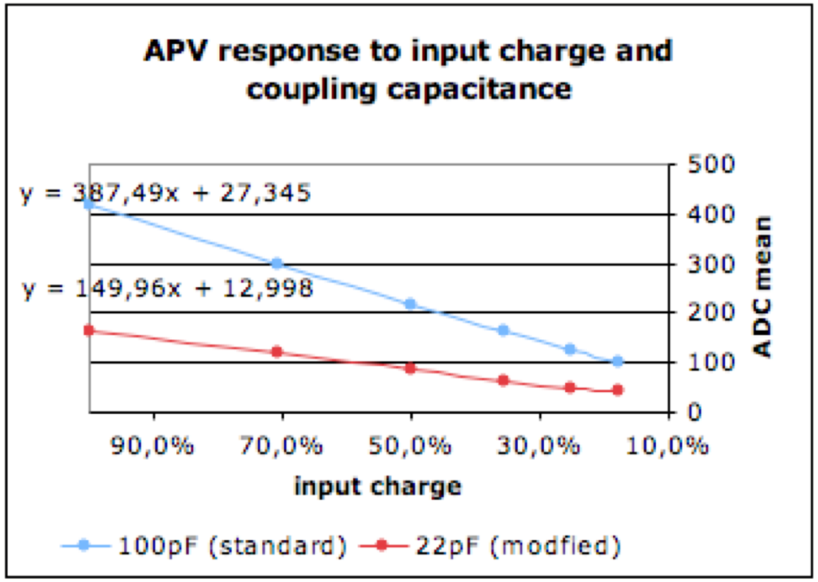


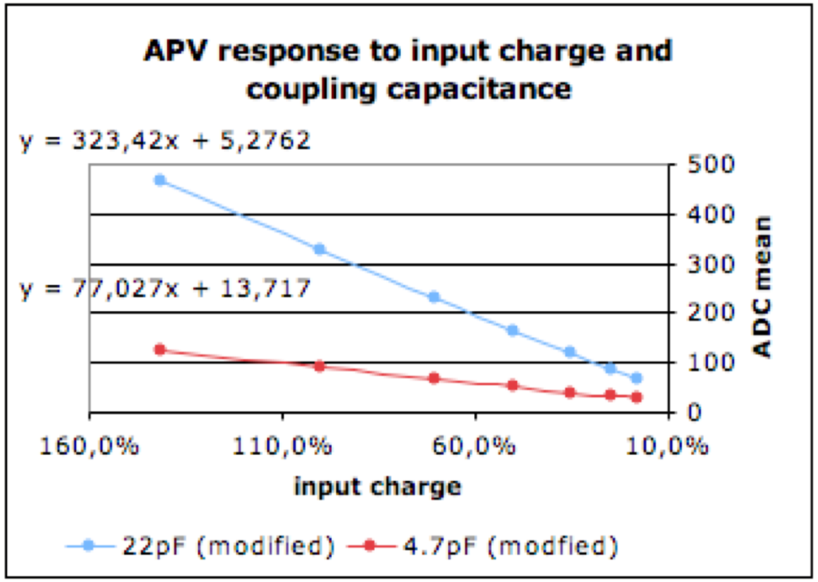
Charge Sharing
vs. Input Amplitude

sharing between different coupling capacitors is quite linear over a wide range of input charge

100% ≙ -32dB



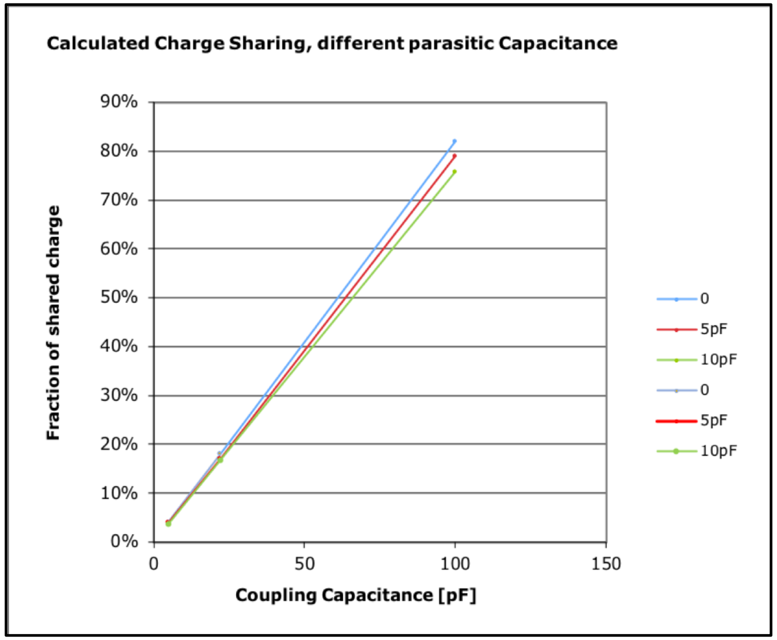




Charge Sharing vs. Coupling Capacitor (1)

Calculation gives a linear dependence,
even if different parasitic capacitances are assumed → slope!

No parasitic capacitor			
Fraction of charge	Coupling Capacitor		
	100pF	22pF	4.7pF
100pF + 22pF	82%	18%	
100pF + 4.7pF	95.5%		4.5%
22pF + 4.7pF		82.4%	17.6%

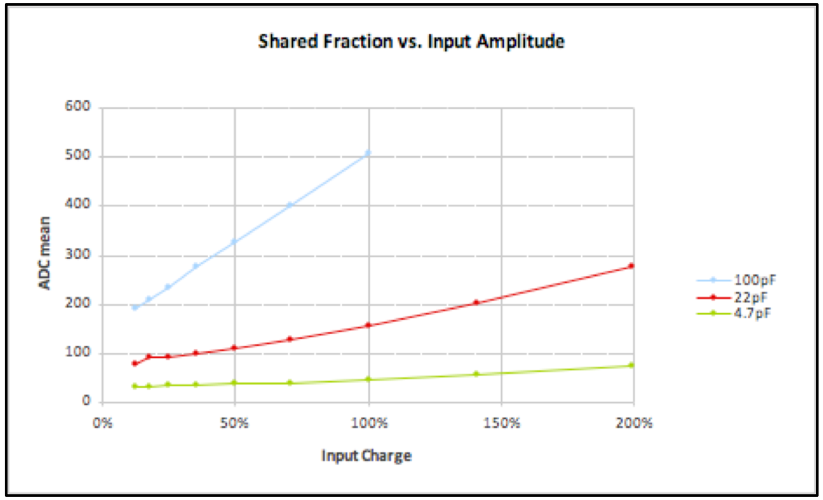


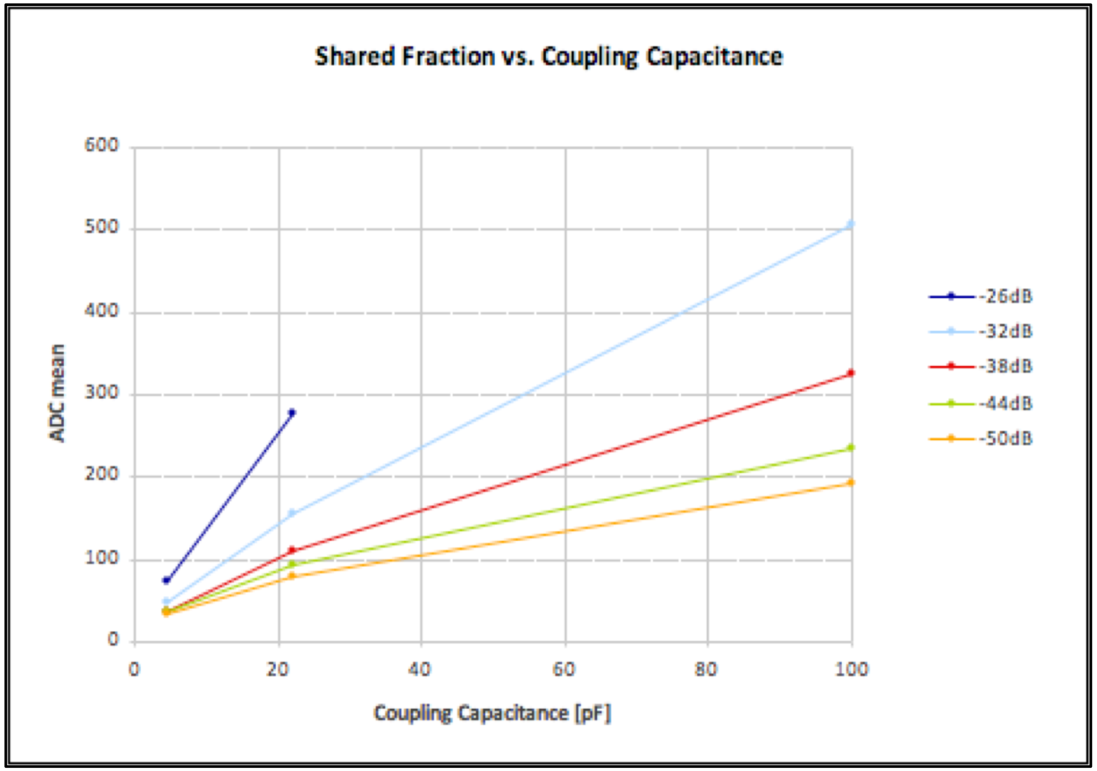
Charge Sharing vs. Coupling Capacitor (2)

measured dependencies differ from calculated ones

while amplitude related sharing is rather linear, capacitance related isn't

➙ **more values needed** (10pF, 47pF)





Thank you for your attention.

Charge Sharing vs. Coupling Capacitor (3)

check with 4 adjacent channels

→ **more values needed** (10pF, 47pF)