The Front-End of PANDA EMC

and its Automatized Testing System

(and Crystal Barrel exp.)

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Group of Prof. Bernd Krusche

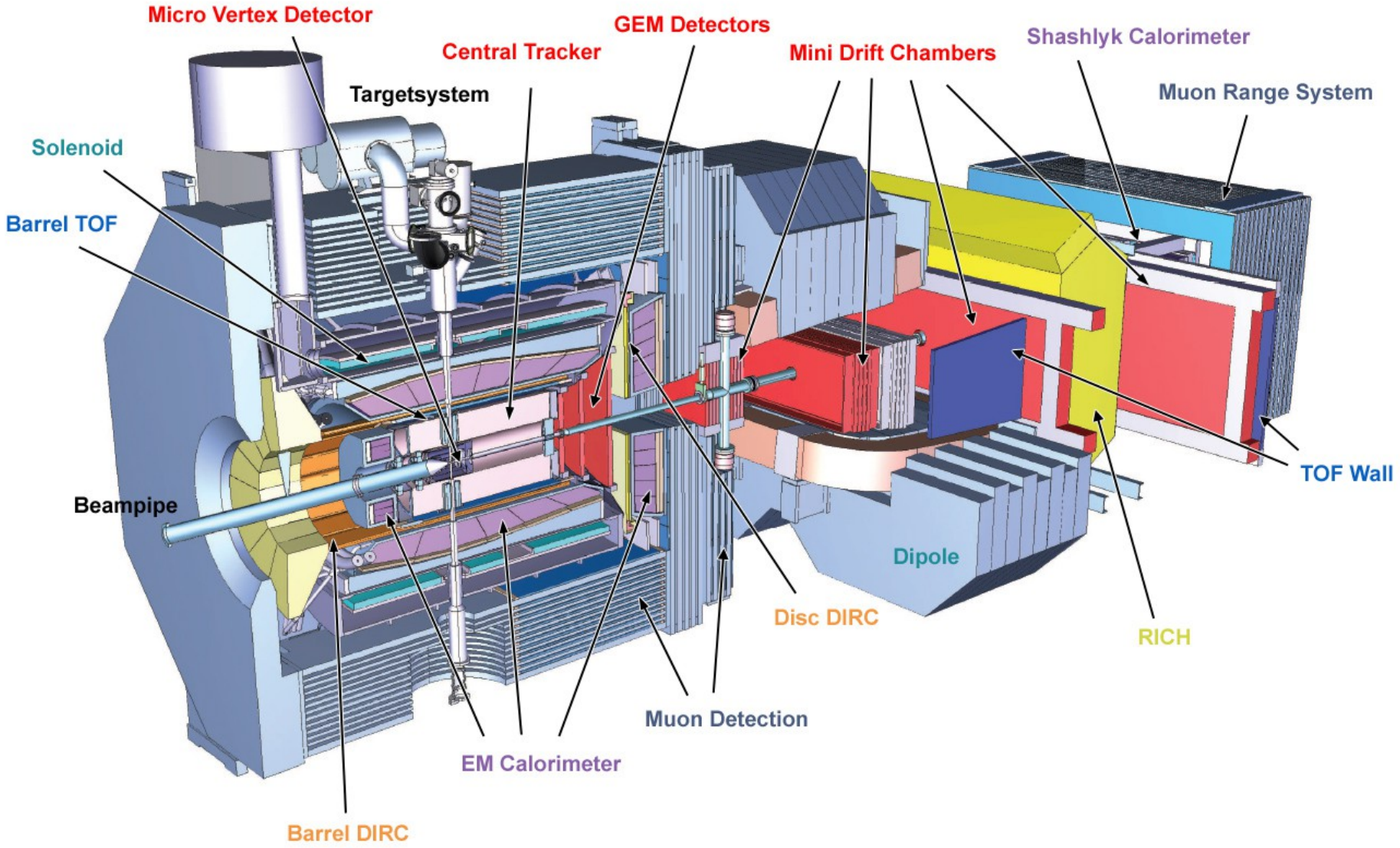
University of Basel

INTRODUCTION

UNI BASEL

- Experiment PANDA / Crystal Barrel
- Basel Low Noise/Low Power (LNP) PreAmplifier
- Double Burst Laboratory Test
- Amplitude Linearity Laboratory Test
- Mass-production Test Setup
- Summary

PANDA Detector



PANDA Electromagnetic Calorimeter

Material: $PbWO_4$ (-25C°)

Crystal size: 2 cm x 2 cm x 20 cm

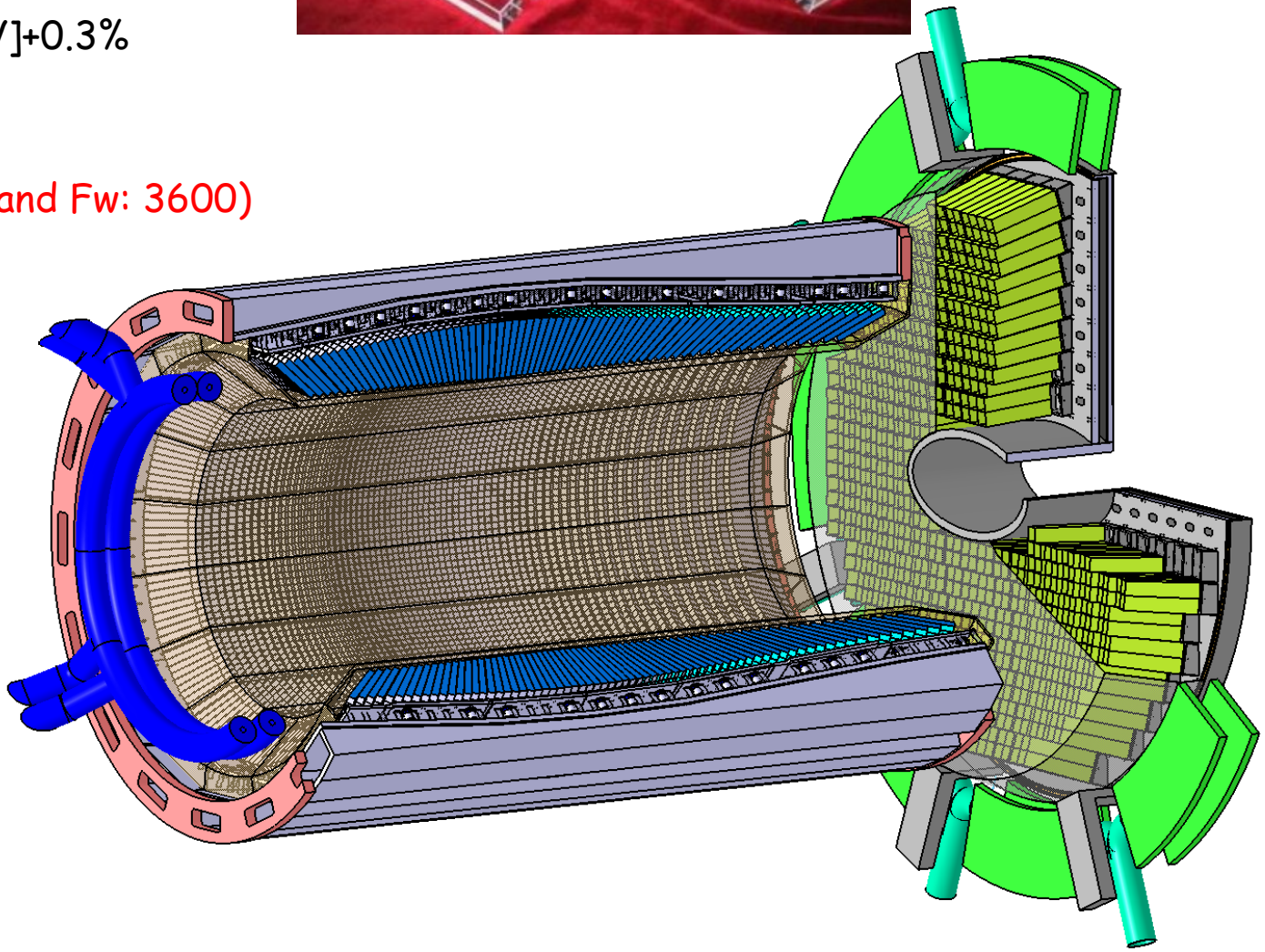
Thickness: 22 X_0

Energy res.: 1.54% / √E/[GeV]+0.3%

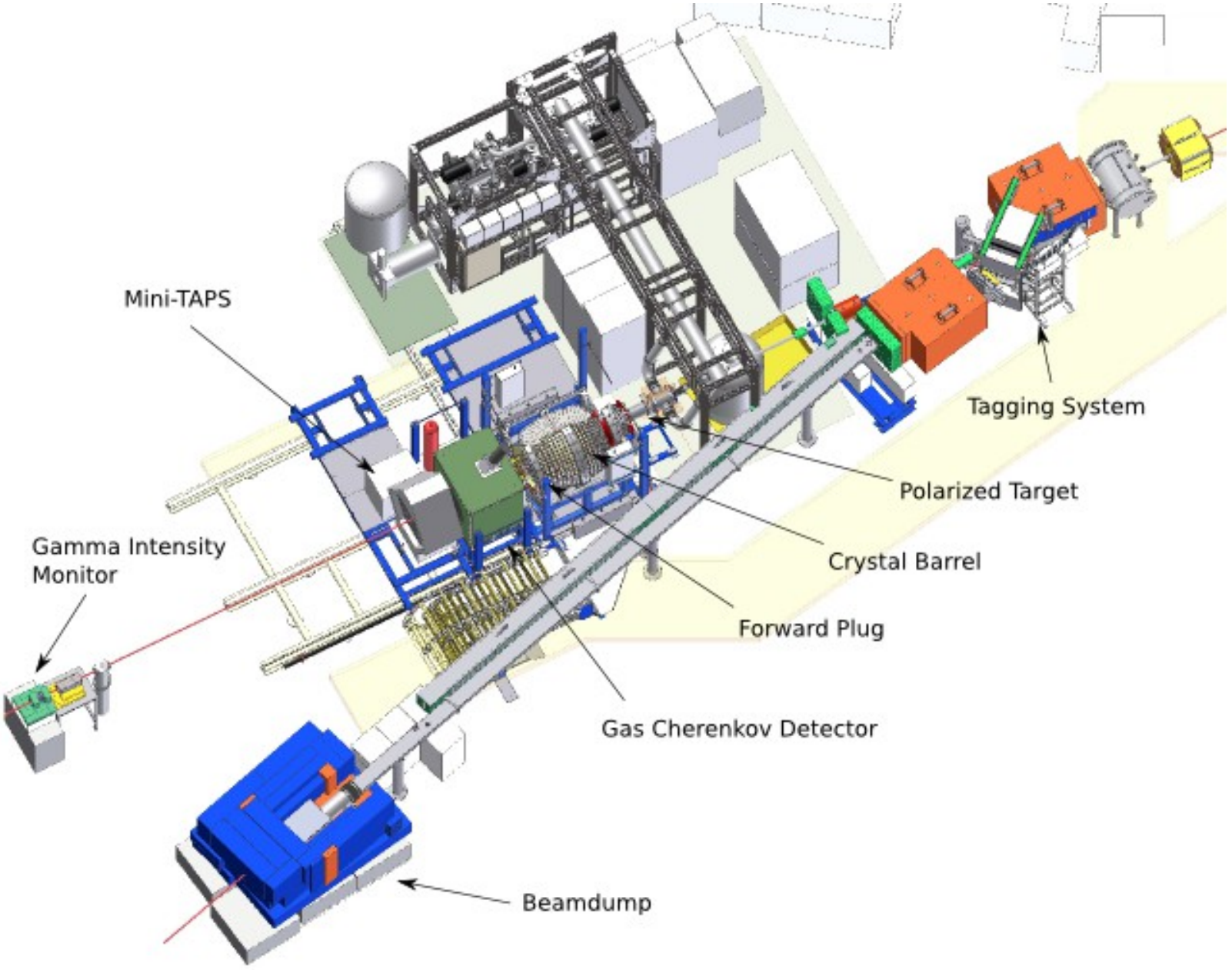
Time res.: < 2 ns

# of crystals: 15552 (Bk: 592 and Fw: 3600)

Coverage: 96% 4π



Crystal Barrel upgrade @ ELSA-Bonn



Crystal Barrel upgrade @ ELSA-Bonn

UNI BASEL

Material: CsI (Tl)

Crystal size: $(6^0 \times 6^0) \times 30$ cm

Thickness: 16.1 X_0

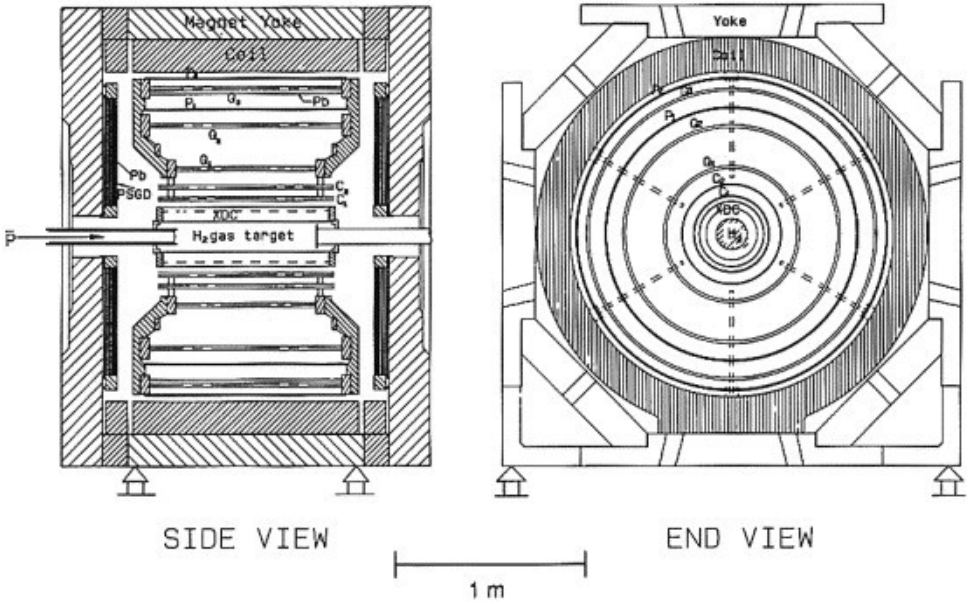
Energy res.: 1.3% / √E/[GeV]+2%

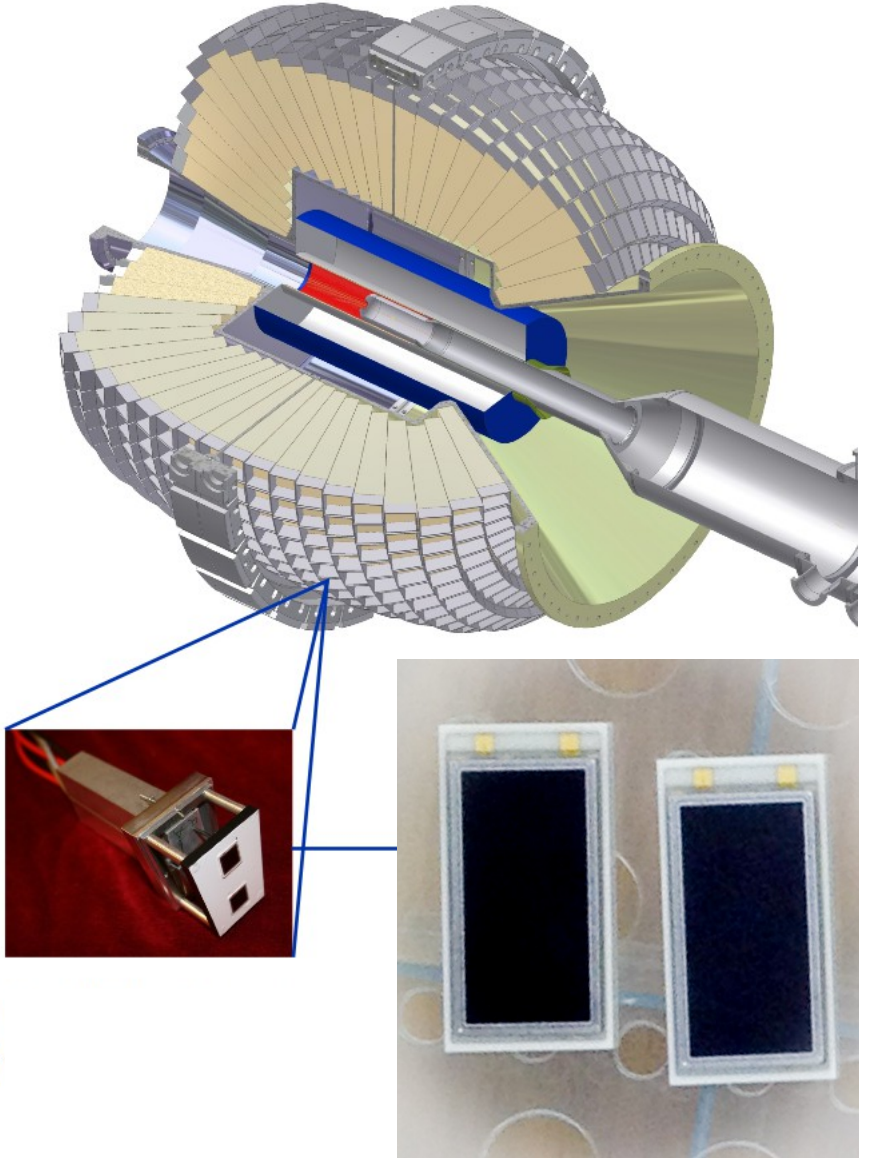
Time res.: I level trigger - PIN no / APD YES!

# of crystals: 1380

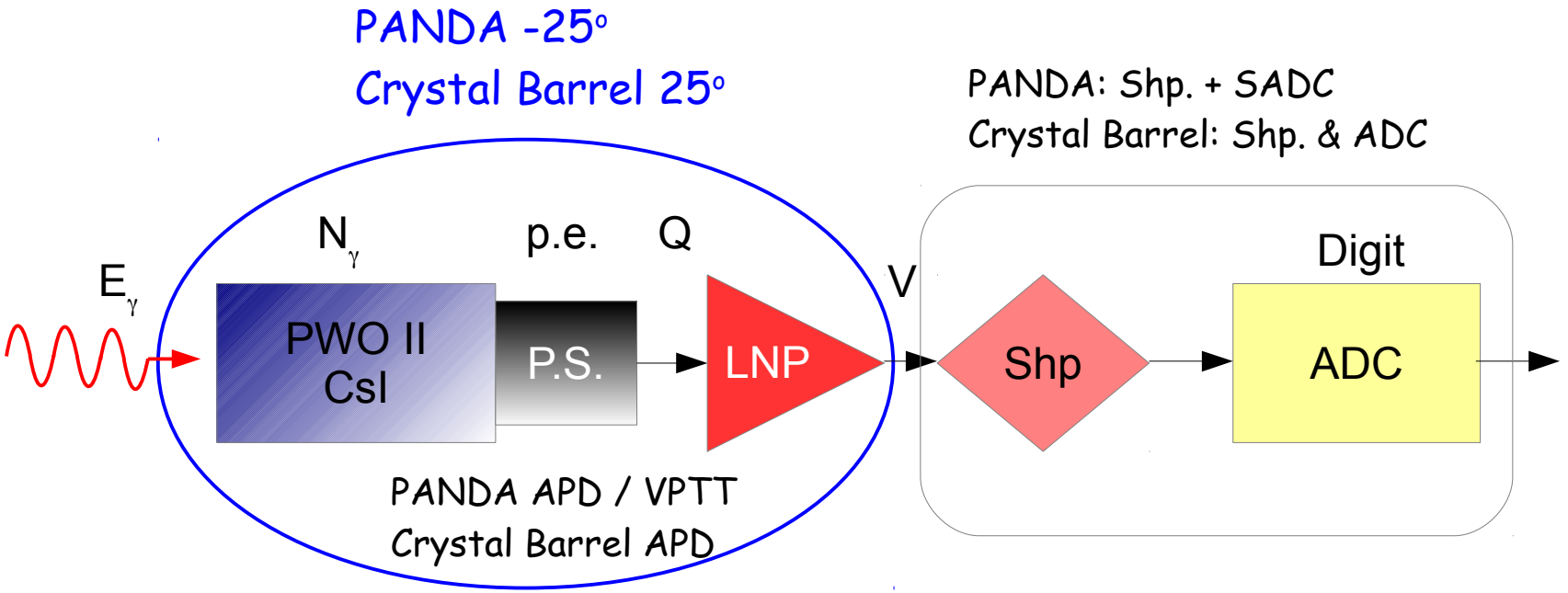
Coverage: 98% 4π

Now PIN --> future APD



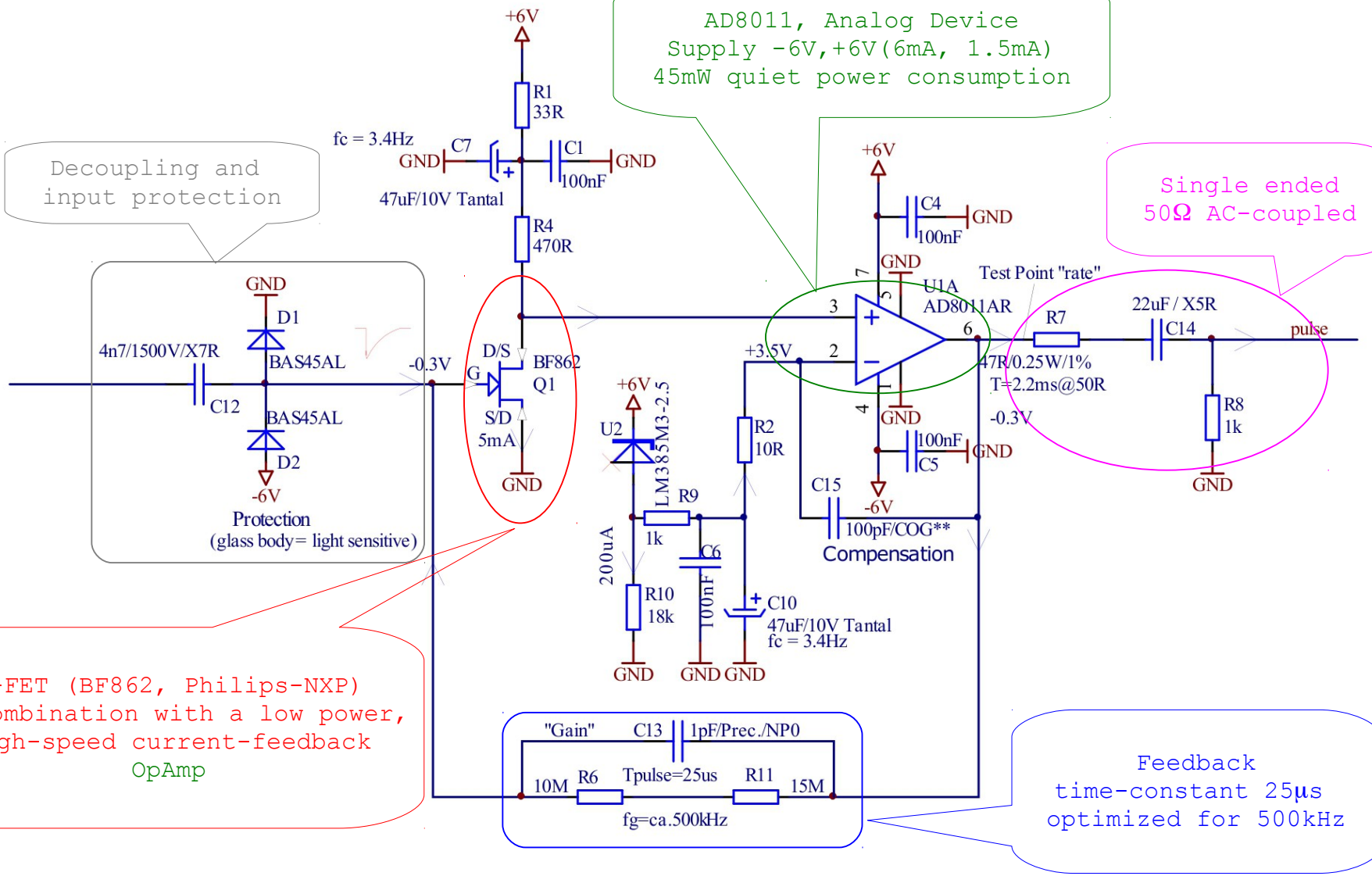


General Concept of ReadOut

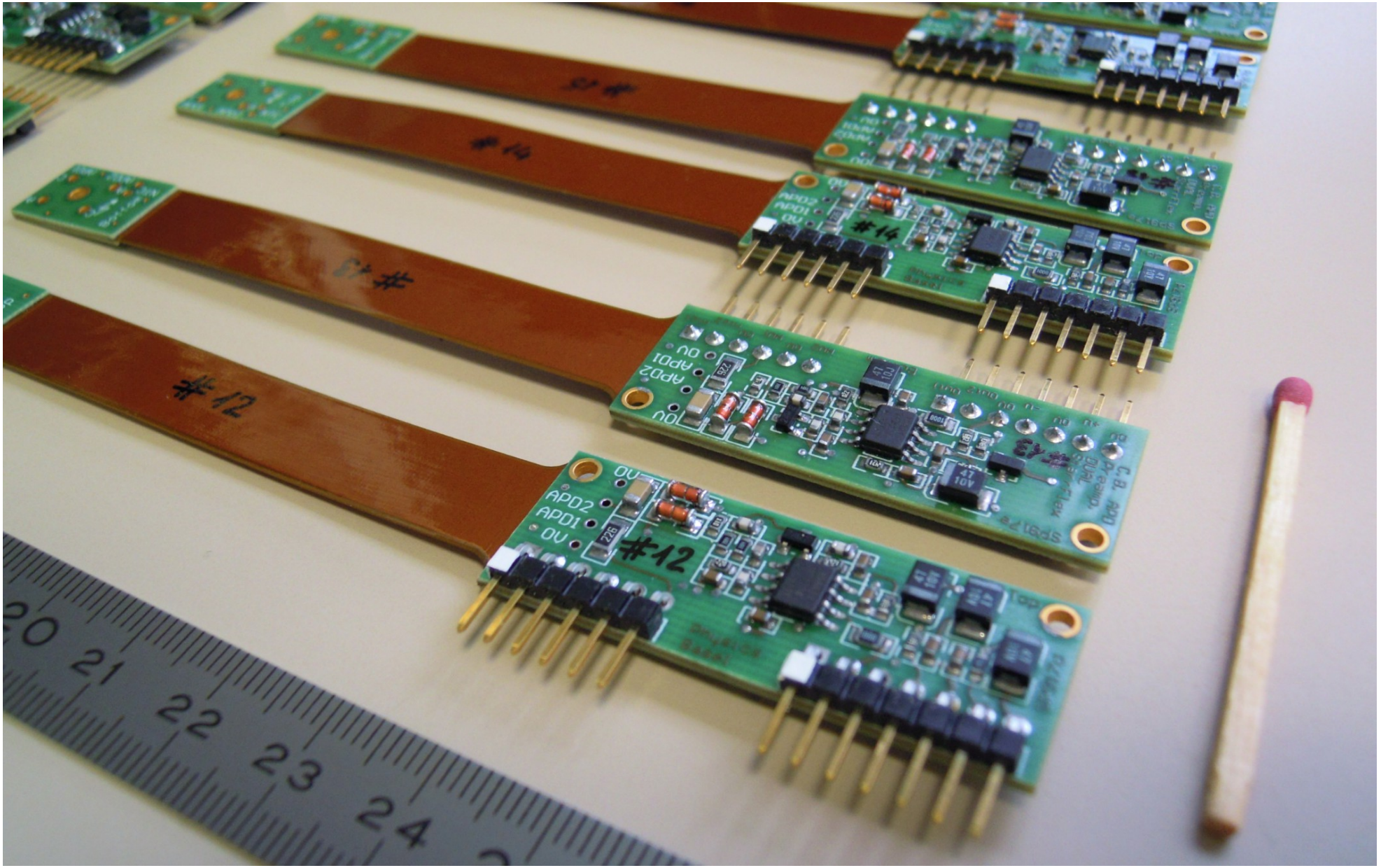


Basel LNP Preamplifier

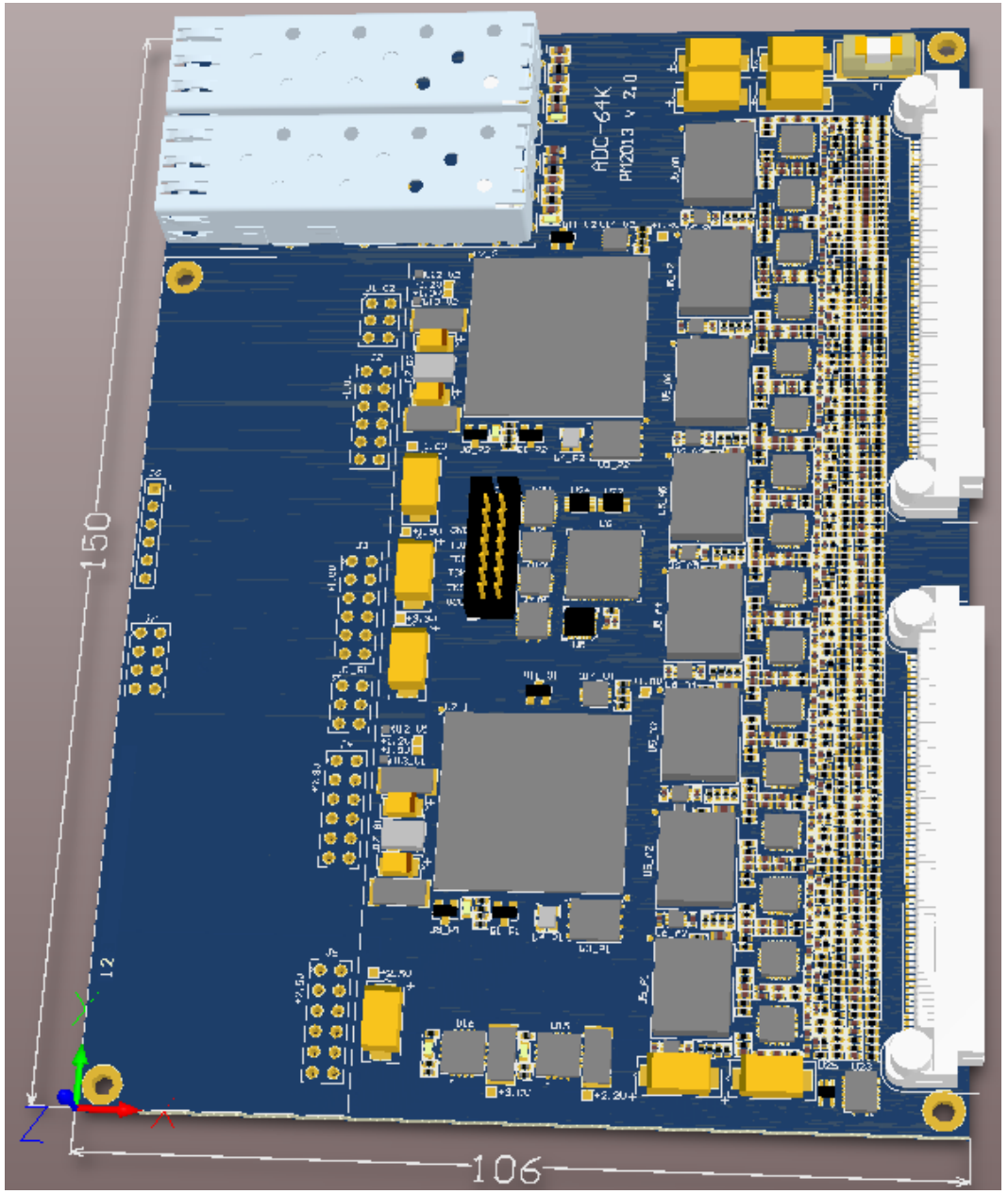
Low Noise / Low Power
discrete charge preamplifier



Dual LNP preamps for Crystal Barrel @ Bonn



PANDA Shaper + SADC



Design: Pawel Marciniewski
Uppsala Uni.

V1.1 – June 2013

* Design clean-up
* Block connectors –
  Samtec ERF8-049-XX-X-D-RA
* 64 – channels with individual gain,
  no filter

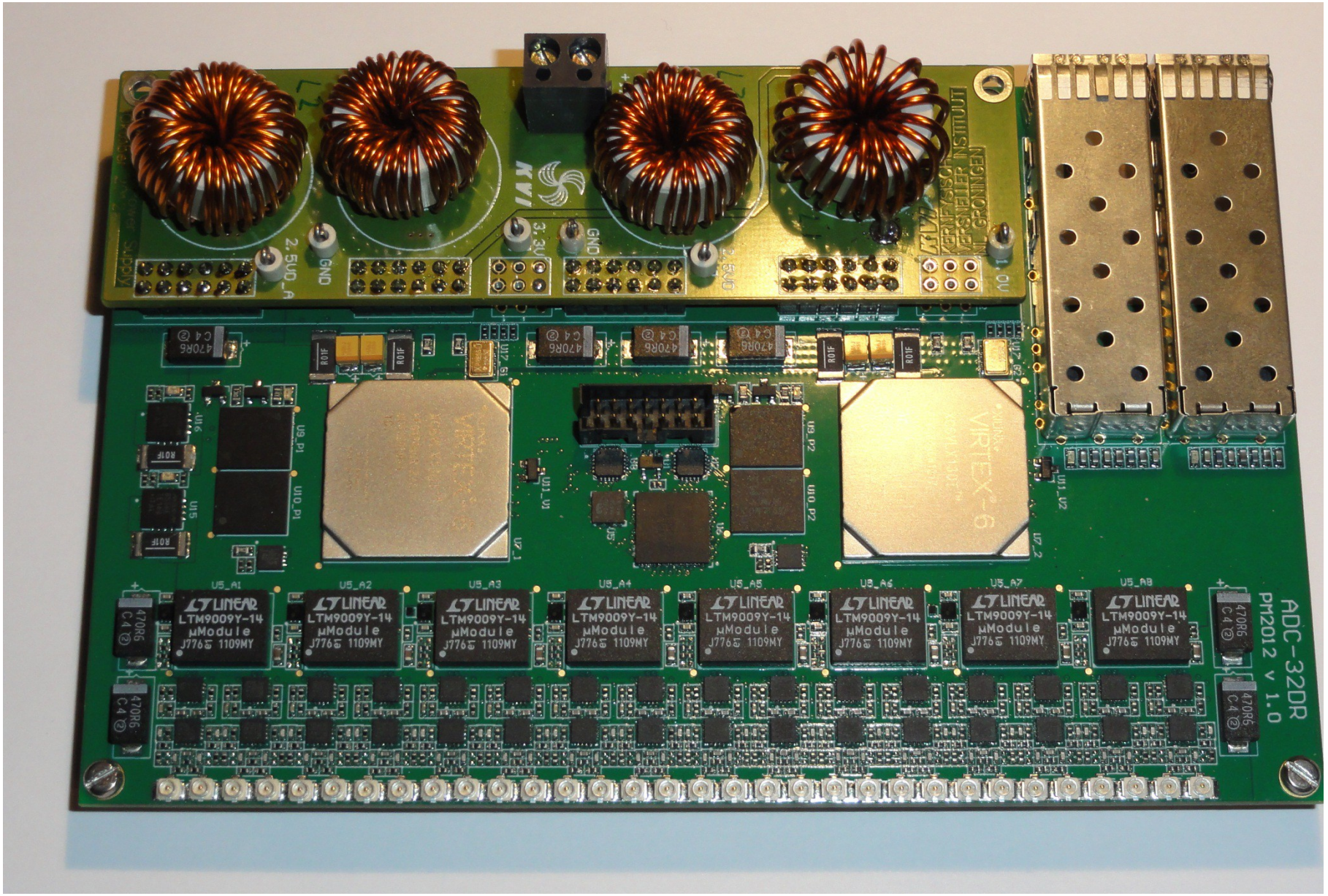
V1.2 – August 2013

* Block connectors
* Low power op-amp ADA4940-2
* 32-ch. with gain G = 0.5, filtered
  32-ch. with gain G = 5.0, filtered

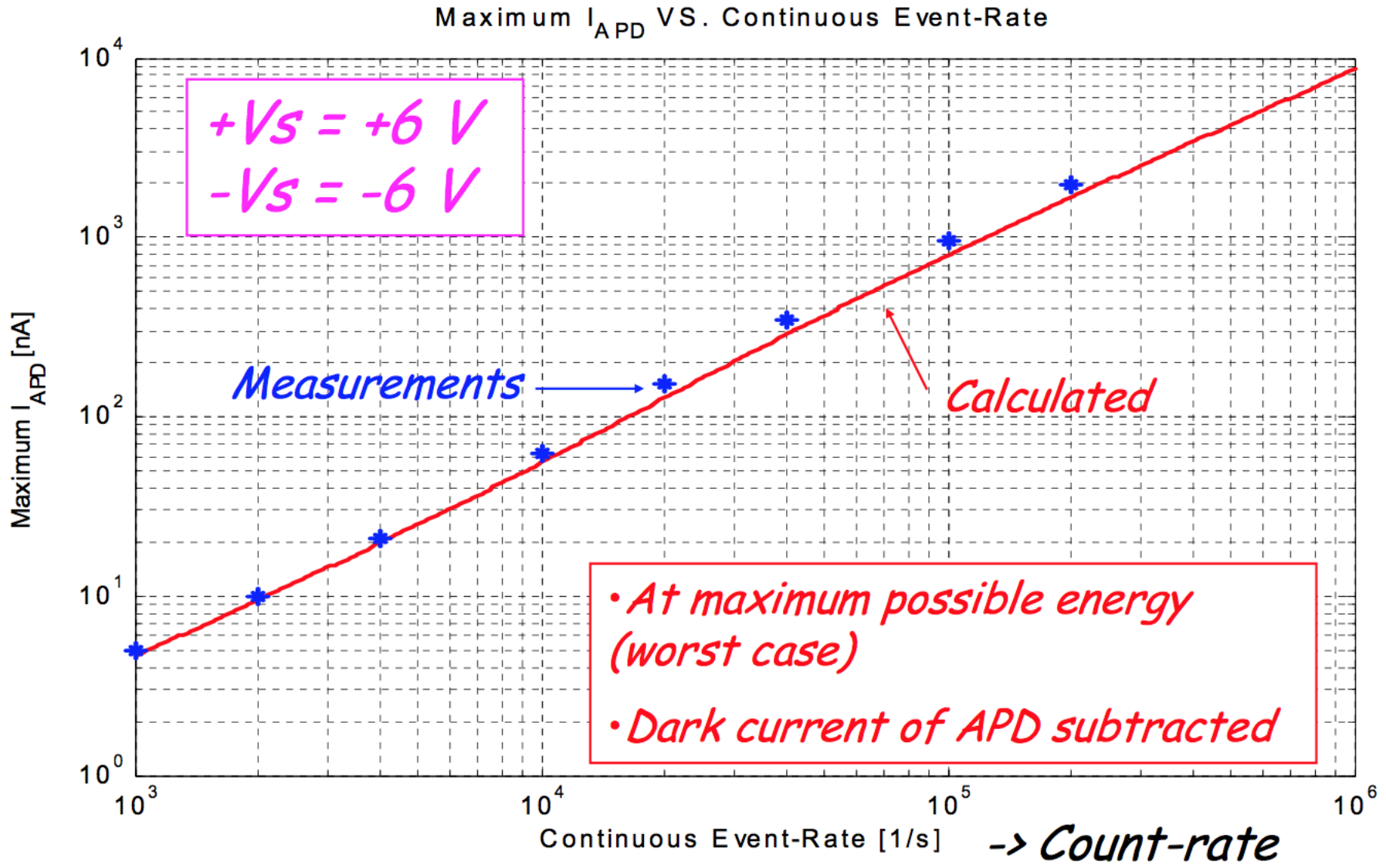
V2.0 – October 2013

* Kintex-7

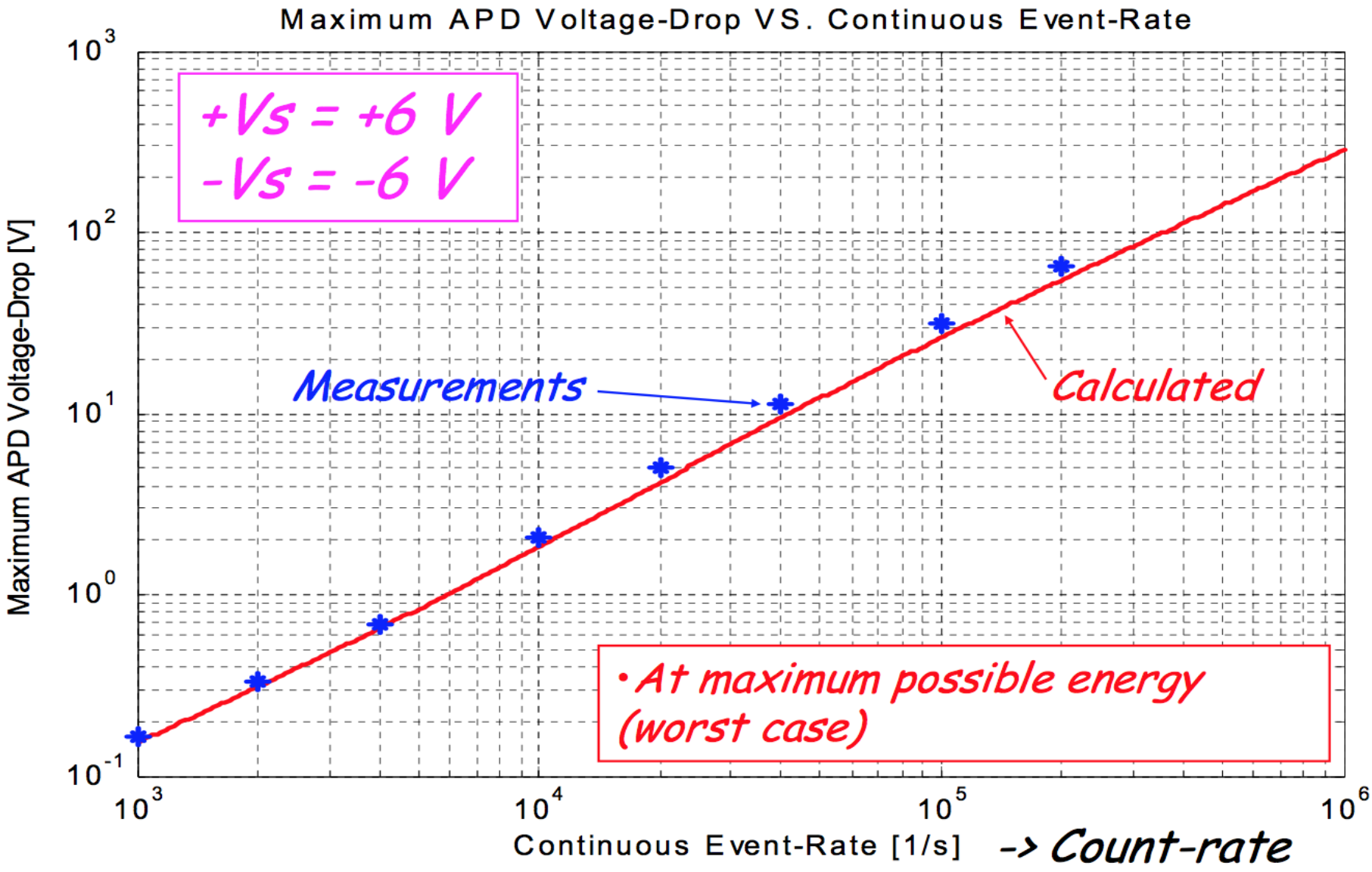
PANDA Shaper + SADC



APD Current Vs Count-Rate

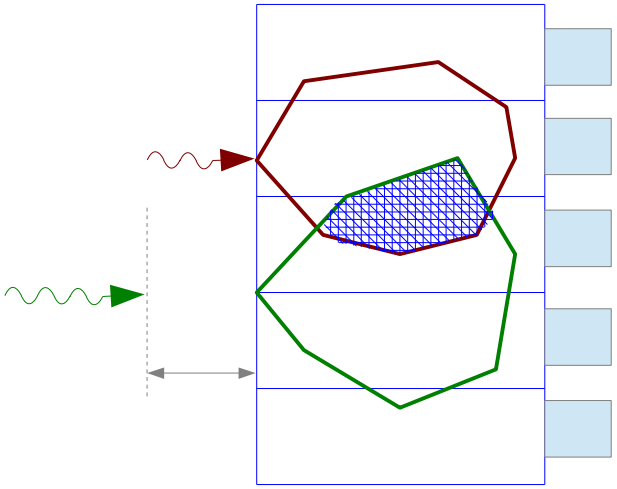


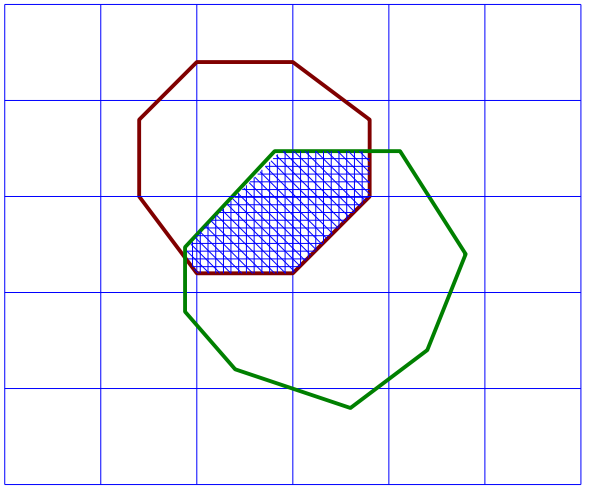
APD Voltage Vs Count-Rate

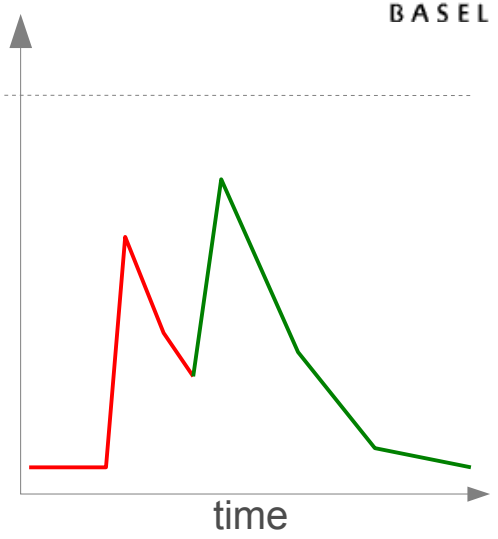


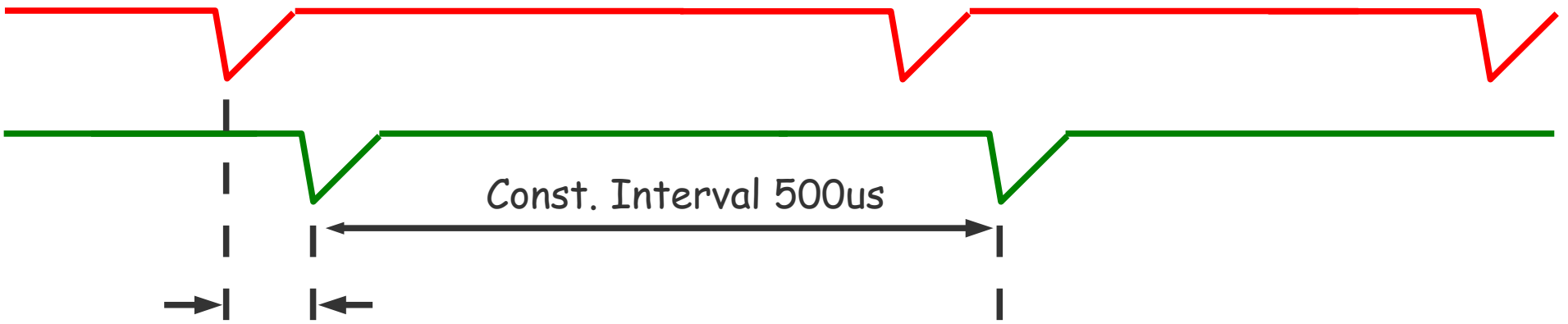
'Double Burst' Test
Or
Pileup Test

Double Burst Linearity





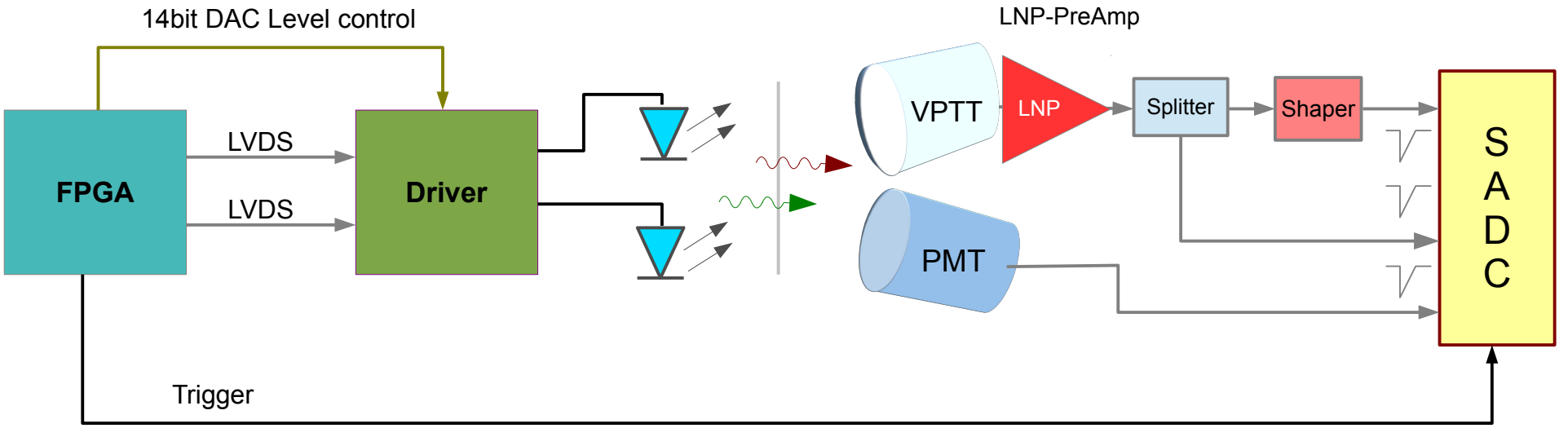




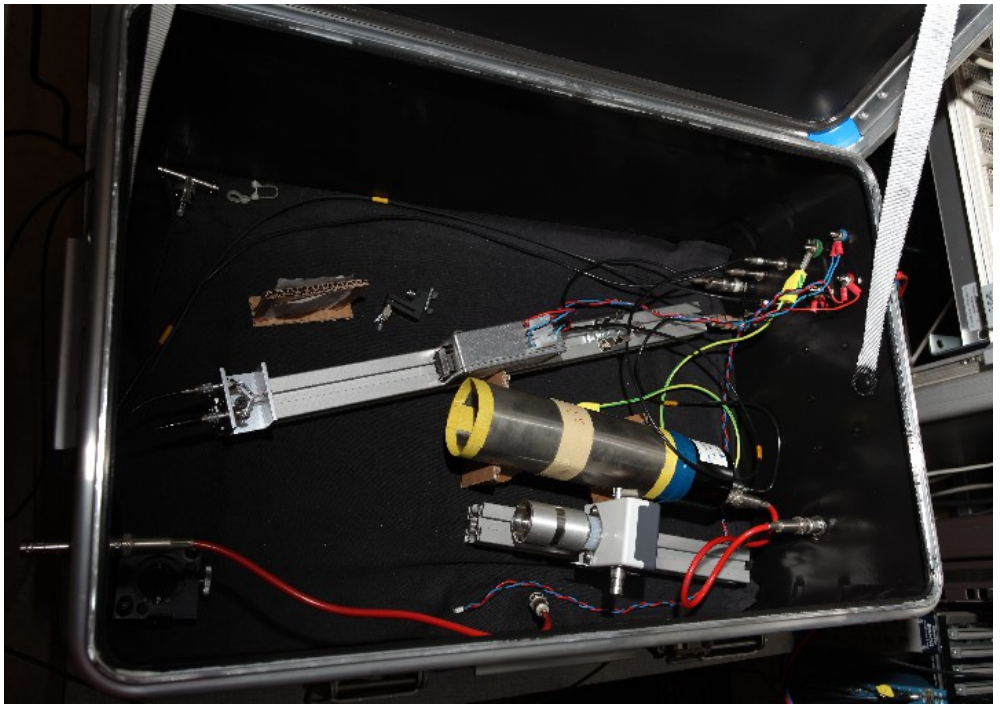
1us - 10us

1MHz - 100kHz

Double Burst Linearity - Measurement Method

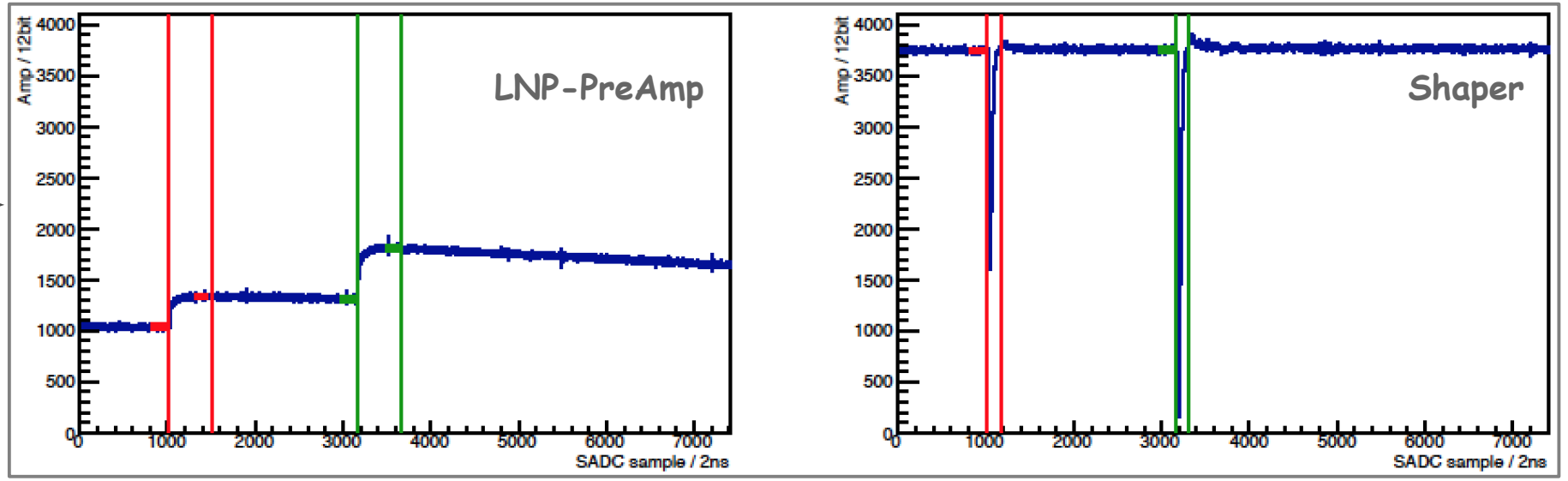


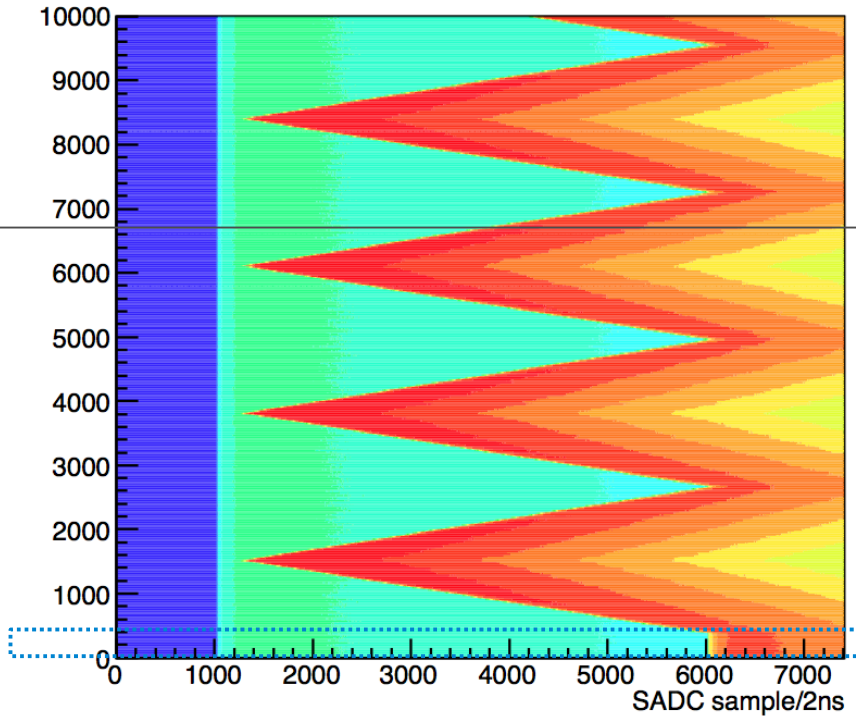
Xilinx Spartan-3AN
LED driver/signal

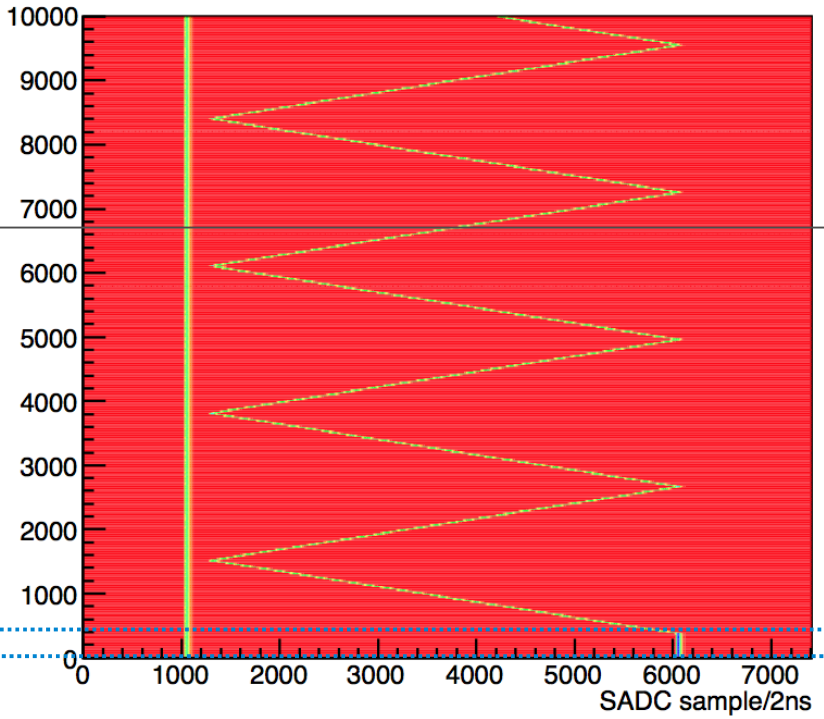


Struck 500MS/s 12bit
500MHz VME SADC

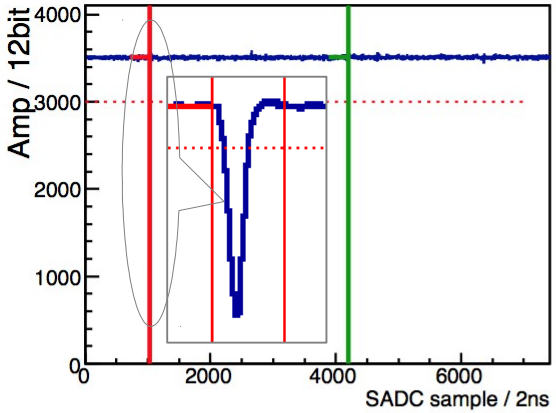
Double Burst Linearity (VPTT)

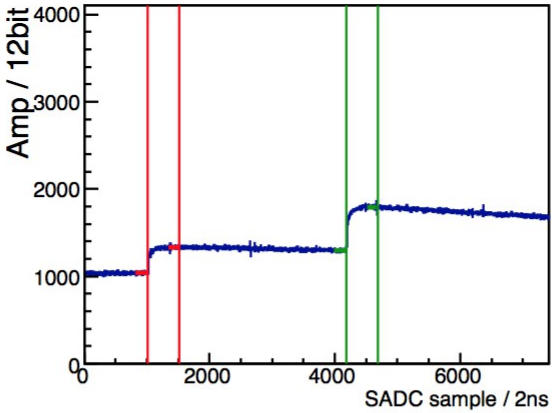


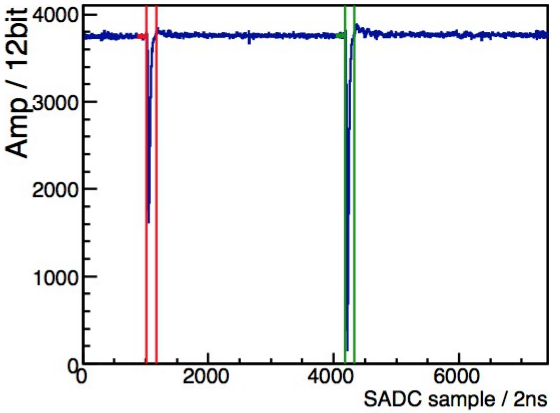




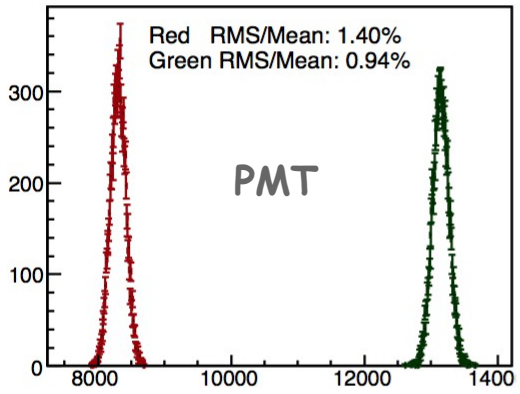
Double Burst Linearity (VPTT)

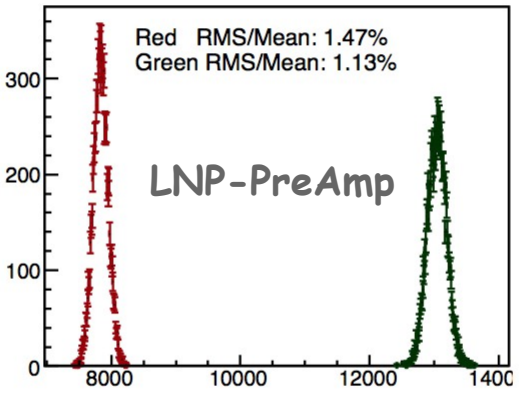


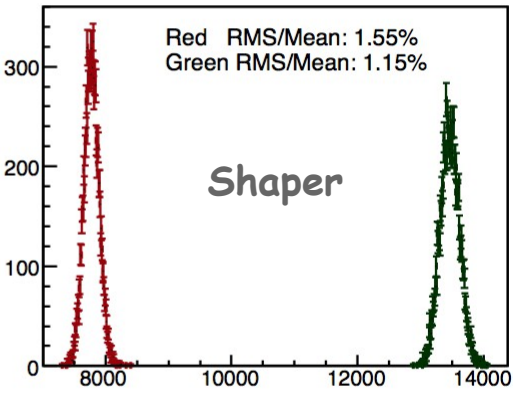




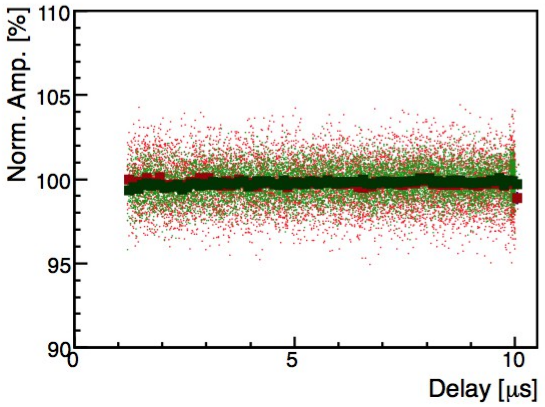
Typical Signal

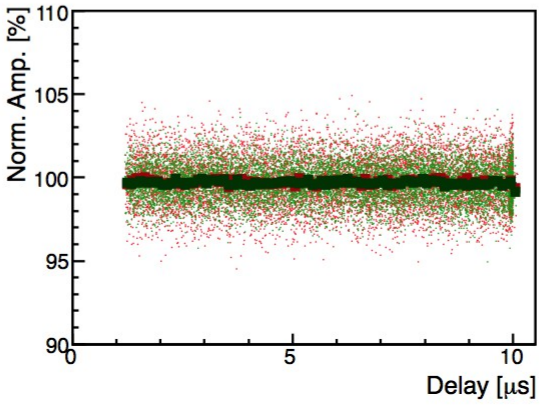


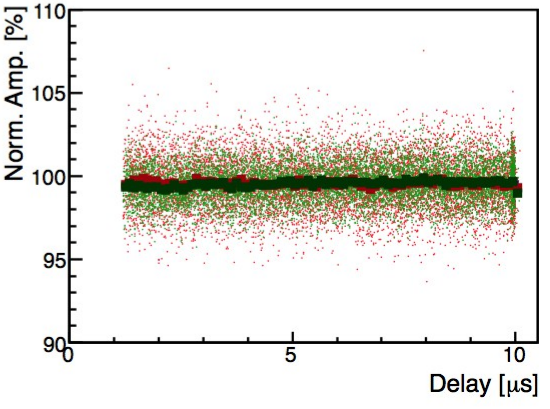




Signal Distribution



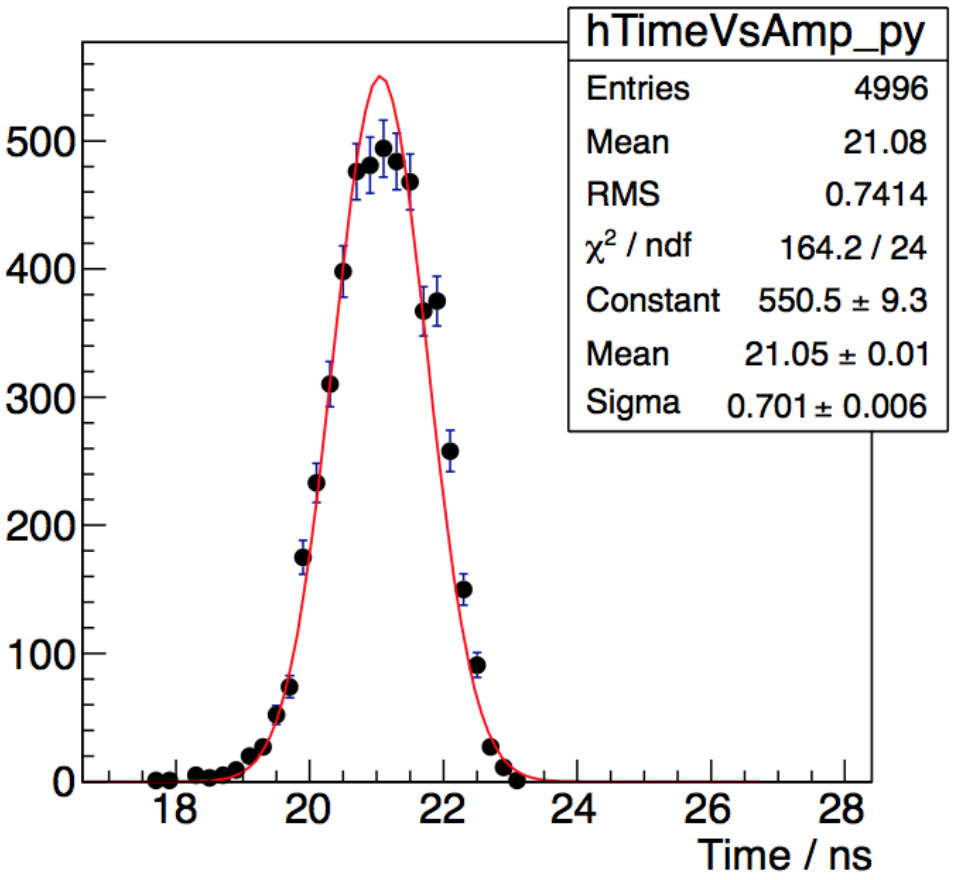




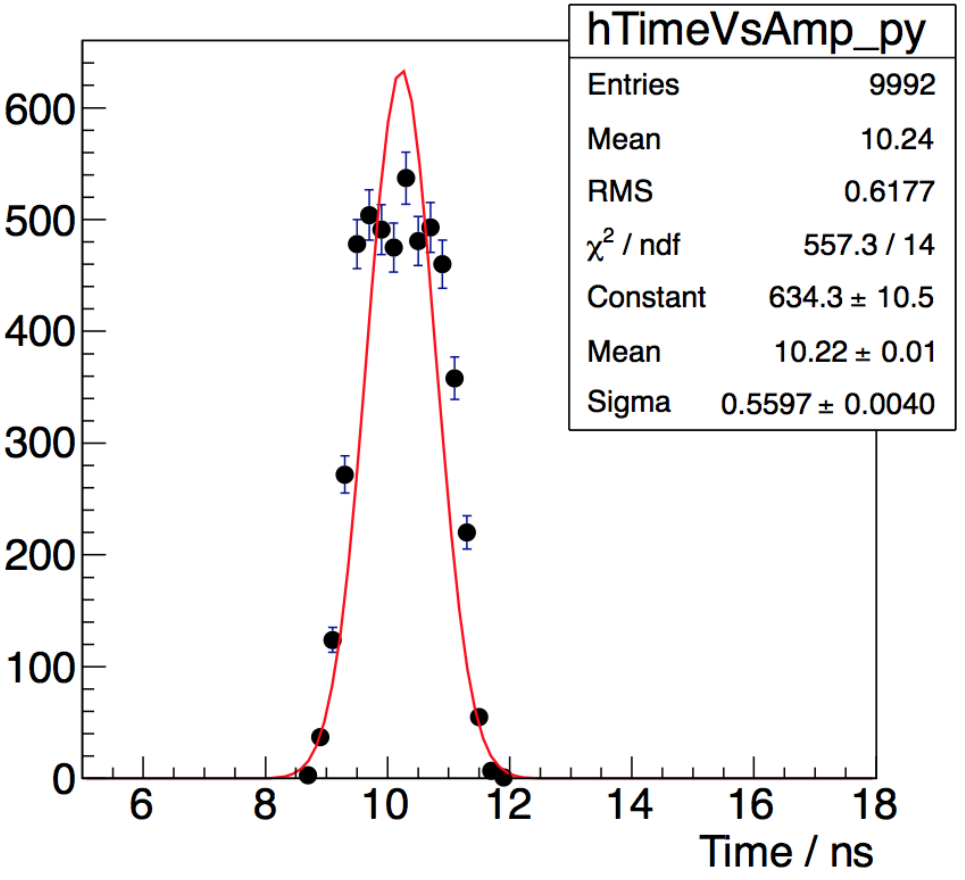
Count-rate Stability

Time resolution for VPTT

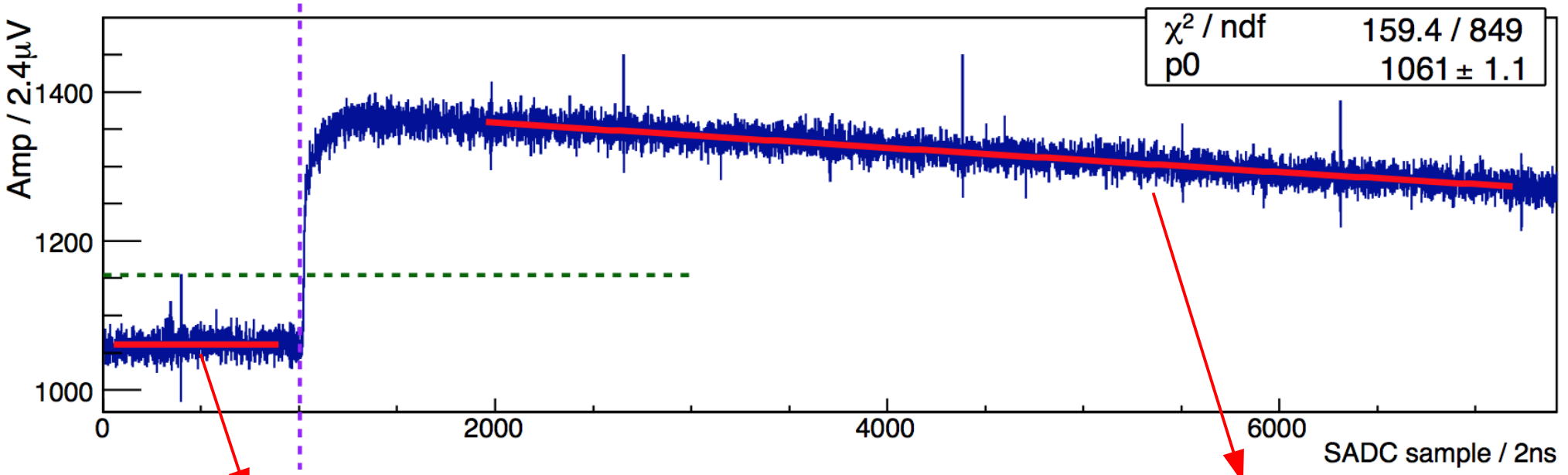
LED 1

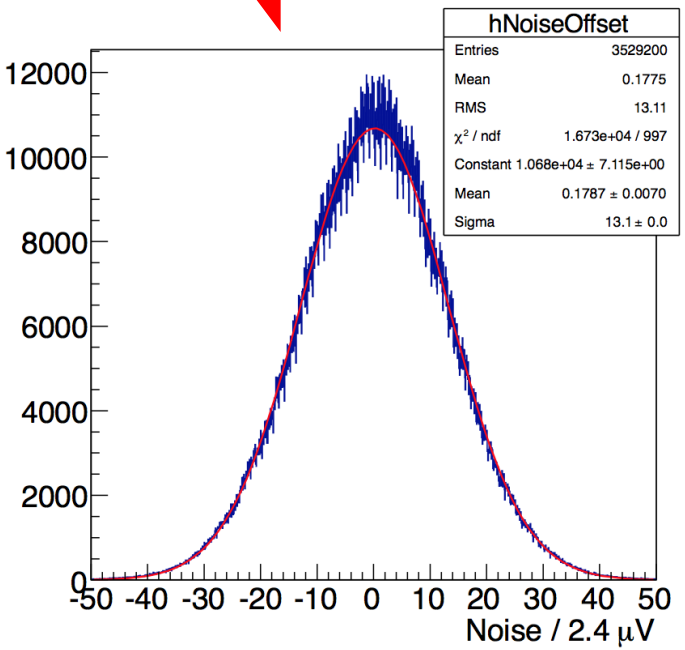


LED 2



Noise & Dynamic range (VPTT)

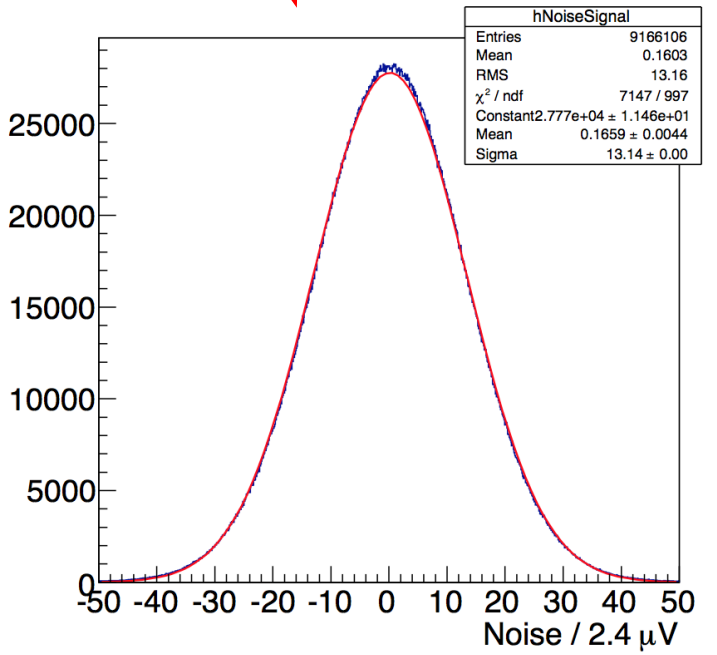




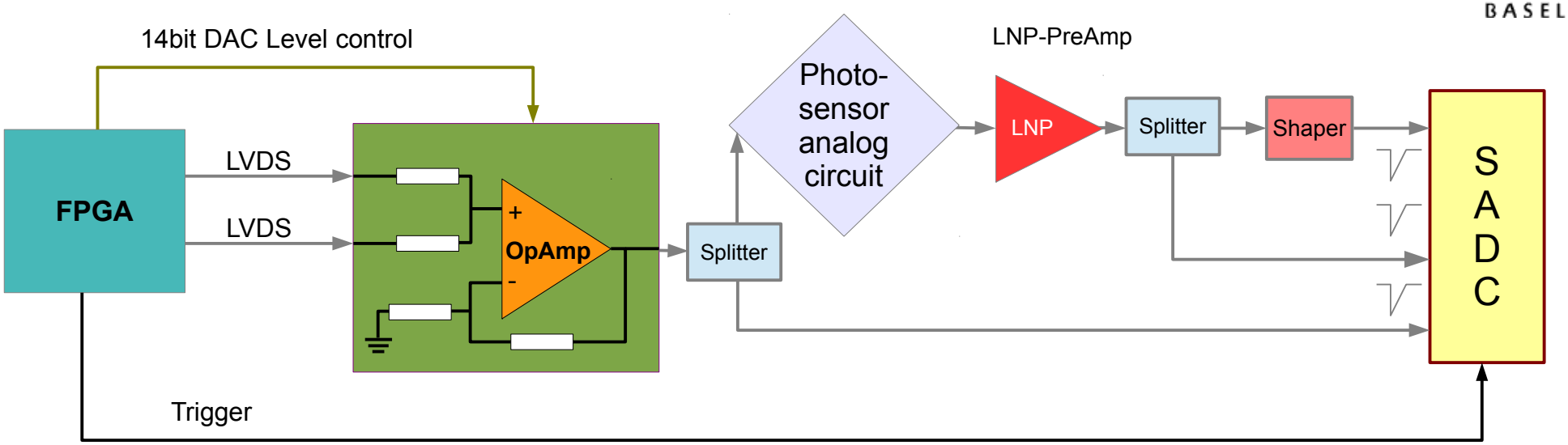
High dynamic range

13x24uV ~310uV

2.5V/310uV ~ 8000



Double Burst Linearity – Measurement Method

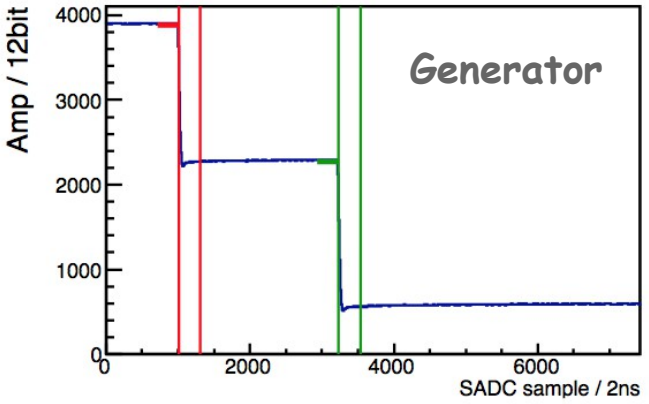


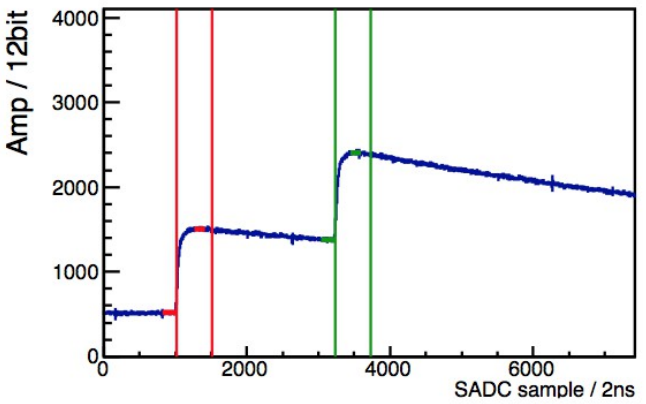
Xilinx Spartan-3AN
LED driver/signal

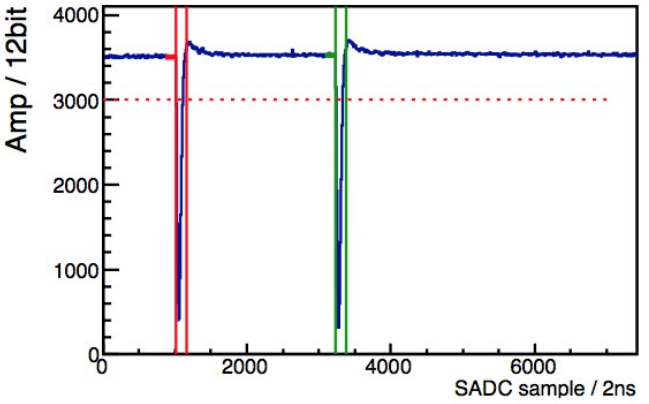
Small VME DAQ system
C++/ROOT based

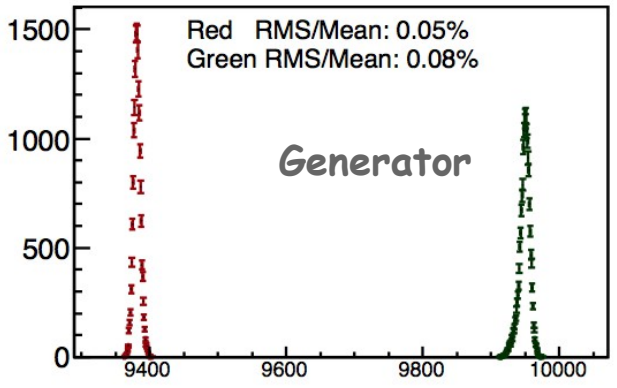
Struck 500MS/s 12bit
500MHz VME SADC

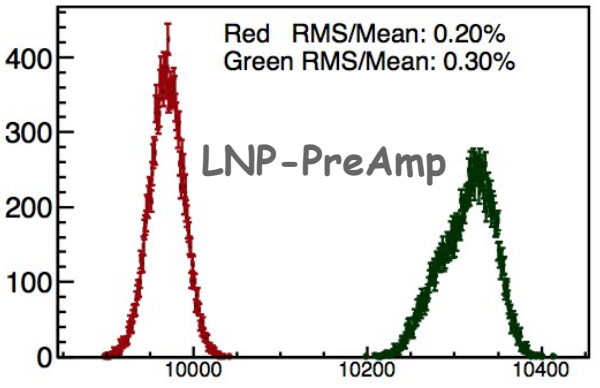
Double Burst Linearity (FPGA+OpAmp Generator)

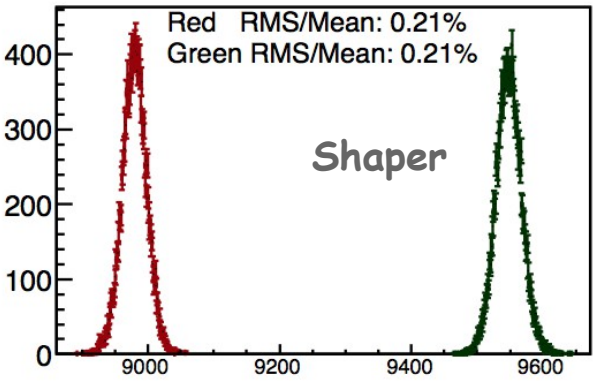


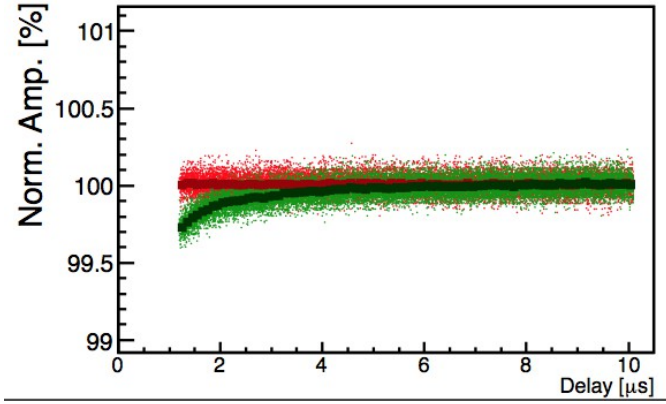


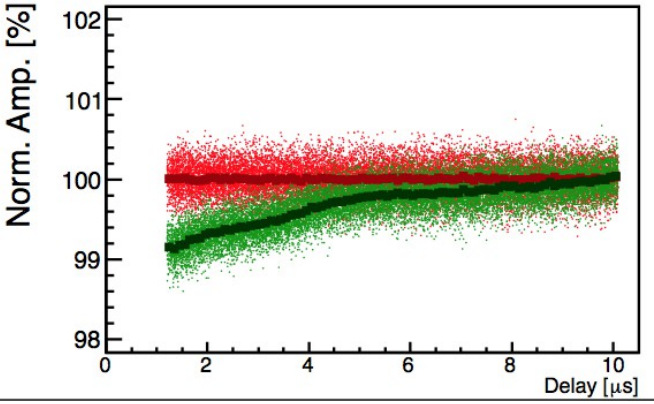


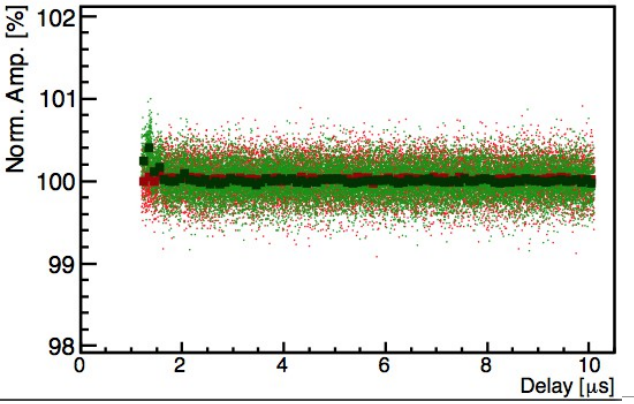






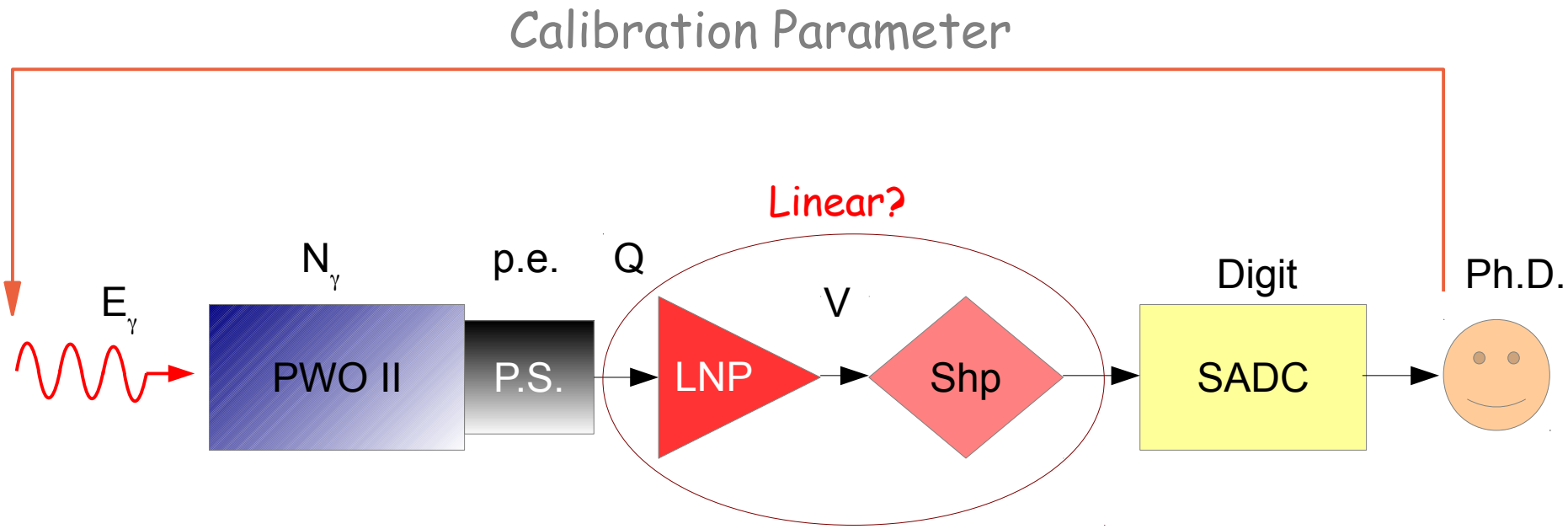


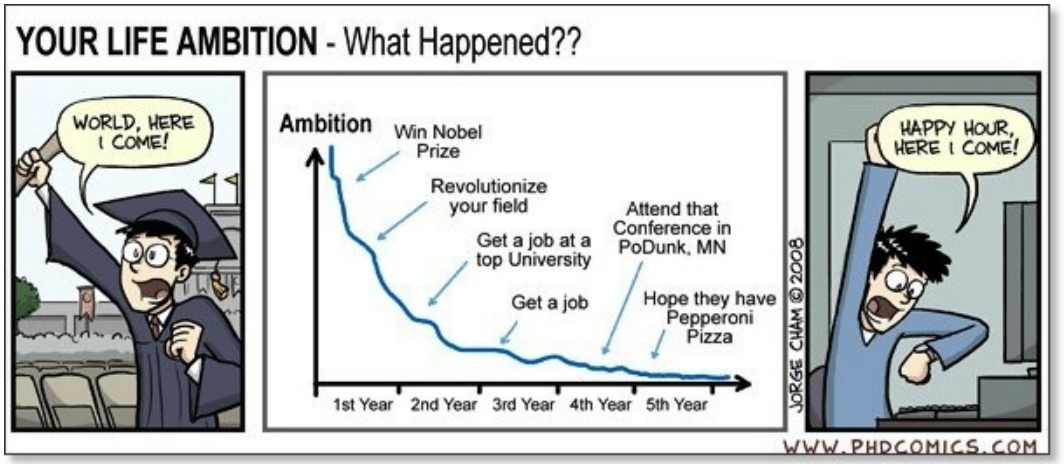




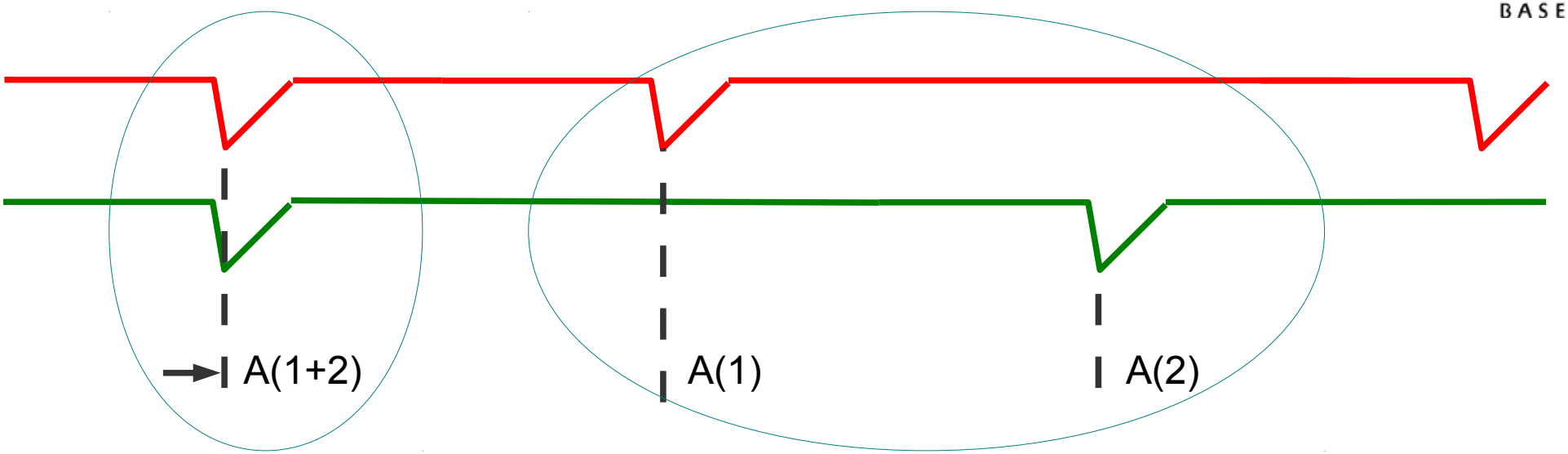
Amplitude Linearity Test

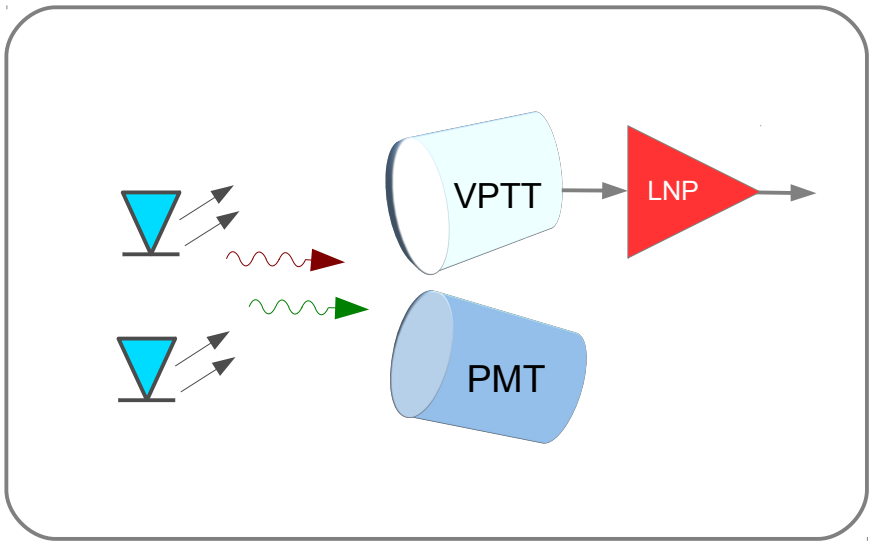
Amplitude Linearity

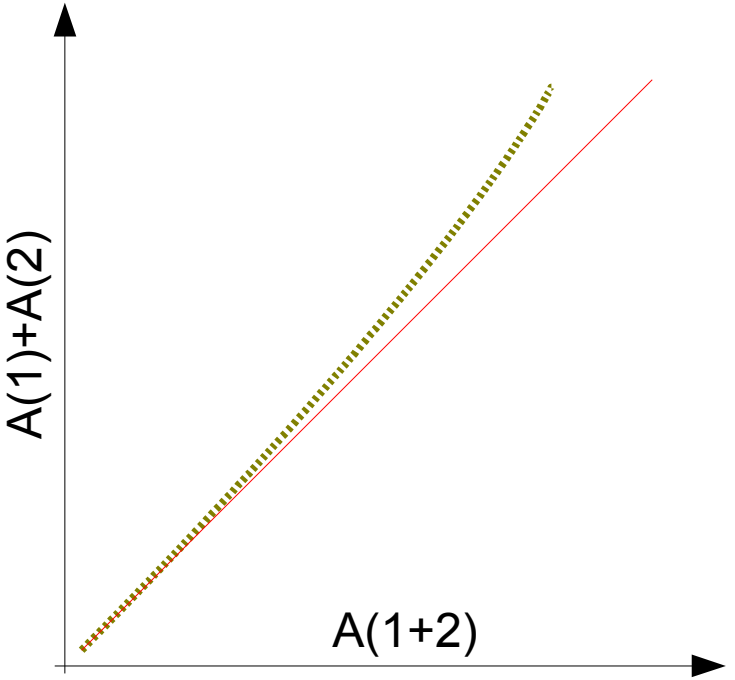




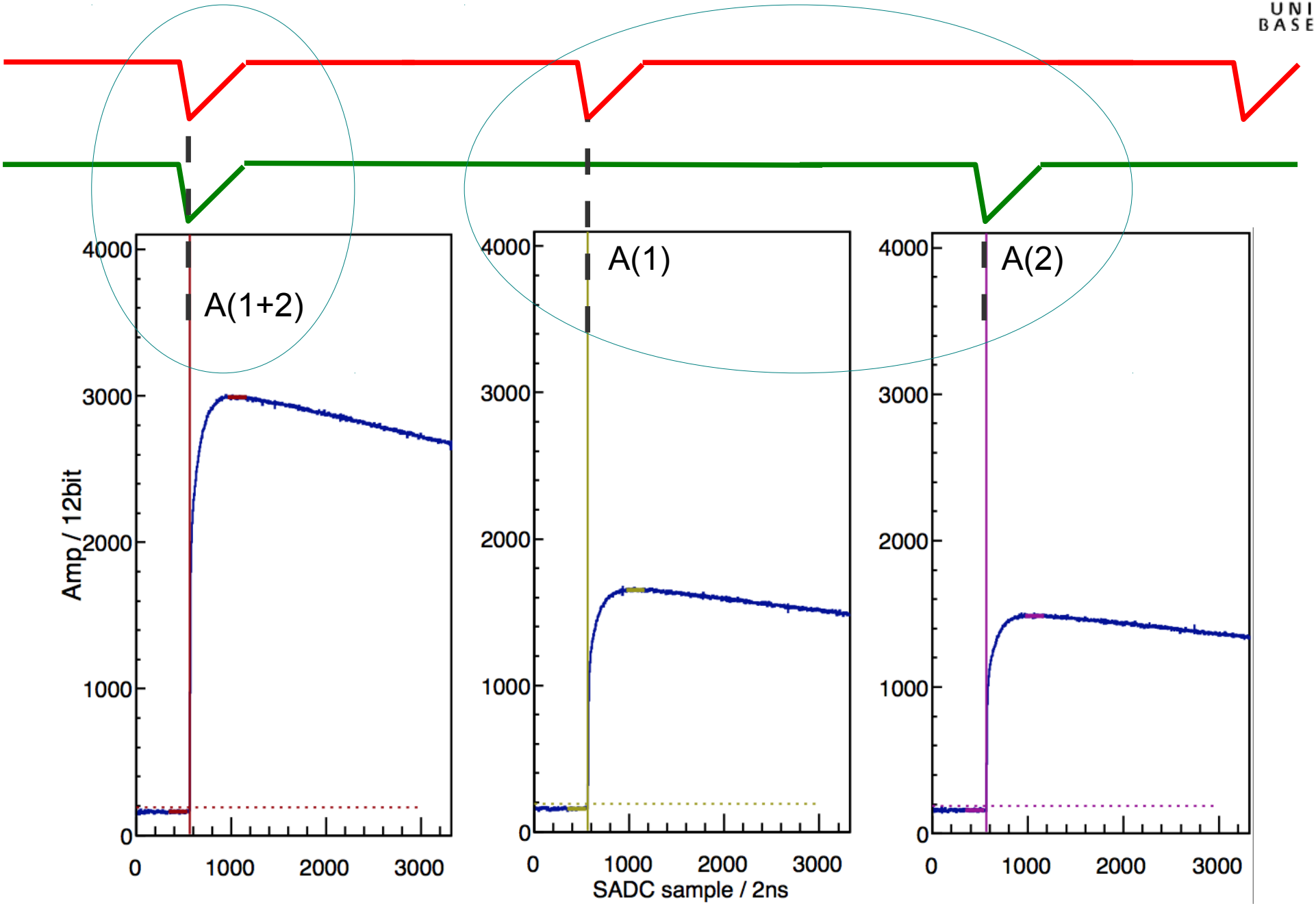
Amplitude Linearity – Measurement Method



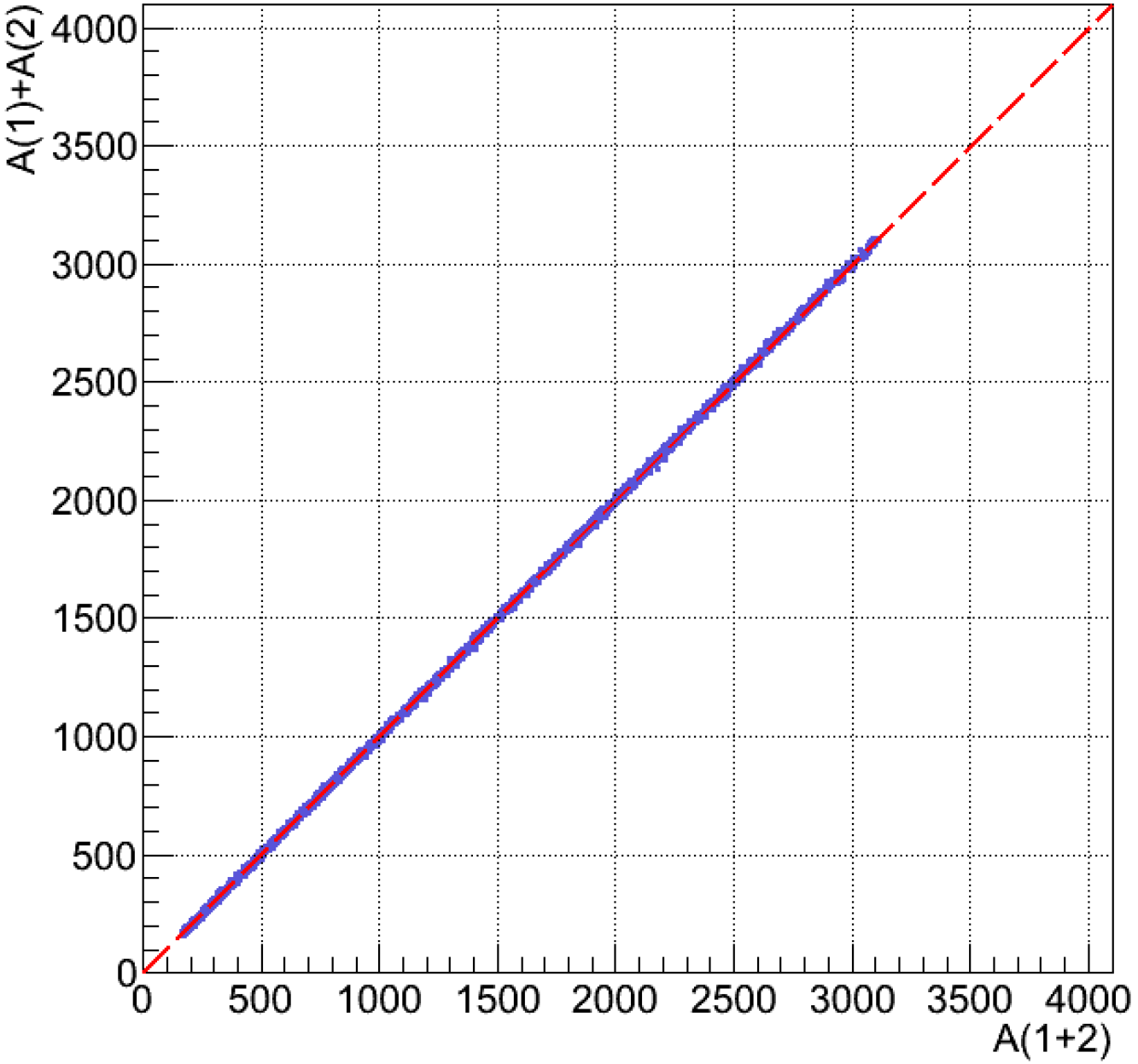




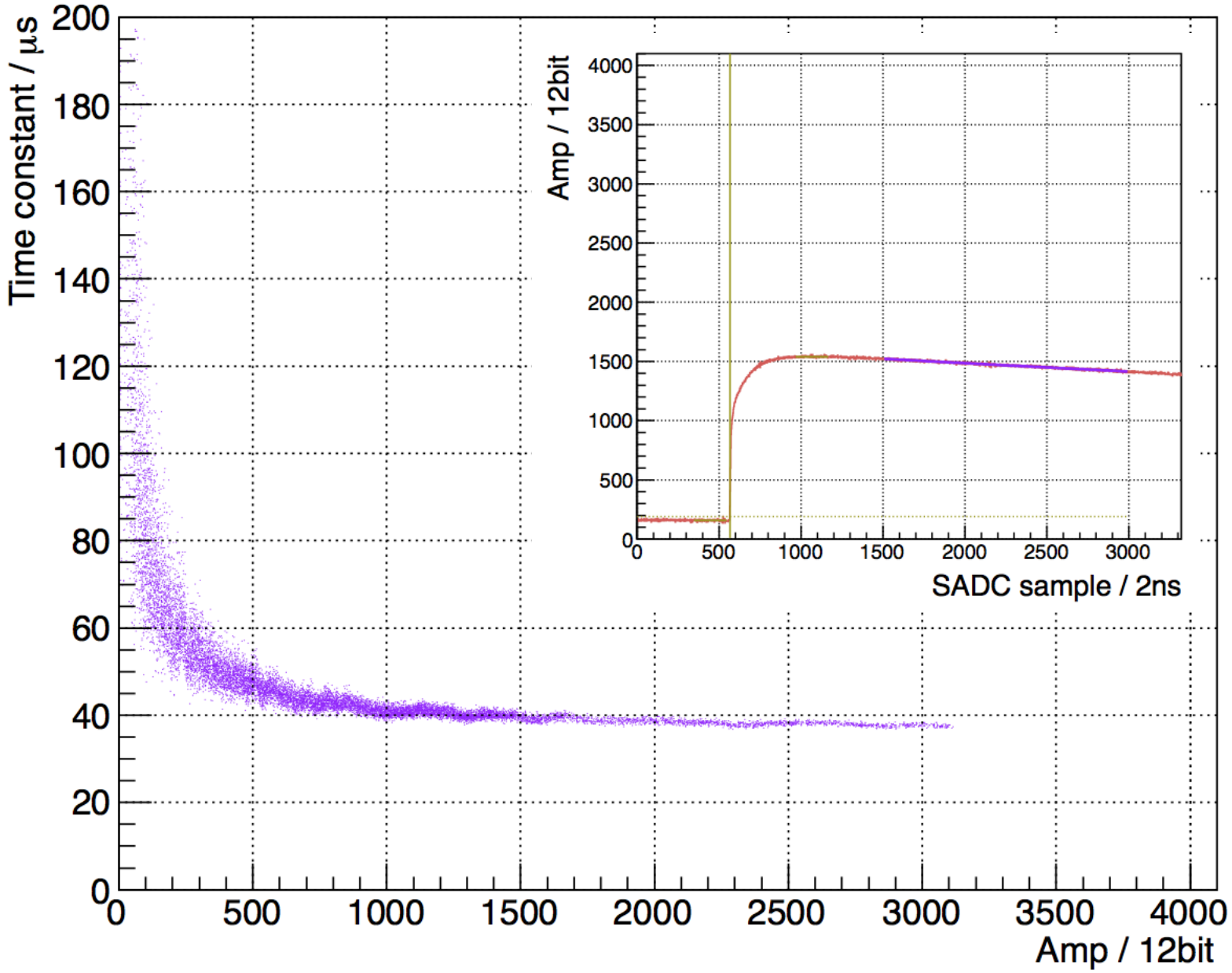
Amplitude Linearity – Typical Signals



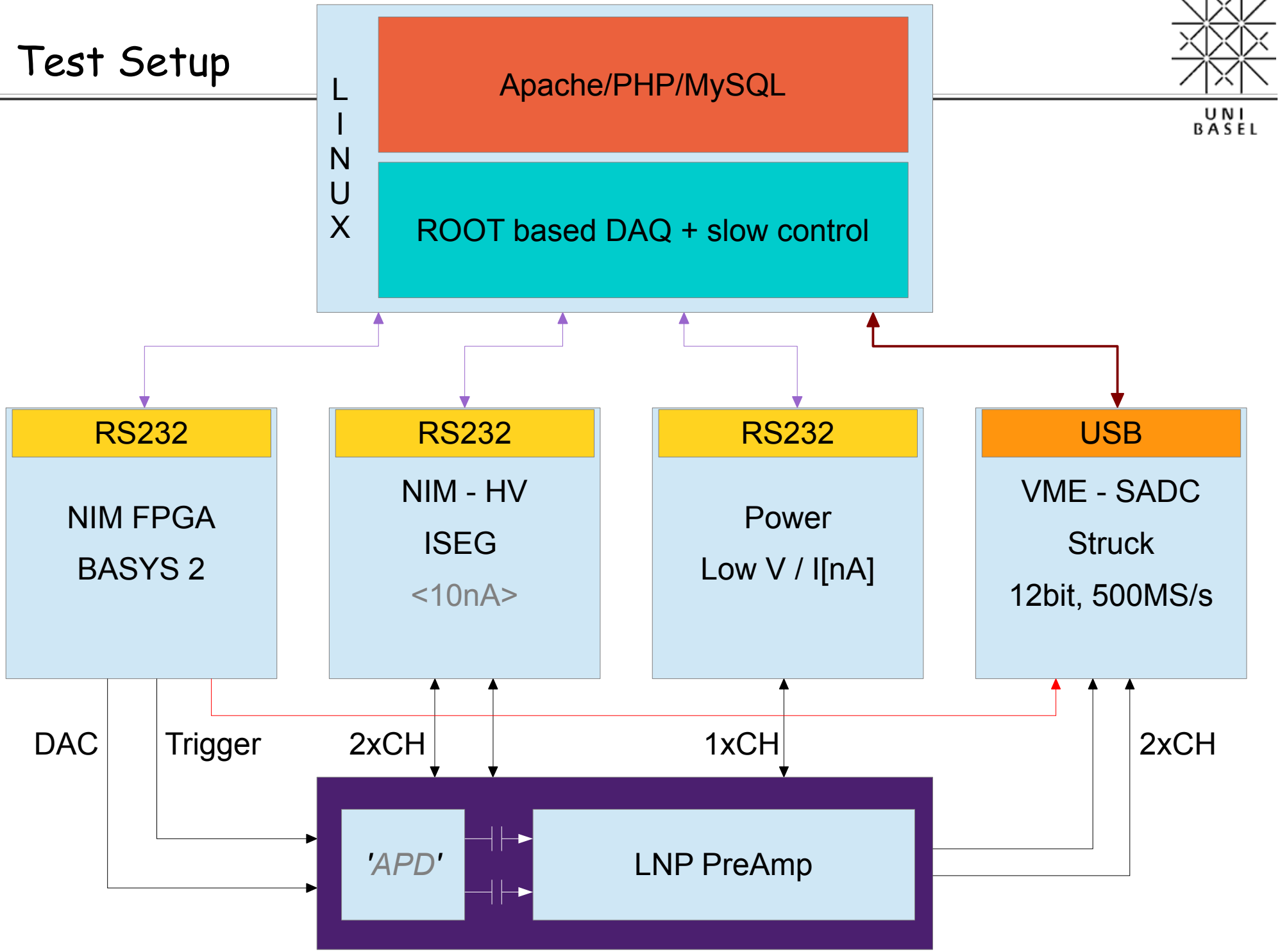
Amplitude Linearity



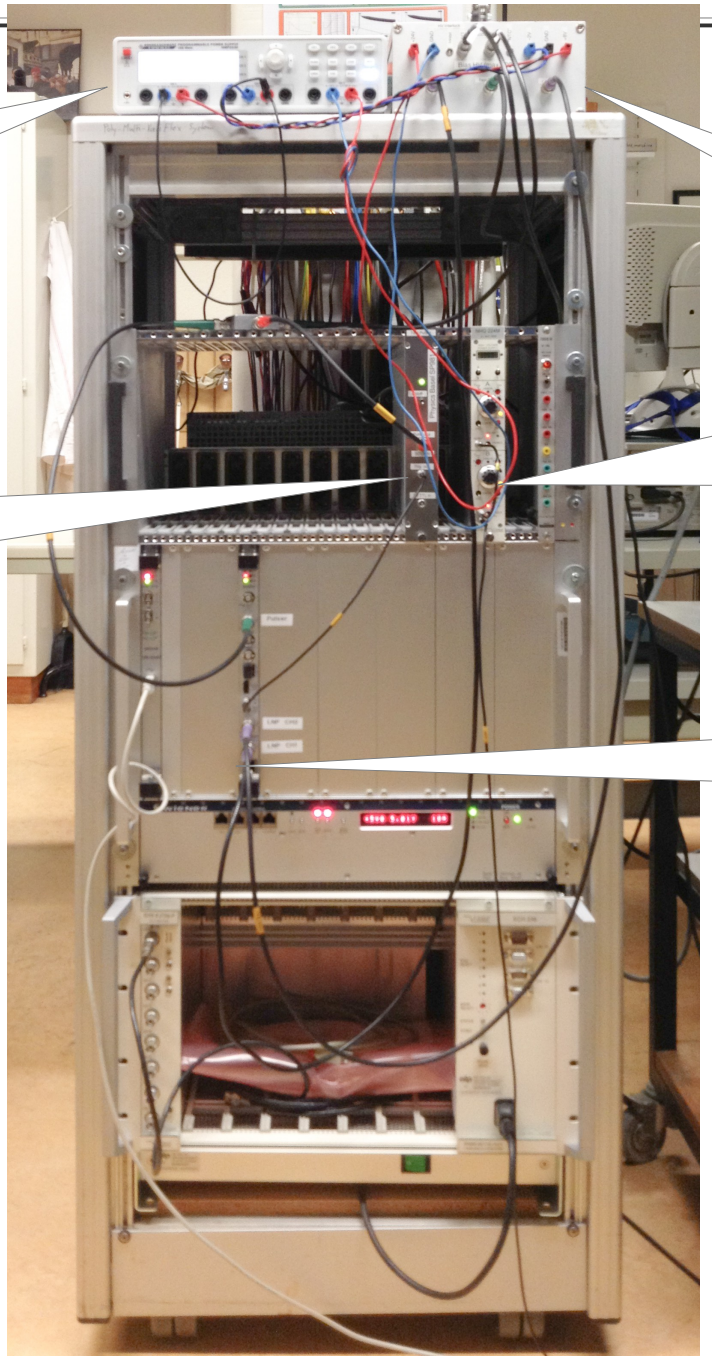
Time constant Vs Amplitude



Test Setup


LINUX
Apache/PHP/MySQL
ROOT based DAQ + slow control
RS232
NIM FPGA
BASYS 2
RS232
NIM - HV
ISEG
<10nA>
RS232
Power
Low V / I[nA]
USB
VME - SADC
Struck
12bit, 500MS/s
DAC
Trigger
2xCH
1xCH
2xCH
'APD'
LNP PreAmp

Test Rack



Low Voltage Supply

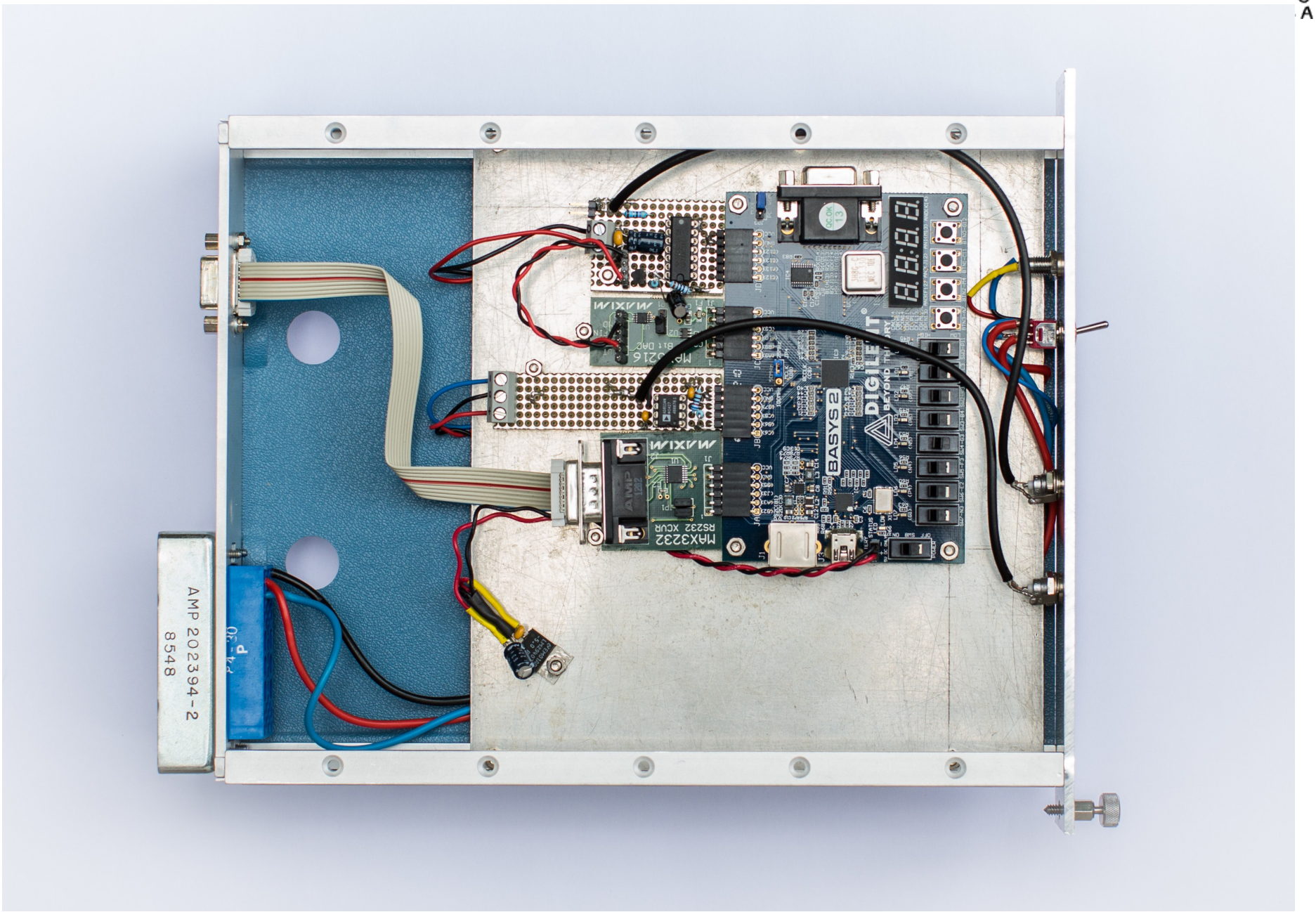
FPGA Generator

Test Box

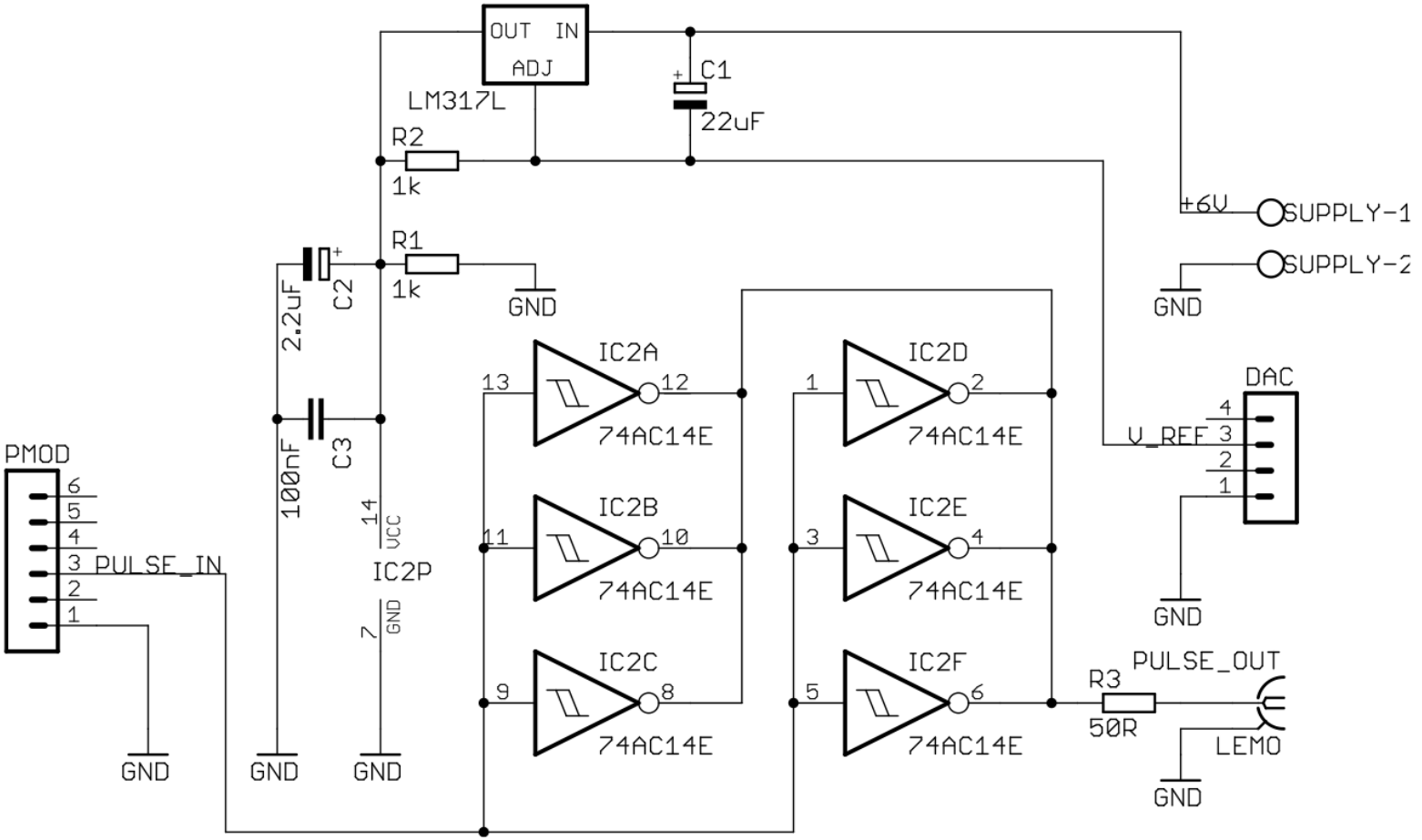
High Voltage Supply

Struck 500MS/s 12bit SADC

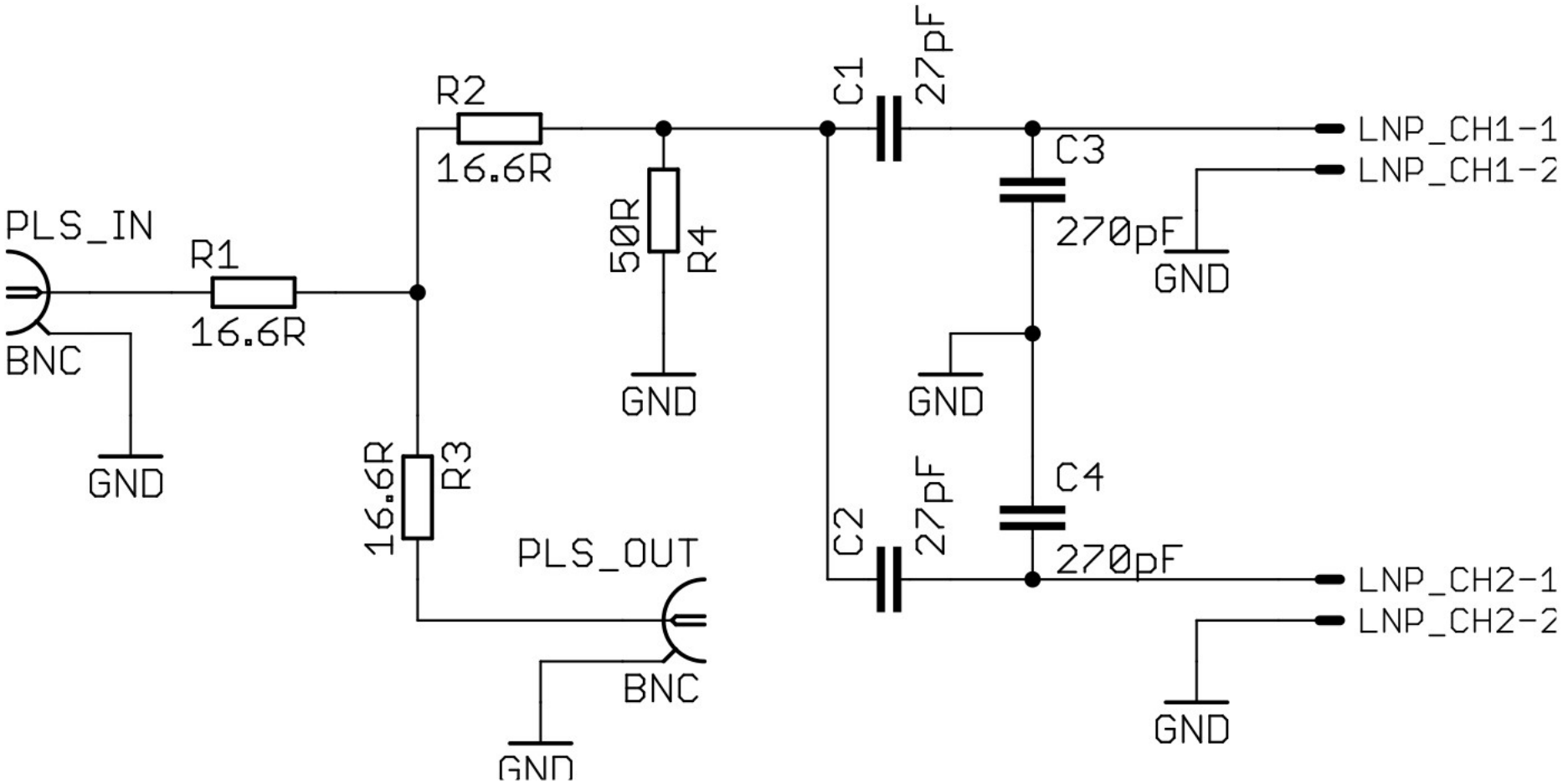
FPGA Generator



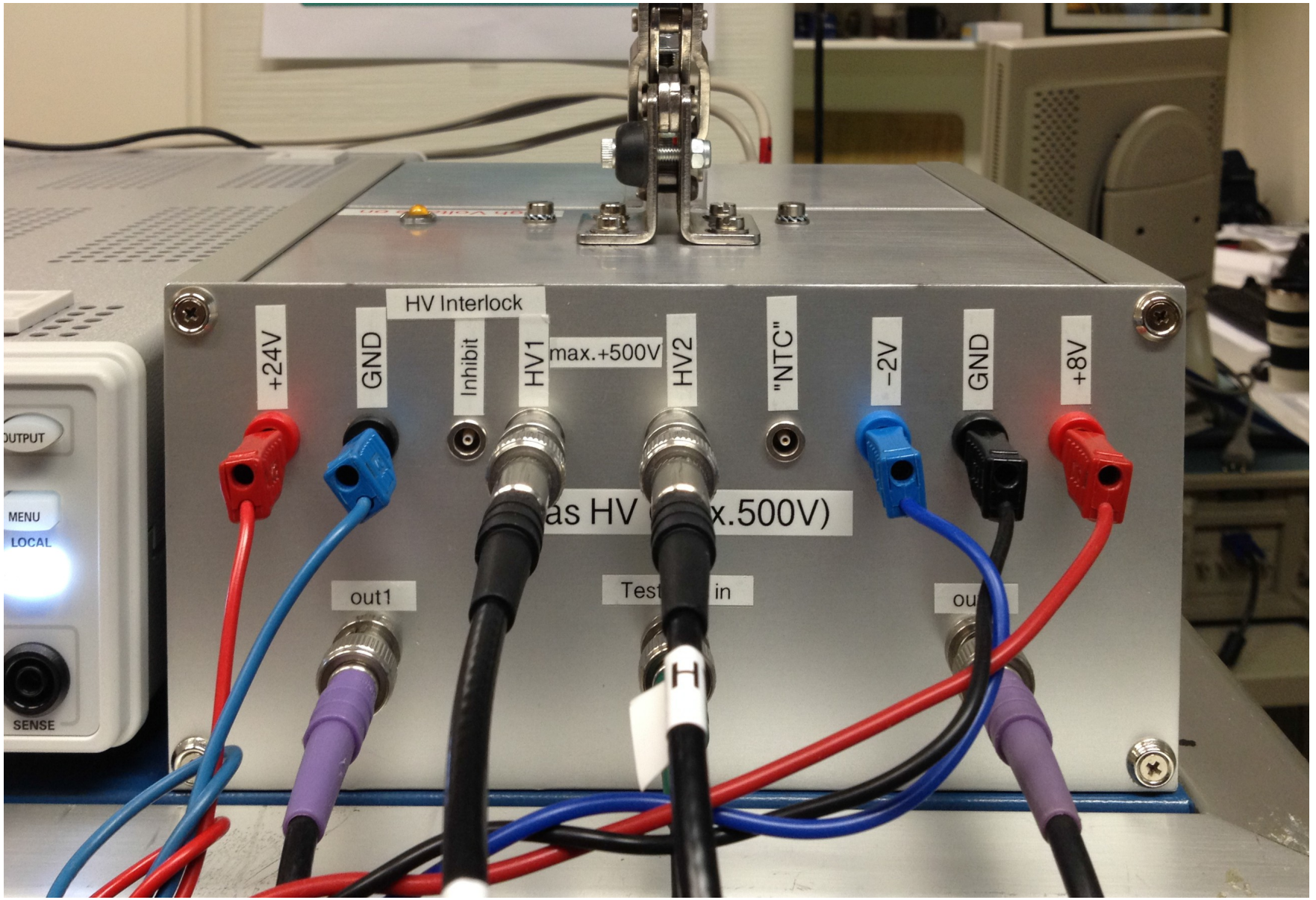
$$V_{out} = V_{DAC} + 1.25V$$



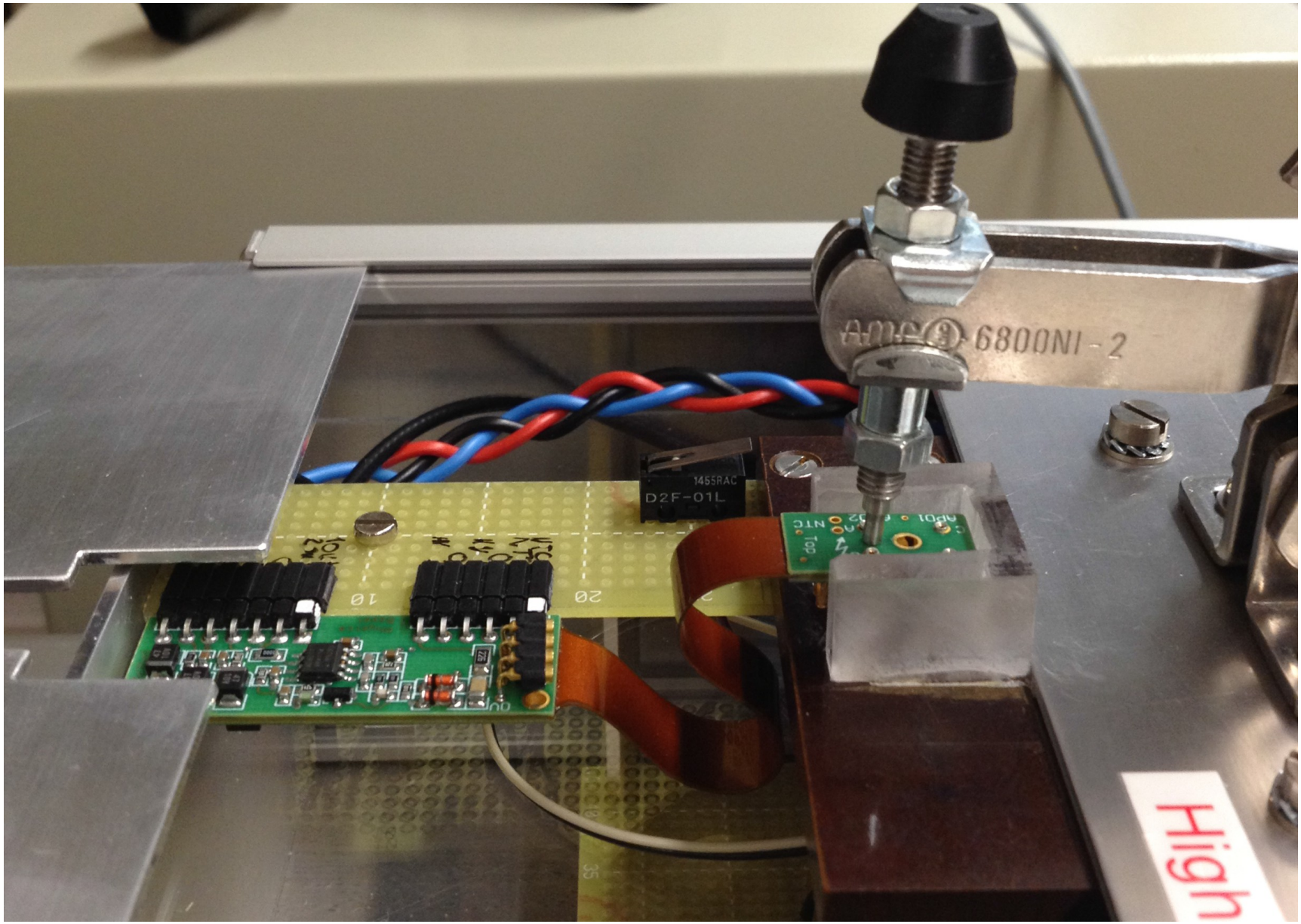
Input Coupling



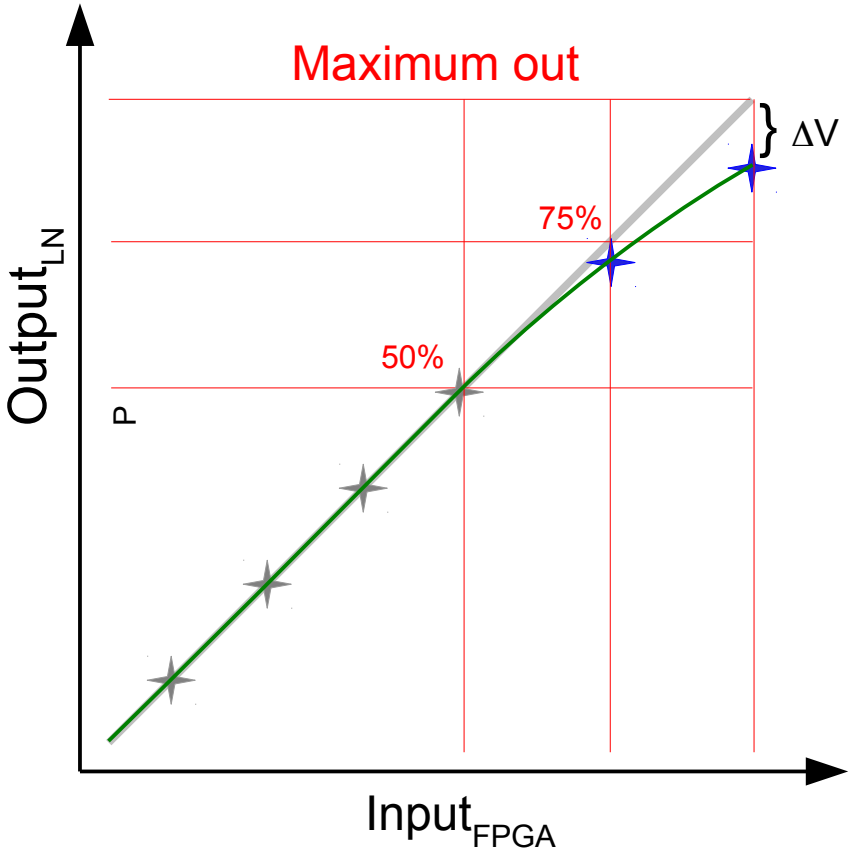
Test Box

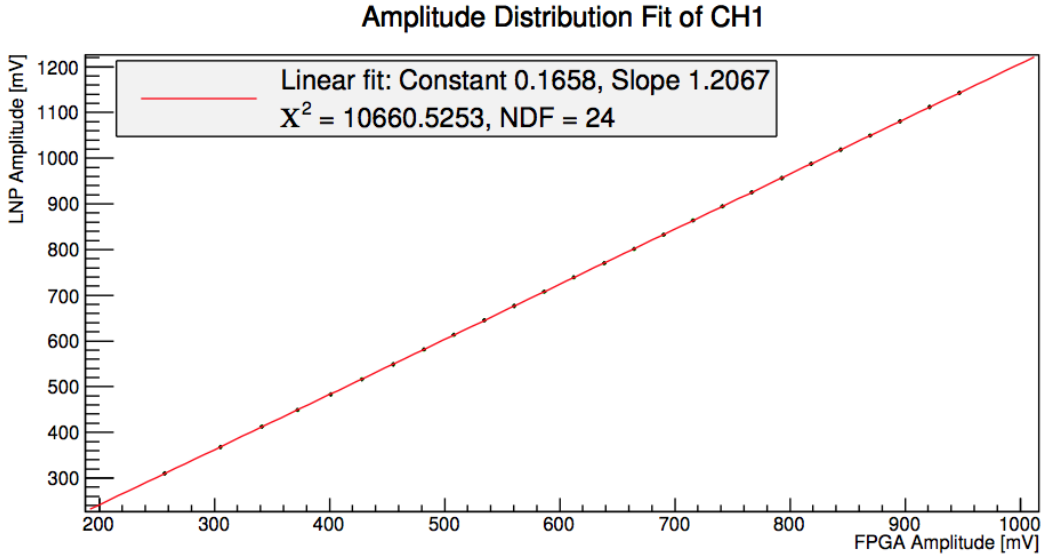

+24V
GND
HV Interlock
Inhibit
HV1
max.+500V
HV2
"NTC"
-2V
GND
+8V
out1
MENU
LOCAL
SENSE

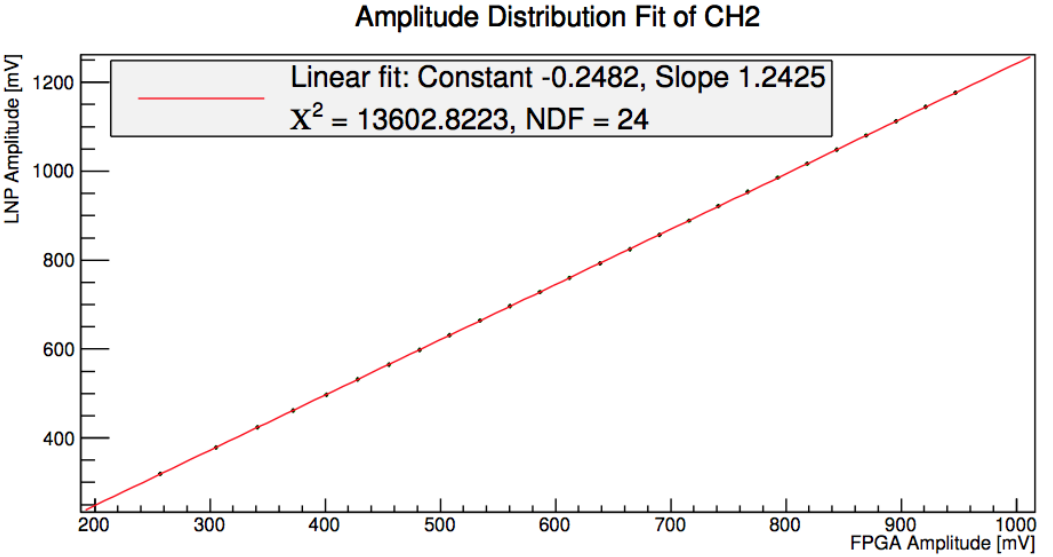
Test Box



Linearity Test



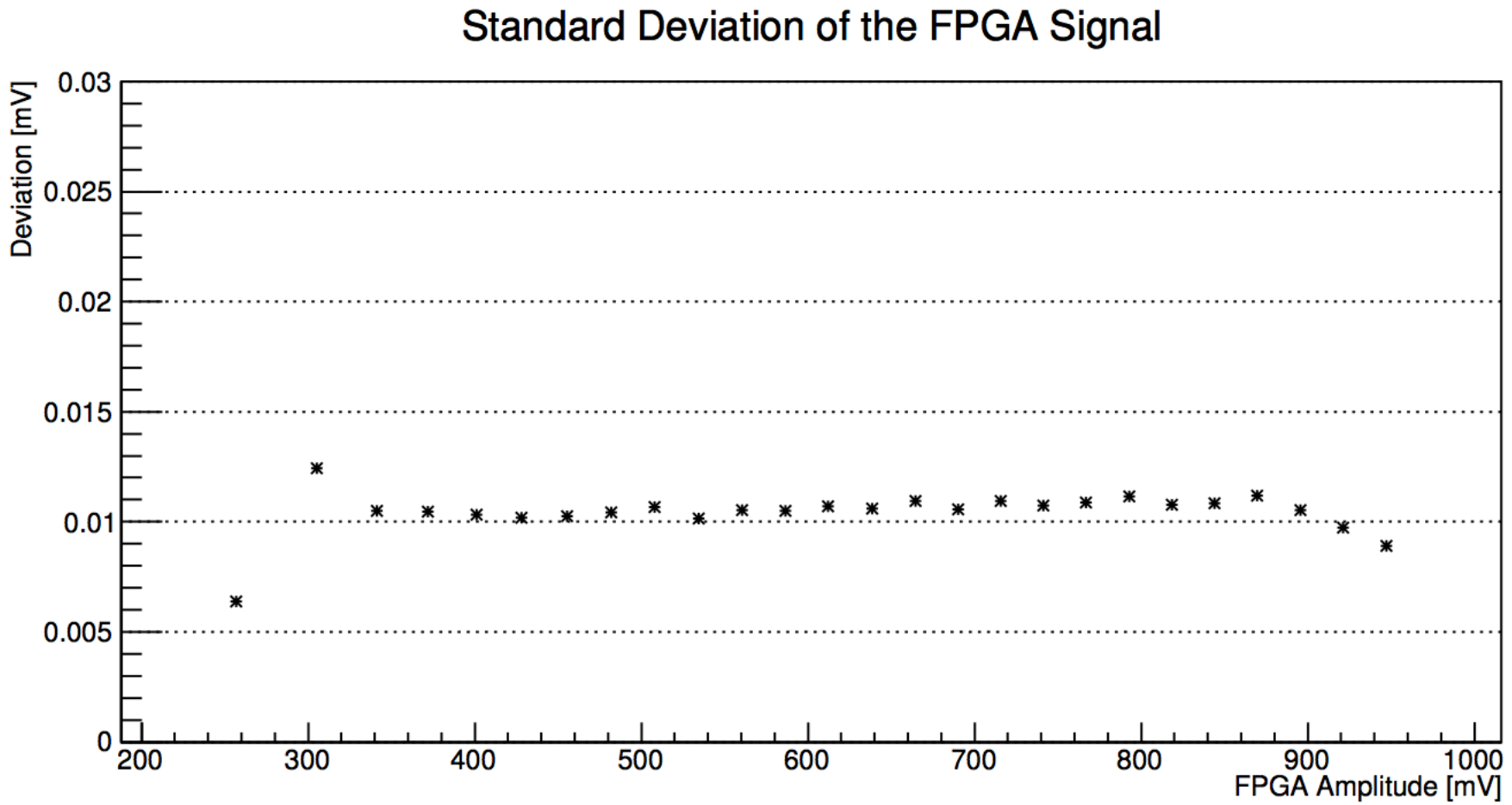




Generated Signal

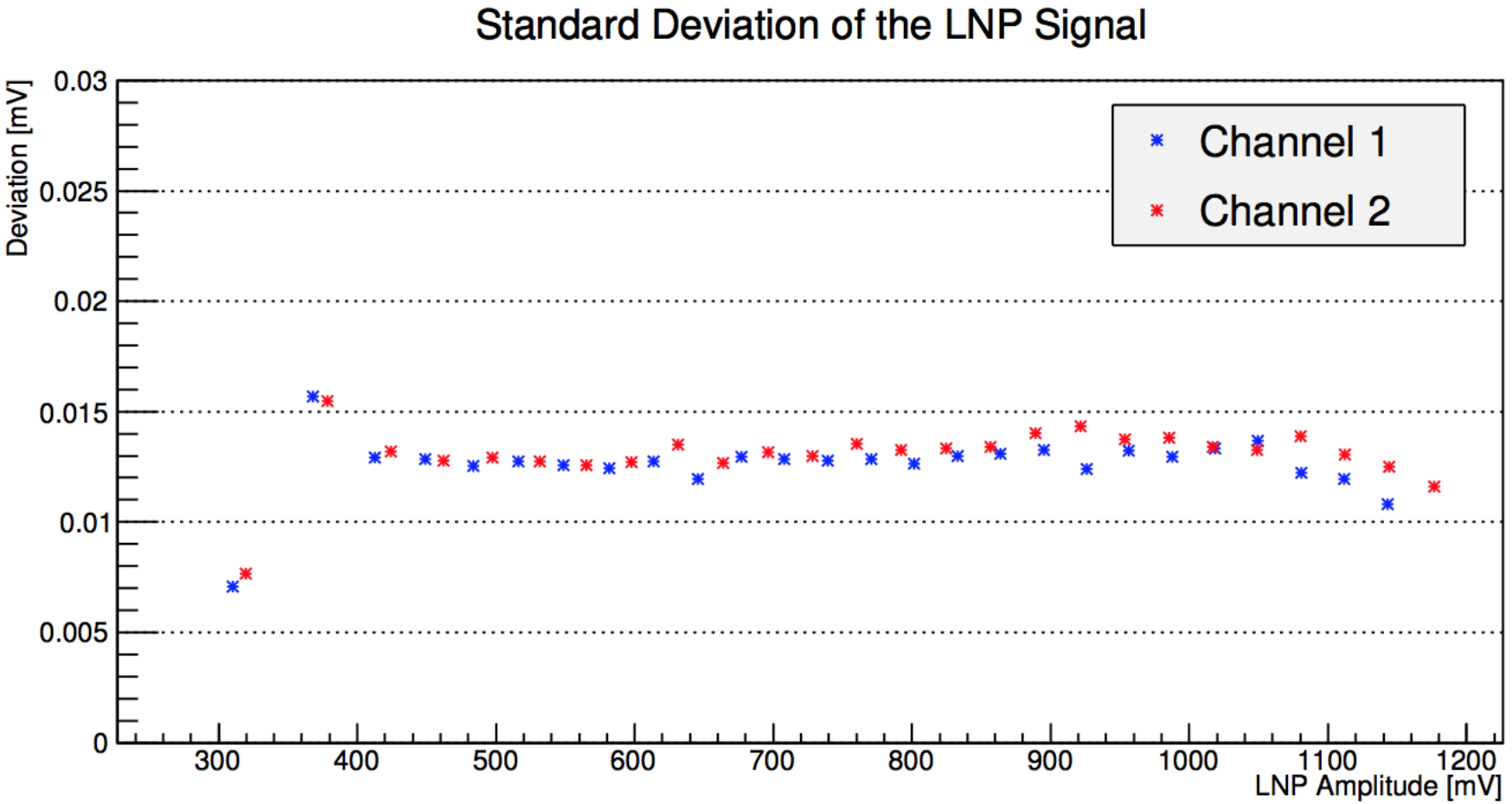
UNI BASEL

Almost constatnt over full range - $10\mu V$



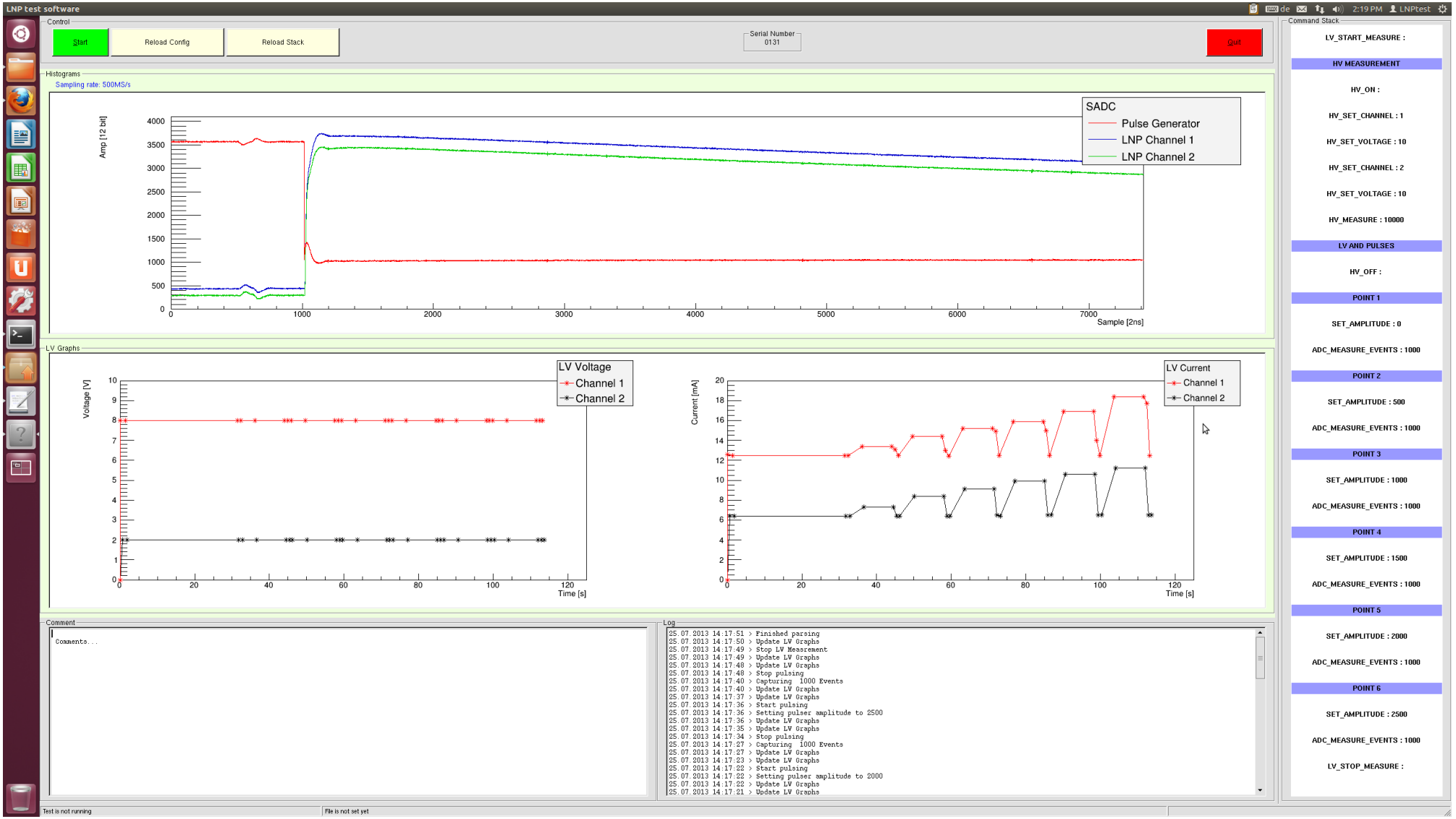
PreAmp Output Signal

$$StDev_{LNP} = \sqrt{0.013^2 - 0.01^2} \approx 0.008mV$$

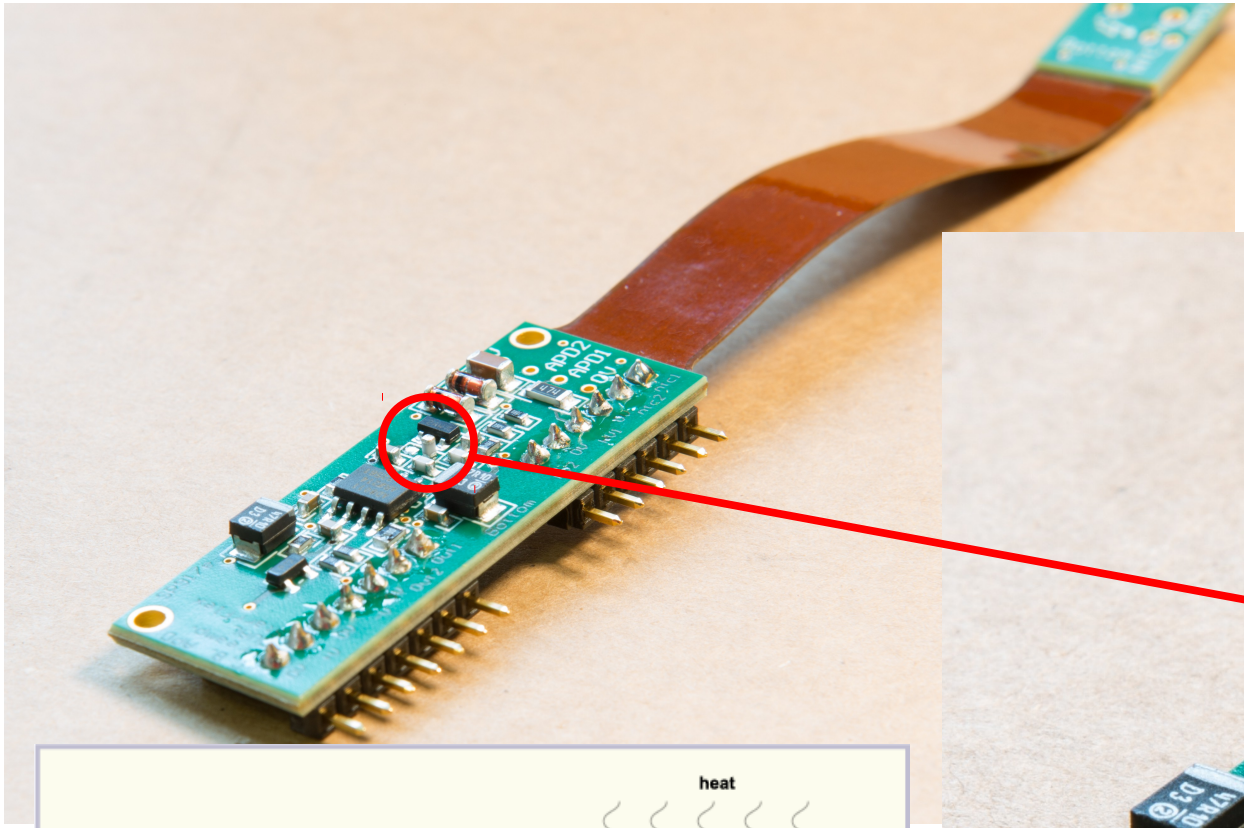


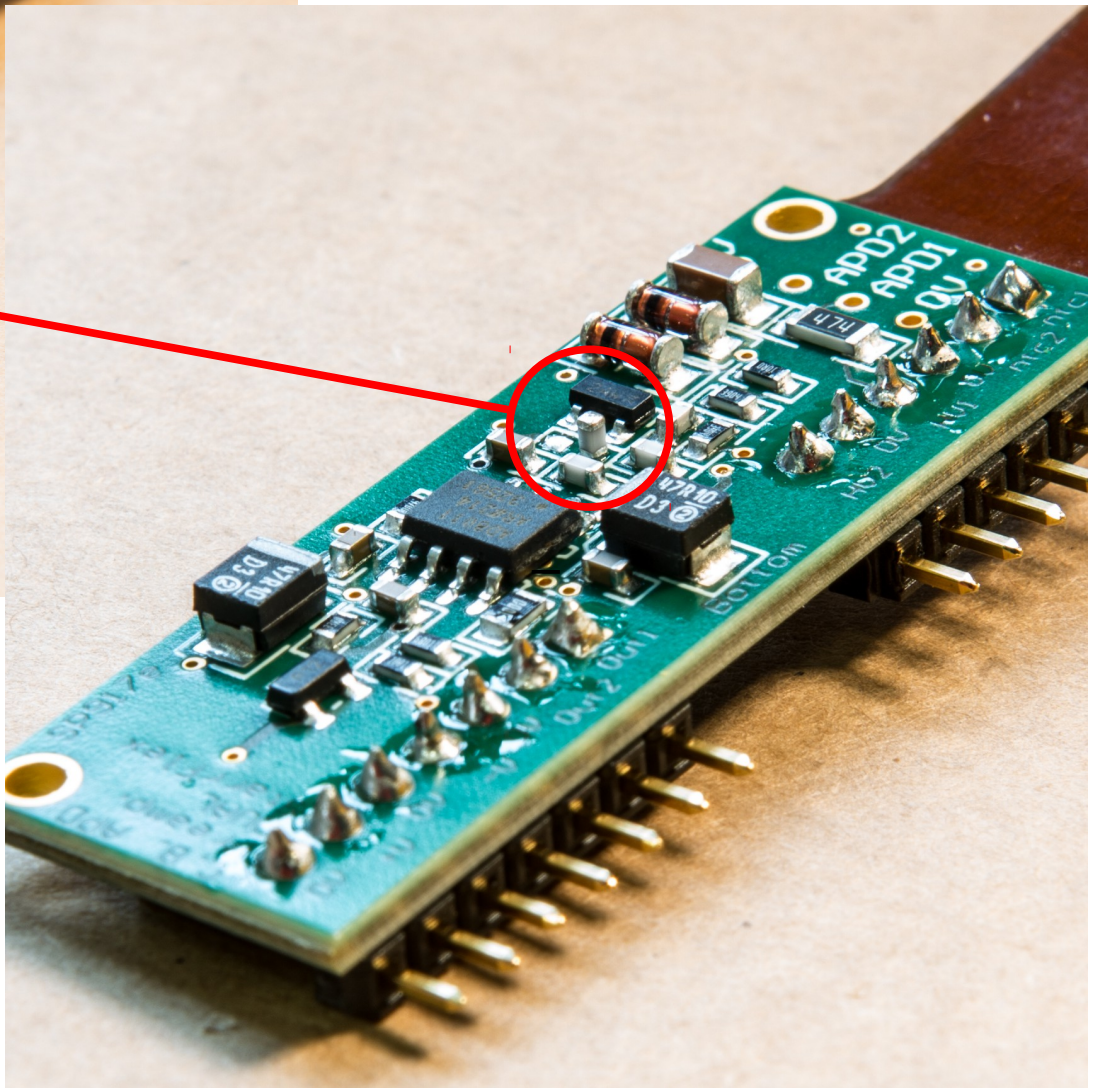
Laboratory for Serial Tests

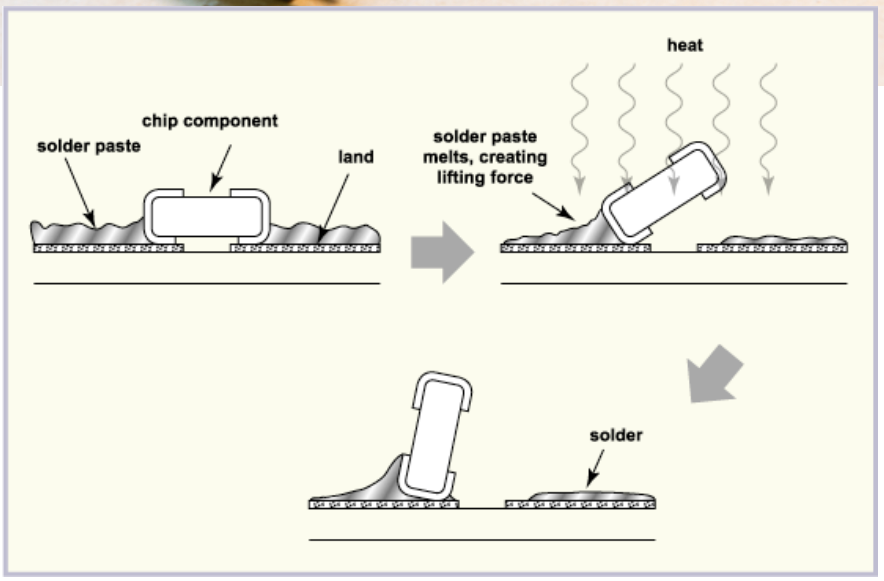
Screenshot


LNP test software
Control
Start
Reload Config
Reload Stack
Serial Number
0131
Quit
Histograms
Sampling rate: 500MS/s
Amp [12 bit]
SADC
Pulse Generator
LNP Channel 1
LNP Channel 2
Sample [2ns]
LV Graphs
Voltage [V]
LV Voltage
Channel 1
Channel 2
Time [s]
Current [mA]
LV Current
Channel 1
Channel 2
Time [s]
Comment
Comments...
Log
25.07.2013 14:17:51 > Finished parsing
25.07.2013 14:17:50 > Update LV Graphs
25.07.2013 14:17:49 > Stop LV Measrement
25.07.2013 14:17:49 > Update LV Graphs
25.07.2013 14:17:48 > Update LV Graphs
25.07.2013 14:17:48 > Stop pulsing
25.07.2013 14:17:40 > Capturing 1000 Events
25.07.2013 14:17:40 > Update LV Graphs
25.07.2013 14:17:37 > Update LV Graphs
25.07.2013 14:17:36 > Start pulsing
25.07.2013 14:17:36 > Setting pulser amplitude to 2500
25.07.2013 14:17:36 > Update LV Graphs
25.07.2013 14:17:35 > Update LV Graphs
25.07.2013 14:17:34 > Stop pulsing
25.07.2013 14:17:27 > Capturing 1000 Events
25.07.2013 14:17:27 > Update LV Graphs
25.07.2013 14:17:23 > Update LV Graphs
25.07.2013 14:17:22 > Start pulsing
25.07.2013 14:17:22 > Setting pulser amplitude to 2000
25.07.2013 14:17:22 > Update LV Graphs
25.07.2013 14:17:21 > Update LV Graphs
Test is not running
File is not set yet
Command Stack
LV_START_MEASURE :
HV MEASUREMENT
HV_ON :
HV_SET_CHANNEL : 1
HV_SET_VOLTAGE : 10
HV_SET_CHANNEL : 2
HV_SET_VOLTAGE : 10
HV_MEASURE : 10000
LV AND PULSES
HV_OFF :
POINT 1
SET_AMPLITUDE : 0
ADC_MEASURE_EVENTS : 1000
POINT 2
SET_AMPLITUDE : 500
ADC_MEASURE_EVENTS : 1000
POINT 3
SET_AMPLITUDE : 1000
ADC_MEASURE_EVENTS : 1000
POINT 4
SET_AMPLITUDE : 1500
ADC_MEASURE_EVENTS : 1000
POINT 5
SET_AMPLITUDE : 2000
ADC_MEASURE_EVENTS : 1000
POINT 6
SET_AMPLITUDE : 2500
ADC_MEASURE_EVENTS : 1000
LV_STOP_MEASURE :

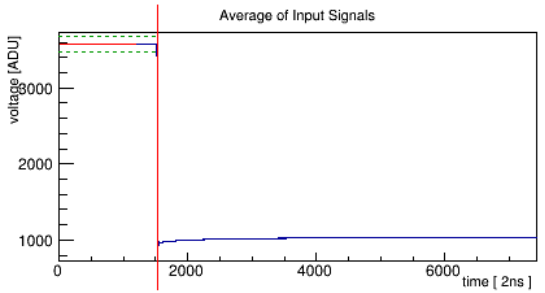
Tombstone SMD effect

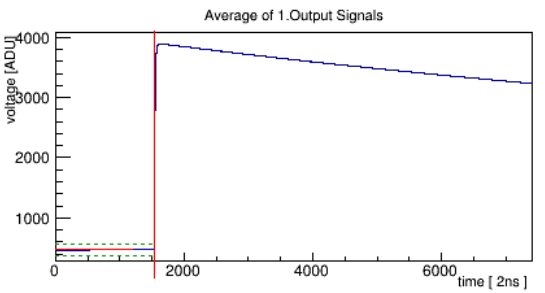


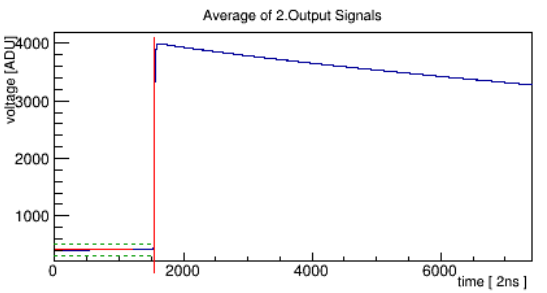


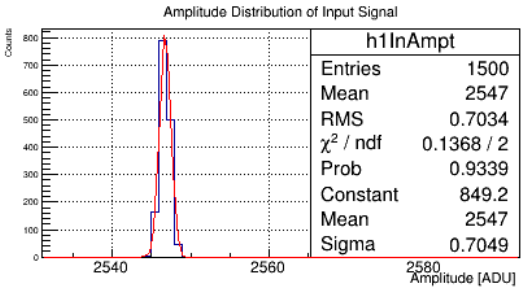


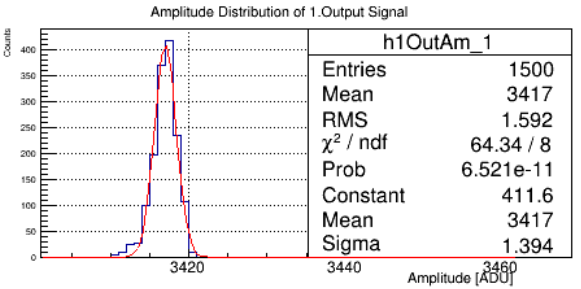
Typical Signals

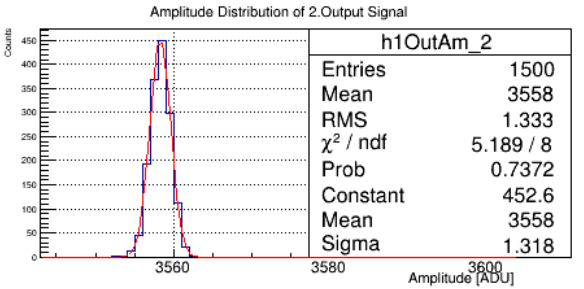












RESULTS OF LNP 0057 A-Nr. 08

In the legends below the RMS, the data corresponds to the fit.

INPUT - SIGNAL	**Histogram Data**	**Fit Data**
Amplitude:	Mean = 2546.776667 [ADU]	Mean = 2546.777900 [ADU]
Amplitude:	RMS = 0.703412	Sigma = 0.704854

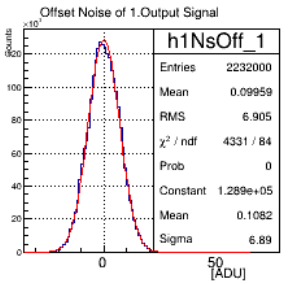
1. OUTPUT - SIGNAL	**Histogram Data**	**Fit Data**
Propagation Delay from Average: 28 ns		
Amplitude:	Mean = 3416.900000 [ADU]	Mean = 3416.996117 [ADU]
Amplitude:	RMS* = 1.591645	Sigma* = 1.393730
Amplitude:	RMS** = 0.888233	Sigma** = 0.688877
Rise Time:	Mean = 197.849333 [ns]	Mean = 194.044656 [ns]
Rise Time:	RMS = 20.052497	Sigma = 14.229541
Decay Time:	Mean = 62.205880 [us]	Mean = 62.205287 [us]
Decay Time:	RMS = 0.064146	Sigma = 0.063532

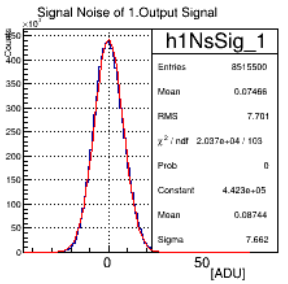
2. OUTPUT - SIGNAL	**Histogram Data**	**Fit Data**
Propagation Delay from Average: 28 ns		
Amplitude:	Mean = 3558.266667 [ADU]	Mean = 3558.275978 [ADU]
Amplitude:	RMS* = 1.332750	Sigma* = 1.317670
Amplitude:	RMS** = 0.629338	Sigma** = 0.612817
Rise Time:	Mean = 192.244000 [ns]	Mean = 192.086054 [ns]
Rise Time:	RMS = 11.288540	Sigma = 10.725472
Decay Time:	Mean = 59.598887 [us]	Mean = 59.597153 [us]
Decay Time:	RMS = 0.072694	Sigma = 0.072352

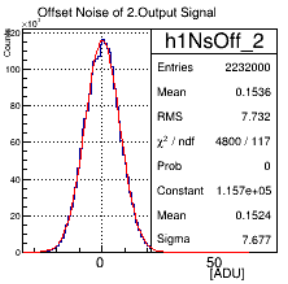
* direct sigma, without manipulation (i.e. includes the sigma of the input)

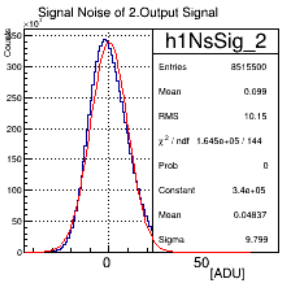
** manipulated sigma (i.e. excluding Input sigma), calculated as follow:

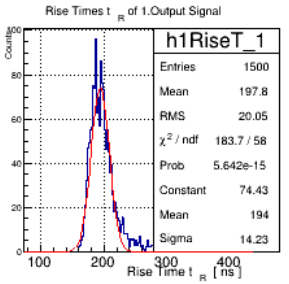
$$\sigma^{**} = \sigma_{out} - \sigma_{in}$$

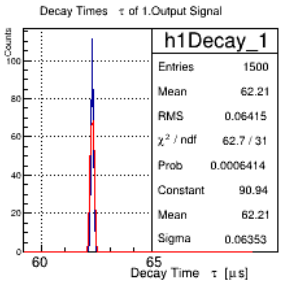


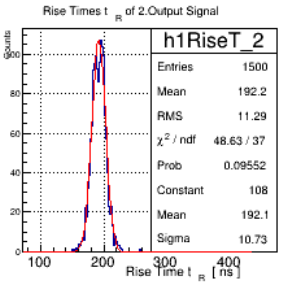


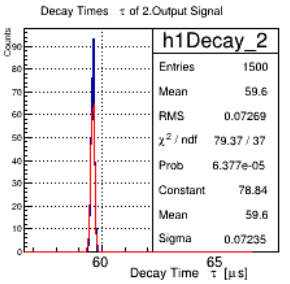




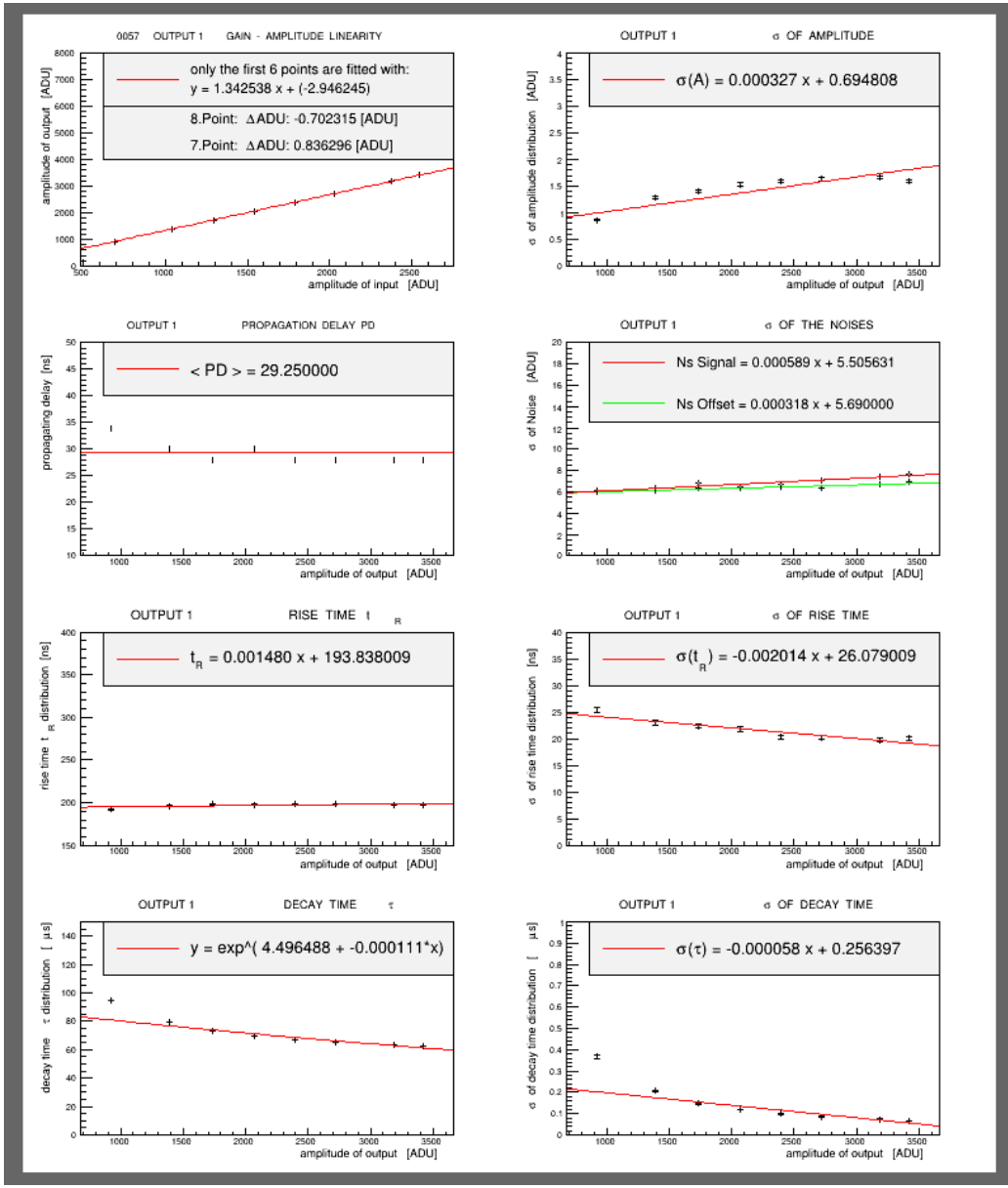


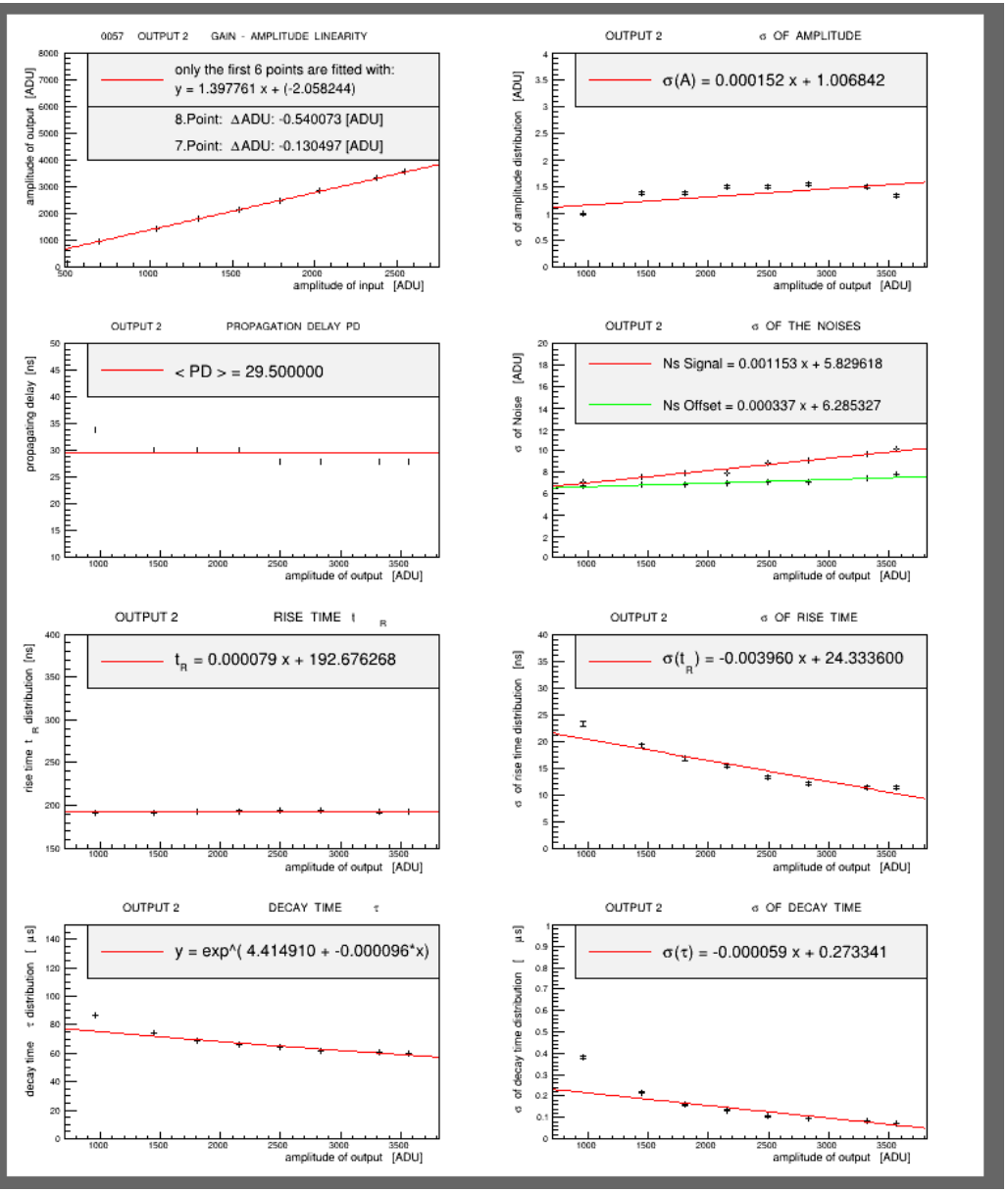






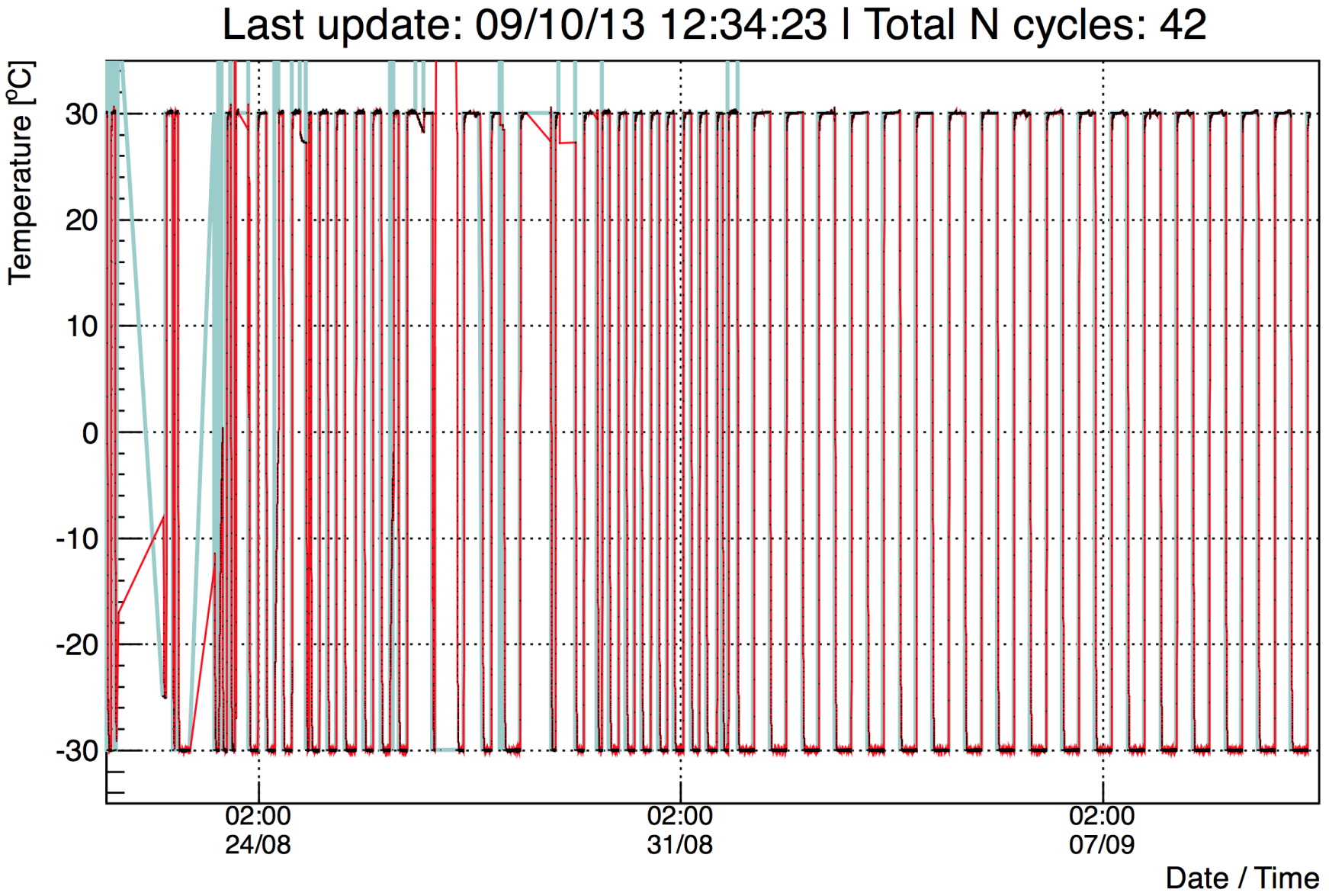
Final Distributions





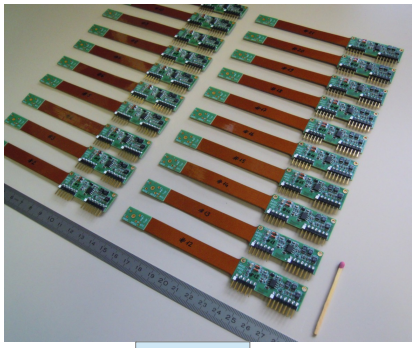
Temperature stability

Temperature Cycles



PANDA PreAmp Test Procedure

50 x PreAmp



Up-Down over night

Extensive test

Summary

Discrete element Basel-LNP charge 2 voltage preamp

Excellent double burst & amplitude linearity (~1%)

Lab. & beam test are very successful (CERN,MAMI,ELSA)

Some other experiments are interested

NIM paper is in preparation