

Development of a new BPM electronic for the PETRA pre-accelerator

Hans-Thomas Duhme
Bastian Lorbeer

DESY 8.6.2022

Development of a new BPM electronic for the PETRA pre-accelerator

There is a large range of bandwidth needed for the BPM electronic for the Petra preaccelerators. The bunch length varied from ns to ps range. Also a new bunch burst mode is request for Petra IV first turn operation.

The new BPM electrons is developed as a universal peakdetector hardware in an mtca.4 environment.

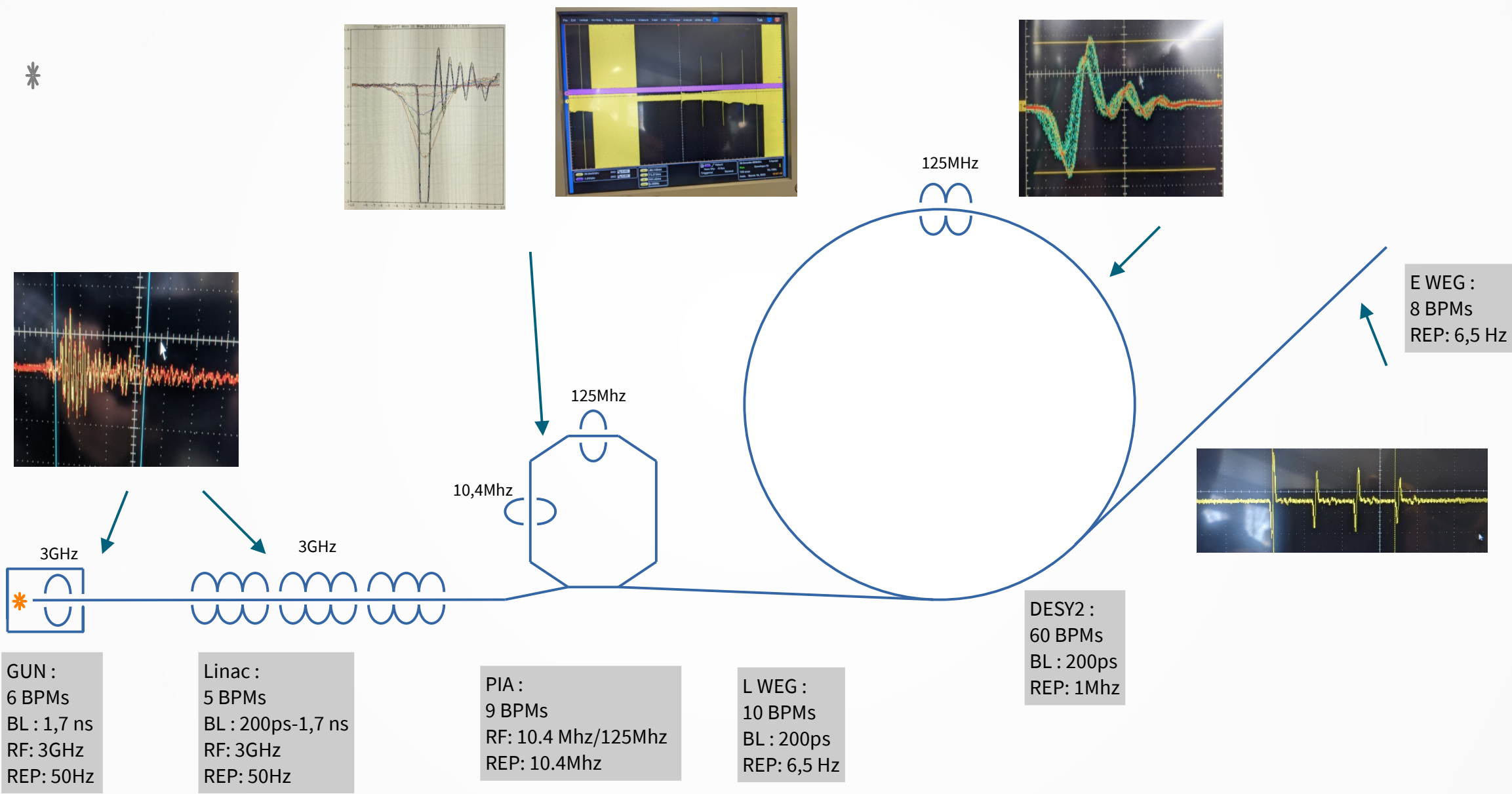
Automatic adjusted Delay lines or 2x2 cross point switch technique will be tested for self calibration.

The goal is a universal mtca.4 based electronic for button BPMs.

The limitation of this detector electronic is the bunch space of at least 100ns.

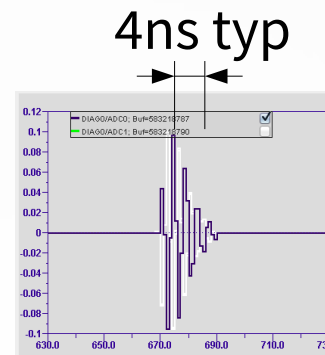
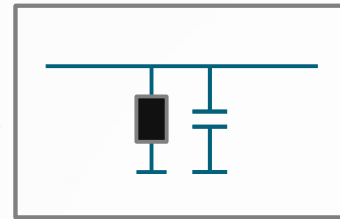
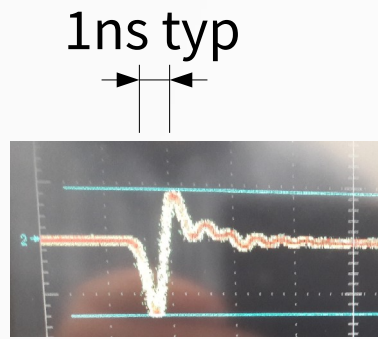
- **Refurbishment of existing electronic**
- **Uniformed Hard and Software**
- **Mtca.4 Hardware**
- **Doocs Server**
- **Self calibrated**
- **Designed for Petra4 requirements**

BPMs in Linac, Pia and DESY2



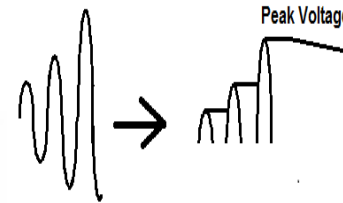
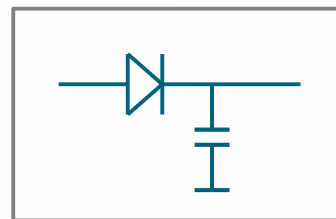
BPM electronic basics

(Button, Strip line type)



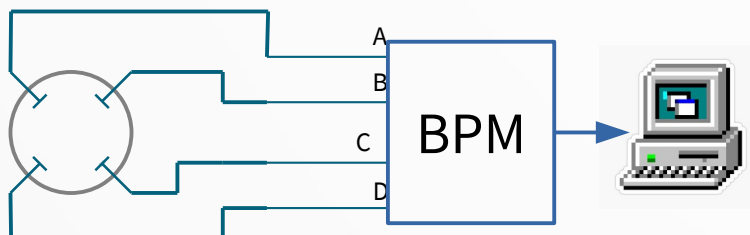
High speed
ADC

(Petra 3/4)



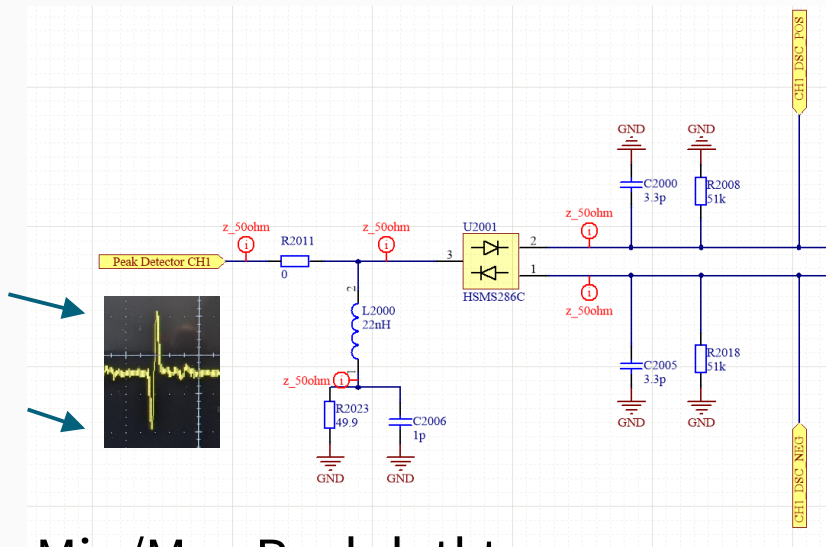
ADC

(Gun, Linac, Pia, DESY, Flash, XFEL)

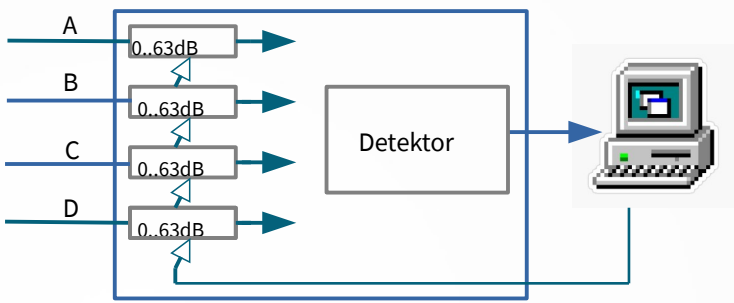


$$X = 10 \frac{A - B}{A + B}$$

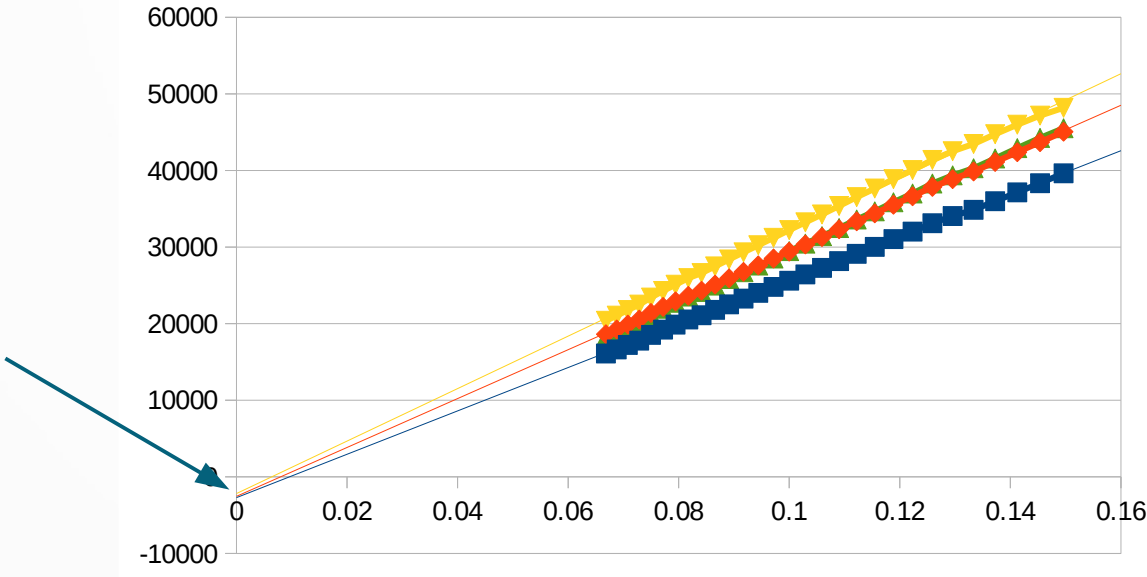
Offset Calibration with attenuator scan



Min/Max Peakdetktor

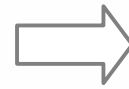
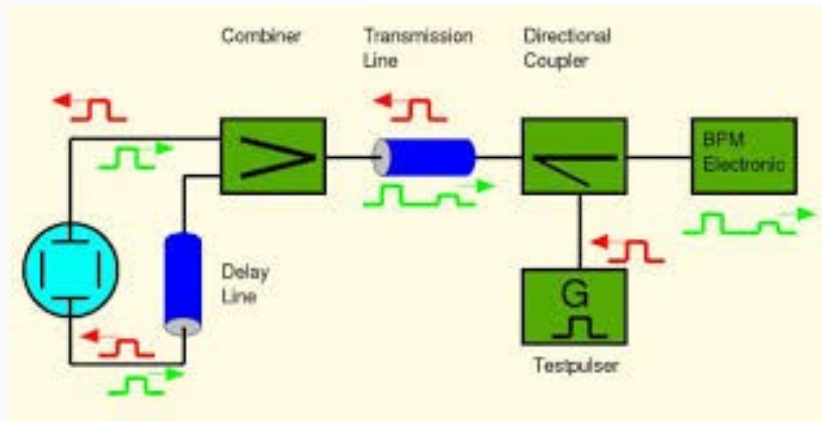


Detektor
Offset

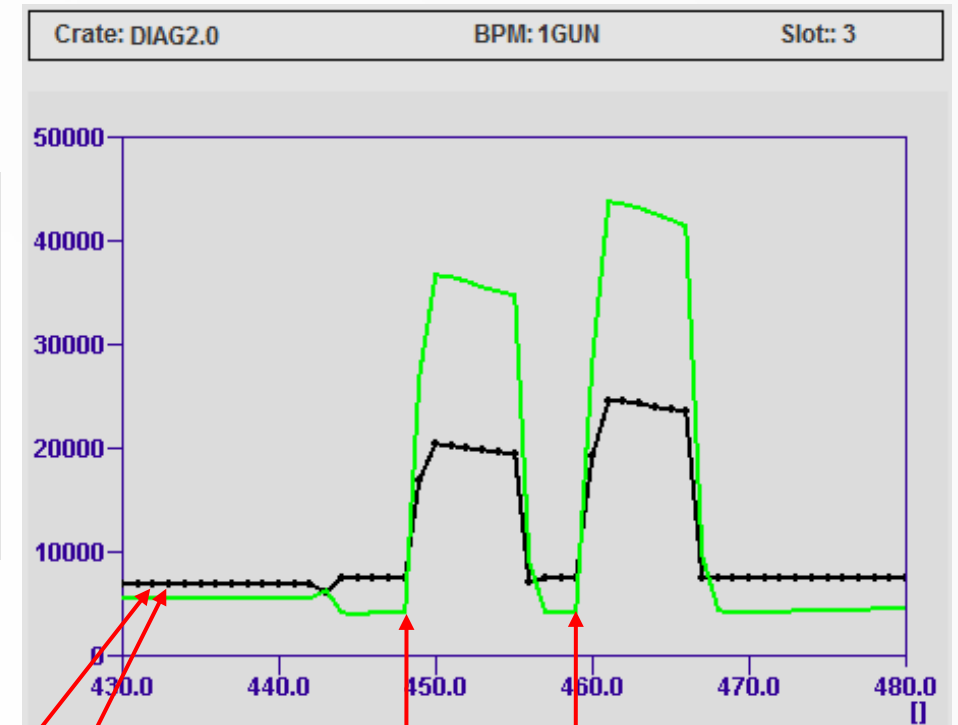


self calibration : delay line

Detektorgain and Cable attenuation canceled out



PreBunchDelay
44584
☐ auto timing
DisplayDelay
44584
first Signal
44588
save as default



$F_{\text{sample}} = 108\text{MHz}$
 $T_{\text{sample}} = 9.23\text{ns}$ sampling rate

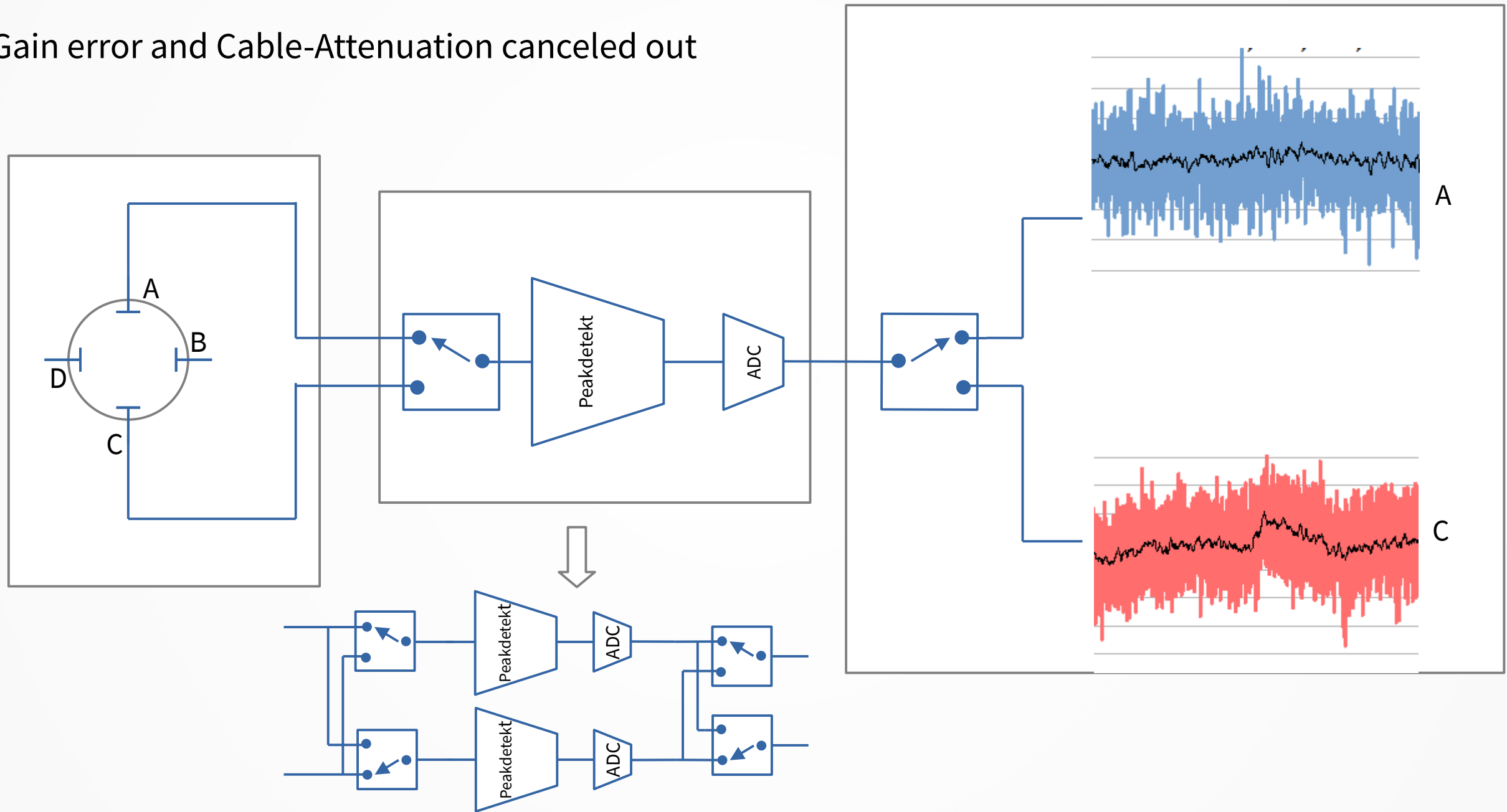
100ns delay



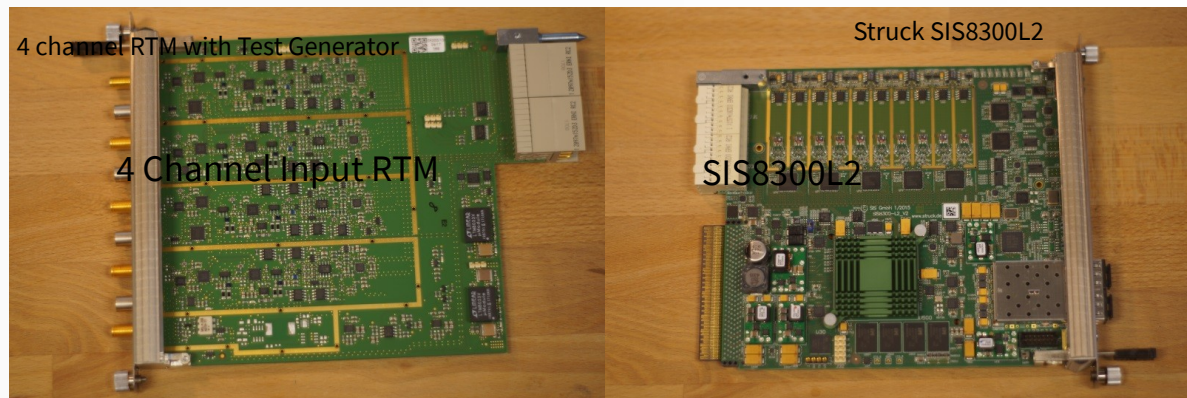
Installed at FLASH 1 + 2

self calibration : 2x2 Cross point switch

Gain error and Cable-Attenuation canceled out

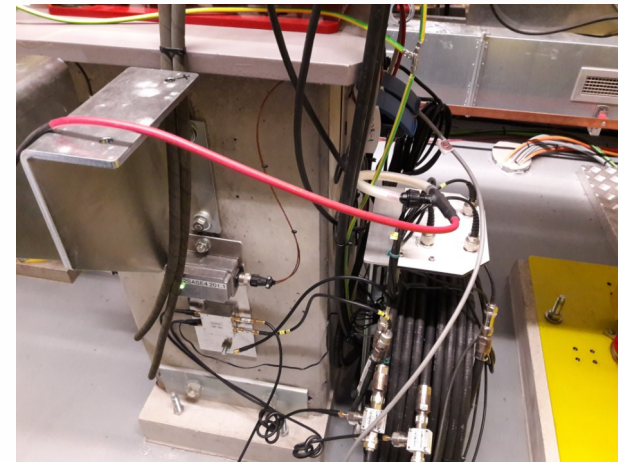


mtca.4 Hardware



RTM

AMC



110ns Delay line

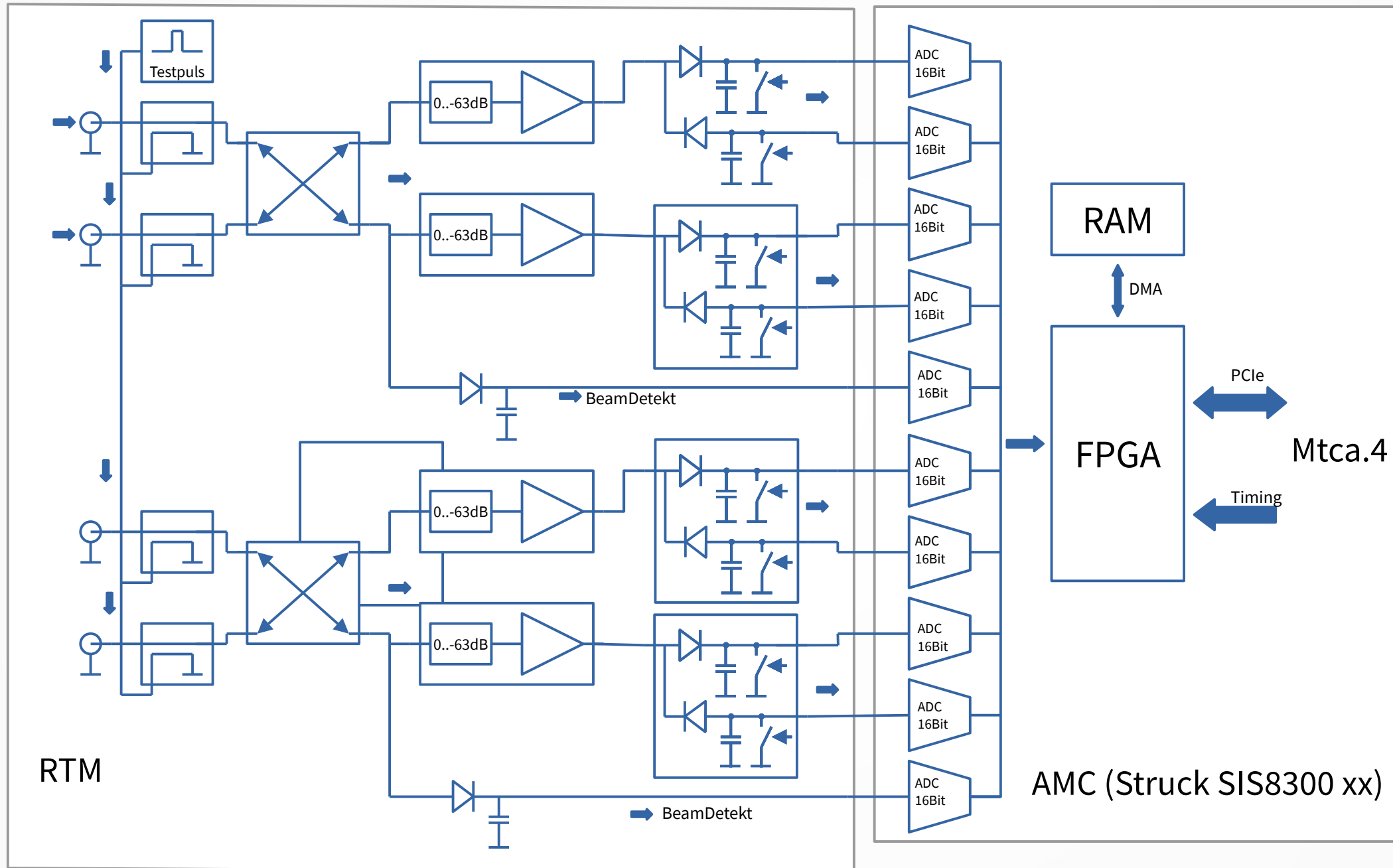


12 slot mtca.4 crate

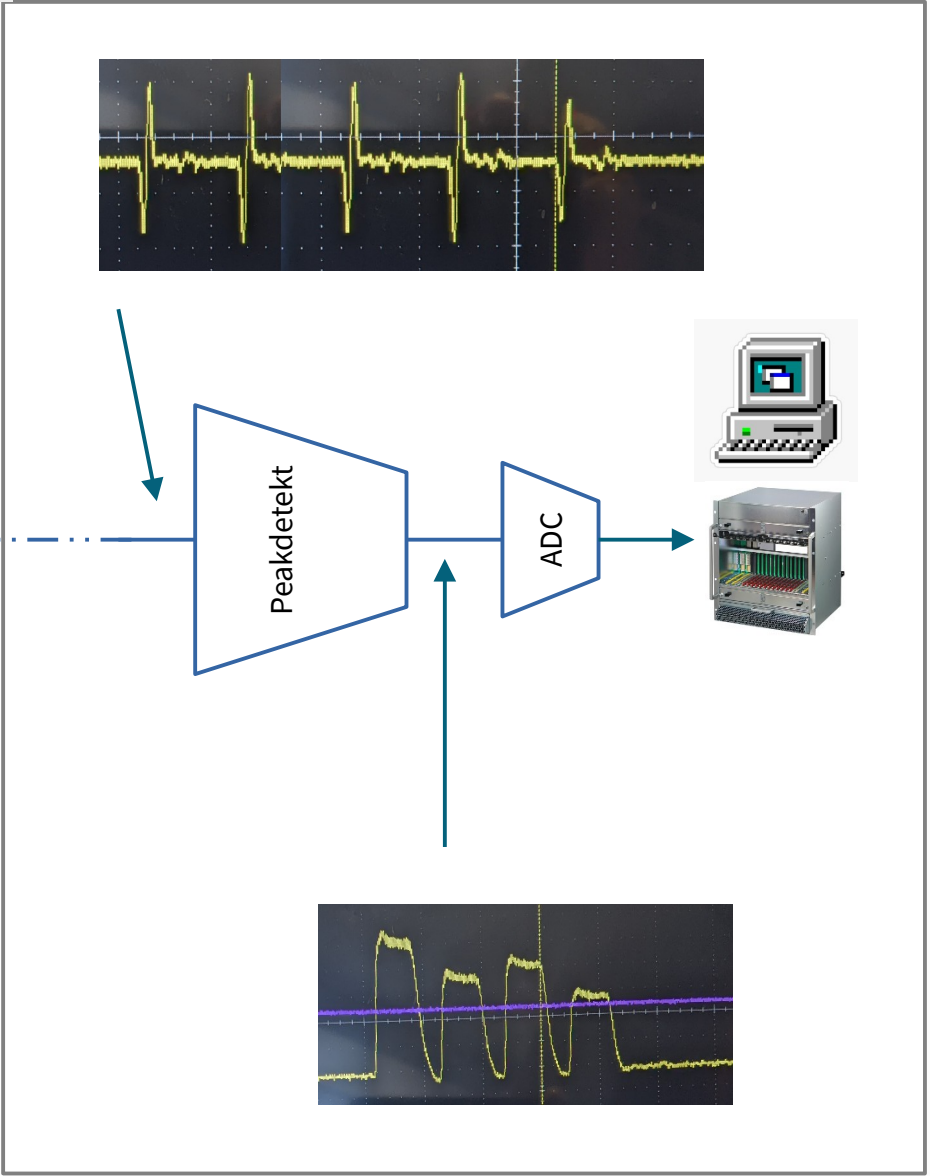
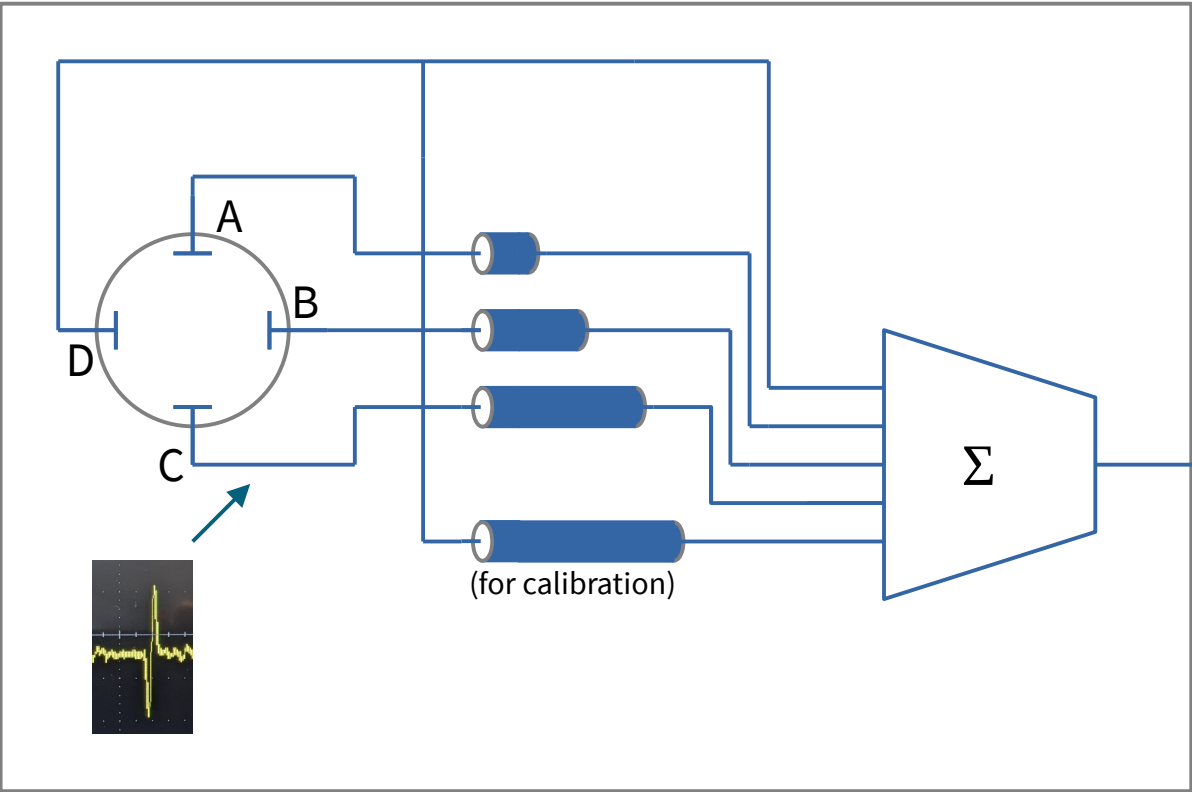


new improved design

Peakdetektor and 2x2 crosspoint

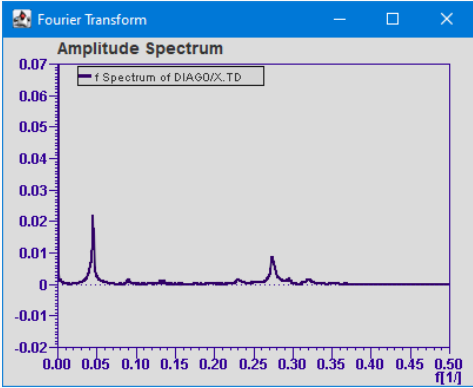


New Delay line with self calibration

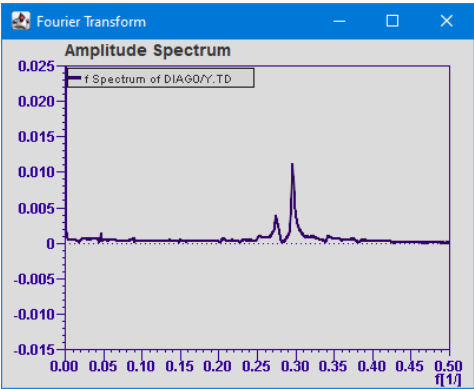
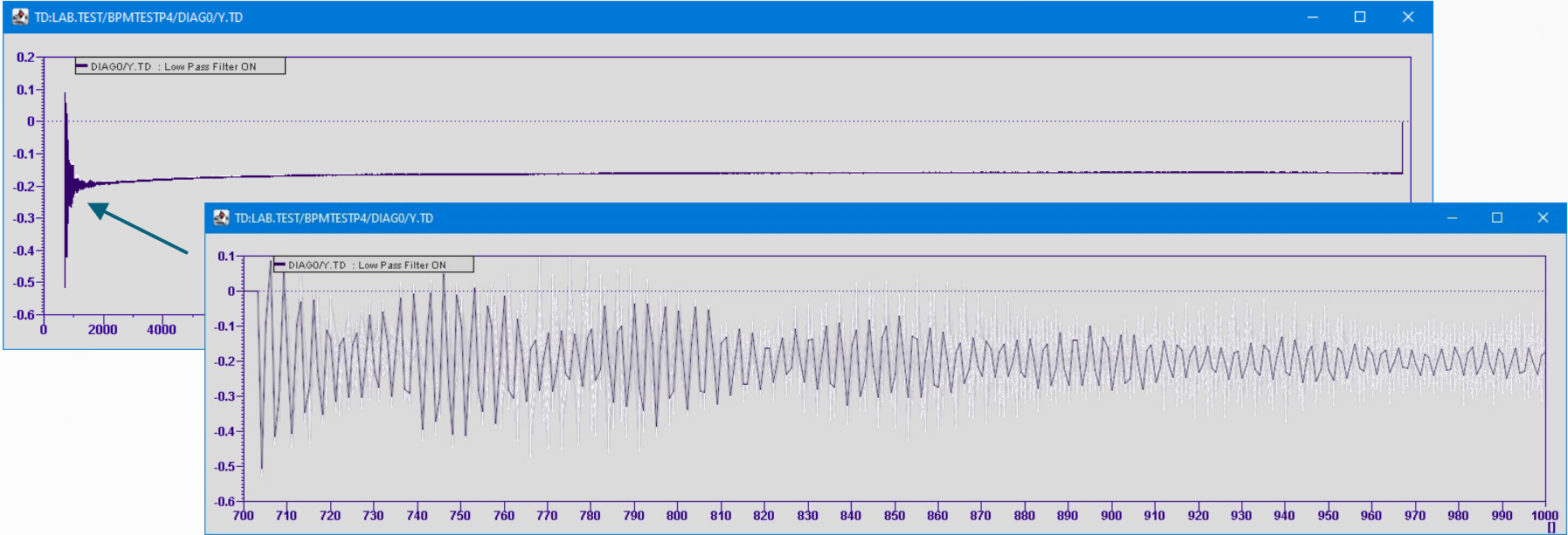


Self calibrating allows smaller delay lines with more damping

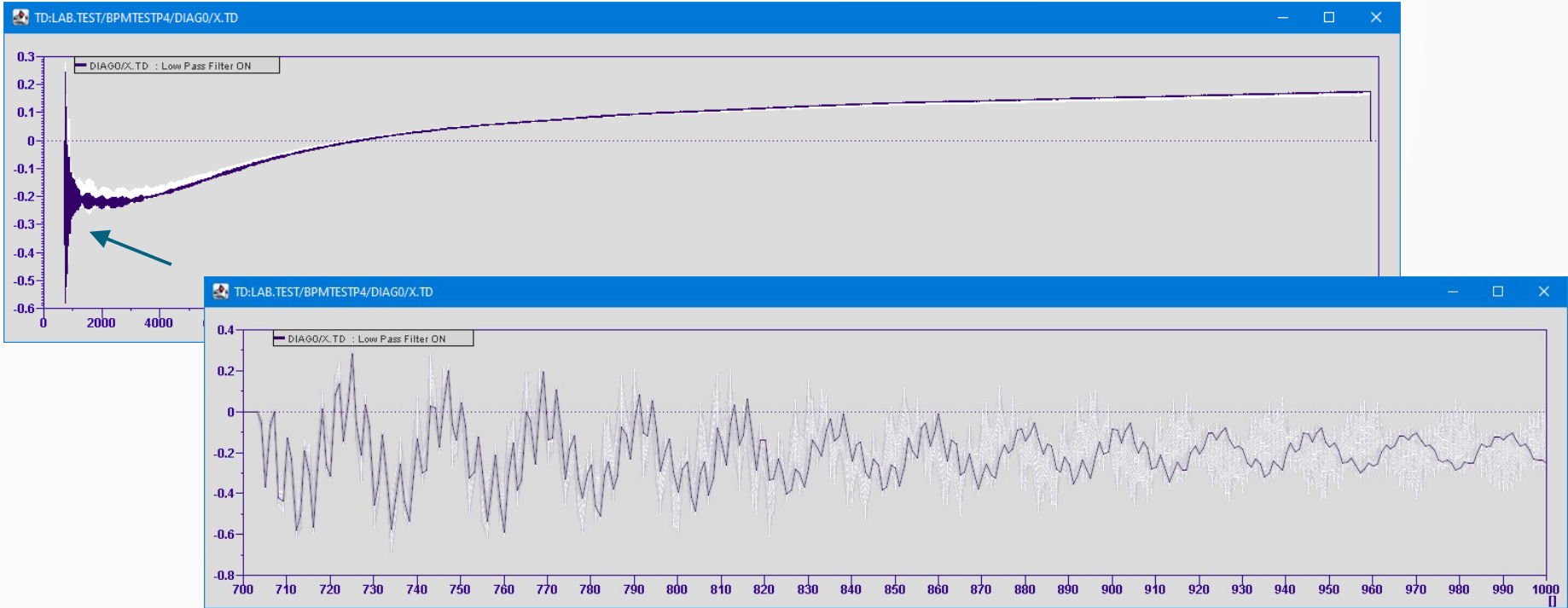
Position measurement at DESY 2



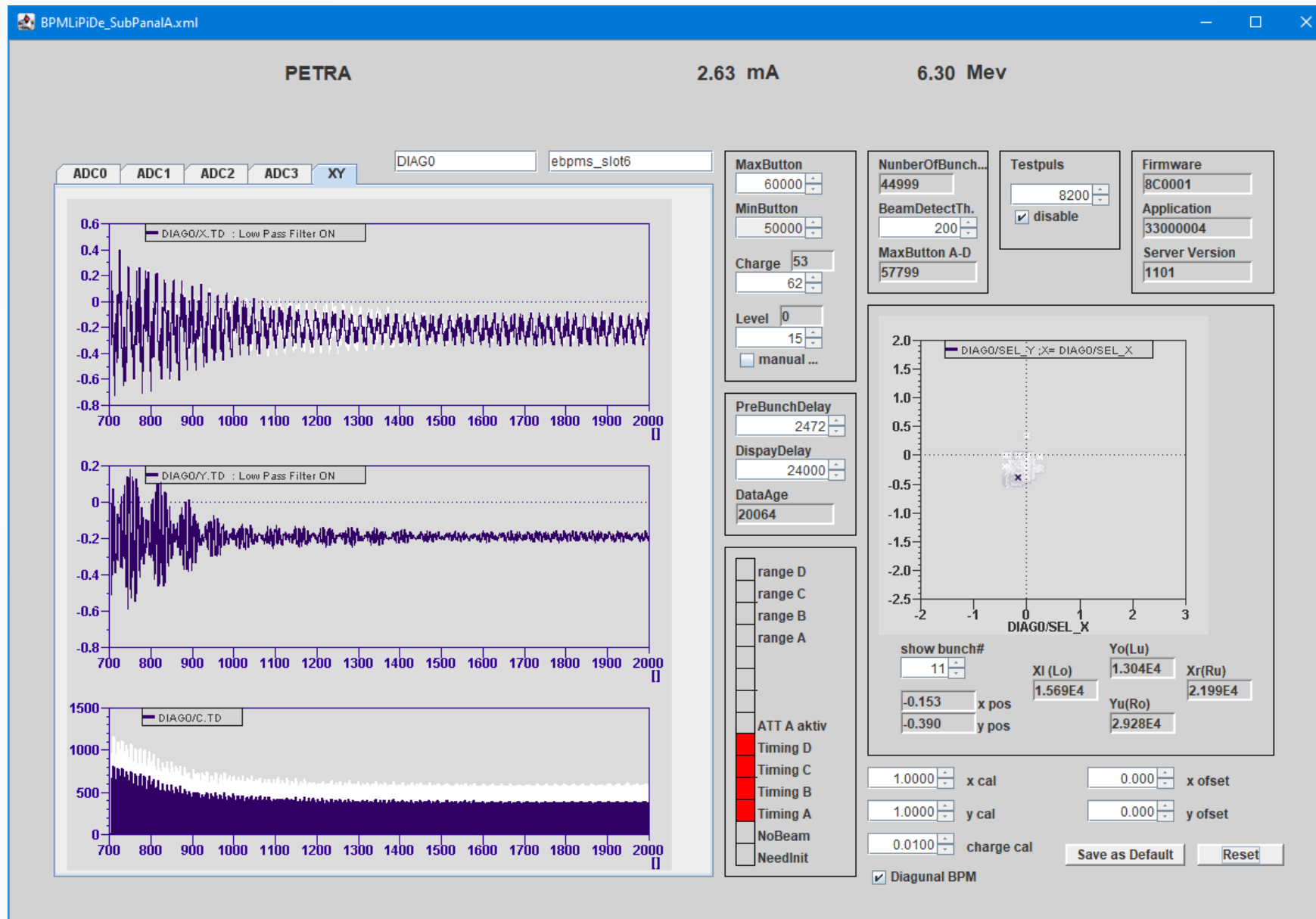
Tune on first 1k revolutions



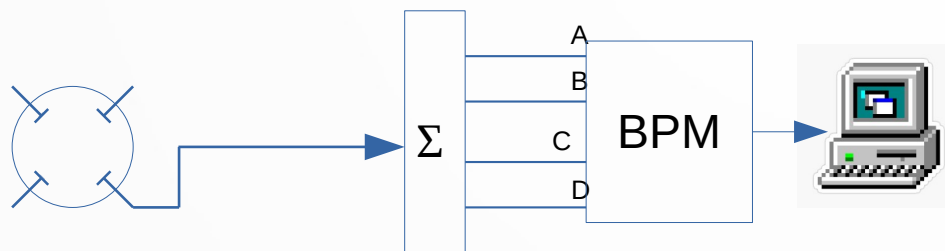
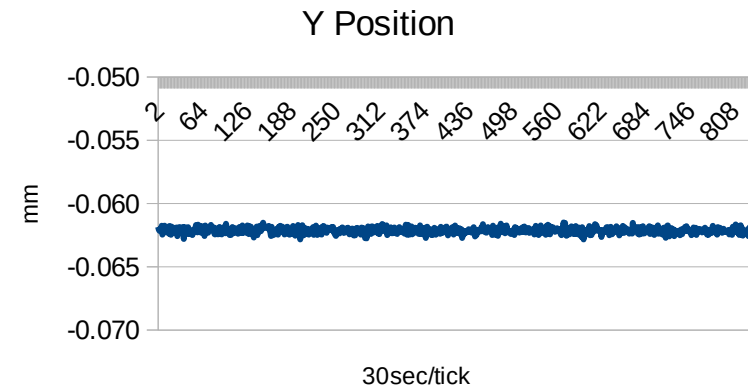
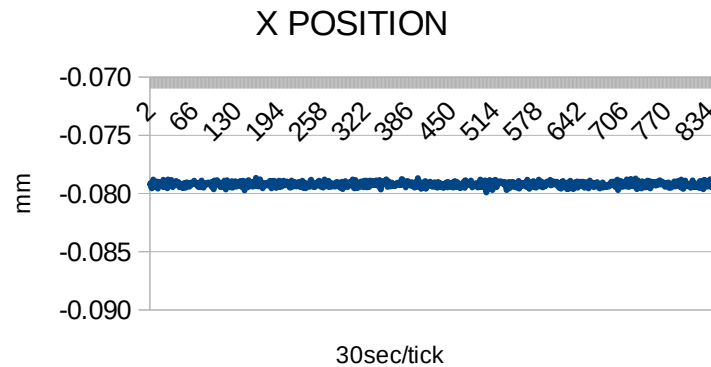
Tune on first 1k revolutions



Doocs Server BPM Application for DESY 2

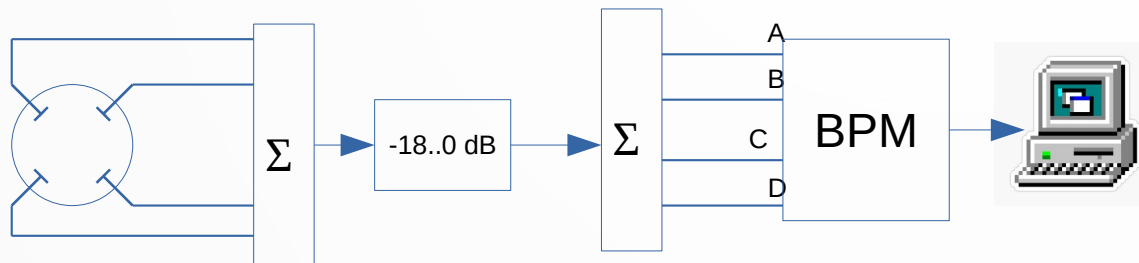
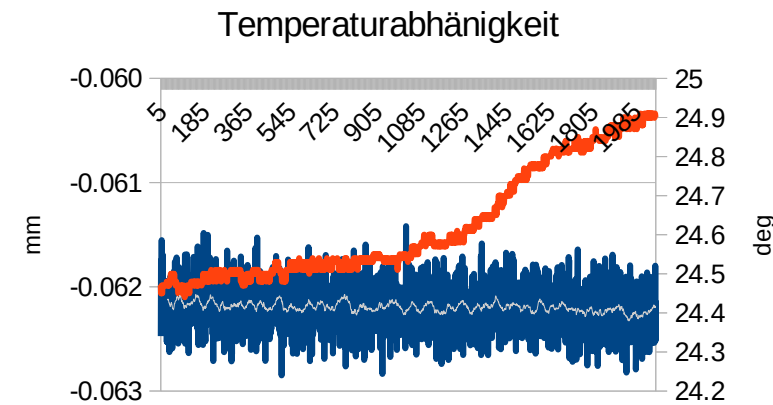
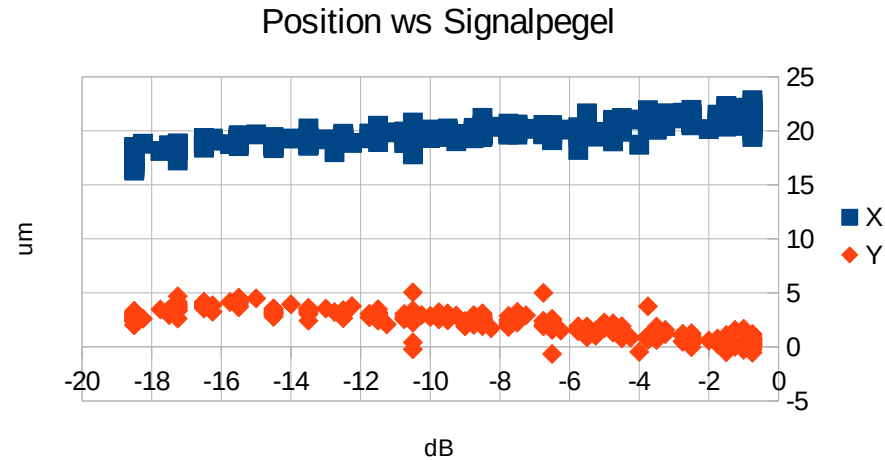


12 h long term stability test



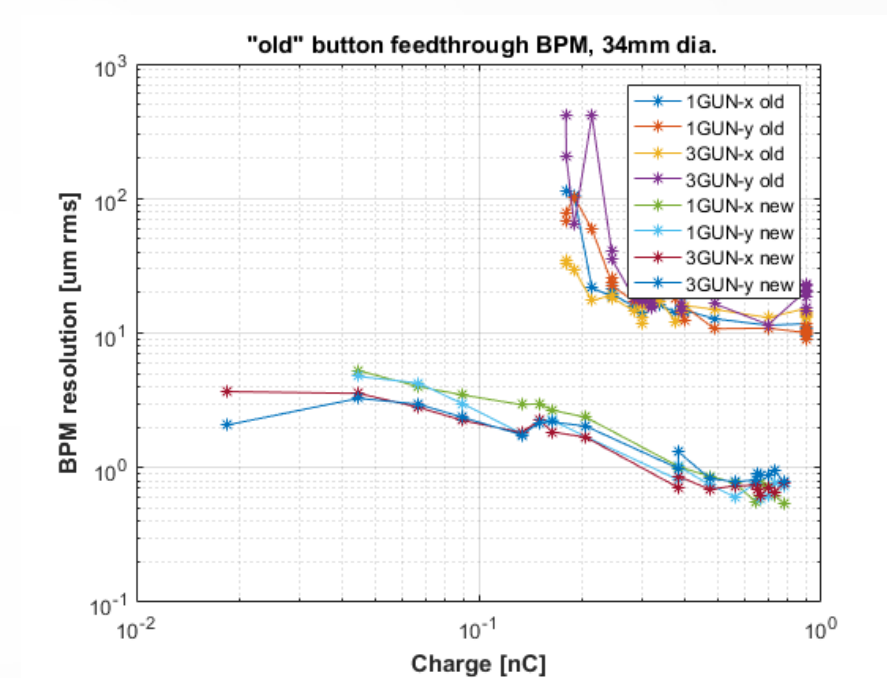
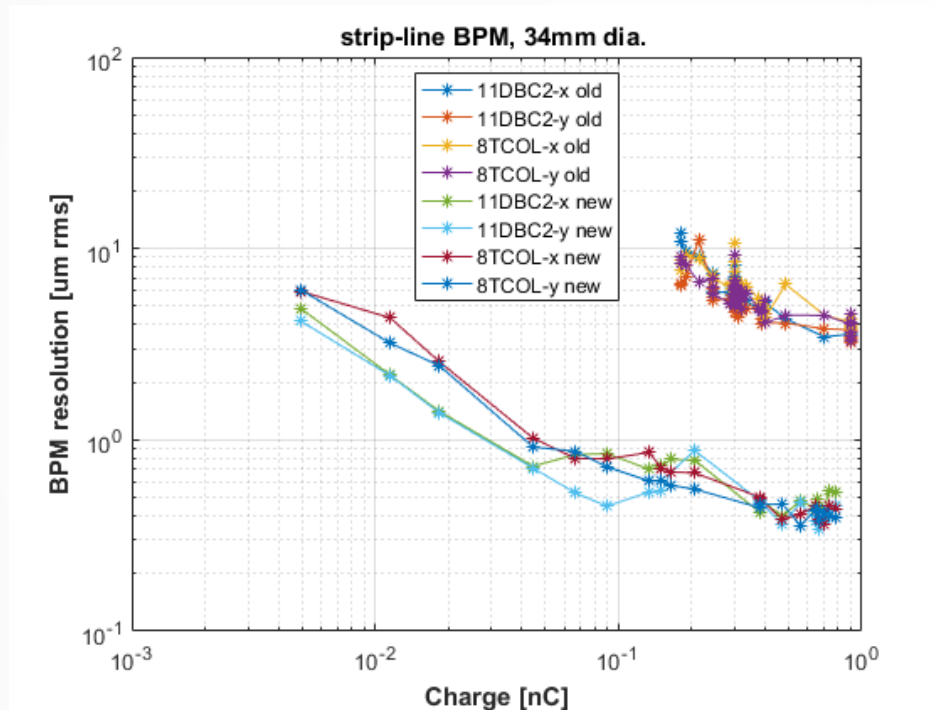
Petra as test generator
@40 Bunche /100mA,
m=10mm

Signal power and temperature dependency



Petra as test generator
@40 Bunche /100mA,
m=10mm

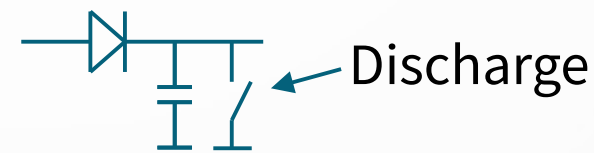
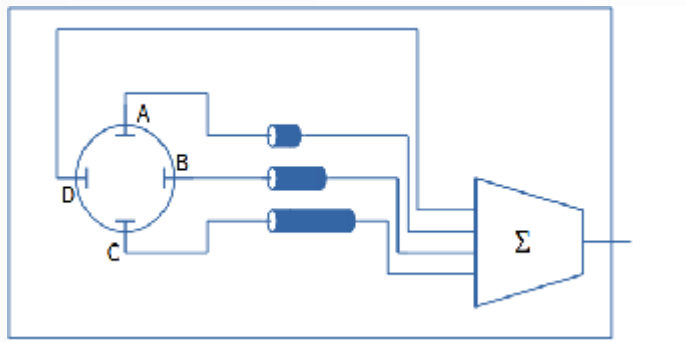
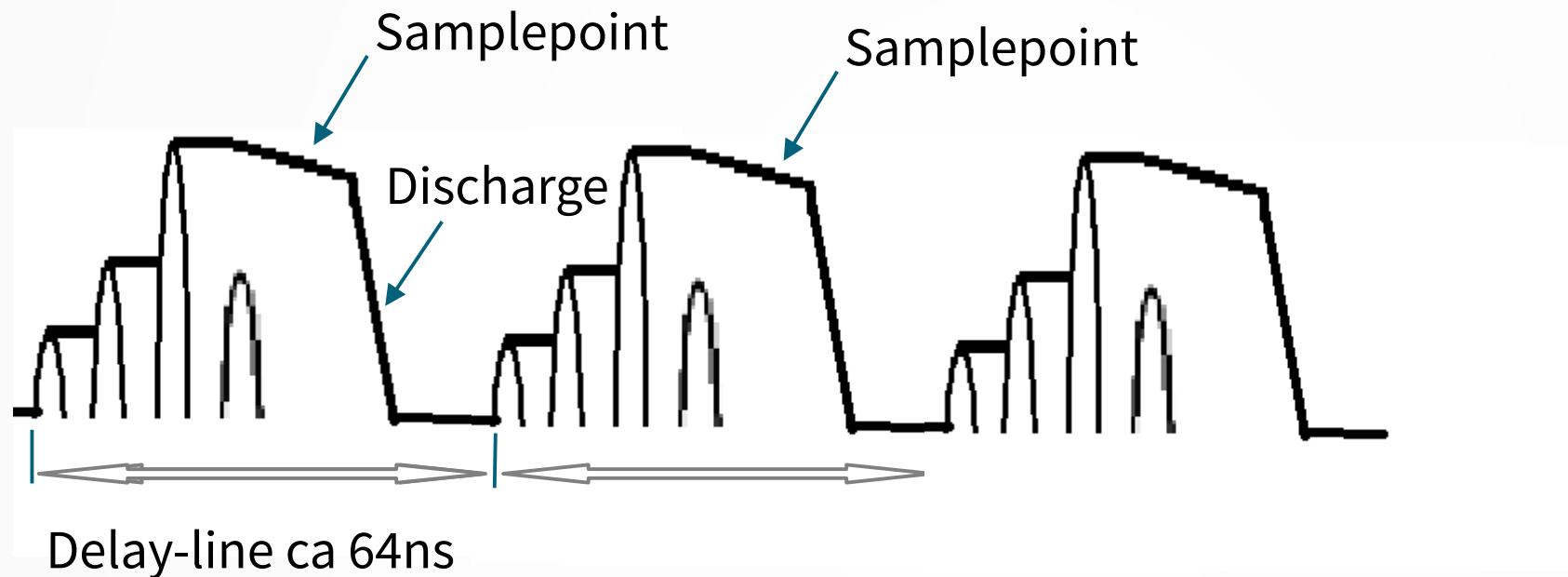
BPM Resolution at Flash



(Quelle: N.Baboi,B.Lorbeer Flash Messschicht 2017-19)

Bunch Burst mode for Petra first turn steering

To improve first turn resolution of Petra BPM an Injektion of 5 Bunches/8ns is planned



Status

June 2022

- Improved Peak detector prototype ready
- Layout nearly finished
- 3GHz BPM at Gun installed under tested
- Desy2 BPM installed parallel to a Libra Spark
- Self calibrated Delay lines in development
- First server and application ready (Doocs/Tine compatible)

Plan for BPM electronic refurbishment

GUN, Anfang Linac 2 (6 BPMs)

1 * mtca Crate GUN: (6 * SIS8300KU, x3Timer)
analog pre filter. single bunch buffer, 2x2 crossbar switch for static calibration,
BPM-A2-7.7, BPM-A2-9.5, BPM-A2-11.0, BPM-A2-11.5, BPM-I2-1.5, BPM-I2-2.9

Linac, mitte Linac 2 (5 BPMs)

1 * mtca Crate Linac: (5 * SIS8300KU, x3Timer)
2x2 Crossbar-switch for static Calibration, single Bunch Buffer
BPM : M-8, M4, M6, M10PI, M10BY, (...)

PIA LKR (9 BPMs)

1 * mtca Crate PIA (9 * SIS8300KU, x3Timer)
attenuator control by feed-forward, 1k Buffer for BPM Data
BPM : MON2, MON4, MON10, MON12, MON16, MON18, MON21, MON24, MON26

Transportwege L-Weg : LKR (10 BPMs)

1 * mtca Crate L-WEG (3 * SIS8300KU, x3 Timer)
Delay line, single Bunch Buffer
BPM : M20, M23, M31, M52, M72, M89, M98, M105, M117, M125

DESY2/4: DESY (60 BPMs)

2 * mtca Crate DESY (15 * SIS8300KU, 2*x3 Timer)
4:1 Delay line with self Calibration (feed-forward), 50k Buffer for BPM Data

E Weg, Petra SO

1 * mtca Crate E-WEG (2 * SIS8300KU, x3Timer)
4:1 Delay line with self Calibration (feed forward), single bunch buffer
BPM : M000, M020, M119, M144, M161, M169, M178, M185

total:

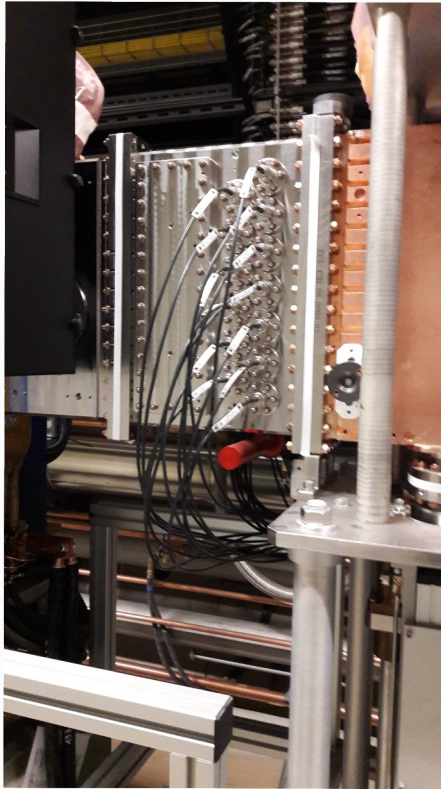
7 * mtca 12 Slot Crates

85 * SIS 8300KU Boards

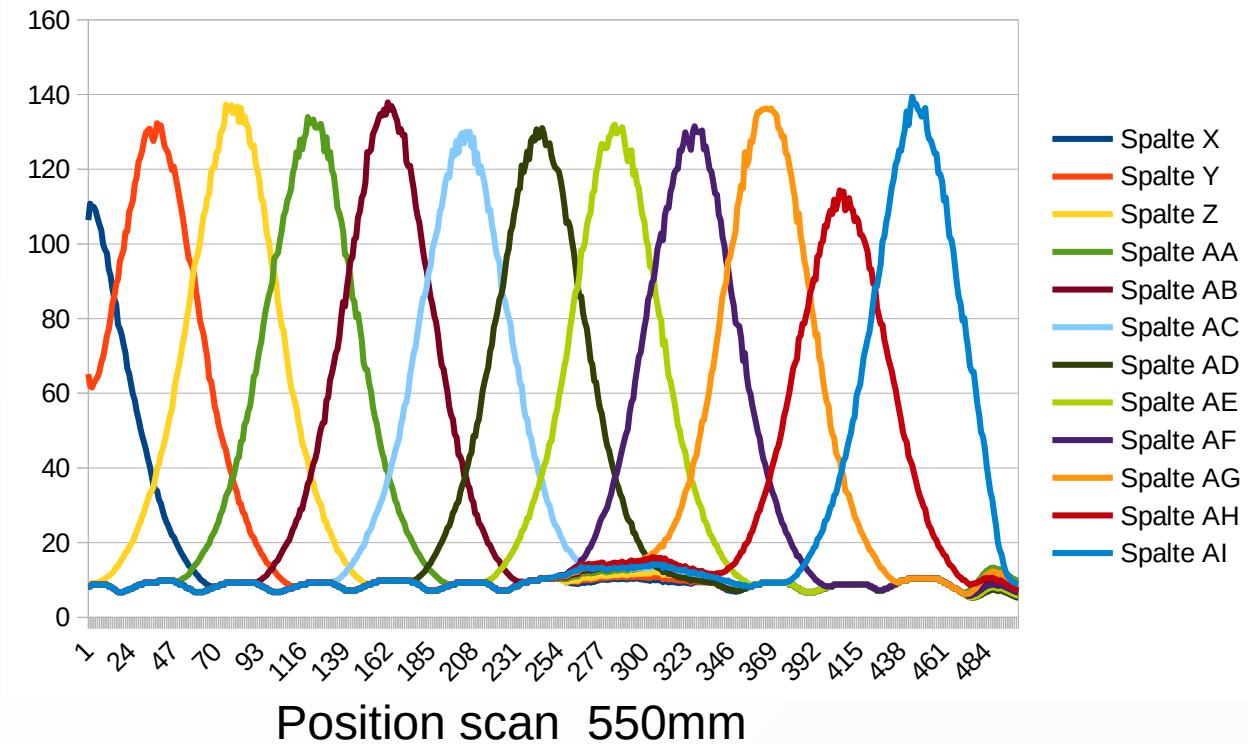
7 * x3 Timer

Thanks for your attention!

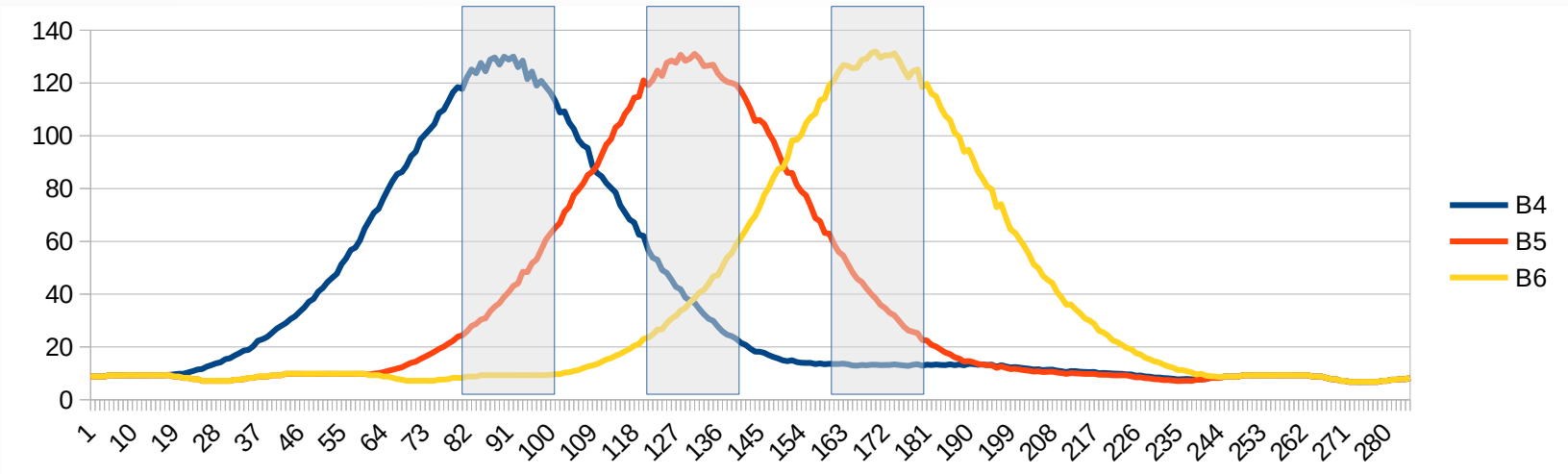
Additional : eBPMs at XFEL



13 x Button array



Additional : eBPMs at XFEL



$$f(x)=m2\frac{B3-B5}{B3+B5}$$

$$f(x)=m1\frac{B4-B5}{B4+B5}$$

$$f(x)=m2\frac{B4-B6}{B4+B6}$$

$$f(x)=m1\frac{B4-B5}{B4+B5}$$

$$f(x)=m2\frac{B5-B7}{B5+B7}$$

Different monitor constants depending on position

