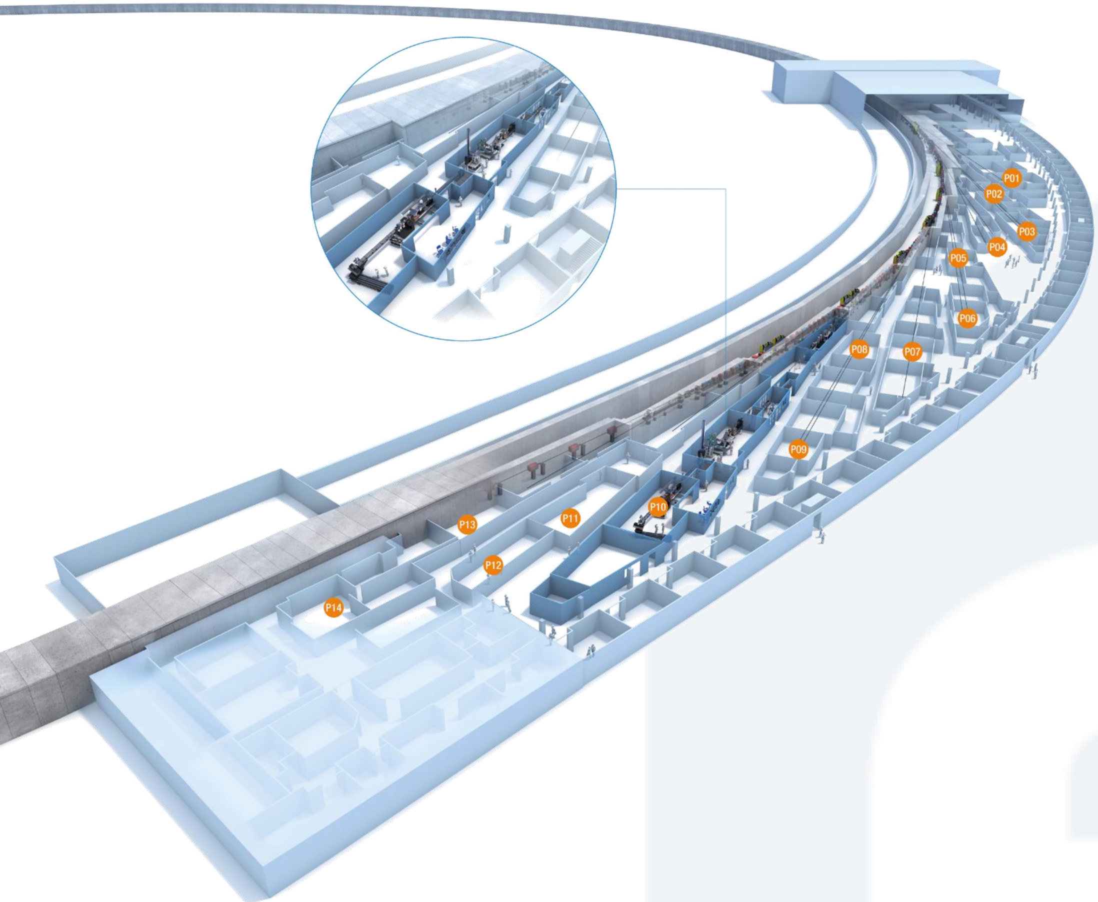


CAENels
Gear For Science

and

DESY.

Partners in the

MicroTCA
TECHNOLOGY LAB
A HELMHOLTZ INNOVATION LAB

Part 1: Beamline Electronic Instrumentation by CAEN ELS

Part 2: MicroTCA for Beamlines by DESY - MicroTCA Technology Lab

Workshop for Beamline Scientists and Engineers – Hamburg, Oct. 9th, 2018

Workshop for Beamline Scientists and Engineers

Part 1: Beamline Electronic Instrumentation by CAENELS

Joachim Theiner
Business Development Manager

Dr. Paolo Scarbolo
R&D Beamline Instrumentation
+ MicroTCA

9:00	Opening Hour
10:00	Welcome by Dr. Thomas Walter (DESY MicroTCA Lab)
10:10	Short Overview of the CAEN Group and CAEN ELS
10:25	History and Evolution of the CAEN ELS picoammeters for photon BPMs
10:40	Charge-Integration picoammeters: AH401D and TetrAMM-CI
10:50	Transimpedance picoammeters: AH501D and TetrAMM
11:05	Coffee Break
11:30	Worldwide Applications of the CAEN ELS picoammeters
11:40	Applications for CAEN ELS picoammeters at DESY Beamlines and facilities
11:55	BEST – Beamline Enhanced Stabilization Technology and encoder integration
12:15	CAEN ELS picoammeters for MicroTCA and further MicroTCA devices
12:30	Lunch Break

Workshop for Beamline Scientists and Engineers

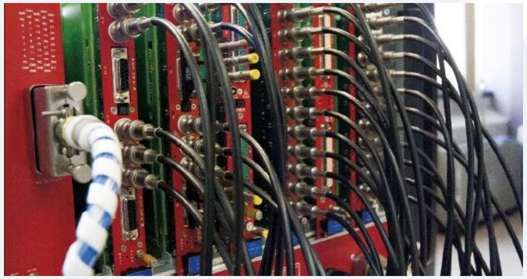
Part 2: MicroTCA for Beamlines by the MicroTCA Technology Lab

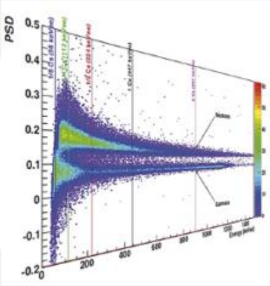
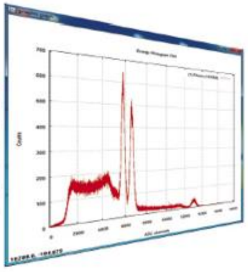
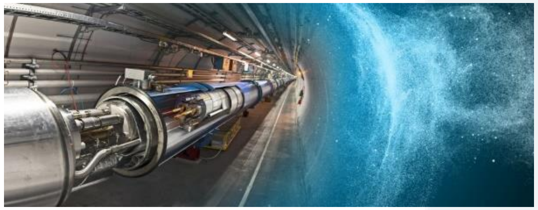
13:30	What is MicroTCA? Short Introduction to the technology and the lab
13:45	High-speed digitizing in MTCA with the DS800 board
14:00	Motor driving in MTCA
14:15	The Piezo driver board PZT4
14:30	Camera read-out with MicroTCA (incl. live demo)
14:45	Coffee Break
15:15	Digital and analog I/O solutions in MTCA
15:30	Timing and Synchronization in MicroTCA
15:45	DAQ System for energy dispersive detectors
16:00	Upcoming projects – ours and yours

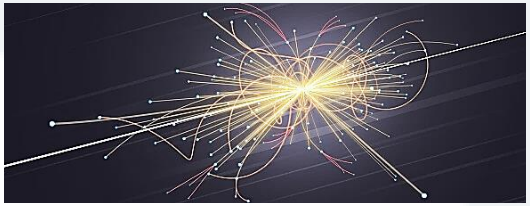
CAEN Locations

CAEN History

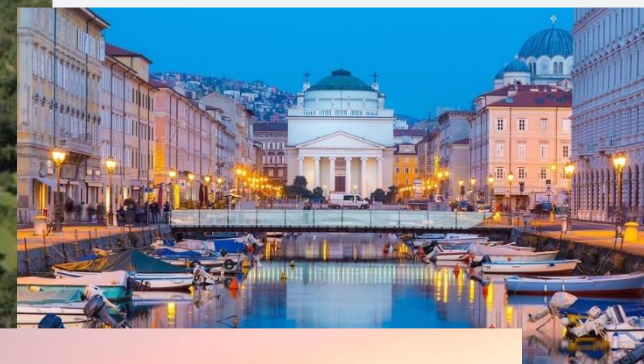
- **CAEN** is the world leader with the most advanced electronic instrumentation for any **particle, radiation and low light detectors**.
- Nearly all **world major research laboratories and institutes** are using **the high end products of CAEN** for the detection and data acquisition in **particle physics experiments**.
- R&D division of **50 high level Physicists and Engineers**.
- High Voltage and Low Voltage Power Supplies
- Signal Conditioning, Read Out Electronics and Emulation
- Acquisition Systems
- Spectroscopy Solutions
- Powered Crates and Chassis
- Educational Kits

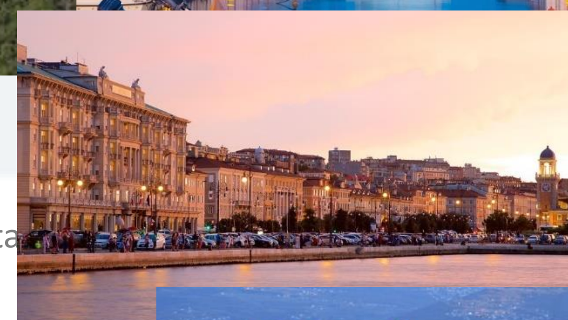




CAEN ELS History + Location





- Founded 2009 as a spin-off from CAEN S.p.A.
- Developer and manufacturer of high-performance digita bipolar and monopolar power sources, high-precision current transducers and current measurement systems, electronic components for beamlines in accelerators and FMC and MicroTCA equipment
- **Headquarters** in Basovizza, **Trieste - Italy** at the location of Elettra-Sincrotrone Trieste S.C.p.A.

CAEN ELS Product Lines

Power Supply Systems

Precision Current Measurements

Beamline Electronic Instrumentation

FMC MicroTCA

Outline

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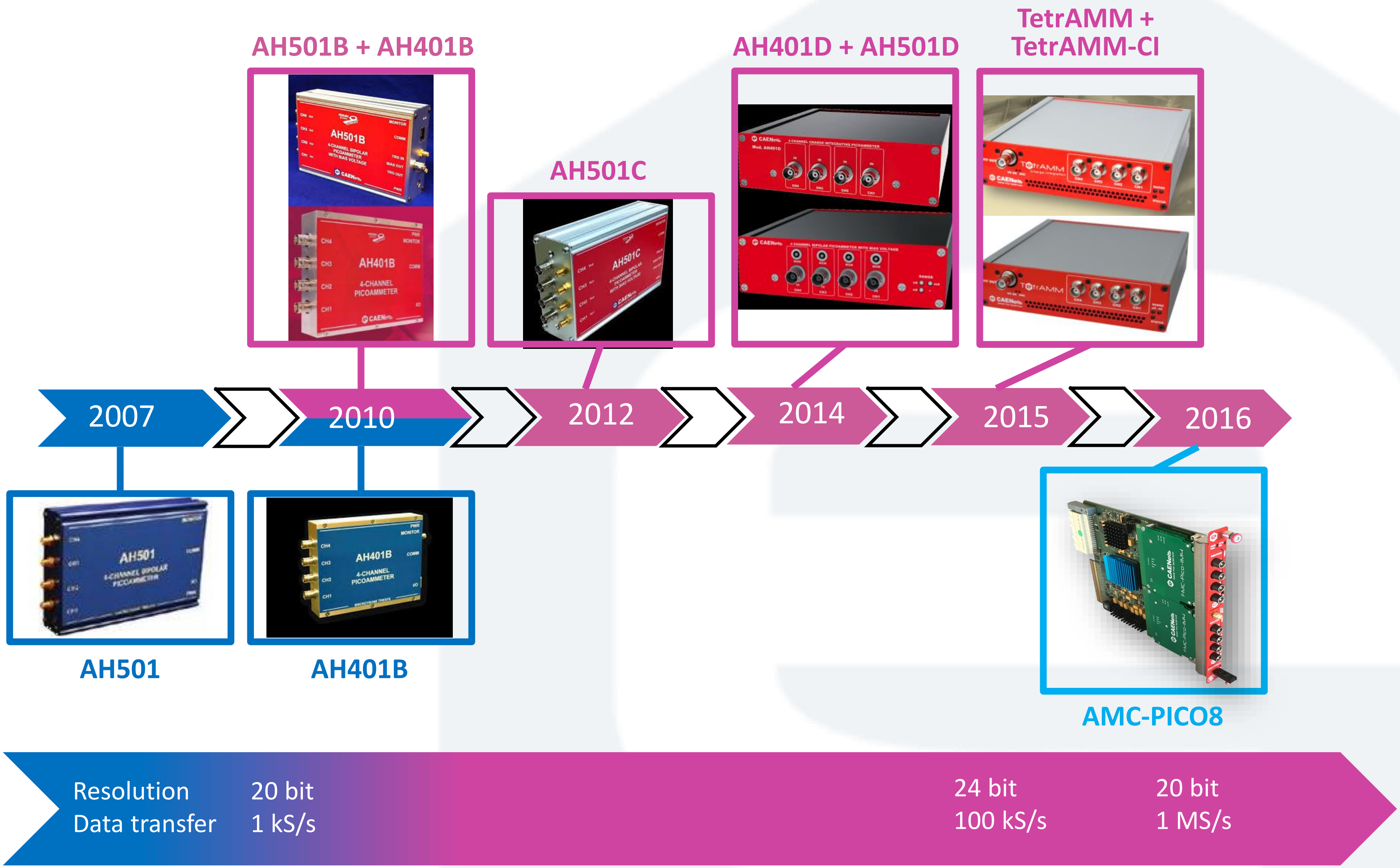
History and Evolution of CAEN ELS Picoammeters



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Time for questions and considerations

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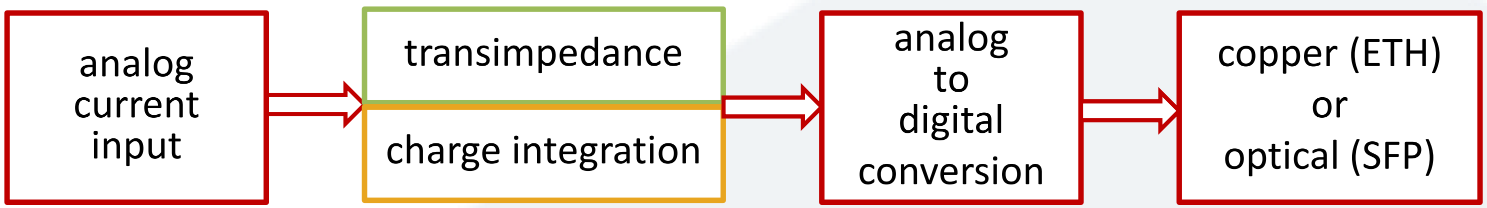
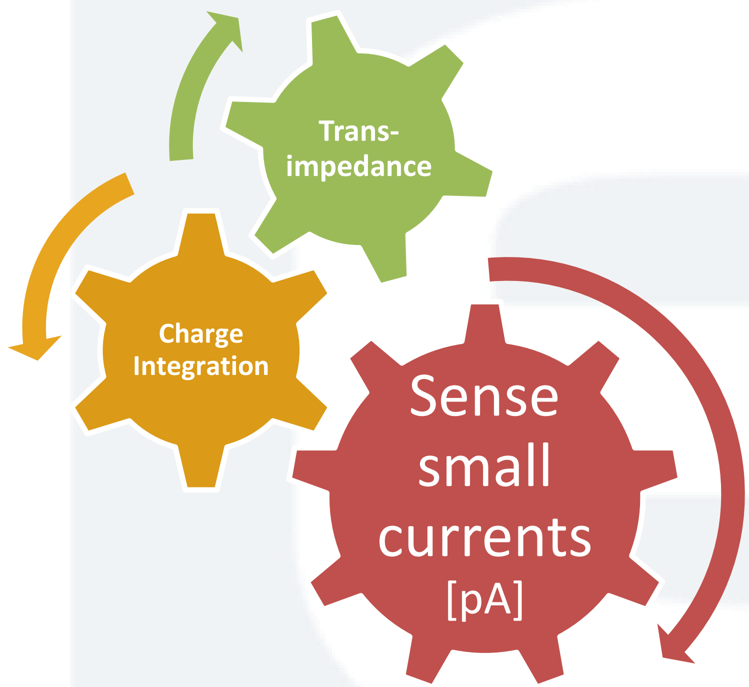
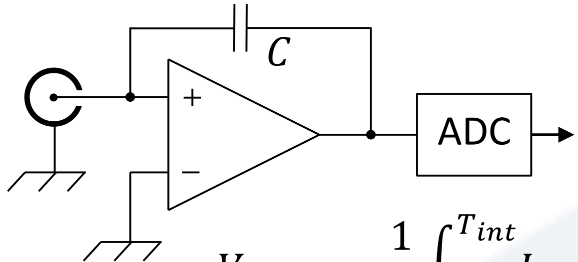
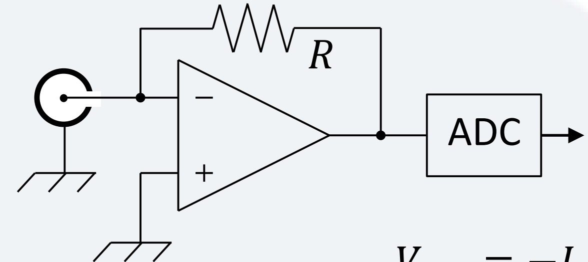
CAENels Gear For Science


analog current input
transimpedance
charge integration
analog to digital conversion
copper (ETH) or optical (SFP)


Trans-impedance
Charge Integration
Sense small currents [pA]



$$V_{out} = -\frac{1}{C}\int_0^{T_{int}} I_{in} \approx -I_{in}\frac{T_{int}}{C}$$

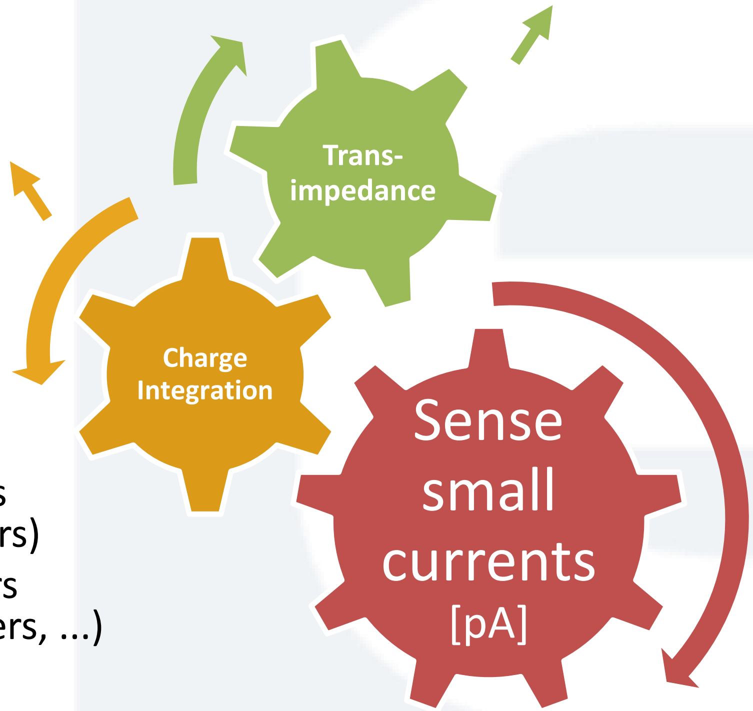


$$V_{out} = -I_{in}R$$

Pros:
- Continuous integration
- noise integration
- small currents (pA)

Cons:
- 2 kHz throughput

Applications:
- Charge generating sensors (piezos, pulsed accelerators)
- Current generating sensors (photodiodes, ion chambers, ...)
- Leakage current meas.



Pros:
- Time-continuous output
- sampling up to 100 KHz
- small currents (pA)

Cons:
- miss short pulses (<1 us)

Applications:
- Current generating sensors (photodiodes, ion chambers, ...)
- High voltage sources
- Leakage current meas.

Very low currents (e.g. at pA level) Very fast pulses (e.g. < μs)	For all other requests (normal operations)
In this case the **CHARGE INTEGRATION** technique is the right choice: **AH401D** or **TetrAMM-CI**	**TRANSIMPEDANCE** picoammeters are more versatile and due to their high sampling frequency they can be integrated in time-continuous feedback systems: **AH501D** or **TetrAMM**

AH501D

4-channel Bipolar Picoammeter with Bias Voltage Source

- 3 different ranges - ±2.5 mA , ±2.5 µA, ±2.5 nA
- Sampling frequency – up to 26 kHz (1 channel @ 16-bit)
- 16- or 24-bit resolution
- Voltage monitors (proportional to input current, configurable gains)
- Ethernet connectivity (remote control based on SCPI-like commands)
- Bias up to 30V (sub-mV RMS noise)
- User-friendly software for photon BPM applications
- TTL gate input signal and output conversion signal → external events

CAENels
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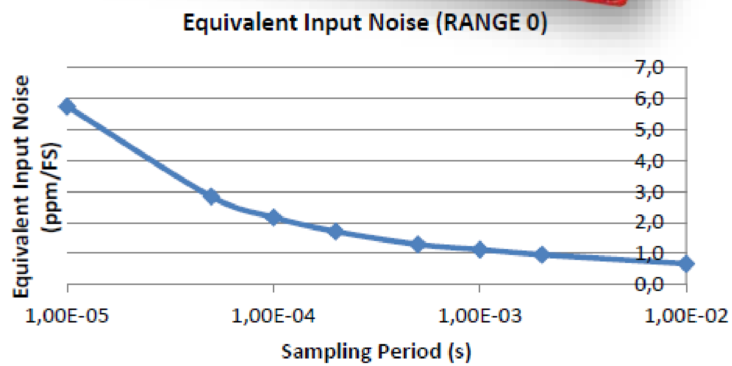
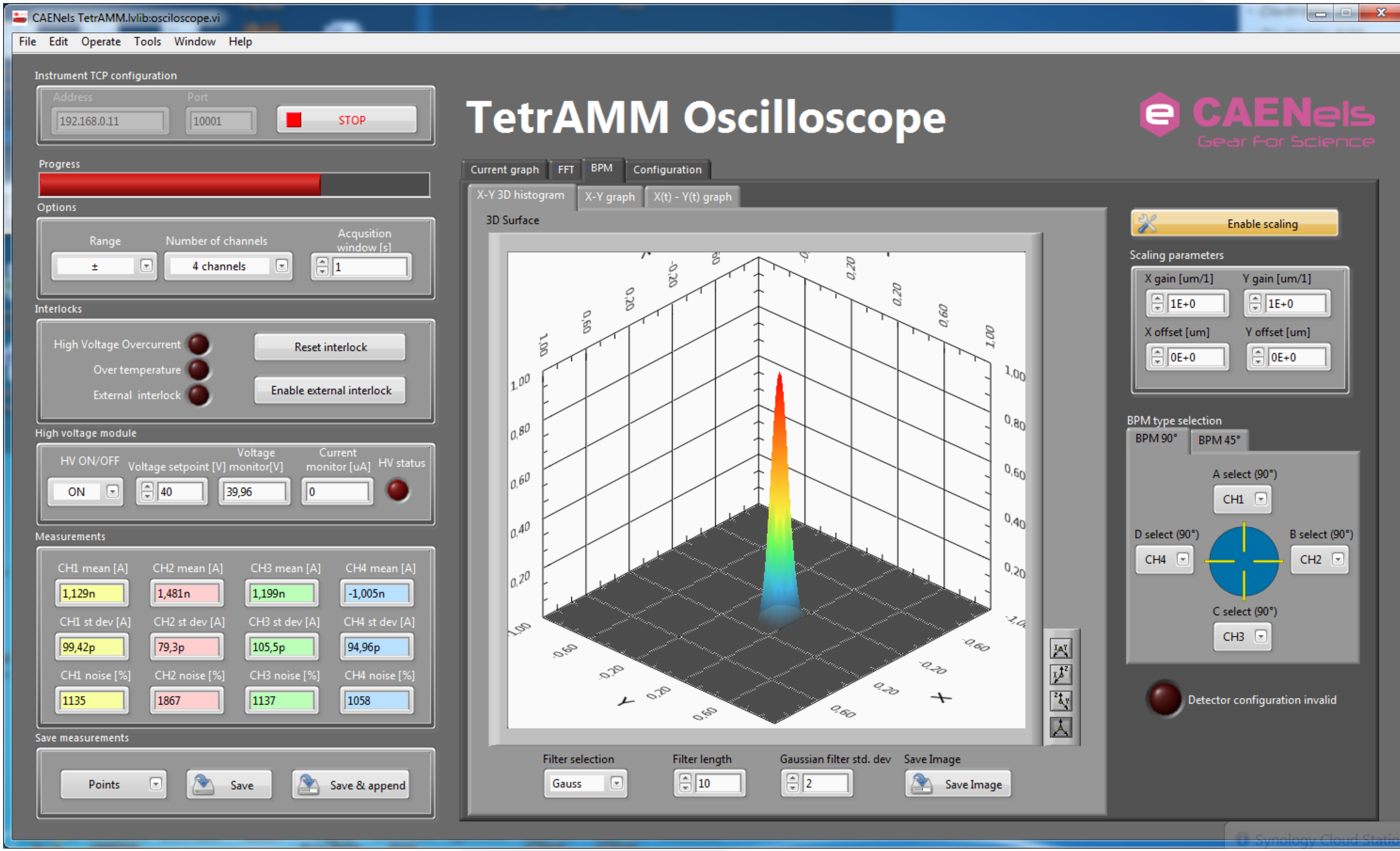
TetrAMM

4-channel Fast-Interface Bipolar Picoammeter with Integrated HV

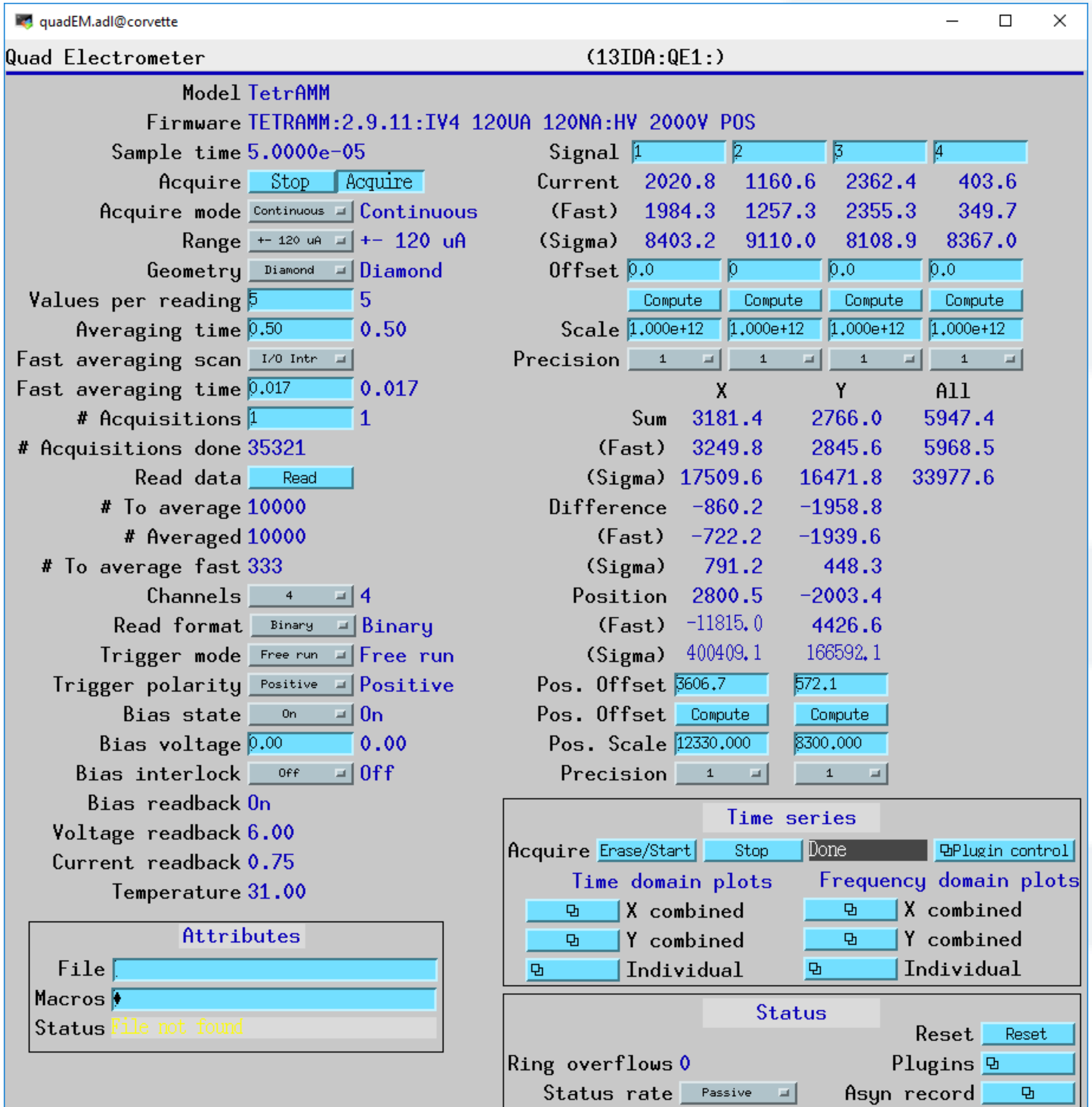
- 4-channel simultaneous sampling
- Up to 100 kHz sampling frequency
- 24-bit ADC conversion
- 2 different full-scale ranges: ±120 µA and ±120 nA (range customization upon request)
- Complete Local and Remote management
- Configurable Sampling Frequency
- Automatic and independent ranging
- External Trigger/Gate and Interlock
- SFP connectivity (for BEST integration)
- Low-noise HV source (500V, 2kV and 4 kV, both polarities)
- HV readback, HV current readback and Overcurrent protection
- Factory calibrated (additional User Calibration available)
- Gigabit Ethernet (remote control based on SCPI-like commands)
- FPGA and soft-processor computations
- User-friendly software for photon BPM applications
- Integration with EPICS (quadEM developed by Mark Rivers)

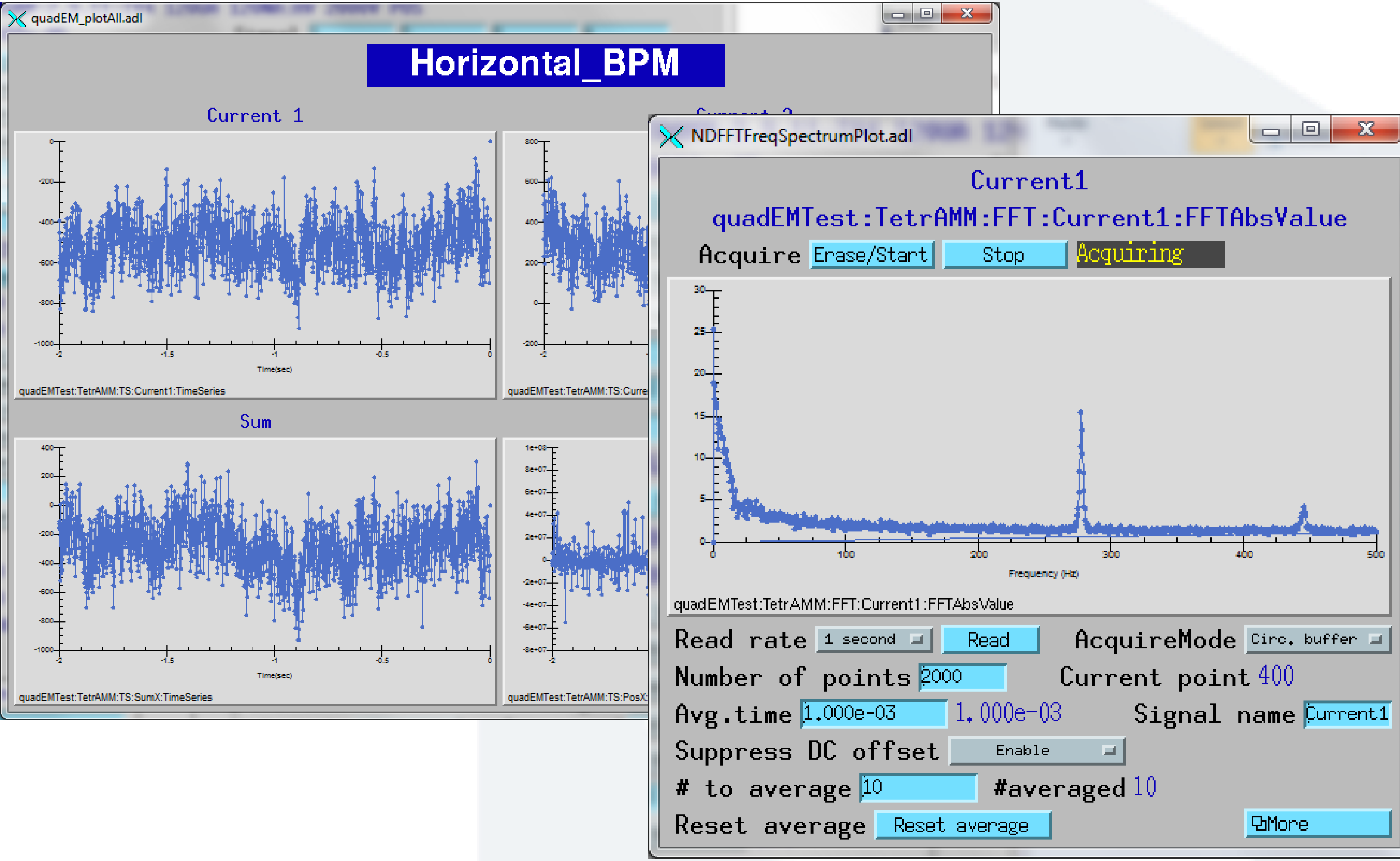


CAENels Gear For Science


CAENels TetrAMM.lvlib:osciloscope.vi
File Edit Operate Tools Window Help
Instrument TCP configuration
Address
Port
192.168.0.11
10001
STOP
Progress
Options
Range
Number of channels
Acqusition window [s]
±
4 channels
1
Interlocks
High Voltage Overcurrent
Over temperature
External interlock
Reset interlock
Enable external interlock
High voltage module
HV ON/OFF
Voltage setpoint [V]
Voltage monitor[V]
Current monitor [uA]
HV status
ON
40
39,96
0
Measurements
CH1 mean [A]
CH2 mean [A]
CH3 mean [A]
CH4 mean [A]
1,129n
1,481n
1,199n
-1,005n
CH1 st dev [A]
CH2 st dev [A]
CH3 st dev [A]
CH4 st dev [A]
99,42p
79,3p
105,5p
94,96p
CH1 noise [%]
CH2 noise [%]
CH3 noise [%]
CH4 noise [%]
1135
1867
1137
1058
Save measurements
Points
Save
Save & append
TetrAMM Oscilloscope
CAENels
Gear For Science
Current graph
FFT
BPM
Configuration
X-Y 3D histogram
X-Y graph
X(t) - Y(t) graph
3D Surface
Filter selection
Filter length
Gaussian filter std. dev
Save Image
Gauss
10
2
Save Image
Enable scaling
Scaling parameters
X gain [um/1]
Y gain [um/1]
1E+0
1E+0
X offset [um]
Y offset [um]
0E+0
0E+0
BPM type selection
BPM 90°
BPM 45°
A select (90°)
CH1
D select (90°)
B select (90°)
CH4
CH2
C select (90°)
CH3
Detector configuration invalid

EPICS quadEM (dev. by M. Rivers)




quadEM_plotAll.adl
Horizontal_BPM
Current 1
Time(sec)
quadEMTest:TetrAMM:TS:Current1:TimeSeries
Sum
quadEMTest:TetrAMM:TS:SumX:TimeSeries
NDFFTFreqSpectrumPlot.adl
Current1
quadEMTest:TetrAMM:FFT:Current1:FFTAbsValue
Acquire Erase/Start Stop Acquiring
Frequency (Hz)
quadEMTest:TetrAMM:FFT:Current1:FFTAbsValue
Read rate 1 second Read AcquireMode Circ. buffer
Number of points 2000 Current point 400
Avg.time 1.000e-03 1.000e-03 Signal name Current1
Suppress DC offset Enable
to average 10 #averaged 10
Reset average Reset average More

AH401D

4-channel Charge Integration Picoammeter

- 7 different ranges – from 50 pC to 2 nC (monopolar)
- integration time range from 1ms to 1s
- 20-bit resolution ADC + noise reduction digital filter
- Ethernet connectivity (remote control based on SCPI-like commands)
- User-friendly software for photon BPM applications provided
- TTL trigger/gate input signal and output conversion signal → external events

TetrAMM-CI

4-channel Fast-Interface Charge-Integration Electrometer with Integrated HV

- 8 different full-scale ranges: from 50 pC to 2 nC
- Continuous integration time: 1 s – 500 µs
- Non-Continuous integration time: 500 µs – 50 µs
- Complete Local and Remote management
- Configurable Integration Period
- SFP connectivity (for BEST integration)
- Low-noise HV source (500V, 2kV and 4 kV, both polarities)
- Factory calibrated
- HV readback, HV current readback and Overcurrent protection
- Gigabit Ethernet (remote control based on SCPI-like commands)
- FPGA and soft-processor computations
- User-friendly software for photon BPM applications
- Automatic and independent ranging
- External Trigger/Gate and Interlock

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Beam position monitors

- Quad-diode
- Diamond detectors (DD)
- Ion chamber
- blade gap monitors
- radiation monitors

- Faraday cups
- Photodiodes
- HV current readings
- Beam loss monitor
- Semioconductor characterization (RSE)

CAEN ELS Beamline Instrumentation
Worldwide Installations – August 2016...September 2018

39 Picoammeter
4 BEST
49 microTCA Picoammeter

92 Total installations

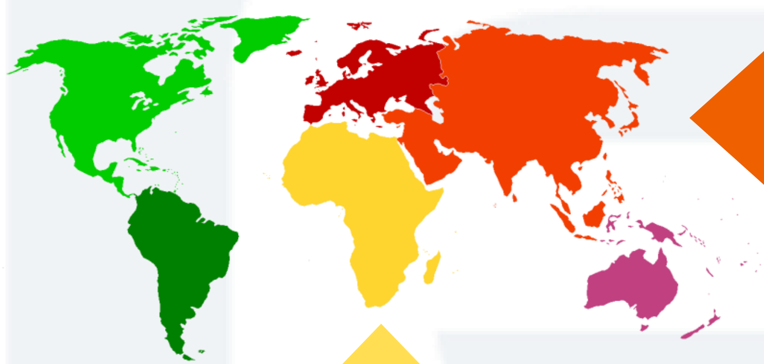
11 Picoammeter
2 BEST
57 microTCA Picoammeter

70 Total installations

1 Picoammeter

30 microTCA Picoammeter

31 Total installations



5 Picoammeter
1 BEST
1 microTCA Picoammeter

7 Total installations

2 Picoammeter

2 Total installations

PicoAMMeters References

Australia

USA

USA

Germany

USA

France

France

USA

Great Britain

Germany

China

Germany

Switzerland

USA

Italy

South Africa

Japan

Germany

Germany

France

PicoAMMeters References

USA

Switzerland

Thailand

Japan

China

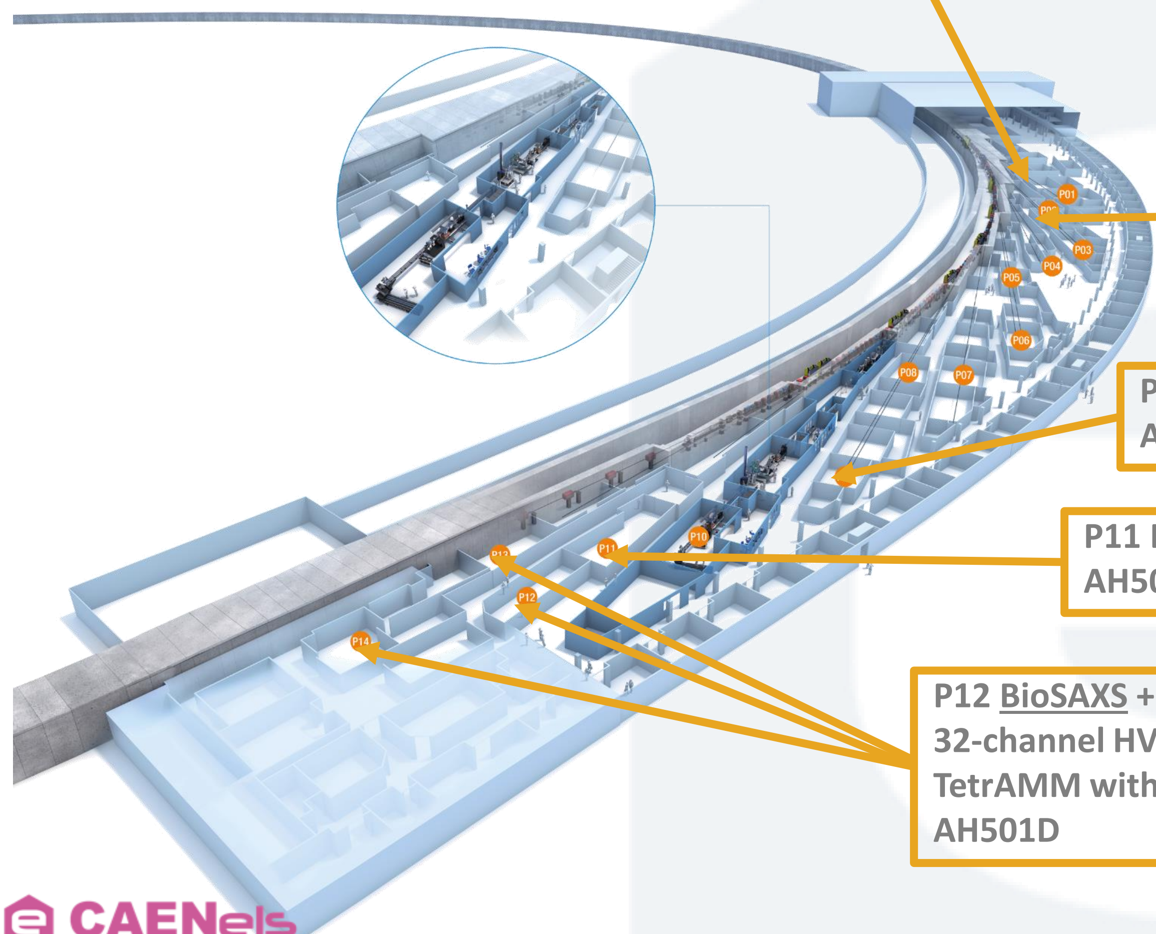
Brasil

Installations at DESY Beamlines

P01 Dynamics:
AH501D

CMS Group:
FMC-4SFP+

FS-BT VAKUUM:
AH501D



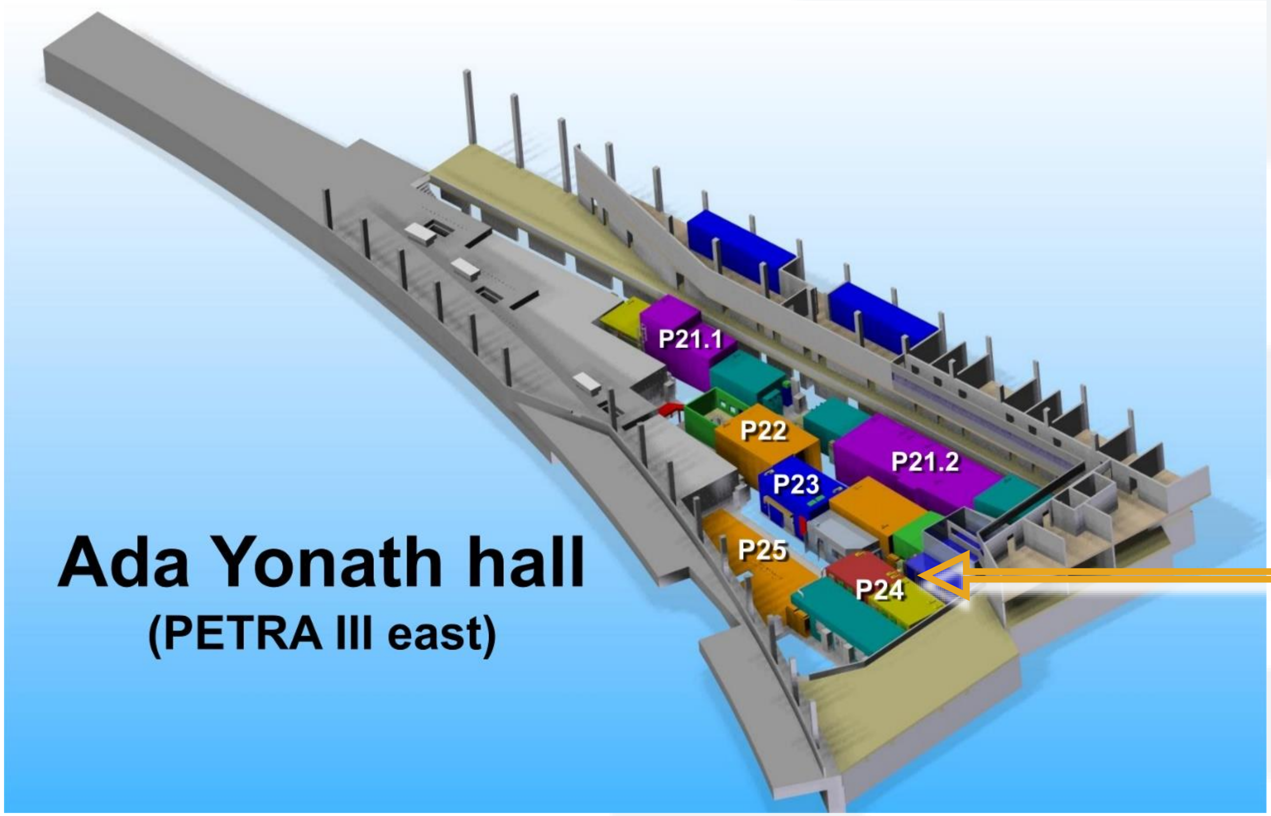
P02.1 Hard X-Ray Diffraction:
TetrAMM

P09 Resonant Scattering and Diffraction:
AH501D

P11 Bio-Imaging and Diffraction:
AH501D

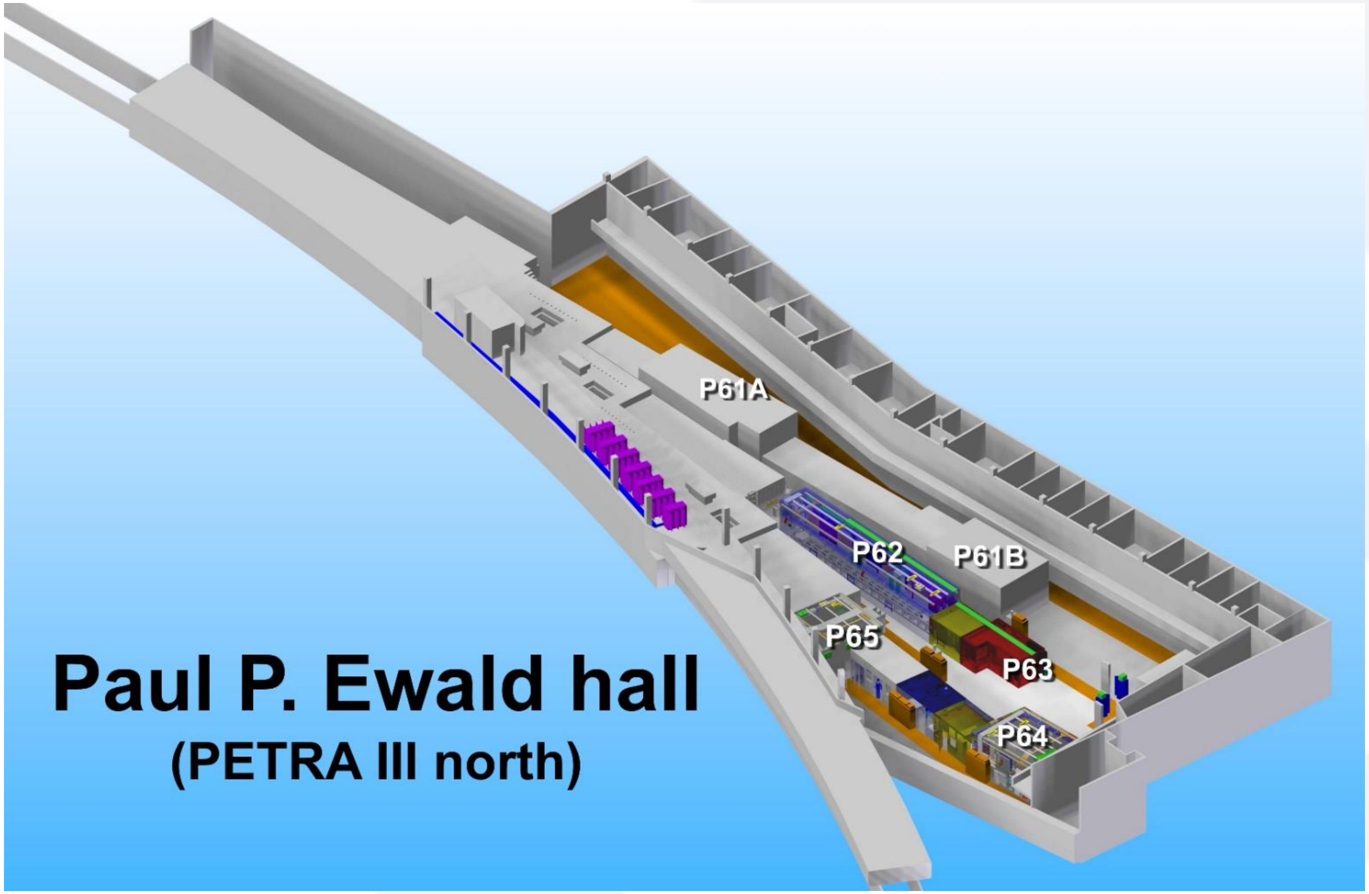
P12 BioSAXS + P13/P14 Macromolecular Crystallography:
32-channel HV-ADAPTOS
TetrAMM with EtherCAT
AH501D

Installations at DESY Beamlines



P24 Chemical Crystallography:
- DAMC-FMC25
- FMC-SFP
- HV-PANDA
- AMC-PICO 8

Installations at DESY Beamlines



No CAEN ELS installations in this hall! Up to now…

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BEST - Beamline Enhanced Stabilization Technology

BEST
Central Unit

TetrAMM
Readout

PreDAC
Actuator

- **Closed Loop Turnkey Solution BEST** - composed by 3 different building blocks:

  the **sensor readout TetrAMM**

  the **central processing unit BEST**

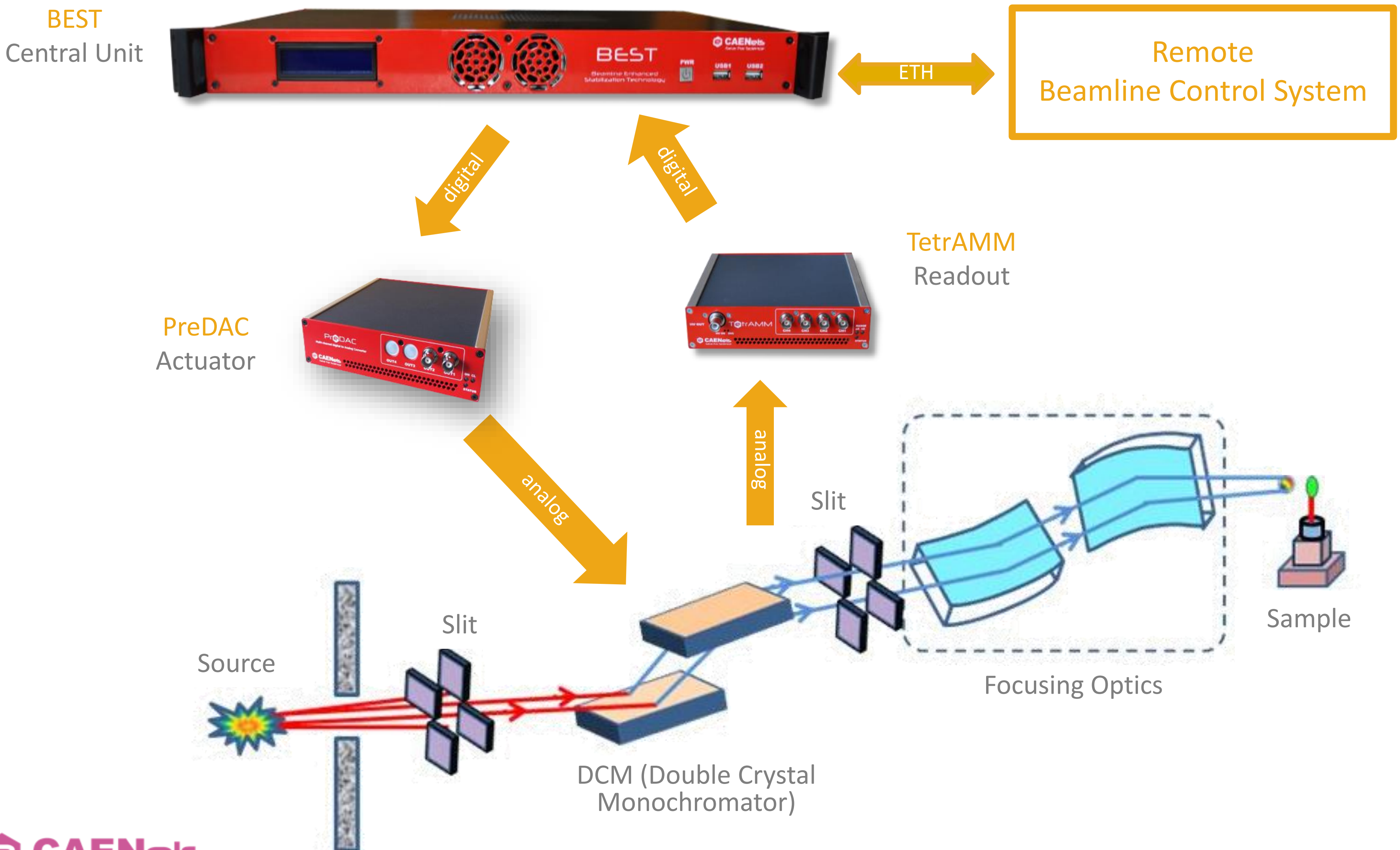
  the **piezoelectric actuator driver PreDAC**

- **Suppression of disturbances** in X-Ray beamlines generated by mechanical vibrations and temperature drift effects.
- **Elimination of wavelength/position shifting** of the radiation beam.
- **Beam Intensity/Position Modulation** – i.e. in DCM – Double Crystal Monochromator setups.

BEST - PreDAC

- 4-channel, 21-bit resolution, wide-bandwidth Digital to Analog Converter (DAC).
- The core system consists of high-speed 16-bit digital to analog converters that use dithering technique and active low-pass filtering to obtain stable very high accuracy (21-bit) output signals.
- 12 V bipolar output voltage with resolution of 12 µV – i.e. 21 bits of resolution on the full bipolar output range.
- Output voltage noise is suppressed using a 4th order active low-pass filter with cut-off frequency (-3 dB) of 10 kHz.
- The PreDAC is placed as near as possible to the amplifier stage driving the low-voltage piezoelectric actuators in order to reduce cable lengths and thus minimize possible noise pick-up
- Low temperature drifts, good linearity and very low noise levels enable users to perform high-precision correction voltage signal generation.
- Standard 10/100/1000 Mbps Ethernet TCP/IP protocol and SFP link for system integration.

BEST - Beamline Enhanced Stabilization Technology



BEST

at a glance

- Closed loop control in modular architecture – communication via optical and Ethernet links.
- Precise control and stabilization of of X/Y positions and intensity of photon beams in X-ray beamlines.
- Modular system for placing the signal-sensitive building blocks close to the detectors and piezo drivers.
- Free selection of the most suitable hardware configuration for each user/application.
- Compensation of noise and disturbances in the X-ray beam up to extremely high frequency (100 kHz).
- Beam intensity control by modifying the monochromator tuning.
- Beam position control by steering mirrors or crystals.

BEST - EnBOX

- Stand-alone readout device to interface with RENISHAW TONiC™ and RESOLUTE™.
- Provides a TCP/IP server to obtain encoder data, configure the device and to check the operational status.
- An SFP interface provides a communication link to transmit the measurement data to BEST via optic fiber.
- BiSS® interface to communicate with RENISHAW RESOLUTE™ encoders and quadrature encoder readout logic to interface with RENISHAW TONiC™ encoders.

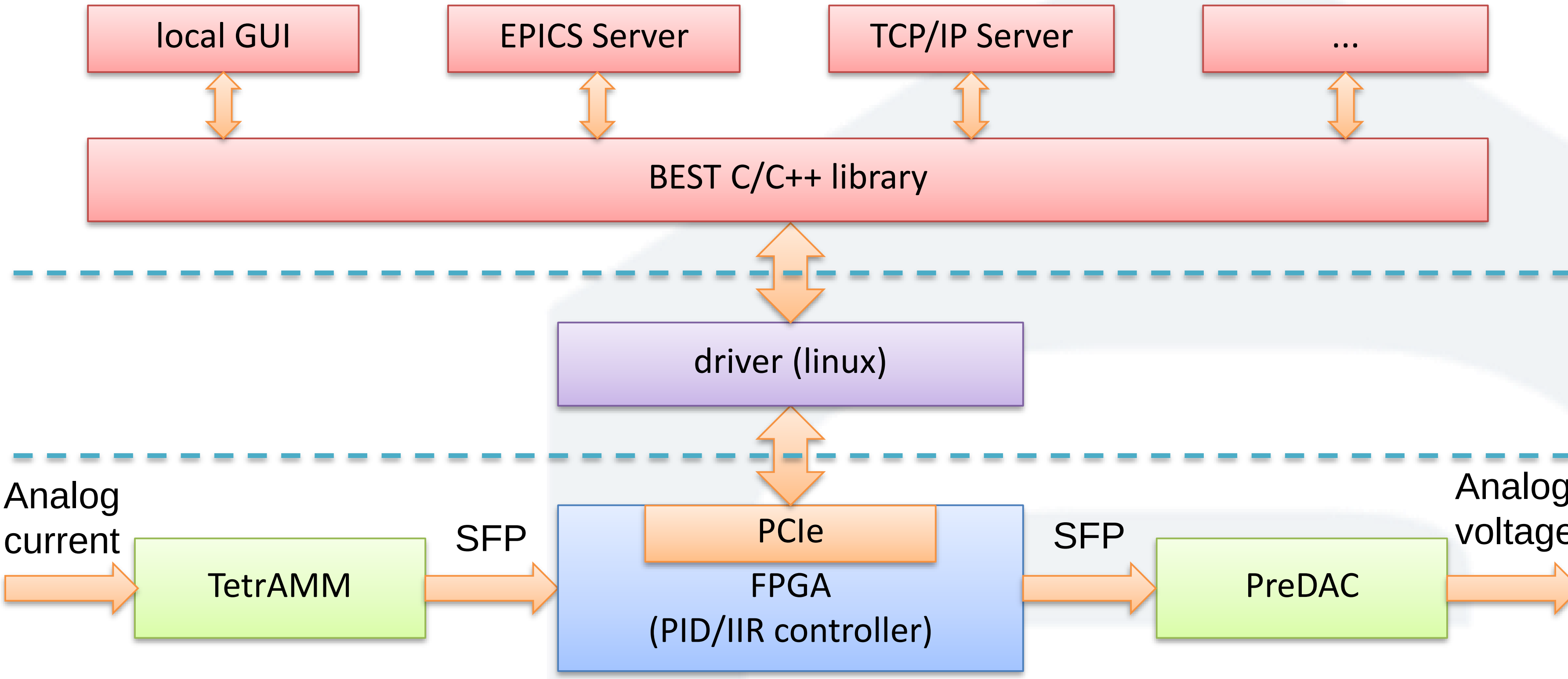
BEST – Readout Configurations

- Reading of beam position by beam position sensitive detectors (**TetrAMM**) or relative/absolute signals coming from optical encoders or interferometers (**EnBOX**).

❑ 1 TetrAMM or 1 EnBOX
❑ 2 TetrAMM or 2 EnBOX

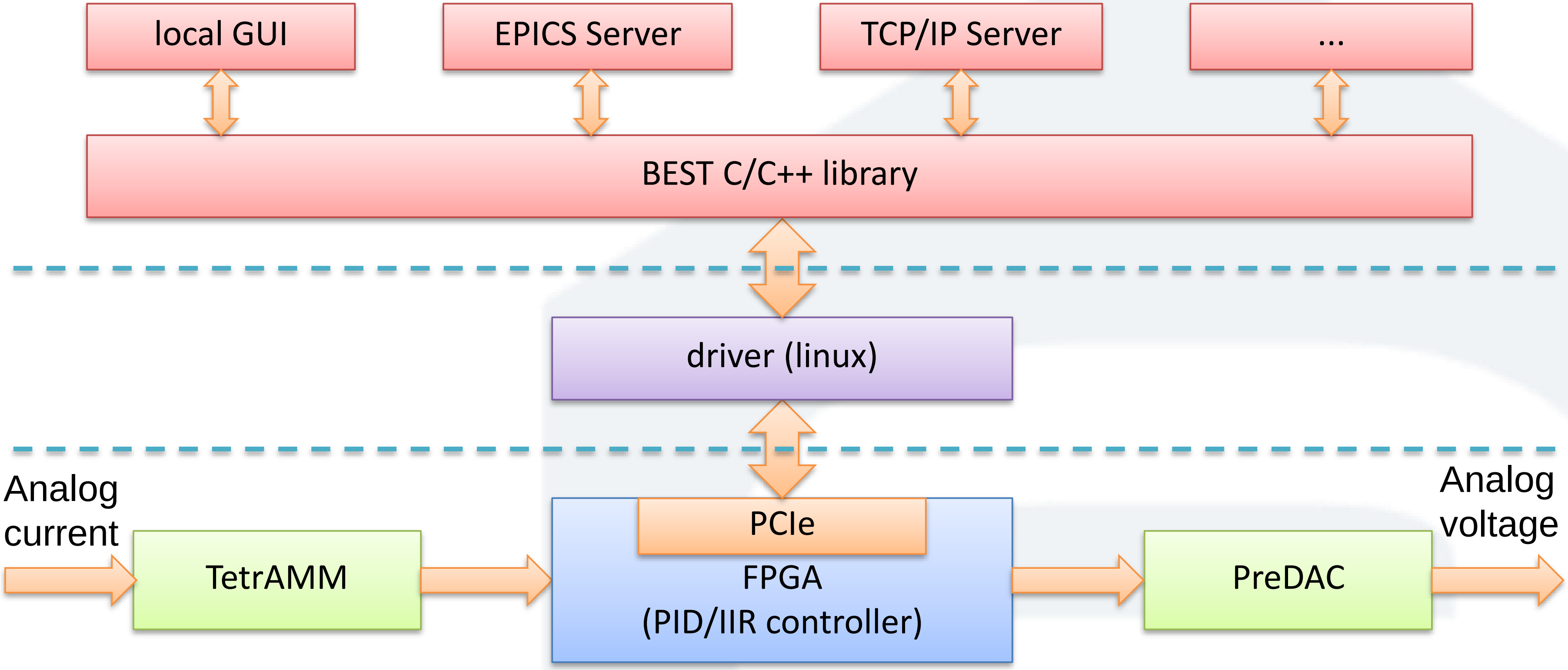
❑ 1/2 Relative encoders
❑ 1/2 Absolute encoders

BEST – Building Blocks



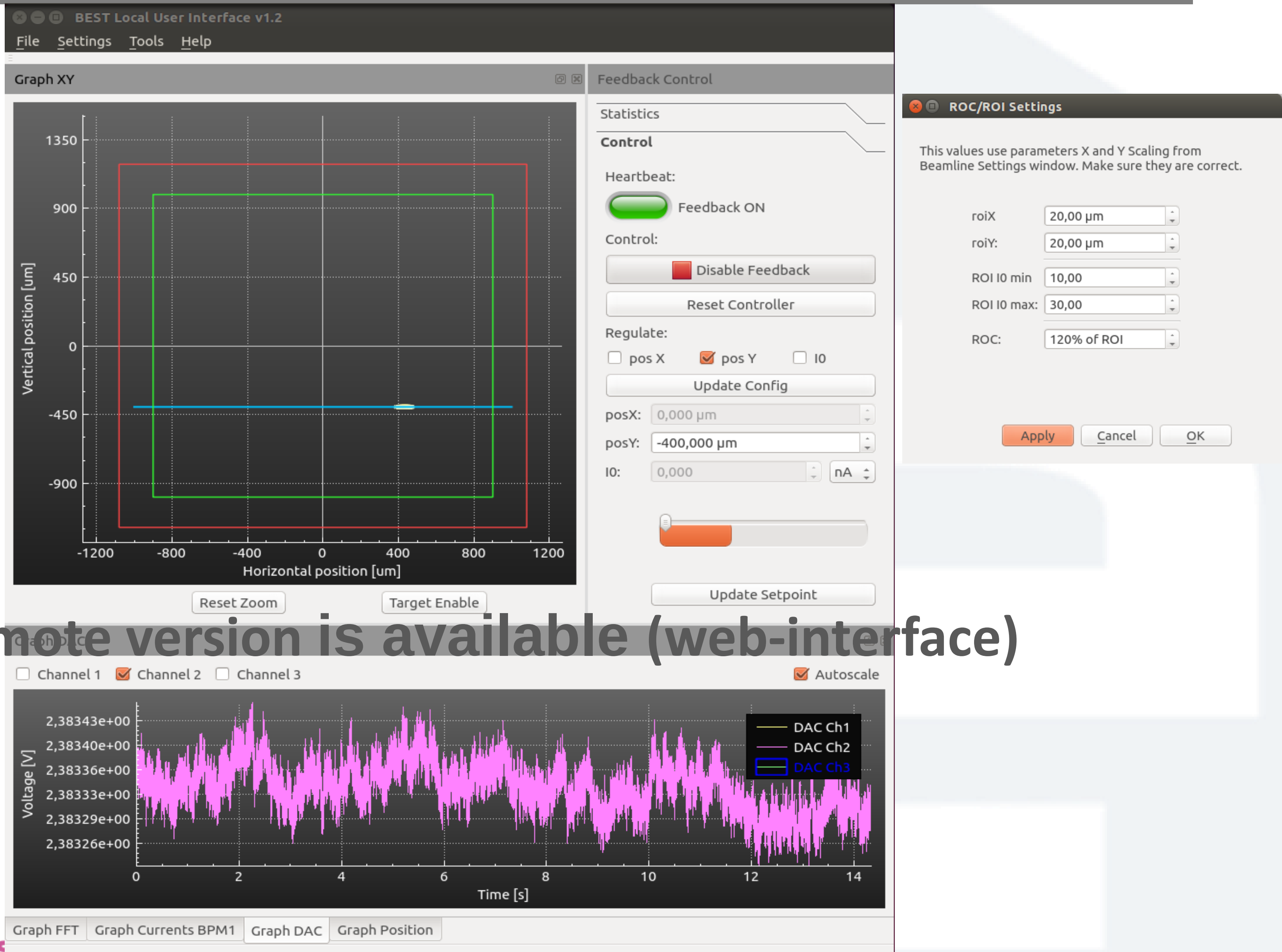
- Hosting a Linux Operating System able to run: local GUI, EPICS Server, TCP/IP Server.
- FPGA logic, able to process the control algorithm (PID or IIR 10-tap filter) in less than 10 μs (TetrAMM Fs=100kHz).
- Compensation of all disturbances within the typical temporal bandwidth of a beamline data acquisition, i.e. up to 1 kHz and even beyond.
- Light systems rigidly connected (e.g.: DCM crystals pitch/roll) can follow the BEST signals up to several hundreds of Hz, whilst heavier units (e.g.: X-ray mirrors pitch) are usually intrinsically limited to the tens of Hz regime.

BEST – Building Blocks



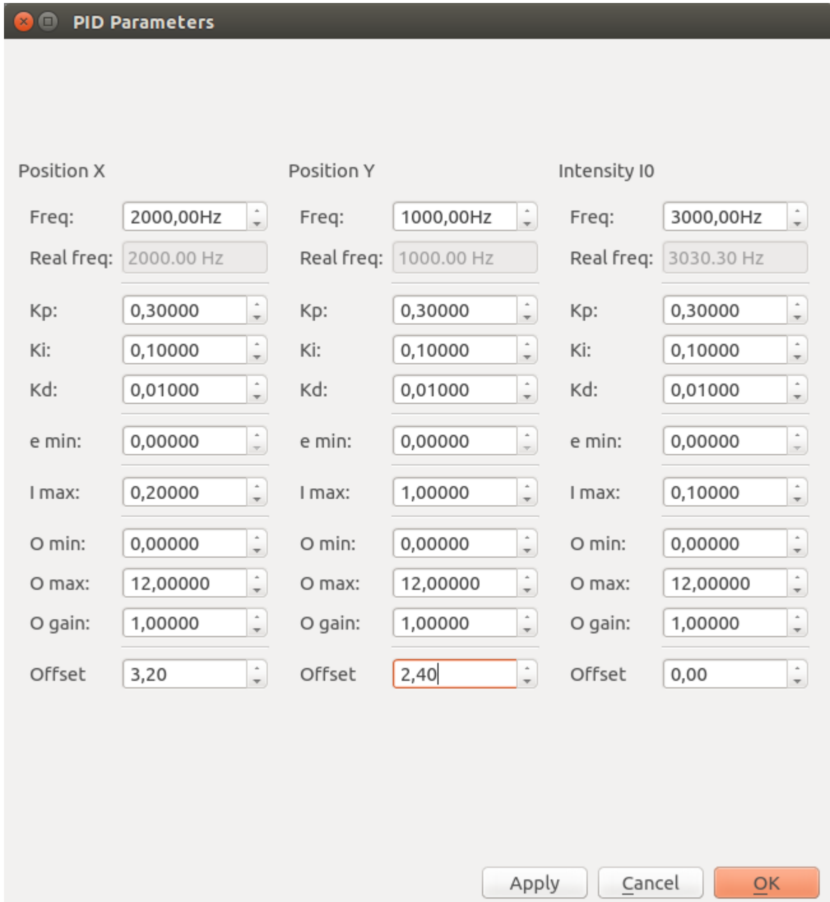
- PID/IIR algorithms are digital and FPGA computed.
- **Positions (X,Y) and intensity of the beam are independently controlled by three different digital controllers.**
- Slower and non-critical tasks (like configuration commands) are performed on the embedded industrial PC running a Linux OS with dedicated software.
- Standard 10/100/1000 TCP-IP Ethernet link allows the remote control and configuration of the BEST system.

BEST – GUI (local version)



Remote version is available (web-interface)

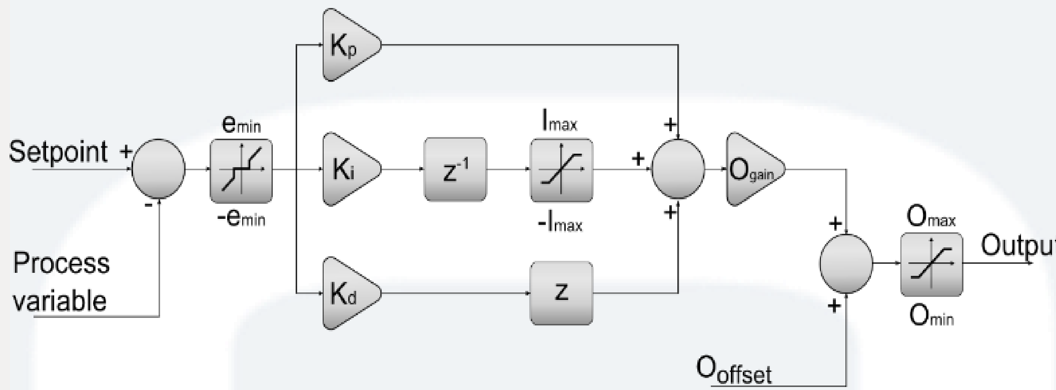
BEST – PID Controller



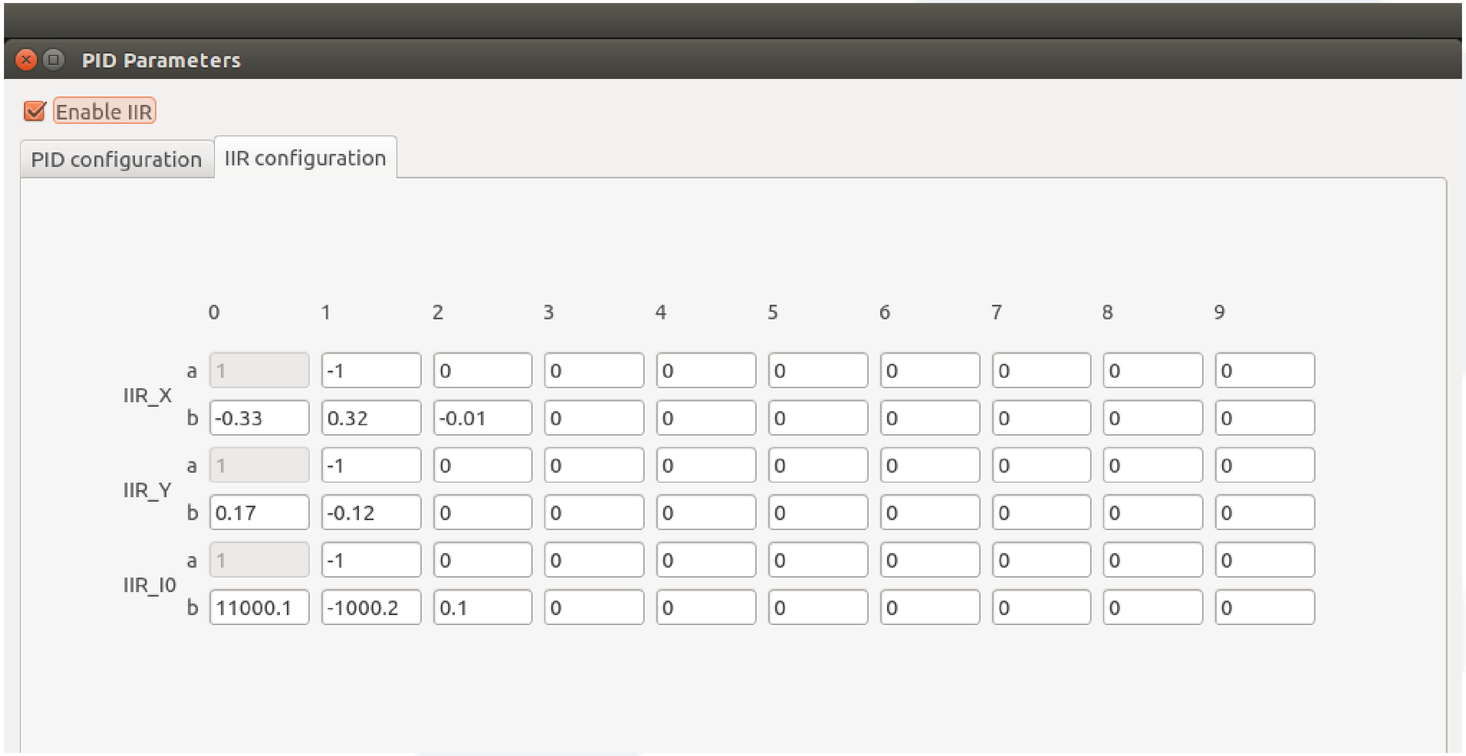
PID Parameters

	Position X	Position Y	Intensity I0
Freq:	2000,00Hz	1000,00Hz	3000,00Hz
Real freq:	2000.00 Hz	1000.00 Hz	3030.30 Hz
Kp:	0,30000	0,30000	0,30000
Ki:	0,10000	0,10000	0,10000
Kd:	0,01000	0,01000	0,01000
e min:	0,00000	0,00000	0,00000
I max:	0,20000	1,00000	0,10000
O min:	0,00000	0,00000	0,00000
O max:	12,00000	12,00000	12,00000
O gain:	1,00000	1,00000	1,00000
Offset	3,20	2,40	0,00

Apply Cancel OK



BEST – IIR Controller



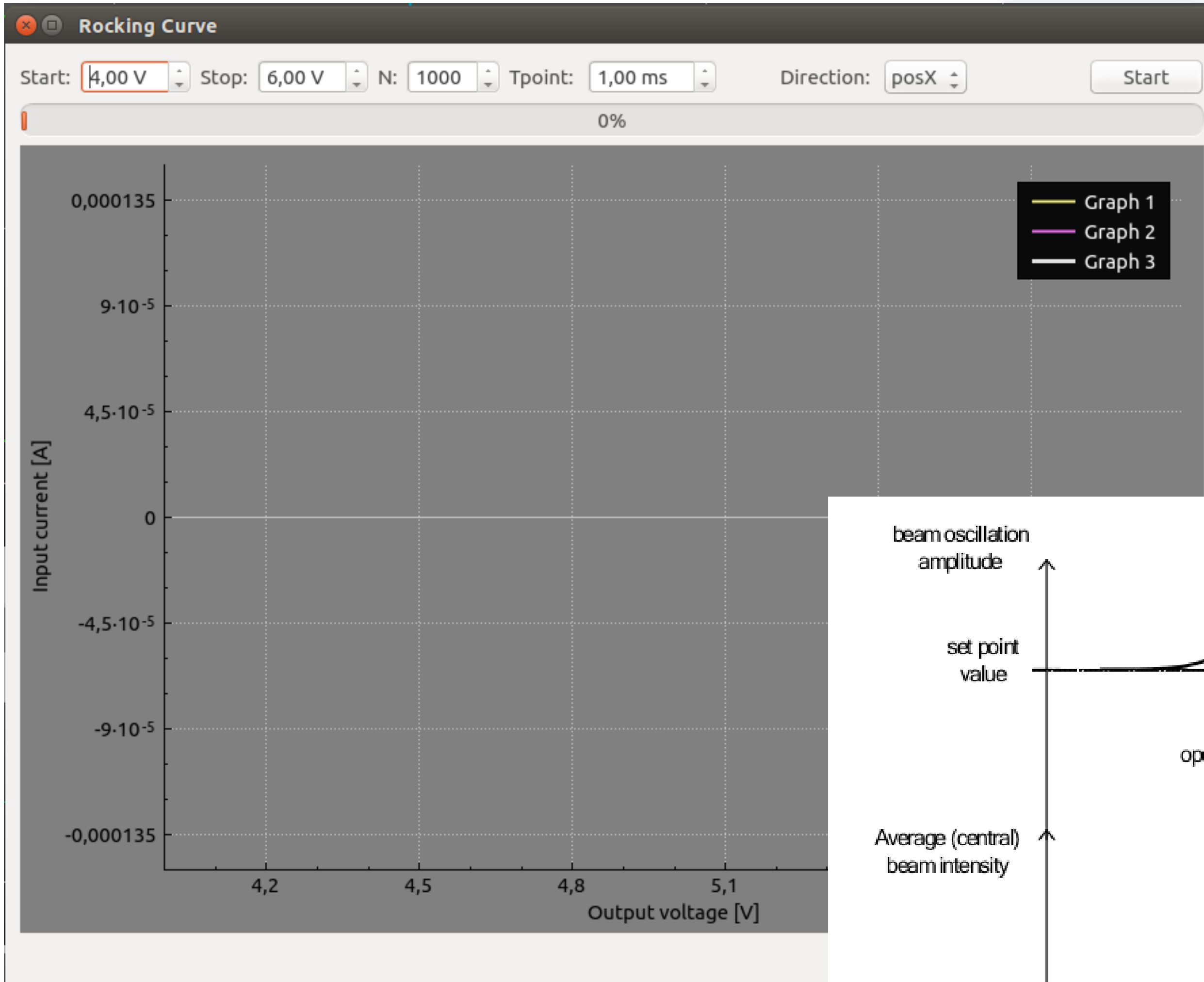
Difference equation:

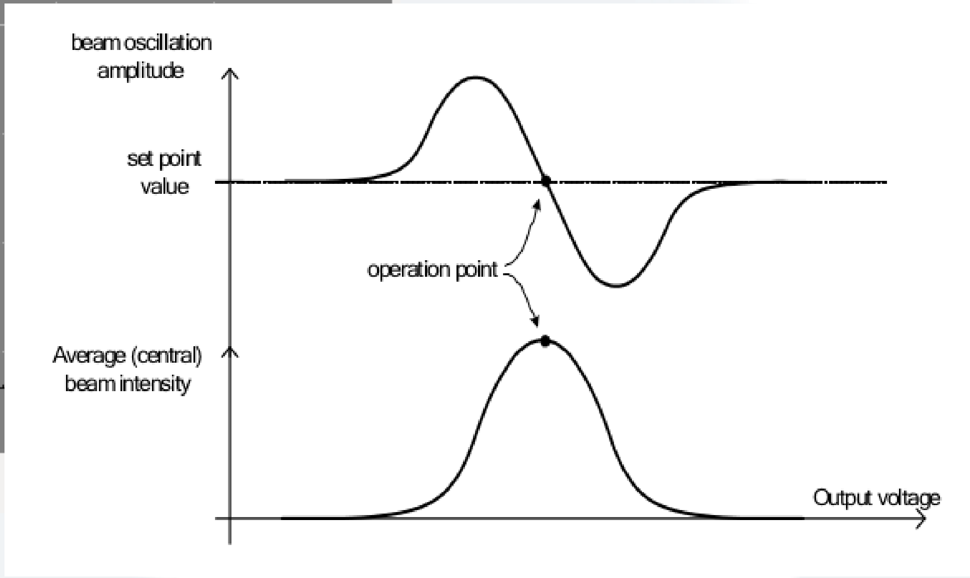
$$y(n) = \sum_{i=0}^{N} b_i x_{(n-i)} - \sum_{i=1}^{N} a_i y_{(n-i)}$$

Transfer function:

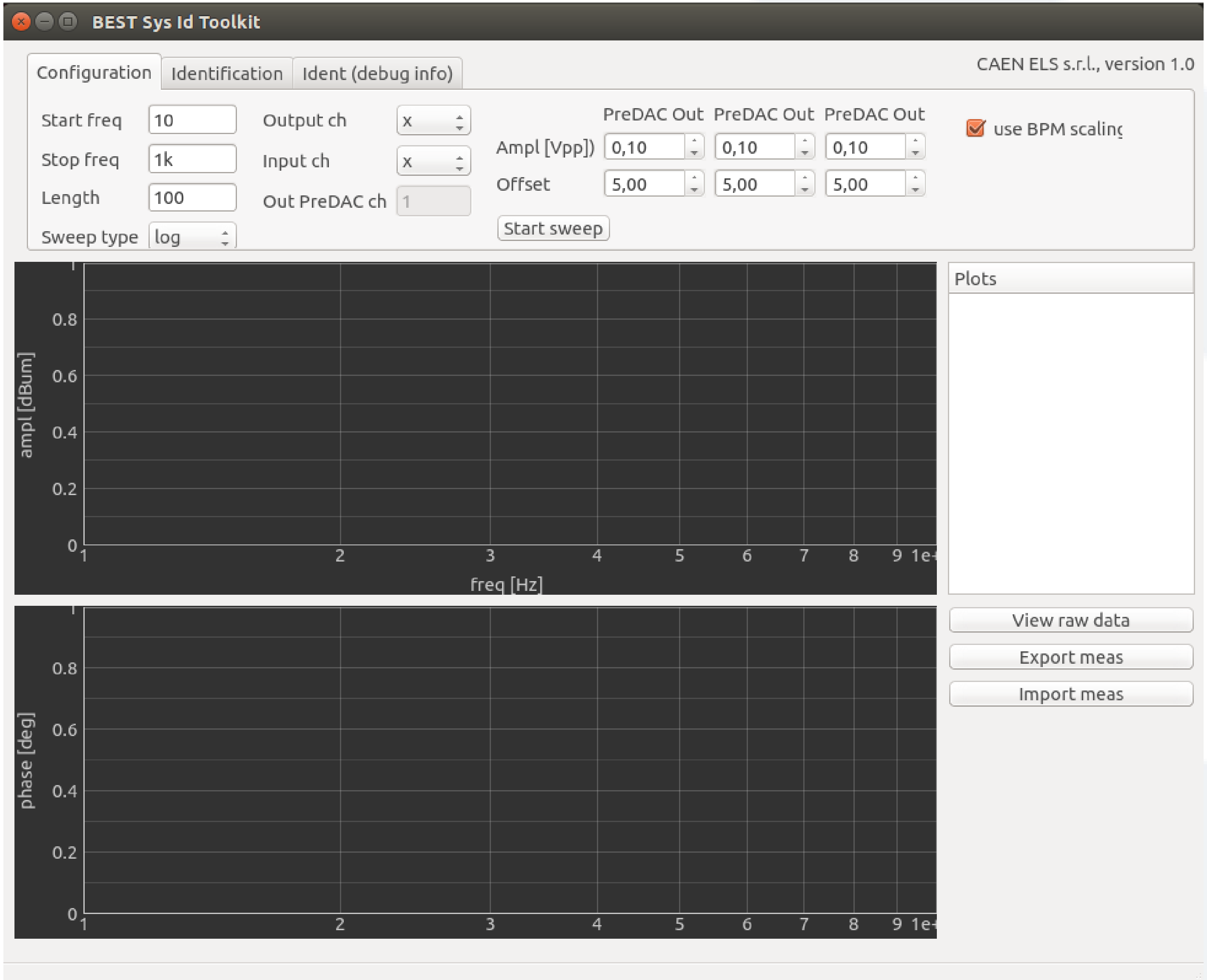
$$\frac{Y_{(z)}}{X_{(z)}} = \frac{\sum_{i=0}^{N} b_i z^{-k}}{1 + \sum_{i=1}^{N} a_i z^{-k}}$$

BEST – Intensity Controller (New Feature)

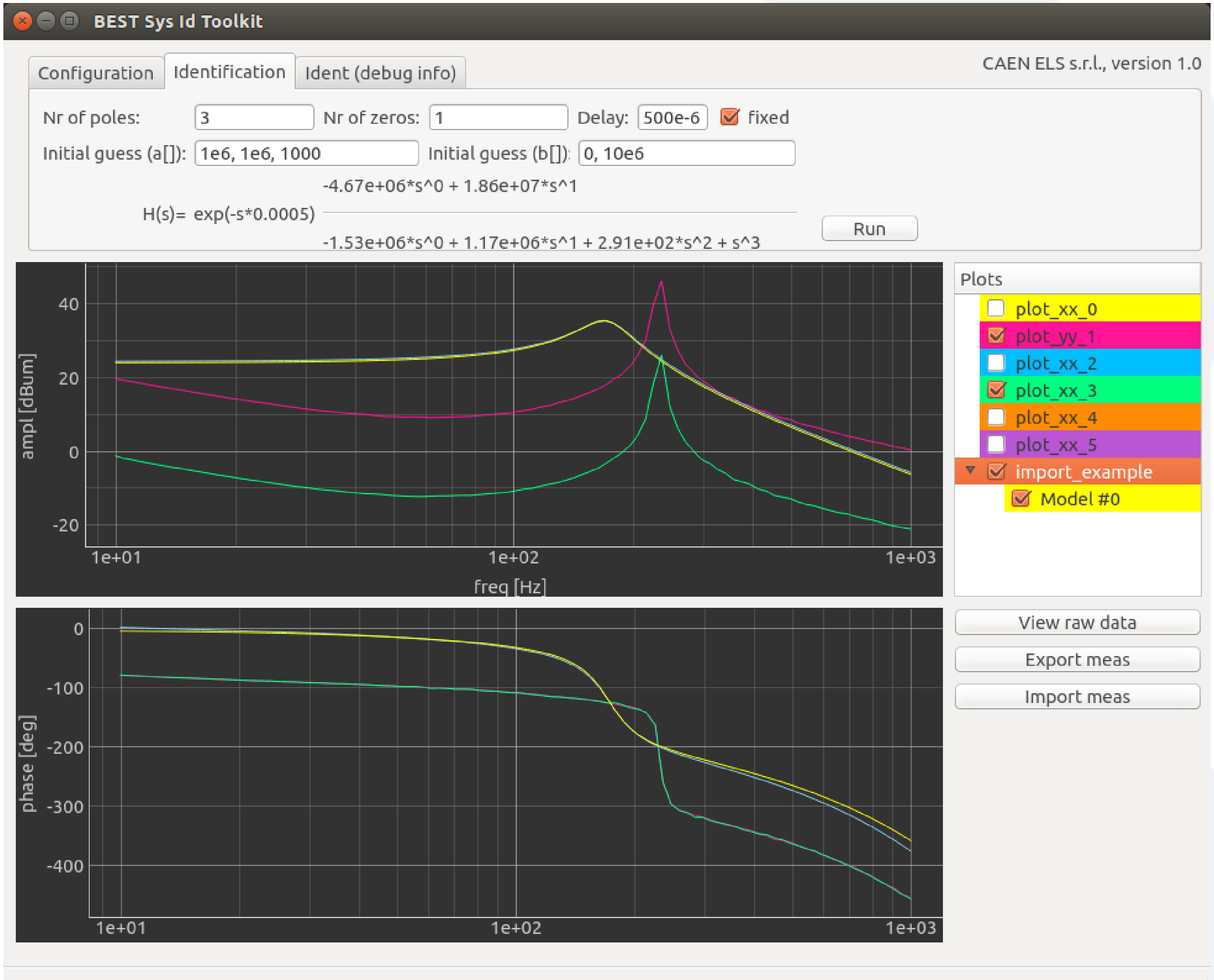




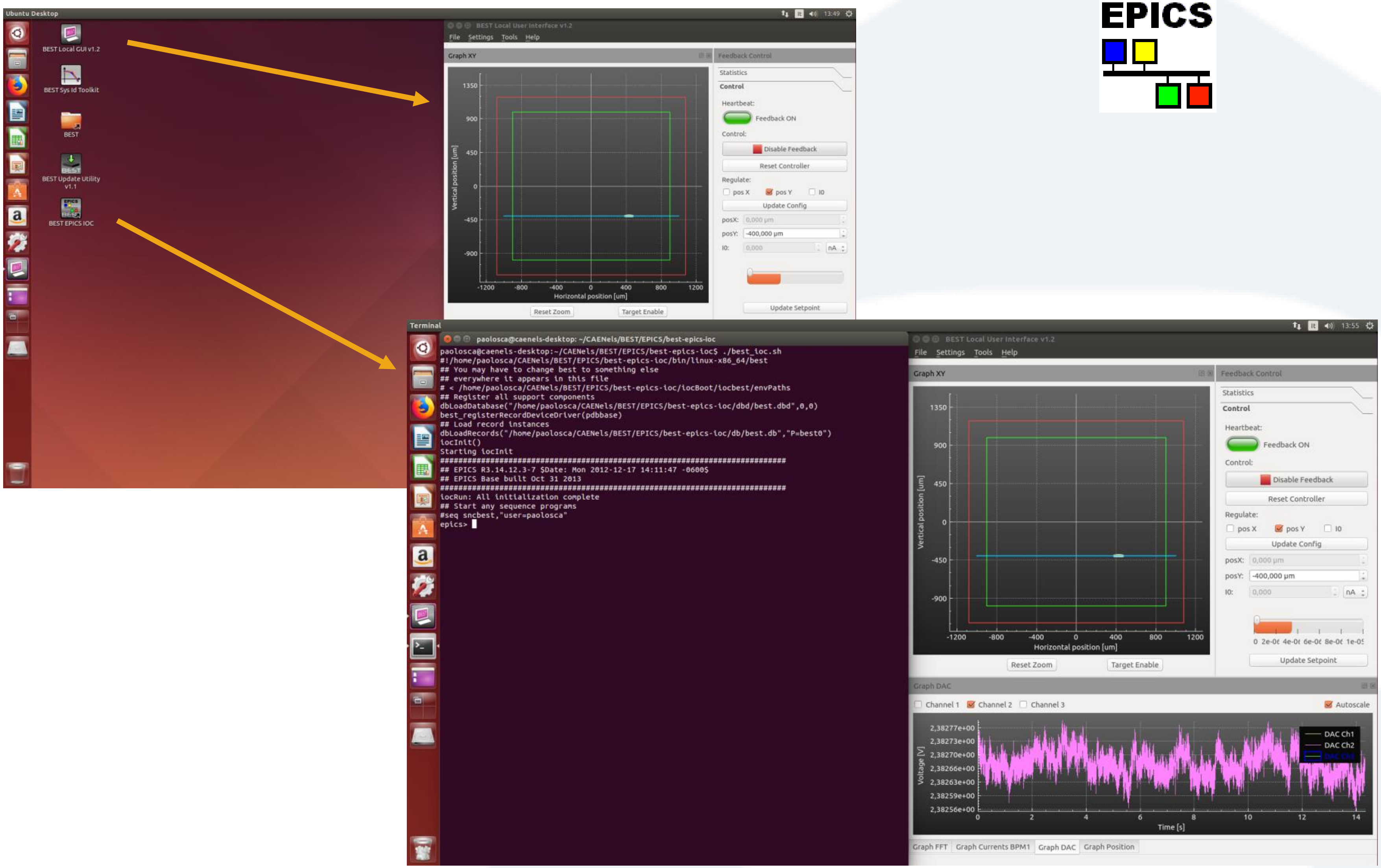
BEST – System Identification Toolkit



BEST – System Identification Toolkit



BEST – EPICS Integration



BEST References

BROOKHAVEN NATIONAL LABORATORY

USA

Canadian Light Source
Centre canadien de rayonnement synchrotron

Canada

diamond

Great Britain

KEK
HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

Japan

SOLEIL SYNCHROTRON

France

SSRF Shanghai Synchrotron Radiation Facility

China

Outline

10:00	Welcome by Dr. Thomas Walter (DESY MicroTCA Lab)
10:10	Short Overview of the CAEN Group and CAEN ELS
10:25	History and Evolution of the CAEN ELS picoammeters for photon BPMs
10:40	Charge-Integration picoammeters: AH401D and TetrAMM-CI
10:50	Transimpedance picoammeters: AH501D and TetrAMM
11:05	Coffee Break
11:30	Worldwide Applications of the CAEN ELS picoammeters
11:40	Applications for CAEN ELS picoammeters at DESY Beamlines and facilities
11:55	BEST – Beamline Enhanced Stabilization Technology and encoder integration
12:15	**CAEN ELS picoammeters for MicroTCA and further MicroTCA devices**
12:30	Lunch Break

MicroTCA and FMC

MicroTCA TECHNOLOGY LAB

A HELMHOLTZ INNOVATION LAB

driven by DESY

Development, Manufacturing and Distribution Partners:

CAENels Gear For Science

elspec group GmbH

struck innovative systeme

PENTAIR

powerBridge Computer

N.A.T.

ROHDE&SCHWARZ

BEVATECH

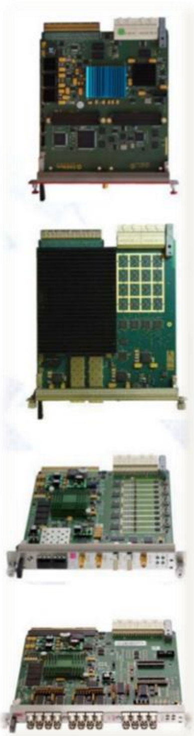
Why MicroTCA?

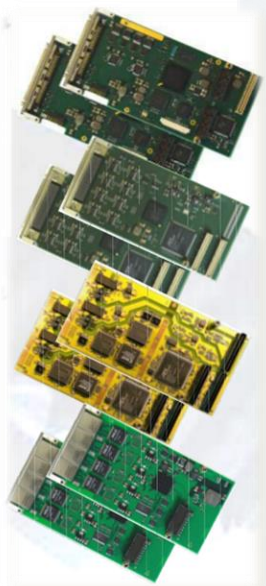
- Growth of particle accelerators applications
- Rapid increase in facilities
- Particle accelerators modularity

The need for industrial standardized solutions

MicroTCA

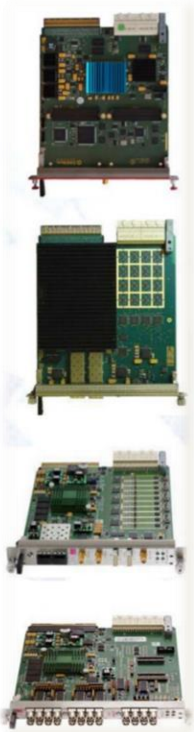
In order to **speed up the design and operation of new facilities**, CAENELS has the commitment of providing **high-tech, ready to be installed solutions** to designers and users

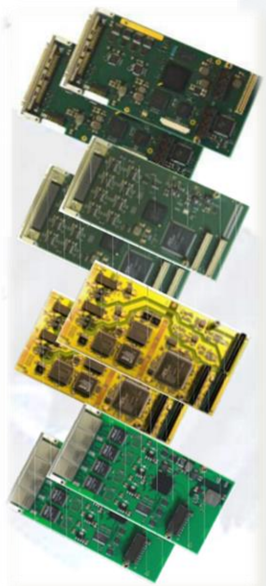




MTCA provides:

- High speed data transfer
  - PCIe x8 Gen.3
  - ETH 1/10/40 Gb
- Excellent analog performance
- Complete local and remote management
- Redundancy
- Scalability
- Open, mature, robust STANDARD and continues to evolve
- Large variety of
  - processor boards (X86, ARM, FPGA, DSP, ..)
  - I/O functions (AMC, IP, FMC, ..)
  - Chassis





Growing Applications:

- ❑ Optical synchronization system
- ❑ Diagnostic systems (monitors)
  - Bunch arrival time
  - Bunch compression
  - Charge measurement
  - Beam loss and Beam Halo
  - Wire scanner
- ❑ Beyond physics
  - Aerospace
  - Telecommunication
  - Industrial automation
  - Defense
  - Test and measurements

CAENels
Gear For Science

CAEN ELS MTCA + FMC Products

FMC-PICO-1M4

4-channel 20 bit 1 MSPS FMC Floating Ammeter

FMC-2SFP+/ FMC-4SFP+

Dual- and Quad- Channel SFP/SFP+ FMC Adapter

FMC-MOTDRV22

FMC Dual-Channel Stepper Motor Driver

DAMC-FMC25

AMC Dual High Pin Count FMC Carrier Board

DAMC-FMC20

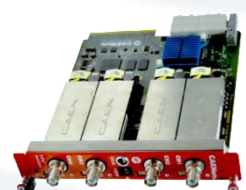
AMC Dual High Pin Count FMC Carrier Board

AMC-PICO-8

8-channel Bipolar 20-bit Picoammeter With MTCA.4 Rear I/O

HV-PANDA

AMC Dual High Pin Count FMC Carrier Board



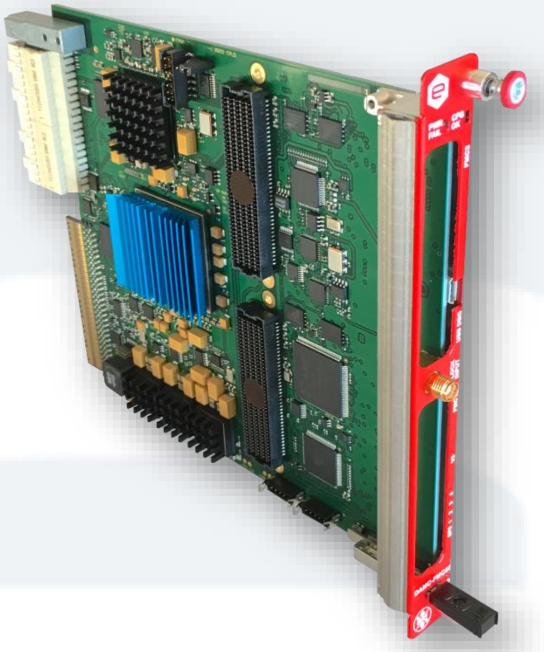
CAENels
Gear For Science

DAMC-FMC25

DAMC-FMC25

AMC Dual High-Pin Count FMC Carrier Board

- Double width AMC board – MTCA.4 carrier
- Two HPC FMC slots
- Data processing on Virtex-5 FPGA
- Board management on Spartan-6 FPGA
- RTM D1.1 connectivity
- DDR2 memories on both FPGAs
- External clock input on front panel SMA connector
- 6.5 Gbps ("-2") transceiver board options



DESY μTCA®

License Agreement LV75 between DESY and CAEN ELS

FMC-PICO-1M4

4-channel 20-bit 1 MSPS bipolar FMC picoammeter

- Standard FMC - Vita 57.1
- Bipolar **current-input** stage (transimpedance readout)
- **Two standard measuring ranges** (±1 mA and ±1 µA)
- **CUSTOMIZATION of ranges** upon request
    - Custom versions for FRIB, Sirius, INFN, European Spallation Source (ESS)
    - **Up to 300 kHz bandwidth** with 3-nF input capacitance (i.e. long cables)
- 20-bit resolution
- Up to 1 MSPS
- **Floating up to ±300 V**
- Extremely low unbalance between channels (by analog design)
- I2C EEPROM in-factory calibration

FMC-Pico-1M4

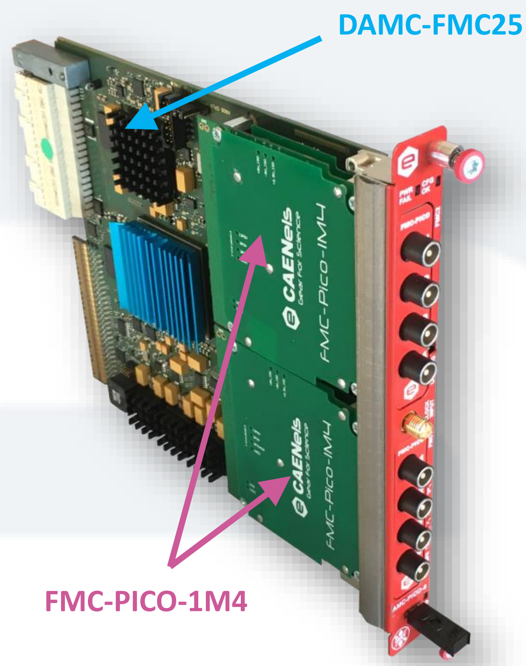
Equivalent Input Noise		
	RNG0: ±1 mA	**RNG1: ±1 µA**
F_S = 2 ksps	1 ppm/FS -120 dB	2.5 ppm/FS -112 dB
F_S = 20 ksps	2 ppm/FS -114 dB	7 ppm/FS -103 dB
F_S = 200 ksps	5 ppm/FS -107 dB	10 ppm/FS -100 dB
F_S = 1 Msps	8 ppm/FS -102 dB	15 ppm/FS -96 dB

CAENels Gear For Science

AMC-PICO8

8-channel 20-bit 1 MSPS bipolar current-input AMC picoammeter

- 1 MSPS 20-bit simultaneous sampling (8-channels)
- Inputs floating up to 300 V
- Trigger/Oscilloscope functionality
- Based on the DAMC-FMC25 carrier designed by DESY
- 2 picoammeter FMC-Pico-1M4 supported
- BSP, driver and GUI available



Avoids ground loops if two different detectors are connected to the same DAMC-FMC25 - e.g. quadrature detectors

Turnkey solution with dual 4-channel (8-channel) floating picoammeter!

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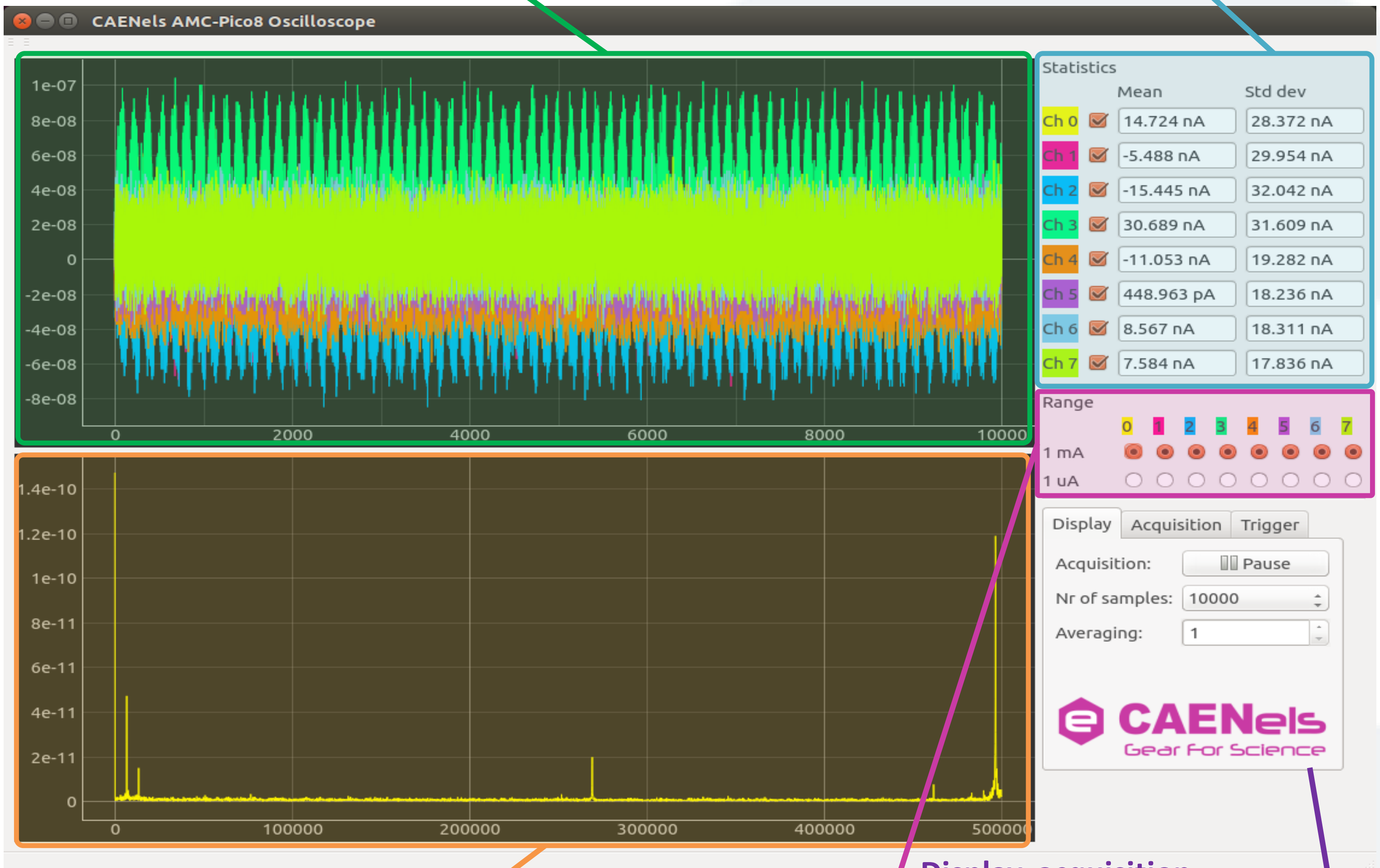
AMC-PICO8 Software

Time Plot

Signal statistics

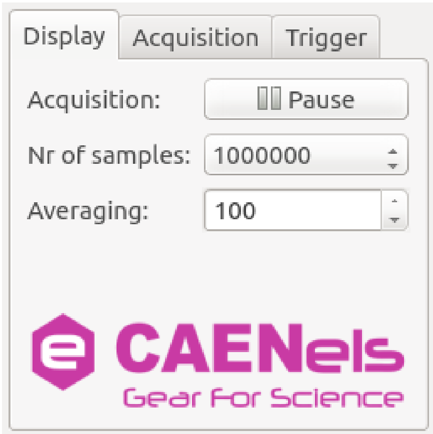


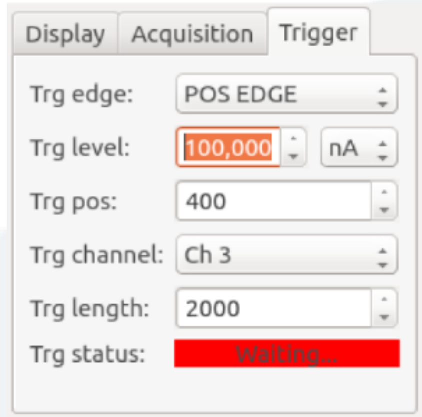
FFT Plot

Range selection

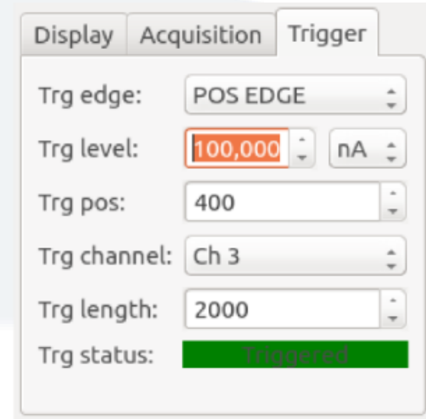
Display, acquisition, trigger options

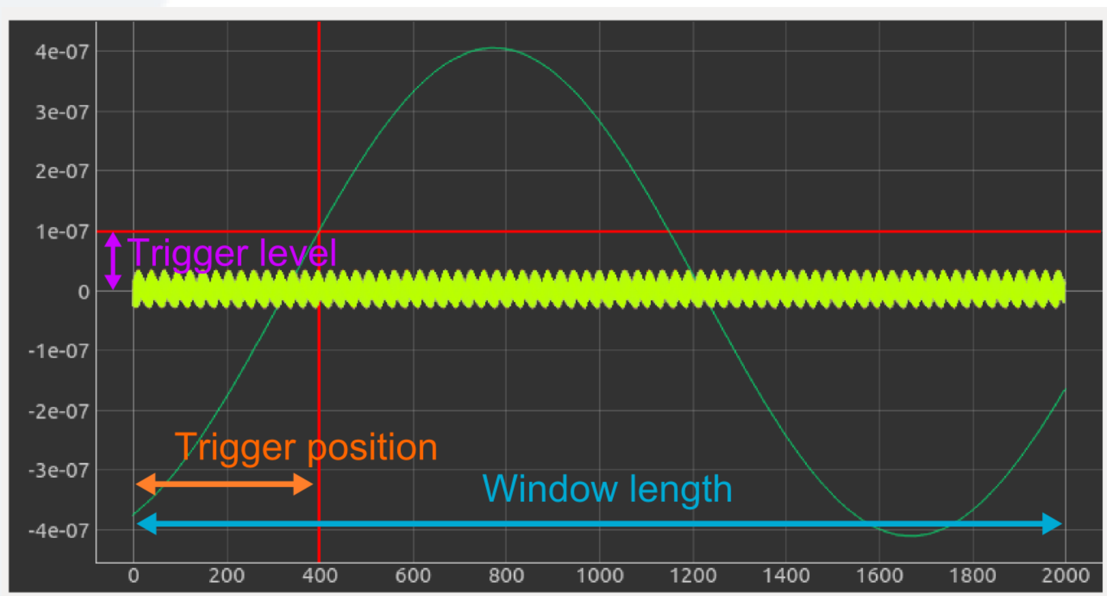
AMC-PICO8 Software





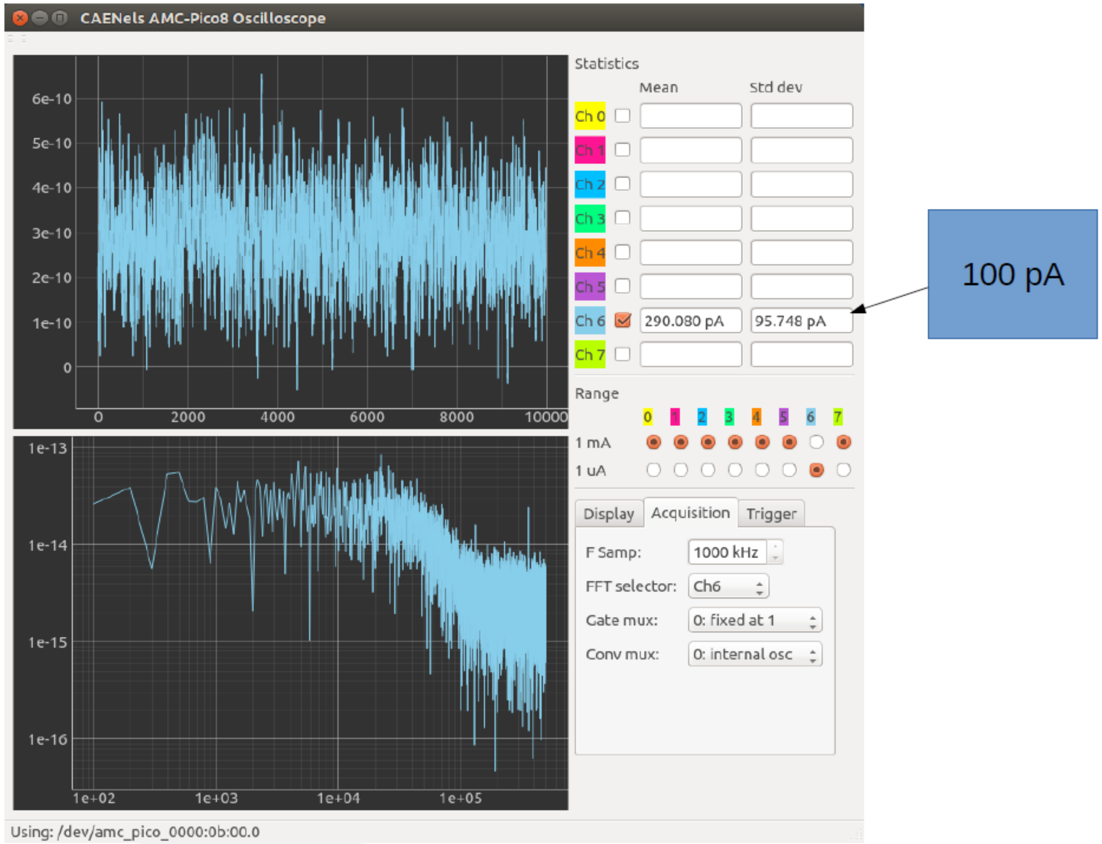
trigger condition →





CAENels
Gear For Science

AMC-PICO8 Noise Performance



The RMS noise with 1 MHz sampling is in the order of 100 pA (30 ppm/full scale).

This can be further reduced by on-board filtering – e.g. averaging – over a user-defined time period.

HV-PANDA

HV-PANDA

HV Positive And Negative Double-width AMC

- Double-Width AMC Board – Full Size
- MTCA.4 carrier
- Four High-Voltage channels
- Output ratings:

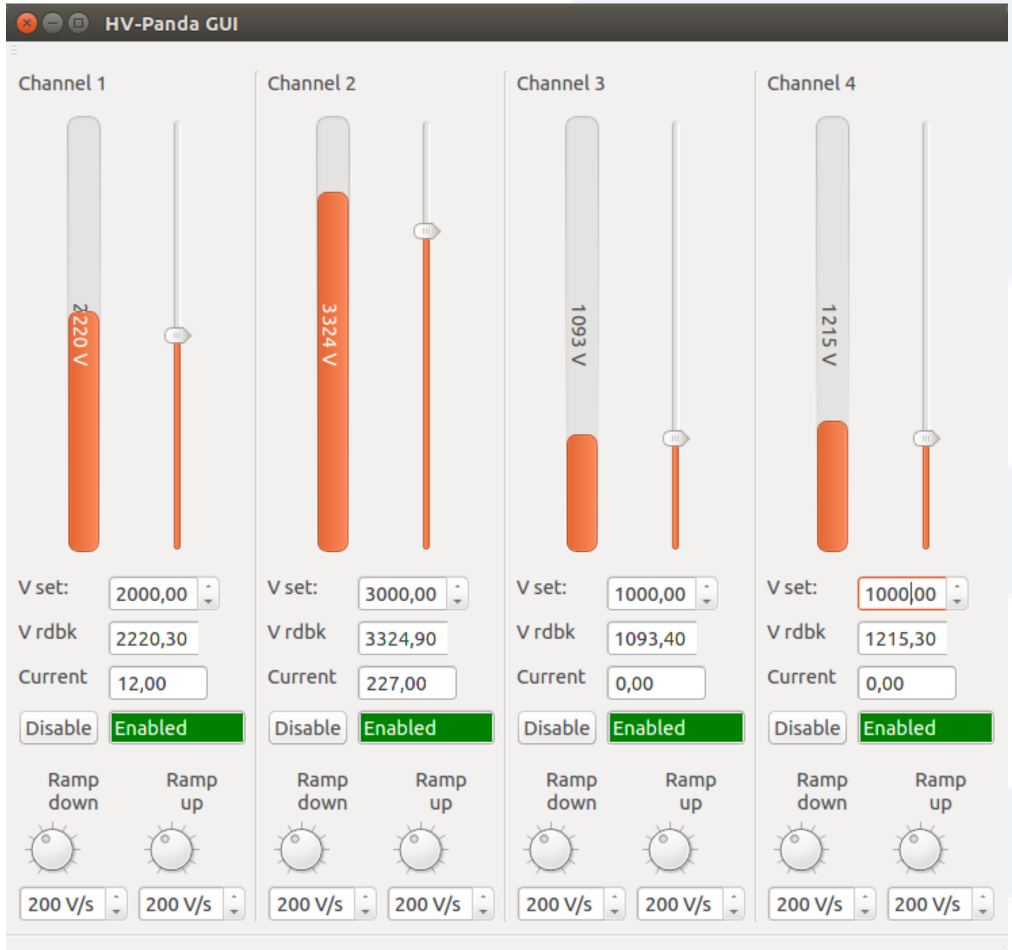
  500 V @ 1.5 W

  4 kV @ 7 W

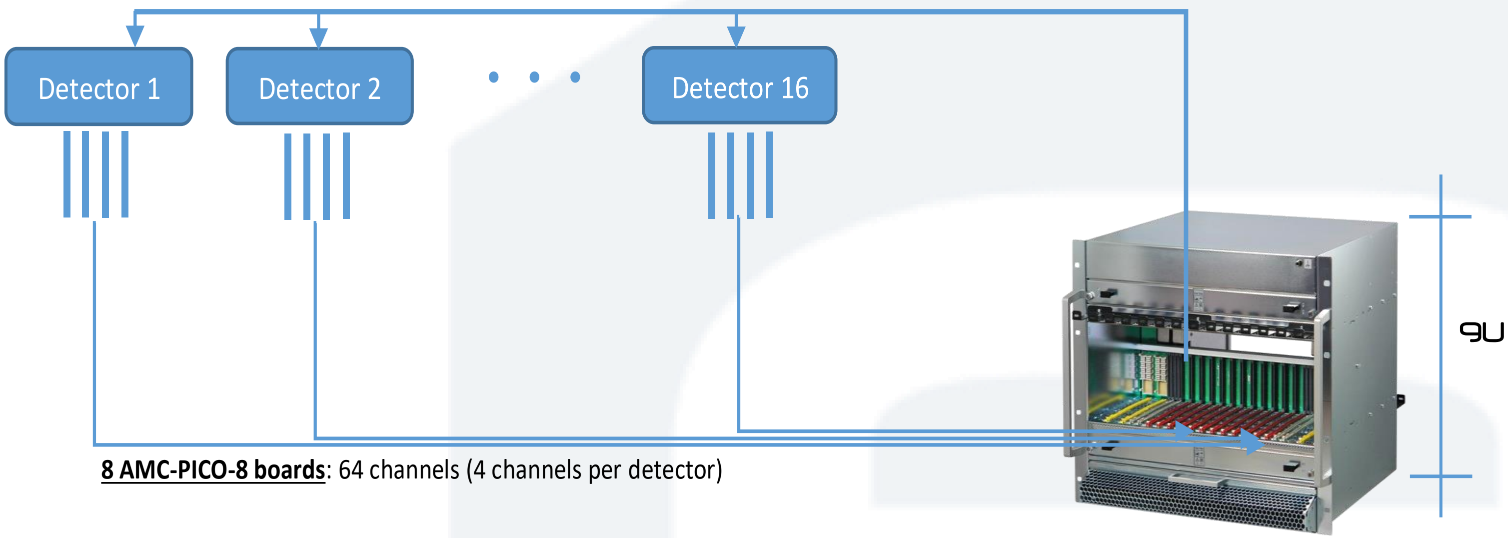
  6 kV @ 6 W
- **Polarity selectable**
- Provides infrastructure for management of optional Rear Transition Module (RTM) boards – class D1.1
- DDR3 On-board Memory (up to 4 Gbit)
- Separate Interlock for each channel and global one
- Stand-by voltage, Ramping, Current Monitoring and Current Limit

Cooperation with DESY in the Helmholtz Validation Fond Project «MTCA.4 for Industry» (**HVF-0016**)

HV-PANDA Software



Control and Monitor of (up to)16 Quadrature detectors



8x

2x

+ 1 Power Module

+ 1 MCH Carrier Hub

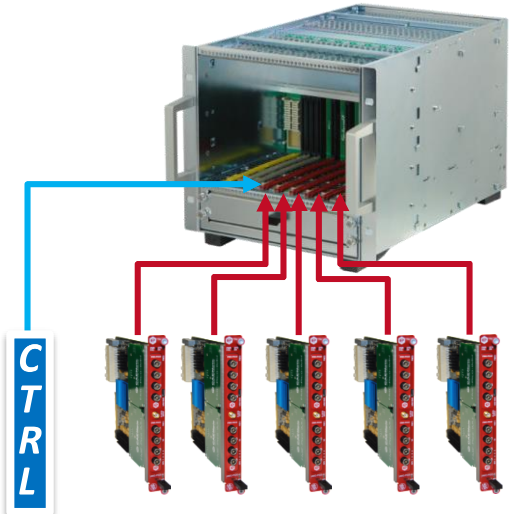
1 MSPS @ 20 bit
mA (custom also) full scales
SW embedded

Up to 6 kV
Ripple at ppm level
Readback at 0.01% accuracy
SW embedded

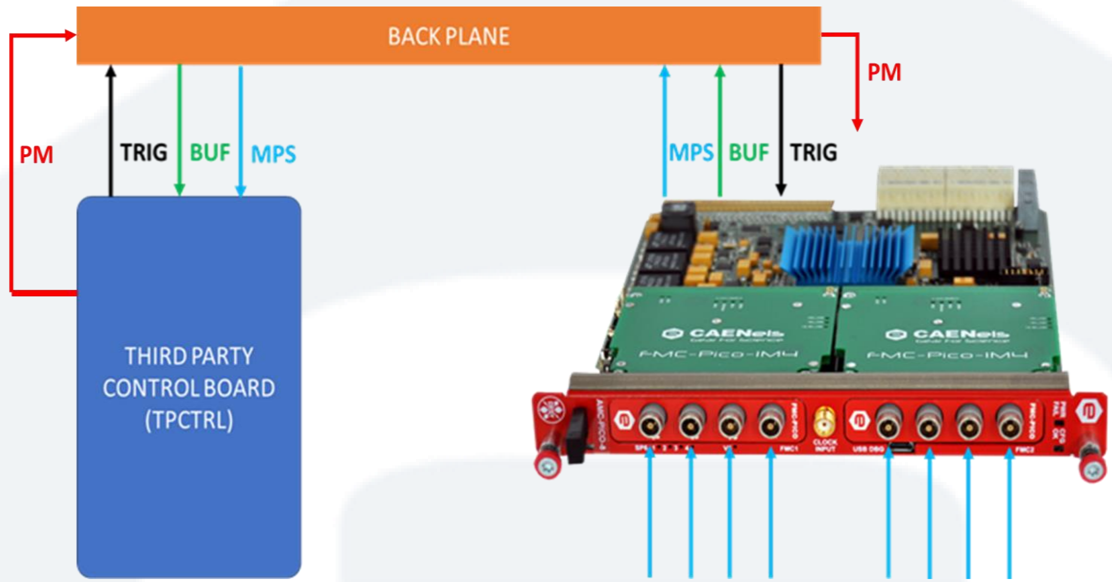
CAENels Gear For Science

AMC-PICO8 Custom Application

Machine Protection System



Up to 5 AMC-Pico-8 boards per crate
(40 channels)



1. **BUF**: The AMC-Pico-8 stores a data buffer (BUF);
2. **TRIG**: In response to a trigger signal (TRIG) from the TPCTRL the AMC-Pico-8 outputs the data buffer (BUF). BUF is sent to the TPCTRL via the backplane. TRIG also comes from the backplane.
3. **MPS**: Under specific situations the AMC-Pico-8 generates a **Machine Protection System (MPS)** signal to be sent to the TPCTRL via the back plane (response time 10 μs).
4. **PM**: Under specific situations the AMC-Pico-8 receives a Post Mortem signal from the TPCTRL. In this case BUF is sent to the TPCTRL also.

FMC-SFP+

Dual- and Quad-channel SFP/SFP+ FMC Adapter

- Dual-channel and Quad-channel versions
  - **FMC-2SFP+**
  - **FMC-4SFP+** (w/out FMC bezel)
- Wide I/O operating range: VADJ can vary from 1.5V to 3.3V
- Tested **up to 10 Gbps / channel**
- True level conversion of all SFP+ module pins including I2C lines
- I2C-controlled Oscillator (10-280 MHz)
- Compatible with the DAMC-FMC25 carrier board
- Produced and supported by CAEN ELS
- Designed by DESY

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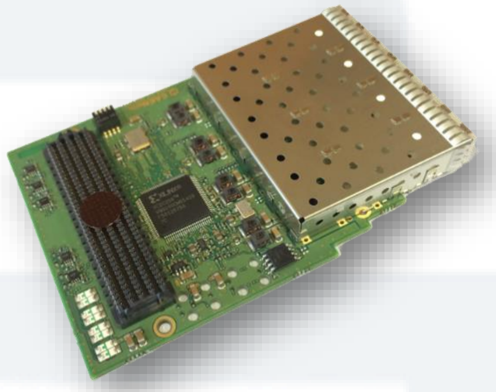
between DESY and CAEN ELS

2-channel version

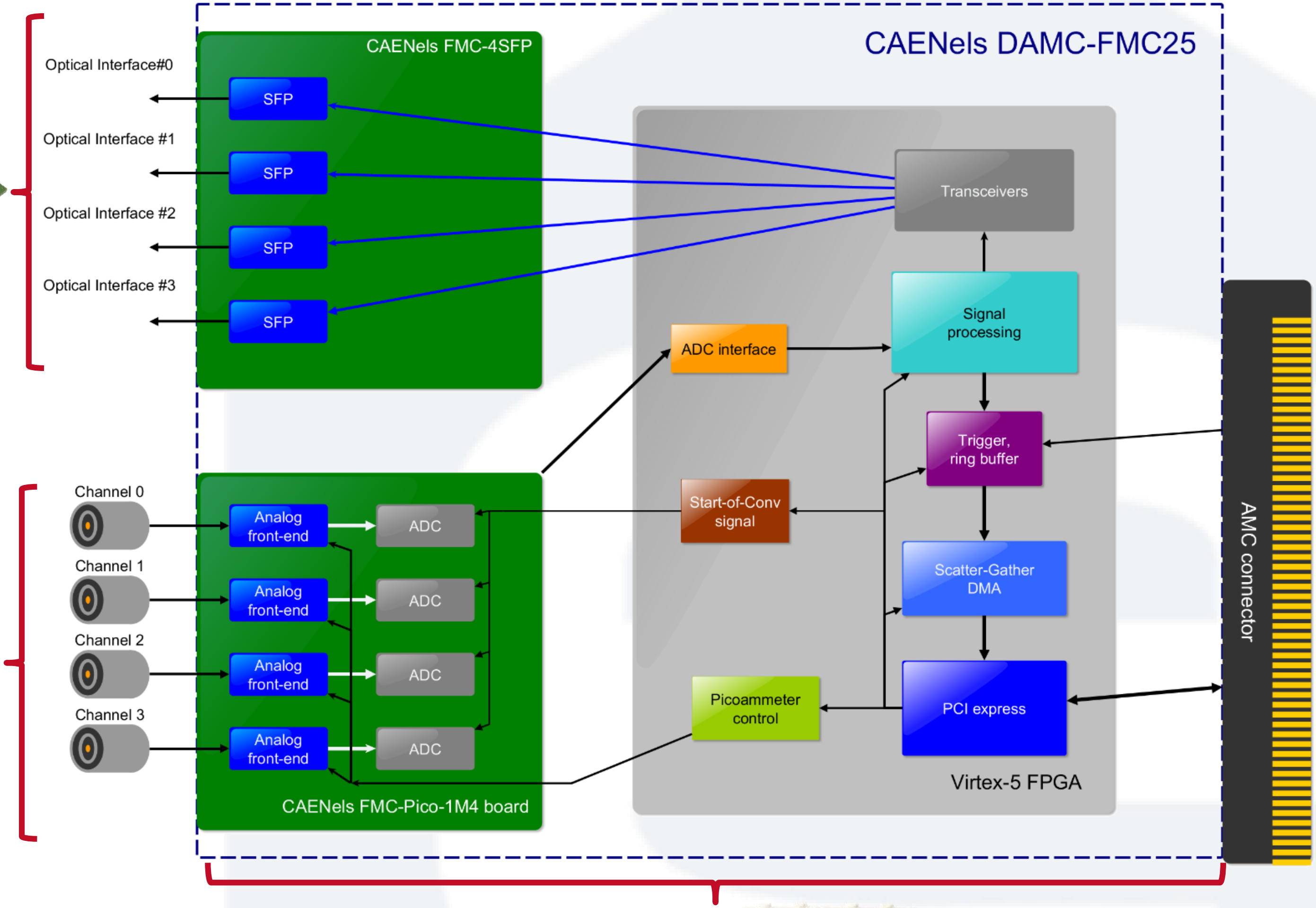


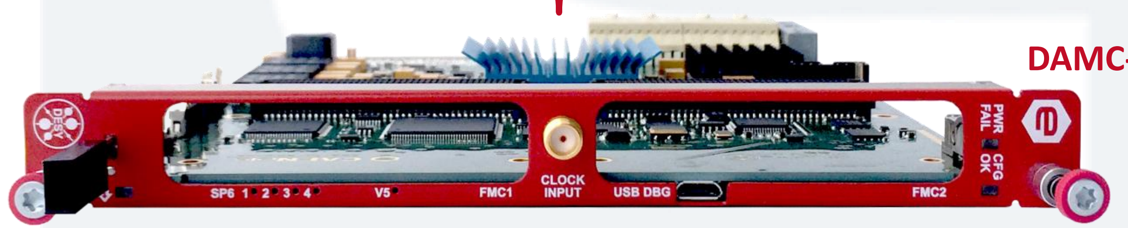
4-channel version

Custom Application

FMC-4SFP+

FMC-PICO-1M4





DAMC-FMC25

MTCA and FMC References

Ankara Üniversitesi 1946
Turkey

Berkeley Lab
USA

DESY
Germany

eli beamlines
Czech Republic

ess European Spallation Source
Sweden

FRIB
USA

GSI
Germany

HZB Helmholtz Zentrum Berlin
Germany

ibs Institute for Basic Science
South Korea

INFN Istituto Nazionale di Fisica Nucleare
Italy

KIT Karlsruher Institut für Technologie
Germany

LNLS sirius
Brasil

Raytheon BBN Technologies
USA

上海交通大學 Shanghai Jiao Tong University
China

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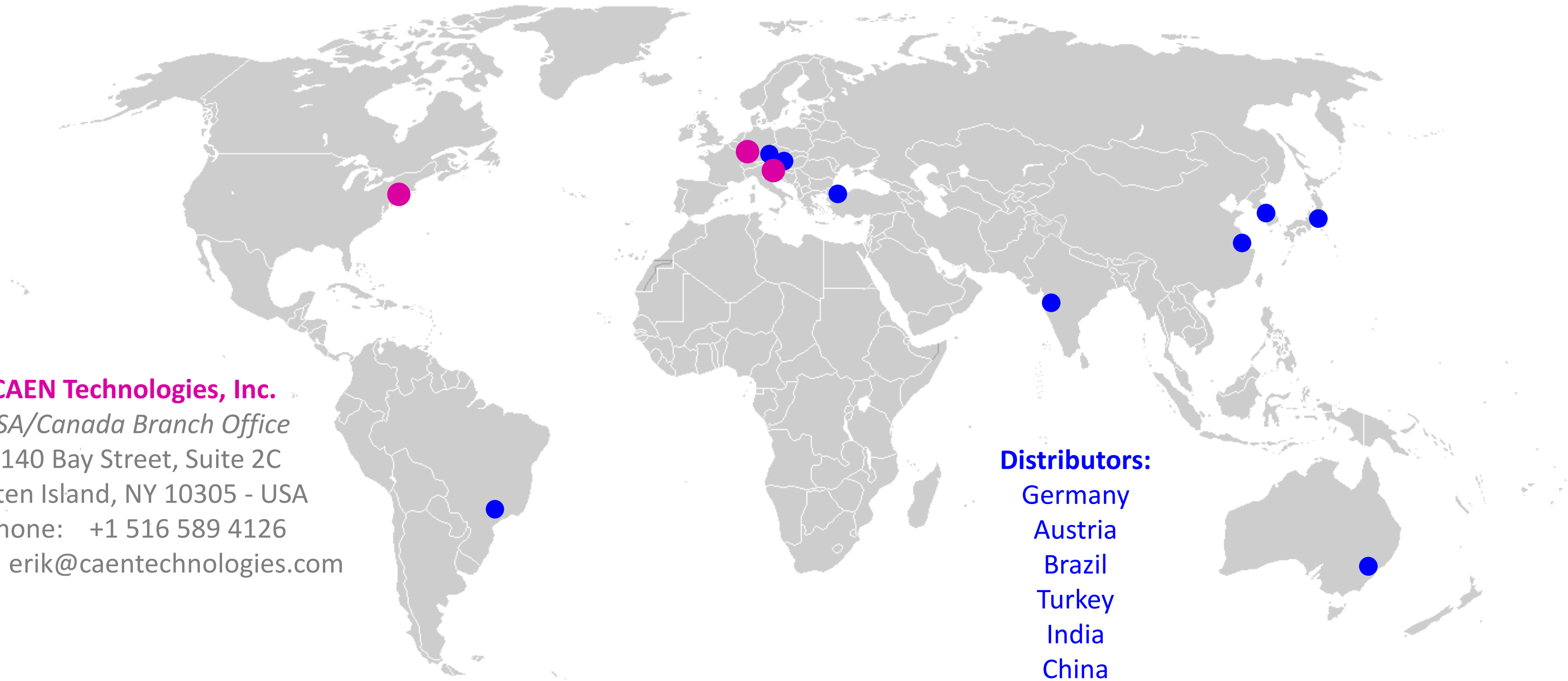
mail: **info@caenels.com**



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India
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South Korea
Japan
Australia
...

www.caenels.com

Paolo and me will be still at DESY tomorrow.

We offer to you to have a personal meeting with us from CAEN ELS!!!

If you want to talk also about MicroTCA devices more specifically our partners from the MicroTCA Lab would be happy to also come along to your office or beamline.

Please just approach us during lunch break or coffee breaks to make an appointment!!!

BACKUP SLIDES

FMC-MOTDRV22

Dual-channel FMC Stepper Motor Driver

- Dual-channel stepper motor driver
- Supports up to **1.8 A motor coil current**
- Three different versions
    - 12-V internal supply
    - 12-V external supply
    - 24-V external supply
- Compatible with the DAMC-FMC25 carrier board
- Produced and supported by CAEN ELS
- Designed by DESY

FMC-MOTDRV22 and cable

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between DESY and CAEN ELS

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Gear For Science
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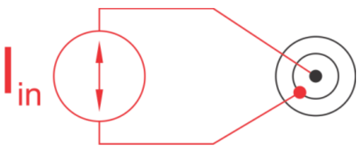
AMC-Pico-8

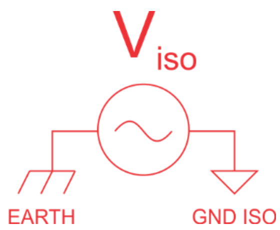
Technical Specifications

Board Size	Double-Width – Mid-Size
Input Channels	8
Input Connector Type	Triaxial – LEMO 00.650 Series (EPL.00.650)
Current Input Full-Scale Ranges (configurable upon request)	±1 mA ±1 µA
Maximum Sampling Frequency	1 MSPS (per channel)
Equivalent Signal-to-Noise	RNG0: >100 dB RNG1: >90 dB
Current Resolution	2 nA 2 pA (20-bit)
Bandwidth (-3dB)	> 10 kHz
Temperature Coefficient – TC	10 ppm/°C
Differential TC	< 25 ppm/°C
Front End Isolation Voltage	± 300 V
Standard	MicroTCA.4: AMC.0, AMC.1 Module Management: IPMI Version 1.5, MMC V1.0
Compatibility	Zone3 Classification: Class D1.1 AMC Backplane Support: Full
Trigger Inputs	Internal, AMC port #17 RX AMC port #18 RX AMC port #19 RX AMC port #20 RX
Operating Temperature	0 … 50 °C

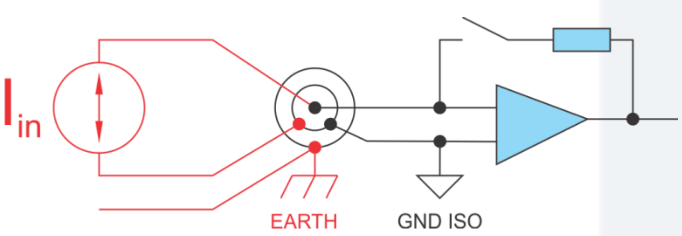


Measured current path

There can be large potential difference between the inner and the outer triaxial cable shield because of the front end isolation. Therefore the outer shield of the triaxial cable must be grounded (see **Figure 2**). The voltage between both shields must be limited as breakdown may occur so the maximum value of the isolation voltage is given in the specifications section.



Definition of isolation voltage. The default ground connection is done on the FMC board side through the FMC bezel which is connected to the grounded chassis



Grounding at the FMC board side

CAENels Gear For Science
www.caenels.com

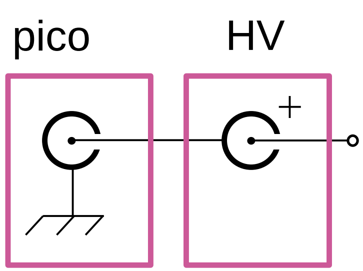
HV-PANDA

Technical Specifications	HV-PANDA	
Board Size	Full-Size	
Number of HV Channels	4	
AMC Board Type	PICMG - AMC.0 R.2	
Output Voltage Rating	6kV@6W 4kV@7W 500V@1.5W	
Polarity	Positive or Negative (Factory-selectable)	
RTM Support	Yes	
High-Voltage Return	Floating (per pair of channels) ±20V to PE	
Nominal Voltage Accuracy	< 0.05 %	
Output Voltage Ripple @ max P_{OUT}	up to 4 kV up to 6 kV	< 3 ppm_{PK-PK}/FS < 4 ppm_{PK-PK}/FS
Voltage/Current Readback Accuracy	< 0.05 %	
Voltage/Current Readback Resolution	0.01 %	
Ramp Slew Rate	from 1 to 500 V/s	
Ramp Slew Rate Step Size	1 V/s	
Stand-by Voltage Set Resolution	1 % of FS	
Current Limit Value Accuracy	< 4 % of FS	
Output Current Threshold Behaviour	Switch-off Current-source mode	
Output Voltage Connectors	SHV-type	

Worldwide Applications

Beamline Electronic Instrumentation

- Quad-diode
- Diamond detectors (DD)
- Ion chamber
- blade gap monitors
- radiation monitors



- Faraday cups
- Photodiodes
- HV current readings
- Beam loss monitor
- Semioconductor characterization (RSE)

BEST - Beamline Enhanced Stabilization Technology

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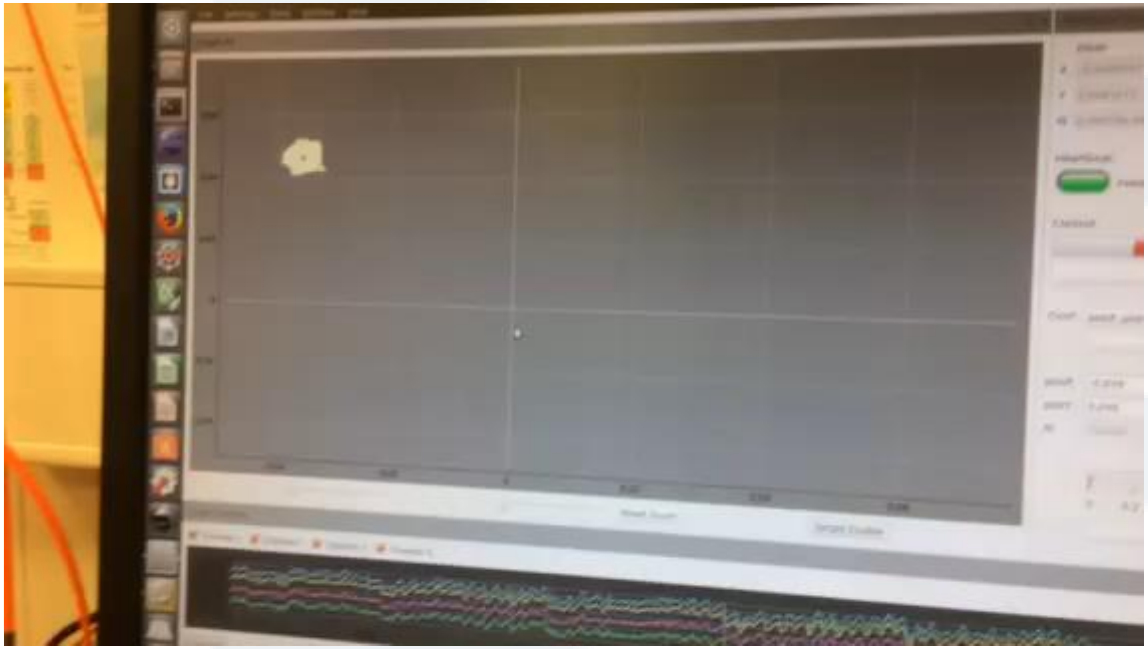
BEST
Software Suite



BEST - Beamline Enhanced Stabilization Technology

BEST

EPICS integration

EPICS

2.1.1 PreDAC Control in Open Loop

In order only to control the PreDAC(s) connected to the BEST-ENC system, at first disable the PID controller:

```
$ caput best0:PID:Enable 0
Old : best0:PID:Enable                  OFF
New : best0:PID:Enable                  OFF
```

Enable the software control via PCIe:

```
$ caput best0:PreDAC0:OutMux 0
Old : best0:PreDAC0:OutMux              SW via PCIe
New : best0:PreDAC0:OutMux              SW via PCIe
```

Set the PreDAC output voltage:

```
$ caput best0:PreDAC0:OutCh2 3.25
Old : best0:PreDAC0:OutCh2              0
New : best0:PreDAC0:OutCh2              3.25
```

2.1.2 Position control in Closed Loop:

In order to control the X and Y positions, the PID controller has to be in operation. At first enable the Hardware control (since the PID controller is FPGA based):

```
$ caput best0:PreDAC0:OutMux 1
Old : best0:PreDAC0:OutMux              SW via PCIe
New : best0:PreDAC0:OutMux              FPGA
```

Now the PID controller can be set:

```
$ caput best0:PID:Enable 1
Old : best0:PID:Enable                  OFF
New : best0:PID:Enable                  ON
```

And so, it is possible to control the position:

```
$ caput best0:PID:SetpointY -600
Old : best0:PID:SetpointY               0
New : best0:PID:SetpointY               -600
```