Single Cavity and Piezo Controls

and Applications

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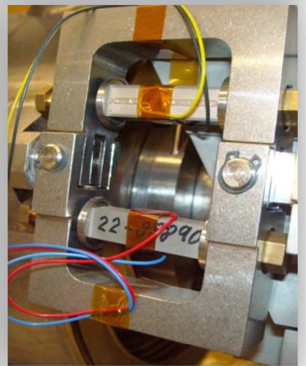
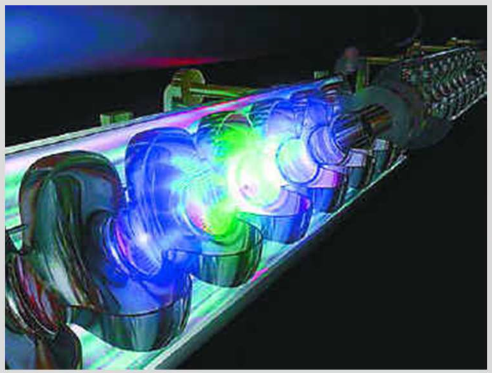
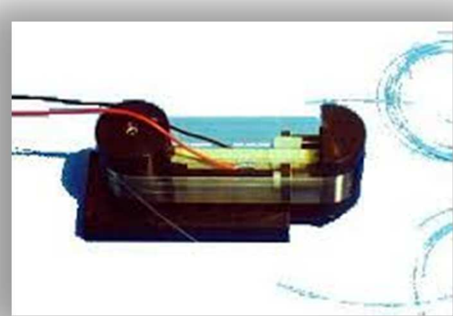


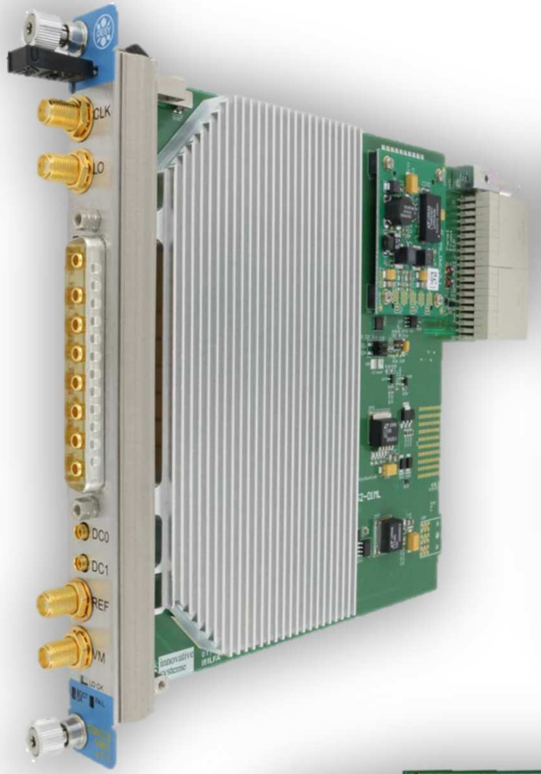
Motivation

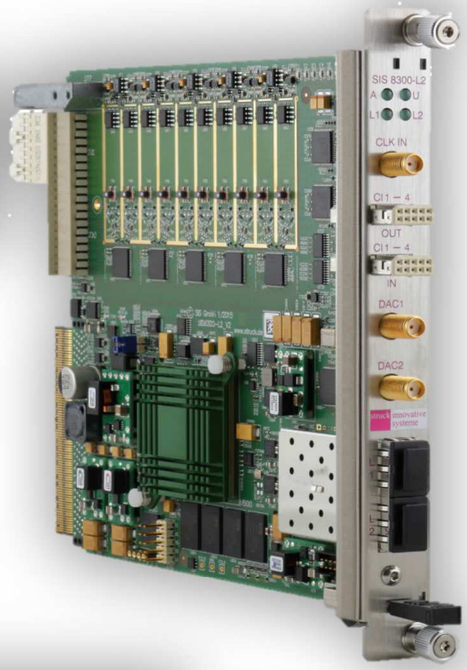
- Strong need to support high energy physics experiments and R&D programs
- Strong need for rapid setup of LLRF systems that will sense and actuate a single plant
- Strong need to use a modular and modern hardware architecture that will support a high availability, high digital and analog performance
- Strong need to use unified firmware and facility independent software

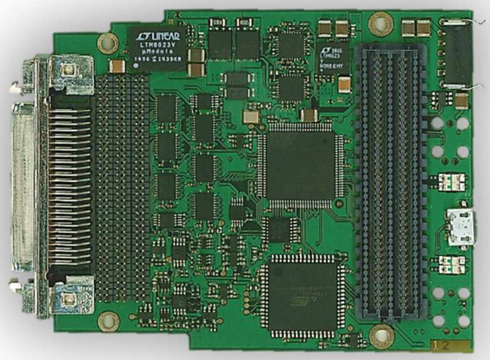




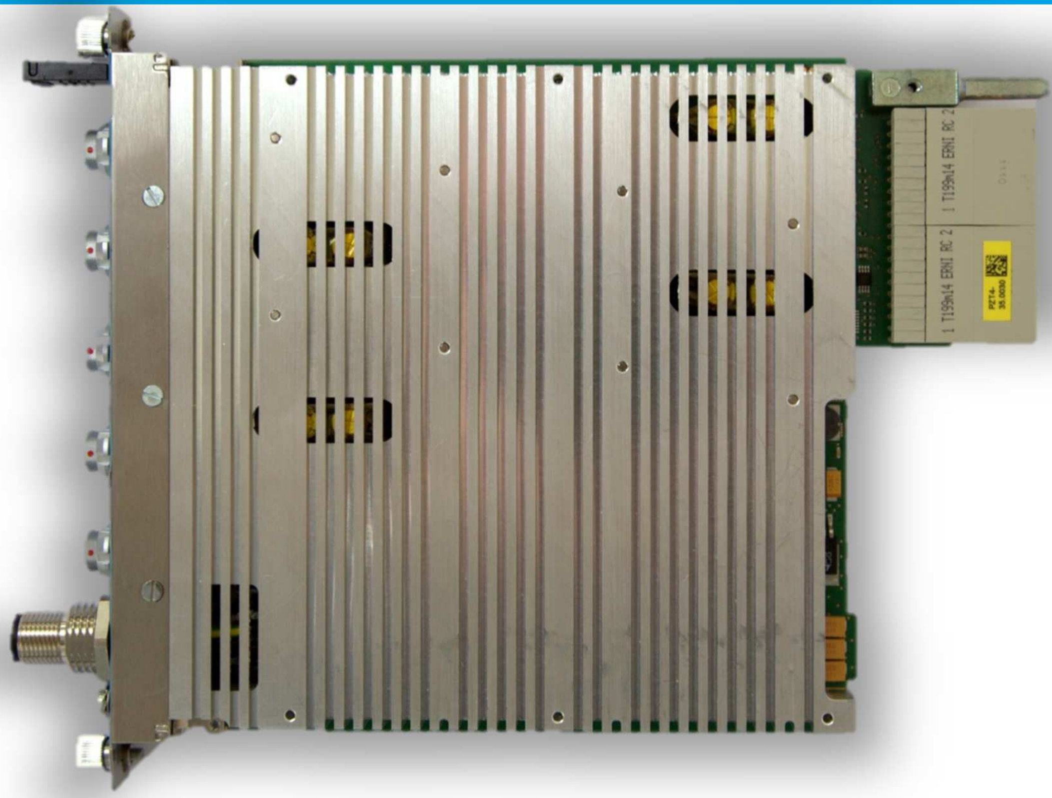
Hardware Portfolio







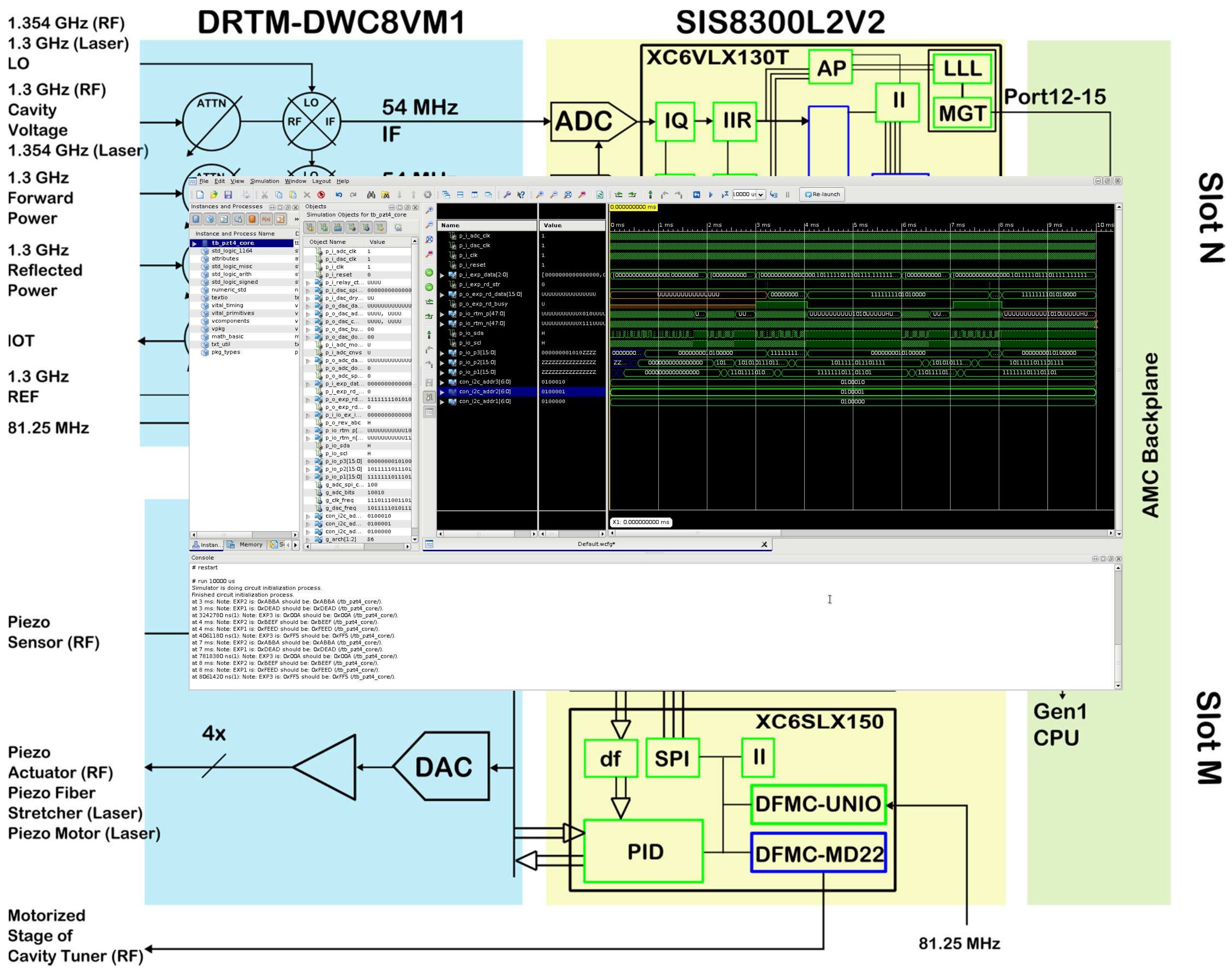
PRTM-PZDR4



More details at talk presented by M. Fenner:
“Improvements of the MicroTCA Piezo Driver DRTM-PZT4”

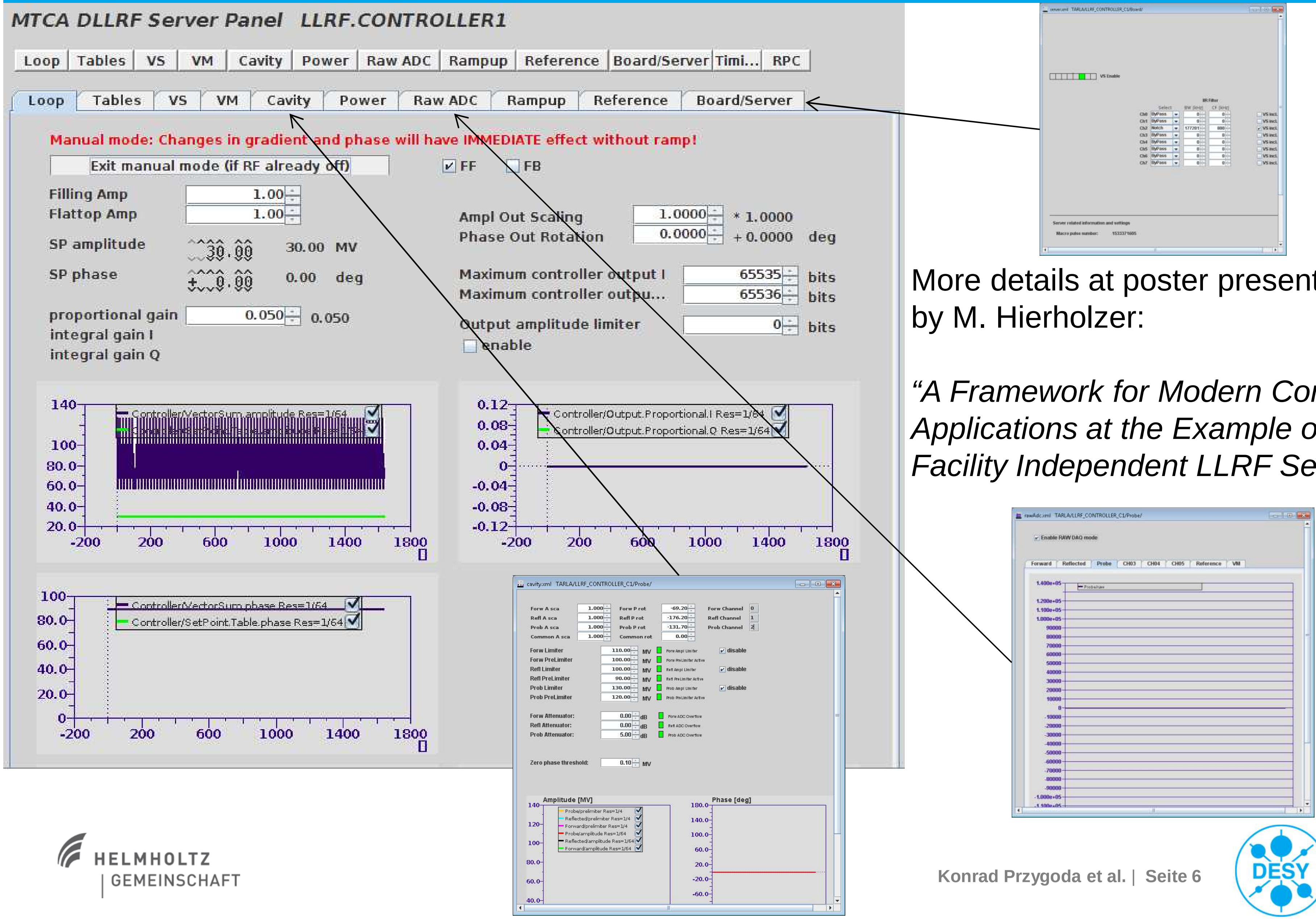
Also come and visit booth from our industry partner
dr. P. Jeanker from ***Piezotechnics***

Firmware Components



Courtesy L. Butkowski & R. Rybaniec

Software



More details at poster presented by M. Hierholzer:

“A Framework for Modern Control Applications at the Example of a Facility Independent LLRF Server”

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LLRF System for CW at CMTB in DESY

Environment:

- 1.3 GHz 9-cell SRF cavities
- Q_L~1.5 e7
- Bdw. ~ 86 Hz
- CW operation up to several MV

- High voltage power source: 120 kW IOT tube
- Cavity mechanical tuner (Saclay II model)
  - Sanyo motorized stage for cavity coarse tuning
  - Physik Instrument piezo elements (~4 µF) for cavity fine tuning

Goal:

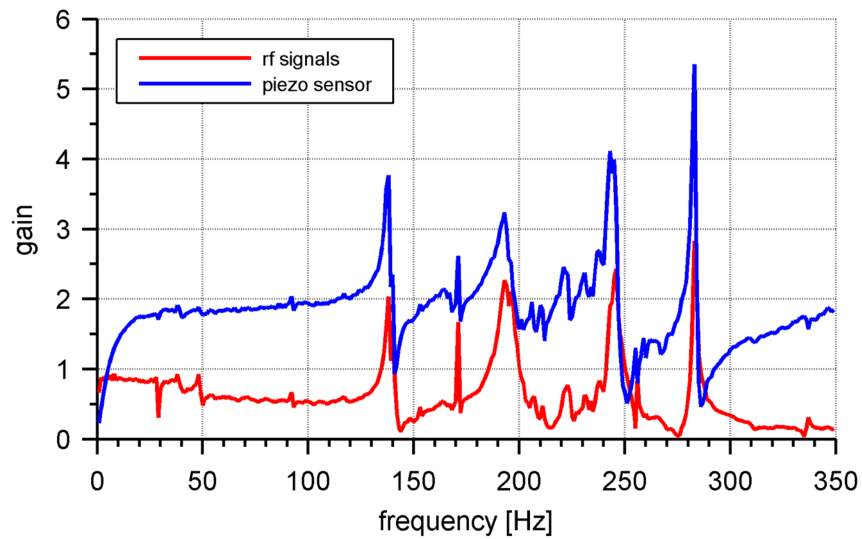
- Stabilize RF field amplitude and phase
- Minimize microphonics effect

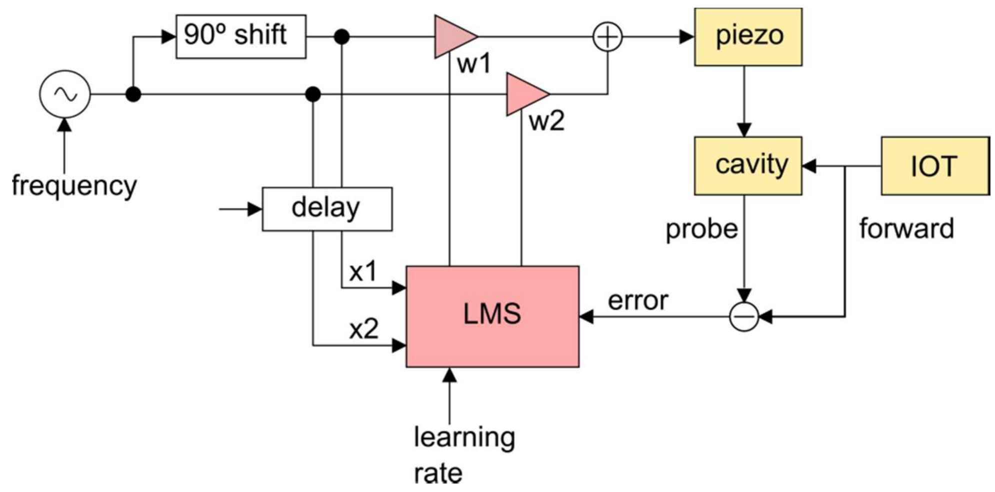
Microphonics Compensation Strategy

> Conventional PI control insufficient due to complicated piezo->detuning transfer function (<10Hz)

> Narrowband Active Noise Control algorithm for the dominating disturbances

- Adaptive feed forward
- LMS update: w(i+1)=w(i)+learning_rate*error*x(i)
- FPGA implementation based on the CORDIC algorithm
- Optionally multiple frequencies compensation
- Accurate transfer function is not required





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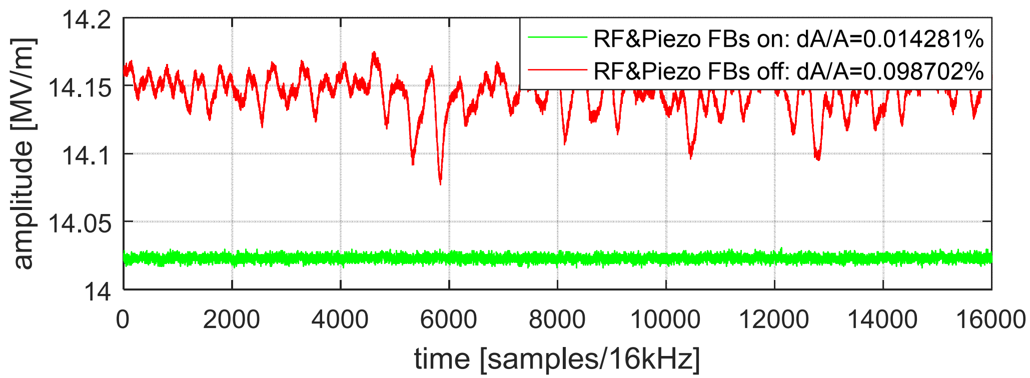
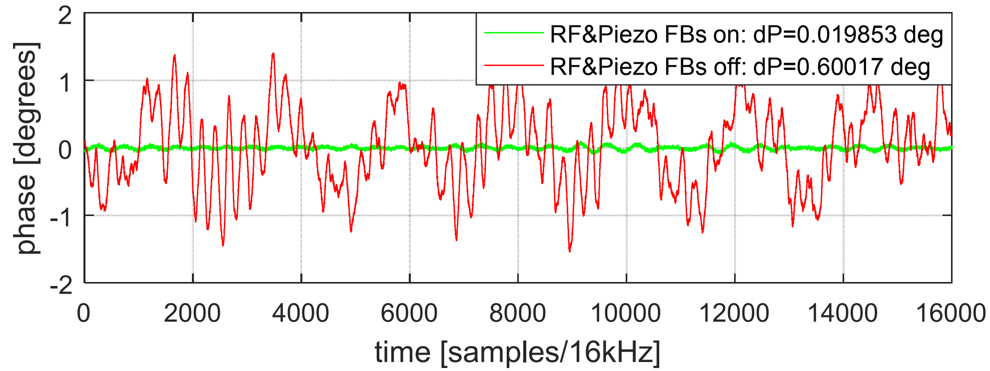
Courtesy R. Rybaniec

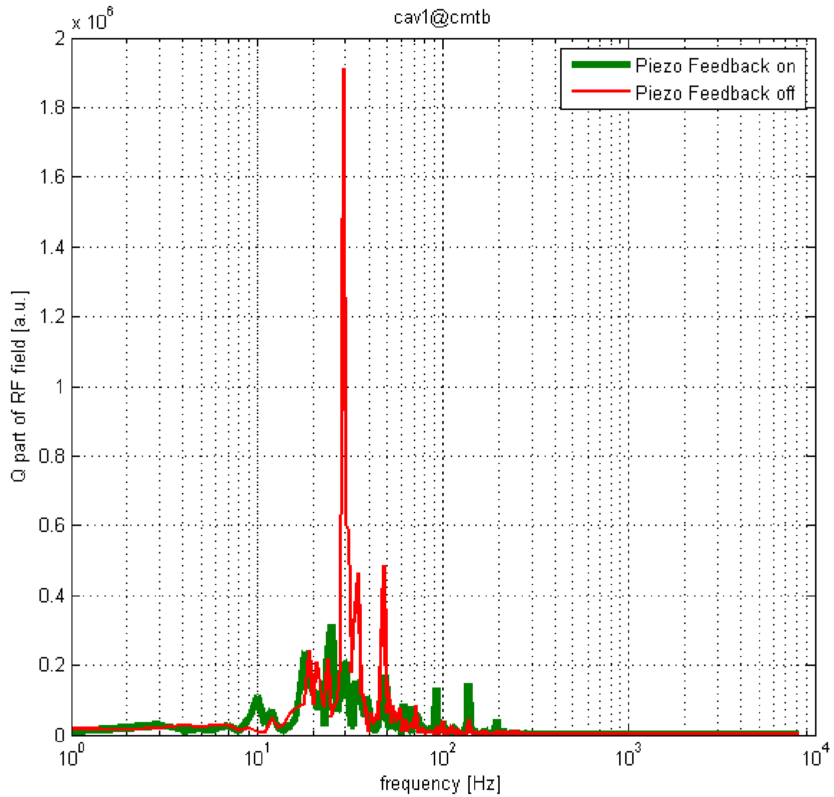
Preliminary Results

> RF & Piezo feedbacks





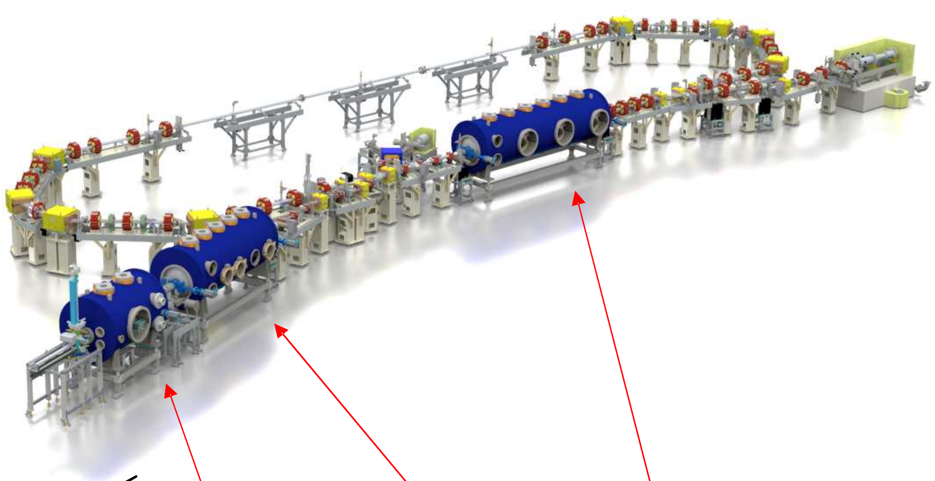
Piezo feedback

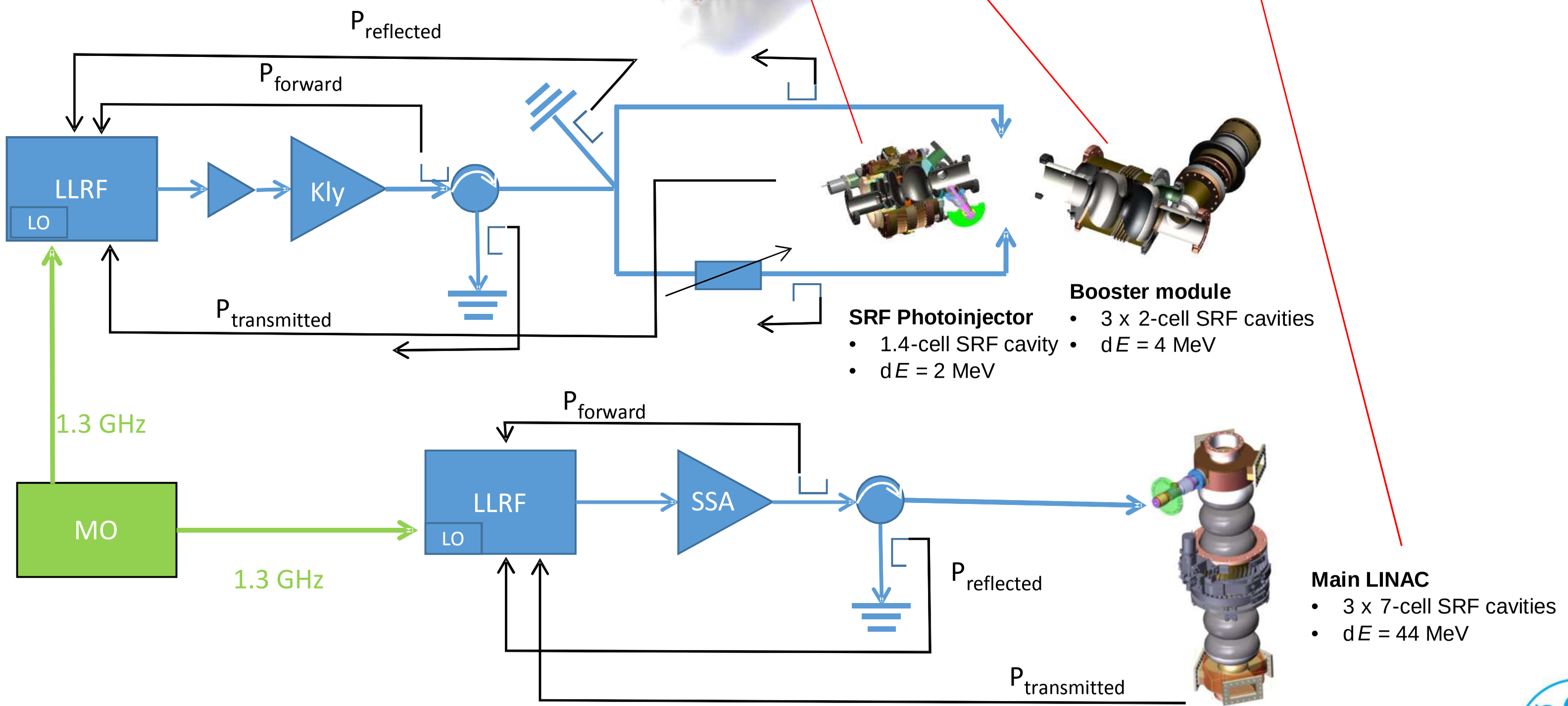


LLRF System for BeRLinPro at HZB

Courtesy P. Echevarria

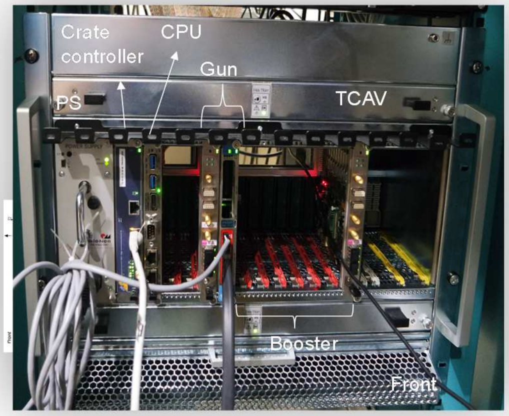
	Basic Parameter
max. beam energy	50 MeV
max. current	100 mA (77 pC/bunch)
normalized emittance	1 µm rad (0.6 µm rad)
bunch length (straight)	2 ps or smaller (100 fs)
rep. rate	1.3 GHz
losses	< 10^{-5}

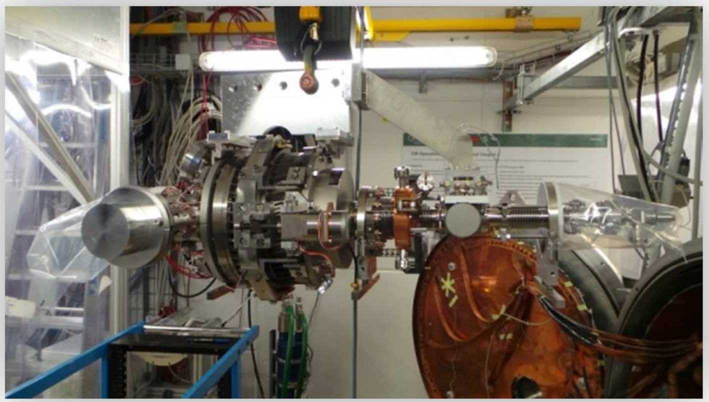




Photoinjector Test in Gunlab

- Lab to demonstrate beam operation with electrons generated from multi-alkali photocathodes.
- One modified TTF coupler operation (currently 2 KW, up to 10 KW)
- Thermal short → Only low fields possible
- $Q_L \approx 1.2e7 \rightarrow f_{1/2} = 55$ Hz
- Gun1.0 prototype cavity pre-tuned to 1.3 GHz - 400 kHz (need additional pre-tuning)
- Possible operation up to ~2.1 MV/m
- Low proportional RF feedback gains possible (<200)
- New microphonics strategy based on Kalman filter in progress

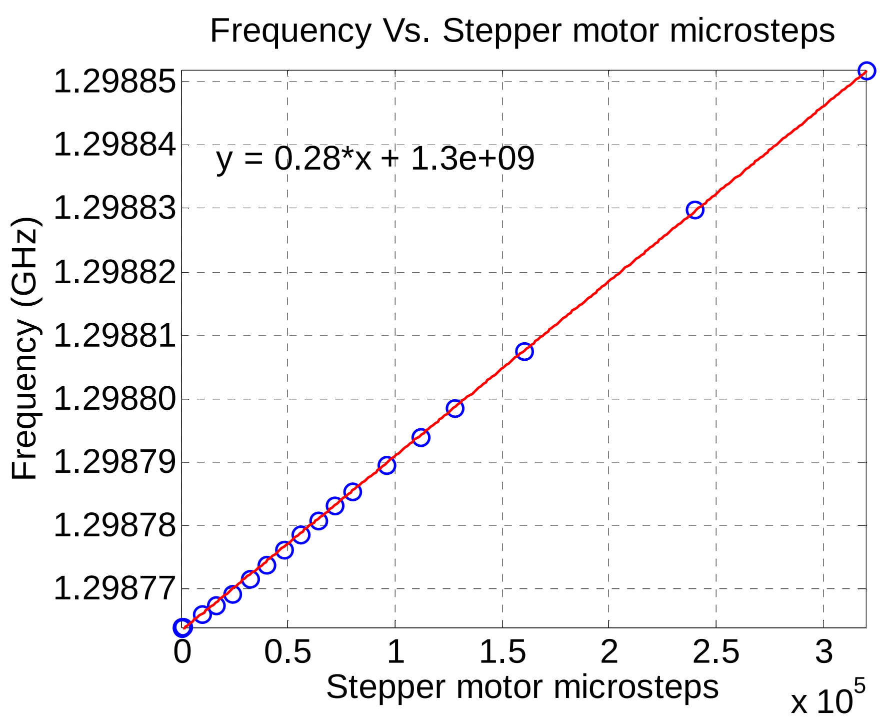




Courtesy P. Echevarria

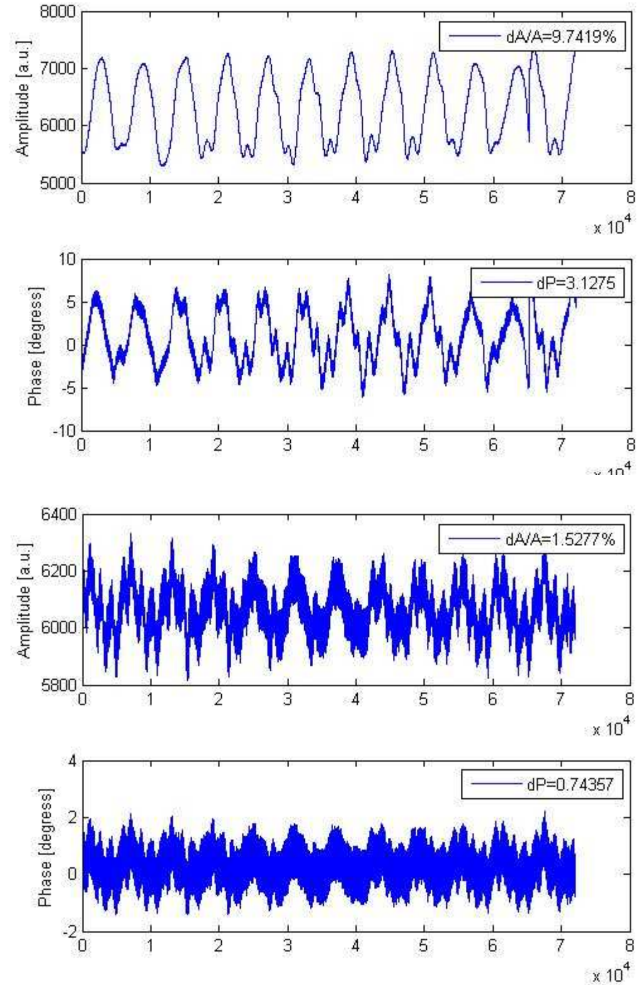
Preliminary Results Using Prototype Gun1.0 cavity

> Gun cavity tuning with FMC-MOTDRV22



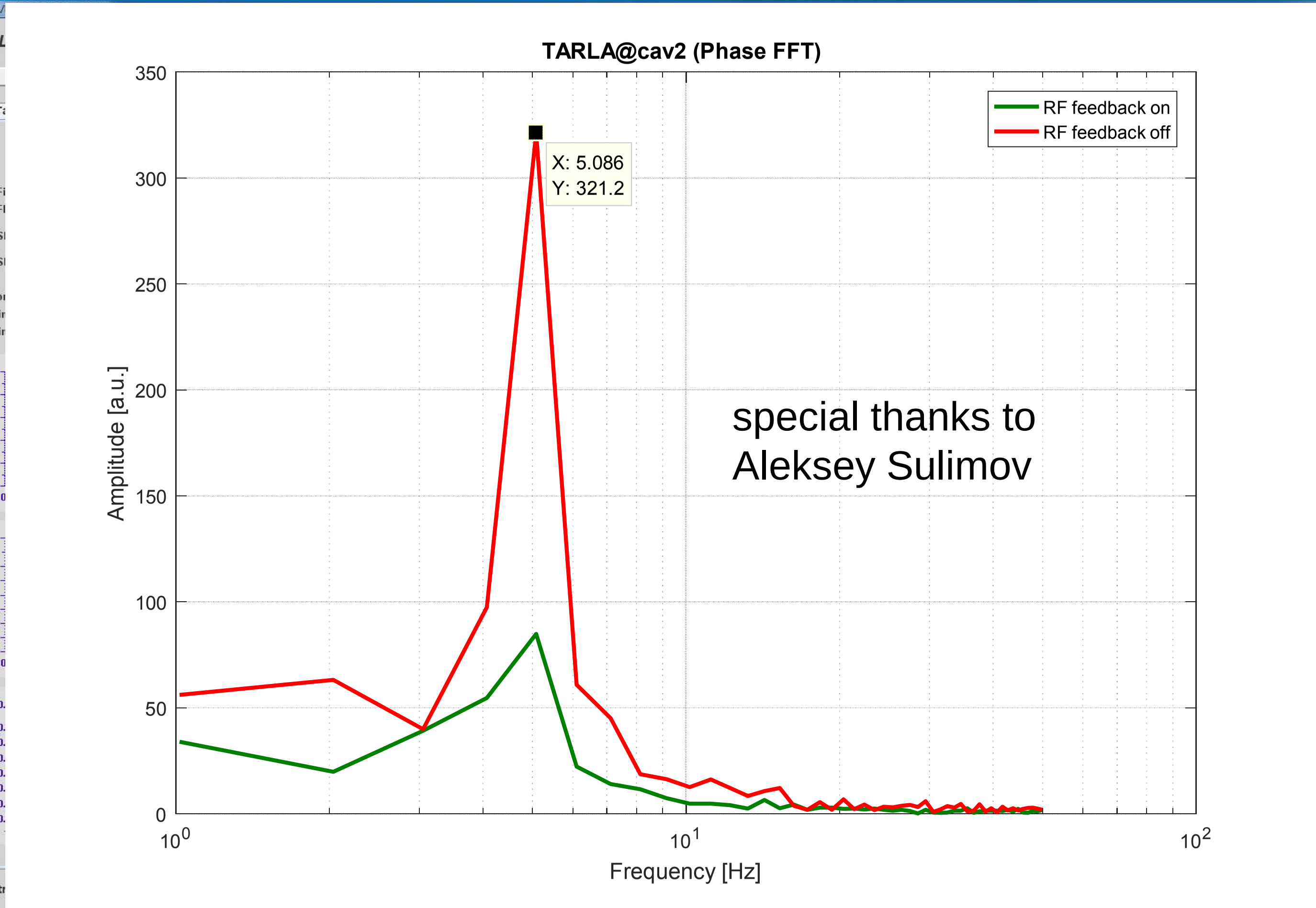
Courtesy P. Echevarria

> RF feedback @ ~2.1 MV/m

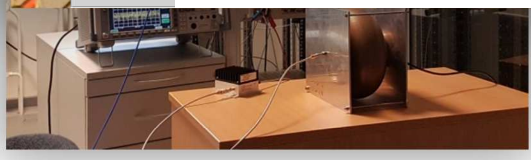


LLRF System for TARLA

- Fac
- 3-25 fixe
- Add sup
- Cav



Basic machine and beam parameters



Integration Test at DESY Site

More details at talk presented by C. Guemues:
"Design and Status of the MicroTCA.4 Based LLRF System for TARLA"

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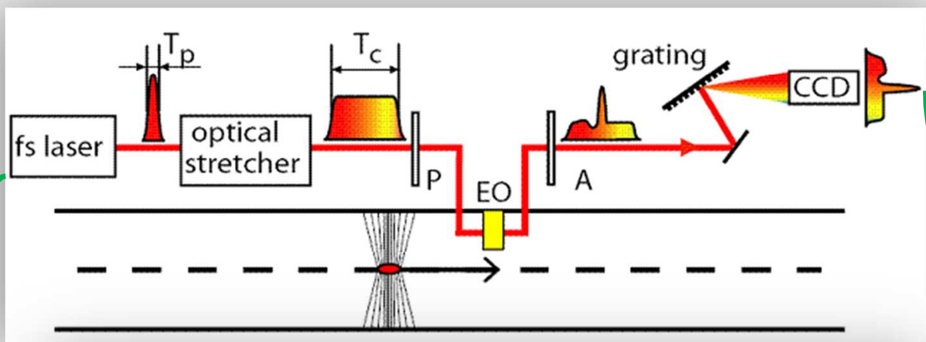
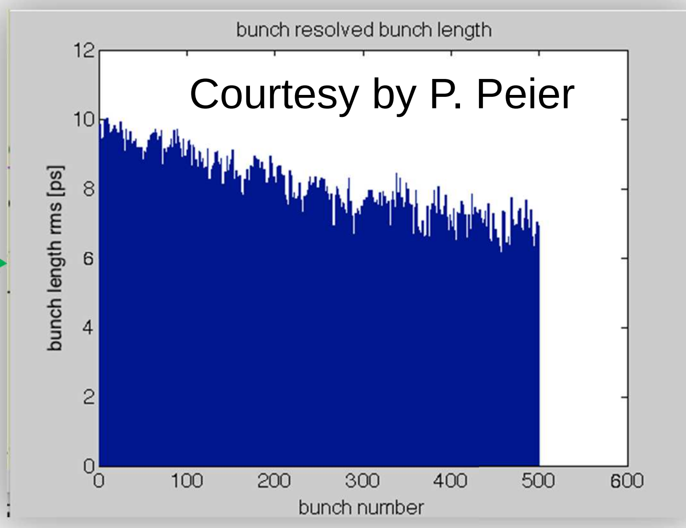
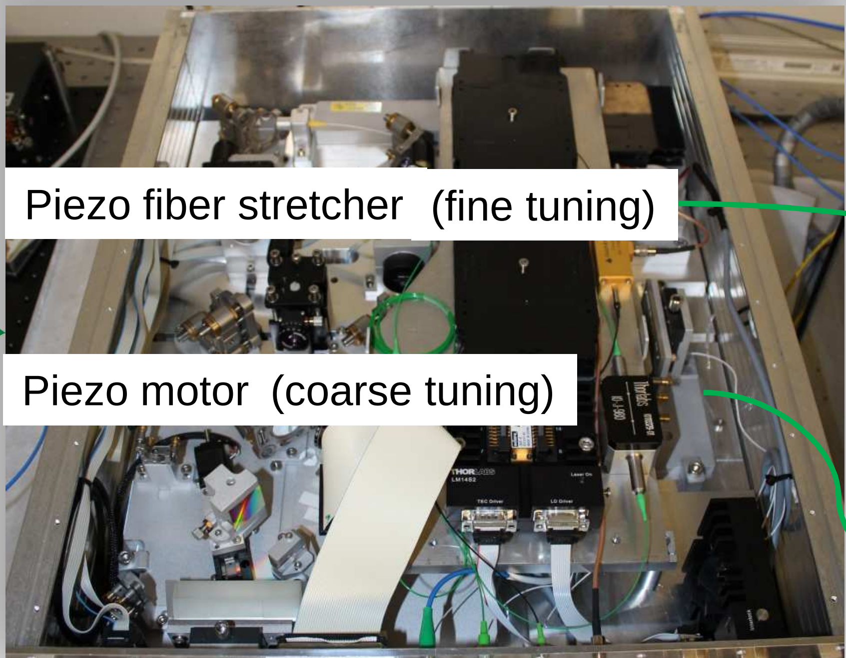
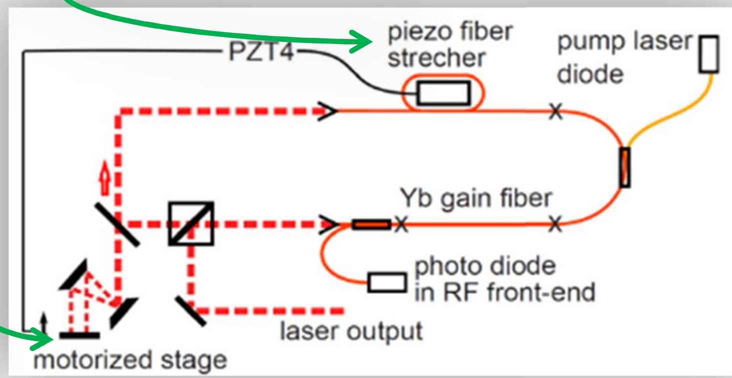
Electro-Optical Bunch Length Spectrometer

> **Enviroment:** XFEL Injector tunnel (No. of Bunches 10, Charge of 1 nC)



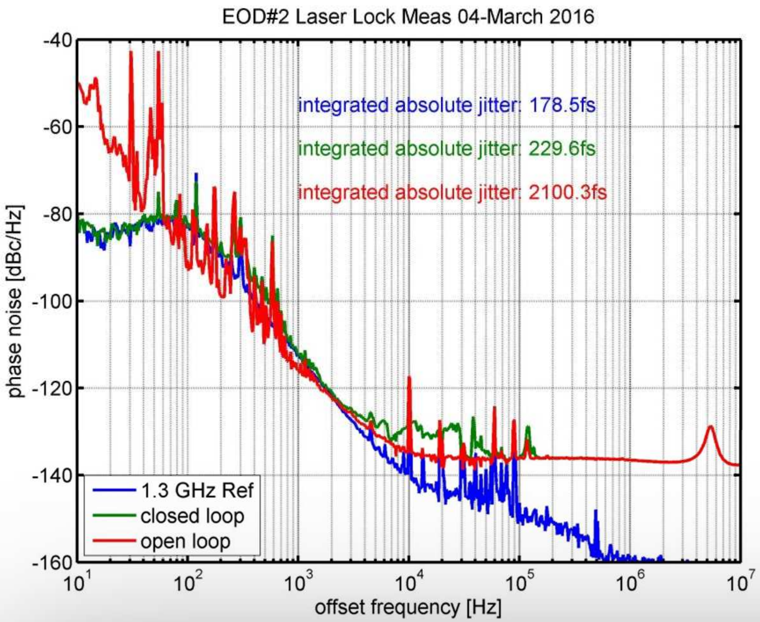




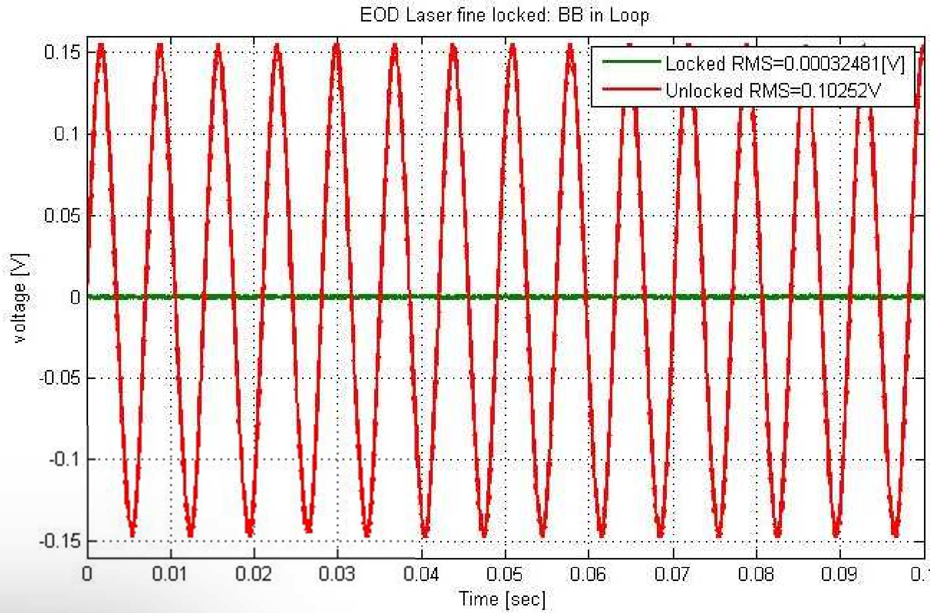


Laser Cavity Coarse Tuning & Fine Tuning

> Phase noise (in-loop)



> Baseband (in-loop)



More details at talk presented by M.K. Czwalinna & B. Steffen: *"MTCA.4 Usage in Longitudinal Electron Beam Diagnostics at the European XFEL"*

Thank You for Attention