LINAC16.

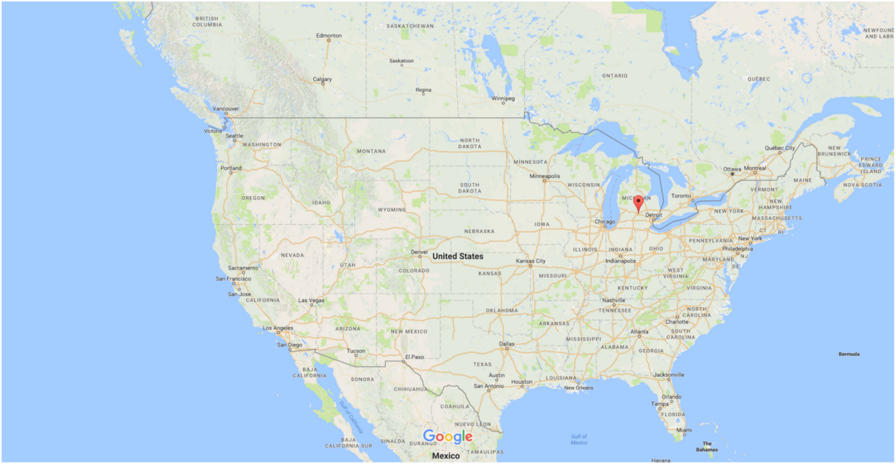
A selection of talks/posters

Yves Renier
LINAC16
PPS, 12th of October 2016

HELMHOLTZ ASSOCIATION

DESY

at East Lansing



Map data ©2016 Google, INEGI 200 km

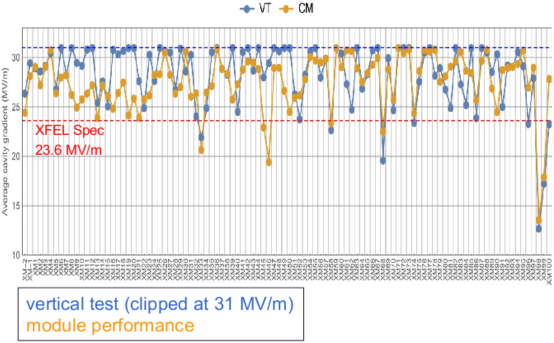
Hottest topic

”N-Doping: The New Breakthrough Technology for SRF Cavities” (WE2A01, M. Martinello)

- Q0 increase: ”Impurity Content Optimization to Maximize Q-factors of Superconducting Resonators” (TUPLR023, M. Martinello)
- Higher field achieved: ”Enhancement of the Accelerating Gradient in Superconducting Microwave Resonators” (TUPLR024,M. Checchin)

"Status of the European XFEL" (MO1A02, H. Weise)

We saw emittance measurement on Tuesday, here are the modules performances.



- Module performance well above specs. and visible improvement with time
- Tunnel installation used sorting of modules based on AMTF performance
- XM98 as scavenger module

Remark:

Clipping at 31 MV/m is done due to max. available RF power; limit given by waveguide distribution.

	N_{cavs}	Average	RMS
VT	815	28.3 MV/m	3.5
CM	815	27.5 MV/m	4.8

"CLIC High-Gradient Accelerating Structure Development" (TU2A04, W. Wuensch)

No LINAC16 materials available, took from publication:

- $\frac{E^{30}\tau^{5}}{BDR} = const$
- Conditioning is function of the number of pulses

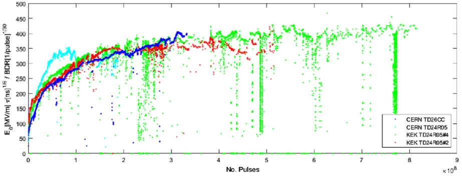


FIG. 3. Comparison of the scaled gradient vs number of accumulated pulses for several structures. Despite the different conditioning approaches, the curves for the scaled gradient are similar.

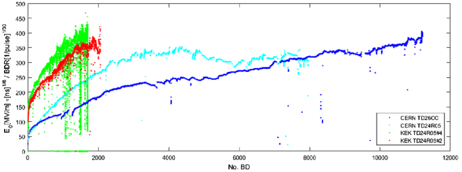


FIG. 4. Comparison of the scaled gradient vs number of accumulated breakdowns for several structures. When plotted with respect to the total accumulated number of breakdowns, the curves of the scaled gradient diverge significantly.

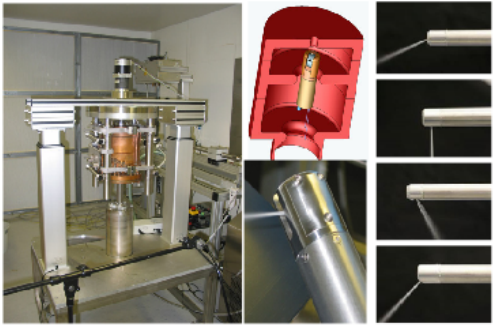
"CLIC High-Gradient Accelerating Structure Development" (TU2A04, W. Wuensch)

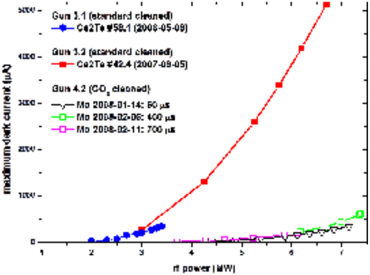
From discussions

- Strong interest to see same kind of analysis for our gun.
- Non-brazed stuctures: $> 5\times$ faster conditioning.
- Conditioning is belived to be an hardening proccess.
- Suggestion to do conditioning at high reprate, moderate peak power.

”Dry Ice Cleaning of RF-Structures at DESY” (MOOP05, A. Brinkmann)

- Cleaning Cu RF Photo Guns for XFEL,FLASH and REGAE





- Maximum dark currents/RF-Power
- Standard liquid cleaned/dry-ice cleaned

courtesy of F. Stephan

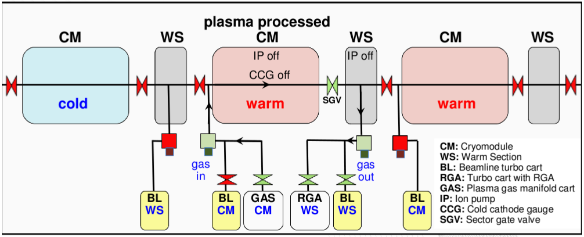
Request to send them data from newer cavities.

”Plasma Processing to Improve the Performance of the SNS SC Linac” (WE2A03, M. Doleans)

- Cavities cleaned in-situ.
- HydroCarbon contamination cleaned

Plasma processing in SNS linac tunnel

- Warm-up 2 cryomodules
- Sections seeing process gas during processing
  - Ion pumps and CCGs off
- Adjacent sections not seeing process gas
  - Close sector gate valves to protect nearest cold cryomodules



18 M. Doleans, Plasma processing at SNS – LINAC 16

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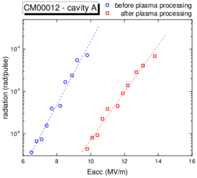
”Plasma Processing to Improve the Performance of the SNS SC Linac” (WE2A03, M. Doleans)

- Cavities cleaned in-situ.
- HydroCarbon contamination cleaned
- Dark current reduced, higher field reached.

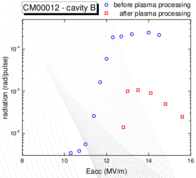
Radiation level reduced after plasma processing

- **Examples of radiation signals from two cavities**
- **Plasma processing has been observed to reduce radiation related to both field emission and multipacting**
- **Reduction varies between cavities**

Field emission regime



Multipacting regime



14 M. Doleans, Plasma processing at SNS – LINAC 16

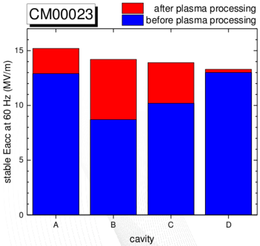
OAK RIDGE National Laboratory | SPALLATION NEUTRON SOURCE

”Plasma Processing to Improve the Performance of the SNS SC Linac” (WE2A03, M. Doleans)

- Cavities cleaned in-situ.
- HydroCarbon contamination cleaned
- Dark current reduced, higher field reached.

Performance of CM00023 cryomodule improved after plasma processing

- **Stable accelerating gradient at 60 Hz improved for all 4 cavities**
- **Gradients improved by ~25%**
  - Avg. gradient 11.2 MV/m before plasma processing
  - Avg. gradient 14.2 MV/m after plasma processing



21 M. Doleans, Plasma processing at SNS – LINAC 16

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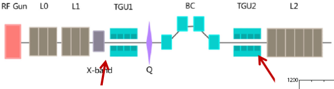
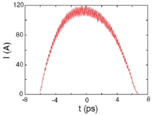
”Applying Transverse Gradient Undulators to Suppression of Microbunching Instability” (TUPLR001, D.Huang)

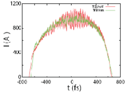
Reversible alternative to laser heater ?

Shanghai Institute of Applied Physics, Chinese Academy of Sciences

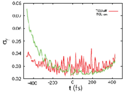
Simulation results







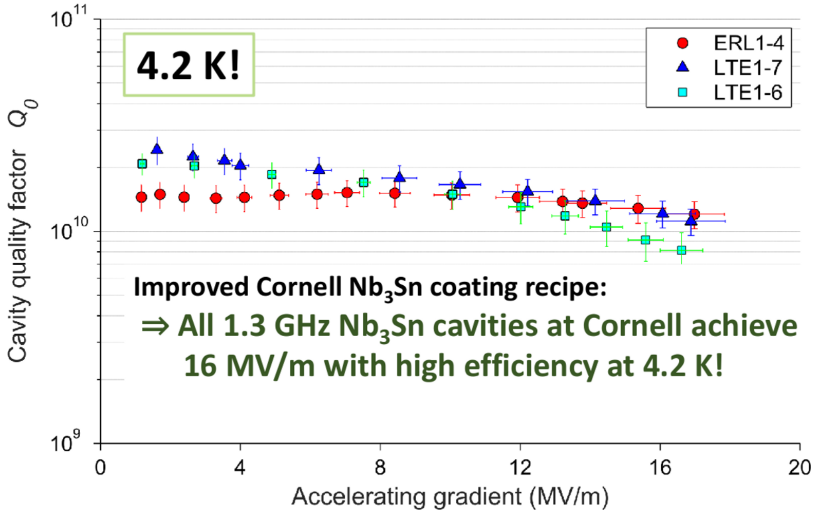
(a) Longitdudinal beam current profile at the exit of TGU2



(b) Slice energy profile of the central part of the beam at the exit of TGU2

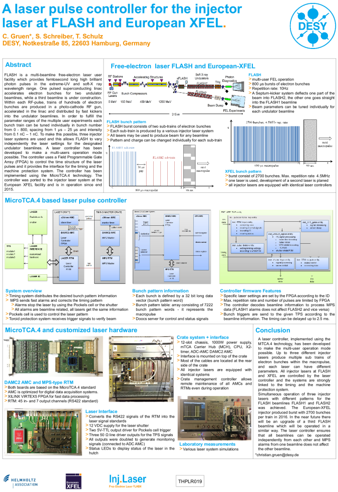
- Initial beam current profile with 10% peak-to-peak modulation.
- Horizontal emittance goes from 0.98 μm to 1.07 μm, the growth mainly comes from nonlinear effects such as CSR, LSC etc.
- Longitudinal beam current (upper) and slice energy profile (lower) at the exit of TGU2 with TGUs on (green) and off (red).

"High Performance Next-Generation $NbSn_3$ Cavities for Future High Efficiency Linacs" (tuop07,R. Porter)



”A laser pulse controller for the injector laser at FLASH and European XFEL” (thplr019, C. Gruen)

Hamburg developed a uTCA driver for pocket cells.



A laser pulse controller for the injector laser at FLASH and European XFEL.

C. Gruen*, S. Schreiber, T. Schulz
DESY, Notkestraße 85, 22603 Hamburg, Germany

Abstract

FLASH is a multi-beamline free-electron laser user facility which provides femtosecond long high brilliant photon pulses in the extreme-UV and soft-X ray wavelength range. One pulsed superconducting linac accelerates electron bunches for two undulator beamlines, while a third beamline is under construction. Within each RF-pulse, trains of hundreds of electron bunches are produced in a photo-cathode RF gun, accelerated in the linac and distributed by fast kickers into the undulator beamlines. In order to fulfill the parameter ranges of the multiple user experiments each bunch train can be tuned individually in bunch number from 0 - 800, spacing from 1 μs – 25 μs and intensity from 0.1 nC – 1 nC. To make this possible, three injector laser systems are used and this allows FLASH to vary independently the laser settings for the designated undulator beamlines. A laser controller has been developed to make a multi-users operation mode possible. The controller uses a Field Programmable Gate Array (FPGA) to control the time structure of the laser pulses and it provides the interface for the timing and the machine protection system. The controller has been implemented using the MicroTCA.4 technology. The controller was ported to the injector laser system at the European XFEL facility and is in operation since end 2015.

Free-electron laser FLASH and European-XFEL

FLASH
> multi-user FEL operation
> 800 μs bursts of electron bunches
> Repetition rate: 10Hz
> A Septum-kicker system deflects one part of the beam into FLASH2, the other one goes straight into the FLASH1 beamline
> Beam parameters can be tuned individually for each undulator beamline

FLASH bunch pattern
> FLASH burst consists of two sub-trains of electron bunches
> Each sub-train is produced by a various injector laser system
> All lasers may be used to produce beam for any beamline
> Pattern and charge can be changed individually for each sub-train

XFEL bunch pattern
> burst consist of 2700 bunches. Max. repetition rate 4.5MHz
> one laser is used, development of a second laser is planed
> all injector lasers are equipped with identical laser controllers

MicroTCA.4 based laser pulse controller

System overview
> Timing system distributes the desired bunch pattern information
> MPS sends fast alarms and corrects the timing pattern
> Alarms stop the laser by using the Pockels cell or the shutter
> All alarms are beamline related, all lasers get the same information
> Pockels cell is used to control the laser pattern
> Toroid protection system receives trigger signals to verify beam

Bunch pattern information
> Each bunch is defined by a 32 bit long data vector (bunch pattern word)
> Bunch pattern table: array consisting of 7222 bunch pattern words - it represents the macropulse
> Doocs server for control and status signals

Controller firmware Features
> Specific laser settings are set by the FPGA according to the ID
> Max. repetition rate and number of pulses are limited by FPGA
> The controller decodes beamline information to process MPS data (FLASH1 alarms does not affect FLASH2 and vice versa)
> Bunch triggers are send to the given TPS according to the beamline information. The timing can be delayed up to 2.5 ms.

MicroTCA.4 and customized laser hardware

DAMC2 AMC and MPS-type RTM
> Both boards are based on the MicroTCA.4 standard
> AMC is optimized for digital data acquisition systems.
> XILINX VIRTEX5 FPGA for fast data processing
> RTM: 45 in- and 7 output channels (RS422 standard)

Crate system + interface
> 12-slot chassis, 1000W power supply, mTCA Carrier Hub (MCH), CPU, X2-timer, ADC-AMC DAMC2 AMC
> Interface is mounted on top of the crate
> Most of the cables are located at the rear side of the crate
> All injector lasers are equipped with identical systems
> Crate management controller allows remote maintenance of all AMCs and RTMs even during operation

Laser Interface
> Converts the RS422 signals of the RTM into the laser signal standards
> 12 VDC supply for the laser shutter
> Two 5V-TTL output driver for Pockels cell trigger
> Three 50 Ω line driver outputs for the TPS signals
> All outputs were doubled to generate monitoring signals (connected to ADC AMC)
> Status LEDs to display status of the laser in the hutch

Laboratory measurements
> Various laser system simulations

Conclusion

A laser controller, implemented using the MTCA.4 technology, has been developed to make the multi-user operation mode possible. Up to three different injector lasers produce multiple sub trains of electron bunches within the macropulse, and each laser can have different parameters. All injector lasers at FLASH and XFEL are controlled by the laser controller and the systems are strongly linked to the timing and the machine protection system.
Simultaneous operation of three injector lasers with different patterns for the FLASH beamlines FLASH1 and FLASH2 was achieved. The European-XFEL injector produced burst with 2700 bunches per train in 2016. In the near future there will be an upgrade of a third FLASH beamline which will be operated in a similar way. The laser controller ensures that all beamlines can be operated independently from each other and MPS alarms from one beamline does not affect the other beamline.

*christian.gruen@desy.de

HELMHOLTZ ASSOCIATION | European XFEL | Inj.Laser Free-Electron Laser FLASH | THPLR019

no materials available

- poster ”UPS Study for CsK2Sb photocathode” (TUPRC022, M. Kuriki) and ”Lifetime Study of Csk2Sb Robust Photo-Cathode for a High Brightness Electron Source” (TUPLR013, M. Kuriki)
  - $QE > 10\%$ @ 532 nm (green).
  - long lifetime (several months under heavy use).