

Operational experience and future plans for X-band at DESY

Summarising (1st) 4 years of X-band operation
in Hamburg

Gregor Loisch on behalf of the short pulse RF team

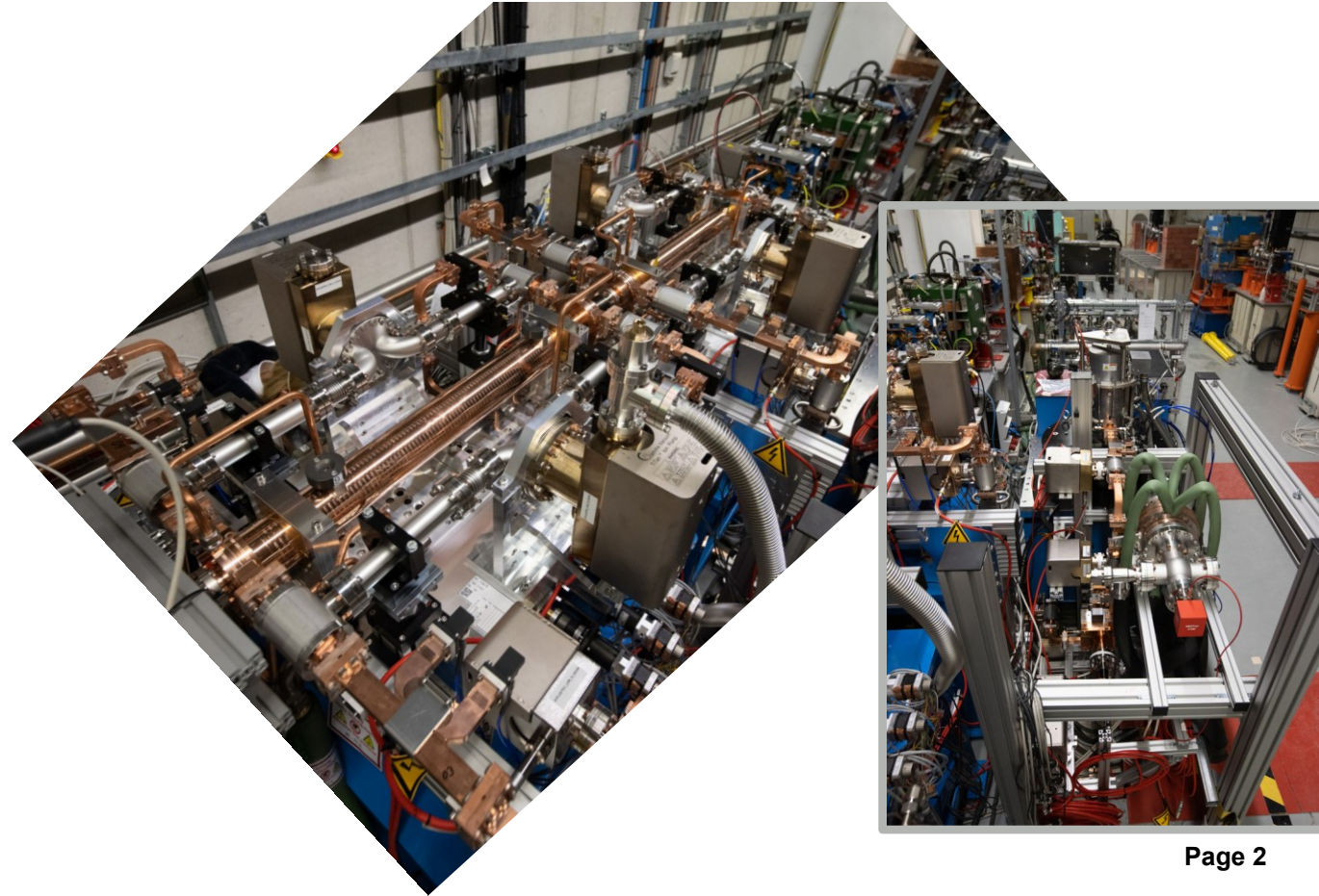
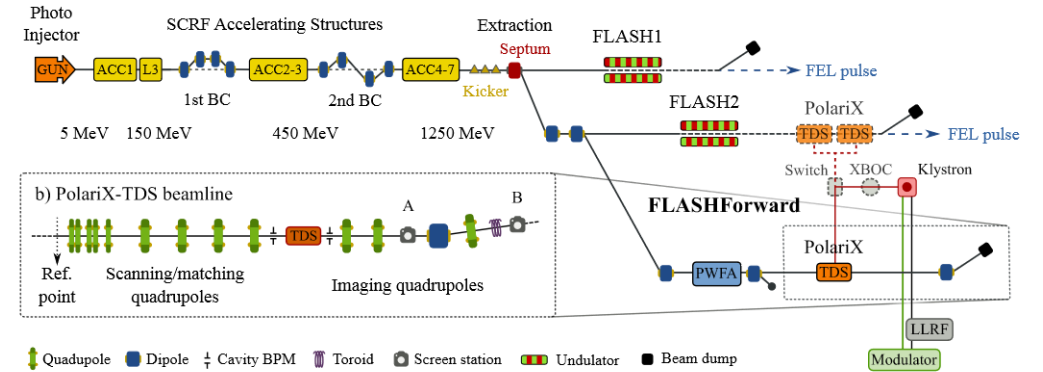
CLIC Mini Week

Geneva, 12.12.2023

FLASH2/FLASHForward

First X-band system at DESY

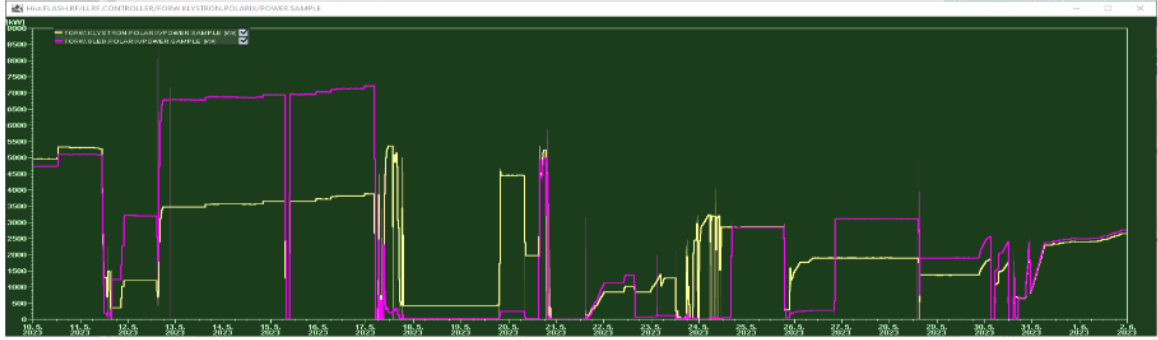
- ▶ Transverse deflecting structure for longitudinal bunch diagnostics
- ▶ First “Polarix” structure in operation since 2019
- ▶ In 2021 added structure in FLASH2 for FEL diagnostics
 - ▶ 1 RF station now feeding either one cavity in FLASH3 or two cavities in FLASH2 beamlines
- ▶ Ampegon PPT Modulator, 6 MW Toshiba klystron
- ▶ BOC cavity (currently detuned)
- ▶ Cavity developed at CERN & provided by PSI



Operational history of FLASH2/FLASHForward system

Conditioning and user operation overview

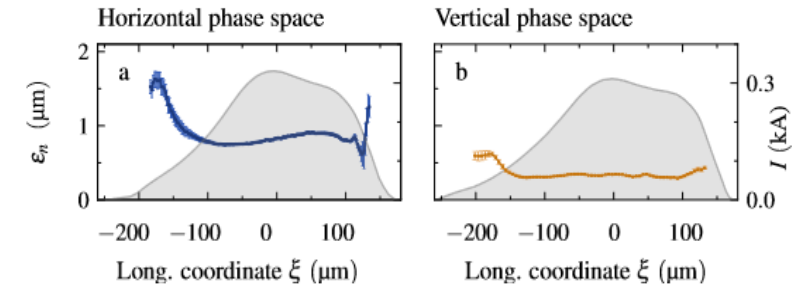
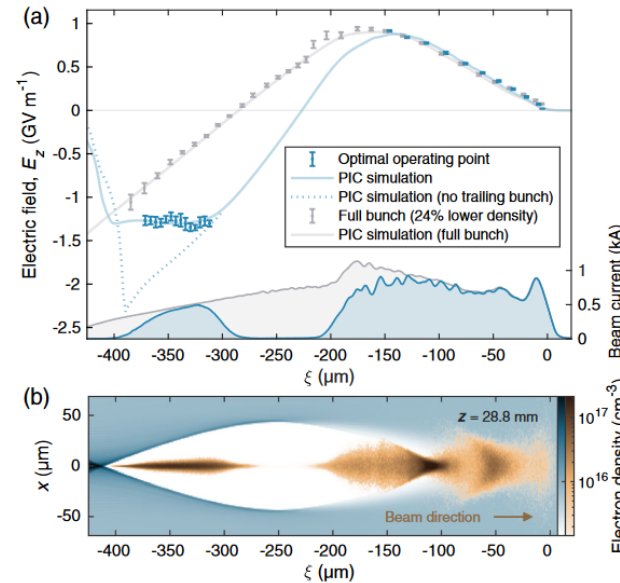
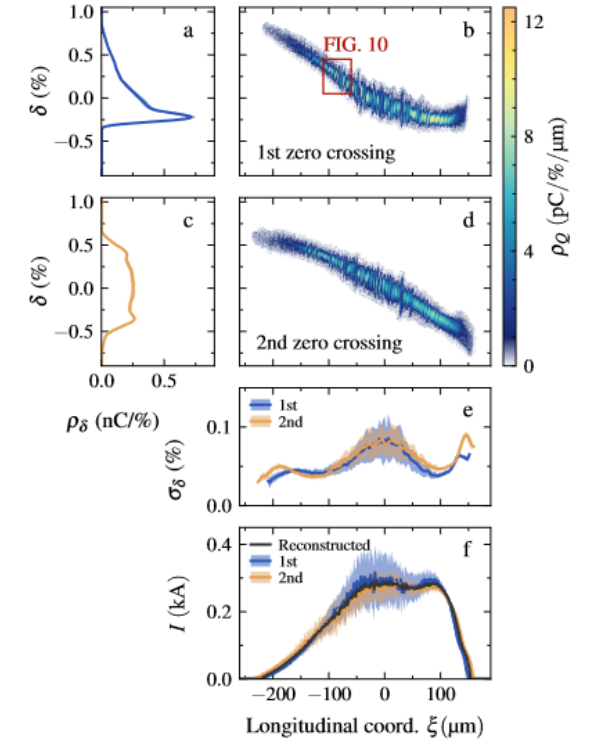
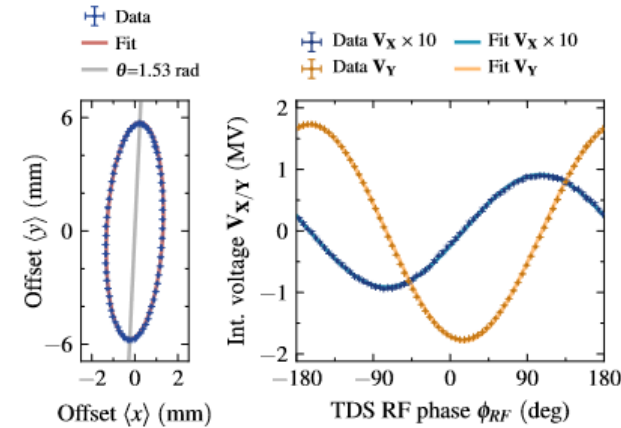
- ▶ FLASHForward/FLASH3
 - ▶ Conditioning of 1st waveguide system/cavity as expected
 - ▶ Currently operating at up to 6 MW routinely
- ▶ Some complications due to system “design flaw”
 - ▶ Field direction in cavity determined by phase & amplitude at input ports
 - ▶ Power distribution to input ports not equal with fixed power divider → correction to phase relation necessary
 - ▶ Using adjustable power divider in new systems
- ▶ FLASH2
 - ▶ Conditioning ongoing at ~4MW
 - ▶ Currently limited by events at power divider (window)



Polarix measurements

Operation of variable polarisation TDS cavity in FLASHForward

- ▶ Relative phase scan reveals power imbalance
 - ▶ ~10% difference between ports
 - ▶ Cavity mostly used in vertical plane
→ uncritical
- ▶ Very good time resolution for ~1GeV bunches
- ▶ Full phase space tomography possible
- ▶ Crucial tool for plasma acceleration measurements



Overview of installation at ARES

Transverse deflecting cavities in 100 MeV S-band linac

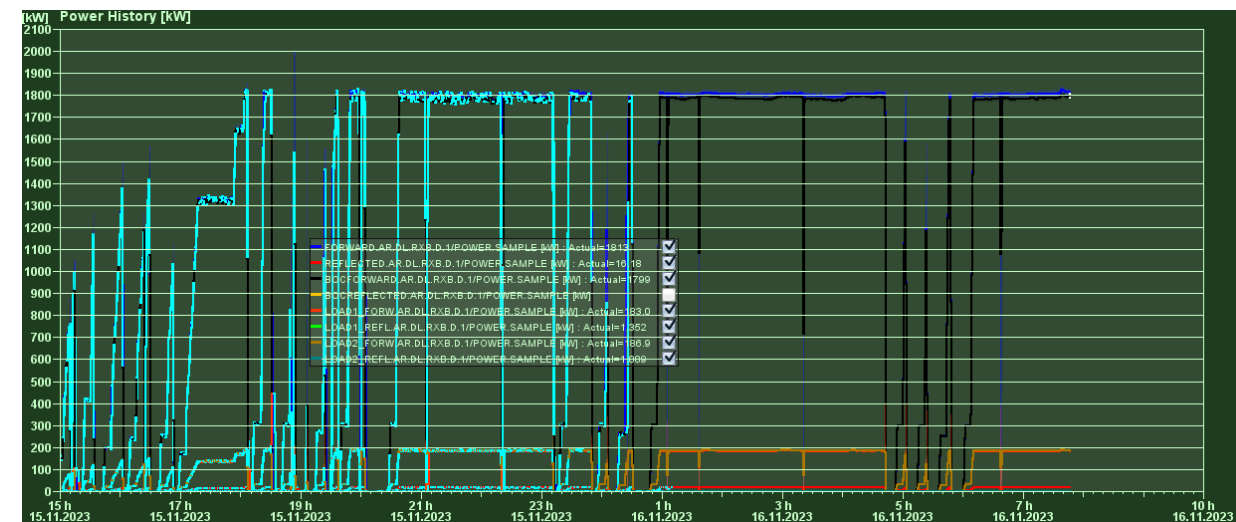
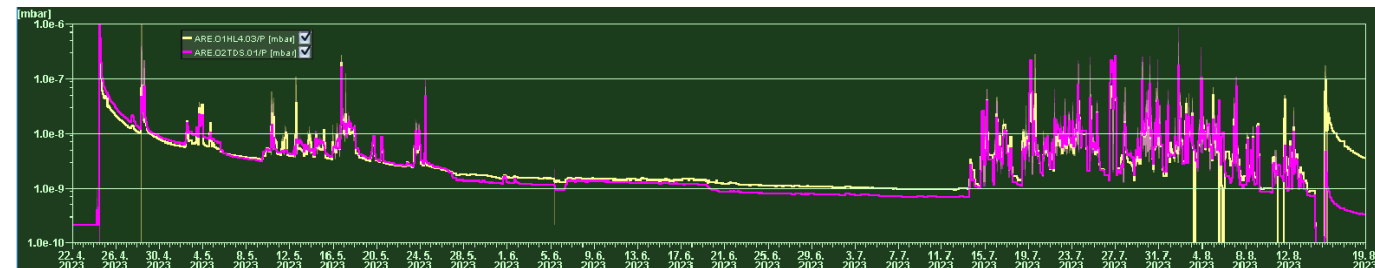
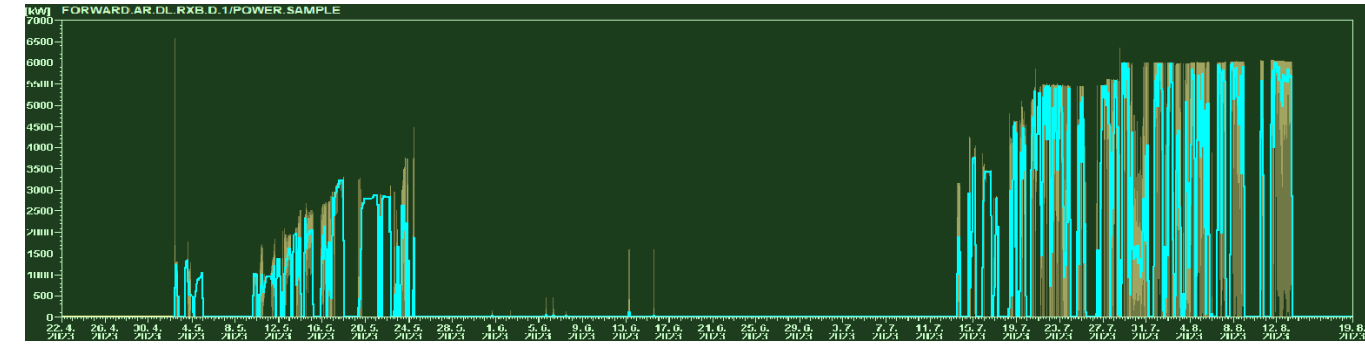
- ▶ 4th & 5th Polarix cavities at DESY
- ▶ Higher time resolution → 2 cavities & 2 RF-stations
- ▶ Scandinova modulators (positioning for shortest pulse transmission lengths)
- ▶ CPI klystrons
 - ▶ 6 MW, 1.5 μ s
 - ▶ Original delivery planned 2020
 - ▶ 1st klystron delivered 05/2023
 - ▶ 2nd to be delivered early 2024
 - ▶ Cooling water consumption ~2x specification → installed system not sufficient anymore...
- ▶ BOC cavity (currently detuned)



System performance

ARES 1st Polarix system

- ▶ Conditioning
 - ▶ Klystron fully conditioned
 - ▶ Conditioning of cavity ongoing
- ▶ 1st beam measurements in November
- ▶ Problems with klystron cathode heating
 - ▶ Observed
 - ▶ drifting filament voltages
 - ▶ Filament heater failures
 - ▶ Ongoing work, system currently being modified by Scandinova



General conclusions so far

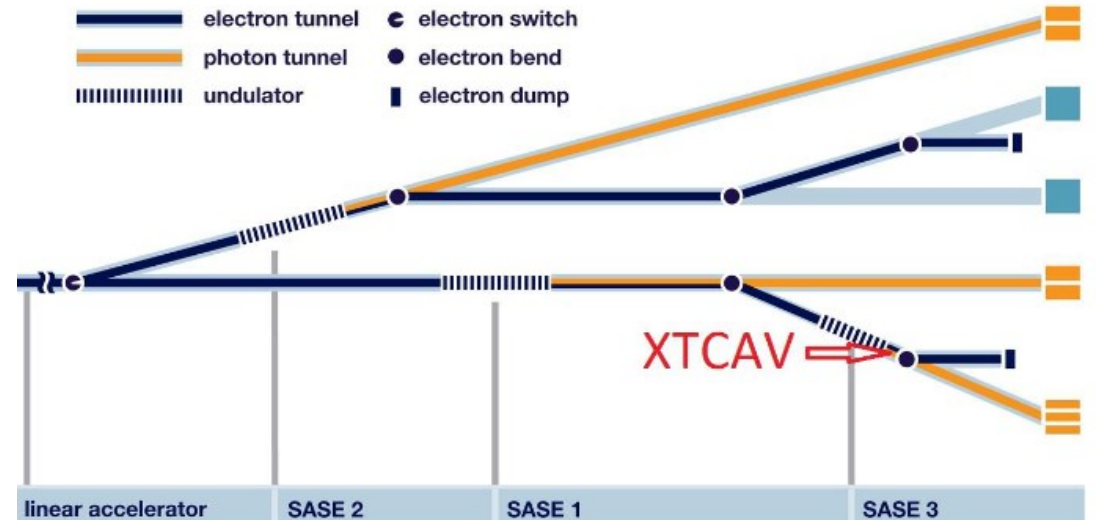
4 years of operation in a nutshell

- ▶ Happy to have technology available
- ▶ Very grateful for collaboration with and support by CERN & PSI
- ▶ X-band systems have enabled various research already
- ▶ Systems not fully matured, still facing various issues & still learning ourselves
- ▶ Currently trying to get funding for X-band test stand
 - ▶ 1 RF station
 - ▶ Conditioning, test of components
 - ▶ Spare components
- ▶ Number of systems will increase

New system at European XFEL

TDS system to measure duration of FEL pulses

- ▶ Transverse deflecting structure for FEL diagnostics
- ▶ Beam energy ≤ 17.5 GeV
- ▶ 3x 6 MW klystron feeding 2x 1m cavities each
- ▶ Study of potential station positioning ongoing
 - ▶ Limited space in technical areas
 - ▶ Radiation in tunnel during beam measurement to be determined (backscattering from measurement screen)
- ▶ Cost planning to be finished early 2024

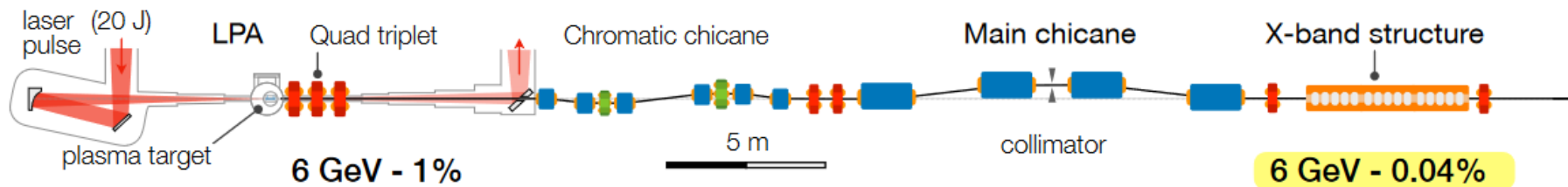
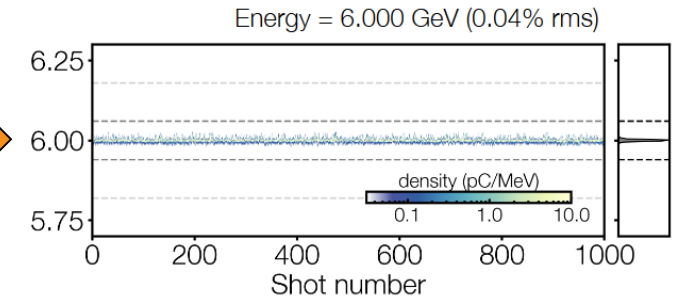
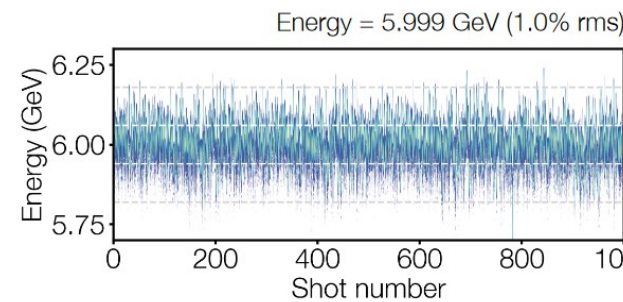
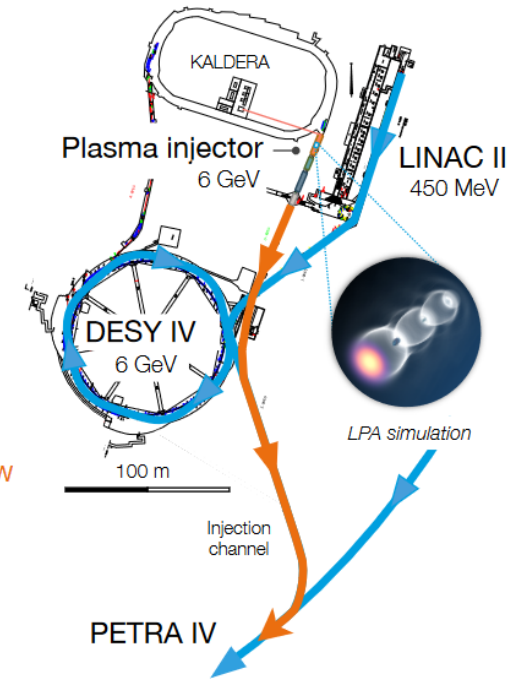
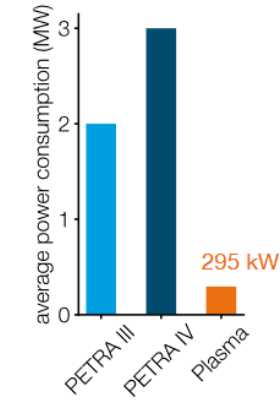


New system for PIP IV

Dechirper cavity for a laser wakefield based injector for PETRA IV

- ▶ Planned injector linac for PETRA IV based on laser wakefield acceleration
- ▶ Conventional cavity needed to reduce jitter & energy spread
- ▶ X-band system foreseen
 - ▶ < 60 MV/m
 - ▶ 5m active length (> 230 MV)
- ▶ Initial funding potentially in 2024

Injector power usage



Summary

Happy users, technicians slowly also happy..

- ▶ Started operating X-band system in 2019
- ▶ Very good scientific results
- ▶ Operation now becoming standard
 - ▶ Still facing issues in operation and with new components
 - ▶ Some systems in routine user operation (incl. operation of 1 RF system for 2 beamlines..)
- ▶ Approach to have 2nd klystron supplier took long time
- ▶ Planning further installations
 - ▶ Additional transverse deflectors
 - ▶ Test stand
 - ▶ Accelerating structures

***Thank you for
your
attention!***

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