X-Band RF at DESY

Polarizable X-Band transverse deflecting structure (PolariX TDS)

Rolf Jonas
Gerd Tews
Daniel Jürgensen
Hamburg, 5 October 2021

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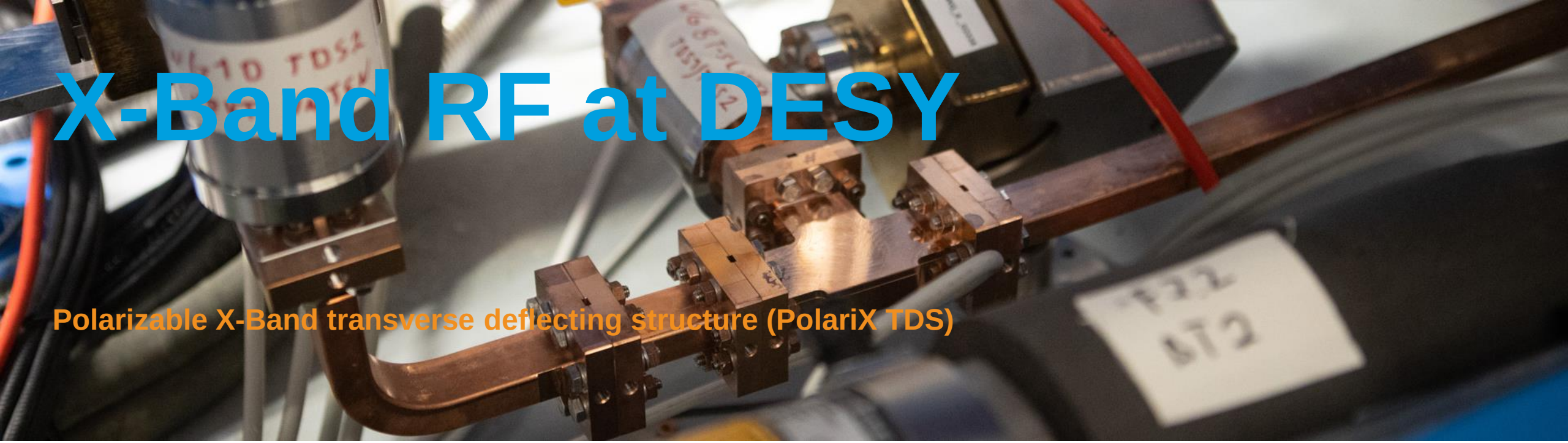

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Foto: Dirk Noelle

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HELMHOLTZ SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

DESY.

Outline

1 X-Band is used for measurements

2 First test setup

3 Installation of PolariX System at FLASH

4 Plans for SINBAD / ARES

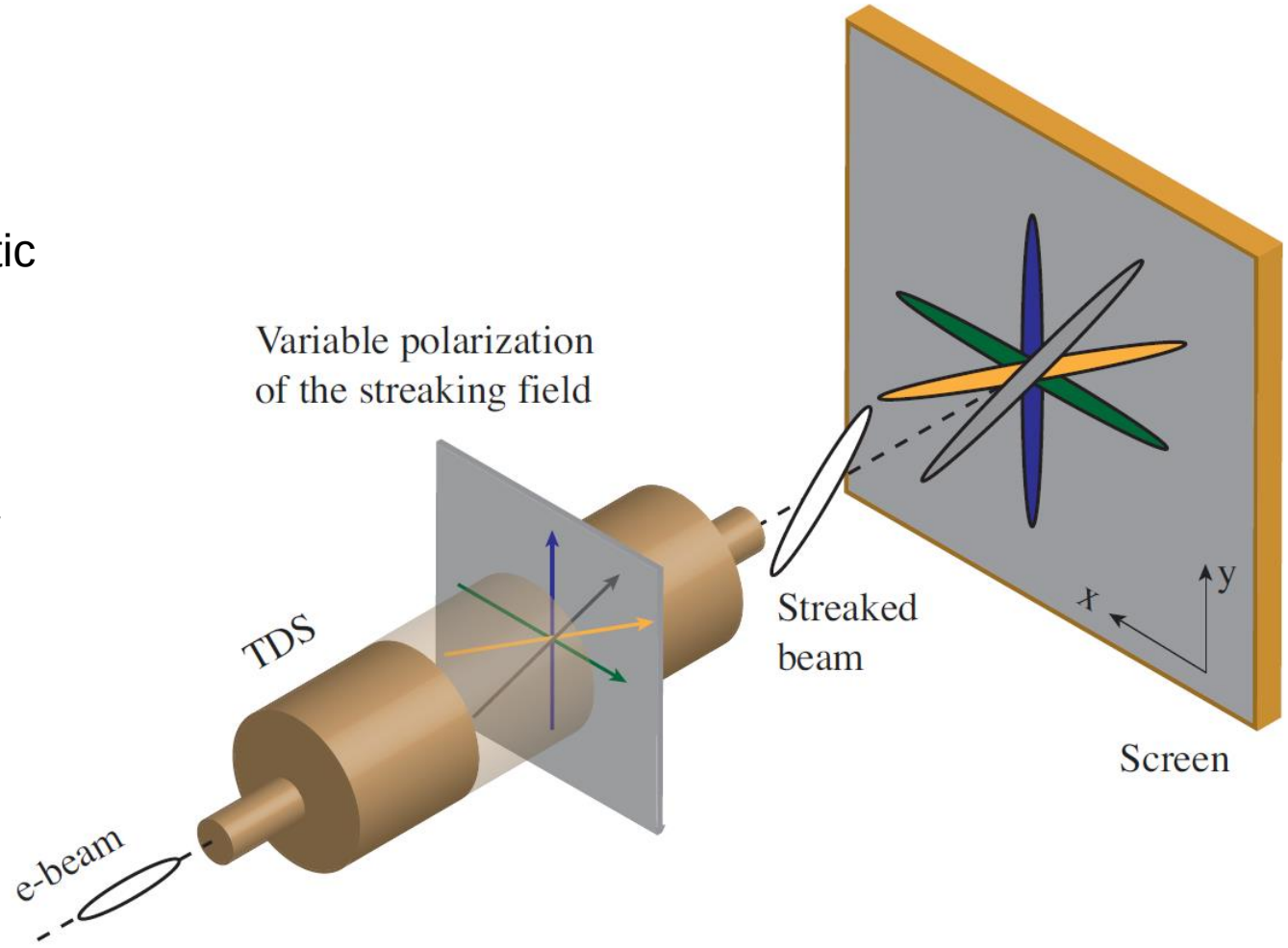
5 Plans for XFEL

X-Band is used for measurements

Measurements of beam parameter

- transverse deflecting structure (TDS)
- applies a transversal force
- streaks the beam for longitudinal diagnostic

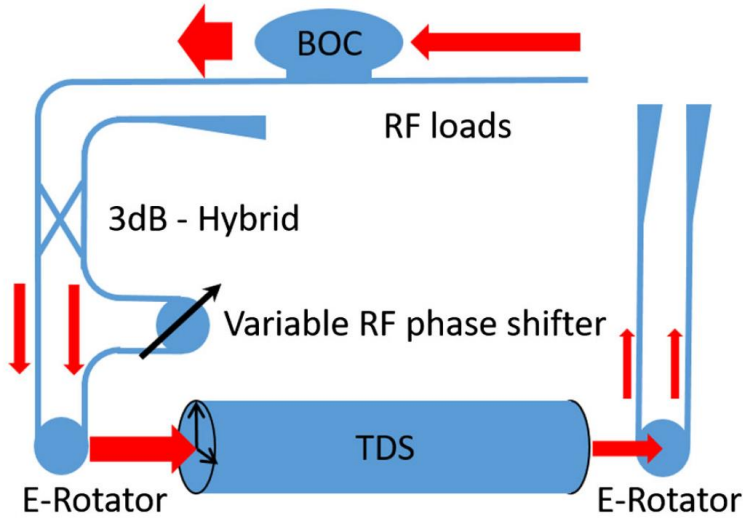
- novel TDS type PolariX
- the direction of the force can be turned by changing the polarization of the e-field
- enables advanced measurements
- necessary to further improve FEL

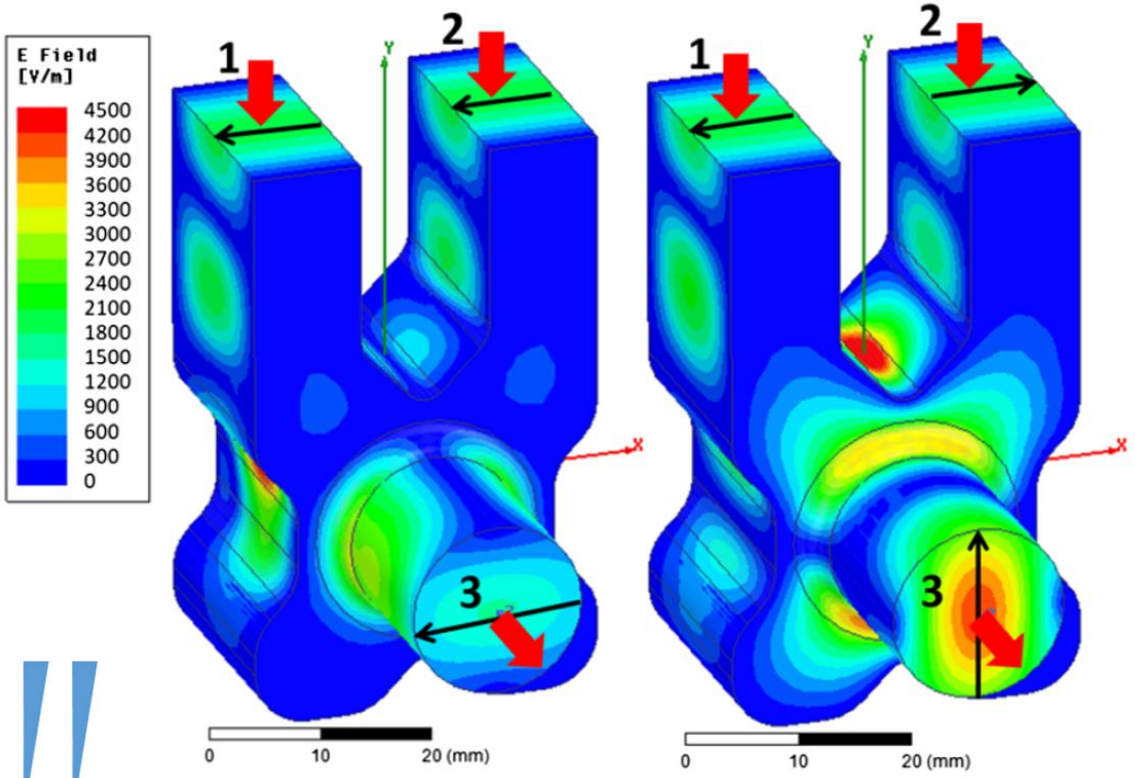


https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.23.112001

polarizable e-field

- E-rotator enables the polarizable e-field
- by adjusting the phase between the two input waveguides it is possible to determine the polarization of the e-field inside the TDS
- phase shifter in one waveguide
- barrel open cavity (BOC) for pulse compression
- t-splitter to split up the RF-power





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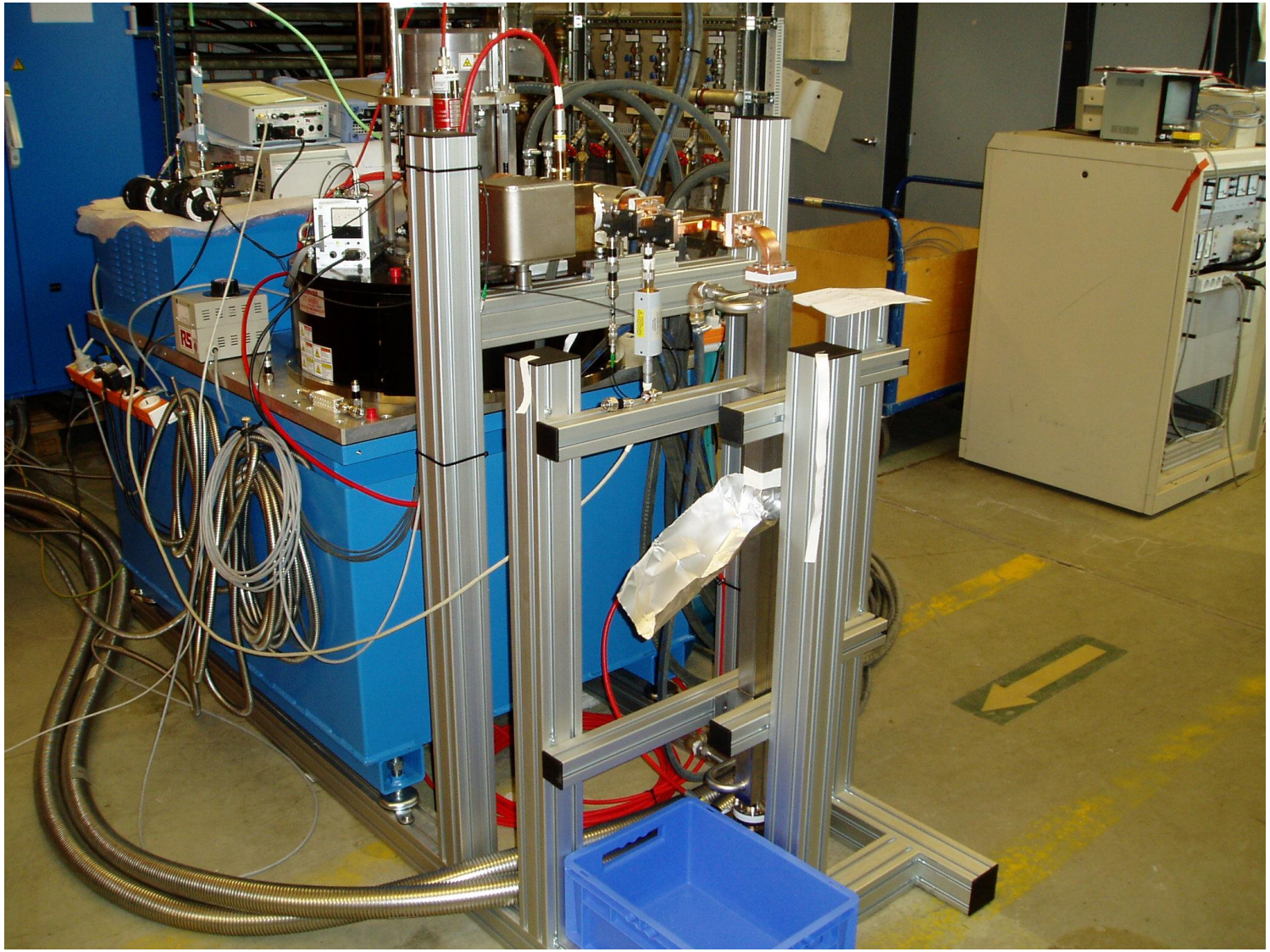
First test setup

Test of the Modulator and the Klystron at DESY April 2019

- Modulator from Ampegon
- 6MW Klystron from TOSHIBA
- Pre-amplifier from Microwave Amps
- water cooled high-power load

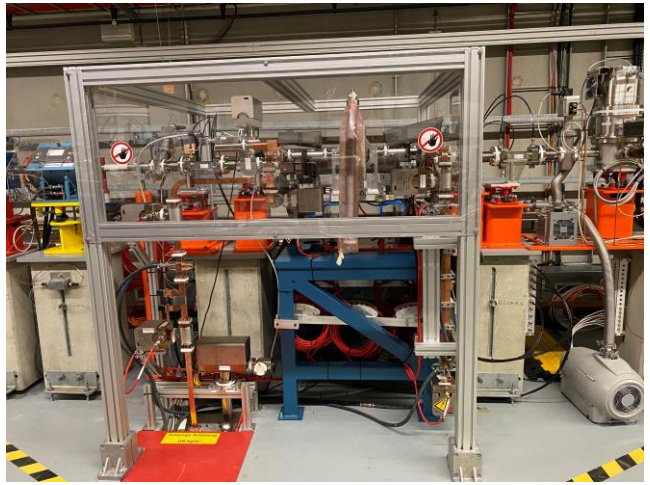
- difficulties:
  - interference on a digital control cable in the Modulator
  - leakage at the load



Installation of the PolariX System at FLASH

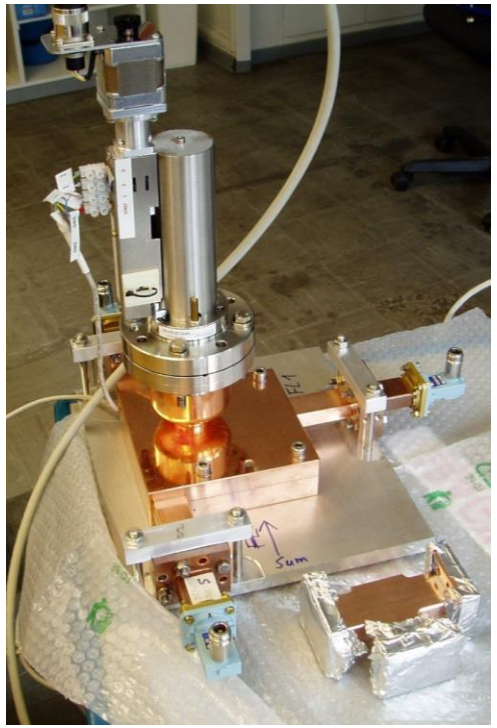
First PolariX at FLASHForward September 2019

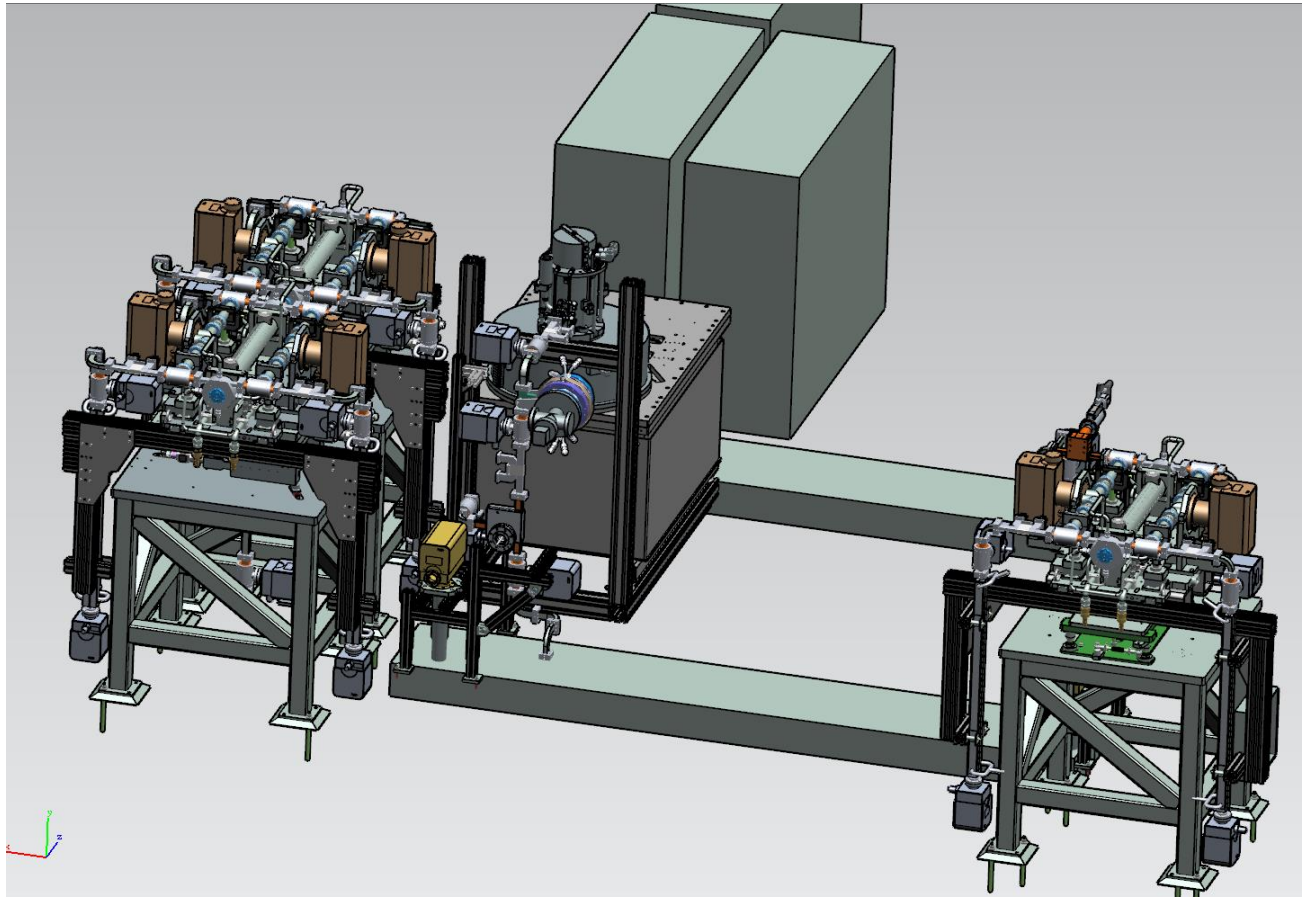
- first PolariX prototype installed at FLASHForward
  - TDS was preconditioned at CERN, so fast conditioning was possible
  - with out a BOC so far
- one Klystron in the Tunnel between FLASHForward and FLASH2
  - will be used also for FLASH2
- Modulator and measurement racks beside the tunnel
- September 7th 2019 first streaked beam, Logbook quote ”World first demonstration of variable polarization streaking”



waveguide switch

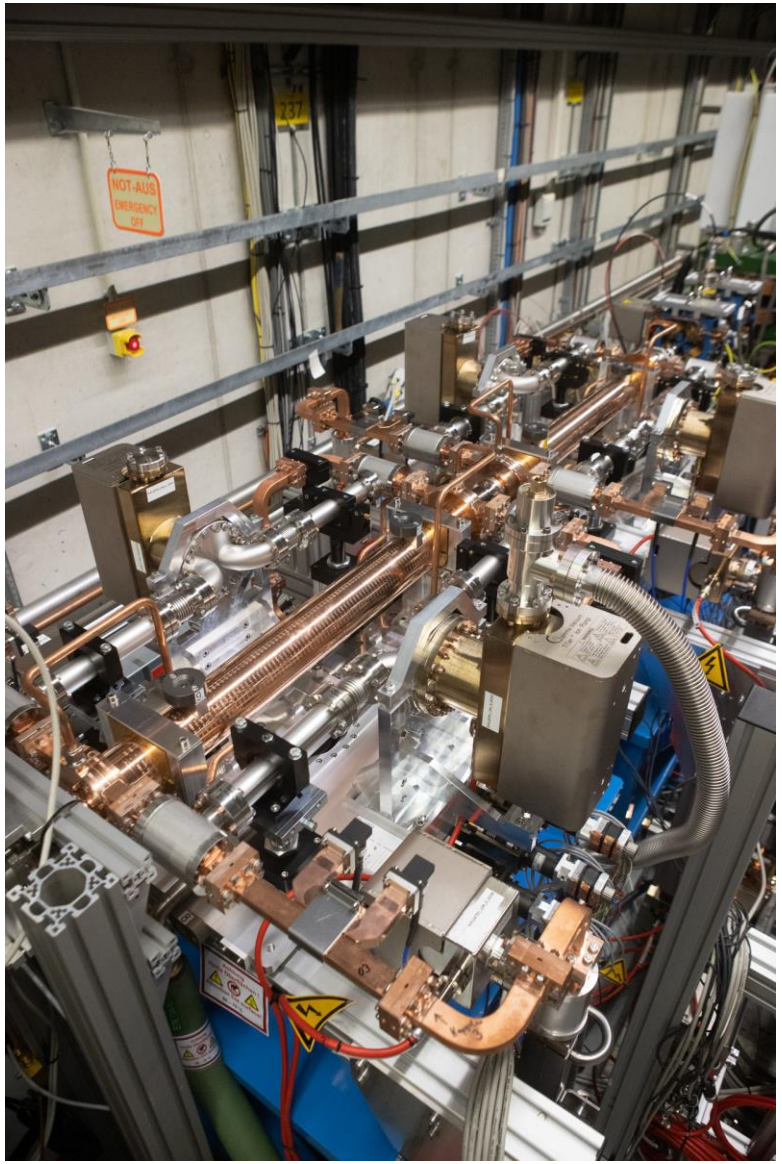
- in summer 2020 a waveguide switch was installed
  - distribute the RF-power either to FLASHForward or to FLASH2
- dummy-load at FLASH2
  - switch can be tested
  - begin of conditioning for the FLASH2 side of the switch
  - no FLASH2 TDS so far





two PolariX TDS for FLASH2

- February 2021
  - install two PolariX TDS at FLASH2
  - install a BOC
- 2nd waveguide window type from MEGA, FFwd type 701, F2 702
- start conditioning with cold, detuned BOC
  - very tough due to many new components
  - now 4MW by 550ns pulse length
  - conditioning ongoing



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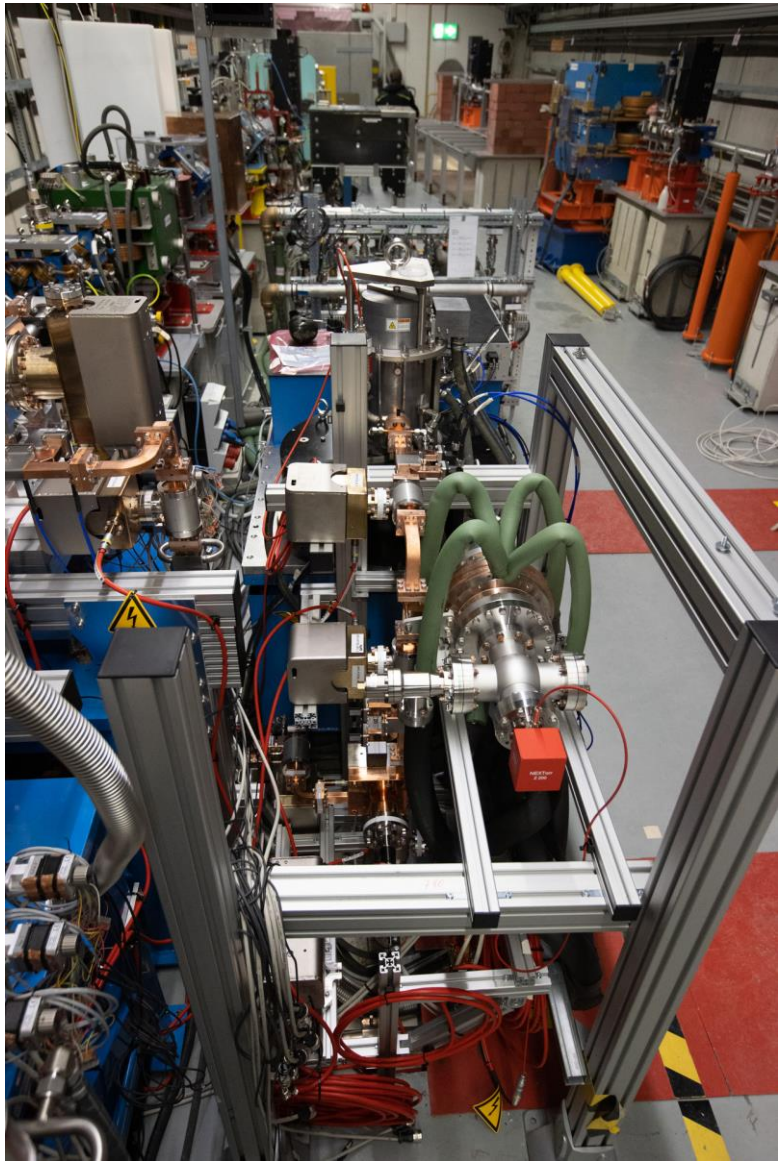

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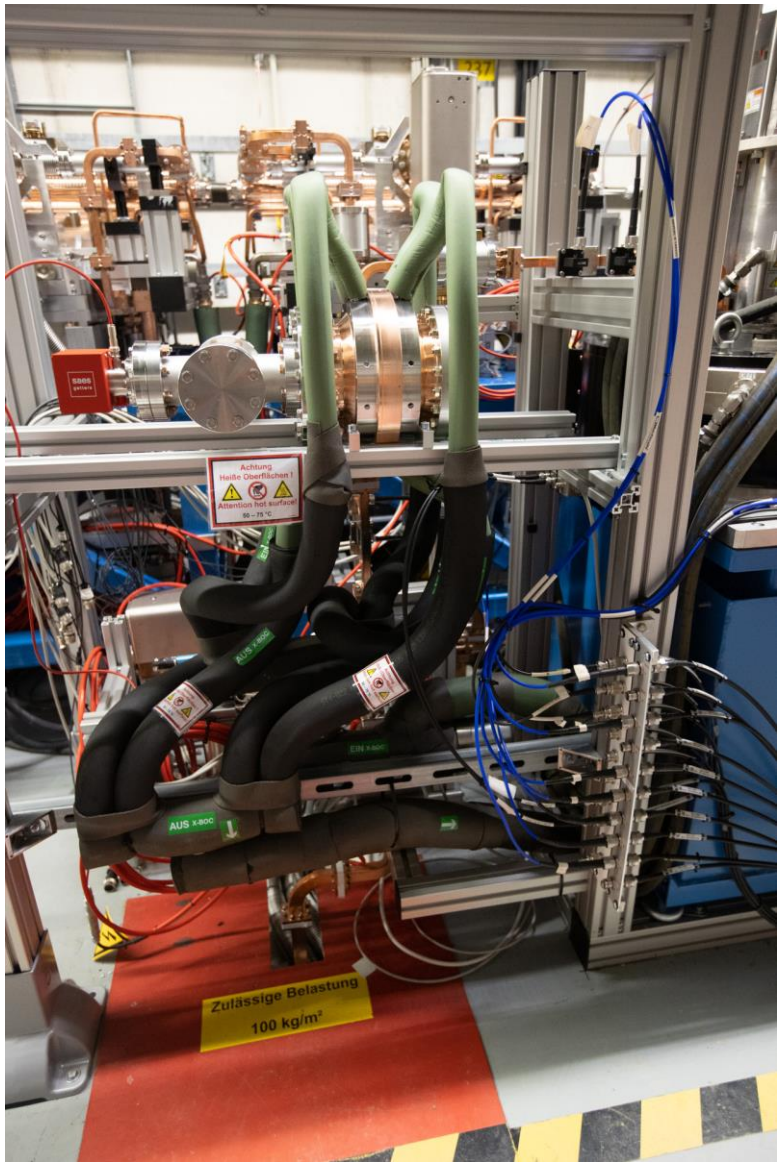
two PolariX TDS for FLASH2



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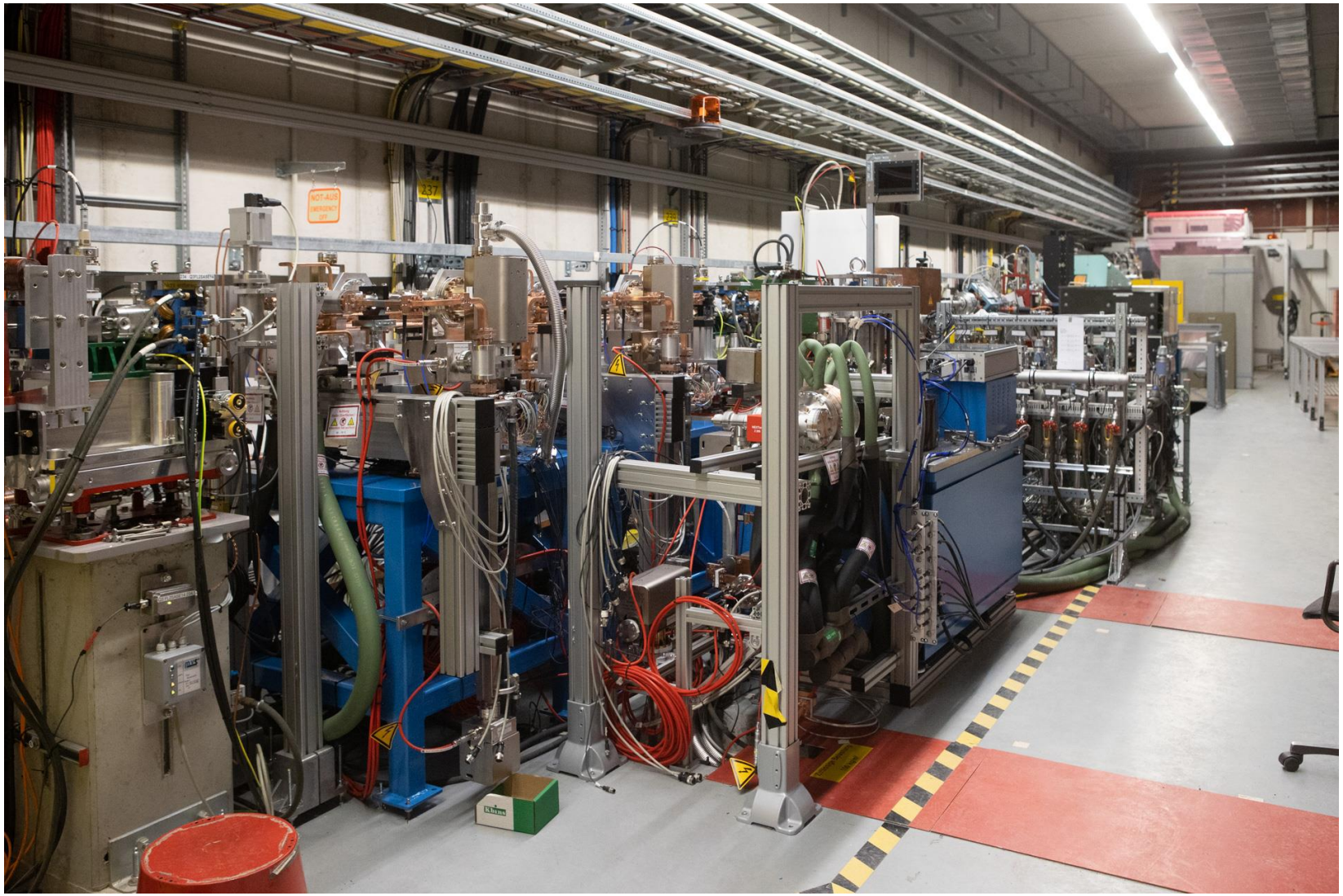


Dirk Noelle

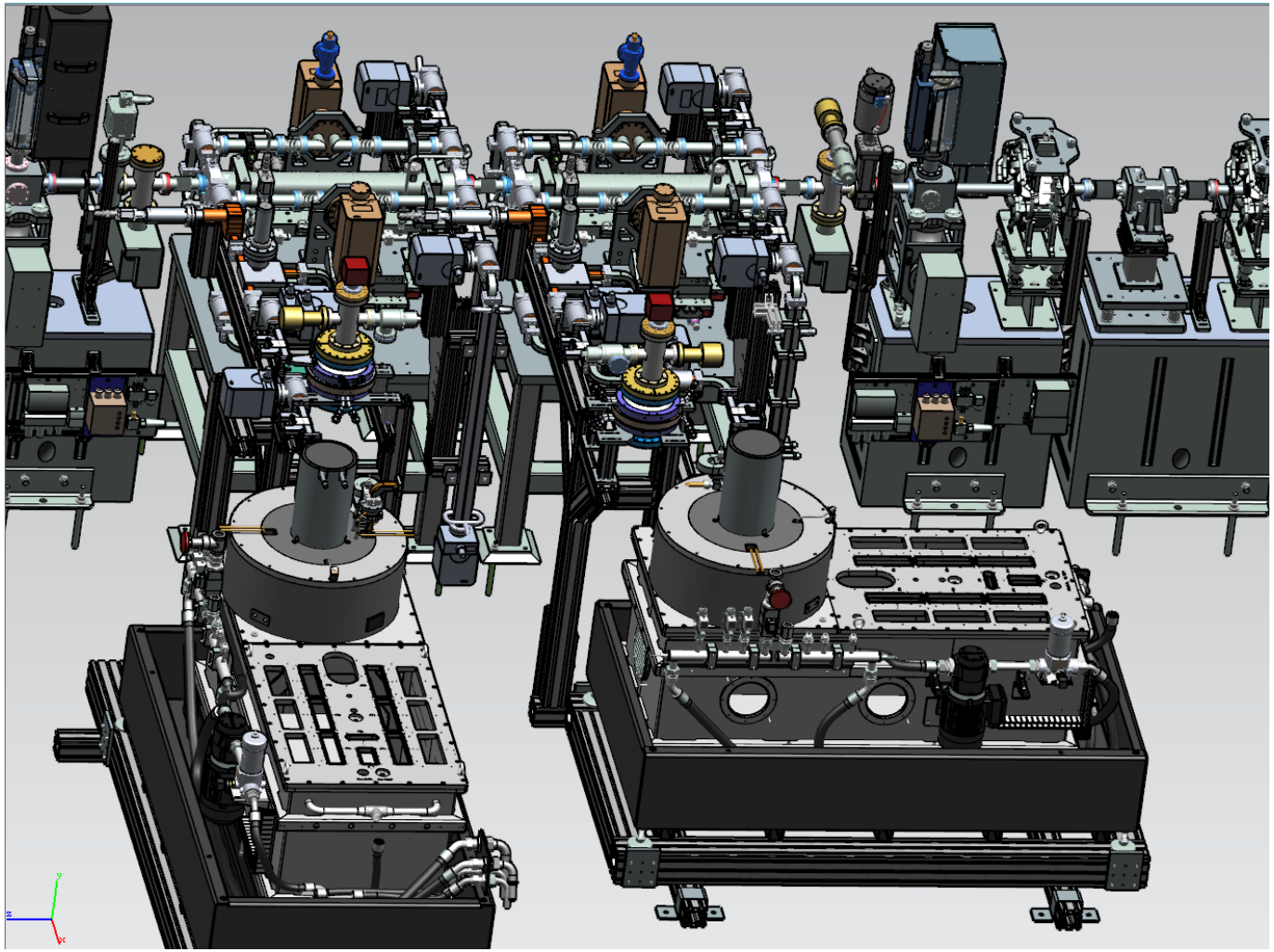
present X-Band Operation at FLASH

- The TDS-systems in both machines, FLASH2 and FLASH Forward, are already in use for machine setup, for studying plasma accelerators (FFwd) and lasing in the undulators (FLASH2). Not on a daily base, but regularly.
- Times without need for measurements are used for conditioning the TDS and the waveguide-systems to higher power.
- Modulator and Klystron have proven reliability
- No evidence for problems caused by both types of windows (MEGA 701 and MEGA 702) so far.
- Tough to get progress in conditioning the complicated FLASH2 waveguide system in the machine for powers >5MW.

Plans for SINBAD / ARES

two PolariX TDS for SINBAD / ARES

- two independent systems
- waveguide switch is used as variable power splitter
- one window from MEGA and one from CML to compare
- Klystrons from CPI
- Modulators from ScandiNova
- same TDS, BOC, phase-shifter and switch as for FLASH



two PolariX TDS for SINBAD / ARES

- both PolariX TDS are installed
- one waveguide system is finished up to the Klystron
- the other waveguide system is installed up to the waveguide switch
- delivery date for the Klystrons and the Modulators is Jan. 2022

Plans for XFEL

TDS for XFEL

- XFEL would like to have a TDS as well
- variable polarization probably not necessary

  → conventional TDS and no PolariX TDS

  → is a conventional X-Band TDS available?
- energy much higher than at FLASH

  → 6 small Klystrons or one 45MW?

Thank you

If you have any questions please contact us.

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