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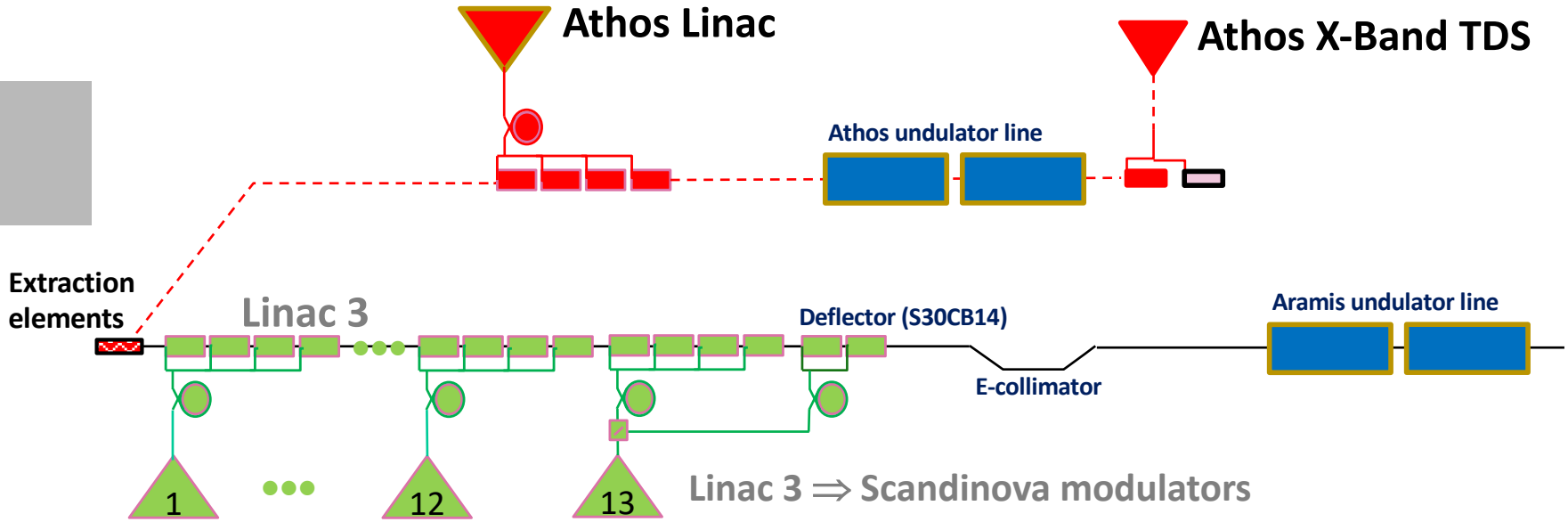
PSI

Paolo Craievich on behalf of RF section :: Paul Scherrer Institut

RF C-Band and X-Band systems

Athos Machine Commissioning Workshop, February 1st, 2019

Overview RF systems in Athos



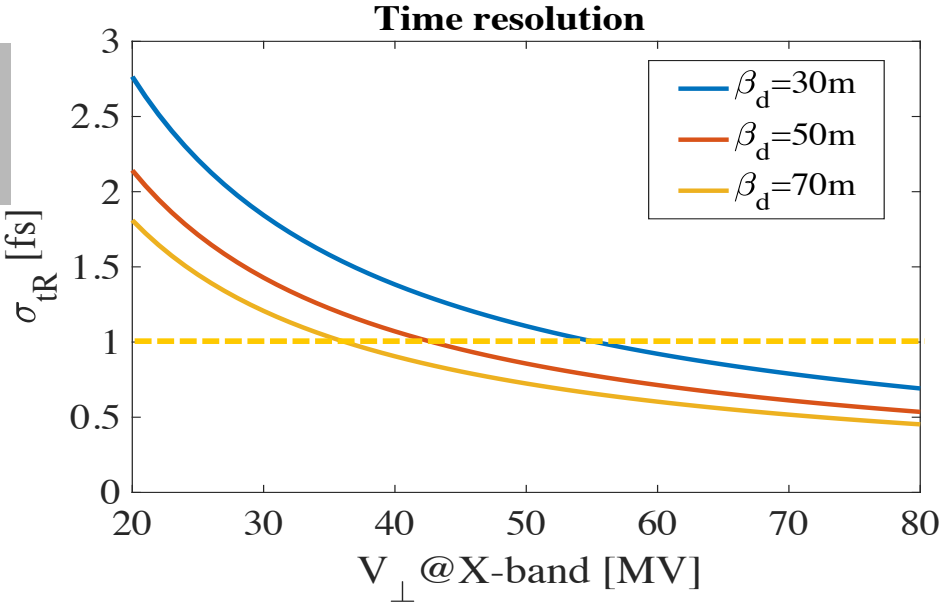
Athos X-band Transverse Deflection Structure (TDS) system

- Post-undulator X-Band system (Structure location => 479.7 – 482.0 m)
- New concept for the TDS: variable polarization of the deflecting field (one at the beginning)

Athos C band station – SATCB01

- 1 C-Band accelerating station (Structure location => 357 – 366 m)
- Energy tuning approximately +/- 240 MeV
- Cavities and power source are a clone of Linac 1&2 (Ampegon modulator)

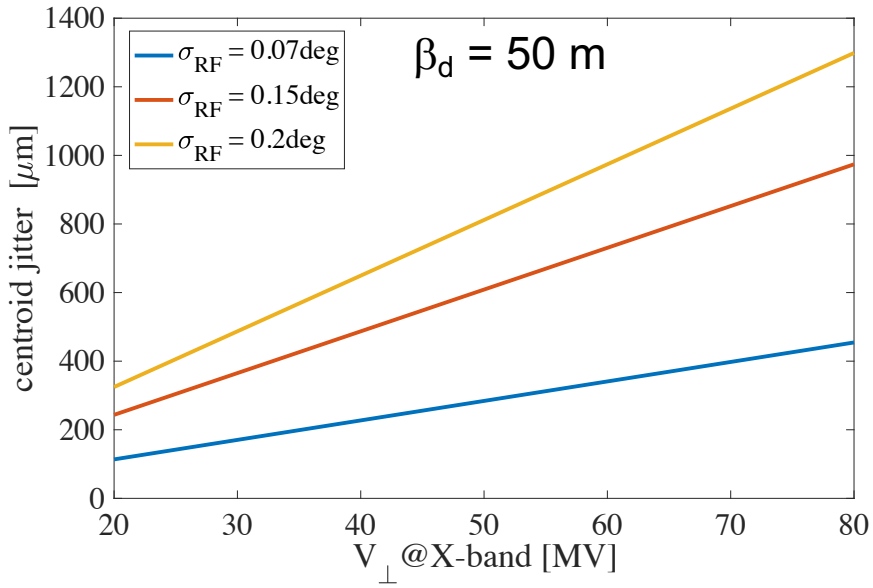
X-Band deflector expected performances

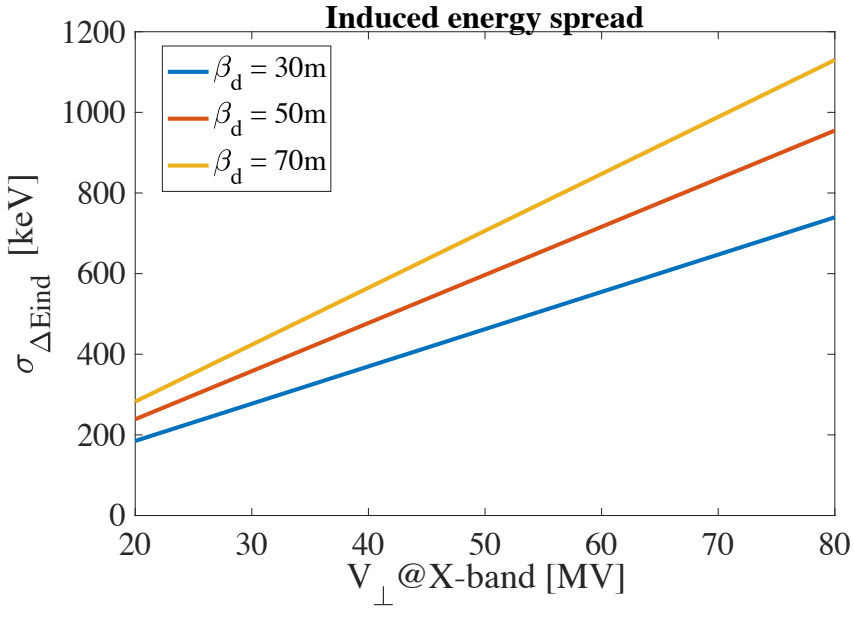


Resolution 0.95 fs at 45MV and b_d = 50 m

0.71 fs at 60MV and b_d = 50 m

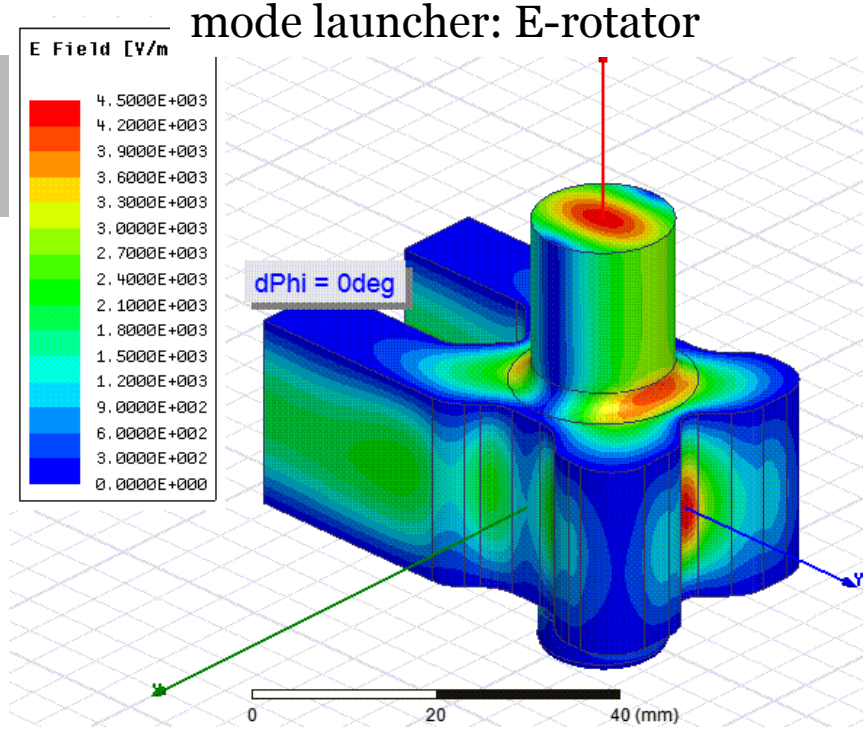
Nominal Beta function: **50 m** (both planes)





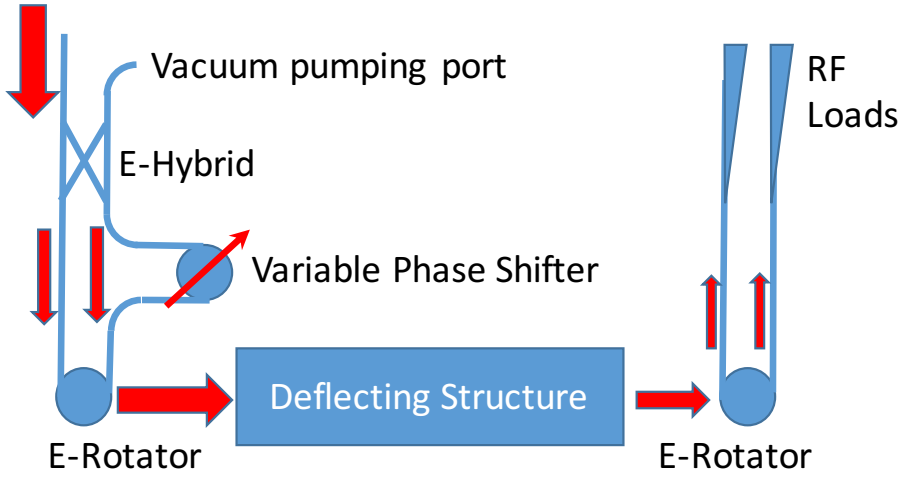
PolariX TDS: Novel Concept with Variable Polarization

Variable polarization circular TE11 mode launcher: E-rotator

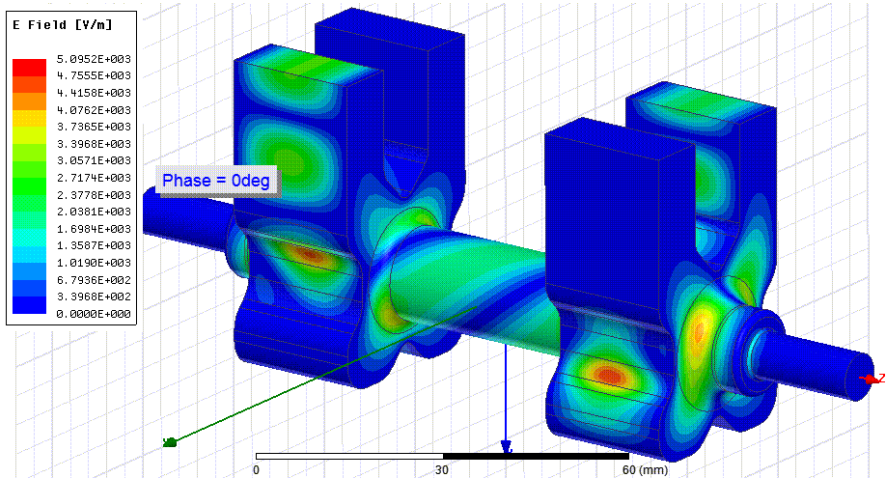


Phase difference between port 1 and port 2:

- 0 degree -> vertical polarization
- 180 degree -> horizontal polarization

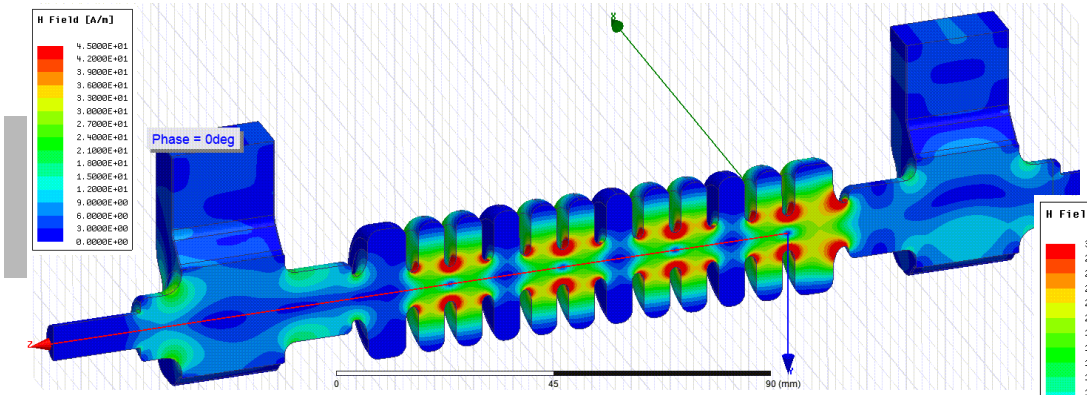


Full geometry for a face-to-face RF check of two E-rotators



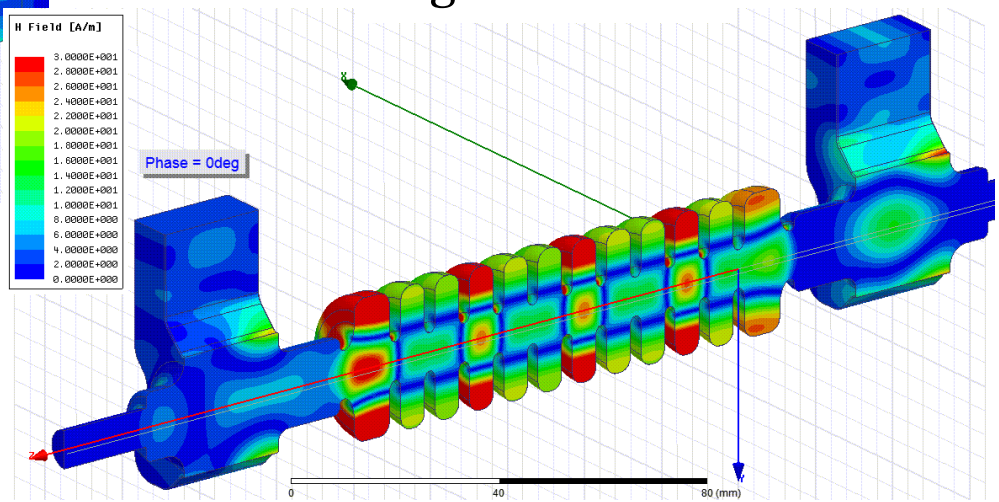
A. Grudiev, CLIC-note-1067 (2016).

PolariX TDS: tolerance



Electric Field

Magnetic Field



- The structure supports only the propagation of the operating modes TM11x and TM11y at the structure operating frequency.
- **BOTH these polarizations must be synchronized with the beam**, otherwise the polarization phase will rotate and the integrated dipolar kick in the operating plane will be reduced.

Tuning may be difficult because a tight azimuthal symmetry is required!

→ Tuning free assembly procedure developed at PSI because a high azimuthal symmetry is required

X-Band TDS structures procurement strategy

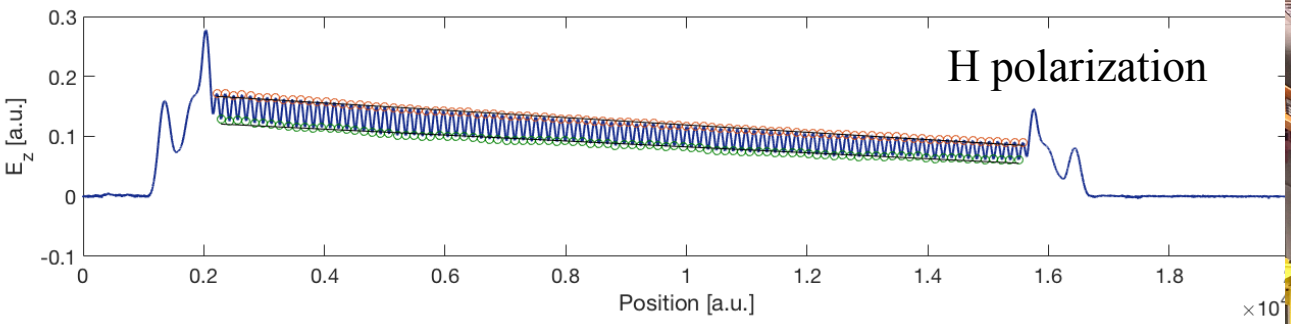
Collaboration between PSI, DESY and CERN

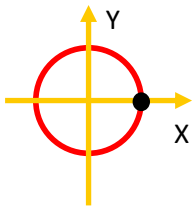
- Goal: Develop PolariX TDS with variable polarization
- Cavity design and tolerance study were performed by CERN
- Common mechanical design of the cavity fulfills the requirements of different experiments:
  - ATHOS beamline at SwissFEL
  - FLASHForward, FLASH2, SINBAD at DESY. XFEL observer of the project
- Structures are assembled and brazed at PSI using the tuning free assembly procedure (C-band linac)
- After successful test of the prototype **six other cavities will be produced** (starting now)
- Test of the prototype cavity with beam at DESY (FLASH2 beamline, 2019)

GOAL: RF structures for ATHOS by 2019

Bead-pull measurements – First structure

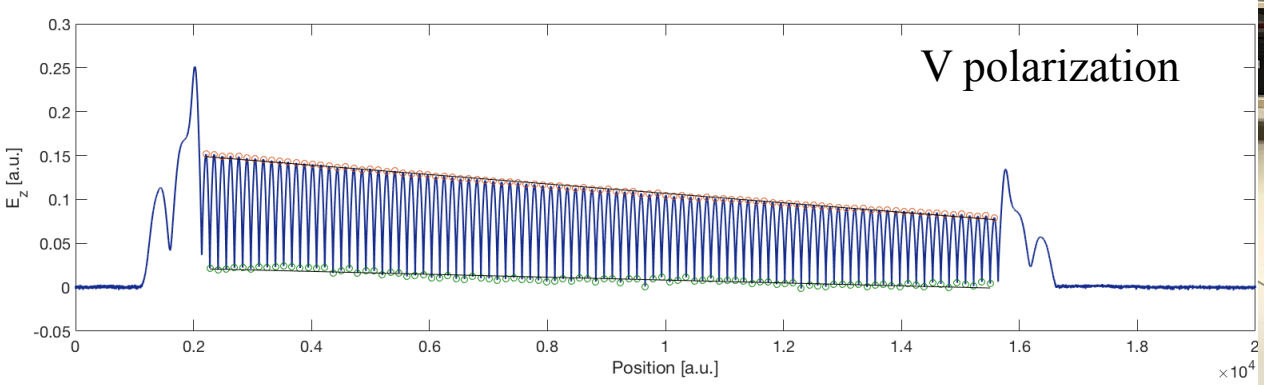
Off-axis measurement for two polarizations





X = 1mm

Y = 0 mm



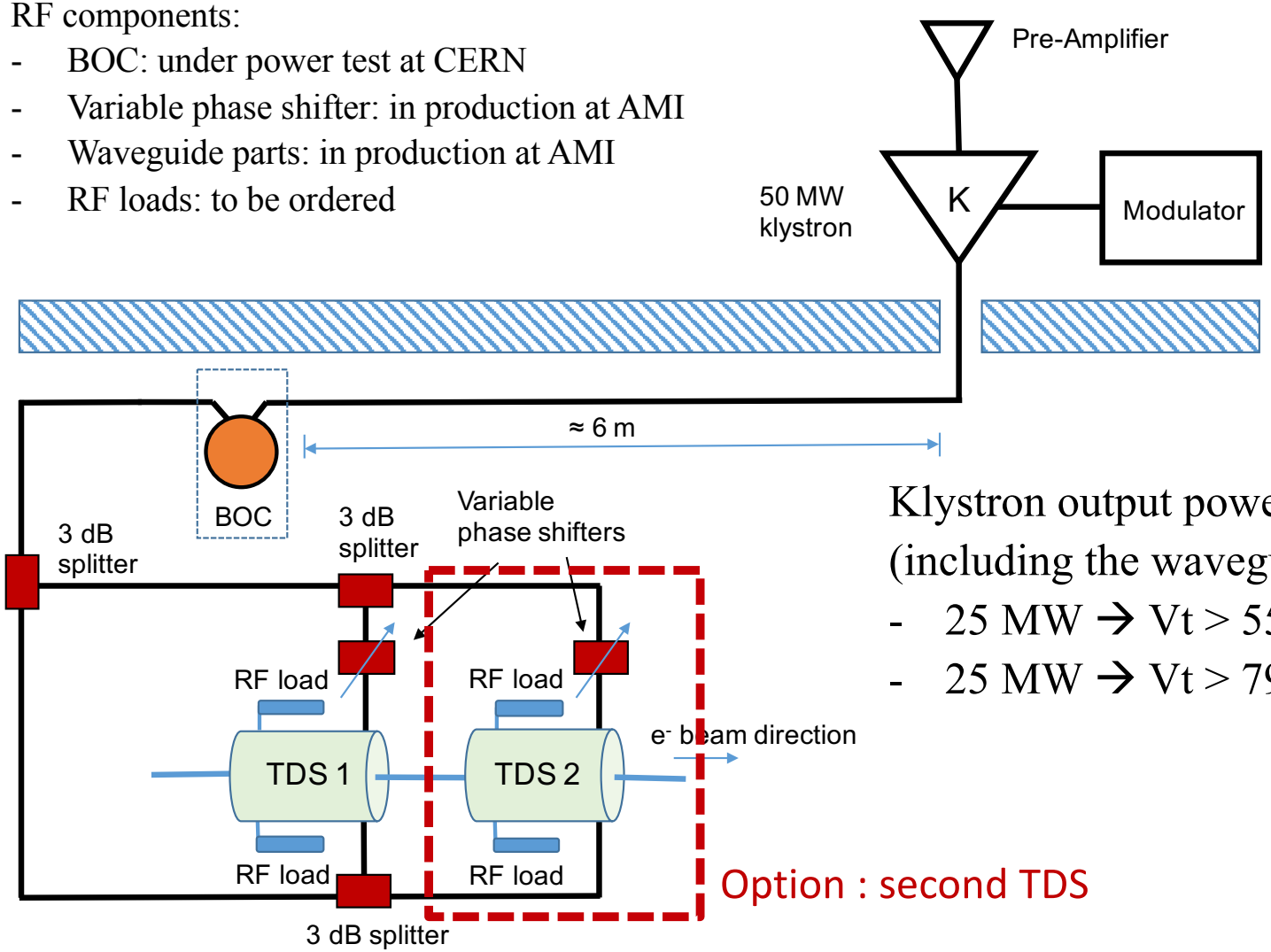
Workshop at PSI

Measurements performed by R. Zennaro and F. Marcellini

Concept of the waveguide network

TDS1 at 479.83 m +1.2m
TDS2 at 482.33 m +1.2m
Modulator and klystron position: 488 m

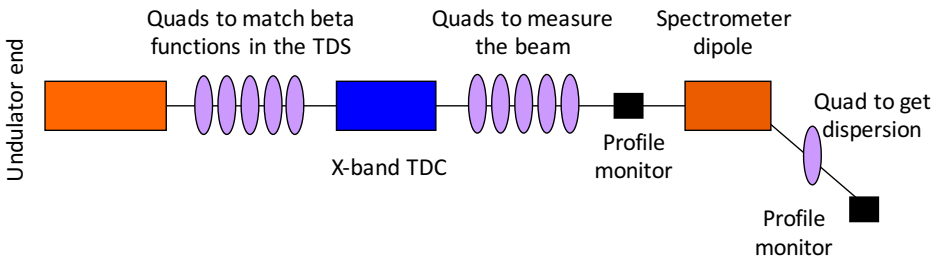
RF components:
- BOC: under power test at CERN
- Variable phase shifter: in production at AMI
- Waveguide parts: in production at AMI
- RF loads: to be ordered



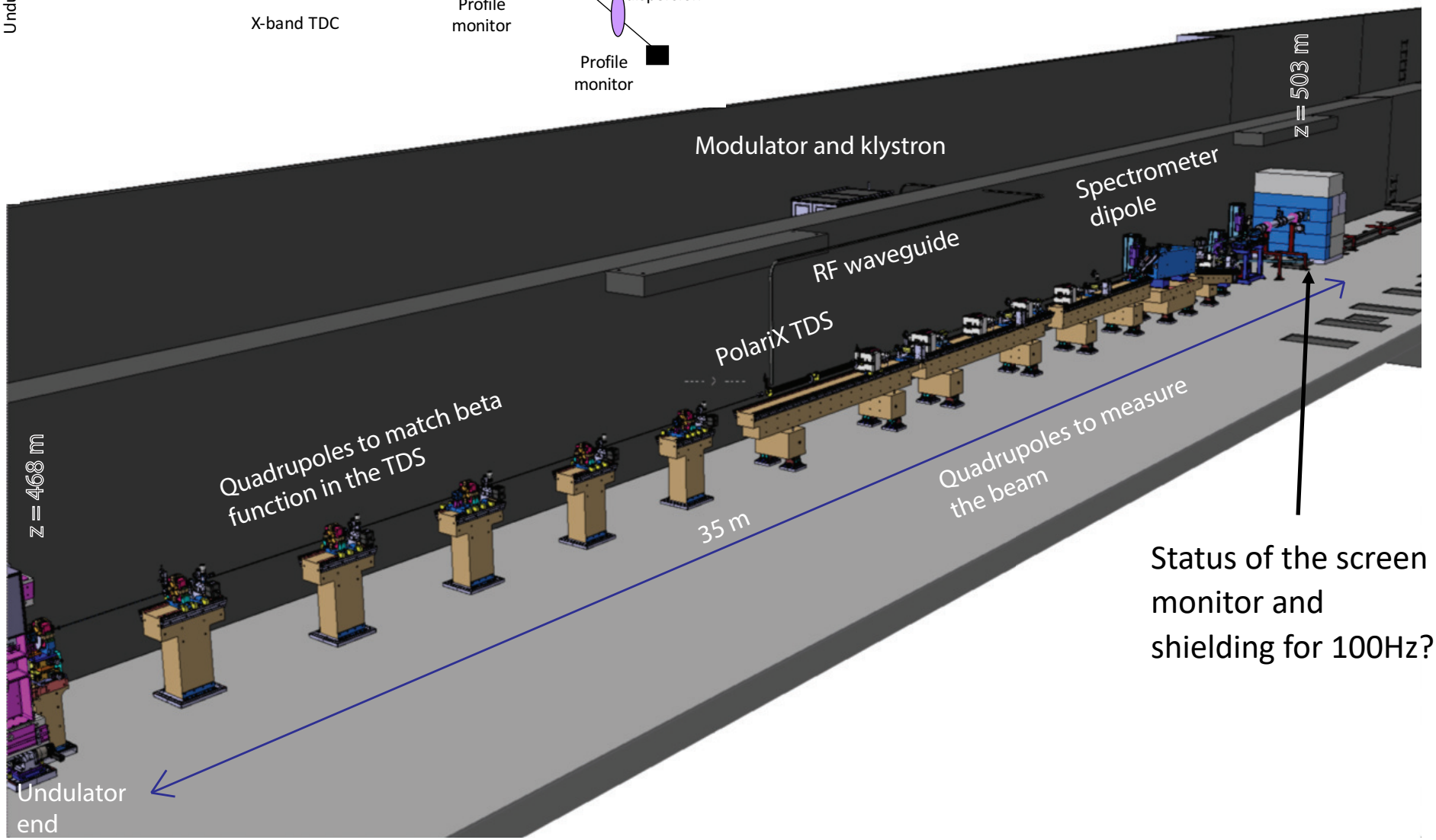
Klystron output power and defl. voltage (including the waveguide losses):
- 25 MW → Vt > 55 MV (one TDS)
- 25 MW → Vt > 79 MV (2 TDS)

Option : second TDS

Layout post-undulator diagnostic



Concept of the post-undulator diagnostic by E. Prat



Status of the screen monitor and shielding for 100Hz?

X-band modulator – Concept
(in charge of the project contact J. Alex)

- PSI decided to build the X-Band modulator for Athos in house
  - Better control of technology
  - Lower dependency on suppliers for support and potential upgrades
  - Simplifies improvements during lifetime
- In order to limit the required R&D the new modulator is based on ***the Linac 1 and 2 design***
- Investment for late renewal of the **injector modulators (S-band and X-band)** – higher klystron HV stability

Draft schedule at the end of this presentation

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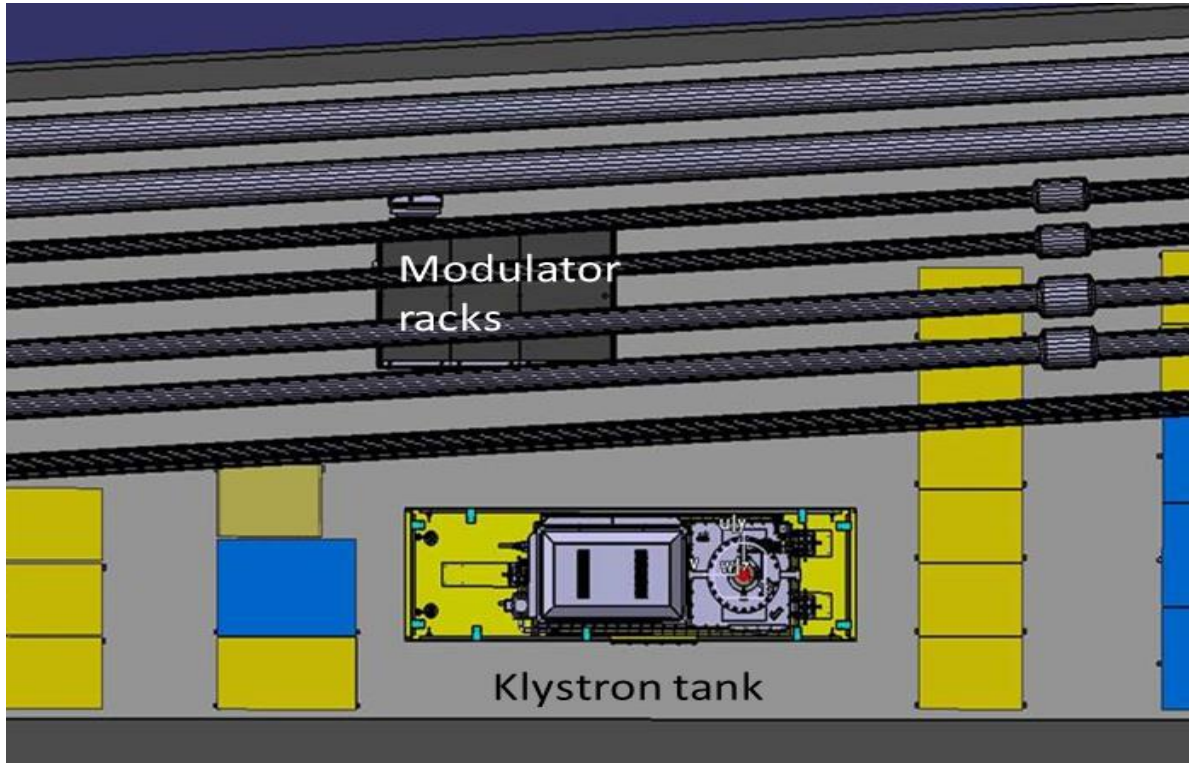
Control system concept
(in charge of the project J. Alex)

- The new X-Band will still based on the same C-band control system hardware platform
  - So ideally they should also have a common control system, just configured for different klystrons
- Use SATCB01 (ATHOS C-band station) as test platform for the new software
  - speed up software development for X-band TDS system
  - Software testing without C-band klystron
- Software upgrade also for all Linac 1 and 2 C-Band modulators

Draft schedule at the end of this presentation

Concept for the implementation



Sketch still under investigation

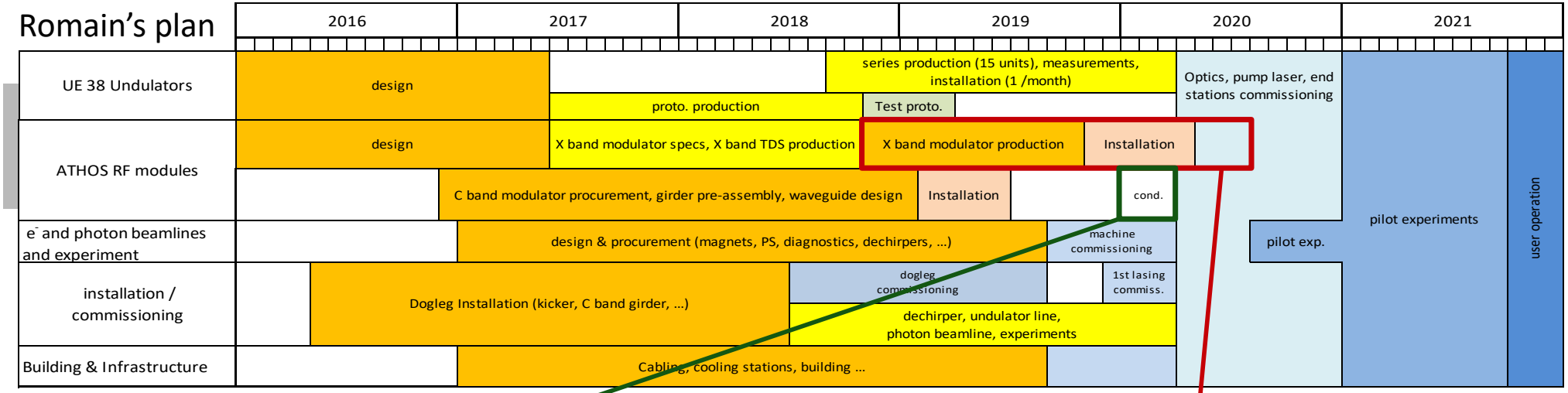
Coordination of the activities with infrastructures and other expert groups

- ❑ Transport corridor in the technical gallery
- ❑ Cooling station KKV015 and water connections (*Contact: B. Grossenbacher)*
- ❑ A crane is necessary to install the klystron and switching units
- ❑ Electrical connections (*contact E. Husler*)
- ❑ Availability timing, synchronization, ILK, controls
- ❑ PSYS integration (need shutdown)

C-band module – SATCB01

- Modulator and klystron in OSFA , ready for HV commissioning
- *Cooling station KKV015 (Contact: B. Grossenbacher)*
  - Assembly Distribution units in the technical gallery and ready for commissioning
  - Piping in tunnel - Connections of structures (and BOC) done.
- Structures, BOC and WG-distribution on girder in OSFA without RF loads
- Waveguides klystron to BOC: vertical waveguide will be installed in April shutdown (but no connection to the klystron)
  - Connection to the klystron delayed until shutdown in November 2019
    - Test stand for the software of the X-band modulator and in general for the new software for the Linac 1 and 2 modulators.
- RF station will be available for RF conditioning in early 2020 (after X-band development)
- Module available for beam in Spring 2020

Athos RF systems Time Plan



C-band module – SATCB01

- ❑ WG connection to the klystron
- ❑ RF startup early 2020 (Jan-Feb)
  - PSYS integration (need shutdown)
  - LLRF station basic setup & RF ILK
- ❑ RF conditioning – 8 weeks
- ❑ LLRF station setup w/o and w/ beam

X-band modulator production