

First bunch duration measurement on the ARES linac at DESY

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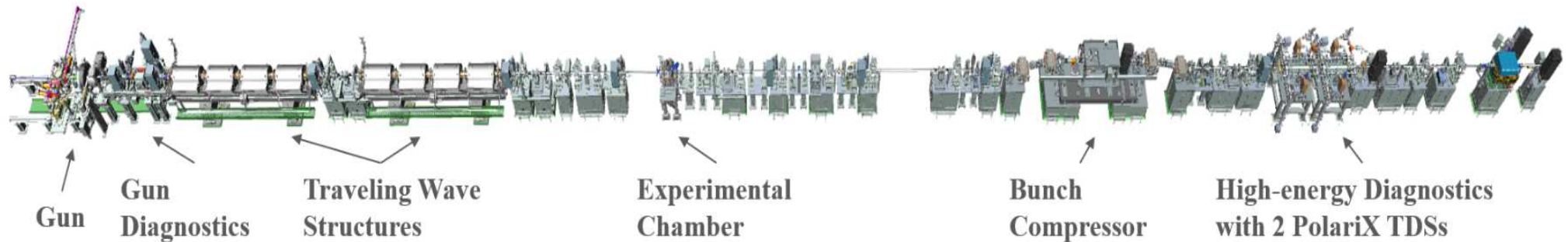
HELMHOLTZ RESEARCH FOR
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DESY.



ARES linac at DESY: Status

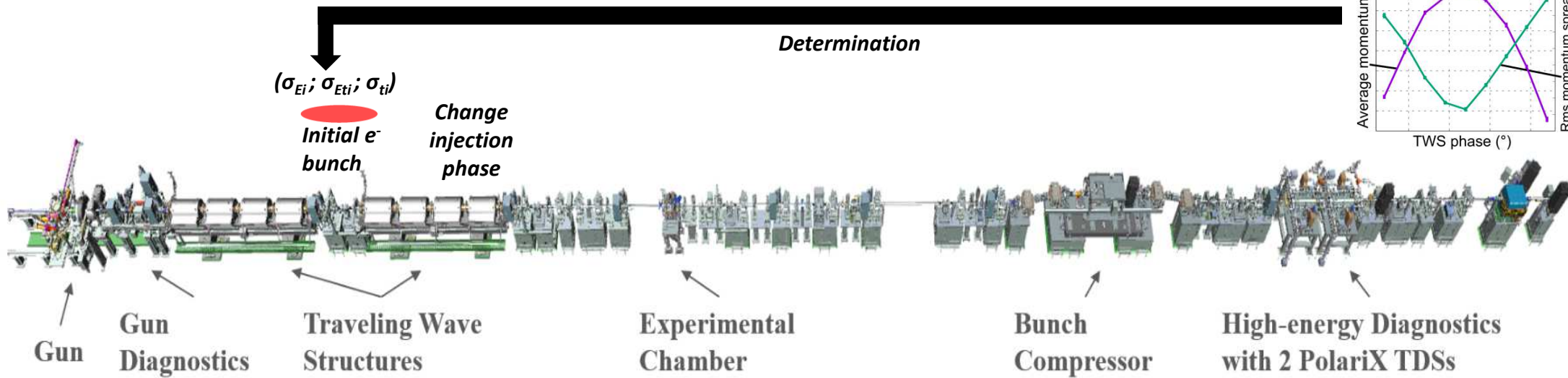
- **ARES goal:** Characterize ultrashort e⁻ bunches for applications (advanced & compact long. diag. and accelerating structures development, FLASH radiotherapy, etc.).



- Beamline installation completed in Spring 2021 with bunch compressor and 2 PolariX TDS'.
- Klystron to operate the PolariX structures expected in December 2021 or beginning 2022.

Properties	Target value	Status
Charge	0.1 – 100 pC	0.1 – 50 pC
Momentum	50 – 150 MeV/c	50 – 156 MeV/c
Momentum spread	10 ⁻⁴	10 ⁻⁴
Transverse emittance	< 0.8 π.mm.mrad	≈ 0.4 π.mm.mrad
Duration	Sub-fs to ≈ 10 fs	≈ 40 fs

Traveling wave structure phase scan: Principle



$$\sigma_{t_{min}} = \frac{R_{spectro} * E_{max}}{\pi * f * e * A_0 * L} \approx 30 \text{ fs}$$

Spectrometer resolution

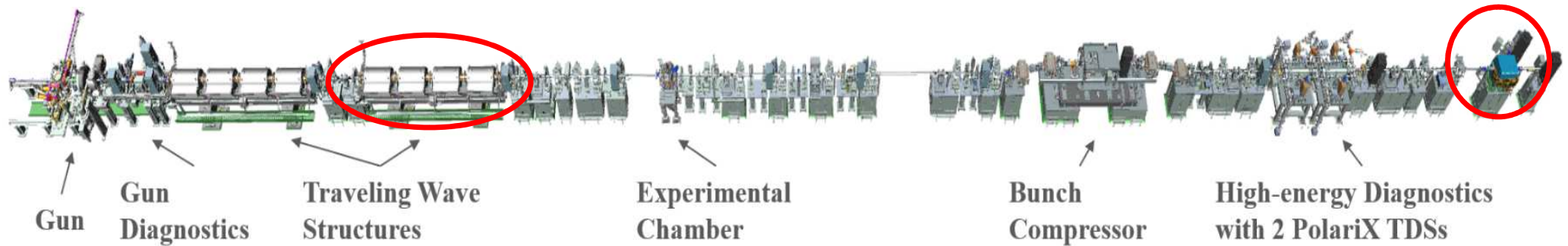
Max. final energy

Time resolution

Frequency, field amplitude and length of the accelerating structure

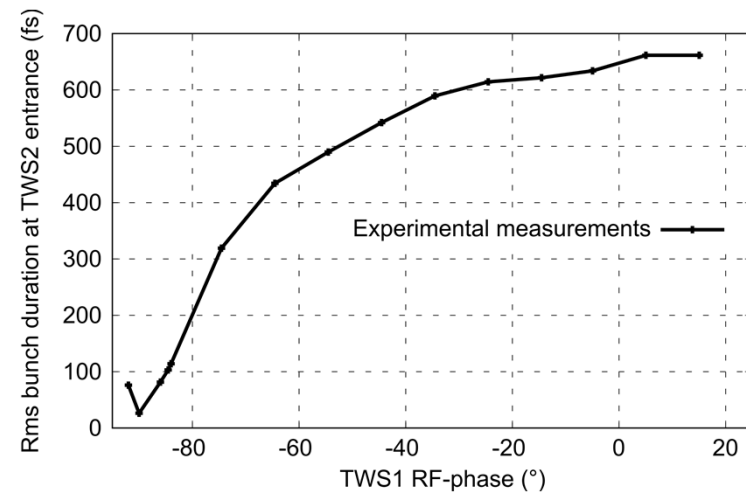
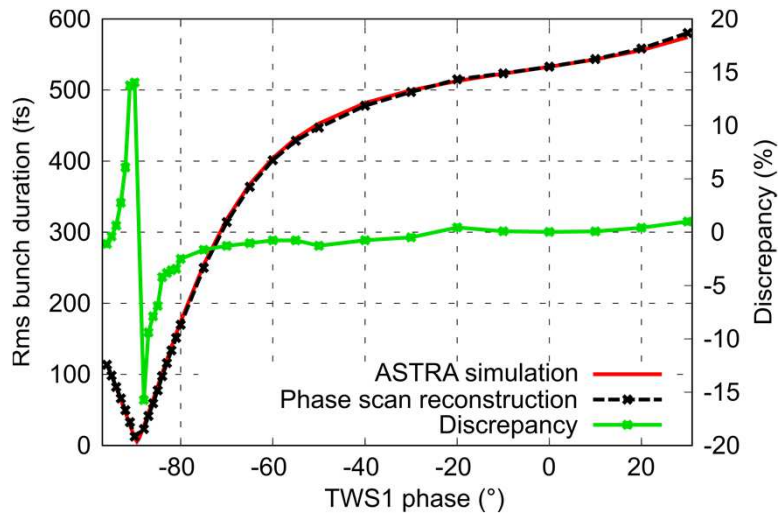
at ARES (with zero initial chirp, can be improved if initial chirp $\neq 0$)

Traveling wave structure phase scan: Application at ARES



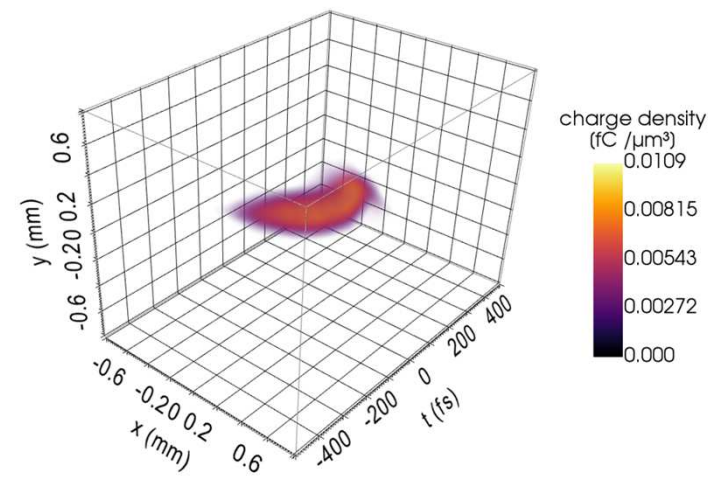
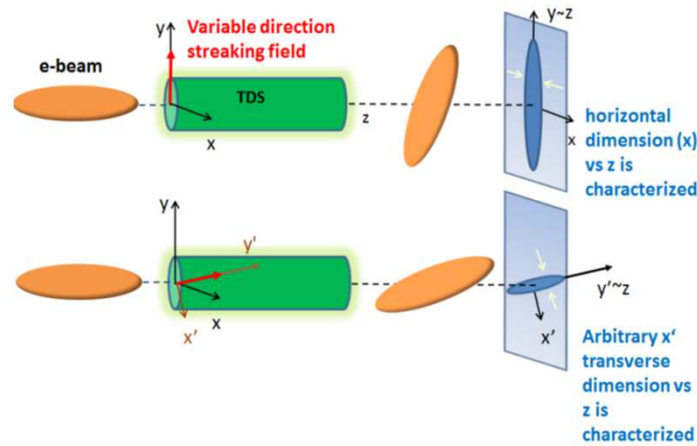
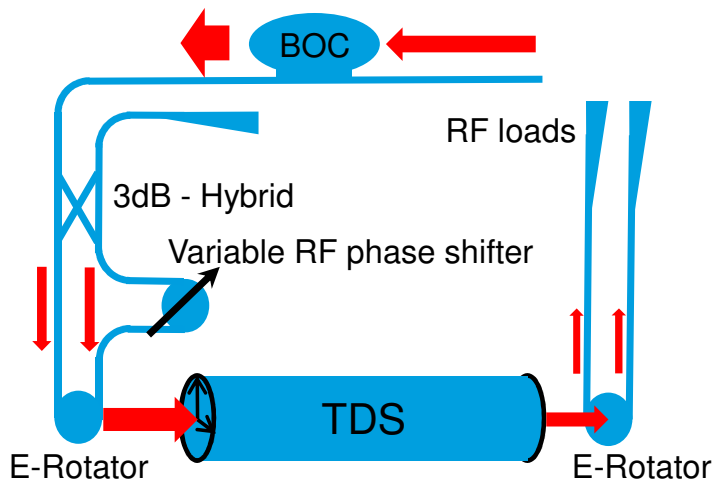
➤ Measurement simulated with ASTRA for typical ARES parameter (1 pC & 155 MeV) → Accuracy evaluation

➤ Measurement performed at ARES (1.6 pC & 155 MeV) → A minimal duration of ≈ 30 fs rms (close to resolution limit) has been reconstructed



ARES linac at DESY in future: PolariX TDS

- Collaboration between CERN, PSI and DESY → X-band (≈ 12 GHz) transverse deflecting structure with the new feature to be able to vary the streaking direction: A. Grudiev, CLIC-note-1067 (2016); P. Craievich et al., PRAB 23 112001 (2020); B. Marchetti et al., Sci. Rep. 11 3560 (2021).



- PolariX will allow diagnosing bunch duration with sub-fs resolution at ARES, as well as the beam phase-space incl. all correlations up to 5D (x, x', y, y', t) with few fs resolution.
- Commissioning phase (end 2021 – beginning 2022) will be greatly supported through benchmark with the traveling wave structure phase scan already in use at ARES.