

PolariX Transverse Deflection Structure

- A transverse deflecting structure is an RF cavity where the Lorentz force is directed in the transverse plane, particles in different points along the beam will feel a different field so that a correlation is imprinted between the transverse coordinate at the screen and particle's longitudinal position

$$\sigma_{streaked} = \sqrt{\sigma_{off}^2 + (K_{rfd}\sigma_t)^2}$$

K_{rfd} : Calibration Factor

σ_t : Bunch Length

σ_{off} : Unstreaked Beam Size

- The **PolariX** is an X-band Transverse Deflecting Structure with the feature of changing the beam streaking direction

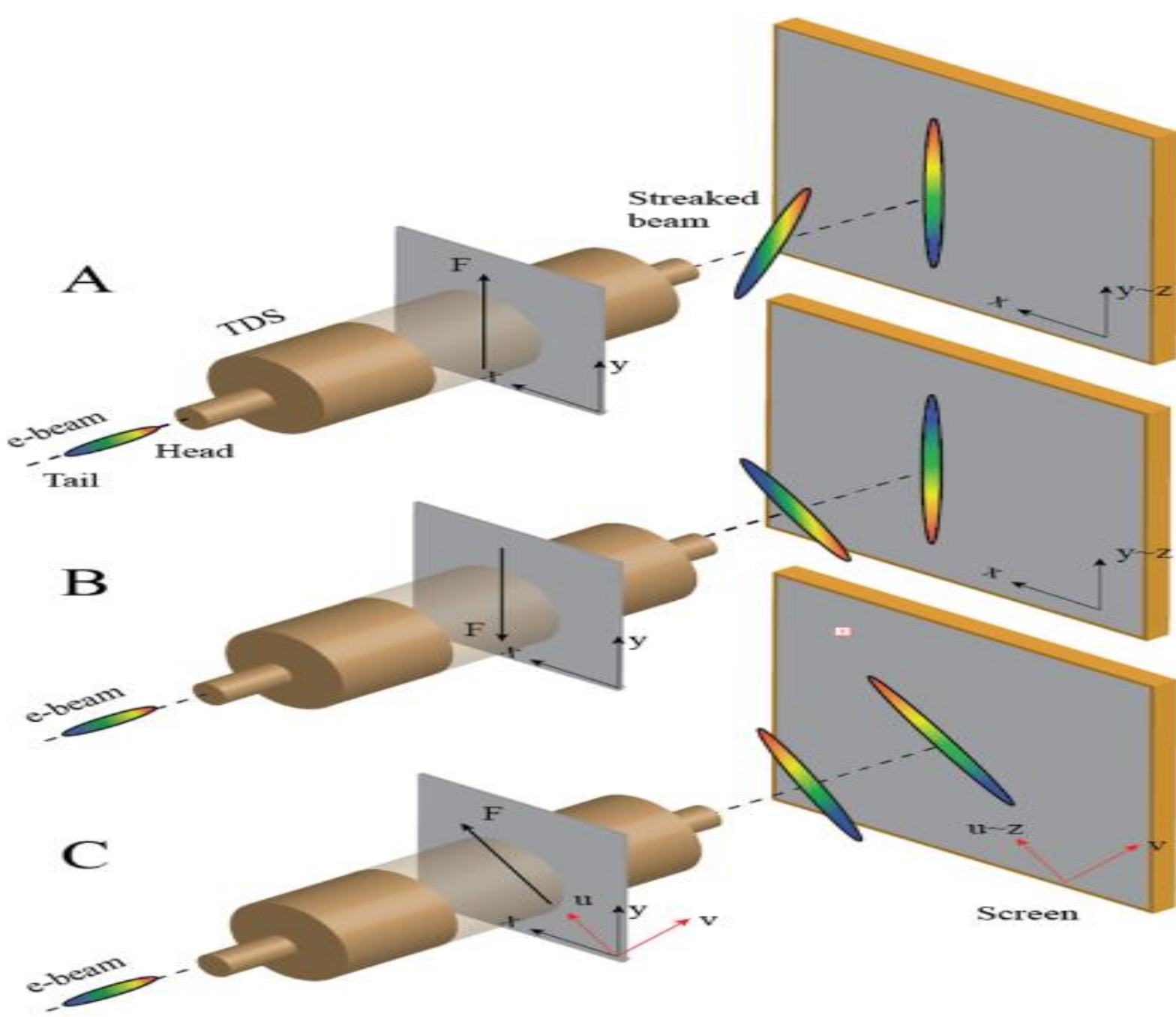


FIG 1: PolariX TDS Working Principle

3D beam distribution Reconstruction

- The 3D beam distribution can be reconstructed by streaking the beam at different angles, covering a polarization range of 180 degrees
- Each streaked beam is divided into longitudinal slices, depending on the resolution, obtaining a set of 1D distributions for each streaking angle

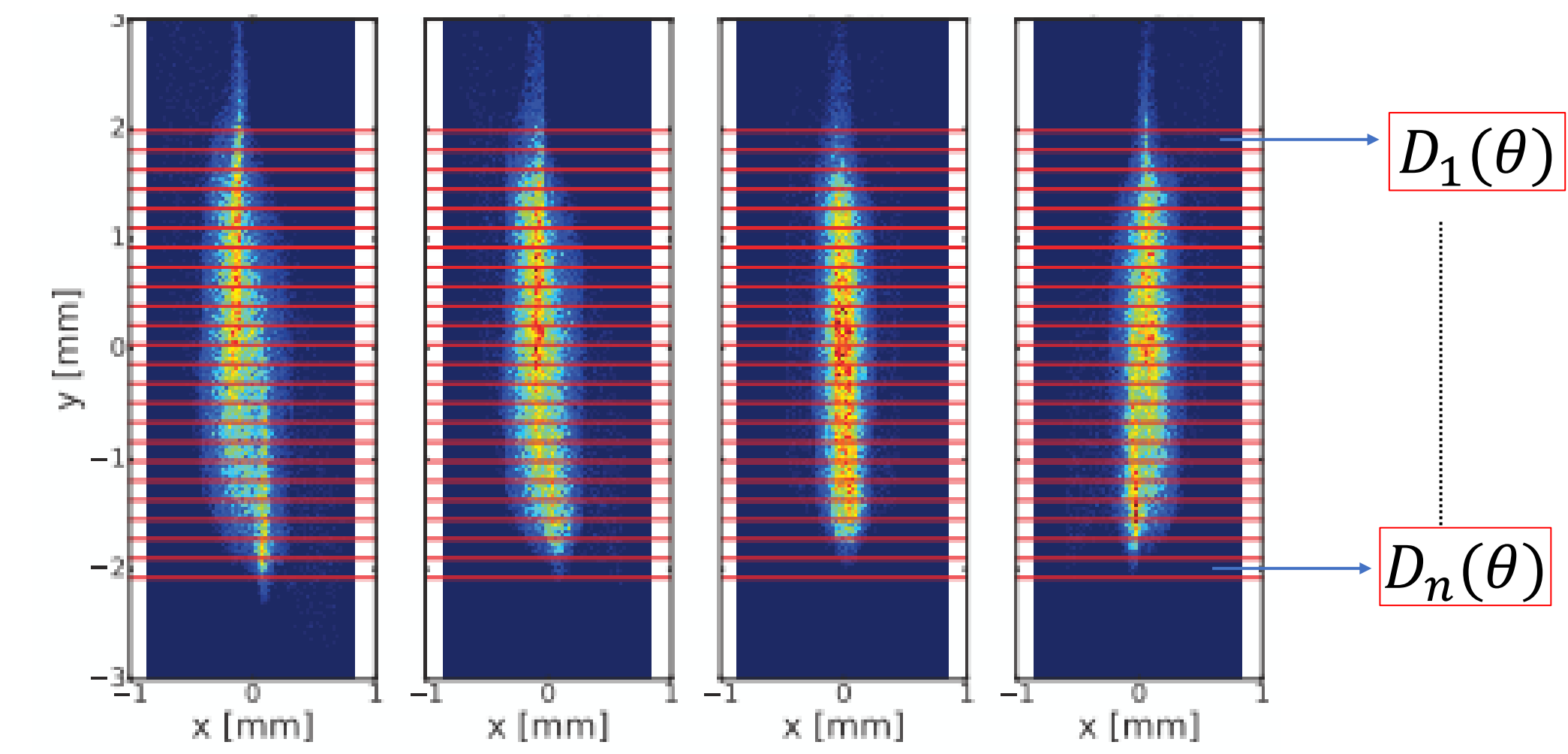


FIG 2: 1D Projections

- The sets of 1D projections are combined using a SART tomographic algorithm, retrieving the 2D distribution for each slice

- By stacking the slices together the 3D distribution is obtained

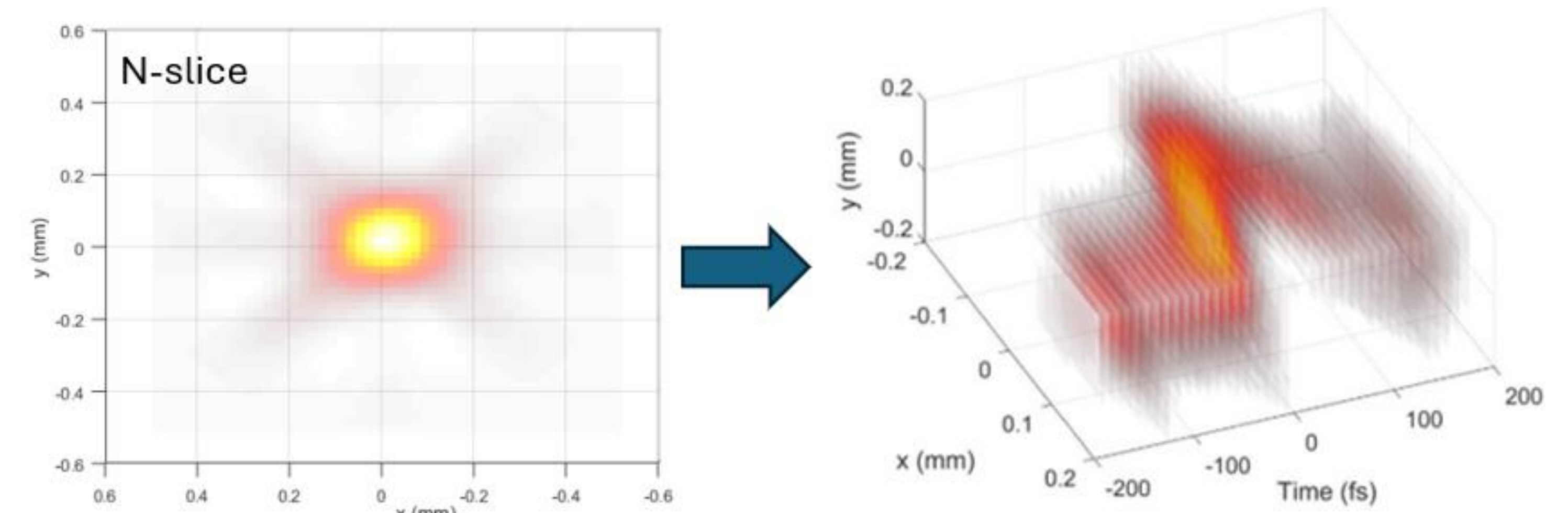


FIG 3: 3D Reconstruction

ATHOS diagnostics beamline at SwissFEL

- ATHOS is the soft X-rays beamline at SwissFEL at 3 GeV, **two PolariX TDS** are installed to measure the longitudinal properties of the beam

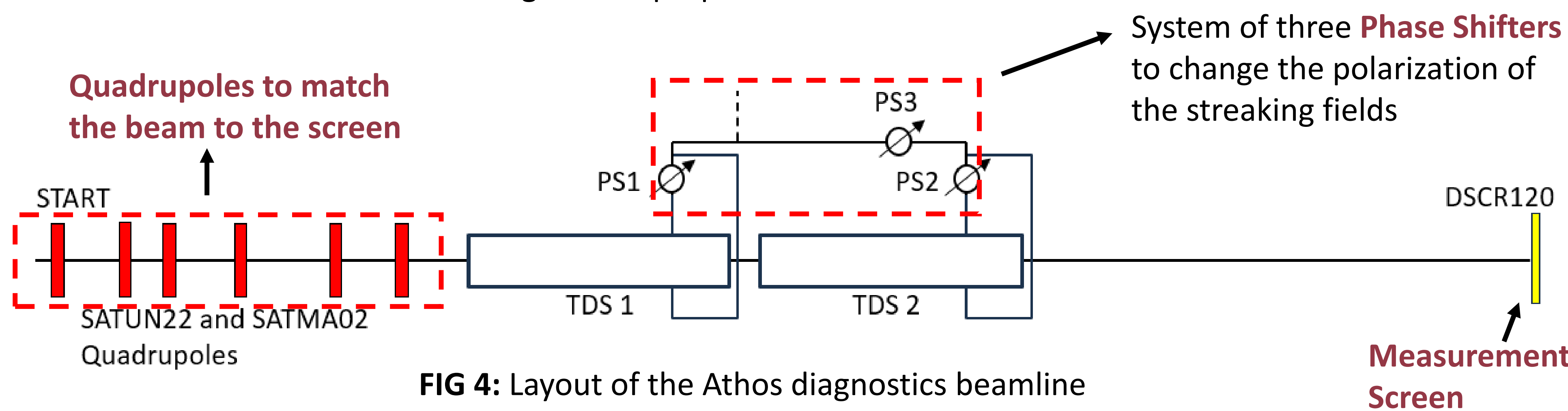


FIG 4: Layout of the Athos diagnostics beamline

Beam Parameters	
Charge [pC]	200
Energy [GeV]	3.4
RMS Bunch Length [fs]	10.2
$\beta_{x,y}$ at the Screen [m]	20

TDS Parameters	
TDS Length [m]	1.2
Voltage [MV]	70
Klystron Power [MW]	28
TDS-Screen Distance [m]	11
TDS Calibration [$\mu\text{m}/\text{fs}$]	16

Measurement results

- To perform the reconstruction the beam has to be streaked by covering a polarization range of 180 degrees
- The Streaking Angle is obtained by measuring the centroid shift when changing the RF phase

Polarization [deg]	Measured Angle [deg]
0	3.0 ± 0.2
18	19.7 ± 0.2
36	37.8 ± 0.4
54	57.0 ± 0.3
72	75.3 ± 0.7
90	94.4 ± 0.6
108	111.4 ± 0.7
126	129.8 ± 0.7
144	138.6 ± 0.4
162	165.3 ± 0.3

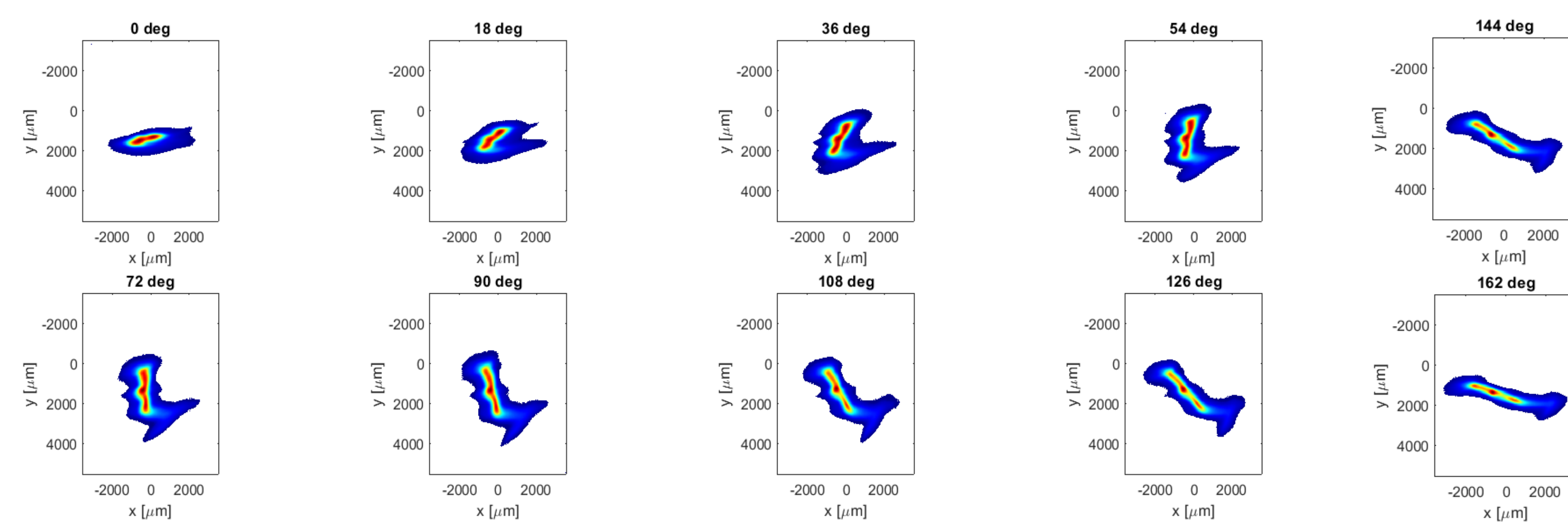


FIG 5: Streaked Beam for different polarizations

- The Reconstruction has been performed with a longitudinal resolution of 5 fs, and shows that there is a tilt in the x-t plane
- This methodology will be complemented with a quadrupole scan, by varying the phase advance to the reconstruction point to the screen, corresponding to a phase space rotation in the transverse plane, allowing to perform a tomography to reconstruct the 5D phase space (x, x', y, y', t)

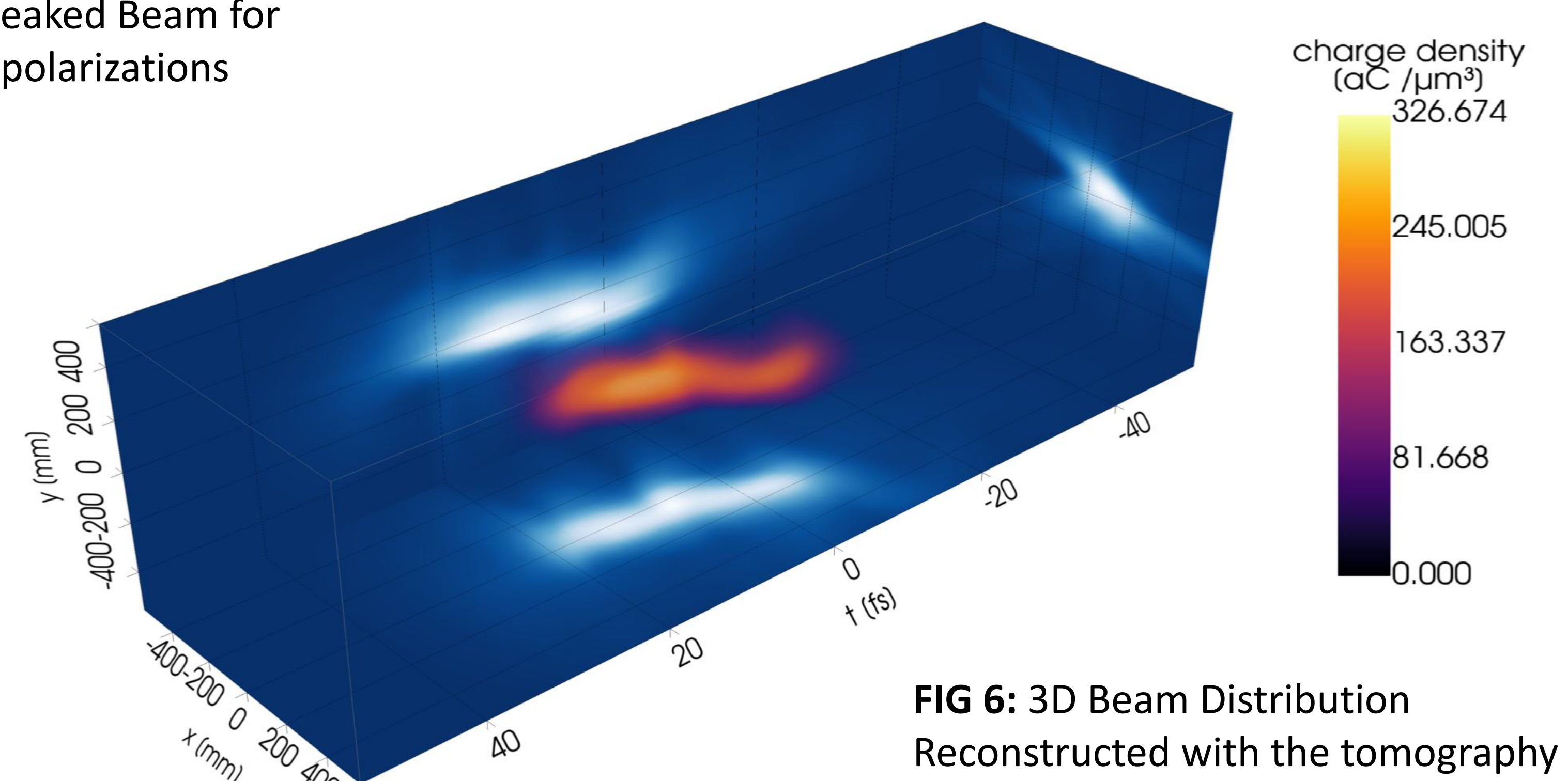


FIG 6: 3D Beam Distribution Reconstructed with the tomography

Reference

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