THZ AND SUB-THZ CAPABILITIES OF A TABLE-TOP RADIATION SOURCE DRIVEN BY AN RF THERMIONIC ELECTRON GUN

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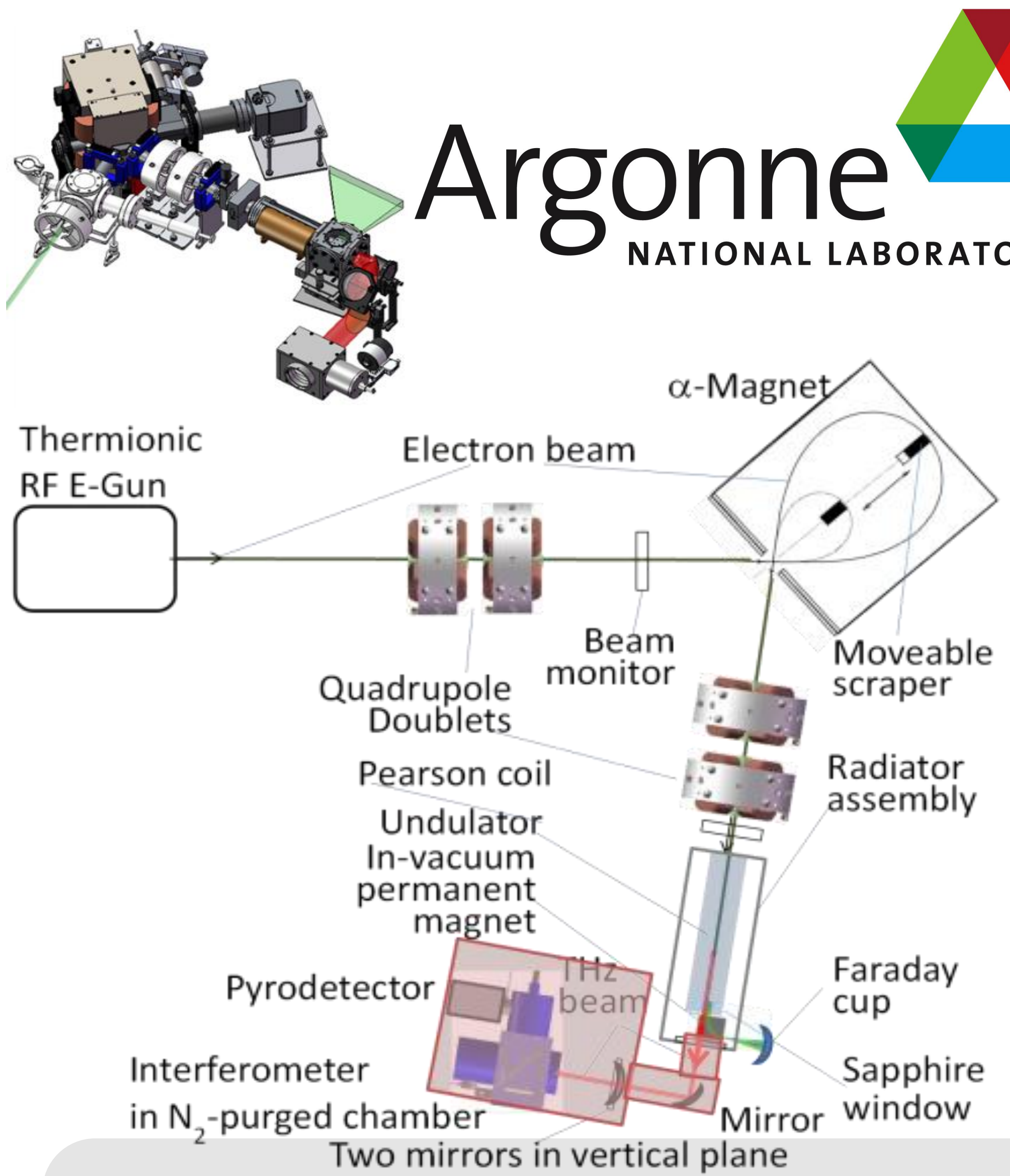
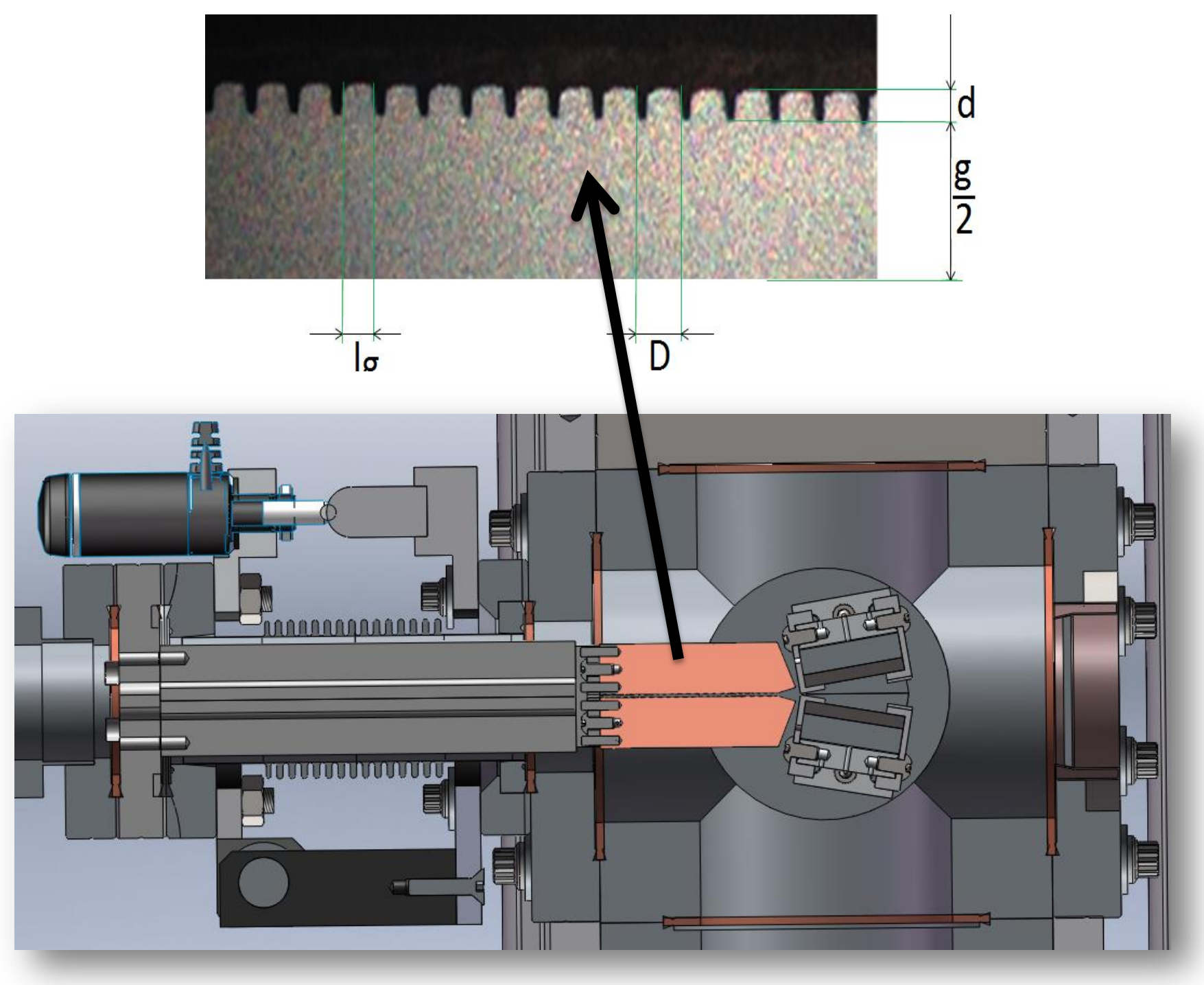
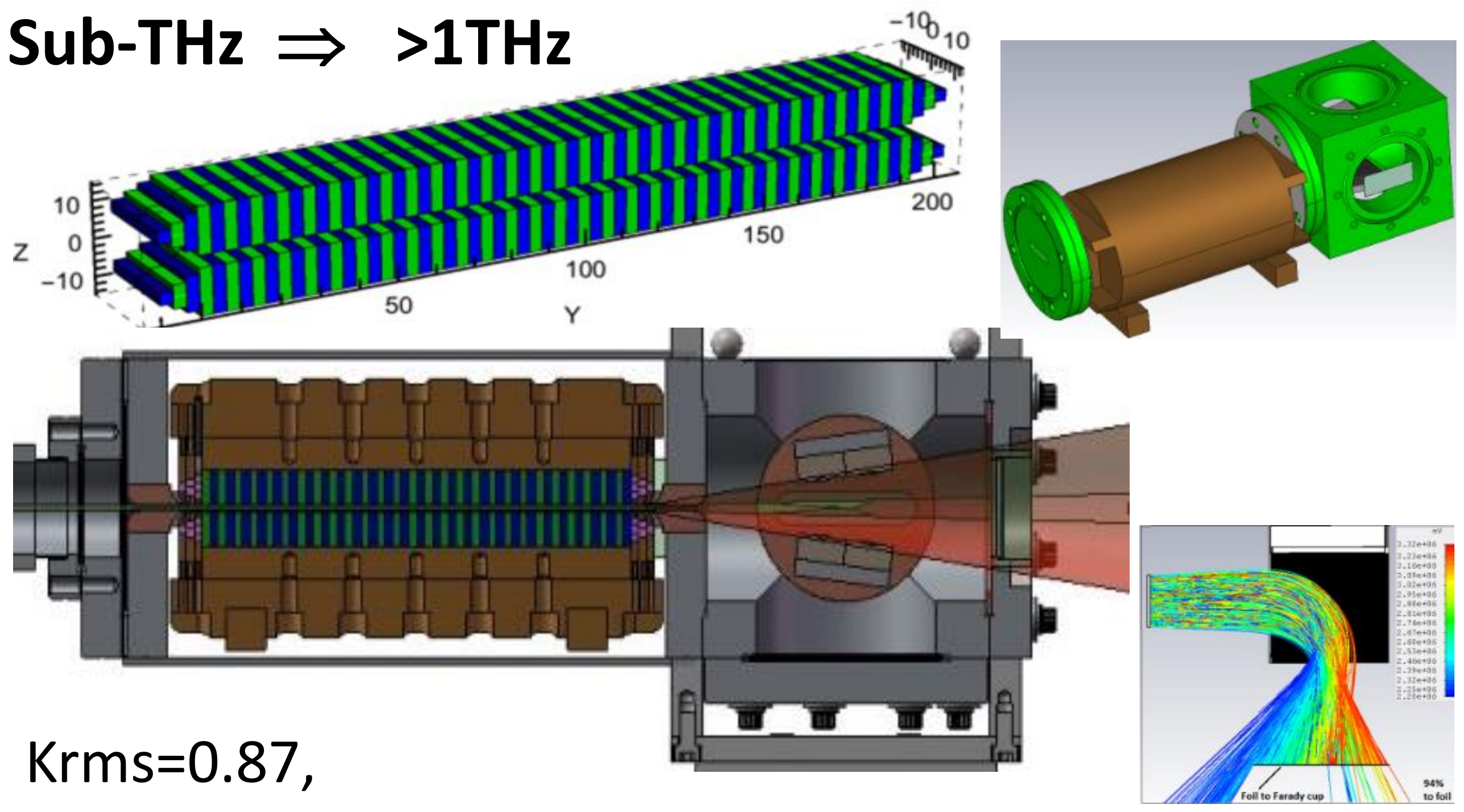


Radiator Replacement: Sub-THz ⇒ >1THz

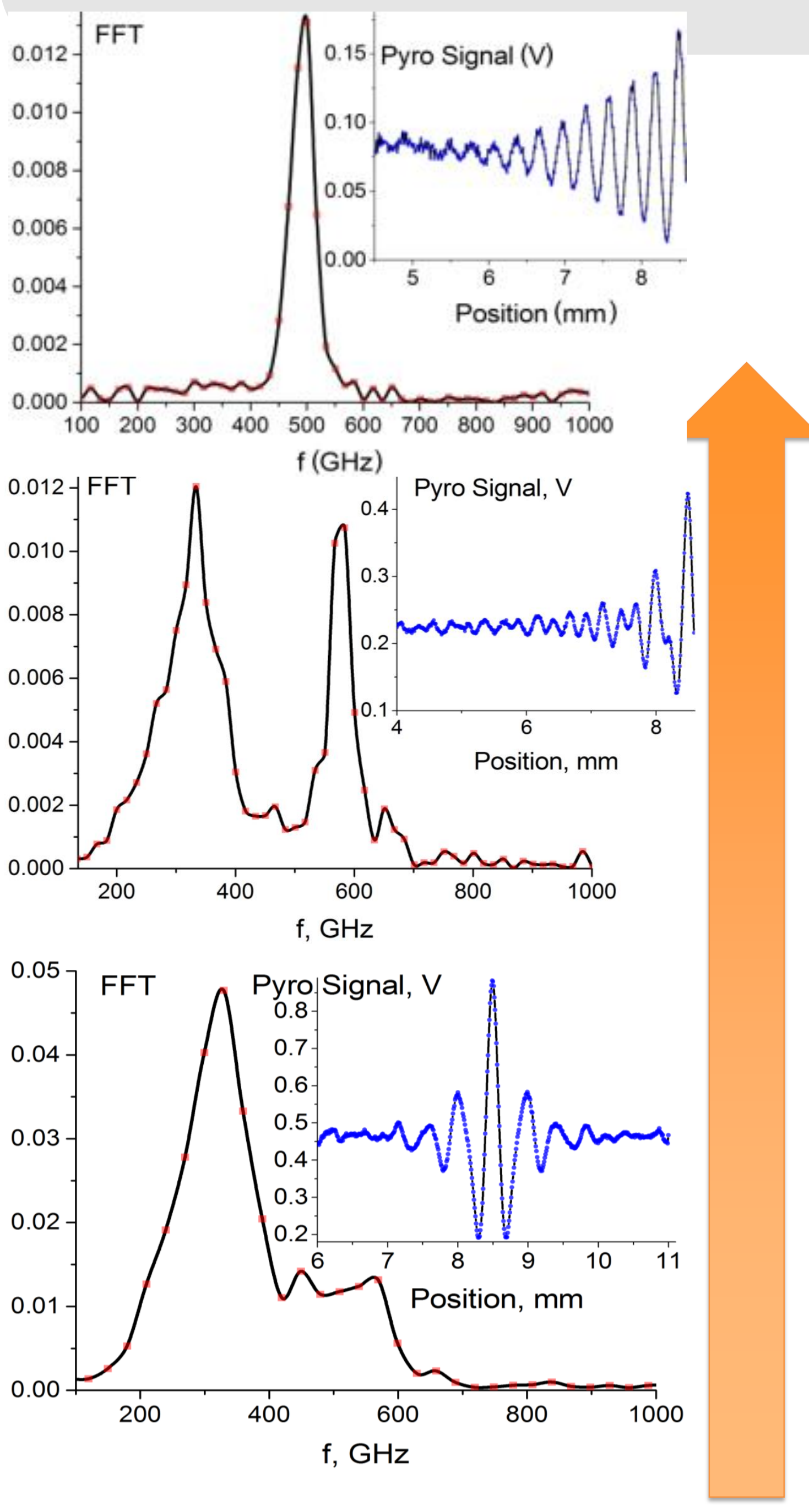




Krms=0.87,
Magnetic aperture 3.5×25.4 mm^2, period 13.15 mm.

Overview

Design features and experimental results are presented for a sub-mm wave source based on APS RF thermionic electron gun. The setup includes compact alpha-magnet, quadrupoles, sub-mm-wave radiators, and THz optics. Source upgrade for generation frequencies above 1 THz replaces the Sub-THz planar gratings with a short-period undulator having 1 T field amplitude, ~20 cm length, and integrated with a low-loss oversized waveguide. Both radiators are integrated with a miniature horn antenna and a small ~90°-degree in-vacuum bending magnet. The electron beamline is designed to operate different modes including conversion to a flat beam interacting efficiently with the radiator. The source can be used for cancer diagnostics, surface defectoscopy, and non-destructive testing. Sub-THz experiment demonstrated a good potential of a robust, table-top system for generation of a narrow bandwidth THz radiation. This setup can be considered as a prototype of a compact, laser-free, flexible source capable of generation of long trains of Sub-THz and THz pulses with repetition rates not available with laser-driven sources.

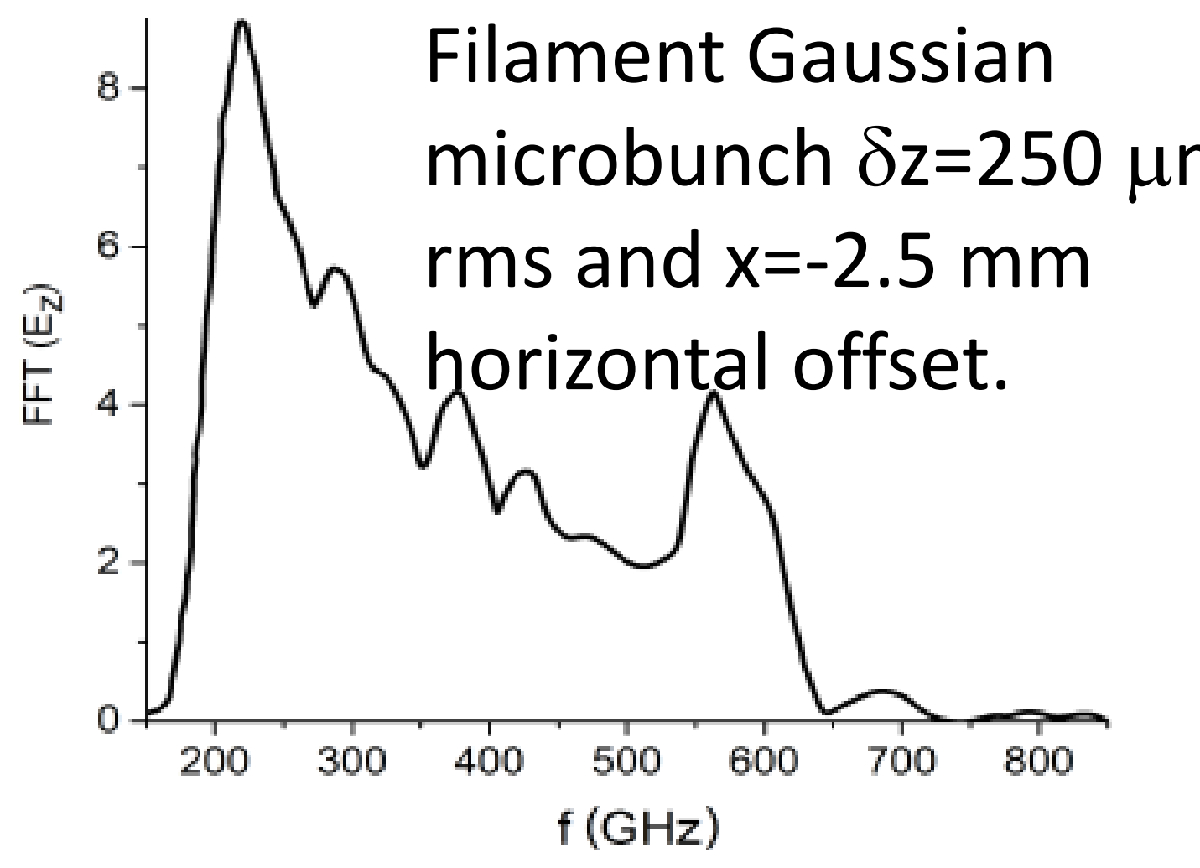


Outline of Cherenkov Sub-THz source:

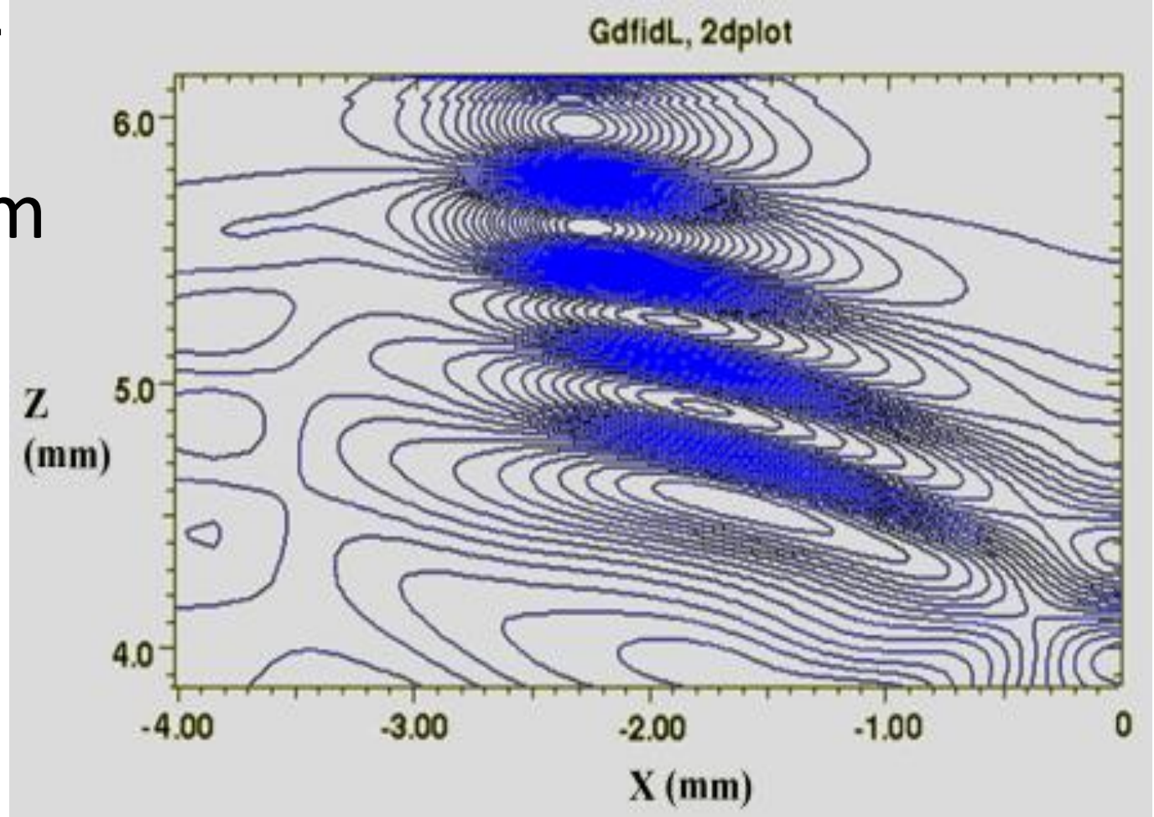
1. Wide tunability of the frequency and the radiation spectrum: (476–584) GHz and (311–334) GHz;
2. Capability to determine effective microbunch length from the spectra taken (230 fs);
3. Reduced α-magnet strength required to compensate microbunch space charge: ~0.65%/pC vs. 0.6%/pC found from GPT.

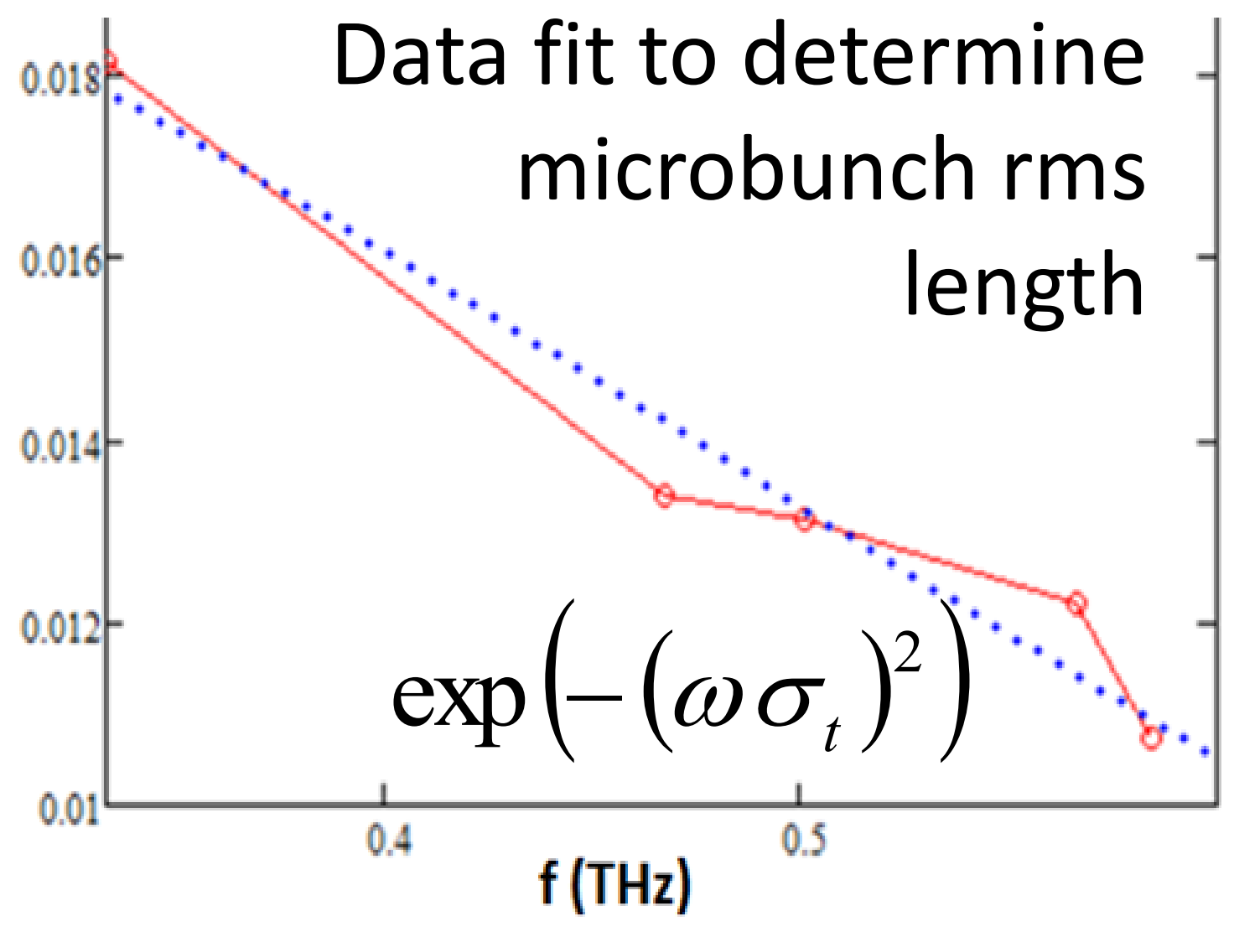
Tuning the beam transport line, in particular the alpha-magnet current, but also the pitch angle of the radiator, allows smooth variation of the intensity between the two spectral components.

GdfidL asymmetric wakefield



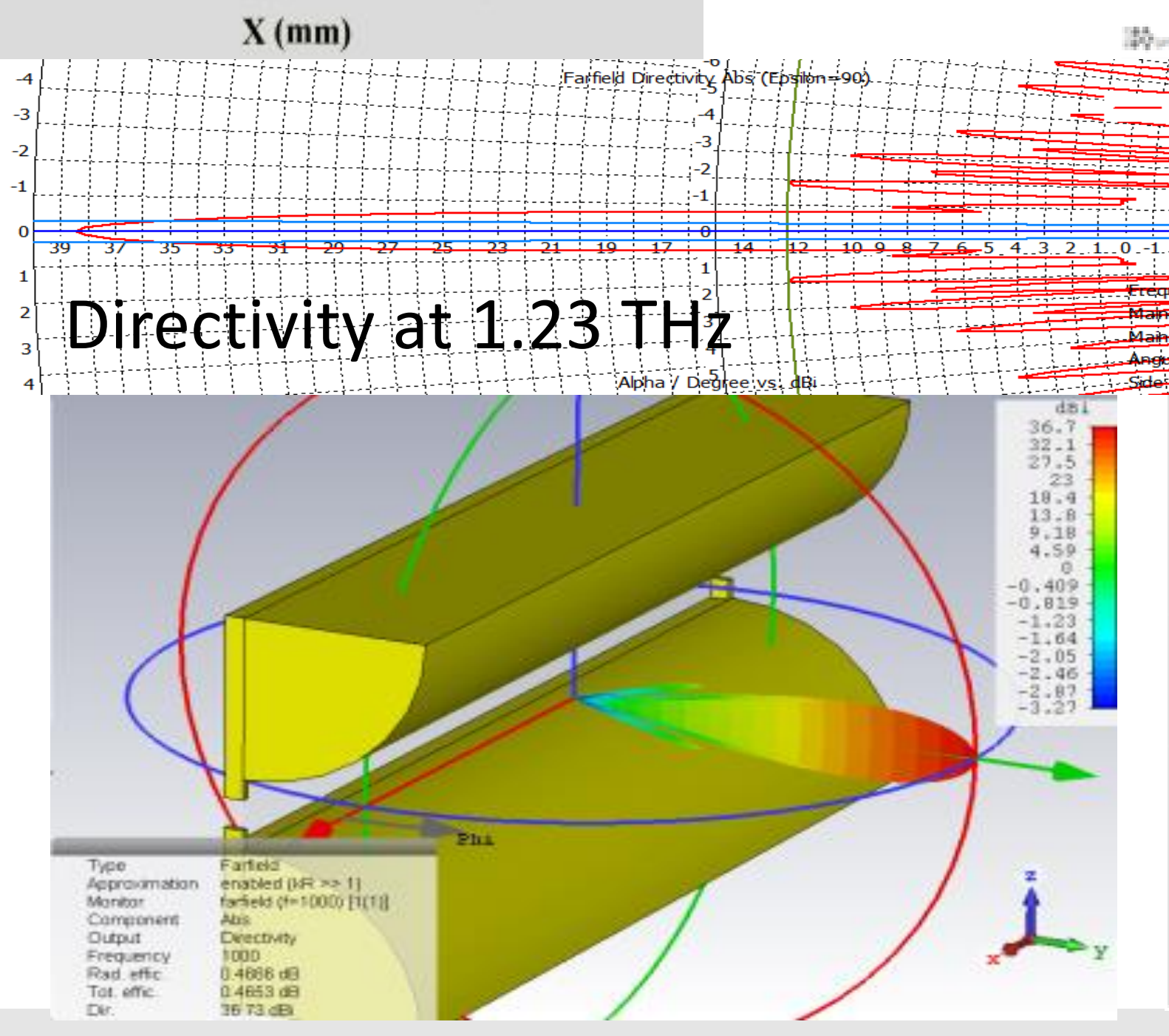
Filament Gaussian microbunch δz=250 μm rms and x=-2.5 mm horizontal offset.





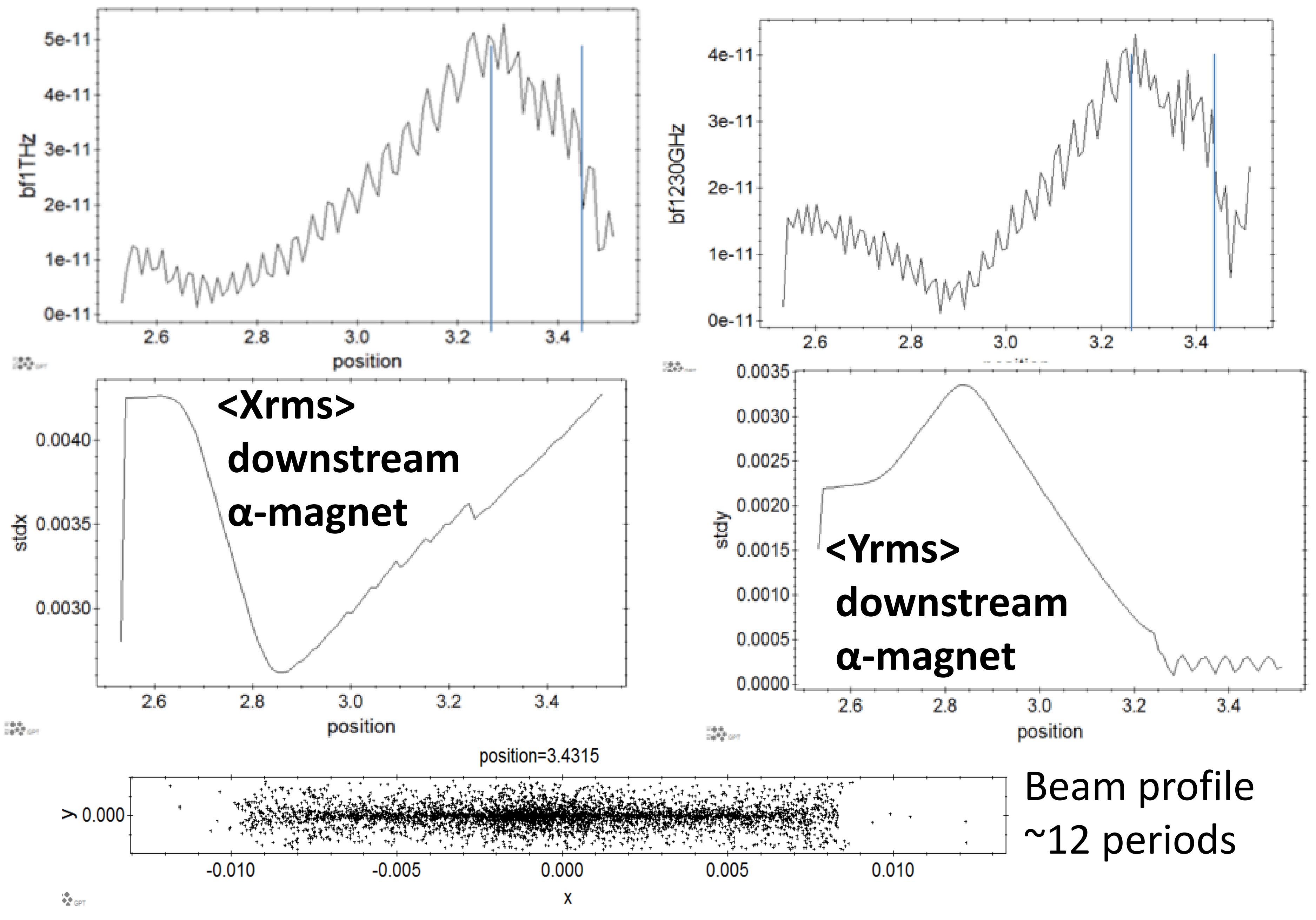
Data fit to determine microbunch rms length

$$\exp\left(-(\omega\sigma_t)^2\right)$$



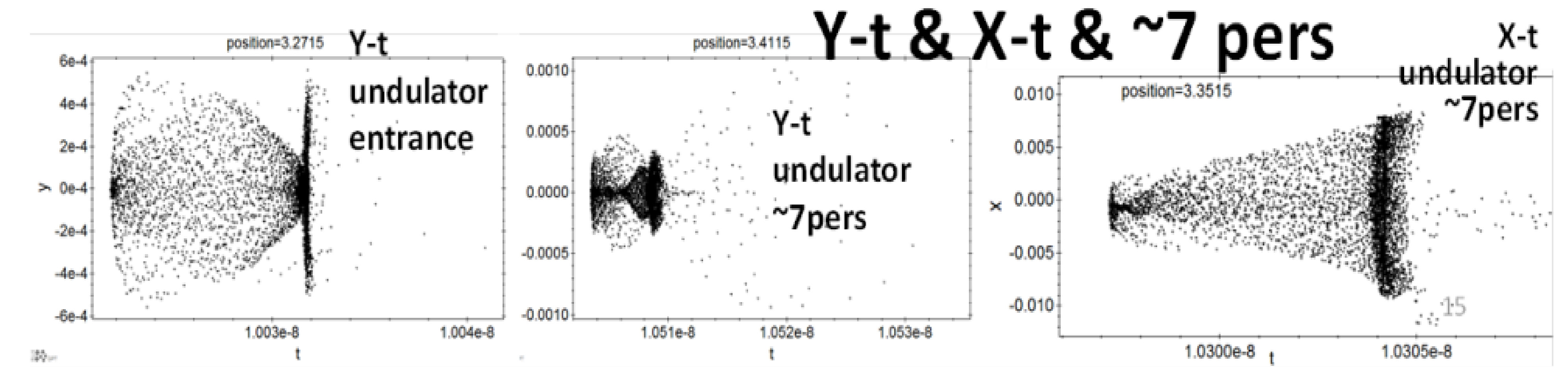
Directivity at 1.23 THz

GPT simulation for equivalent zero-length charge radiating at 1 THz & 1.23 THz



Beam profile ~12 periods

Y-t & X-t & ~7 pers



Spontaneous coherent undulator radiation with DPU (λu=7mm) and new (λu=13mm) undulator.

Undulator	Beam Kinetic Energy, MeV	f$_1$, THz, main harmonic	Formfactor Rms Φ_1	Trans-verse coherency factor	Funda-mental micropulse energy, nJ	Fund. harm. efficiency %	Fund. peak power, kW	Macro-pulse energy, μJ
DPU warm 0.77T	3	3.6	0.067	0.24	9	0.0056	1.04	26
λu=1.28cm, Nu=13 B=1T, gap=2.5mm	3.22	1.45	0.11	0.86	36	0.022	13	104
	2.85	1.15	0.17	0.89	72	0.049	14.6	206

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