IPAC'24

Pre-press release: https://www.jacow.org/ipac2024/index.html

Xiaoyang Zhang, C. Richard

HELMHOLTZ

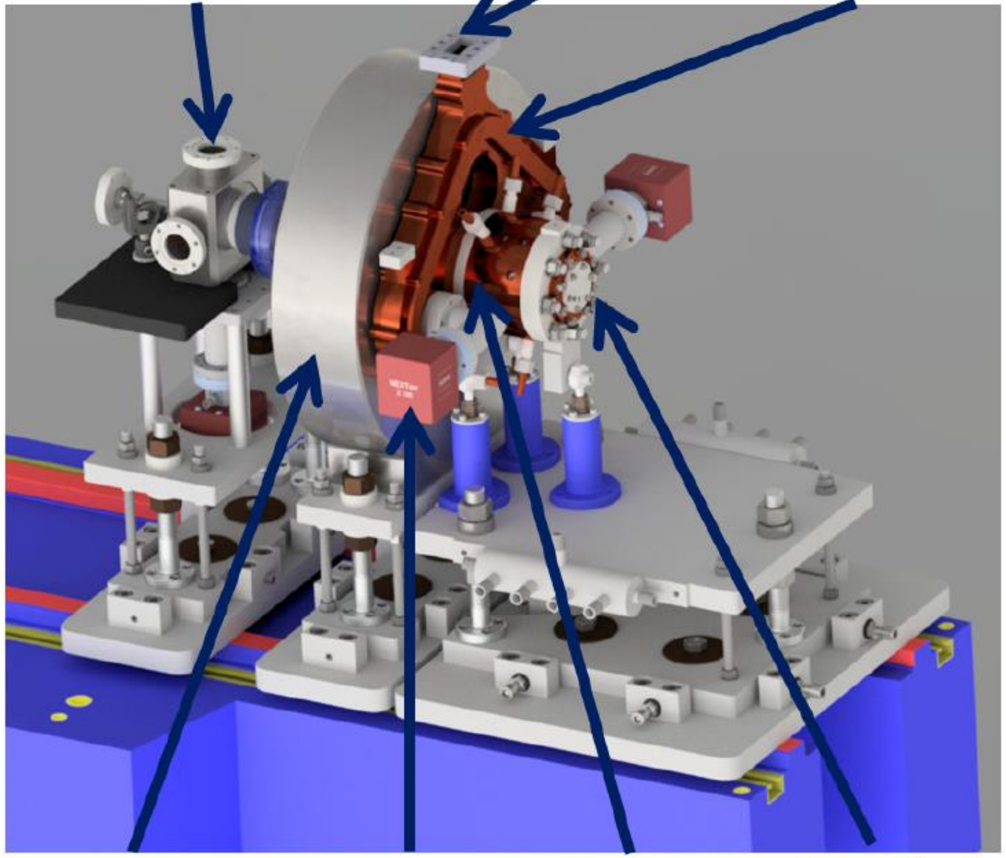
DESY.

Brazed Free C-band Photo-gun

Designed and realized at INFN, High power test at PSI

Main Parameters of the C-band Gun

Parameter	Value
Resonant frequency [GHz]	5.712
E_{cath}/P_{diss} [MV/(mMW$^{0.5}$)]	51.4
rf input power [MW]	18 (19)
Cathode peak field [MV/m]	160
Rep. rate [Hz]	100-400
Quality factor	11900
Filling time [ns]	166 (147)
Coupling coefficient	3 (3.5)
rf pulse length [ns]	300
Mode sep. $\pi - \pi/2$ [MHz]	47 (48.3)
E_{surf}/E_{cath}	0.96
Mod. Poy. vector [W/m^2]	2.5
Pulsed heating [°C]	16
Average diss. Power [W]	250-1000



D. Alesini et al., "Design, realization and high power RF test of the new brazed free C band photo-gun"

Brazed Free C-band Photo-gun

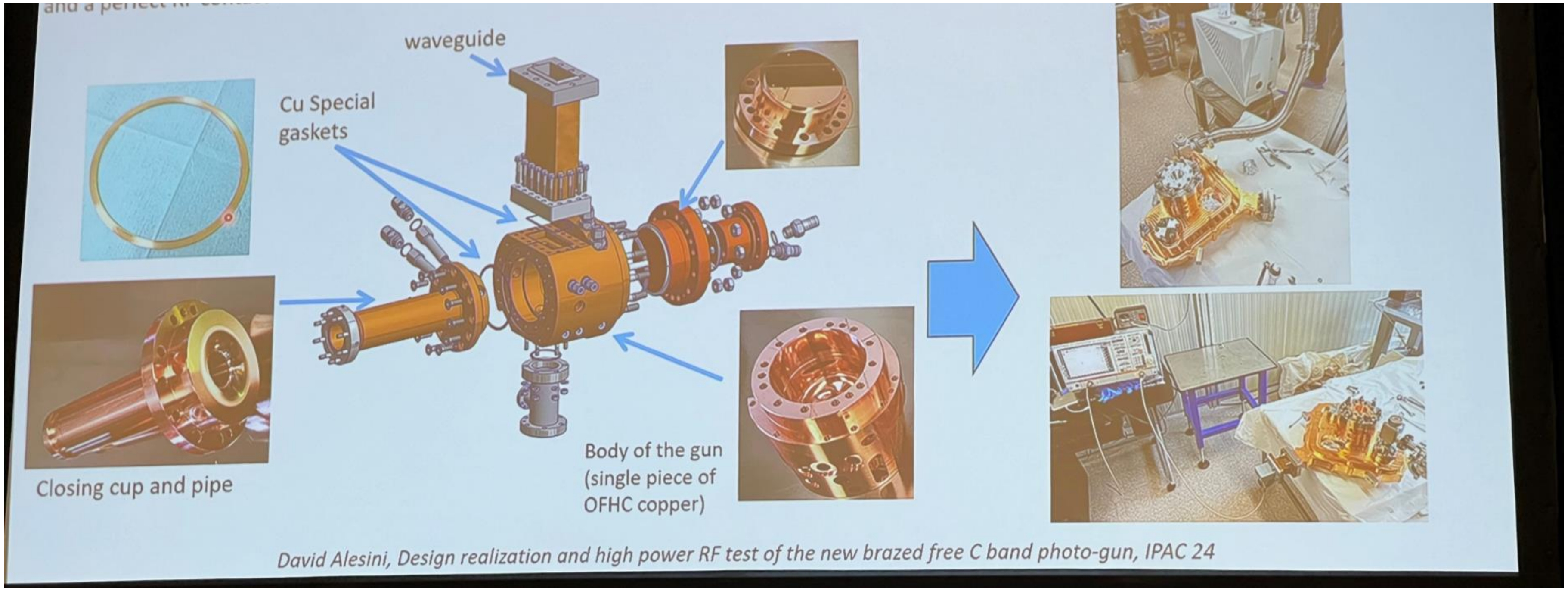
Brazing free technology

The **brazing free technology** uses a novel process developed at INFN (Frascati) involving the use of special **RF-vacuum gaskets** (same Cu material of gun) that guarantee (simultaneously) the vacuum seal and a perfect RF contact when the structure is clamped

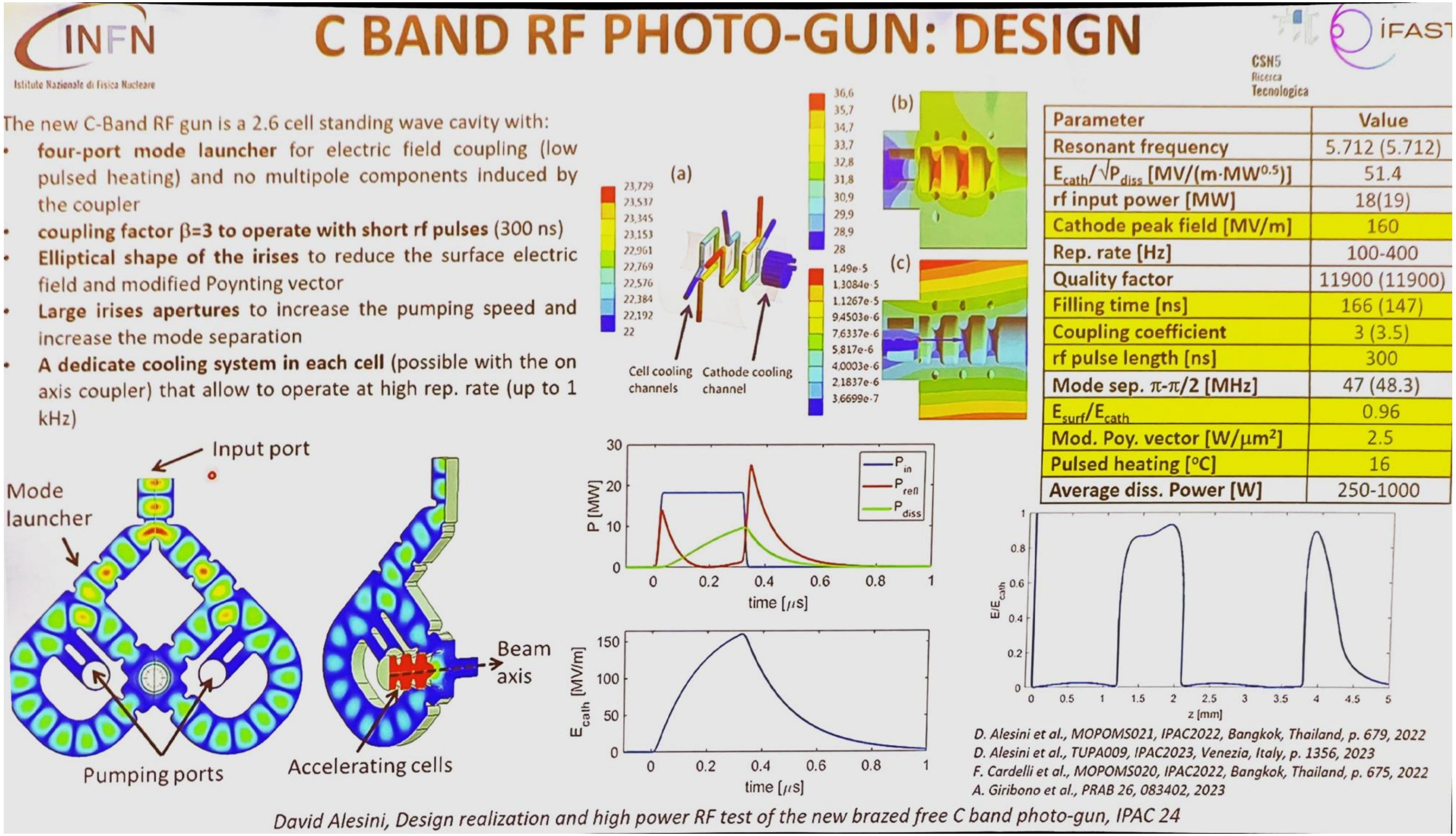
⇒ **simplify** the fabrication

⇒ **reduce the cost** and the risk of failure

⇒ reach in principle (because of the hard copper not annealed) **higher accelerating field** with lower BDR and lower conditioning time



Brazed Free C-band Photo-gun



C BAND RF PHOTO-GUN: DESIGN

The new C-Band RF gun is a 2.6 cell standing wave cavity with:

- **four-port mode launcher** for electric field coupling (low pulsed heating) and no multipole components induced by the coupler
- **coupling factor β=3 to operate with short rf pulses** (300 ns)
- **Elliptical shape of the irises** to reduce the surface electric field and modified Poynting vector
- **Large irises apertures** to increase the pumping speed and increase the mode separation
- **A dedicate cooling system in each cell** (possible with the on axis coupler) that allow to operate at high rep. rate (up to 1 kHz)

Parameter	Value
Resonant frequency	5.712 (5.712)
$E_{cath}/\sqrt{P_{diss}}$ [MV/(m·MW$^{0.5}$)]	51.4
rf input power [MW]	18(19)
Cathode peak field [MV/m]	160
Rep. rate [Hz]	100-400
Quality factor	11900 (11900)
Filling time [ns]	166 (147)
Coupling coefficient	3 (3.5)
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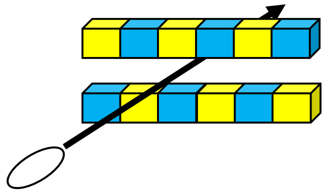
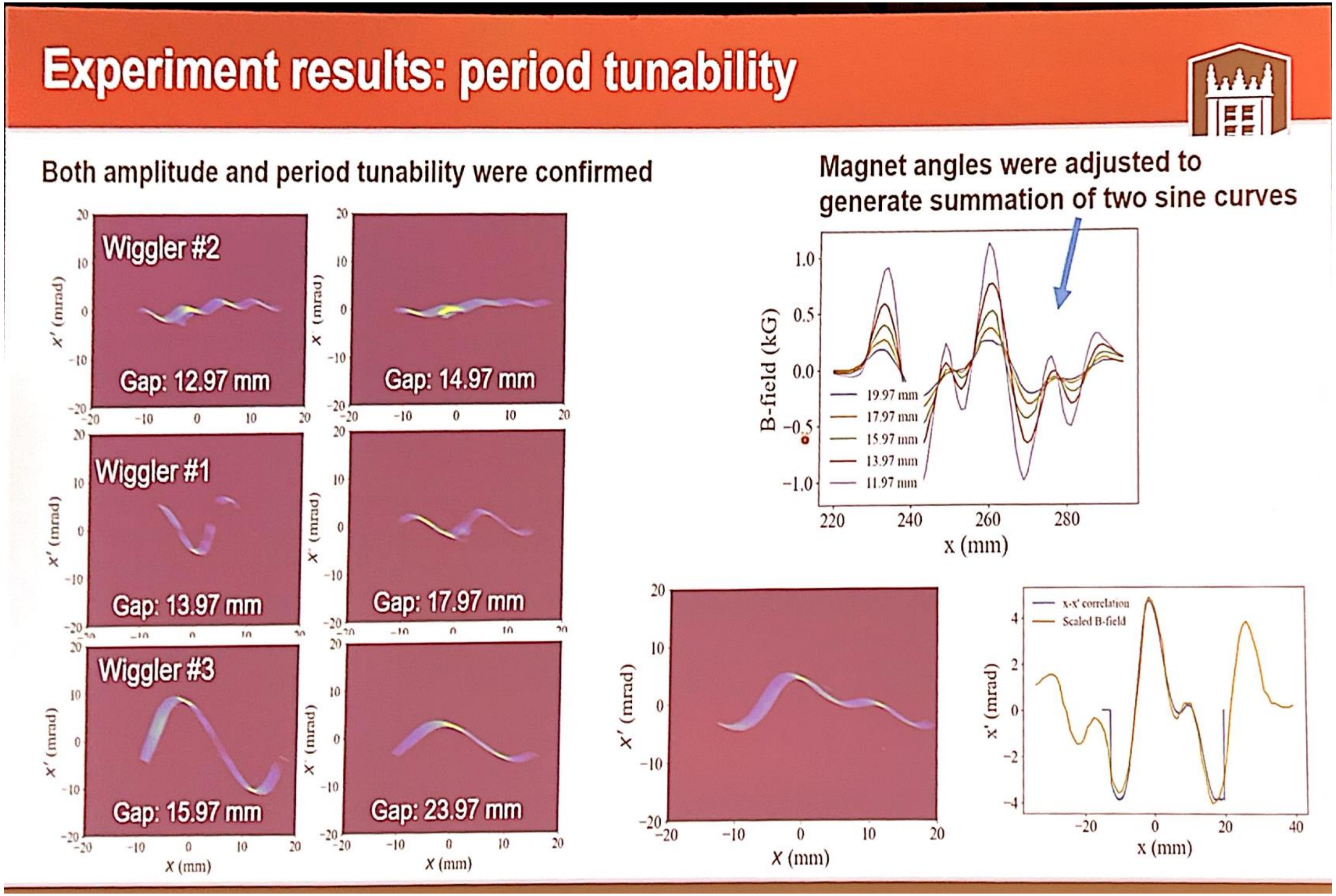
D. Alesini et al., MOPOMS021, IPAC2022, Bangkok, Thailand, p. 679, 2022
D. Alesini et al., TUPA009, IPAC2023, Venezia, Italy, p. 1356, 2023
F. Cardelli et al., MOPOMS020, IPAC2022, Bangkok, Thailand, p. 675, 2022
A. Giribono et al., PRAB 26, 083402, 2023

David Alesini, Design realization and high power RF test of the new brazed free C band photo-gun, IPAC 24

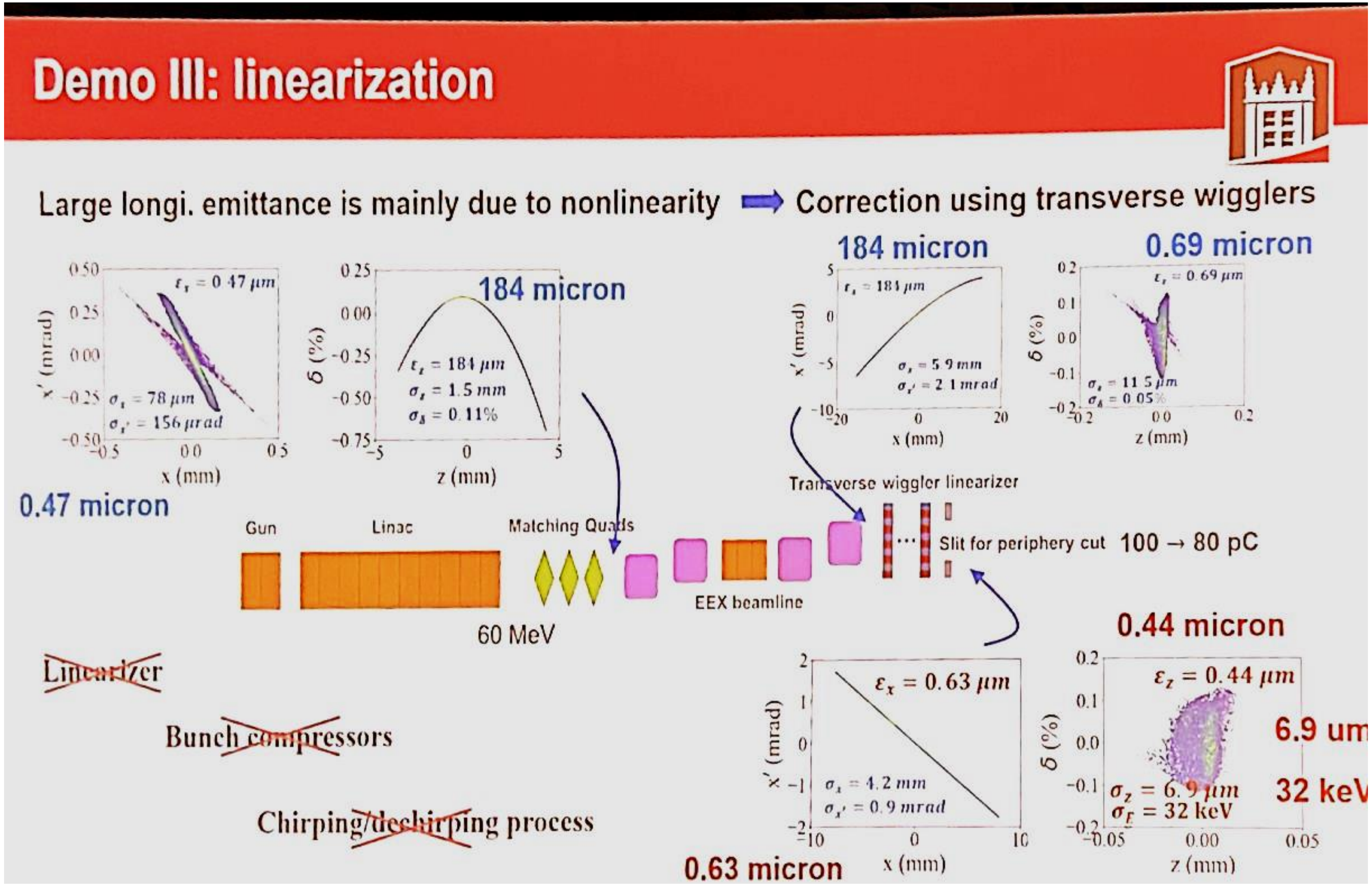
Preparation for experimental demonstration of arbitrary correlation generation

Transverse wiggler is used to introduced correlation in transverse phase space



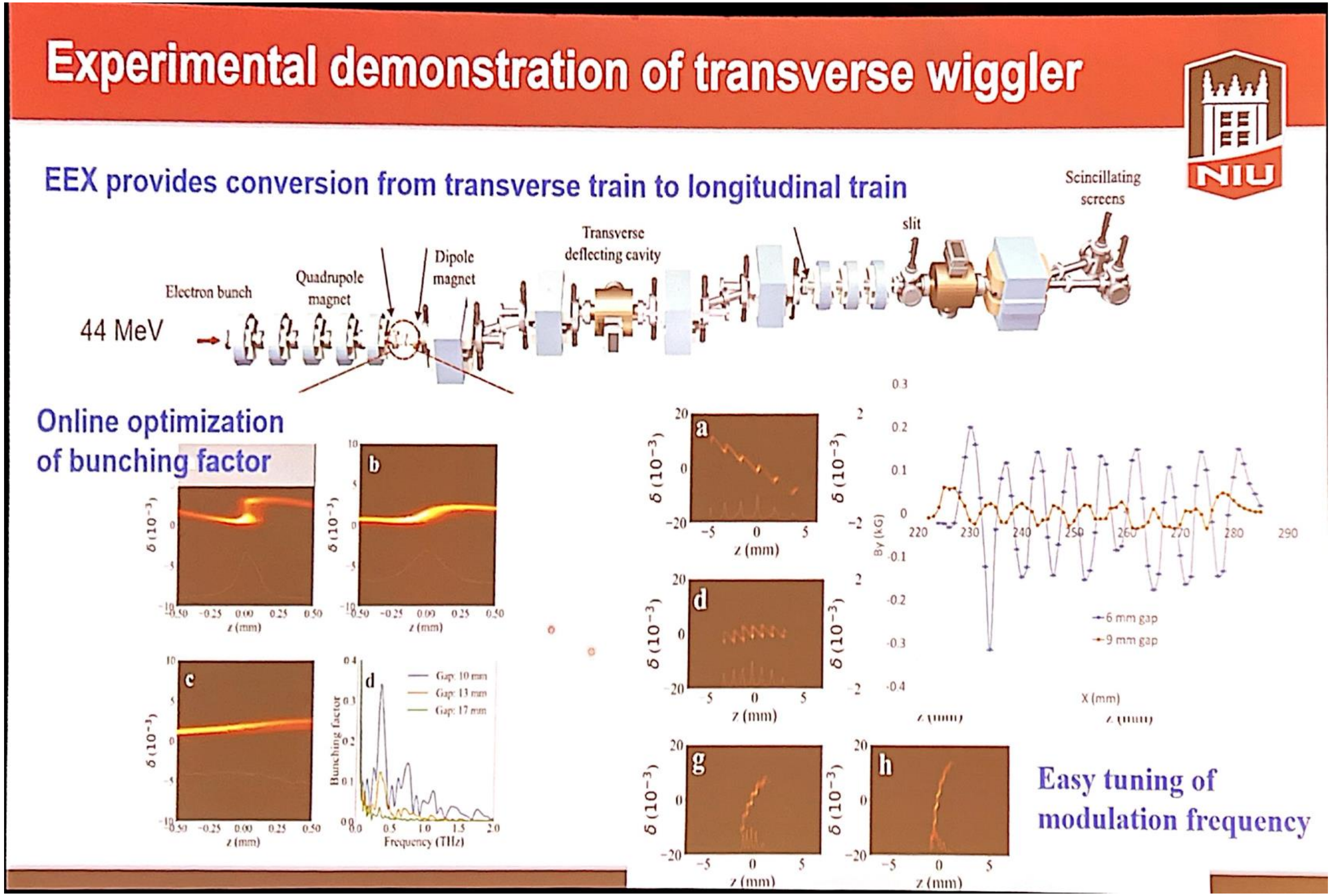


Preparation for experimental demonstration of arbitrary correlation generation



Preparation for experimental demonstration of arbitrary correlation generation

- Experimental data has not been published yet



THz FEL

University of Science and Technology of China, Hefei, China

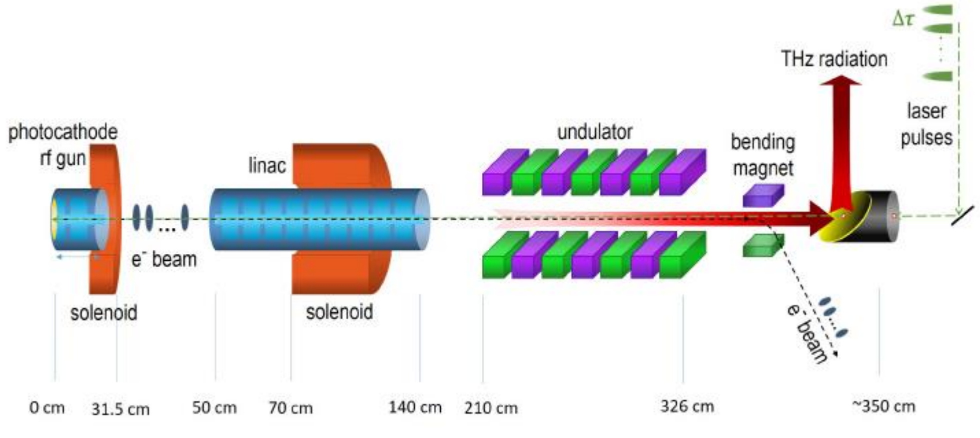
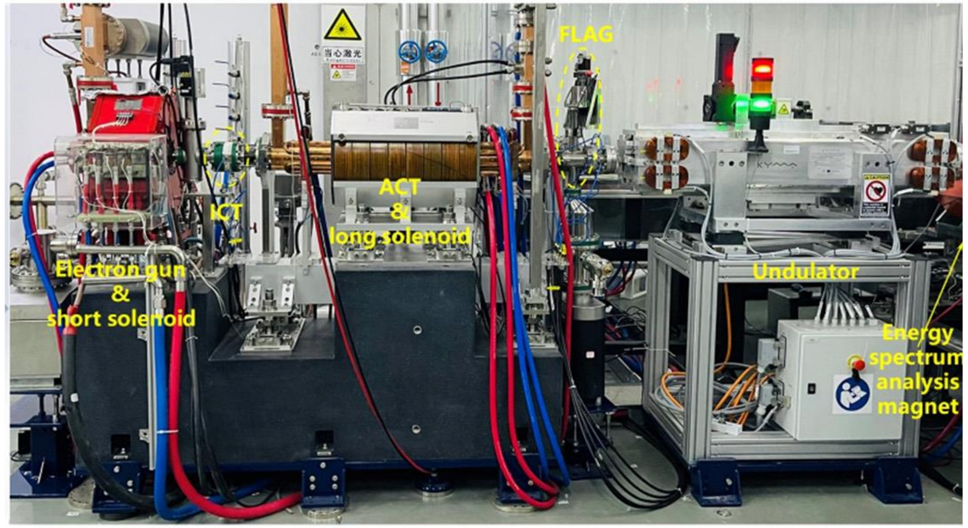
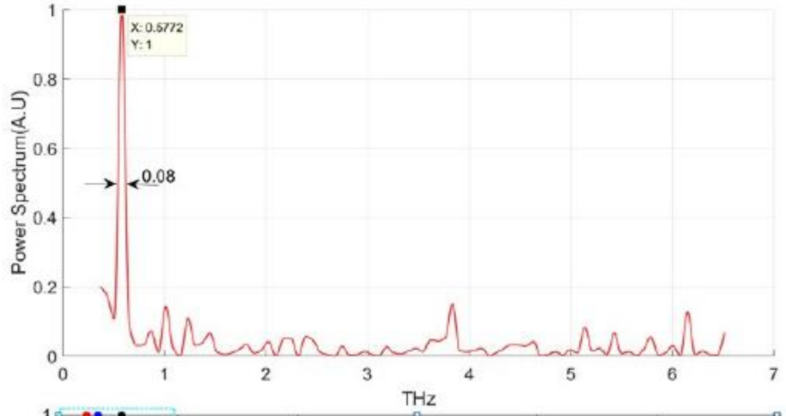
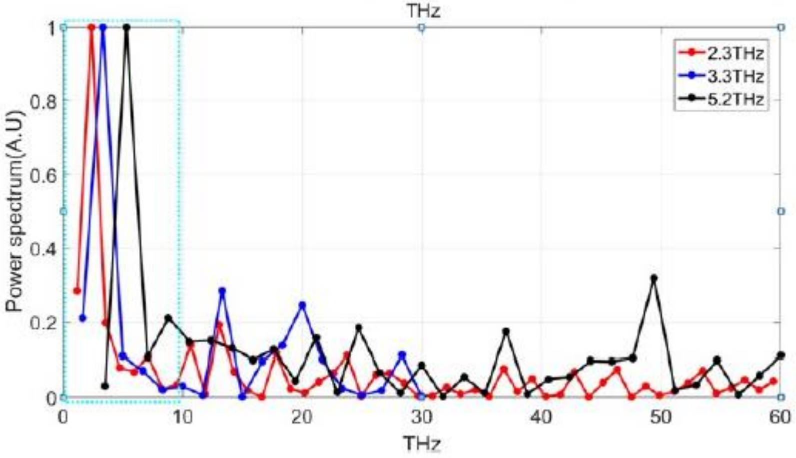


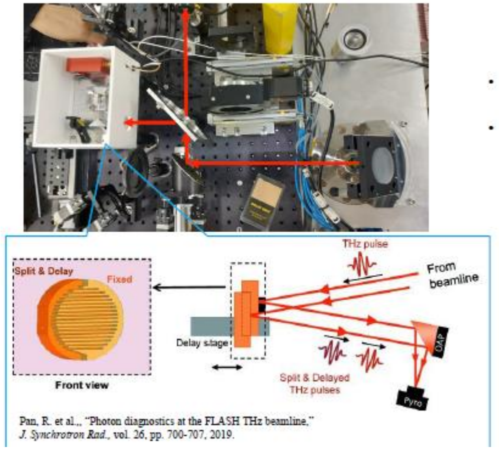
Figure 1. Overview of the pre-bunched THz FEL.





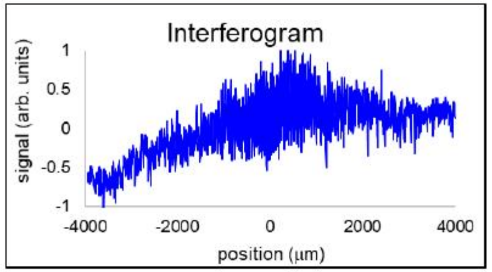


THz FEL



First Spectral measurem

- The first spectral measurements were performed at the TD3 station using an FTIR (Fourier Transform Infrared) spectrometer based on a reflective lamellar grating
- A narrow-band spectrum centered at 2.82 THz was measured, and a FWHM bandwidth of ~1.7% was estimated. In addition, higher odd harmonics were detected



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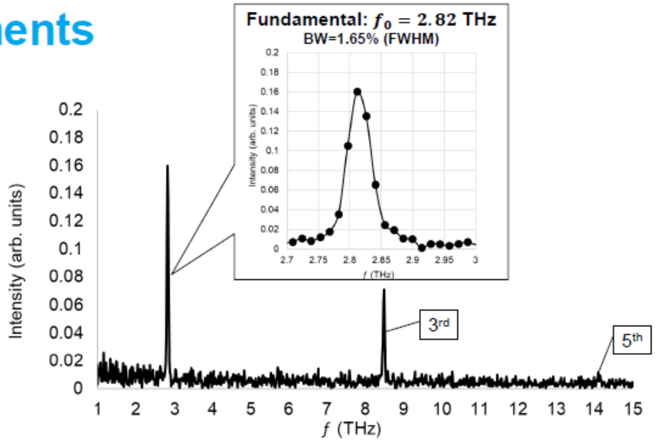
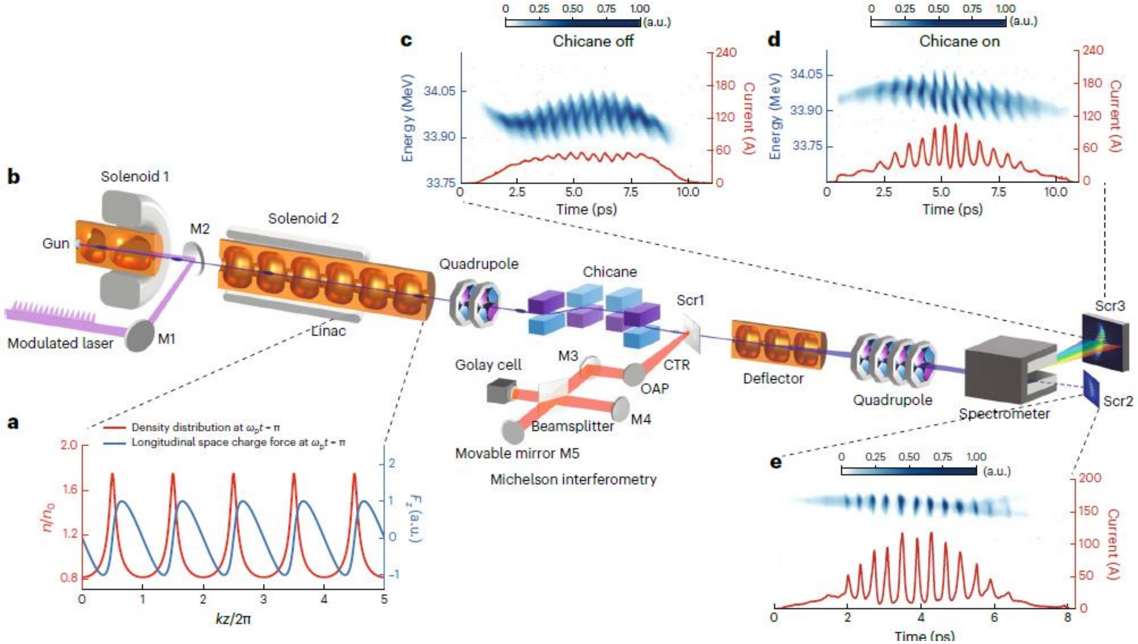
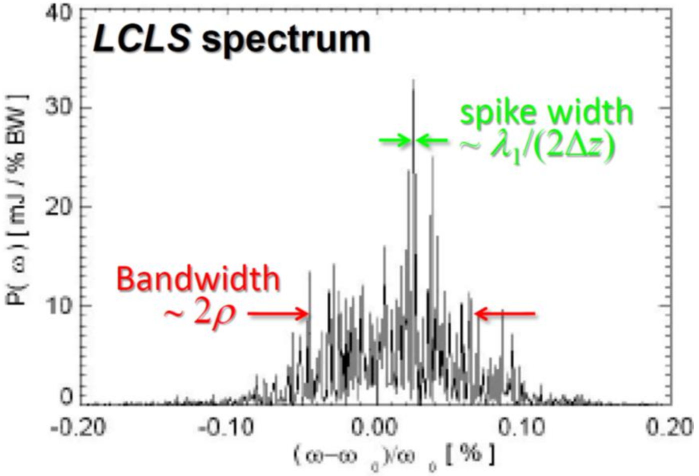






For THz bandwidth(2%) is of the same order as spike width (1%)

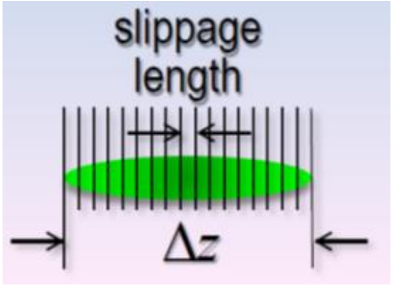
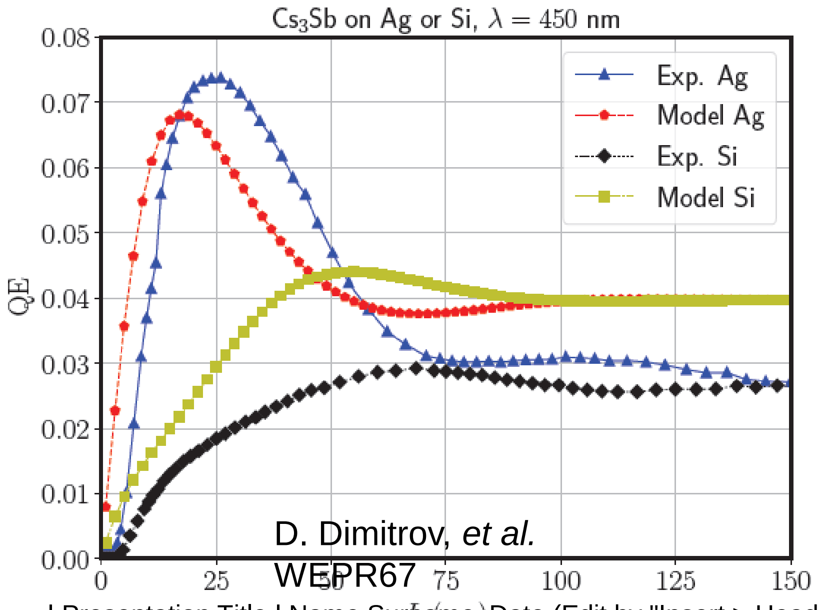


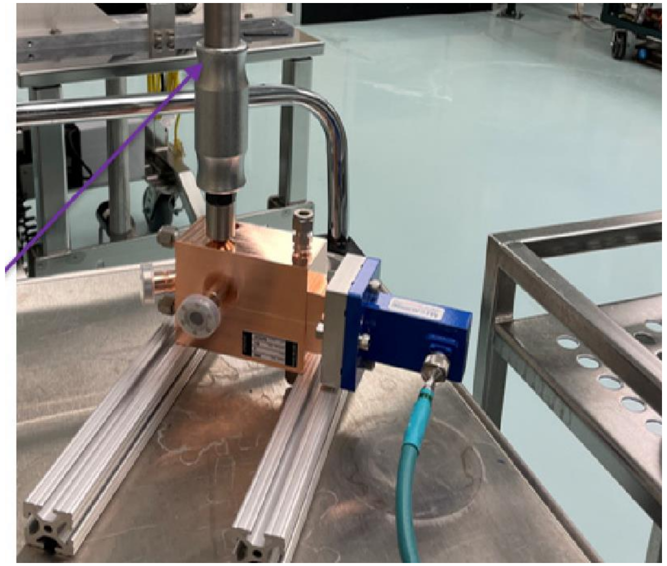
Photo cathode test stand at LANL

Cathodes and Radio frequency Interactions in Extremes (CARIE)

- C-band, 1.6 cell photogun for studying photocathode performace
- Plan on studying behavior of cathodes with different properties e.g. thickness and substrate
- Currently finishing design and starting construction
- Also working on modeling photocathodes

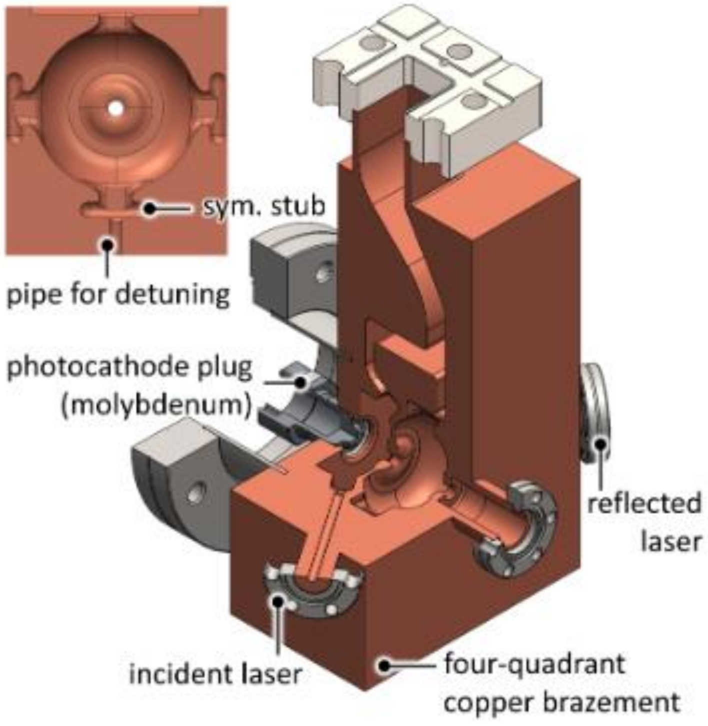


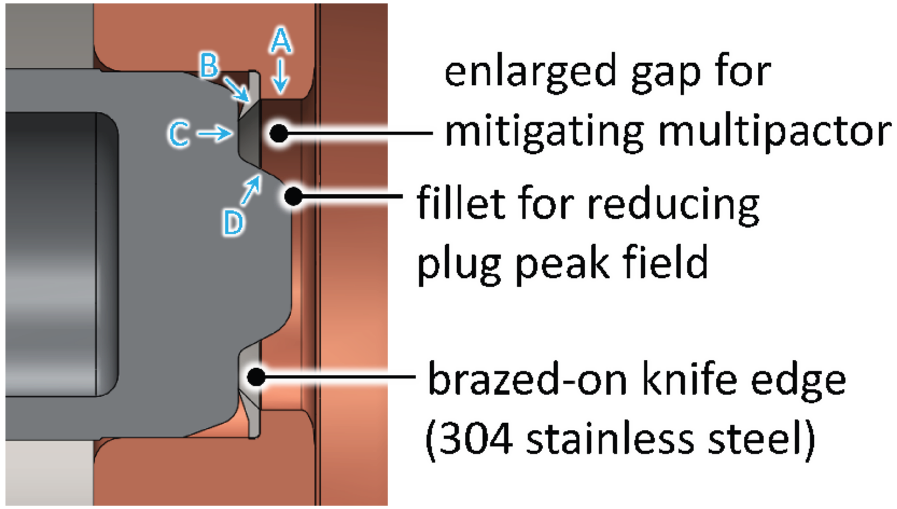
D. Dimitrov, *et al.* WEPR67



Cavity without cathode plug for RF tests

E. Simakov, *et al.* WEPC60





H. Xu, *et al.*

LPS tomography at KIT

- Using turn-by-turn bunch profile measurements in ring for tomography
- Tomography method: IRconstr_ls in matlab (I don't know what's under the hood)
- Currently no experimental results

General non-linear equation from Vlasov

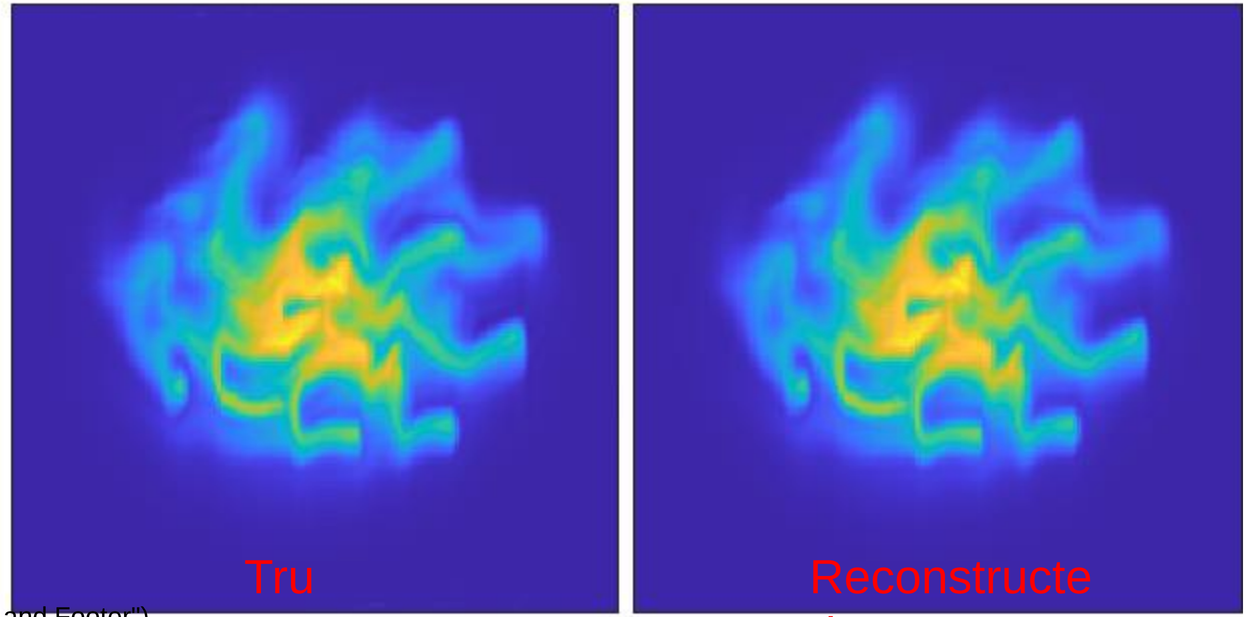
$$\psi(q,p,t+\Delta t) \approx \mathrm{D} \circ \mathrm{R} \circ \mathrm{K}(\rho(t)) \circ \psi(q,p,t)$$

LPS(turn+1) Damping Rotation Wakefield

Approximations

Linear matrix equation

$$\psi(s,t+\Delta t) = \mathrm{D} \cdot \mathrm{R_K} \cdot \mathrm{R_D} \cdot \mathrm{K}(\rho(t)) \cdot \psi(s,t)$$



True

Reconstructed

F. Donoso, *et al.*
WEPG55

Emittance measurements at EuXFEL

Measurements for 250 pC, 130 MeV

Y. Chen, *et al.* MOPG47, 48

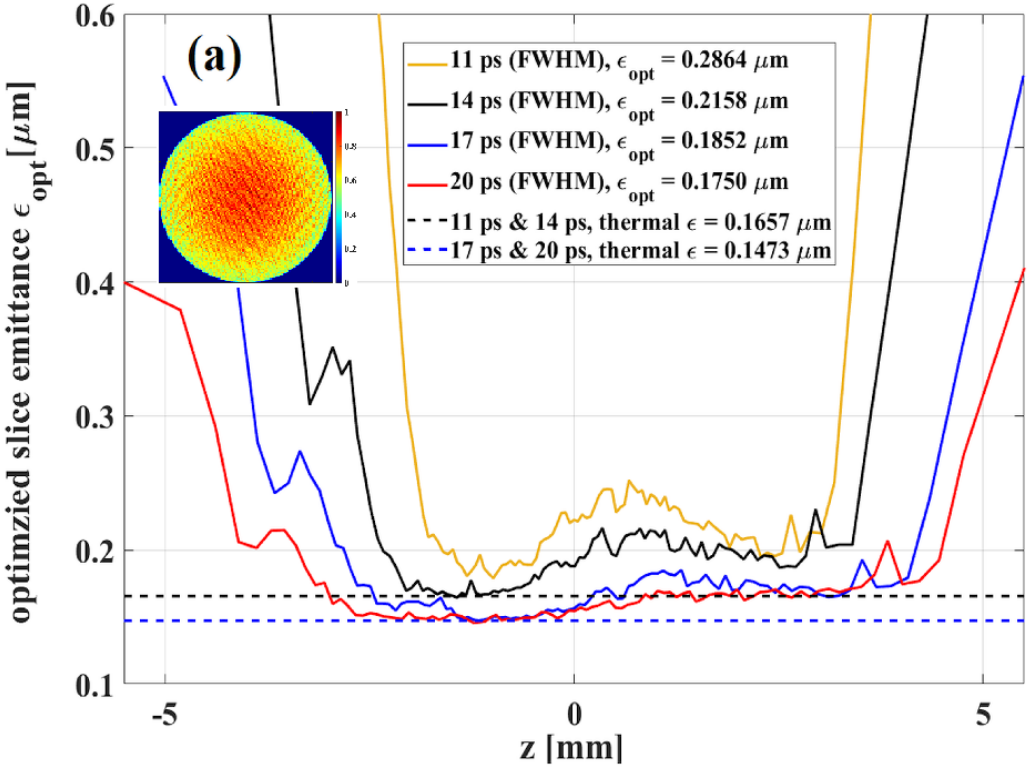
- Average emittance over last 6 months: 0.38 mm mrad
- Measured slice emittance for laser 11-20 ps FWHM

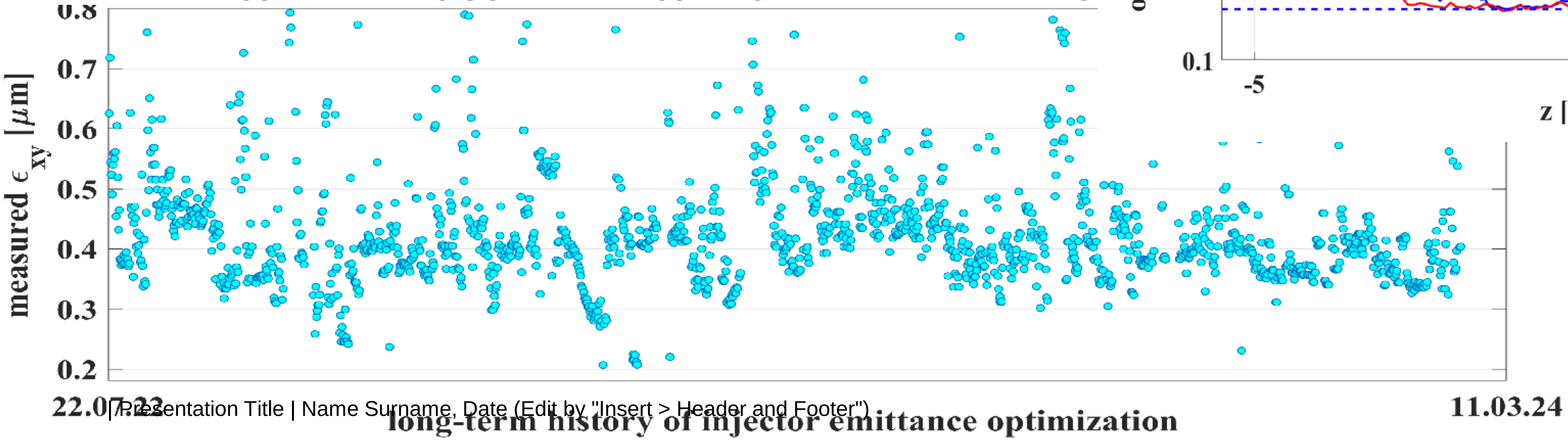
Table 1: Simulation Parameters and Conditions

Parameter	Value	Unit
Laser pulse temporal shape	Gaussian	n/a
Laser pulse length[1]	11 - 20	ps
Laser pulse transverse shape	Truncated Gaussian	n/a
Laser pulse transverse spot size[2]	0.6 - 1.0	mm
Bunch charge	250	pC
Electron beam energy	130	MeV
RF gun gradient	58.5	MV/m
RF gun phase[3]	-4 - +4	deg

[1] in full width half maximum; [2] size of the beam shaping aperture in diameter; [3] with respect to the maximum mean momentum ga

Slice emittance for different laser lengths





Thank you