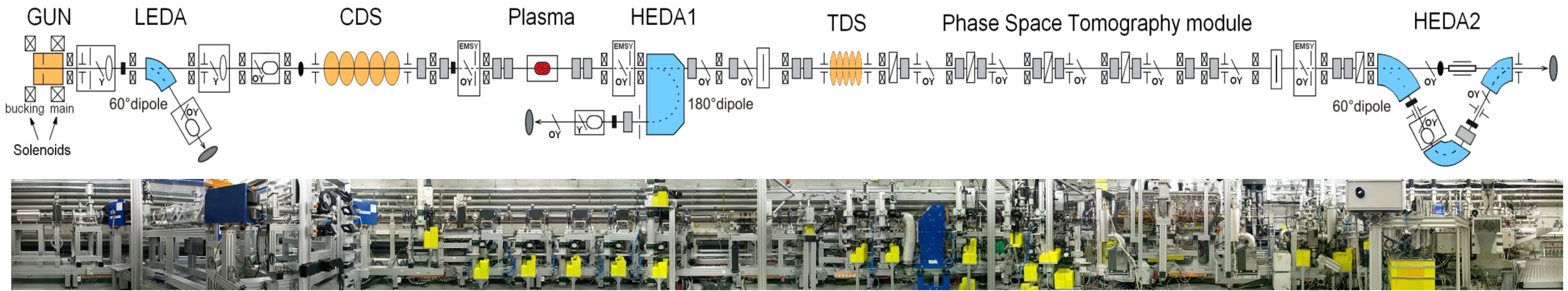


PITZ – Photo Injector Test Facility at DESY, Zeuthen Site.



M. Krasilnikov for PITZ Collaboration

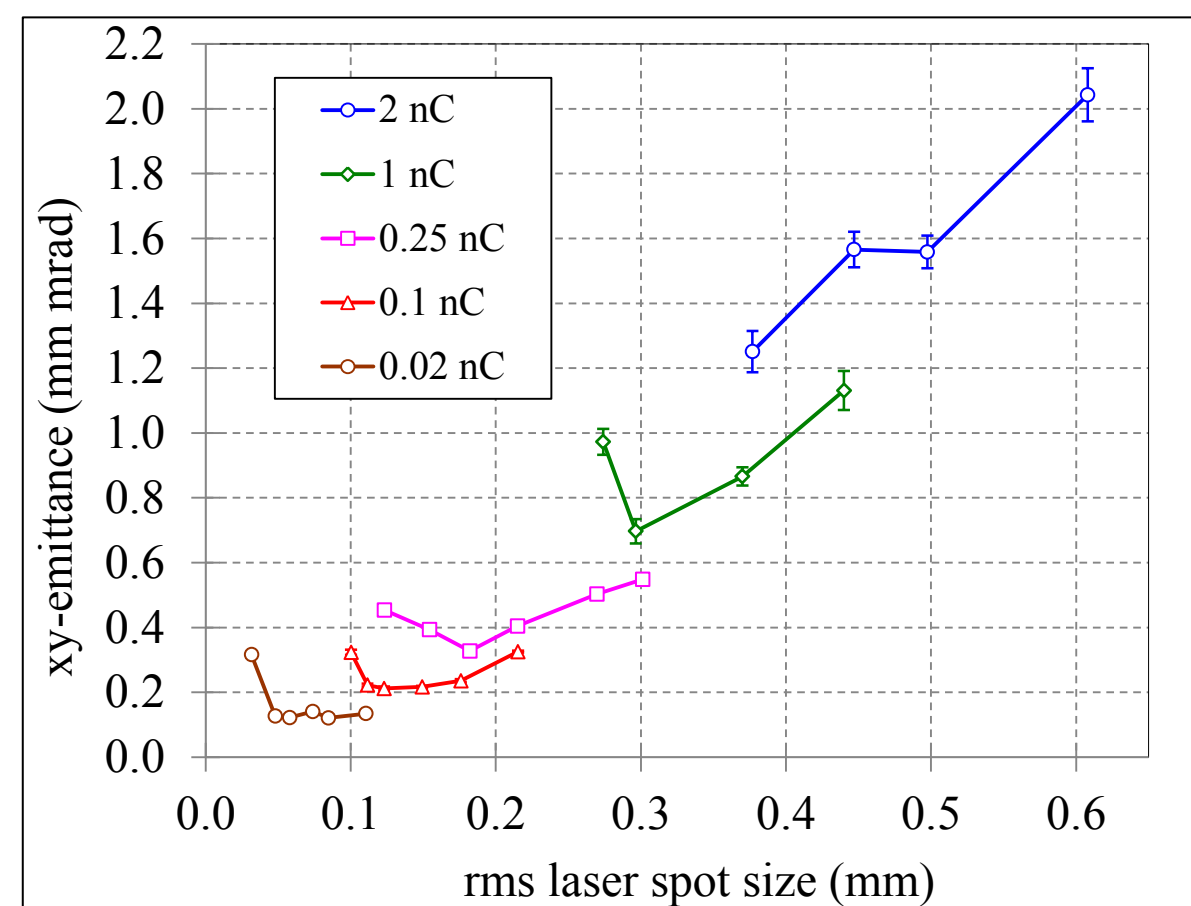
PITZ Beamline



PITZ Activities for the European XFEL

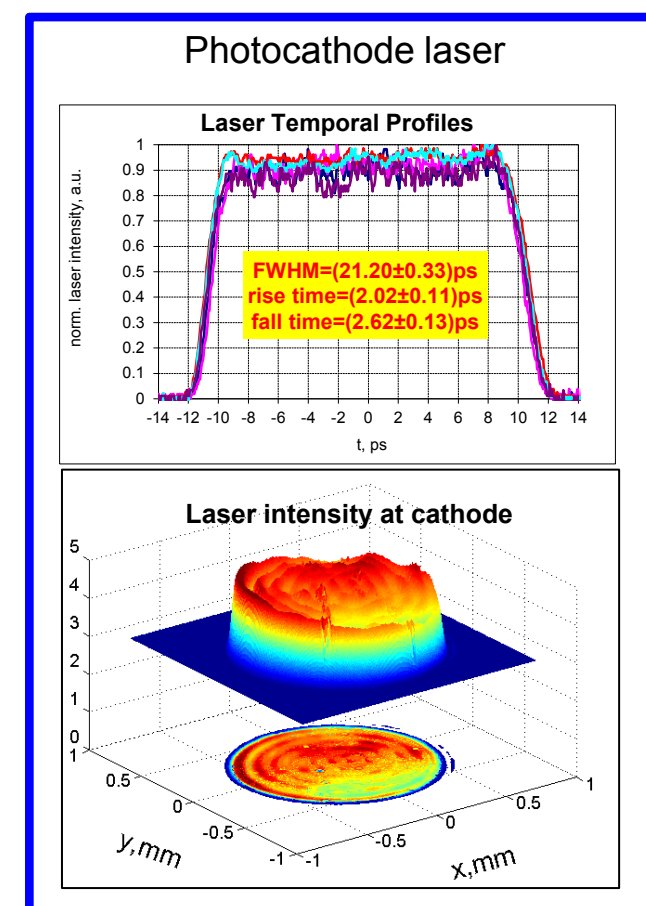
Measured (100%) rms normalized emittance

→ PITZ world record on projected emittance in 2011 still valid

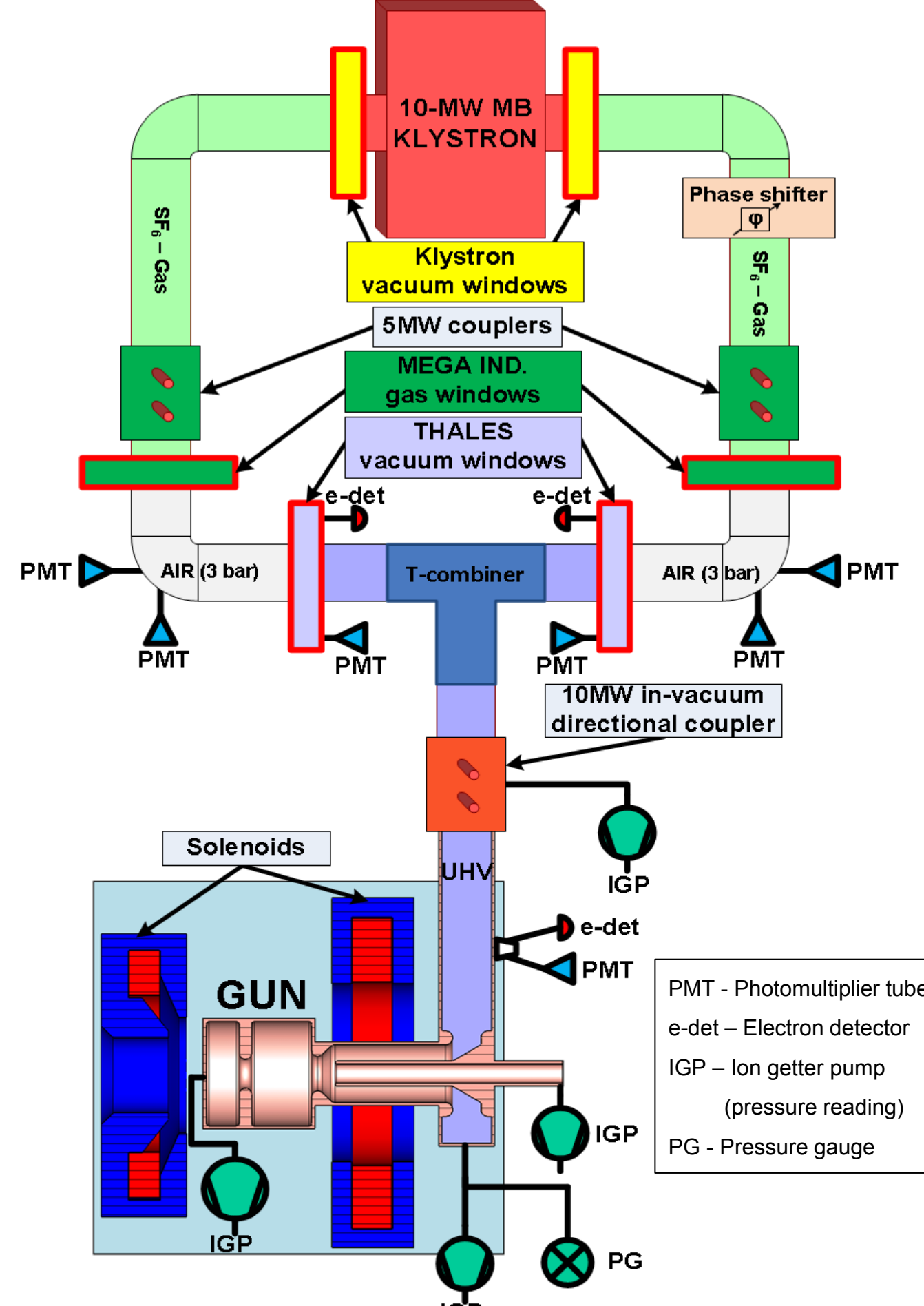


Minimum emittance ($\sqrt{\epsilon_{n,x}\epsilon_{n,y}}$)

Charge, nC	Measured, mm mrad
2	1.25±0.06
1	0.70±0.02
0.25	0.33±0.01
0.1	0.21±0.01
0.02	0.121±0.001



Current PITZ RF-Gun Setup



Highest priority at PITZ currently
→ Participate in the solution of the remaining problems of the RF gun for XFEL:

- check the principle of operation with 2 RF windows
- RF spring
- stability and long term reliability



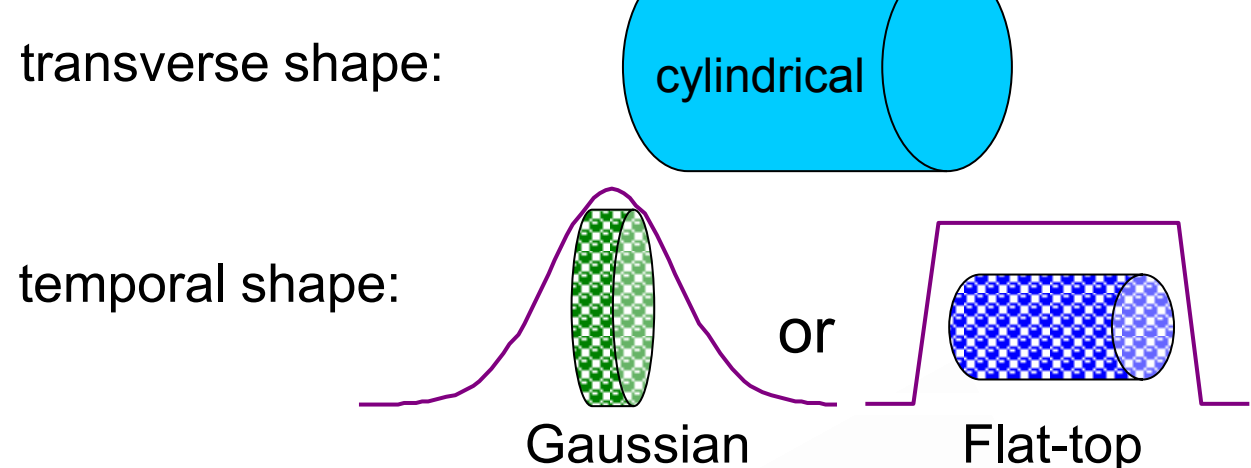
RF-Guns, conditioned and characterized at PITZ

European XFEL FLASH

3D quasi ellipsoidal cathode laser pulses

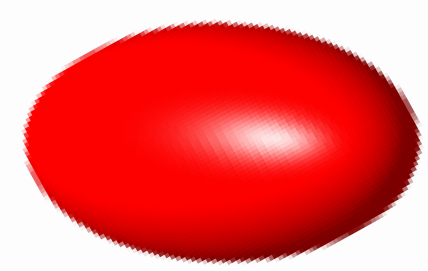
Main idea: minimize the impact of the space charge on the transverse emittance.

Standard:



New:

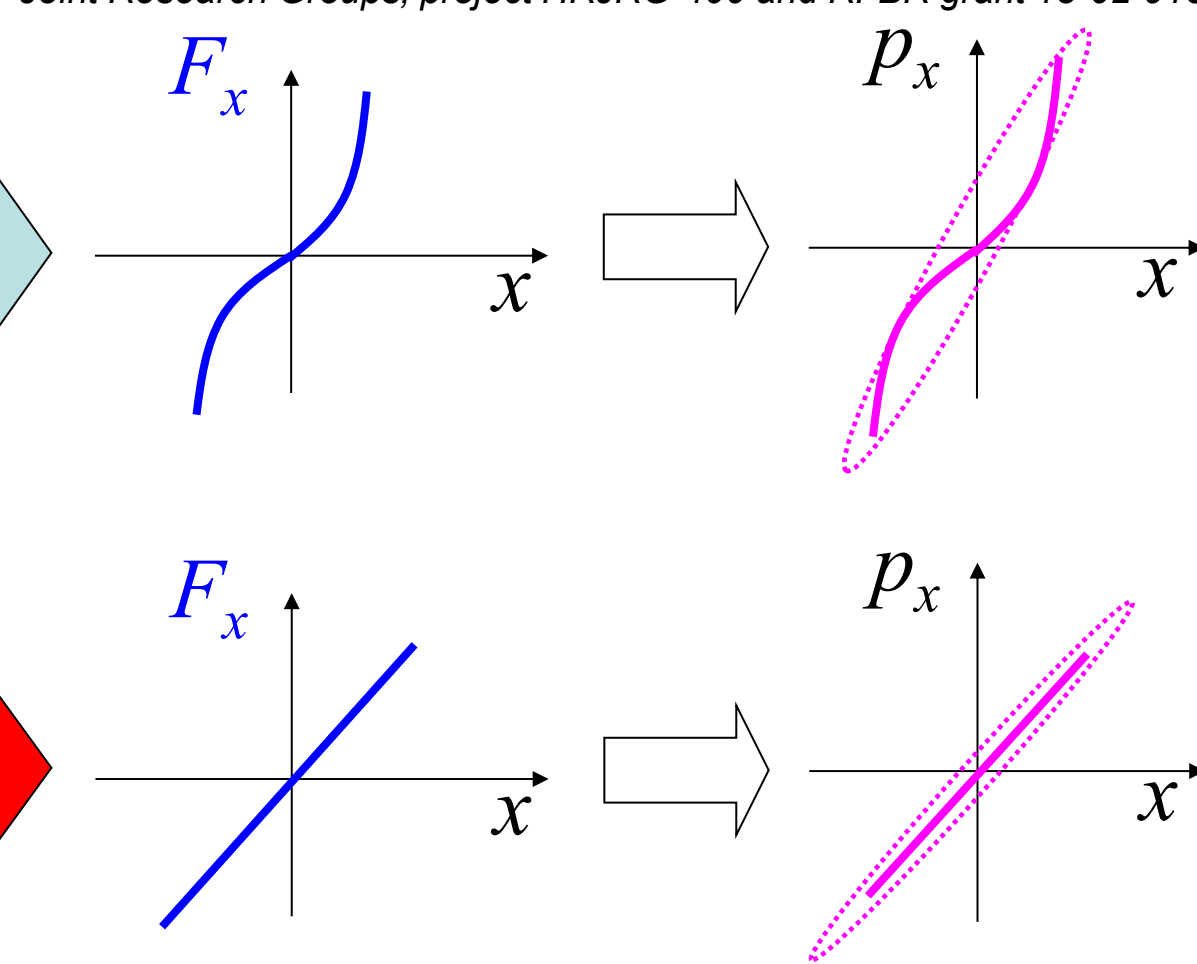
3D ellipsoid (in space and time)



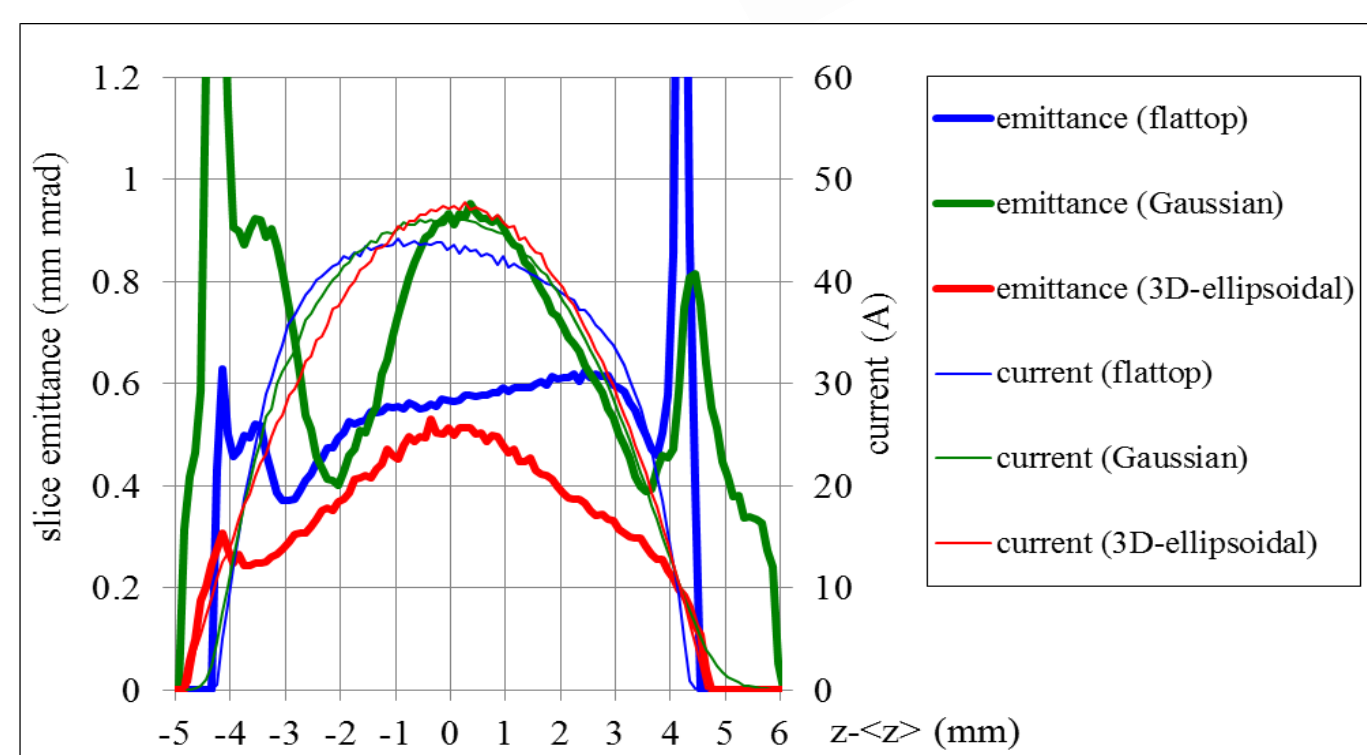
Non-linear space charge forces and non-linear phase spaces!

Linear space charge forces and linear phase spaces!

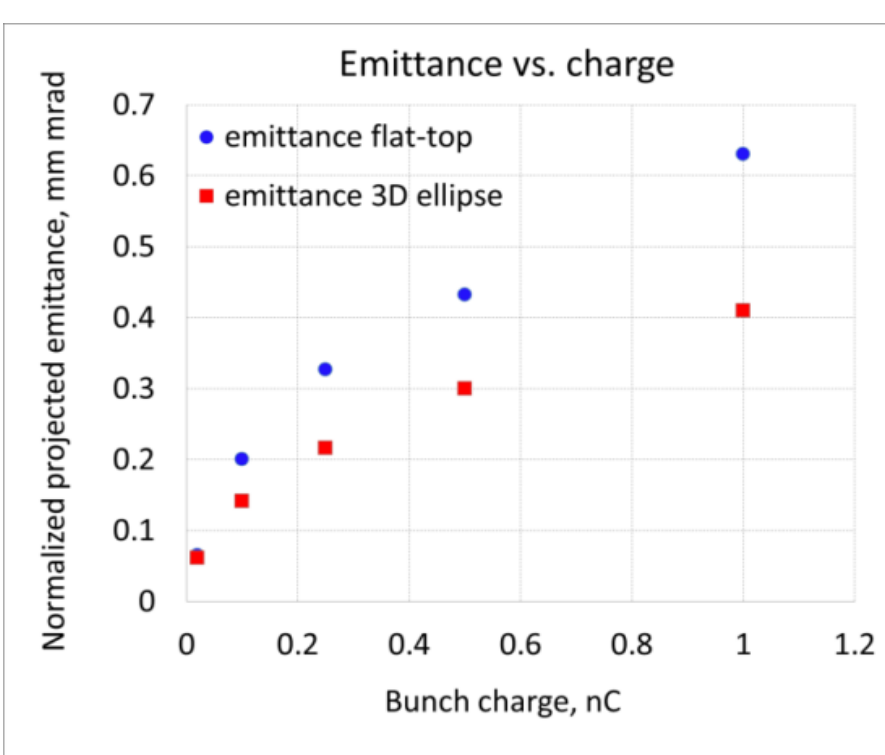
Work supported by the German Federal Ministry of Education and Research, project 05K10CHE "Development and experimental test of a laser system for producing quasi 3D ellipsoidal laser pulses", Helmholtz Joint Research Groups, project HRJRG-400 and RFBFR grant 13-02-91323.



Simulated slice emittance for 1 nC bunches



- 30-50% lower av. slice emittance
- better longitudinal compression
- reduced beam halo

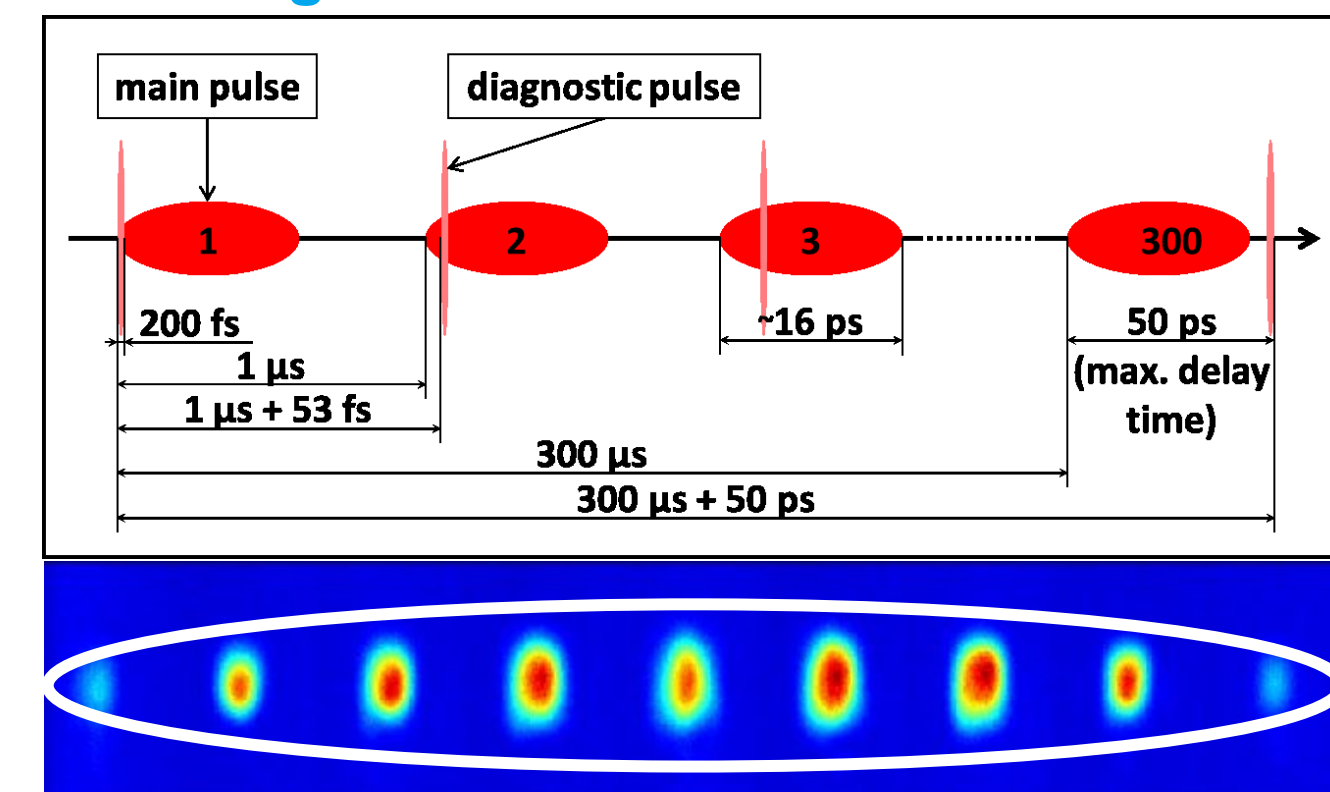


Laser system parameters

parameter	value	unit	remark
wavelength	258	nm	1030 nm fundamental
micropulse energy	15	μJ	for 1 nC bunch production from Cs ₂ Te photo cathodes
pulse train frequency	1	MHz	4.5 MHz → in future
pulse train length	0.3	ms	0.6 ms → in future
pulse train rep. rate	10	Hz	1.2, 5 Hz as an option
micropulse rms duration	6±2	ps	3D quasi ellipsoidal distribution
transverse rms size	0.5±0.25	mm	

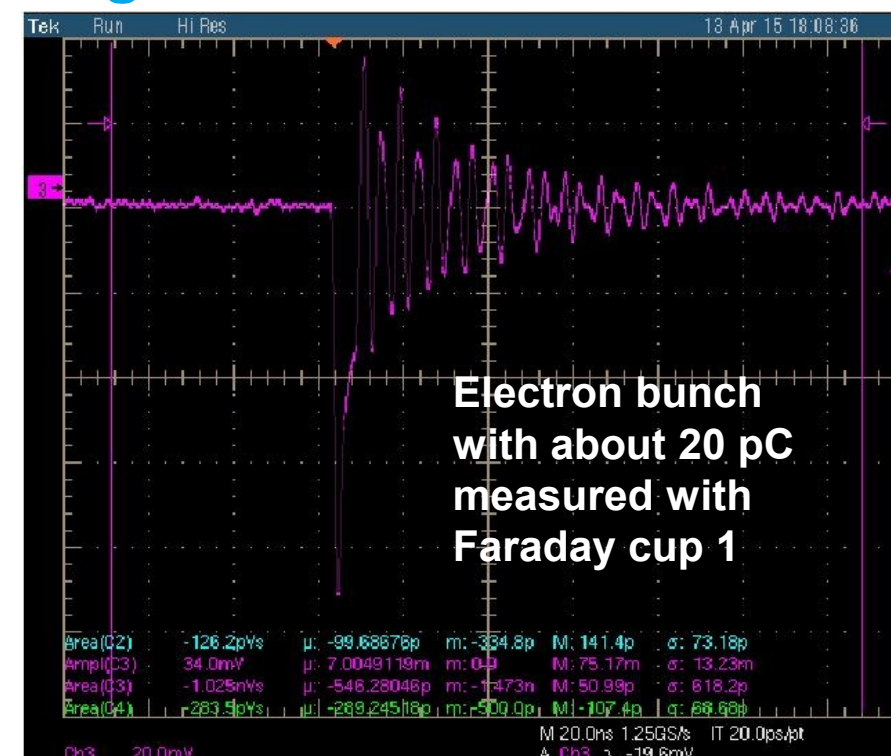
First Experimental Results

Scanning-cross correlator measurements:



Transverse image from BBO-based cross-correlator (IRxIR), here 1.7 ps delay between two neighboring shots

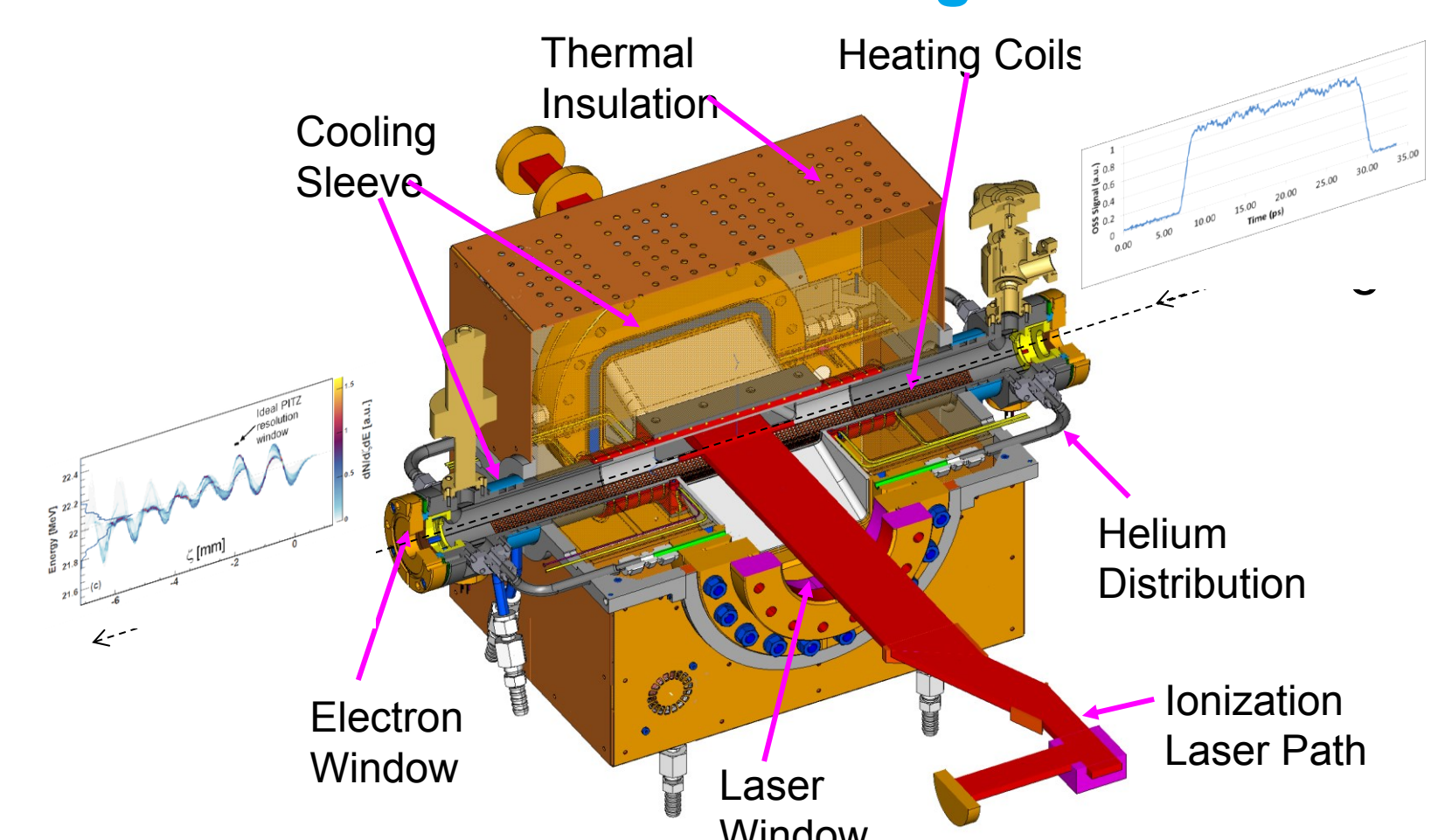
First photo electrons generated on 13.04.2015



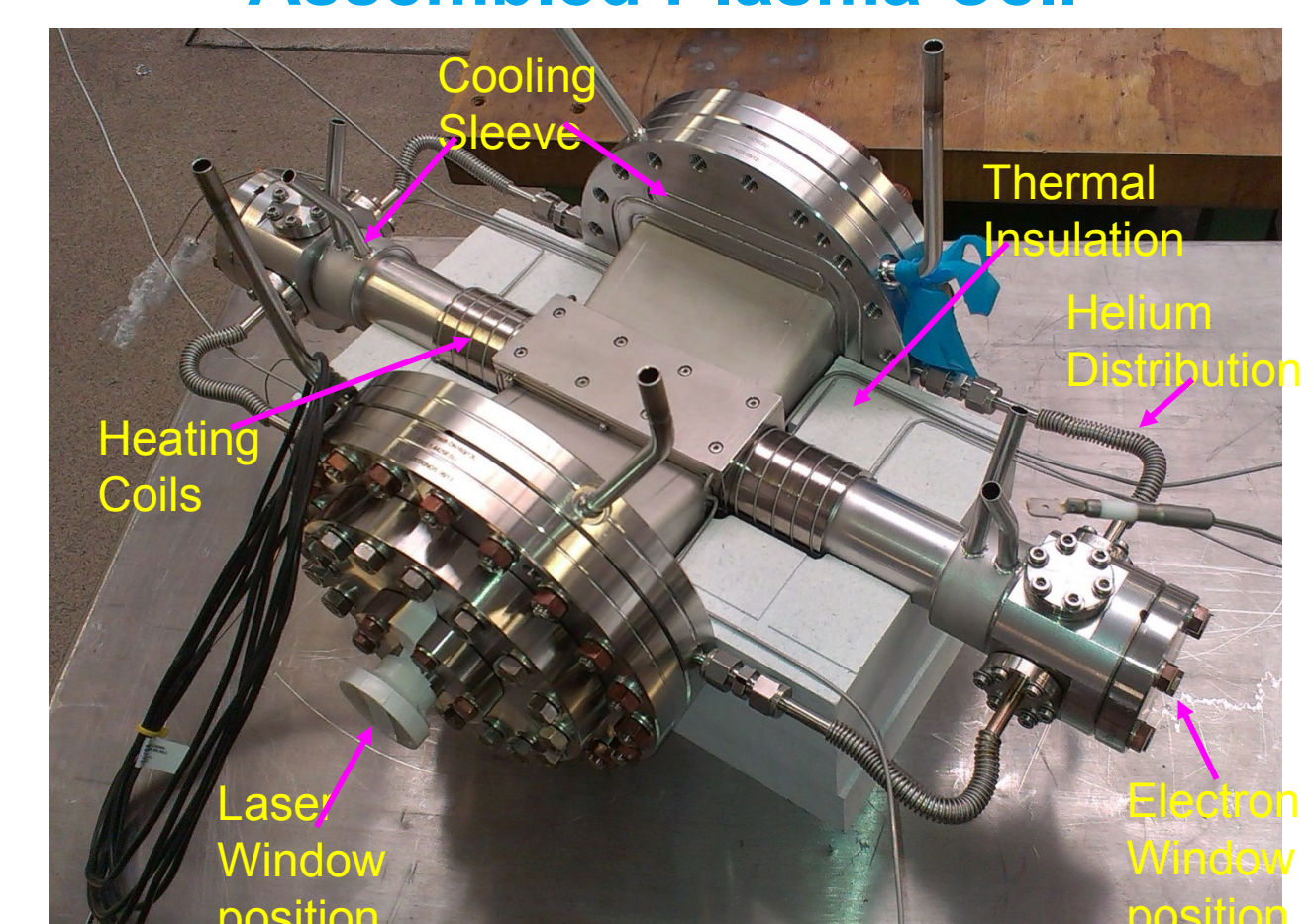
PDWA Experiments at PITZ

- Background: proton driven PWFA experiment at CERN (AWAKE collaboration) plans to utilize beam-plasma instability for **self modulation**
 - Use high energy proton beam from SPS to drive wake and convert the proton beam energy into electron beam energy in a single stage
 - Problem: $E_{z,max} = 240(MV m^{-1}) \left(\frac{N}{4 \times 10^{10}} \right) \left(\frac{0.6}{\sigma_z(mm)} \right)^2$
 - short bunches ($\sigma_z < 100 \mu m$) needed
 - SPS delivers $\sigma_z \approx 10 cm$
 - Solution: use beam-plasma instability to **modulate the beam at the plasma wavelength**, driving strong plasma waves for acceleration
 - But: so far simulations only (no direct experimental evidence)
- Goal: detect and characterize **self modulation of electron beams** in PITZ beam line to gain critical insights into **relevant physics** (dephasing, hose instability etc.)

Plasma Cell Design



Assembled Plasma Cell



- Further plasma experiments at PITZ:
- High transformer ratio (factor up to 8 possible)
 - Case studies: astrophysics in the lab