An Idea on Upgrade of the FLASH Gun Section

-Draft-

1. Present setup
2. A proposal – 0.3 m upstream shift of the gun
3. Conclusion and Outlook

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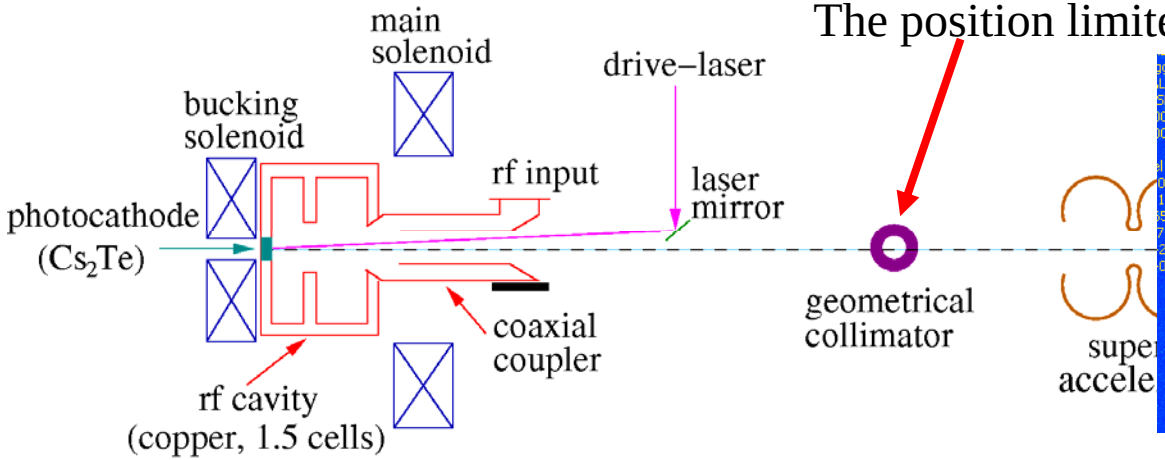
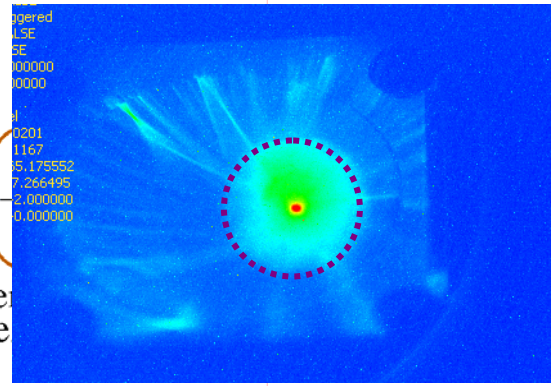
XFEL Beam Dynamics Meeting

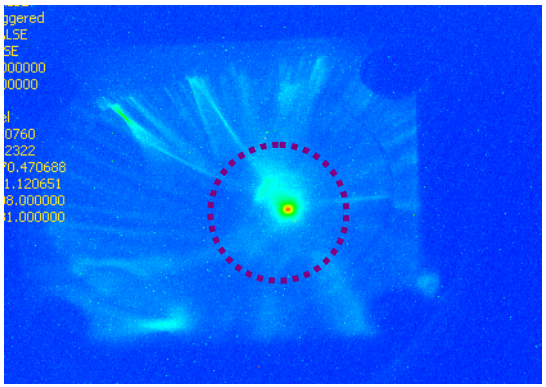
Present setup

8 mm diameter collimator
1.27 m downstream of the cathode
The position limited by the cryo-module

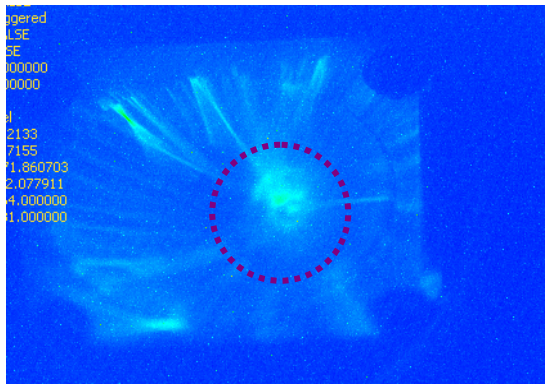




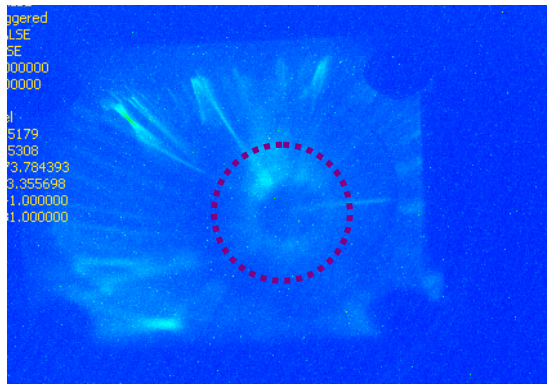
Dark current + 1 nC beam
(45 MV/m, I_{main} = 278 A)



Dark current
(45 MV/m, I_{main} = 278 A)



Dark current
(45 MV/m, I_{main} = 283 A)

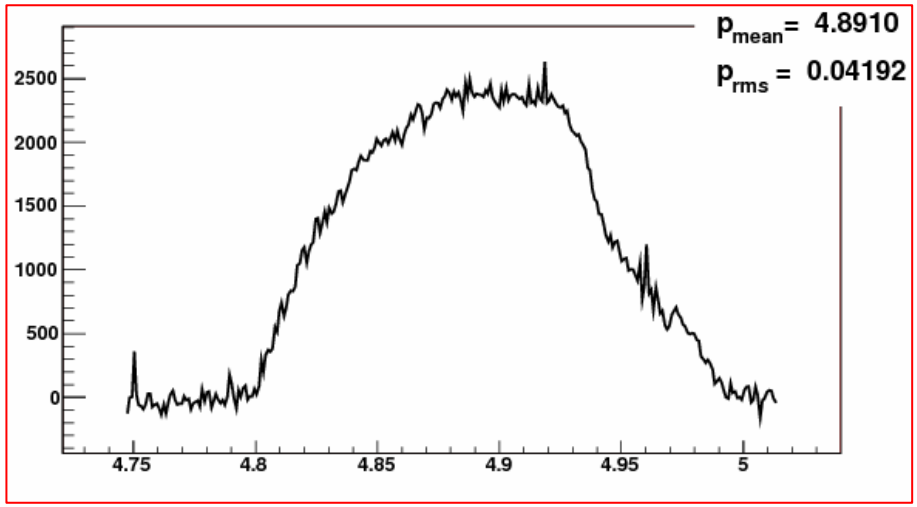


Dark current
(45 MV/m, I_{main} = 290 A)

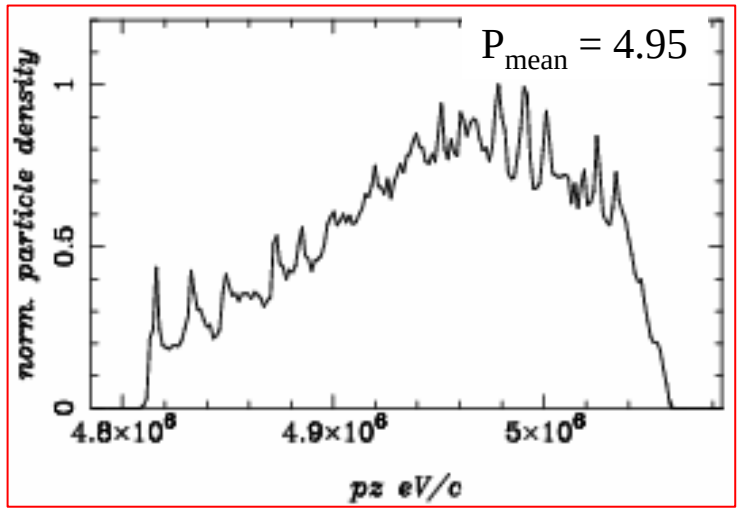
Present Operating Condition

Original design of the FLASH injector (K. Flöttmann and Ph. Piot, EPAC 2002)

40 MV/m gun gradient → 44 MV/m



Measurement with 3.34 Pfwd

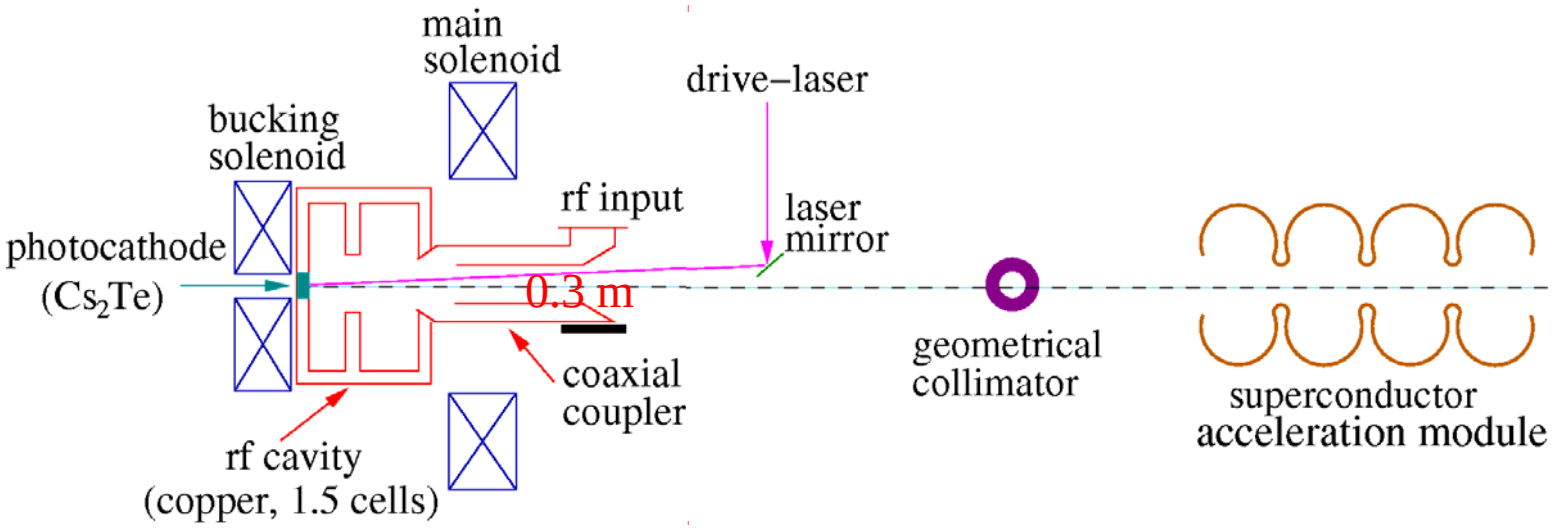


Simulation with 44 MV/m

20 ps long flat-top laser profile → 5 ps rms Gaussian

A proposal

0.3 m elongation between the gun and ACC1



Distance from the cathode

to the laser mirror 0.66 m → 0.96 m

to the collimator 1.27 m → 1.57 m

to ACC1 2.4 m → 2.7 m

Beam Simulation

Parameters	Present setup	Proposed setup
Input parameters		
Laser, transverse (radial)	0.85 mm (rms)[1]	0.73 mm (rms)[2]
Laser, temporal (Gaussian)	5 ps	5 ps
Gun max RF field	44 MV/m	44 MV/m
Max solenoid field	0.174 T	0.173 T
ACC1 mas RF field	30 MV/m	30 MV/m
Beam simulation result at 20 m (200 000 macro-particles)		
Projected transverse ε	2.0 mm mrad (no ε_{therm})	1.75 mm mrad (no ε_{therm})
Slice ε	0.8 mm mrad (no ε_{therm})	0.8 mm mrad (no ε_{therm})
Bunch length	1.67 mm (rms)	1.82 mm (rms)
Beam size at the mirror	2.64 mm (rms)	2.25 mm (rms)
Beam size at the collimator	1.47 mm (rms)[3]	1.25 mm (rms)

1) with 3.0 mm laser iris; 2) with 2.5 mm laser iris; 3) 1.8 mm in measurement

Dark Current Simulation

Dark current simulation result at 6 m (20 000 macro-particles)
Dark current starts from the cathode area (2 mm rms)

Parameters	**Present setup**	**Proposed setup**	**Difference**
Collimator position	1.27 m	1.57 m	
Without collimator	3385	2604	**20% ↓**
With 8 mm ϕ collimator	1808	801	**55% ↓**

Conclusion & Outlook

With **0.3 m longer distance** between the gun and ACC1;

- The **dark current, originated from the cathode area, will be reduced at ACC1**.
- The gained space can be used for installing **dark current kicker** and **more diagnostics**.
- Transverse emittance is reduced.
- Beam size at the vacuum mirror and at the collimator will be smaller → smaller wake effect.

Next steps;

- Find the actual operating parameter in more detail.
- Other operating conditions, e.g. gun gradient or laser temporal profile, will be considered.