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PITZ layout

The Photo Injector Test Facility at the Desy location in Zeuthen is mainly operated as a facility which tests, characterizes and optimizes photo-injectors, which are used as electron sources at FLASH and the European XFEL facilities.



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Problem description

Main reasons

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- Main solenoid calibration, MaxB(1)=-(3,72e-5+5,88e-4*Imain)
- Gun focusing (plug, field balance)
- Solenoid focusing
- Beam energy, beam charge
- Beamline ASTRA model & real coordinates

Goal – Refine gun model and minimize discrepancy between simulation and measurement







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Gun focusing effect depends on plug location

- > Change of plug location can correspondingly cause change of electromagnetic field on the cathode surface hence changing gun focusing effect on the beam
- Superfish simulation to involve the case when cathode is not ideally flat in the entrance of gun





Superfish simulation results







Local finer meshes



Gun field maps for different plug locations and field balances



Beam trajectory response from cathode to screen





Experiment: M11 of gun only



- Gun setting: 30 MV/m & 40 MV/m
- Solenoid on, check MMMG phase
- Solenoid off, find the gun focusing phase
- Scan laser position on cathode, measure beam centroid movement on screen 2
- Using different gun field maps, fit simulation to experiment
 >by tuning cathode plug insertion in gun
 >by changing the field balance between 1st and 2nd cell



Experiment vs Astra simulations for 30 MV/m



Experiment vs Astra simulations for 40 MV/m

~ 3 degree difference





Experiment errors



- It's difficult to determine the MMMG phase accuracy within 1 degree.
- 2) Fitting M11 for gun only is not a good way to refine gun field map due to experiment accuracy.





Next step: M11 of gun & solenoid combined

ASTRA Simulation (30 MV/m): Solenoid setting for M11=0





Accuracy improvement

- 1) Gun only,
 - 1) 0,1 mm plug change \rightarrow ~0,25 degree focusing phase change
 - 2) 10% change of field balance \rightarrow ~1 degree focusing phase change
- 2) Gun & solenoid (much easier)
 - 1) 0,1 mm plug change \rightarrow ~2.5% solenoid current change
 - 2) 10% change of field balance \rightarrow ~1.5% solenoid current change

M11 fit with both gun and solenoid on is more sensitive to small changes in plug location and field balance.



Summary

> What's done

- Superfish simulations for different gun field maps, with cathode plug geometry included
- ASTRA simulations of beam trajectory response with different gun field maps
- > Experiment measurements for trajectory response around gun focusing phases
- > Fitting simulations to experiment, and error analysis
- > Simulations for next experiment

> Conclusion

- Simulation results didn't fit to measurements and possible reason is the MMMG phase measurement error
- Trajectory response with solenoid on is more sensitive to gun geometry changes (plug location, field balance)
- > Next step is to do beam trajectory response test with solenoid on



Thank you for attention



