PITZ Run Coordination Meeting

20.02.2014

Week 8: Plans&Run

1. Conditioning
   A. HV=9.7kV→ max peak power at 100/200/400/650?us → with Mo cathode (3-4 first shifts)
   B. Another approach: conditioning with 800us pulses
   C. **Reach the milestone : 24h=6.5/650/390 → reached 6.0MW**
   D. Monitor resonance temperature (Excel file: ResTemp400usMonitoring.xlsx)
   E. Monitor dark current: 6.5MW, 200us, LOW.FC1 (same Excel file)→ + solenoid scan

2. Measurement program
   1.4 BPM commissioning → (quasi-) parasitic mode → higher charge (~1nC)
   1.6 Emittance 1nC + Tomo → GeK+GV
   2.5 Phase stability measurements (+new WCS tests) → Igl+MK → week 8
   2.8 Coupler kick studies → preliminary done (MK)
   2.85 low charge measurements + bunch length measurements → BM+DM+MR+TV
   3 XFEL Toroid → (quasi-) parasitic mode →Mo,17.02 (FT)

20pC studies:
Laser temporal profile:
- 19.02 – FT=24ps (remains)
- 20.02M → FT=5-6ps (MG)
- ?21.02A → FT=17ps
- ? XX.02X → G=2.8ps

Week 8	Mon Feb-17	Tue Feb-18	Wed Feb-19	Thu Feb-20	Fri Feb-21	Sat Feb-22	Sun Feb-23
Morn. 7:00 to 15:30	Isaev Pathak	Isaev	Isaev	Laser→ 5.4ps / DC, Tres cond. check	Isaev Pathak	Isaev Pathak	Isaev Path[illegible]k
Late 15:00 to 23:30	Vashchenko Melkumyan	Vashchenko Melkumyan	Vashchenko Melkumyan	Vashchenko Melkumyan	Otevr[illegible] [illegible]	[illegible]vrel Melkumyan	Otevrel Melkumyan
Night 23:00 to 7:30	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan

Gun stability with 20pC?

XFEL Toroid

Gun stability measurements

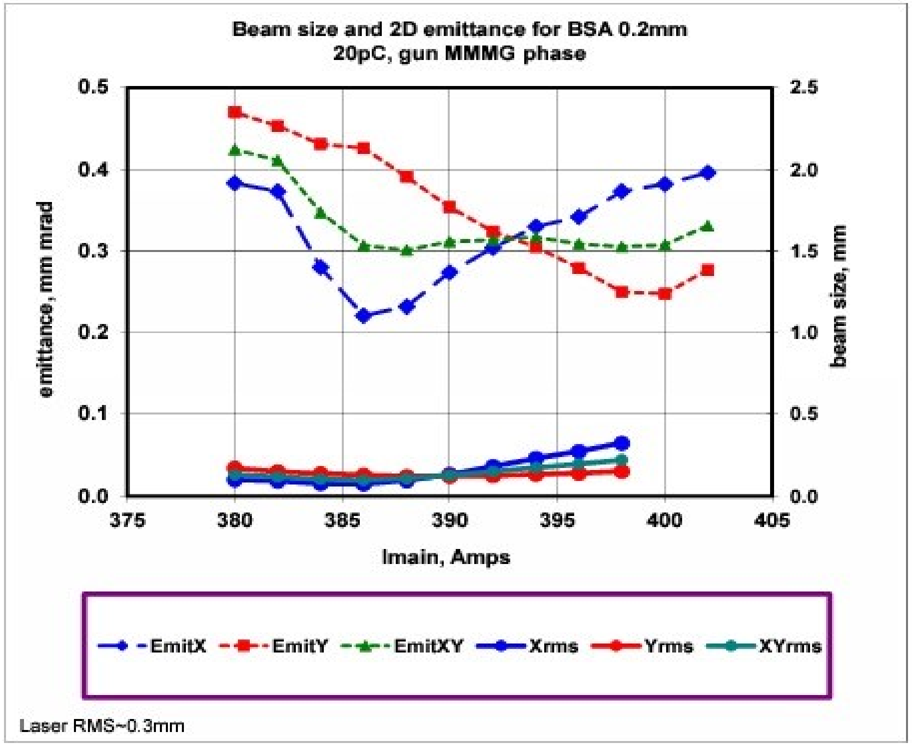
20pC studies

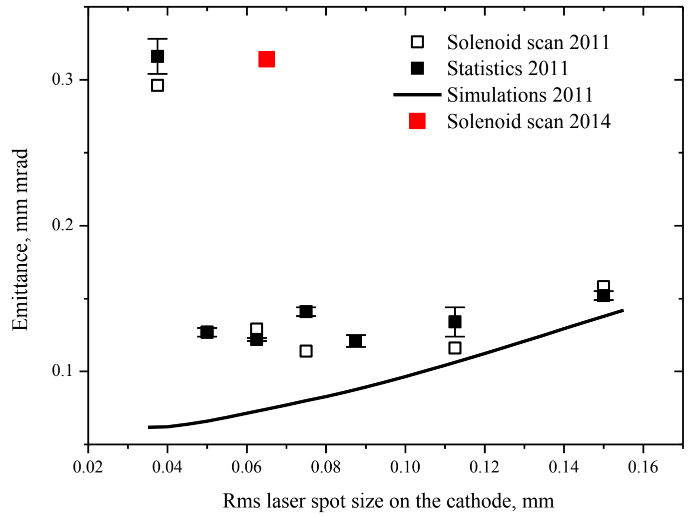
Emittance 1nC

?Emittance 1nC?

I_main (A)	Xrms, mm	Yrms, mm	EmitX_2D, mm mrad	EmitX_2D, nonscaled	XYrms, mm	EMSY1 NoP	EMSY1 Gain	MOI NoP	MOI, Gain	XBL NoP	XBL gain	EmitY_2D, mm mrad	EmitY_2D, nonscaled	YBL NoP	YBL gain	EmitXY_2D, mm.mrad	EmitXY_2D, nonscaled	comment
Shutter speed 20 us for all BL measurements																		
402	0.488	0.226	0.396	0.285	0.332	67	22	42	24	145	24	0.277	0.151	145	24	0.331	0.207	
400	0.411	0.181	0.382	0.260	0.273	50	22	32	24	145	24	0.248	0.148	145	24	0.308	0.196	
398	0.325	0.153	0.373	0.246	0.223	37	22	35	22	145	24	0.250	0.166	145	24	0.305	0.202	
396	0.275	0.141	0.342	0.214	0.197	28	22	35	22	145	24	0.279	0.199	145	24	0.309	0.206	
394	0.232	0.133	0.330	0.214	0.176	23	22	33	22	145	24	0.305	0.232	145	24	0.317	0.223	
392	**0.182**	**0.125**	**0.304**	**0.200**	**0.151**	**18**	**22**	**33**	**22**	**140**	**24**	**0.324**	**0.238**	**145**	**24**	**0.314**	**0.218**	
390	0.133	0.122	0.274	0.205	0.127	14	22	30	22	140	24	0.354	0.282	145	24	0.311	0.24	
388	0.096	0.122	0.232	0.206	0.108	10	22	25	22	130	24	0.391	0.319	145	24	0.301	0.256	
386	0.075	0.129	0.221	0.215	0.098	8	22	25	22	130	24	0.426	0.340	145	24	0.307	0.27	
384	0.078	0.138	0.280	0.217	0.104	9	22	20	22	130	24	0.431	0.387	145	24	0.347	0.29	
382	0.093	0.151	0.373	0.255	0.119	12	22	16	22	130	24	0.453	0.400	145	24	0.411	0.319	
380	0.101	0.171	0.383	0.254	0.131	16	22	13	22	135	24	0.470	0.417	145	24	0.424	0.325	

Emittance measurement with long flat-top laser pulse: ε_{xy} = 0.314 mm mrad



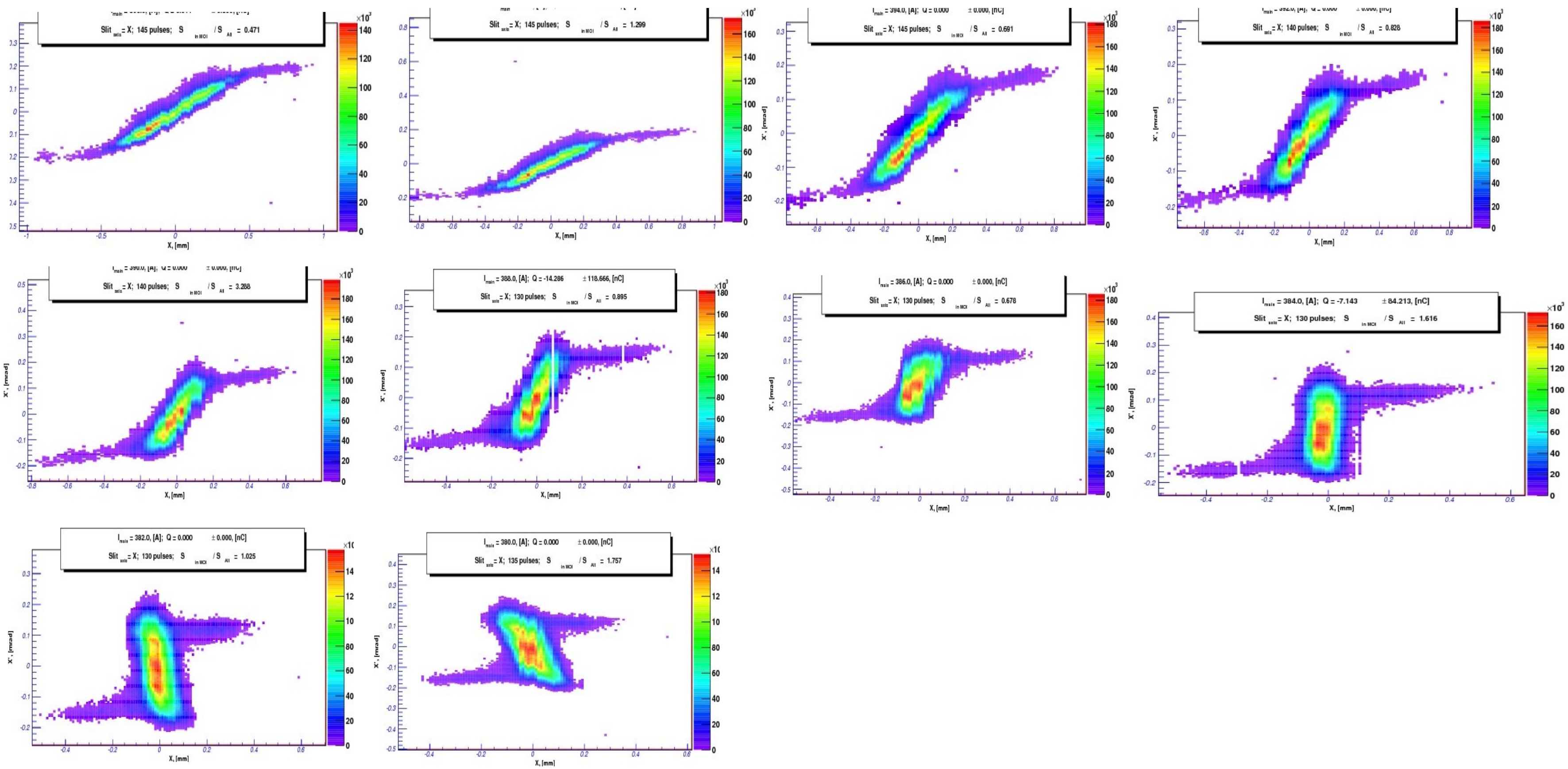


Strong different between optimum solenoid currents for X and Y planes

Problems:

Low.Scr1 was misaligned again after tunnel access.

Beam is asymmetric at High1.Scr1 – any changes off low section steerers do not change the shape.



Week 8: Plans

1. Conditioning
   A. HV=9.7kV→ max peak power at 100/200/400/650?us → with Mo cathode (3-4 first shifts)
   B. Another approach: conditioning with 800us pulses
   C. **Reach the milestone : 24h=6.5/650/390 → reached 6.0MW**
   D. Monitor resonance temperature (Excel file: ResTemp400usMonitoring.xlsx)
   E. Monitor dark current: 6.5MW, 200us, LOW.FC1 (same Excel file)→ + solenoid scan

2. Measurement program
   1.4 BPM commissioning → (quasi-) parasitic mode → higher charge (~1nC)
   1.6 Emittance 1nC + Tomo → GeK+GV
   2.5 Phase stability measurements (+new WCS tests) → Igl+MK → week 8
   2.8 Coupler kick studies → preliminary done (MK)
   2.85 low charge measurements + bunch length measurements → BM+DM+MR+TV
   3 XFEL Toroid → (quasi-) parasitic mode →Mo,17.02 (FT)

20pC studies:
Laser temporal profile:
- 19.02 – FT=24ps (remains)
- 20.02M → FT=5-6ps (MG)
- ~~?21.02A → FT=17ps~~
- ? XX.02X → G=2.8ps

Request from M.Rehders:
- Cathode laser: Gaussian pulse form, approximately 2.4ps, 3.6ps, 4.8ps, 15.3ps FWHM
- **BSA=0.4, 0.8, 1.2mm**
- Gun gradient set to **5.5-5.6MeV/c** after the gun (max. momentum gain, corresponding to FLASH conditions) → ??
- booster gradient as high as possible while still allowing stable operation (not critical, but should be the same for all measurements)
- standard conditions for emittance measurements
- RF pulse length: 200µs
- Bunch charge: **20pC**
- Number of bunches: up to 100
- Measurement locations: LEDA, EMSY1, HEDA1

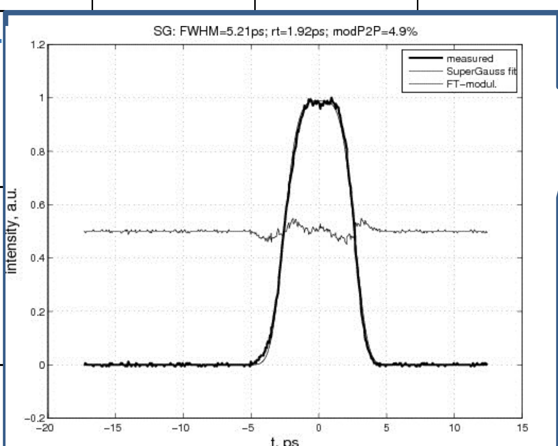
Measurements
→Emittance(Imain)
→LPS tomography (Pz vs. booster phase)

Week 8	Mon Feb-17	Tue Feb-18	Wed Feb-19	Thu Feb-20	Fri Feb-21	Sat Feb-22	Sun Feb-23
Morn. 7:00 to 15:30				Laser→ 5.4ps DC, Tres cond. check	Gun stability with 20pC? Isaev Pathak	Isaev Pathak	Isaev Pathak
Late 15:00 to 23:30				Vashchenko Melkumyan	Otevrel [illegible]	Otevrel Melkumyan	Otevrel Melkumyan
Night 23:00 to 7:30	Kalantaryan	Kalantaryan	Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan

20pC studies

24

G



?Emittance 1nC?

Measurement program: Gun-4.4

priority	program item	num.of shifts	coordinator	prefered dates	Remarks
0.9	Dark current measurements	1-2	M.Krasilnikov		200us, 2D scan(RF power, Imain)
1	Laser alignment (rough)	2-4	M.Gross		done
1.1	Solenoid BBA	4	M.Krasilnikov		done*
1.2	Long momentum measurements	2	M. Otevrel		done*
1.2	QE and QE-map measurements	2	M. Otevrel, M. Gross		done*
1.2	**Kapton foil tests with e-beam**	**1**	**M.Gross**		**solenoid scan+booster**
1.2	Booster steering studies	7	M.Otevrel, D.Kalantaryan		?combined with Cathode-1?
1.4	*BPMs commissioning*	*3*	*M.Krasilnikov, F.Tonisch*		*+booster*
1.6	**Emittance-1nC**	**17**	**G.Vashchenko, M.Krasilnikov**		**Flattop laser temporal profile**
1.61	**Emittance-250pC**	**10**	**G.Vashchenko, M.Krasilnikov**		**Flattop laser temporal profile**
1.62	**Emittance-100pC**	**20**	**G.Vashchenko, M.Krasilnikov**		**Flattop laser temporal profile**
1.63	**Emittance-20pC**	**21**	**G.Vashchenko, M.Krasilnikov**		**Flattop laser temporal profile**
1.7	**Tomo-1**	**14**	**G.Kourkafas**		
2.41	**Tomo-2 (matching studies)**	**14**	**G.Kourkafas**		
2.5	Cathodes-1 (life time)	21	S.Lederer		21 shift/cathode!->63?; 6500nC/sec!
2.5	**Gun phase stability**	**9**	**I.Isaev**		**to be combined with Cathodes-1?**
2.6	Cathodes-2 (emittance,QE,QE-map)	6	S.Lederer,...		2 cathodes
2.8	**Emission studies --> Coupler kick**	**6**	**M.Krasilnikov**		**laser temporal profile to be changed**
2.85	**Bunch length by 3-phase method**	**??**	**T.Vinatier**		**LPS (D.Malyutin?) + D.Lipka (DCM1)?**
2.9	**Low charge bunches characterization**	**9**	**B.Marchetti, D.Malyutin**		**Laser=5.4ps FWHM**
2.91	**Gauss-20pC**	**12**	**M.Rehders**		**laser temporal profile to be changed**
2.95	Thermal emittance	??	M.Otevrel		
3	Bunch length with DCM1	3	D.Lipka	KW14	cross-check with LPS Tomo (DM)
3	*XFEL Toroid*	*1*	*R.Neumann (N.Baboi), F.Tonisch*	*2013/KW50, 2014/KW3,6,8; Mo-Do*	*to be combined with Cathodes-1?*
3.5	?Booster dark current studies?	??			1week for higher peak power

Detailed program for low charge measurements + bunch length measurements
(D. Malyutin, B. Marchetti, T. Vinatier)

- NOTE: the points in orange might be included or not according to the number of machine shifts available.
- 1) Adjustment of the longitudinal profile of the laser (**flat-top 5.4ps FWHM**)
- 2) Study with BSA (Beam Shaping Aperture) =0.2 mm. Fix BSA=0.2 mm. Adjust the LT (Laser Transmission) to have **Q=20pC.**
- a. Study with beam momentum at the gun exit 6.5 MeV/c:
- i. Adjust the gun gradient to have 6.5 MeV/c beam momentum at LEDA (LEDA scan). Check the charge and eventually readjust LT.
- ii. Fix booster gradient at the maximum value possible g0 to have a stable run
- iii. Trajectory study up to HEDA1
- iv. Emittance vs solenoid scan
- v. Fix the solenoid current to I0 which provides the best emittance
- vi. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- vii. Transport up to HEDA2
- viii. HEDA2 scan for the reconstruction of the phase space of the beam at the booster entrance
- ix. Fix the solenoid current to I1 which provides an easier transport up to HEDA2
- x. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- xi. HEDA2 scan for the reconstruction of the phase space of the beam at the booster entrance
- b. Study with beam momentum at the gun exit 4.5 MeV/c, maximum momentum gun phase:
- i. Change the gun gradient to have 4.5 MeV/c beam momentum at the gun exit + LEDA scan. Check the charge and eventually readjust LT.
- ii. Keep the booster gradient at g0
- iii. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- iv. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- v. Reduce the booster gradient to g0/2
- vi. Check of the trajectory
- vii. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- c. Change the gun phase by +20deg:
- i. Check the charge and eventually readjust LT to keep 20 pC
- ii. Fix the booster gradient at g0
- iii. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- iv. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- d. Change the gun phase by -20deg:
- i. Check the charge and eventually readjust LT to keep 20 pC
- ii. Keep the booster gradient at g0
- iii. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- iv. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- e. Study with beam momentum at the gun exit 3 MeV/c:
- i. Change the gun gradient to have 3 MeV/c beam momentum at the gun exit + LEDA scan. Check the charge and eventually readjust LT.
- ii. Keep the booster gradient at g0
- iii. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- iv. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- f. LEDA scan using other 3 different gun gradient values (for example corresponding to 1MeV/c, 2 MeV/c, 5.3 MeV/c MMMG)

Detailed program for low charge measurements + bunch length measurements -2 (D. Malyutin, B. Marchetti, T. Vinatier)

- 3) Study with BSA (Beam Shaping Aperture) =0.3 mm. Fix BSA=0.3 mm. Adjust the LT (Laser Transmission) to have Q=20pC.
- a. Adjust the gun gradient to have 6.5 MeV/c beam momentum at LEDA (LEDA scan). Check the charge and eventually readjust LT.
- b. Keep booster gradient at g0
- c. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- d. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- e. Transport up to HEDA2
- f. HEDA2 scan for the reconstruction of the phase space of the beam at the booster entrance

- 4) Study with BSA (Beam Shaping Aperture) =0.4 mm. Fix BSA=0.4 mm. Adjust the LT (Laser Transmission) to have Q=20pC.
- a. Adjust the gun gradient to have 6.5 MeV/c beam momentum at LEDA (LEDA scan). Check the charge and eventually readjust LT.
- b. Keep booster gradient at g0
- c. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- d. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- e. Transport up to HEDA2
- f. HEDA2 scan for the reconstruction of the phase space of the beam at the booster entrance

- 5) Study with BSA (Beam Shaping Aperture) =0.6 mm. Fix BSA=0.6 mm. Adjust the LT (Laser Transmission) to have Q=20pC.
- a. Adjust the gun gradient to have 6.5 MeV/c beam momentum at LEDA (LEDA scan). Check the charge and eventually readjust LT.
- b. Keep booster gradient at g0
- c. Trajectory study up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- d. HEDA1 scan for the reconstruction of the phase space of the beam at the booster entrance
- e. Transport up to HEDA2
- f. HEDA2 scan for the reconstruction of the phase space of the beam at the booster entrance

- 6) Study with higher charges
- a. Fix the BSA to 1.2 mm
- b. Fix the gun gradient to have 6.5 MeV/c maximum momentum gain. Fix the phase to the maximum momentum gain phase.
- c. Fix LT to have Q=1nC (if possible, otherwise keep the highest charge)
- d. LEDA scan
- e. Check the trajectory up to HEDA1, fix the solenoid current in order to have an easy beam transport.
- f. Keep the booster at the high gradient value
- g. HEDA1 scan
- 7) Repeat the study 6) with a different transmission in order to have the following charges: Q=500pC, Q=200pC.

Bunch characterization studies for injector optimization for FLASH - M. Rehders

Goals and expected experimental results

- Experimentally characterize the influence of the laser pulse duration (gaussian longitudinal profile) on the bunch properties (especially on the transverse and longitudinal phase space distribution) at **20pC**. This is important for the operation of the short pulse injector laser at FLASH.
- A measurement of the bunch length or longitudinal phase space distribution immediately after the injector is currently not possible at FLASH. This has to be studied at PITZ

Machine setup

- Cathode laser: Gaussian pulse form, approximately 2.4ps, 3.6ps, **4.8ps**, 15.3ps FWHM
- BSA=0.4, 0.8, 1.2mm
- Gun gradient set to 5.6MeV/c after the gun (max. momentum gain, corresponding to FLASH conditions)
- booster gradient as high as possible while still allowing stable operation (not critical, but should be the same for all measurements)
- standard conditions for emittance measurements
- RF pulse length: 200µs
- Bunch charge: 20pC
- Number of bunches: up to 100
- Measurement locations: LEDA, EMSY1, HEDA1
- Measurement procedure: see next slide
- Number of shifts required (estimated): 8 - 12

Preliminary shift plan

- Setup of laser (longitudinal profile, BSA, LT for charge of 20pC)
- adjust the gun gradient to 5.6MeV/c (max. momentum gain), LEDA scan
- Emittance measurement vs. Solenoid scan at EMSY1
- Longitudinal tomography (probably at HEDA1?)
- Adjust BSA and repeat…

Measurement procedure will be the same for all laser pulse durations