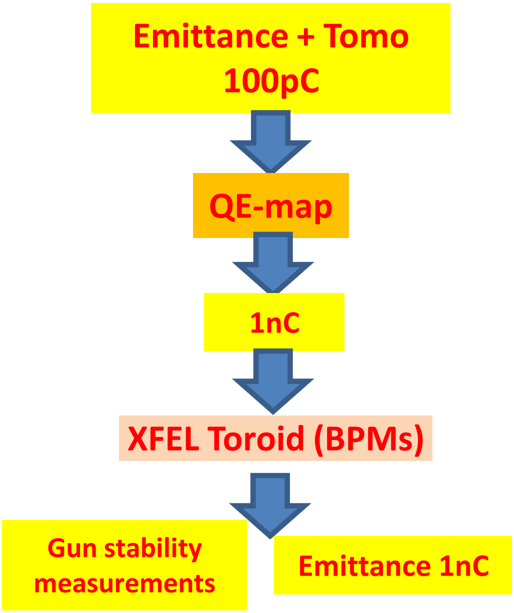
PITZ Run Coordination Meeting

13.02.2014

Weeks 6-7: 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
   - 1.2 Kapton foil tests with e-beam → to be repeated 06.02.2014 ➔ internal summary report
   - 1.2 Booster steering
   - 1.4 BPM commissioning → (quasi-) parasitic mode → higher charge (~1nC)
   - 1.6 Emittance 100pC (then 1nC) + Tomo ➔ GeK+GV →Check max charge vs. BSA
   - 2.5 Phase stability measurements (+new WCS tests) ➔ Igl+MK ➔ week 7
   - 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


Emittance + Tomo 100pC

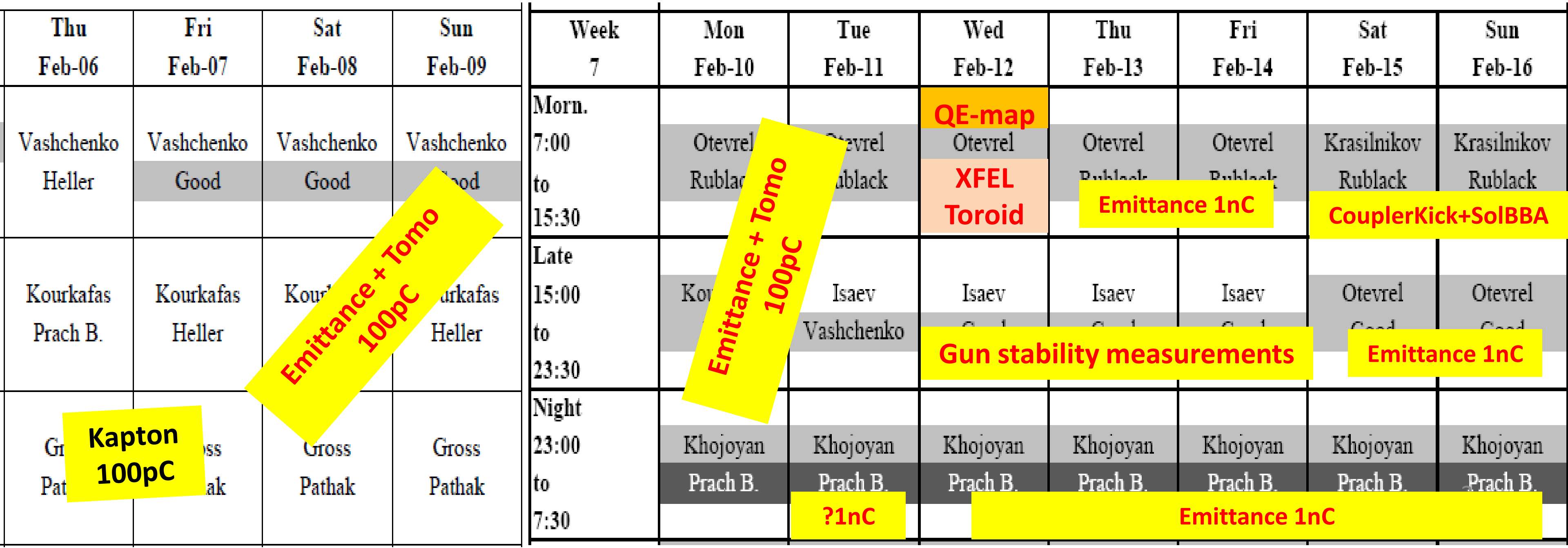
QE-map

1nC

XFEL Toroid (BPMs)

Gun stability measurements

Emittance 1nC



Thu Feb-06	Fri Feb-07	Sat Feb-08	Sun Feb-09
Vashchenko Heller	Vashchenko Good	Vashchenko Good	Vashchenko ood
Kourkafas Prach B.	Kourkafas Heller	Kour	urkafas Heller
Gr Pat	ss ak	Gross Pathak	Gross Pathak

Week 7	Mon Feb-10	Tue Feb-11	Wed Feb-12	Thu Feb-13	Fri Feb-14	Sat Feb-15	Sun Feb-16
Morn. 7:00 to 15:30	Otevrel Rublac	tevrel ublack	Otevrel	Otevrel	Otevrel	Krasilnikov Rublack	Krasilnikov Rublack
Late 15:00 to 23:30	Ko	Isaev Vashchenko	Isaev	Isaev	Isaev	Otevrel	Otevrel
Night 23:00 to 7:30	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.

Weeks 6-7: 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**
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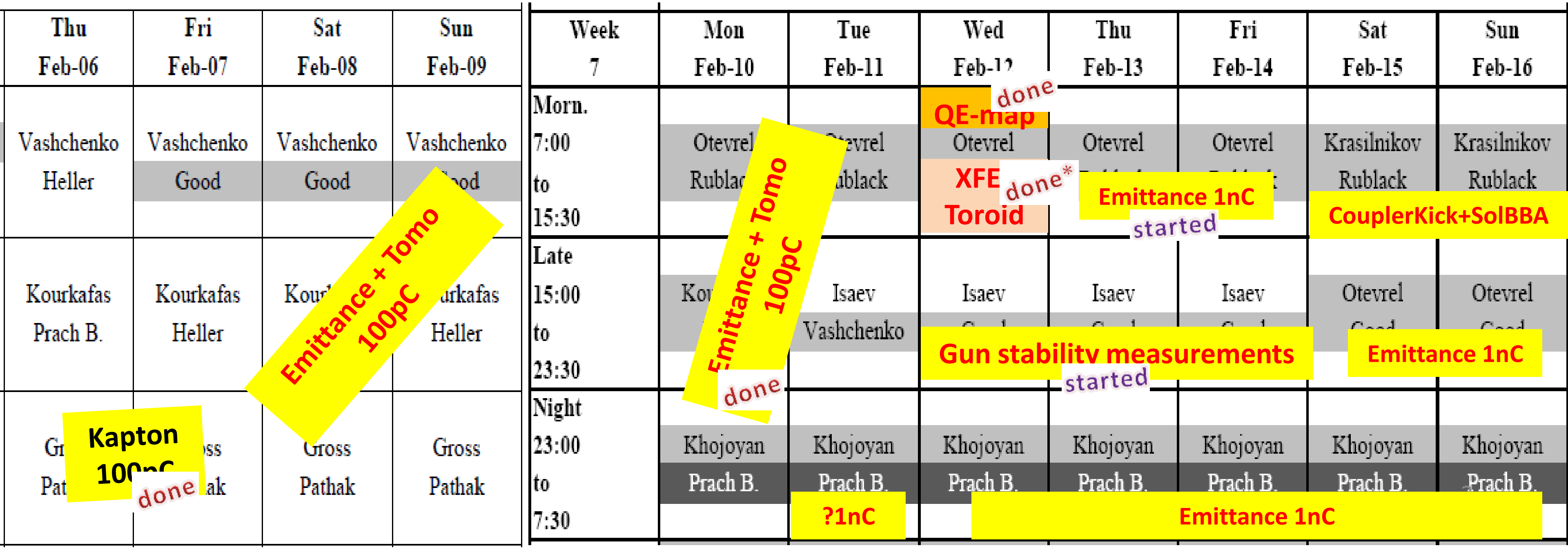
2. Measurement program
   - 1.2 Kapton foil tests with e-beam → to be repeated 06.02.2014 → internal summary report
   - 1.2 Booster steering
   - 1.4 BPM commissioning → (quasi-) parasitic mode → higher charge (~1nC)→checked (only HIGH1.BPM1-Y no signal, others →ok)
   - 1.6 Emittance 100pC (then 1nC) + Tomo → GeK+GV →done
   - 2.5 Phase stability measurements (+new WCS tests) → Igl+MK → week 7
   - 2.85 low charge measurements + bunch length measurements → BM+DM+MR+TV
   - 3 XFEL Toroid → (quasi-) parasitic mode →partially done



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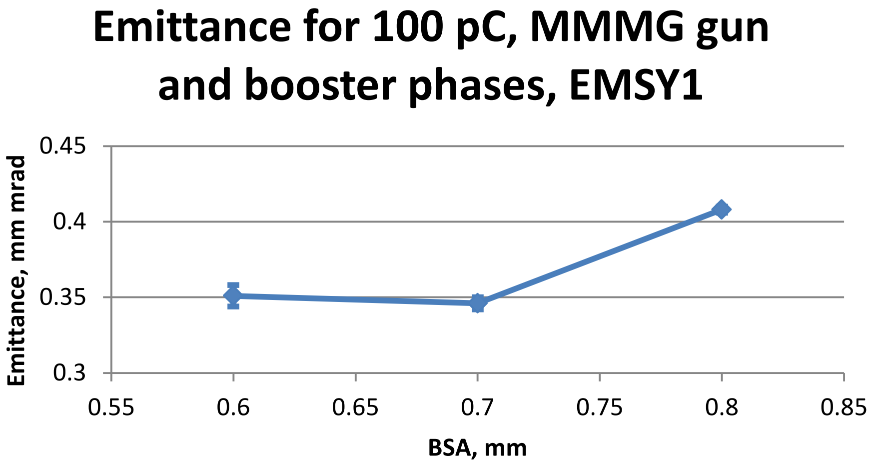
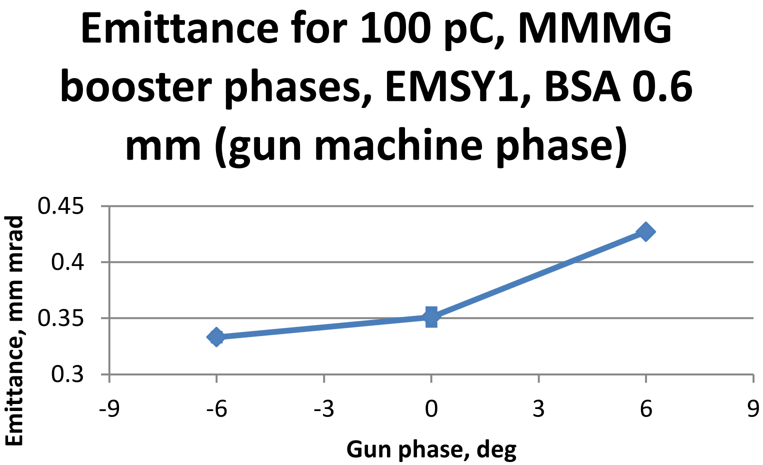
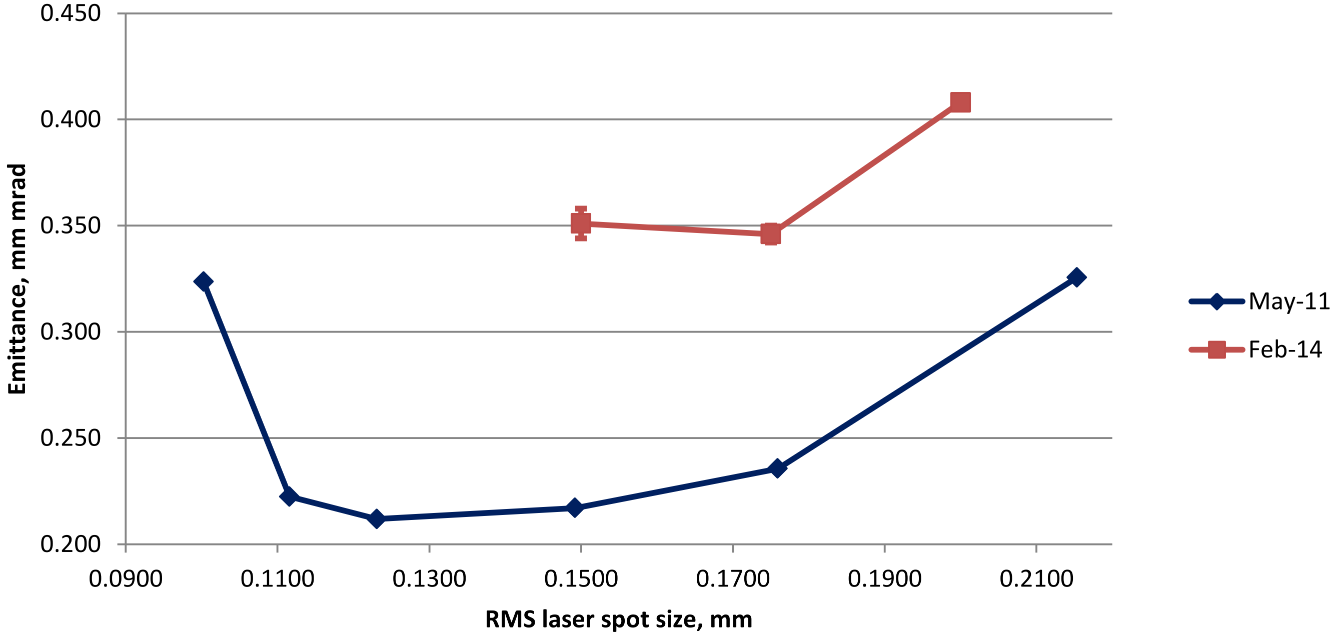
Emittance measurements 100pC

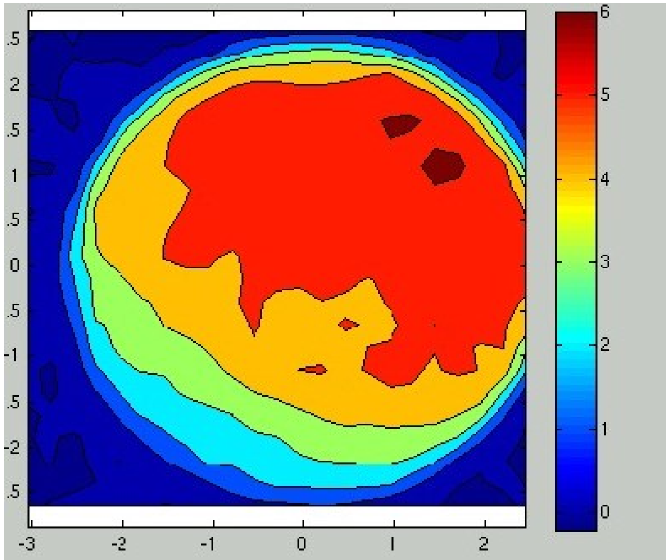






QE-map measurements

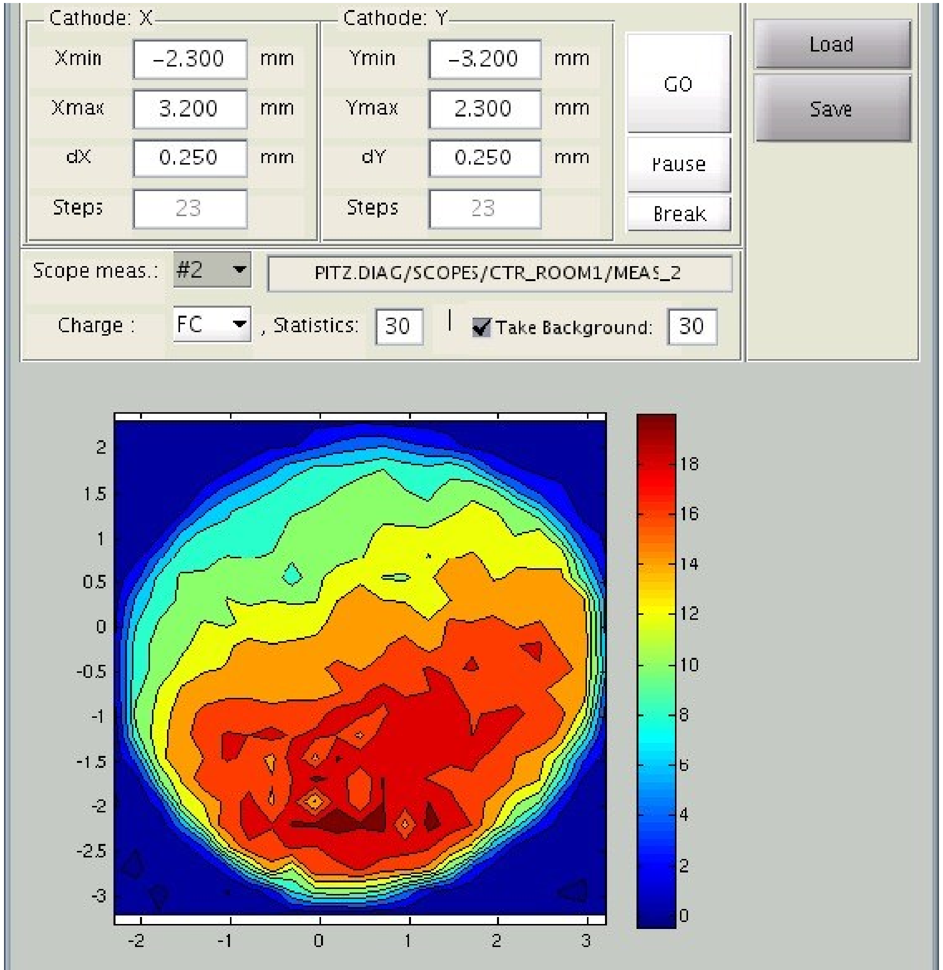
- 24.01.2014 12:43



QE measured (1.5 and 6 MW):
20.01.2014: 6.3%
14.01.2014: 6.8%

- 11.02.2014 19:01

NB: cathode was rotated by 45 (135)deg before insertion on 03.02.2014



Cathode: X
Xmin -2.300 mm
Xmax 3.200 mm
dX 0.250 mm
Steps 23

Cathode: Y
Ymin -3.200 mm
Ymax 2.300 mm
dY 0.250 mm
Steps 23

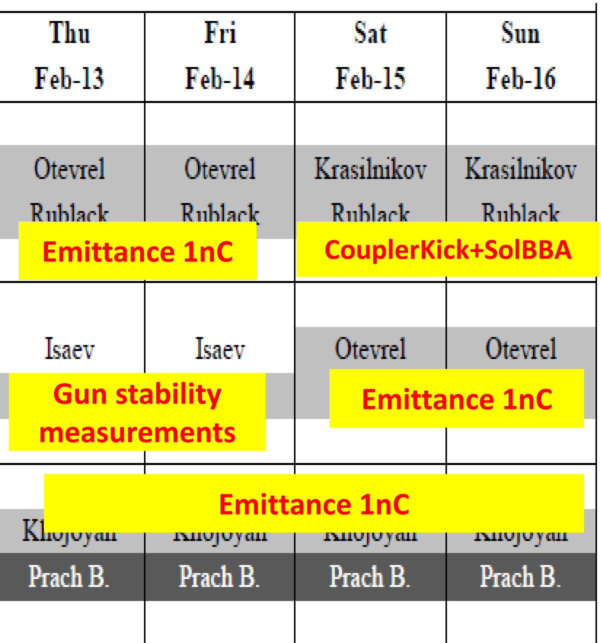
Scope meas.: #2 PITZ.DIAG/SCOPES/CTR_ROOM1/MEAS_2
Charge : FC , Statistics: 30 ☑ Take Background: 30

QE measured at 6.5 MW: 4.8 %

Weeks 7-8: 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 100pC (then 1nC) + Tomo ➔ GeK+GV →Check max charge vs. BSA
   - 2.5 Phase stability measurements (+new WCS tests) ➔ Igl+MK ➔ week 7
   - 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



Thu Feb-13	Fri Feb-14	Sat Feb-15	Sun Feb-16
Otevrel Rublack	Otevrel Rublack	Krasilnikov Rublack	Krasilnikov Rublack
Isaev	Isaev	Otevrel	Otevrel
Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.	Khojoyan Prach B.

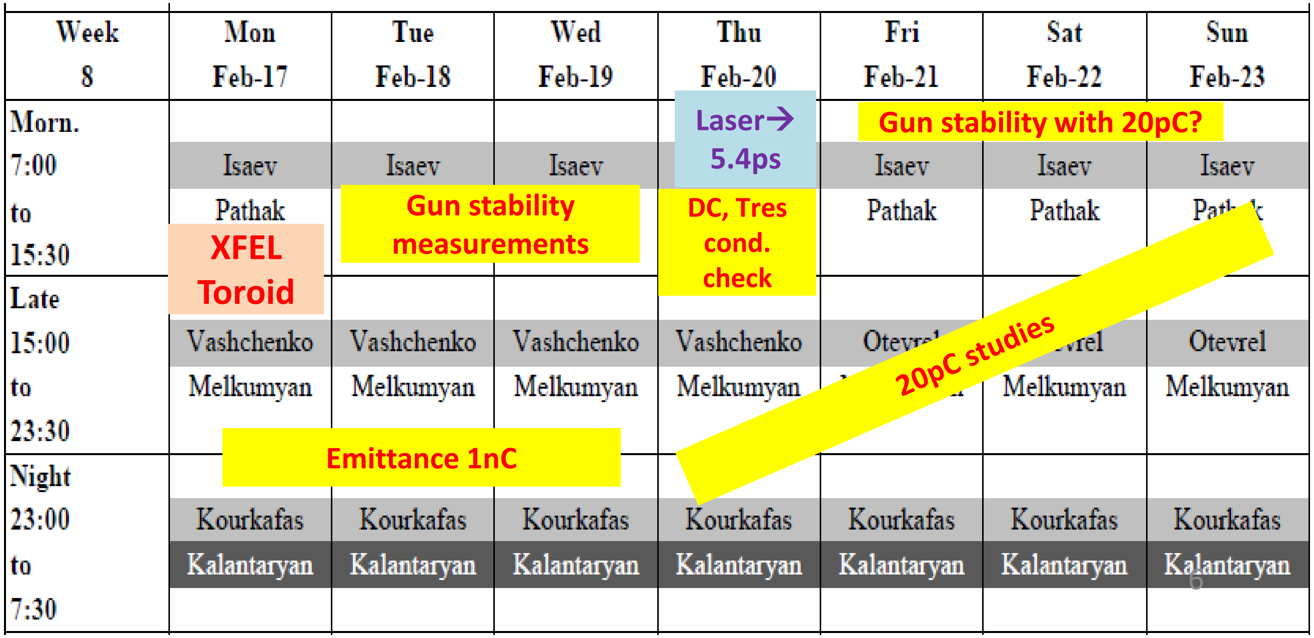
Emittance 1nC

CouplerKick+SolBBA

Gun stability measurements

Emittance 1nC

Emittance 1nC



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		Isaev Pathak	Isaev Pathak	Isaev Path k
Late 15:00 to 23:30	Vashchenko Melkumyan	Vashchenko Melkumyan	Vashchenko Melkumyan	Vashchenko Melkumyan	Otevr	vrel Melkumyan	Otevrel Melkumyan
Night 23:00 to 7:30	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan	Kourkafas Kalantaryan

Laser→ 5.4ps

Gun stability with 20pC?

XFEL Toroid

Gun stability measurements

DC, Tres cond. check

20pC studies

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

Emittance 1nC (GV)

Emittance measurement for 1 nC charge:

- Emittance vs. BSA:
  - 1.0 mm?, 1.2 mm, 1.5 mm, 1.8 mm, 1.4 mm?, 1.6 mm?

  Estimated time 3-5 shifts.

- Emittance vs. gun phase
  - For optimum BSA (+- 1 step ?): phase range [-9;9] deg in step of 3 deg.

  Estimated time: 5-8 shifts.

- Emittance vs. booster gradient:
  - Optimum gun launching phase, BSA.
  - Electron beam momentum = Max; 25 MeV/c; 22 MeV/c; 19 MeV/c; 16 MeV/c; …?

  Estimated time: 2 shifts.

- Emittance vs. EMSY station:
  - Optimum gun launching phase, BSA.
  - Emittance at EMSY1, EMSY2, EMSY3 at fixed solenoid current?

  Estimated time: 2 shifts.

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