PITZ Run Coordination Meeting

30.01.2014

Week 4: Plans

1. Conditioning
   A. HV=9.7kV➔ max peak power at 100/200/400/650?us → with new Mo cathode (633.1)
   B. Another approach: conditioning with 800us pulses
   C. Reach the milestone : 24h=**6.5**/650/390 → ?
   D. Monitor resonance temperature (Excel file: ResTemp400usMonitoring.xlsx)
   E. Monitor dark current: 6.5MW, 200us, LOW.FC1 (same Excel file)➔ + solenoid scan
2. Photoelectrons:
   A. QE and QE-map measurements
   B. Solenoid BBA → check may be if time (MK)
3. Measurement program
   1.2 Long momentum measurements → with precise MMMG phase w.r.t 0
   1.2 Kapton foil tests with e-beam → to be repeated
   1.2 Booster steering
   1.4 BPM commissioning → ok
   2.5 Phase stability measurements (+new WCS tests) → ok
   1.6 Emittance 1nC or 100pC

Week 4	Mon Jan-20	Tue Jan-21	Wed Jan-22	Thu Jan-23	Fri Jan-24	Sat Jan-25	Sun Jan-26
Morn. 7:00 to 15:30	Otevrel	QE-map Malyutin	Otevrel Prach B.	Otevrel ach B.	Otevrel Khojoyan	Otevrel Khojoyan	Otevrel Khojoyan
Late 15:00 to 23:30	Vashchenko Prach B.	Vashchenk…	…henko Good	Vashchenko Good	Vashchenko Good	Vashchenko Good	Vashchenko Good
Night 23:00 to 7:30	Kourka…s Kalantaryan	Kourkafas Kalantaryan	Kourkafas Marchetti	Kourkafas Marchetti	Kourkafas Marchetti	Kourkafas Marchetti	Kourkafas Marchetti

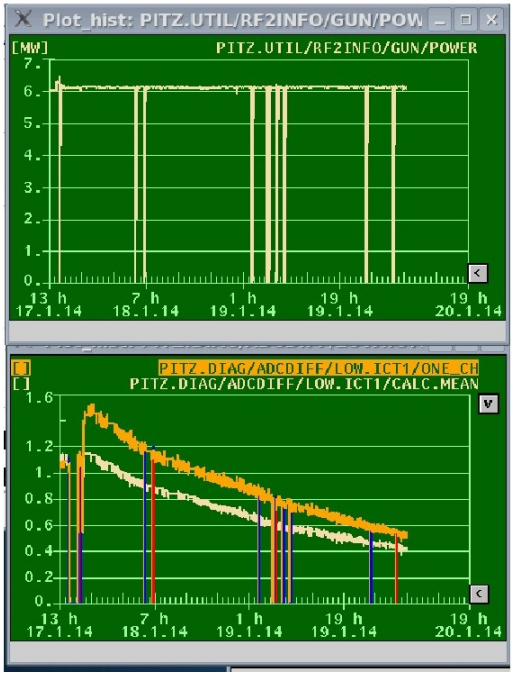
QE

LMM

Kapton 100pC

Problems:

1) Charge drop by a factor of 3 during the day



2) Booster is out of order (water):
Firmware problem – solved
SPS problem – ??

3) AFS space problem for year 2014 – partially solved, still some reallocation of volumes is needed.

4) Booster WCS server hanging due to broken SPS. To be corrected by Bagrat

5) Many not critical bugs in fastscan3 due to outdated version – solved.
Serious bug (multiple clients access conflict) in VSV3 found by shifts and fixed by S. Weisse – solved.

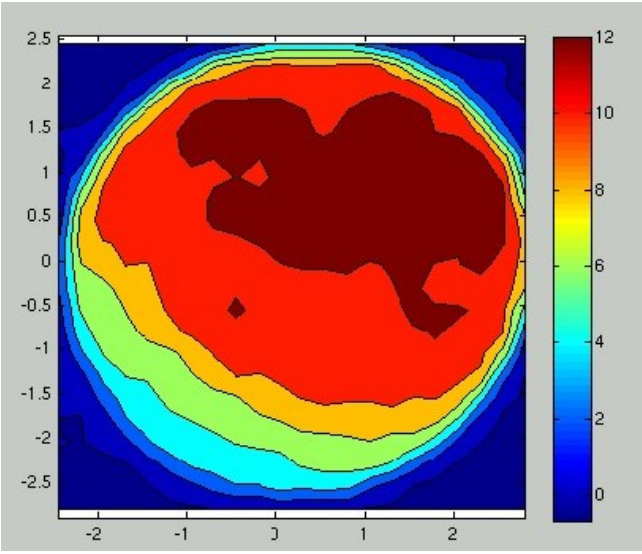
Achievements:

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

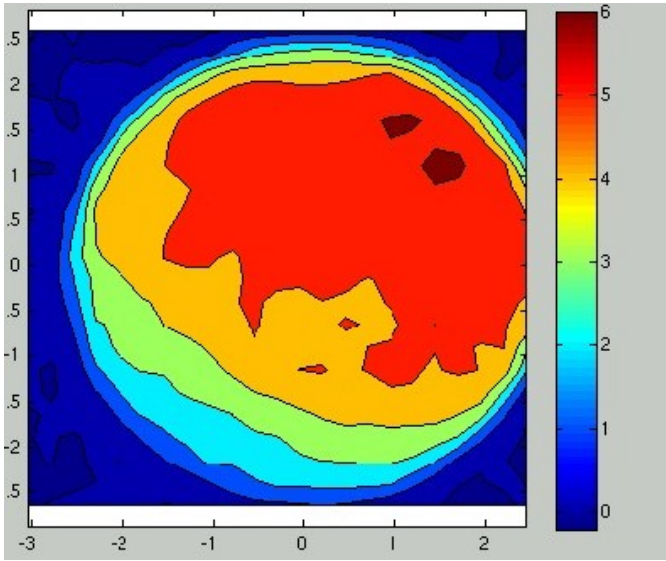
Camera timing for majority of cameras is adjusted

QE map measured with adjusted BSA position in order to avoid beam cutting on M5 and M6 mirrors:

M5, M6 range problem



No M5, M6 range problem



Still cathode QE has a gradient

Cathode exchange on 27.01.2014

Cathode # 640.1 (Cs2Te) ➔ cathode #633.1 (Mo)

Cathode # 640.1 (Cs2Te) visual inspection:

exchange chamber

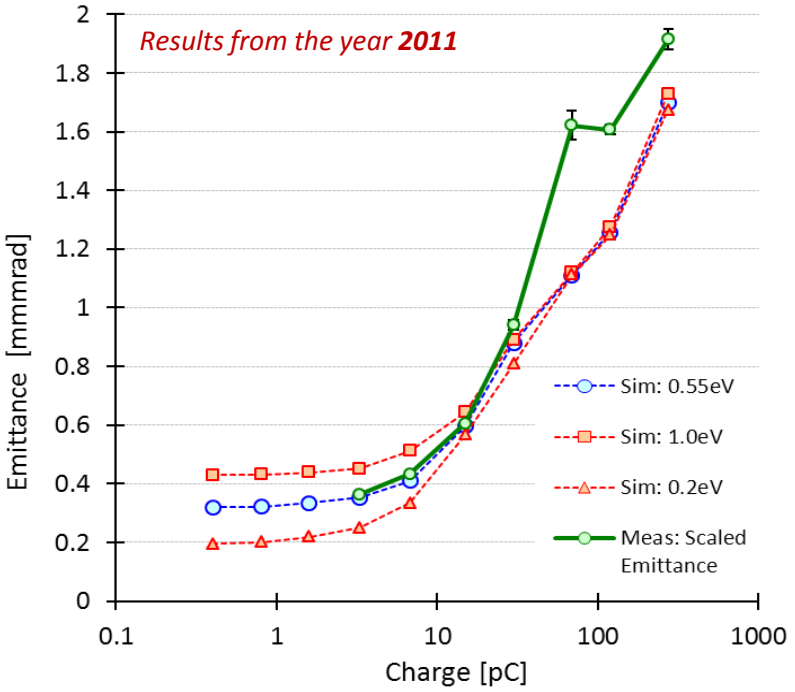
in the cathode box

Thermal emittance: Measurement Approach

> Emittance measured for various charge (densities), laser spot size fixed & large.

> **Motivation:** to have high intrinsic emittance and low other emittance contributors, to reach and recognize the region where space charge effects disappear

> **Analysis:** Measured data compared with ASTRA simulations for various average kinetic energies



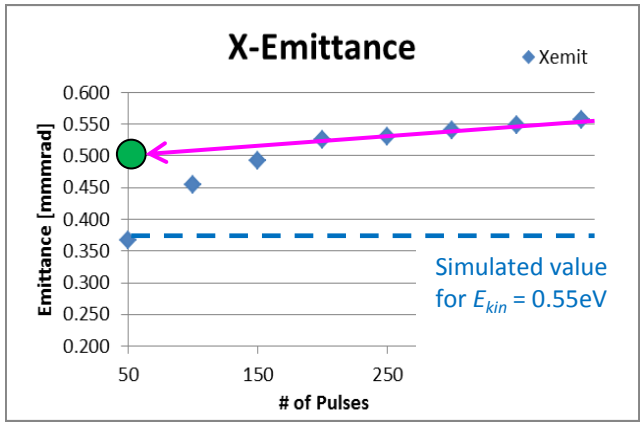
> **Measurement procedure:**

a) Preparation steps:

- As usual: (Laser beam properties, transport, BBA, charge at MMMG phase)
- Momentum and MMMG phase along the RF pulse
  ->should be constant

b) Measurement:

- Beam size solenoid scan -> find focus
- Emittance for different # of pulses



Thermal emittance: conditions

Ideal Measurement settings		Comments
LASER- temporal	2ps gaussian or 4ps short flat-top	mimimize RF effects
LASER - transverse	min. 300um RMS, better 500um+	enhance thermal emittance
BOOSTER	OFF	if booster on -> very small beam -> resolution problems
Charge	depends of BSA, low (1-30pC)	±Equidistant in logarithmic scale
Gun power	almost MAX	Momentum around 6.5MeV, Margin must be left for **FB**
Gun phase	On-crest	
Feedback	ON	
Slit width	50um	the "bigger one"
observation screen (H1.Scr4) lens	f = 160	
EMSY1 screen (H1.Scr1) lens	f = 160	

Problems:

No feedback

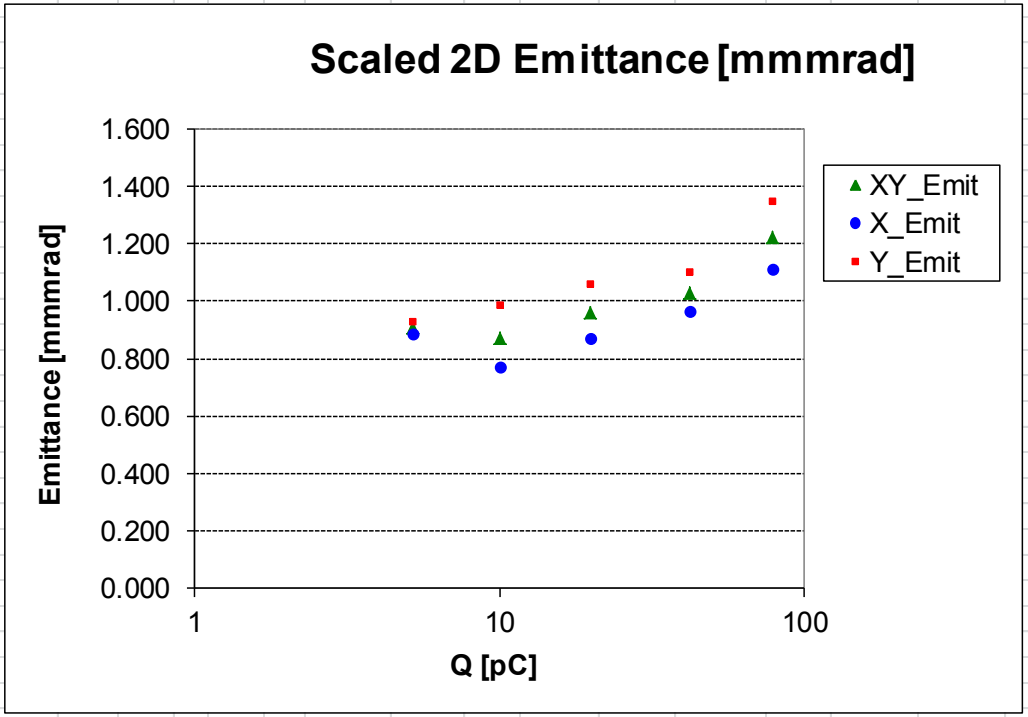
17ps flat top pulse

Fastscan+Emcalc+Videosystem3 bugs

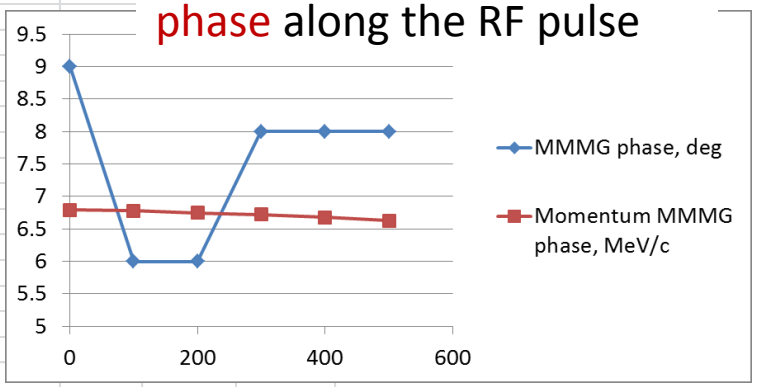
Thermal emittance: Results

Thermal Emittance *BSA* RMS = 0.627mm, 17ps Flat-top!

Q [pC]	Imain [A]	EMSY NoP	EMSY Gain	MOI NoP	MOI Gain	Xrms [mm]	Yrms [mm]	X Beamlet Gain	Ex sheared [mmmrad]	Ex 2D nsc [mmmrad]	Ex 2D sc [mmmrad]	Y Beamlet Gain	Ey sheared [mmmrad]	Ey 2D nsc [mmmrad]	Ey 2D sc [mmmrad]	XYrms [mm]	Exy sheared [mmmrad]	Exy 2D nsc [mmmrad]	Exy 2D sc [mmmrad]
5.17	336	0	22	336	336	0.437	0.570	22	0.872	0.724	0.885	22	0.912	0.659	0.931	0.499	0.892	0.691	0.907
10.03	340	30	22	340	340	0.457	0.533	22	0.762	0.778	0.773	22	0.968	0.797	0.985	0.494	0.859	0.787	0.872
19.87	340	24	22	340	340	0.531	0.616	22	0.859	0.907	0.872	22	1.046	0.980	1.058	0.572	0.948	0.943	0.961
42	348	15	22	348	348	0.626	0.755	22	0.951	1.002	0.964	22	1.085	1.090	1.101	0.687	1.016	1.045	1.031
78.23	356	15	22	356	356	0.877	1.052	22	1.093	1.167	1.114	22	1.316	1.362	1.347	0.961	1.199	1.261	1.225

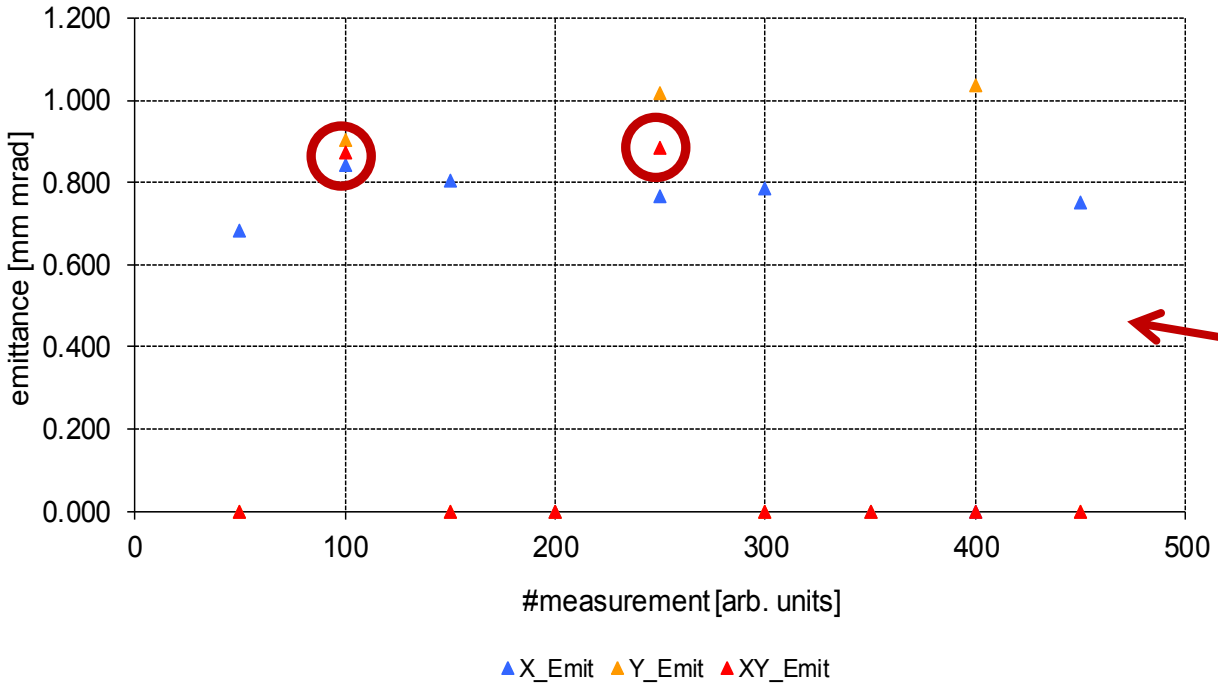


Momentum and MMMG phase along the RF pulse



Thermal emittance: results – for "Q2" = 10pC

Beamlet NoP	Gain	beam size @ EMSY			X-emittance			Y-emittance			XYemit, scaled
	(default 22)	X	Y	XY	sheared	nonscaled	scaled	sheared	nonscaled	scaled	
50	22	0.457	0.533	0.494	0.671	0.496	0.682	TBA	TBA	TBA	#VALUE!
100	22			0.000	0.832	0.712	0.844	0.889	0.627	0.902	0.873
150	22			0.000	0.793	0.781	0.806	TBA	TBA	TBA	#VALUE!
200	22			0.000	TBA	TBA	TBA	TBA	TBA	TBA	#VALUE!
250	22			0.000	0.759	0.862	0.768	0.997	0.859	1.016	0.883
300	22			0.000	0.775	0.895	0.784	TBA	TBA	TBA	#VALUE!
350	22			0.000	TBA	TBA	TBA	TBA	TBA	TBA	#VALUE!
400	22			0.000	TBA	TBA	TBA	1.018	0.904	1.038	#VALUE!
450	22			0.000	0.741	0.922	0.751	TBA	TBA	TBA	#VALUE!
Mean		0.457	0.533	0.055	0.762	0.778	0.773	0.968	0.797	0.985	#VALUE!
Std		#####	#DIV/0!	0.165	0.054	0.158	0.055	0.069	0.149	0.073	#VALUE!



$$E_{kin} \cong \frac{3m_0c^2}{2}\left(\frac{\varepsilon_{Exp}}{\sigma_{RMS}}\right)^2$$

$$m_0c^2 = 0.511\,\mathrm{MeV}$$

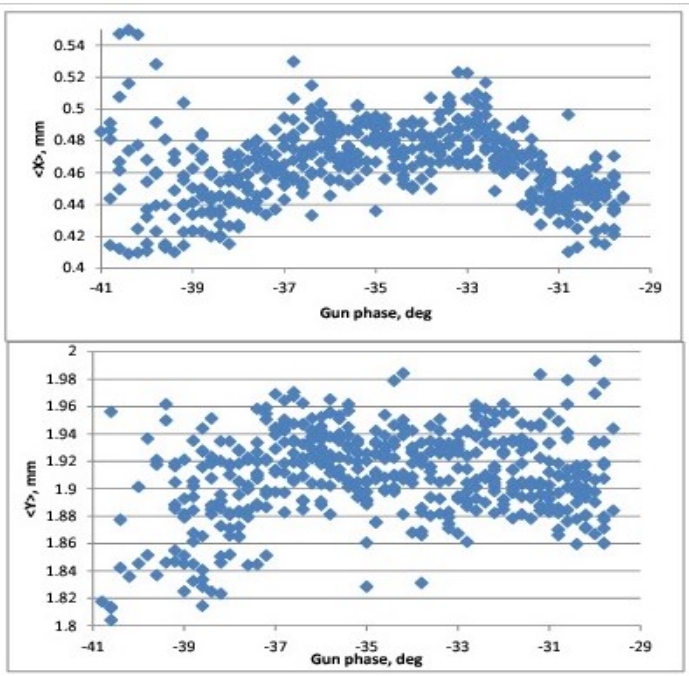
*For ε = 0.878*mmmrad:*

E_{kin} = 1.36eV

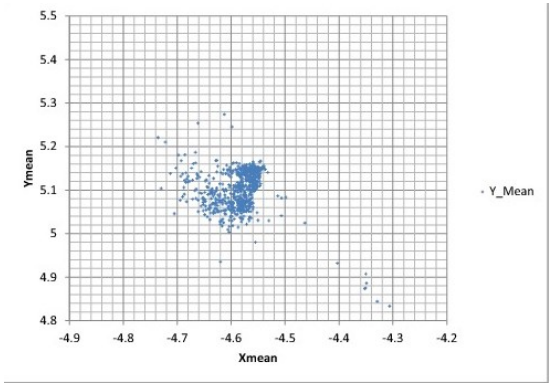
* Average of the two points

Other measurements/ tuning: BBA is done several times:

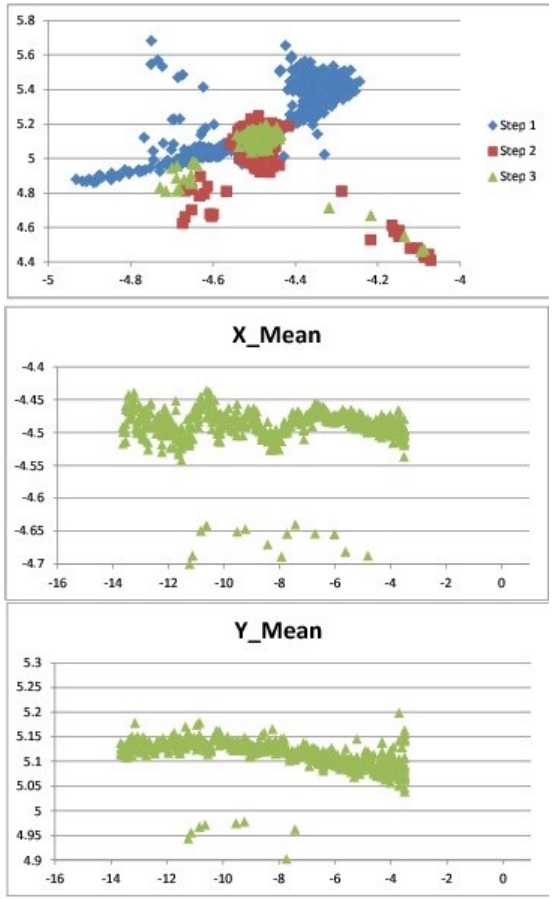
1) < 100 um position drift



2) < 200 um position drift



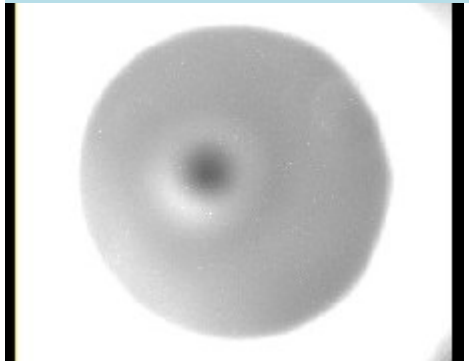
3) < 200 um position drift

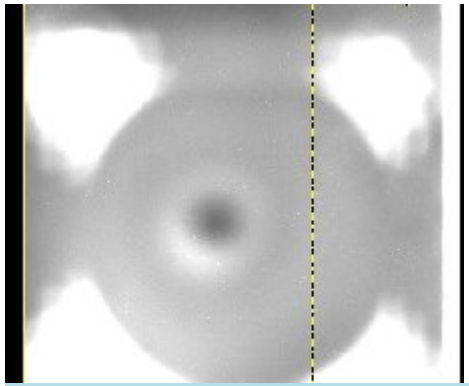


Kapton foil tests repeated: no kapton found in your foil…

Camera view at High1.Scr5:

Empty tube – opposite flange can be seen

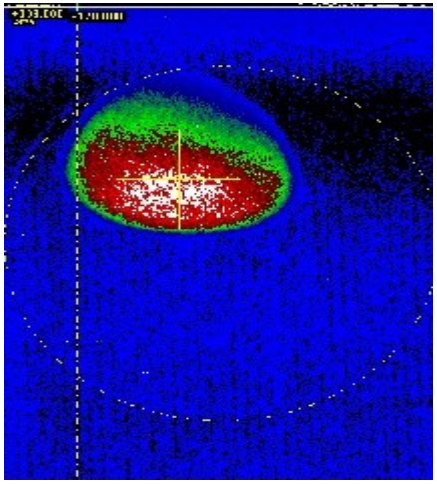


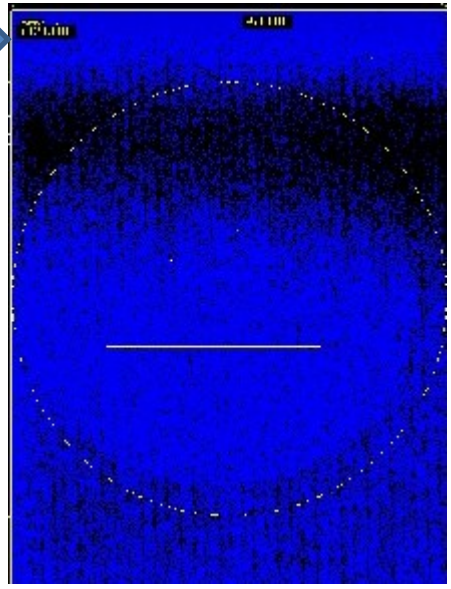


Kapton foil – opposite flange still can be seen

e-beam (w/o booster)

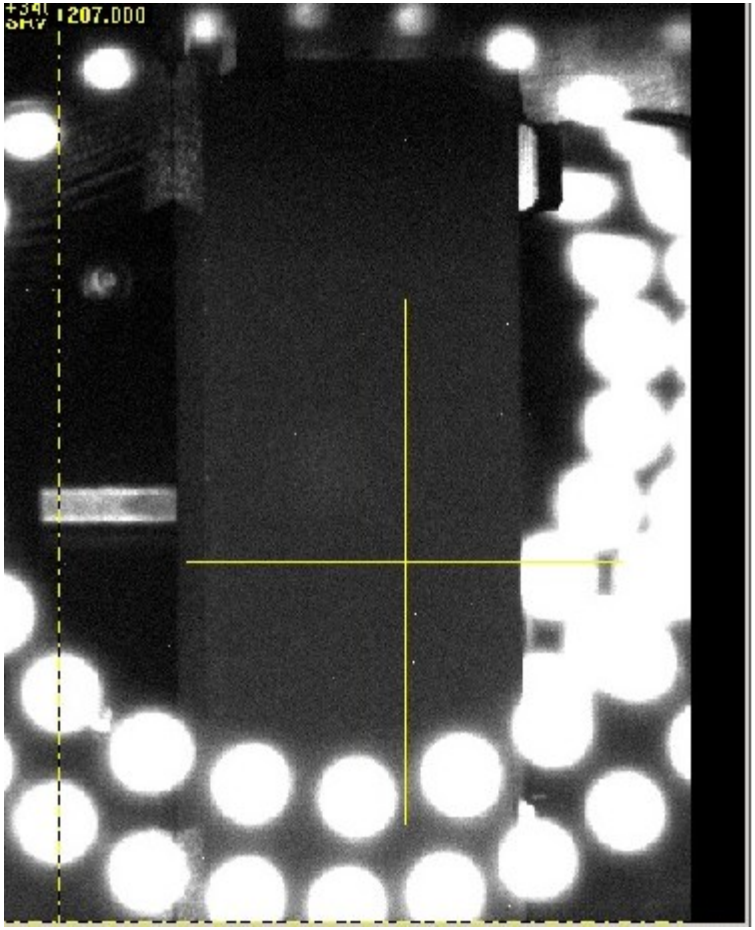
at PST.Scr1YAG



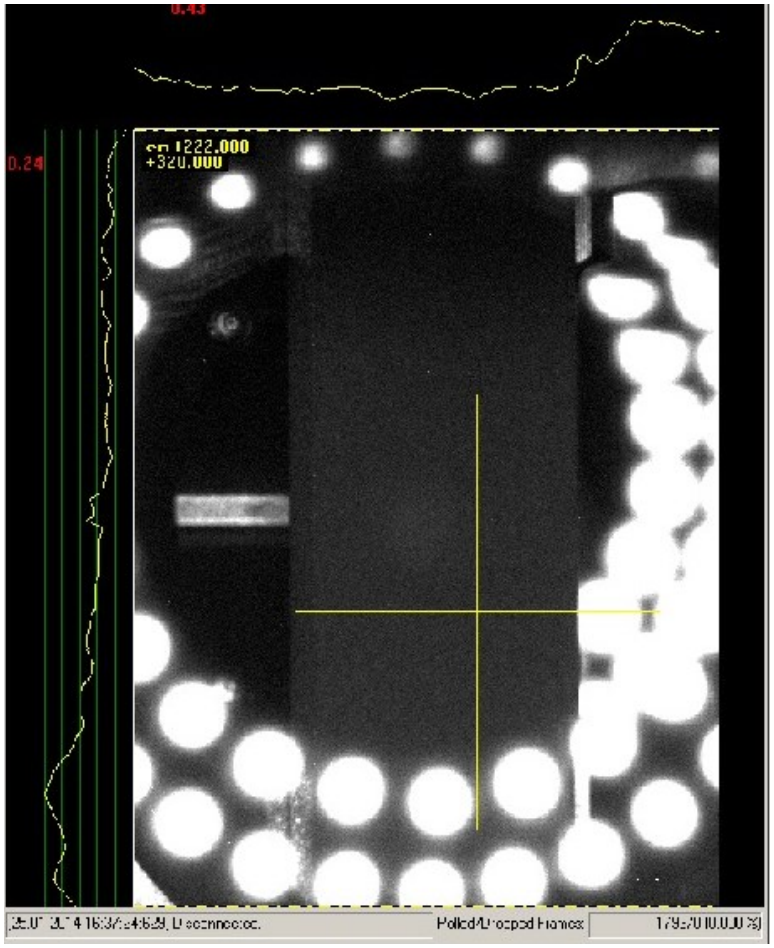


e-beam strongly scattered

Screen position seems to be moved after server restart several days ago. We have repeat home search several times - always land at the same place. Previously used position was probably not entirely correct, measured data has to be corrected with relative (presumably small) error.

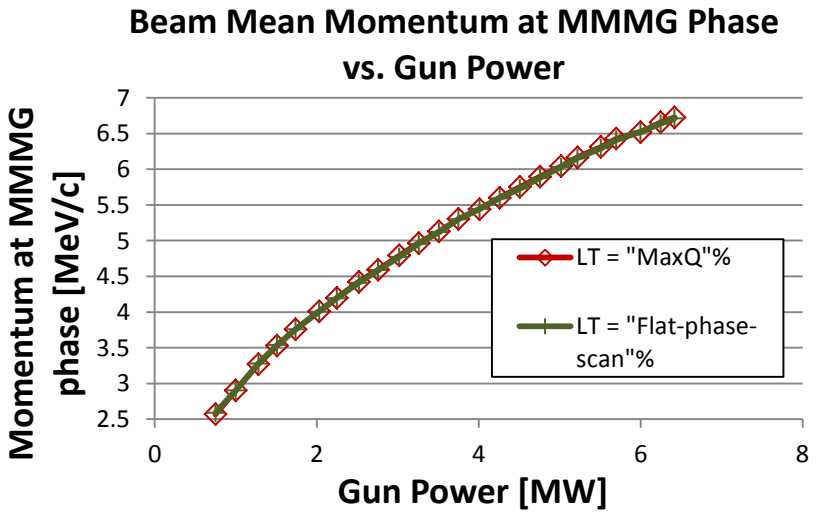


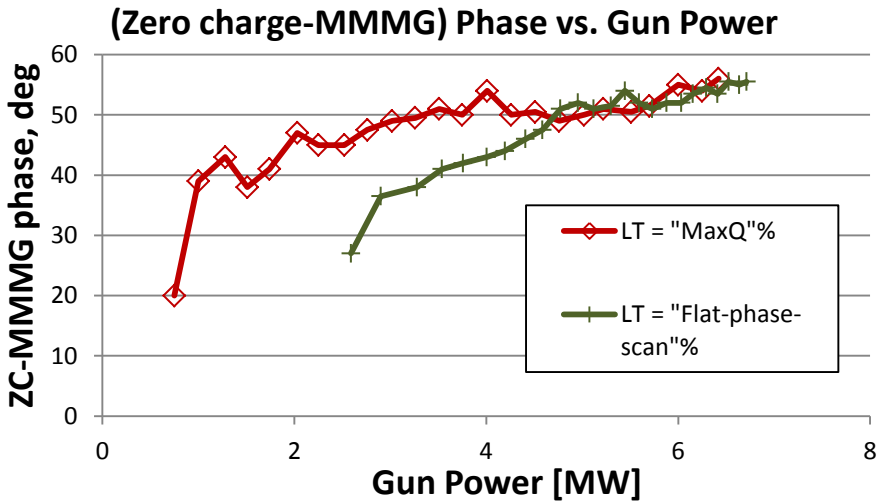
New (restored old) screen position



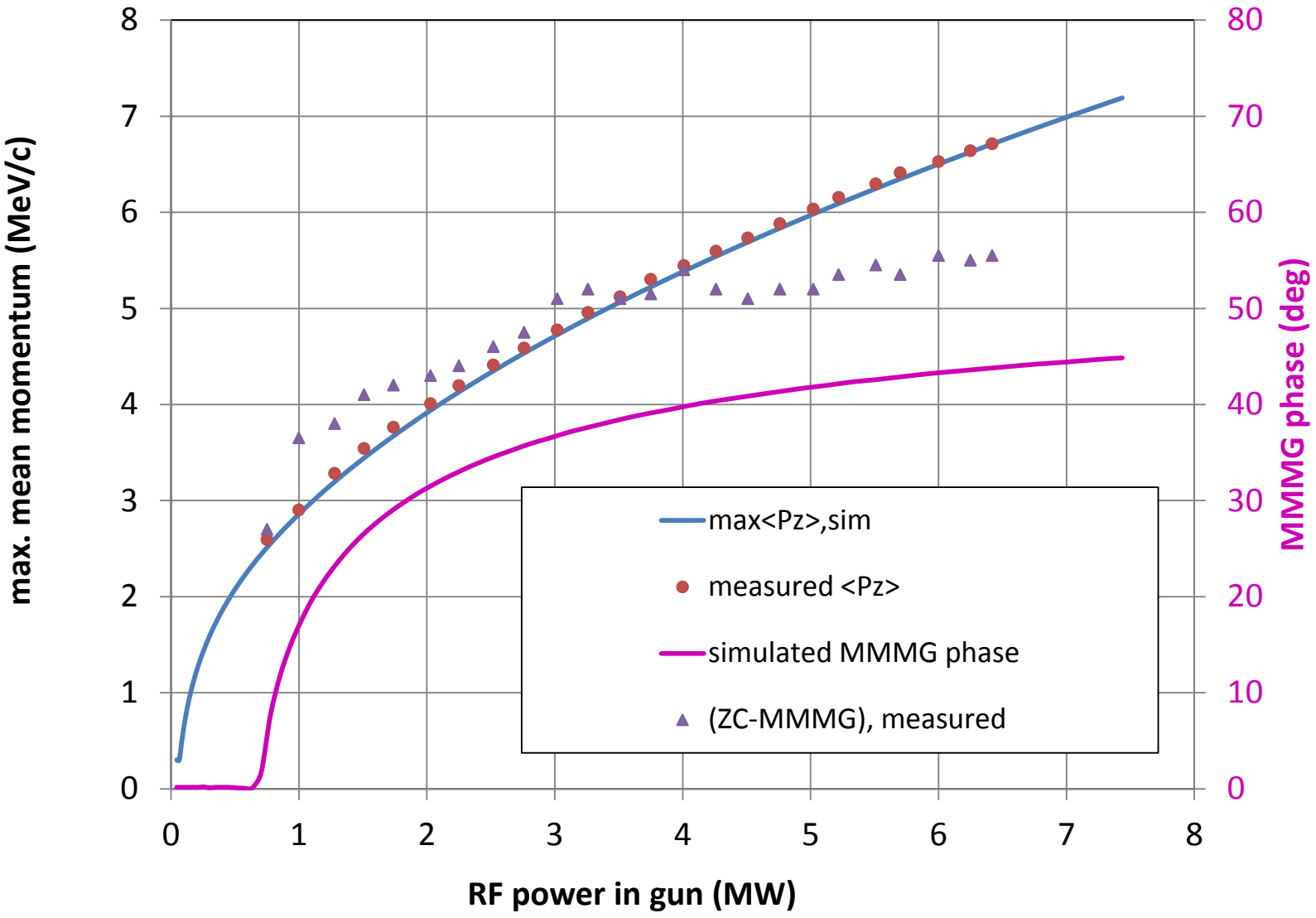
Momentum measurement summary

RF		Dipole	LT = "MaxQ"%							LT = "Flat-phase-scan"%								
Goal RF power, [MW]	RF power, [MW]	Idip, [A]	LT, [%]	Imain, [A]	# of pulses	MMMG phase, [deg]	Zero crossing phase, [deg]	(ZC-MMMG), [deg]	Beam momentum at MMMG, [MeV/c]	LT, [%]	Imain, [A]	# of pulses	MMMG phase, [deg]	Zero crossing phase, [deg]	(ZC-MMMG), [deg]	Beam momentum at MMMG, [MeV/c]		
0.75	0.75	-0.6507	100	170	18	54	74	20	2.57	17	170	29	47	74	27	2.59	20.01.14N	
1	1	-0.73086	90	204	25	42	81	39	2.9	12	204	111	39	75.5	36.5	2.9	21.01.14A	
1.25	1.28	-0.8207	90	235	24	36	79	43	3.27	5	235	50	34	72	38	3.28	21.01.14N	
1.5	1.51	-0.90061	90	250	10	31	69	38	3.53	5	250	50	26	67	41	3.54	21.01.14N	
1.75	1.74	-0.9507	90	268	8	24	65	41	3.76	5	268	50	22	64	42	3.76	21.01.14N	
2	2.03	-1.0207	90	284	9	20	67	47	4.01	5	270	45	23	66	43	4.006	22.01.14M	
2.25	2.25	-1.0776	90	296	9	22	67	45	4.199	5	291	45	21	65	44	4.195	22.01.14M	
2.5	2.52	-1.1396	90	311	9	20	65	45	4.423	5	311	90	18	64	46	4.4094	22.01.14M	
2.75	2.76	-1.1607	90	327	7	18.5	66	47.5	4.592	5	311	30	17.5	65	47.5	4.587	22.01.14A	
3	3.02	-1.2406	90	336	7	13	62	49	4.793	4	336	100	13	64	51	4.773	22.01.14A	
3.25	3.26	-1.2706	90	351	7	11.5	61	49.5	4.964	4	351	150	9	61	52	4.956	22.01.14A	! Disp1.Scr1 Fshutter was at 100 !
3.5	3.51	-1.3106	90	365	7	11	62	51	5.129	4	365	150	10.5	61.5	51	5.12	22.01.14A	
3.75	3.75	-1.3706	50	376	11	10	60	50	5.303	4	376	150	8.5	60	51.5	5.3	22.01.14A	
4	4.01	-1.3907	50	383	6	13	67	54	5.44	4	383	150	7	61	54	5.445	22.01.14N	
4.25	4.26	-1.4307	50	393	6	9	59	50	5.601	4	393	150	7	59	52	5.592	22.01.14N	
4.5	4.51	-1.4709	50	410	6	8.5	59	50.5	5.751	4	410	150	7	58	51	5.73	22.01.14N	
4.75	4.76	-1.5205	50	413	6	9	58	49	5.898	4	413	150	7	59	52	5.879	22.01.14N	
5	5.02	-1.5707	50	424	7	8	58	50	6.043	4	416	100	6	58	52	6.0325	23.01.14M	
5.25	5.22	-1.6004	50	431	6	7	58	51	6.167	4	428	100	4.5	58	53.5	6.1535	23.01.14M	
5.5	5.51	-1.6506	50	441	5	7.5	58	50.5	6.313	4	438	100	3.5	58	54.5	6.2946	23.01.14M	
5.75	5.7	-1.7007	50	447	5	4.5	56	51.5	6.4274	4	447	100	4.5	58	53.5	6.4111	23.01.14M	
6	6	-1.7208	50	459	7	4	59	55	6.52	4	459	150	1	56.5	55.5	6.526	23.01.14A	
6.25	6.249	-1.7508	50	466	6	1	55	54	6.657	4	466	150	-1	54	55	6.638	23.01.14A	
6.5	6.42	-1.7706	50	468	6	-1	55	56	6.726	4	468	150	-2.5	53	55.5	6.712	23.01.14A	

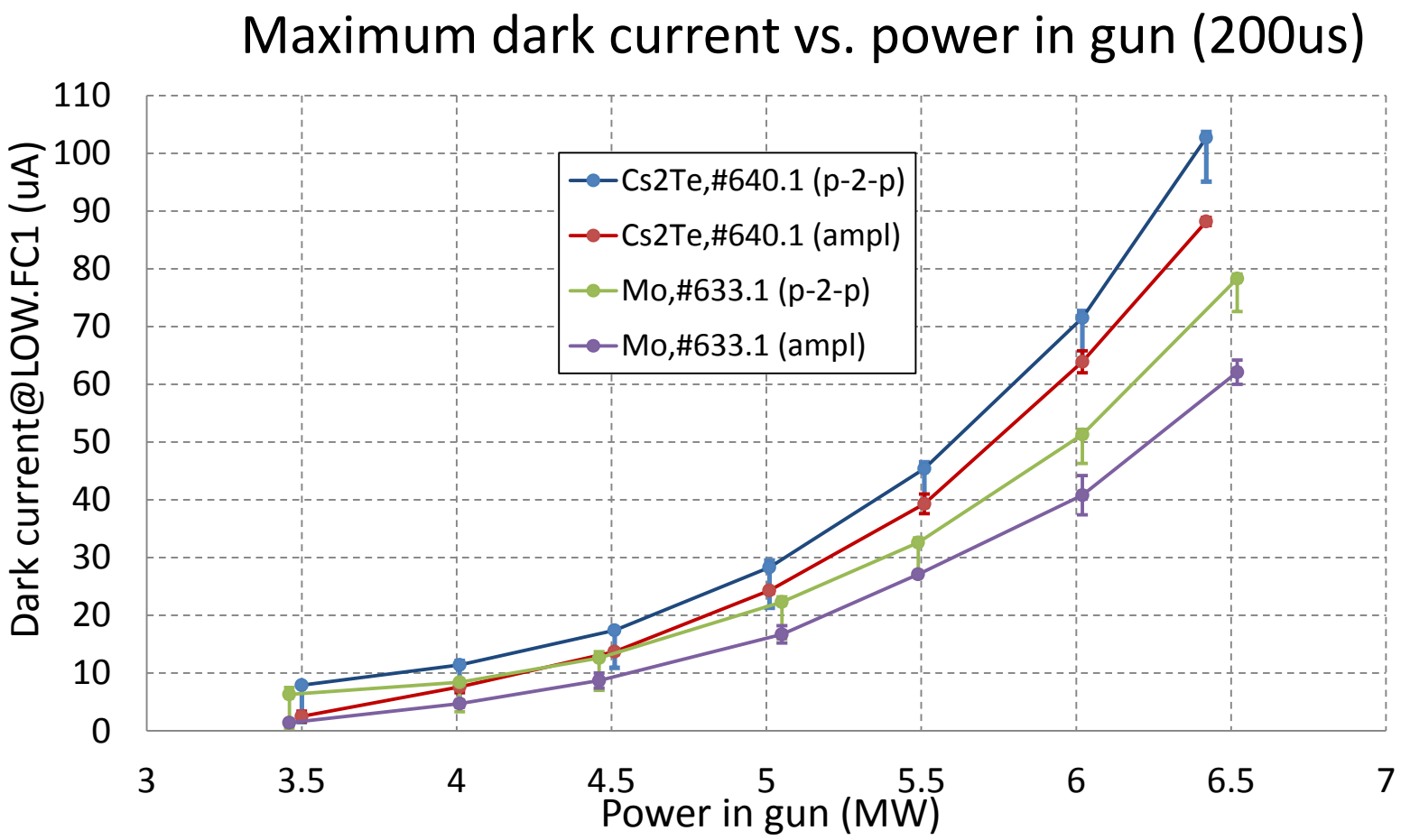




Momentum measurement vs. simulations



Dark current for different cathodes



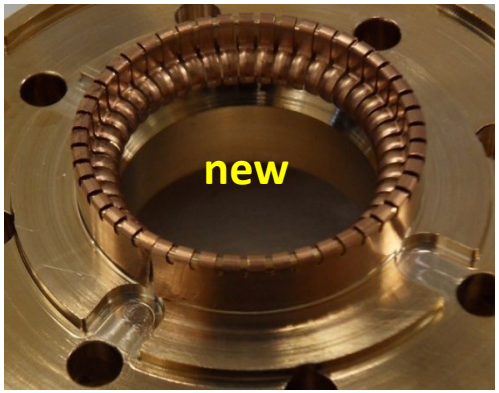
SPTemperature for 3.6MW and 400us
Set point gun tempearture (degC)
62
60
58
56
54
18.10.13
23.10.13
28.10.13
2.11.13
7.11.13
12.11.13
17.11.13
22.11.13
27.11.13
2.12.13
7.12.13
12.12.13
17.12.13
22.12.13
27.12.13
1.1.14
6.1.14
11.1.14
16.1.14
21.1.14
26.1.14
31.1.14
5.2.14

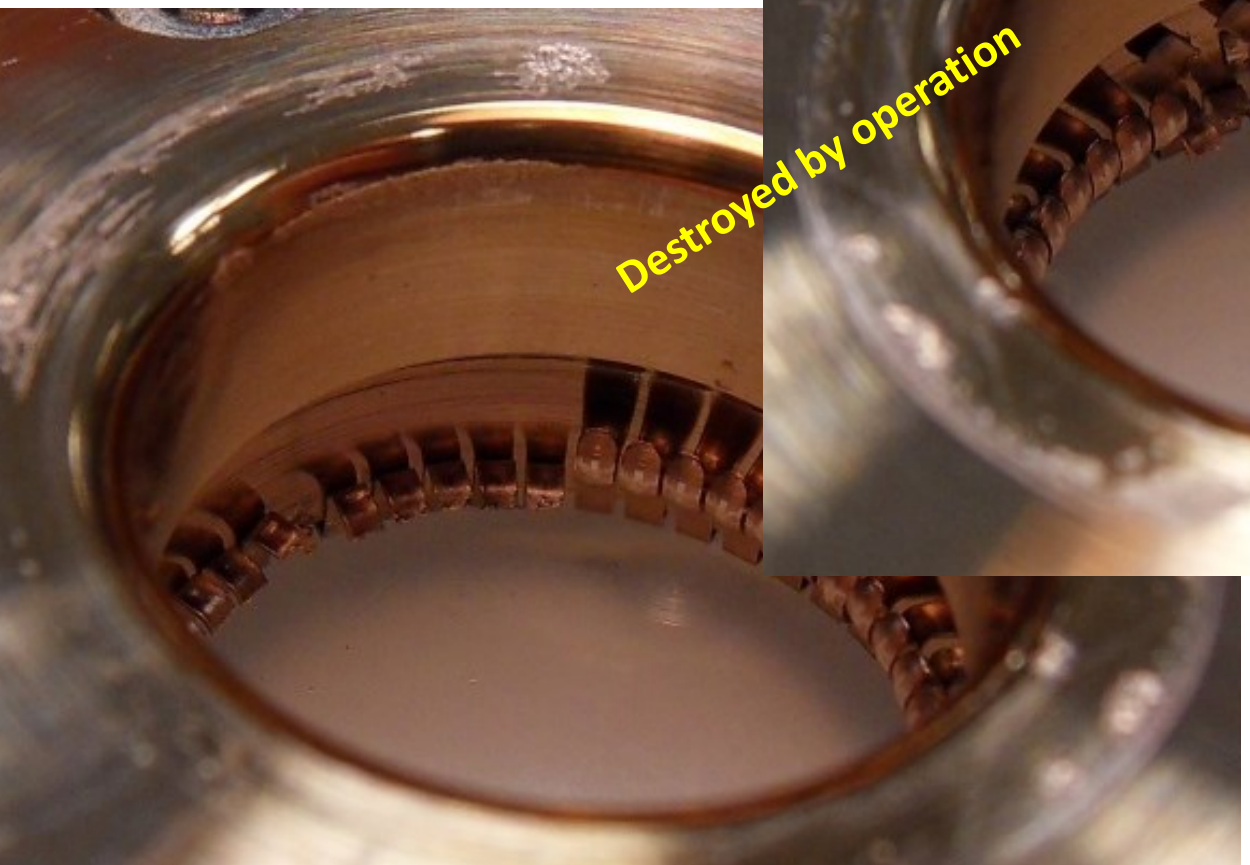
Dark current at LOW.FC1 (Pgun=6.5MW, 200us) @ 0A
dark current (uA)
100
50
0
p-2-p
18.10.13
23.10.13
28.10.13
2.11.13
7.11.13
12.11.13
17.11.13
22.11.13
27.11.13
2.12.13
7.12.13
12.12.13
17.12.13
22.12.13
27.12.13
1.1.14
6.1.14
11.1.14
16.1.14
21.1.14
26.1.14
31.1.14
5.2.14

Dark current at LOW.FC1 (Pgun=6.5MW, 200us) @ Maximum
dark current (uA)
150
100
50
0
p-2-p
amplitude
18.10.13
23.10.13
28.10.13
2.11.13
7.11.13
12.11.13
17.11.13
22.11.13
27.11.13
2.12.13
7.12.13
12.12.13
17.12.13
22.12.13
27.12.13
1.1.14
6.1.14
11.1.14
16.1.14
21.1.14
26.1.14
31.1.14
5.2.14

Major problem → boundary conditions (BCs) for further run

Destroyed RF contact spring at gun-4.3





BCs (status 30.01): in 3-4 weeks:

- **Gun → opened**
- **A new (modified) spring expected**

Another boundary conditions for further run

- LLRF (re-) calibration may be needed (up to 2 days?) → monitor dark current and beam momentum
- Laser pulse energy (temporal profile) → to be improved
- Now Mo cathode is inserted
- Booster WCS is still not working!
- …

Week 6: 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

Conditioning check:
- 9.7kV (+MK) → max peak power (10, 50, 100, 200, 400us)
- 9.3 (9.4)kV 650us:
  - 6.5MW, if 2-3 IIs then
  - 6.4MW …

2. Measurement program
   - 1.2 Kapton foil tests with e-beam → to be repeated
   - 1.2 Booster steering
   - 1.4 BPM commissioning → (quasi-) parasitic mode
   - 1.6 Emittance 1nC or 100pC + Tomo ➔ GeK+GV
   - 2.5 Phase stability measurements (+new WCS tests) ➔ IgI+MK
   - 2.8 Coupler kick studies ➔ (MK +IgI)
   - 2.85 low charge measurements + bunch length measurements ➔ BM+DM+MR+TV
   - 3 XFEL Toroid → (quasi-) parasitic mode

Week 6	Mon Feb-03	Tue Feb-04	Wed Feb-05	Thu Feb-06	Fri Feb-07	Sat Feb-08	Sun Feb-09
Morn.		Cs2Te					
07:00	V…ko	Vashchenko	Vashchenko	Va…henko	Vashchenko	Vashchenko	Vashchenko
to			Heller		Kalantaryan	Kalantarya…	…lantaryan
15:30							
Late							
15:00	I…ás		Kourka…	…Kourkafas	Kourkafas	…las	Kourkafas
to	….		Pra…	Prach B.	Heller	…eller	Heller
23:30							
Night							
23:00		Gross	Gross		Gross	Gross	Gross
to		Pathak	Pathak		Pathak	Pathak	Pathak
07:30							

Conditioning check

Condit. and RF power check

Emittance + Tomo

Kapton 100pC

Emittance + Tomo

Week 7	Mon Feb-10	Tue Feb-11	Wed Feb-12	Thu Feb-13	Fri Feb-14	Sat Feb-15	Sun Feb-16
Morn.							
07:00	Isaev	Isaev	Isaev	Isaev	Kourkafas	Kourkafas	Kourkafas
to	Rublack	Rublack	Rublack	Rublack	Rublack	Rublack	Rublack
15:30							
Late							
15:00	Khojoyan	Khojoyan	Khojoyan	Khojoyan	Krasilnikov	Krasilnikov	Krasilnikov
to	Prach B.	Prach B.	Prach B.	Prach B.	Prach B.	Prach B.	Prach B.
23:30							
Night							
23:00	Otevrel	Otevrel	Otevrel	Otevrel	Otevrel	Otevrel	Otevrel
to							
07:30							

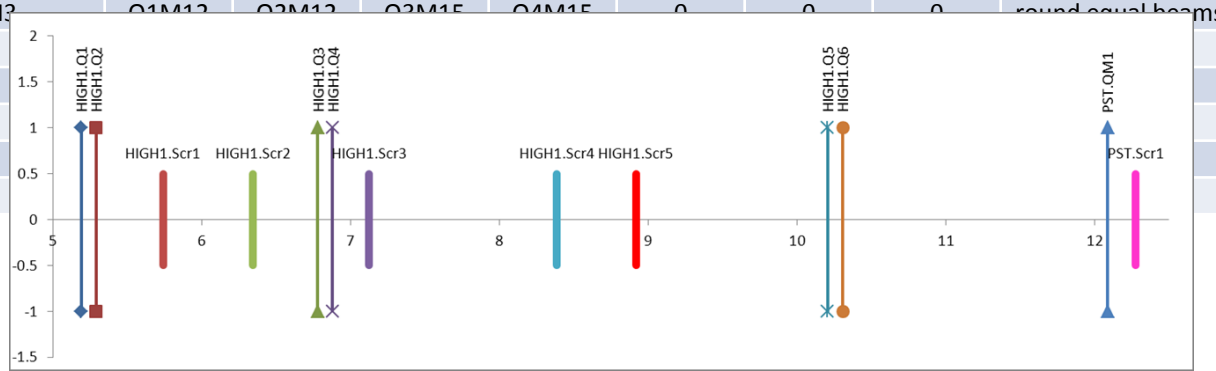
Weeks 4: Kapton foil tests (proposals)

Setup

- Gun 200 (650) us, 6.5 (6) MW, MMMG phase
- Laser temporal – available profile (17ps FWHM?)
- Transverse: smallest BSA for Q=100pC at LT=80%
- Booster 3MW (final Pz=22MeV/c)
- Transport – centered at screens up to Tomo.Scr1
- Solenoid and Quads → to be tuned – see the measurement table for focusing

- For images at PST.S1 with kapton inserted use 2 pulses and 30 pulses (2 files)
- Additional measurement with kapton – try to focus the scattered beam with H1.Q5, H1.Q6, PST.QM1
- 10 frames+bkg for an image
- Keep the same gain for the same camera within the same measurement

meas#	Imain	H1.Q1	H1.Q2	H1.Q3	H1.Q4	H1.Q5	H1.Q6	PST.QM1	conditions
M1	I1	0	0	0	0	0	0	0	focus at H1.S5
M2	I2	0	0	0	0	0	0	0	focus at PST.S1
M3	I3=0.5*(I1+I2)	0	0	0	0	0	0	0	focus between
M4	I1	Q1M4	Q2M4	0	0	0	0	0	focussed round beam at H1.S5
M5	I1	Q1M5	Q2M5	0	0	0	0	0	focussed round beam at PST.S1
M6	I1	Q1M6	Q2M6	0	0	0	0	0	round equal beams at H1.S5 and PST.S1
M7	I2	Q1M7	Q2M7	0	0	0	0	0	focussed round beam at H1.S5
M8	I2	Q1M8	Q2M8	0	0	0	0	0	focussed round beam at PST.S1
M9	I2	Q1M9	Q2M9	0	0	0	0	0	round equal beams at H1.S5 and PST.S1
M10	I3	Q1M10	Q2M10	0	0	0	0	0	focussed round beam at H1.S5
M11	I3	Q1M11	Q2M11	0	0	0	0	0	focussed round beam at PST.S1
M12	I3	Q1M12	Q2M12	0	0	0	0	0	round equal beams at H1.S5 and PST.S1
M13	I3	Q1M12	Q2M12	Q3M13	Q4M13	0	0	0	focussed round beam at H1.S5
M14	I3	Q1M12	Q2M12	Q3M14	Q4M14	0	0	0	focussed round beam at PST.S1
M15	I3	Q1M12	Q2M12	Q3M15	Q4M15	0	0	0	round equal beams at H1.S5 and PST.S1



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