ATF2 Goal 1 discussion : plans for the nominal and ultra-low β_y^* tuning study at ATF2 using octupoles

Fabien Plassard*, Jonas Breunlin, Rogelio Tomás García, Eduardo Marin, Vera Cilento
and the ATF2 collaboration

LCWS17, Strasbourg, France

October 24th 2017

OUTLINES

- November-December operation plan : 10x1 optics tuning using octupoles

- December last week of operation : Ultra-low β_y^* tuning week schedule and expected beam size

Nov 2nd week : 1 shift for Octupoles after 6 shifts of 10x1 optics tuning

Switch ON OCT2FF and OCT1FF to nominal current (-->check beam size):

Only octupoles tuning

→ Scan of the horizontal and vertical offset of OCT1 & 2
Y22, Y26 correction (vertical) and Y24, Y46 (horizontal displacement)

→ 3rd order knobs ---> strength variation in same and opposite direction (U3224 & U3246 knobs)

Octupoles + NL Sextupoles knobs tuning

→ Normal sextupole knobs: (Y24, Y46) x2
→ Octupole (2nd and 3rd order) correction
→ Skew sextupole knobs: (Y22, Y26,Y66,Y44)
→ Octupole (2nd and 3rd order) correction

(Consecutive scan with Octupoles ON & OFF)

Dec 1st week : 1.5 shift for Octupoles after 5 shifts of tuning
Dec 2nd week : 1.5 shift for Octupoles after 6 shifts of tuning

Switch ON OCT2FF and OCT1FF to nominal current (-->check beam size):

Minimize the NL aberrations by combining all the multipoles

→ Octupole (2nd and 3rd order) correction
→ Normal sextupole knobs: (Y24, Y46)
→ Octupole (2nd and 3rd order) correction
→ Skew sextupole knobs: (Y22, Y26,Y66,Y44)
→ Octupole (2nd and 3rd order) correction

Include the linear corrections

→ Linear Knobs Ay, Ey, Coup2
→ Normal & Skew sextupole knobs: (Y24, Y46) + (Y22, Y26,Y66,Y44)
→ Octupole (2nd and 3rd order) correction
→ Linear Knobs Ay, Ey, Coup2

(Consecutive scan with Octupoles ON & OFF)

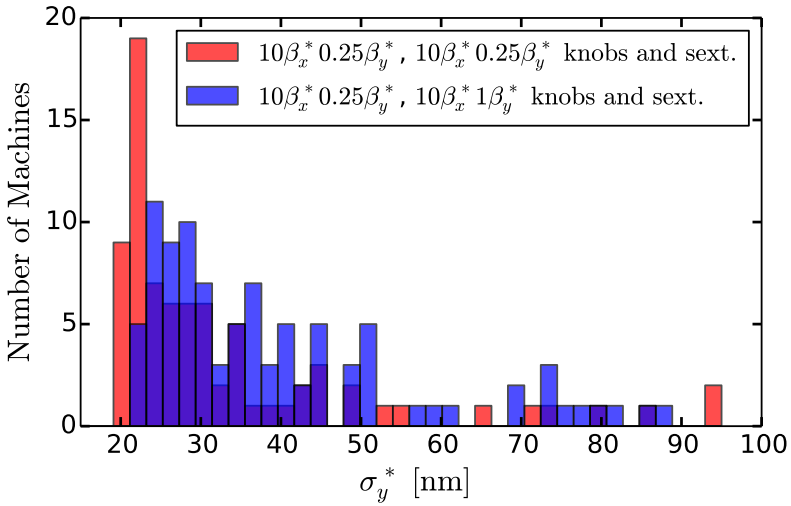
3rd week of December: Ultra-low betay* study

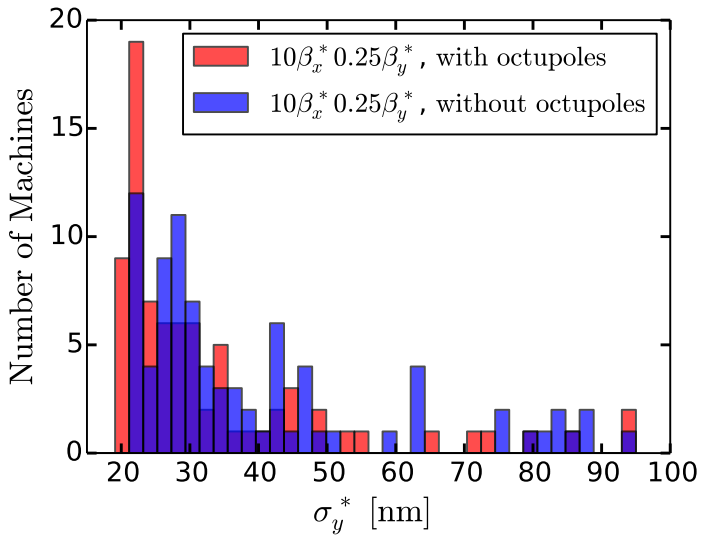
	1:00 – 9:00	9:00 – 17:00	17:00 – 25:00
Mon		Start-up / DR tuning	**Set the 10x0.25 optics:** **orbit correction, emittance(multi-OTR and possible use of ODR), dispersion, beta measurement**, IP-BSM at 6-degree mode Measurement of beta functions using random jitter analysis
Tue	**IP-BSM 30 degree mode:** -(10x1) linear knobs: Ay, Ey, Coup2, horizontal dispersion (QF3X,QF4X), vertical dispersion (QS1X, QS2X), coupling (QK1X->QK4X) -(10x1) Nonlinear knobs (test of all of the available knobs) **Repeat iterations of knobs up to 174 degree mode**. **-Normal&Skew sextupole strength rematch with the low-beta model** **-Implementation of the 10x0.25 sextupole knobs** **-(10x0.25)** Linear + Ref cavity +Nonlinear knobs - Intensity dependence scan		
Wed	**Switch ON the octupoles:** -Nominal current (one by one) -3rd order knobs, strength optim. of OCT1FF & OCT2FF -2nd order correction using octupoles (4 knobs) -3rd order knobs again -2nd order correction using octupoles again --- **-2nd order aberrations minimization using sextupoles nonlinear knobs + Linear knobs +octupoles knobs iteratively. => minimum beam size at 174 deg** - Intensity dependence scan If large beam (no mod in 174 degree mode) => **emittance, dispersion and beta-function correction or increase beta_x* (25x0.25 optics)**		

- Simulations of 12 shifts of tuning shows the impact of using the designed sextupole knobs, and the octupoles, on the tuning performance :

Table – Errors applied to Quadrupoles and Sextupoles

σ_{offset}	100μm
σ_{roll}	200μrad
Strength error	0.1%





- $10\beta_x^* 0.25\beta_y^*$ tuning (10x1 optics knobs) : average beam size is **43.5 nm** $\pm$ **12 nm**; 37% of the machines reach $\sigma_y^* \leq 30$ nm
- $10\beta_x^* 0.25\beta_y^*$ tuning (optimized knobs) : average beam size is **35 nm** $\pm$ **11 nm**; 63% of the machines reach $\sigma_y^* \leq 30$ nm
- $10\beta_x^* 0.25\beta_y^*$ tuning without octupoles : average beam size is **44.2 nm** $\pm$ **13 nm**; 41% of the machines reach $\sigma_y^* \leq 30$ nm

3rd week of December: Ultra-low betay* study

	1:00 – 9:00	9:00 – 17:00	17:00 – 25:00
Mon		Start-up / DR tuning	**Set the 10x0.25 optics:** **orbit correction, emittance(multi-OTR and possible use of ODR), dispersion, beta measurement**, IP-BSM at 6-degree mode Measurement of beta functions using random jitter analysis
Tue	**IP-BSM 30 degree mode:** -(10x1) linear knobs: Ay, Ey, Coup2, horizontal dispersion (QF3X,QF4X), vertical dispersion (QS1X, QS2X), coupling (QK1X->QK4X) -(10x1) Nonlinear knobs (test of all of the available knobs) **Repeat iterations of knobs up to 174 degree mode**. **-Normal&Skew sextupole strength rematch with the low-beta model** **-Implementation of the 10x0.25 sextupole knobs** **-(10x0.25)** Linear + Ref cavity +Nonlinear knobs - Intensity dependence scan		
Wed	**Switch ON the octupoles:** -Nominal current (one by one) -3rd order knobs, strength optim. of OCT1FF & OCT2FF -2nd order correction using octupoles (4 knobs) -3rd order knobs again -2nd order correction using octupoles again --- **-2nd order aberrations minimization using sextupoles nonlinear knobs + Linear knobs +octupoles knobs iteratively. => minimum beam size at 174 deg** - Intensity dependence scan If large beam (no mod in 174 degree mode) => **emittance, dispersion and beta-function correction or increase beta_x* (25x0.25 optics)**		

3rd week of December: Ultra-low betay* study

	1:00 – 9:00	9:00 – 17:00	17:00 – 25:00
Mon			
Tue			
Wed			
Thu	- Continue the tuning with all knobs in hands (low-beta* sextupole knobs) - 2nd and 3rd order octupole knobs iteratively -Check the impact on beam size with Octupoles ON&OFF -Check the intensity dependence - Wakefield study at ultra-low (Pierre Korysko) - Rematch the optics for larger beta_x* **(25x0.25)** => **redo the full tuning procedure** (should ease the tuning)		
Fri			

Instrumention needed: **Beam Size Monitor** (Shintake monitor will be use during the full week), beta_y* and emittance measurements using **carbon wire** and **multi-OTR and/or ODR**, orbit correction using **FF BPMs**

Operators from CERN: **Jonas Breunlin, Eduardo Marin and Fabien Plassard with the help of Vera Cilento and Pierre Korysko**