BBA Plans at ATF2

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Outline

- Recap of Beam-based Alignment
- Recap of previous results
- Motivation
- Plans
- Conclusions

Recap of Beam-based Alignment: DFS and WFS

BBA: use the beam as a *probe* to improve the beam performance itself

- DFS: measure and correct the system response to a change in energy
  (changing the beam energy)
- WFS: measure and correct the system response to a **change in the bunch charge**
  (changing the beam intensity)

Recap of the equations

$$\begin{pmatrix} & & y - y_0 \\ \omega_{\mathrm{DFS}} & \cdot & (\eta - \eta_0) \\ \omega_{\mathrm{WFS}} & \cdot & y_{\mathrm{w}} \\ & & 0 \end{pmatrix} = \begin{pmatrix} & & \mathbf{R} \\ \omega_{\mathrm{DFS}} & \cdot & \mathbf{D} \\ \omega_{\mathrm{WFS}} & \cdot & \mathbf{W} \\ \beta & \cdot & \mathbf{I} \end{pmatrix} \begin{pmatrix} \theta_1 \\ \vdots \\ \theta_m \end{pmatrix}$$

$$\omega^2 = \frac{\sigma^2_{\text{bpm resolution}} + \sigma^2_{\text{bpm position}}}{2\sigma^2_{\text{bpm resolution}}}$$

Application of BBA consists of two steps

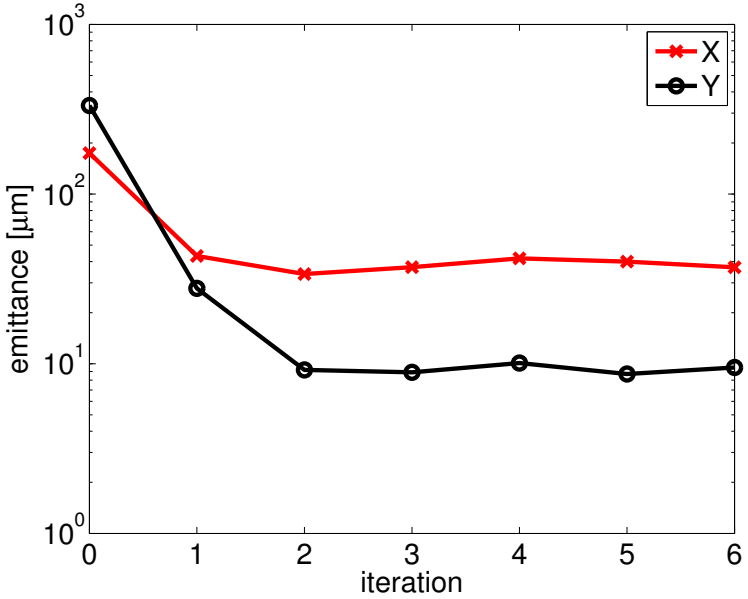
- Response matrix(-ces) measurement
- Correction and parameters scan

Automatic BBA tools

We propose and already tested (at SLAC, FERMI, and ATF2) an *automated beam-steering tool* to improve the performance of linacs by simultaneously correcting *orbit, dispersion (DFS),* and *wakefields* (WFS).

Our technique is:

- *Model independent*
- *Global*
- *Automatic*
- *Robust and rapid*



H and V emittance reduction thanks to DFS at SLAC

We base our algorithms operate in two phases: **automatic system identification**, and **BBA**.

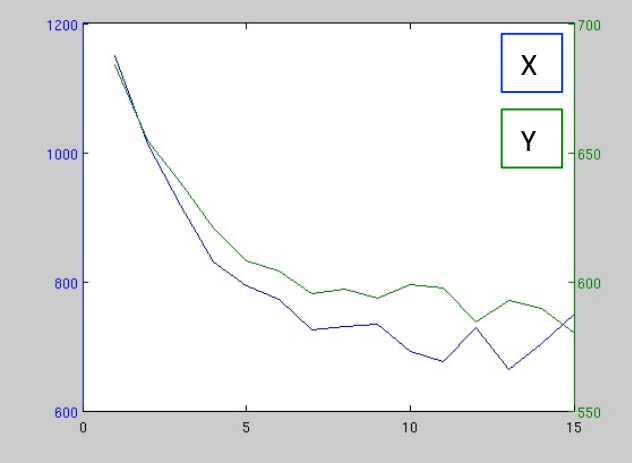
Previous tests at the ATF2 extraction line

First tests of BBA performed in Dec 2014:

- Rationale: install and test the tools, we focused on the extraction line only (no FFS)
- At that time it wasn't possible to measure the emittance, but we gained good control on the orbit

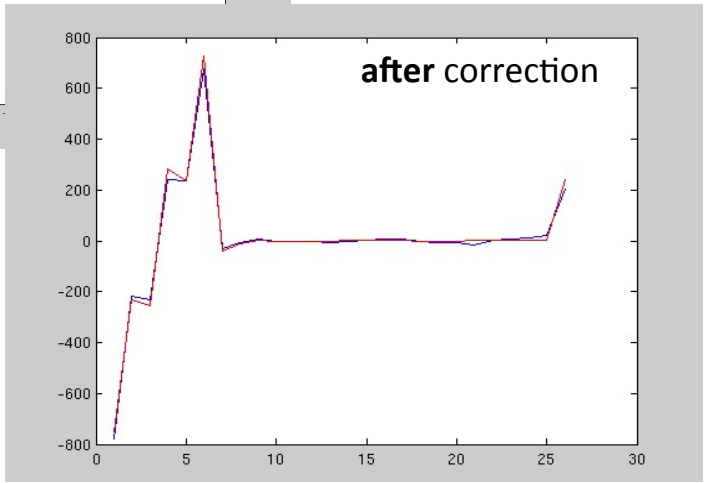
Dispersion-free Steering:

- Good convergence, managed to improve dispersion profile in both X and Y axes ☺



Average measured dispersion during correction (notice: it gets reduced)

Horiz. dispersion



Wakefield-free Steering:

- No significant wakefield effects measured in the Ext. Line
- Once we excited wakefields (off-setting the reference cavity) WFS managed to remove them ☺

Motivation for additional tests

- Include the final focus
- Try DFS and WFS in the FFS with the hope of reducing any intensity dependent effects
- Reduce intensity-dependent effects on the beam
- Improve the beam size / beam stability at the IP

Preparation and Shift Plan

- We need to devote a few weeks to detailed simulations using PLACET, including dynamic effects during BBA

- 4 or 5 shifts spread over two weeks
  - 1 to warm up: refresh our scripts, bring them up to date
  - 3 or 4 to perform measurements and tests:
    - Set up techniques to cope with jitter and slow drifts
    - Measure response matrices
    - Study variability of response matrices with the orbit
    - Study variability of response matrices in time
    - Finally: Test orbit / dispersion / wakefield correction
    - Study impact of BBA on orbit
    - Study impact of BBA on emittance

Conclusions

- We would like to complete our tests of BBA at ATF2
  - Potential for reducing intensity-dependence effects
  - Potential for beam stability improvements
  - Potential for reducing the beam size at the IP

- We need some weeks to work on detailed simulations (February)

- We would need 4 or 5 shifts over a couple of weeks to perform our tests (March or June)