Issues for optical tuning

Planned contributions at LAL

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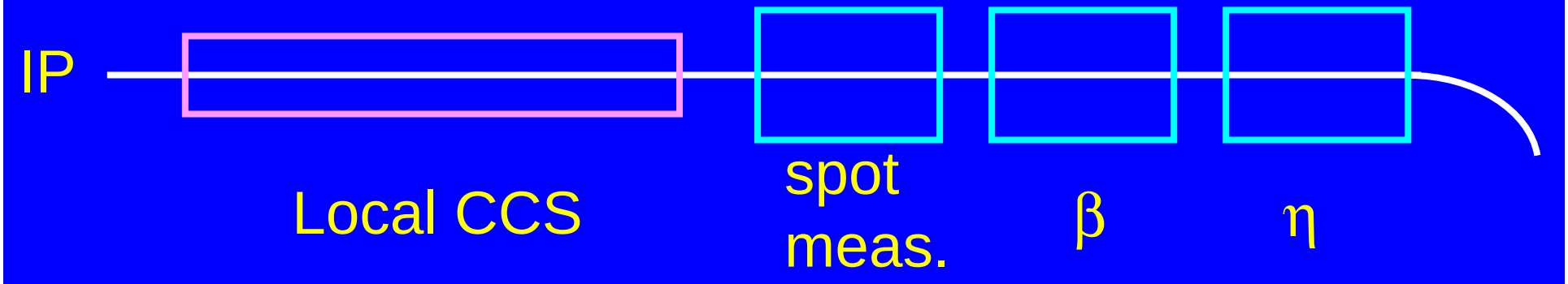
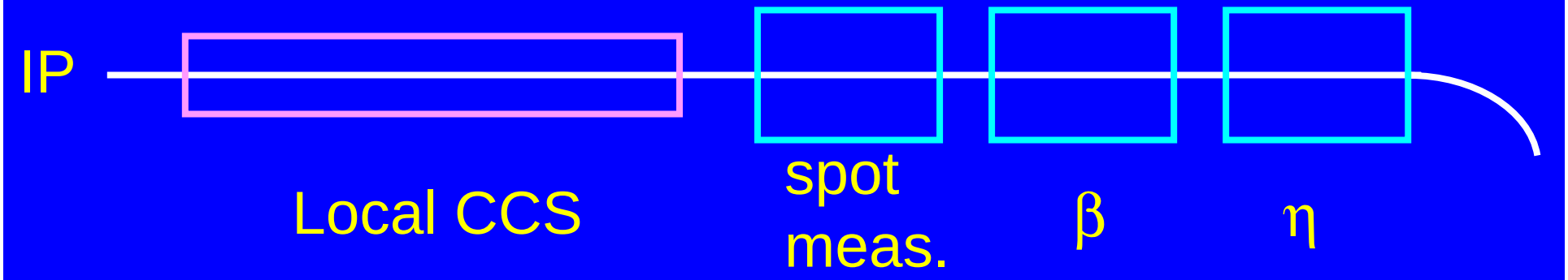
Sequential & orthogonal injection match



- initial alignement of elements around beam trajectory
- separate corrections for input trajectory mismatch from in-line perturbations (hypothesis testing)
- initial injection dispersion match $\eta_{x,y}, \eta'_{x,y}$: measure trajectory shift with energy + 4 spot sizes and fit 4 quads (upright and skew) in the initial dispersive region
- initial injection betatron match $\alpha_{x,y}\beta_{x,y}$: measure 4 spot sizes and fit 4 quads in dispersion free region

Betatron cross-plane coupling corrections



- 10 independent parameters $\alpha_{x,y}$ $\beta_{x,y}$
  <xy'> <x'y> <xy> <x'y'>
- round emittances → only 2 independent xy parameters
- flat emittances 0.001 – 0.01 → < 4 xy parameters ?

- 4 skew quad adjustments needed in β match section

Issues

- capabilities to absorb input mismatches by refitting optics upstream of CCS ?
  magnet ranges, laser IP sizes, 12 orthogonal controls
- capability to use variable magnifications (“zooming”) during commissioning, to start with larger β^* and a re-optimised local CCS
  range ? can it only be done in the initial β match ?
- tolerance on injected trajectory stability
- general $\rightarrow$ possibility to separately detect and correct
  1) variations from errors in injection phase-space
  2) variations within the FT + CCS

Parametrisation of input mismatch

$$\frac{d^2z}{ds^2} + k_z(s)z = 0$$

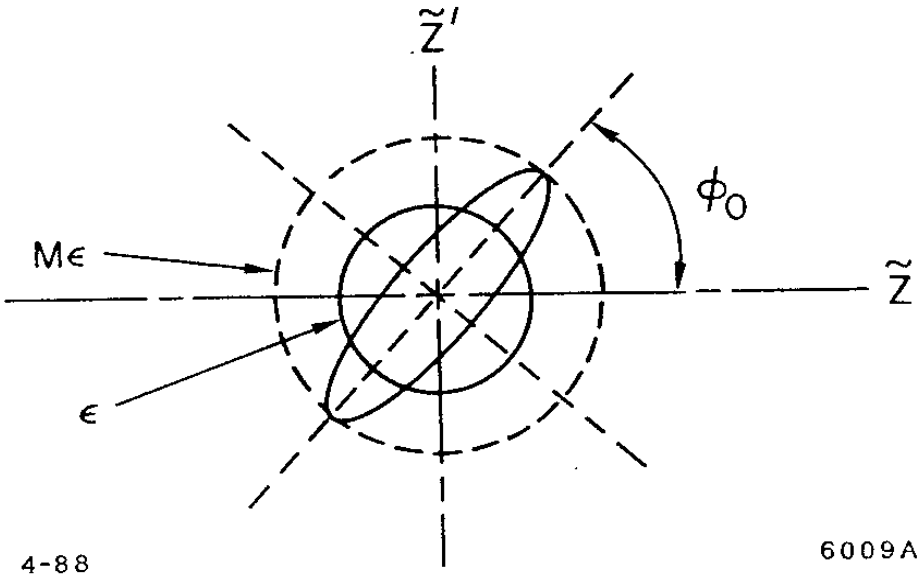
normalized variables $\tilde{z} = \frac{z}{\sqrt{\beta}}$ and $d\phi = \frac{ds}{\beta}$

→ pure harmonic oscillator: $\frac{d^2\tilde{z}}{d\phi^2} + \tilde{z} = 0.$

Beam matrix in normalised system :

$$\tilde{\sigma} = \epsilon \begin{pmatrix} M^2 sin^2\phi_0 + \frac{cos^2\phi_0}{M^2} & -cos\phi_0 sin\phi_0 (M^2 - \frac{1}{M^2}) \\ -cos\phi_0 sin\phi_0 (M^2 - \frac{1}{M^2}) & M^2 cos^2\phi_0 + \frac{sin^2\phi_0}{M^2} \end{pmatrix}.$$

$$\begin{cases} \sigma_{11} = \beta\tilde{\sigma}_{11}, \\ \sigma_{12} = \tilde{\sigma}_{12} - \alpha\tilde{\sigma}_{11}, \\ \sigma_{22} = \frac{1}{\beta}(\tilde{\sigma}_{22} + \alpha^2\tilde{\sigma}_{11} - 2\alpha\tilde{\sigma}_{12}). \end{cases}$$



Case of FODO array :

$$\sigma^2(\phi) \simeq \frac{\epsilon\beta}{2}((M^2 + \frac{1}{M^2}) + (M^2 - \frac{1}{M^2})cos2(\phi - \phi_0)).$$

$$\begin{cases} \epsilon \simeq \frac{\sigma_{Min}\sigma_{Max}}{\beta}, \\ M^2 \simeq \frac{\sigma_{Min}}{\sigma_{Max}}, \\ \phi_0. \end{cases}$$

Usefully adapted to input betatron mismatch ?

Possible studies & plans @ LAL

2007 - 2009 PhD (Maria Alabau-Pons)
ANR post-doc
staff (J.Brossard, P.Bambade)
EuroTeV post-doc (O. Dadoun $\rightarrow$ 2007)
(IN2P3 post-doc ?)

Topics : optics/trajectory tuning and correction strategy
commissioning
background calculations
(instrumentation)
impact for ILC MDI / BDS