Collision tunes at injection and ramp

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Thanks to Stephane Fartoukh, Massimo Giovannozzi, Wolfgang Hofle, Jorg Wenninger

May 2011
Motivation

- Shorter squeeze sequence
- Less complexity for feedbacks operation
- Absence of tune swing crossing resonances
- Synergy with future MD (Squeeze and ramp, S. Redaelli)
- Only obstacle is good coupling control
Tune scan at injection

![Graph showing tune scan at injection with points marked as B1 and B2.](image)
Tunes

Beam Lifetime [h]

Intensity [10^{10} p]

Collision tunes at injection and ramp

Everything OK!
Coupling measurement along the ramp

Correction along E ramp

Longitudinal position [m]

0.45 TeV  0.9 TeV  1.4 TeV  2 TeV

Knob setting

Time along energy ramp [s]

Used in experiment  Refined
Ramps with $10^{10}$ protons

Collision tunes OK for the ramp!
$10^{11}$ p
E Ramp

Tunes OK!

Oops!

Coupling OK!
$10^{11}$ p

E Ramp

Oops!

Coupling OK!

Instability?
Instability explained with $Q' \approx -1$
Conclusions

- Injection tunes equivalent to collision tunes
- Coupling corrected along the energy ramp with AC dipole and reproducible (left in for physics)
- Perfect pilot bunch energy ramp with collision tunes
- Losses during the nominal bunch energy ramp due to $Q' \approx -1$ (easy to avoid).
- Next step: Use matched optics (not MQTs); this naturally merges with combined ramp & squeeze (S. Redaelli)