PS2 Design status

Riccardo de Maria (BNL),
and... see the end.

April 8, 2009

PS2 in the injector chain

PS2 beams

Layout

Collimation

Chromatic aberrations

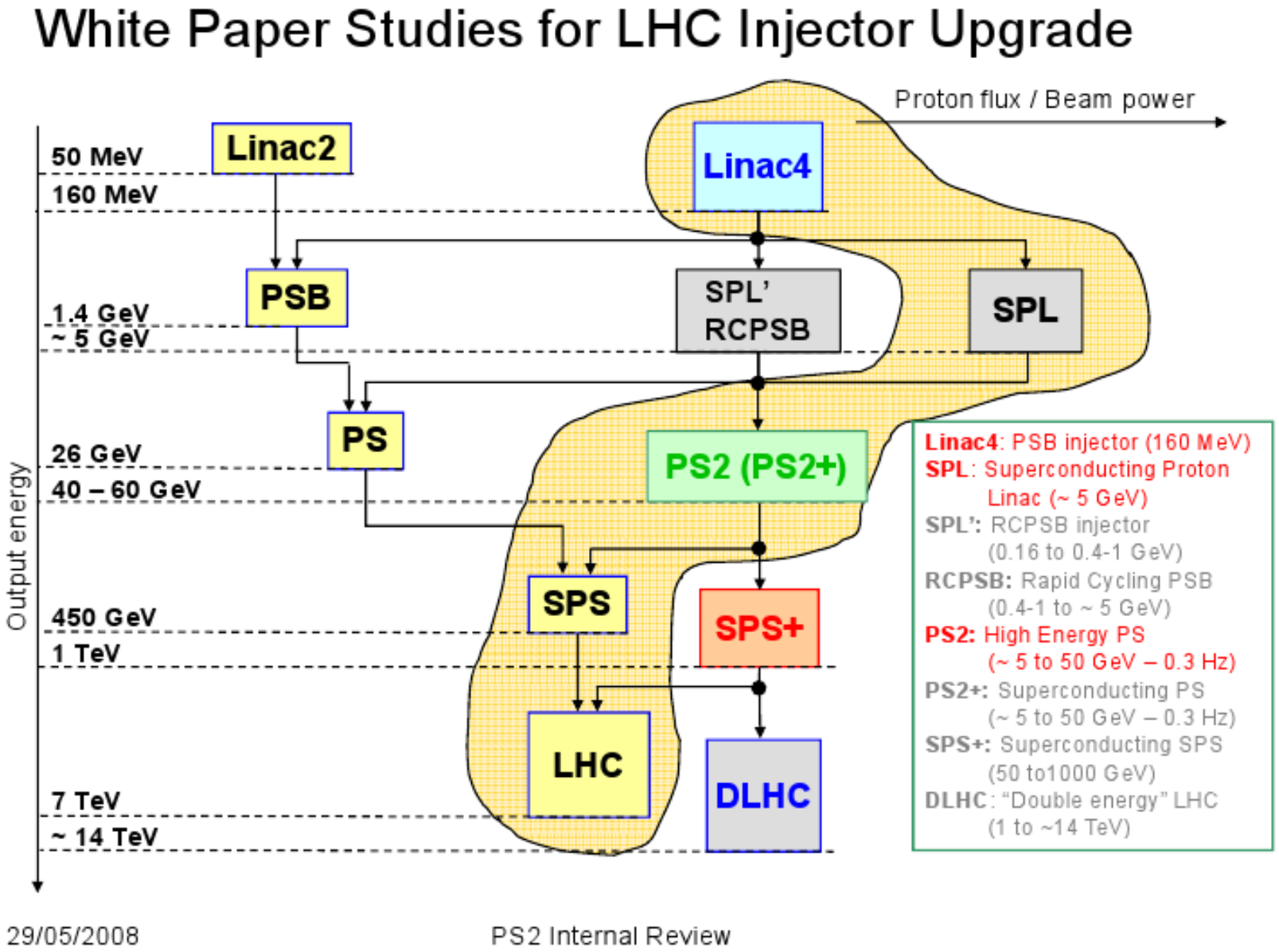
Resonances

Longitudinal aspect

RF system

Vacuum

PS2 in the injector chain



M. Benedikt

PS2 improvement for the LHC luminosity

The PS2 will contribute to an increase of the LHC luminosity because of:

- increase of beam current;
- reduce turn around time;
- improve the reliability of the injector complex;
- reduce the emittance growth and losses in SPS (reduce space charge, smaller beam size);
- allows a potential energy upgrade of the SPS and the LHC.

Conceptual Design Report is due by mid 2012.

PS2 beams

Protons for the LHC:

- $4.2 \cdot 10^{11}$ for 25ns bunches (40Mhz),
- 4GeV - 50GeV (3% RF frequency change),
- H- from LPSPL (commissioning from PS),
- RF: chopping at 40MHz,
- Transverse emittance: 3 mm mrad.

Ions for the LHC:

- extracted from LEIR at 6.7Tm,
- 210% RF frequency change.

Protons for fixed target experiments.

- $7 \cdot 10^{11}$ for 25ns bunches (40Mhz),
- SPS filling for CNGS using multi turn extraction (MTE),
- slow resonant and fast extraction and to target area,
- Transverse emittance:: 9 mm mrad, 6 mm mrad.

PS2 main parameters

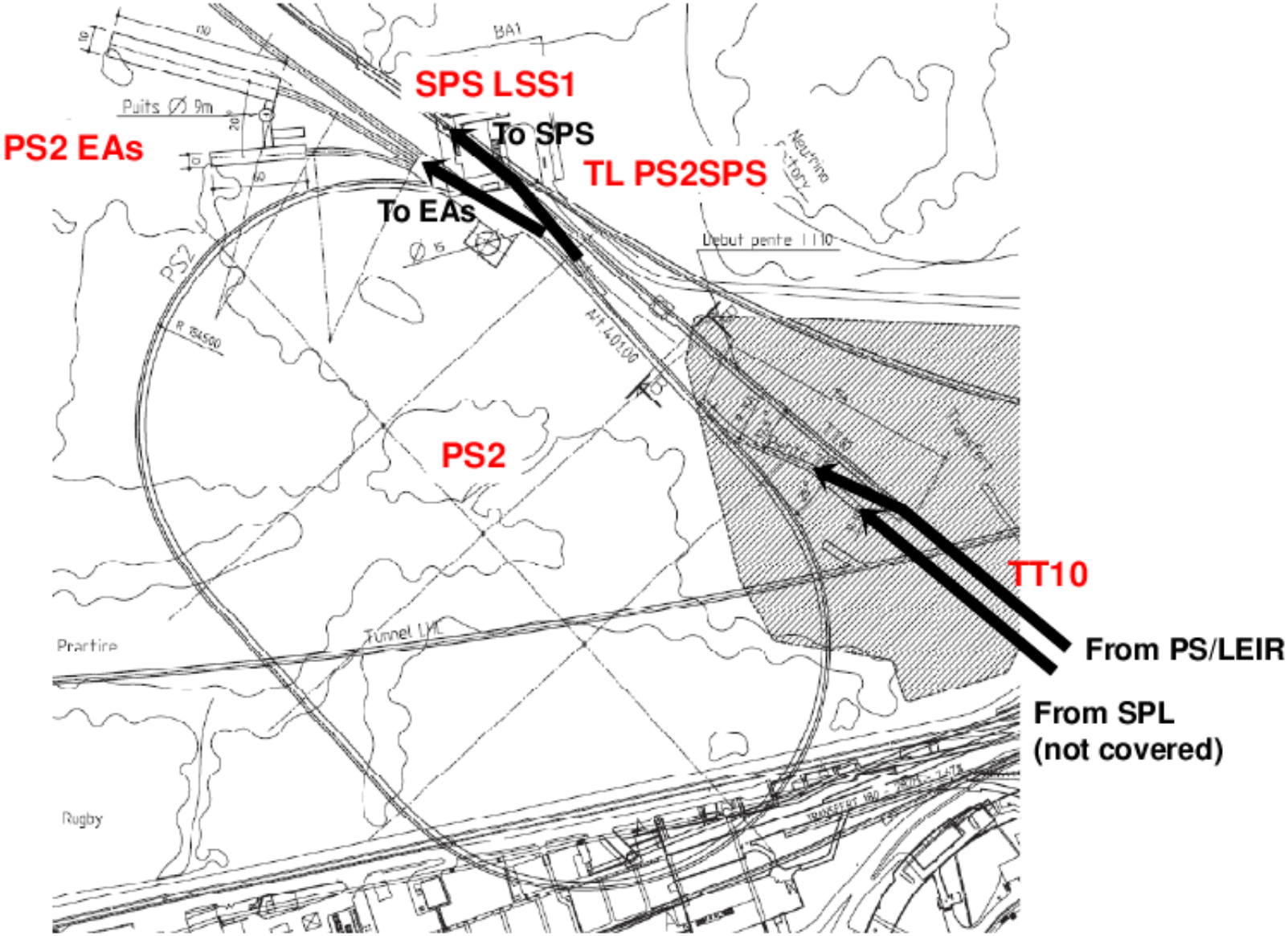
The PS2 main parameters are:

- length: PS2 = 15/77 SPS = 15/7 PS = 1346.4m,
- h (at 40Mhz) = 180,
- normal conducting magnets, separate functions,
- max bending field 1.8T,
- max gradient 18T/m,
- cycle time 2.4s. (1.2s ramp).

Layout

M. Benedikt

Layout



B.Goddard, A.Koschik CERN AB-BT-TL PS2 Review 29.05.2008

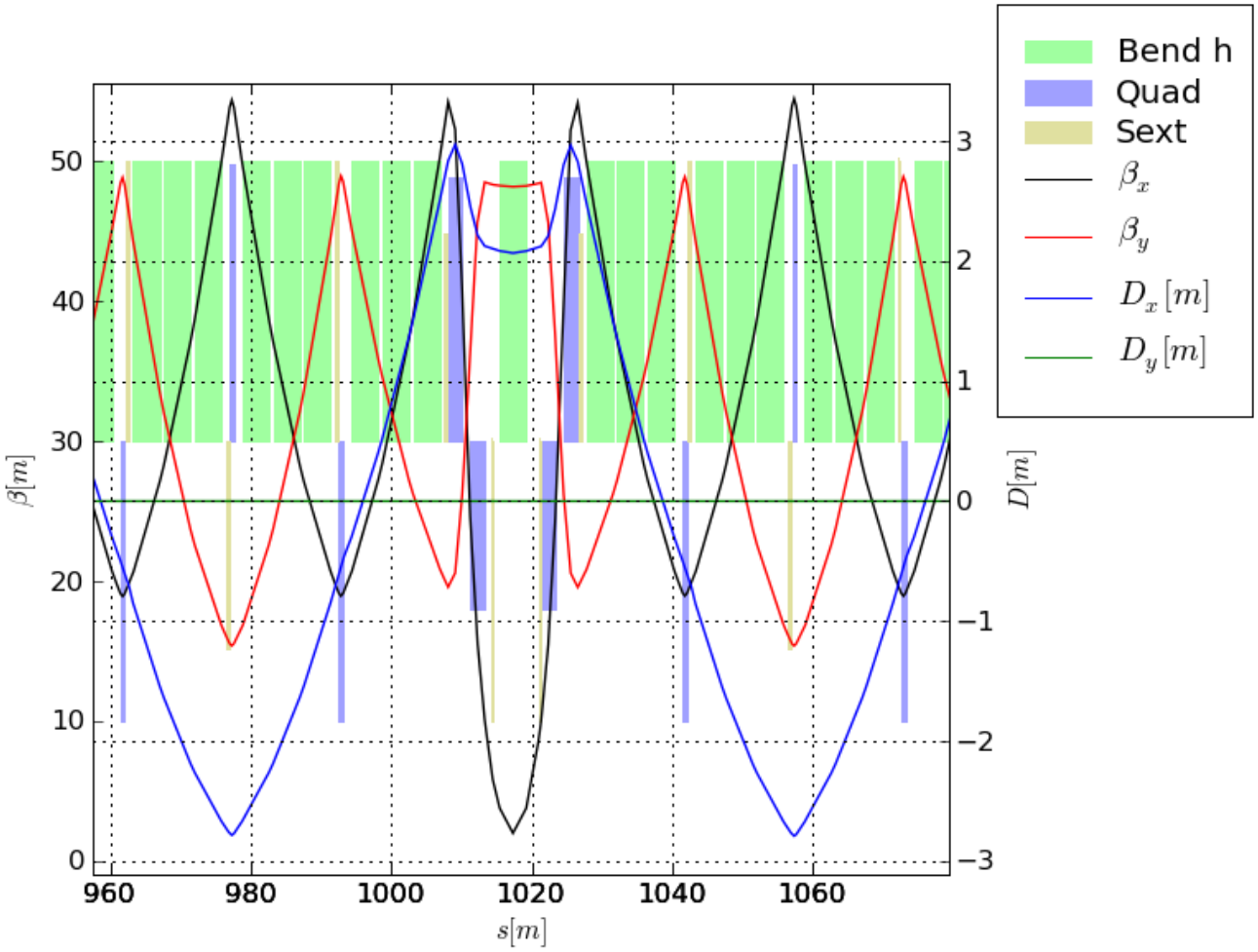
Lattice

The lattice has a negative momentum compaction factor that avoids the transition crossing. Target value for γ_{tr} is $35\mathrm{i}$.
The advantage is to avoid losses at transition and reduce the cycle time.
The drawback is a larger number of quadrupoles compared to a FODO lattice.

Y. Pappaphilippou

Arc cell

531 option



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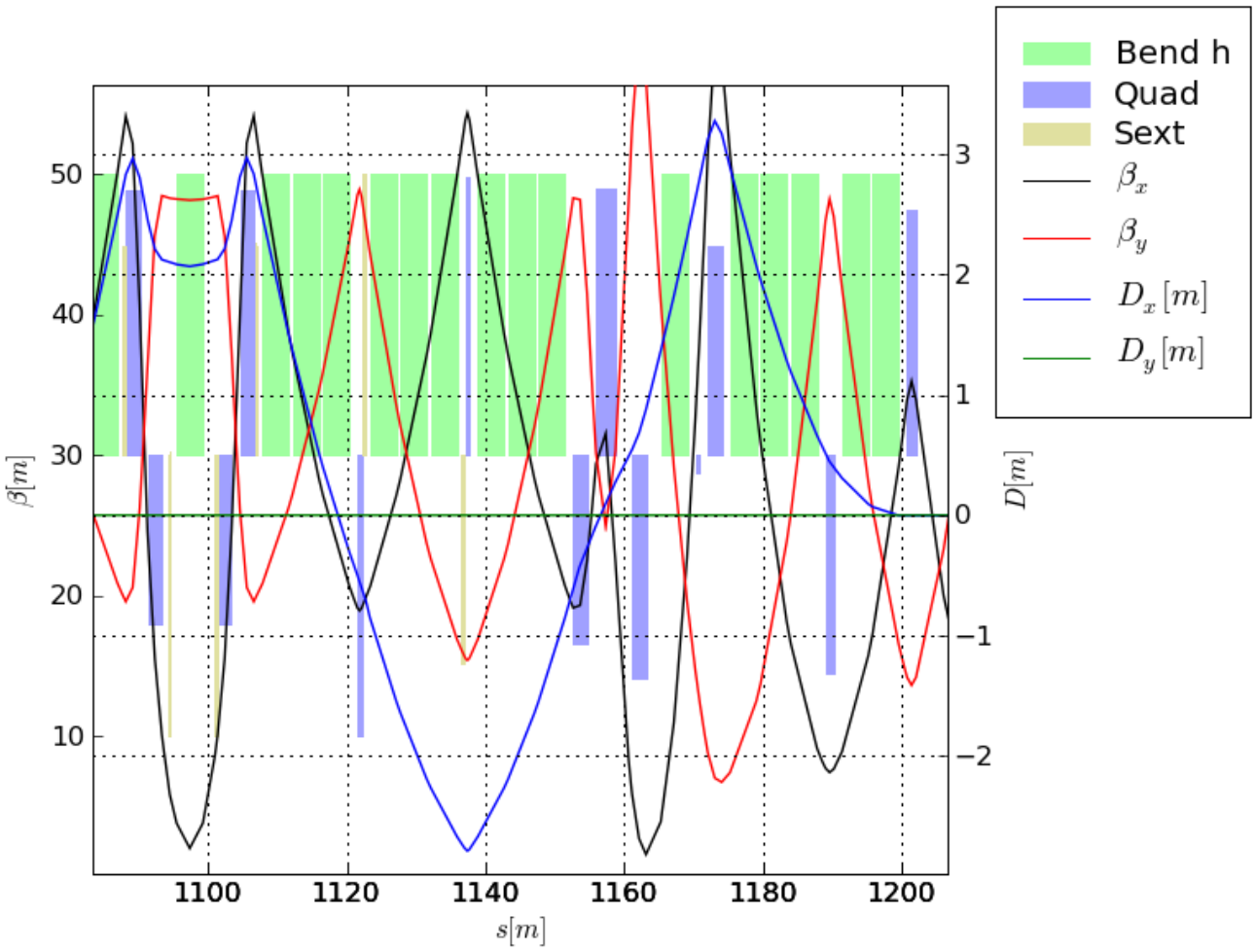
Dispersion Suppressor



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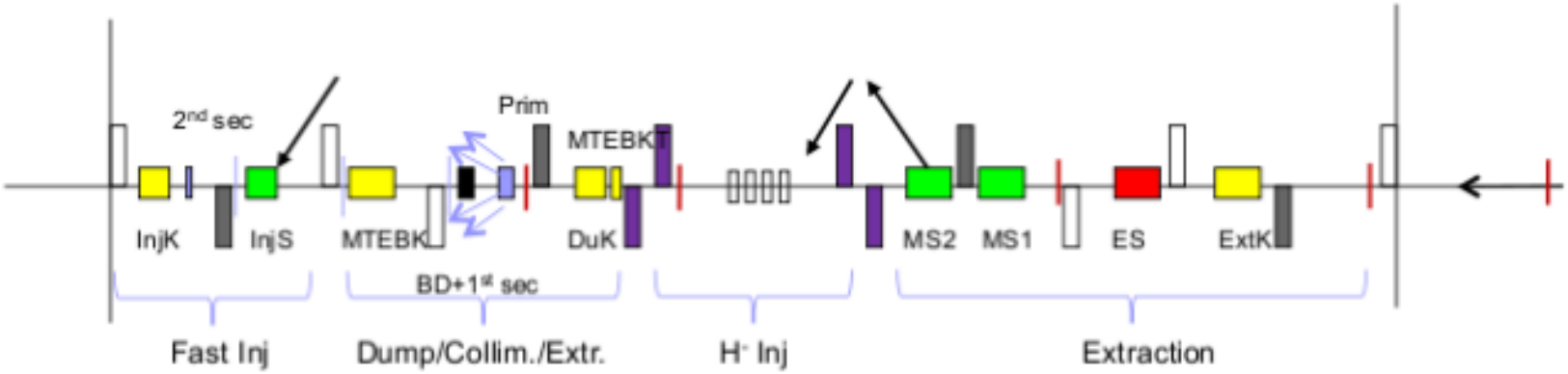
Straight section

H- Injection: two optics for foil and laser stripping.
Fast Injection: InjK, InjS
Extraction: ExtK, ES
Slow resonant extraction: MS1, MS2,
MTE extraction: MTEBK, MTEBKT
Dump: DuK

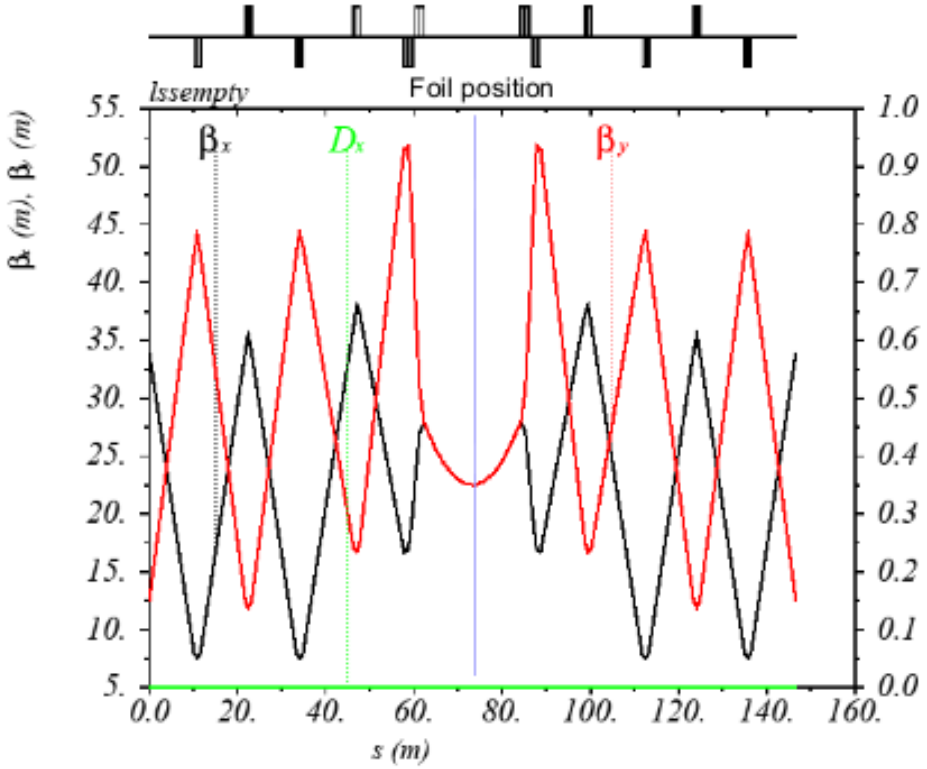


Two optics for foil and laser stripping.

B. Goddard, W. Bartmann

Straight section

LSS Optics – Foil Stripping



Minimization of foil width by a deliberate mismatch of the optics parameters between injected and circulating beam gives at the waist:

Machine parameters:

$_{x,y} = 0$ and $_{x,y} \approx 22.5$ m

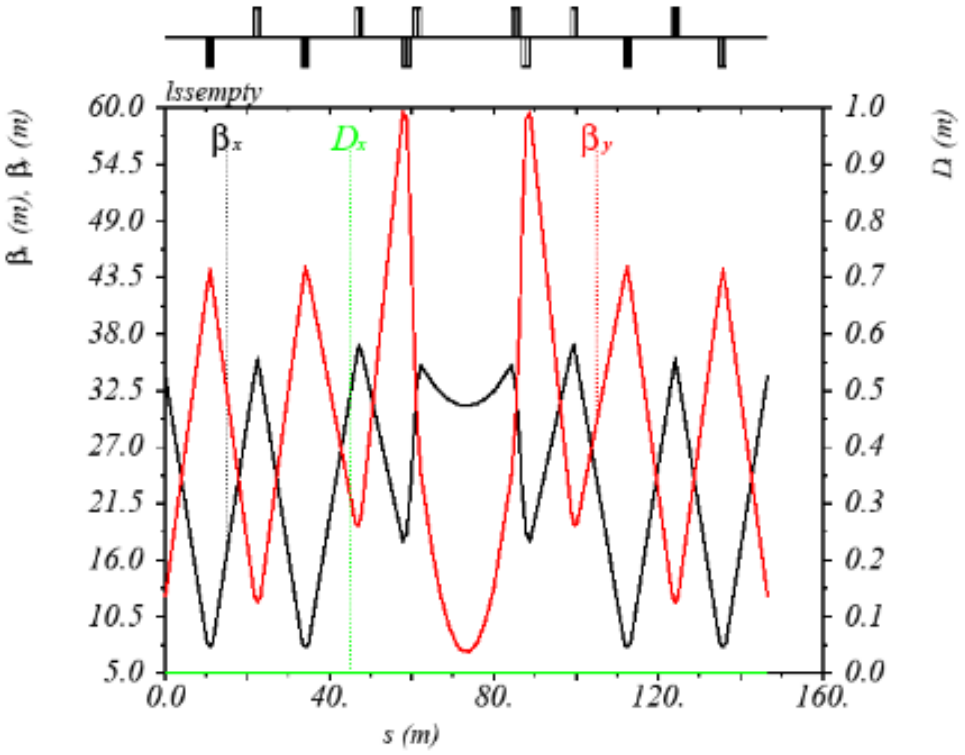
Injected beam parameters:

$_{x,y} = 0$ and $_{x,y}$ at least 10 m

B. Goddard, W. Bartmann

Straight section

LSS Optics – Laser Stripping



Laser peak power is proportional to vertical beam size if the beam-laser interaction is horizontal

reduce vertical beam size as much as possible for laser stripping LSS optics

B. Goddard, W. Bartmann

Collimation

Radiation would not be compatible with kickers.
Working hypothesis is down stream the RF section.
Second straight section will be designed when RF requirements and collimation will be ready.
Beam pipe aperture model under discussion.
Constraints: quadrupole pole tip field (1.17T at 65mm) , CNGS beam size (15mm at 1σ, factor of 3 less for LHC beams), collective effects.

Y. Pappaphilippou, J. Barranco

Orbit correction

Summary

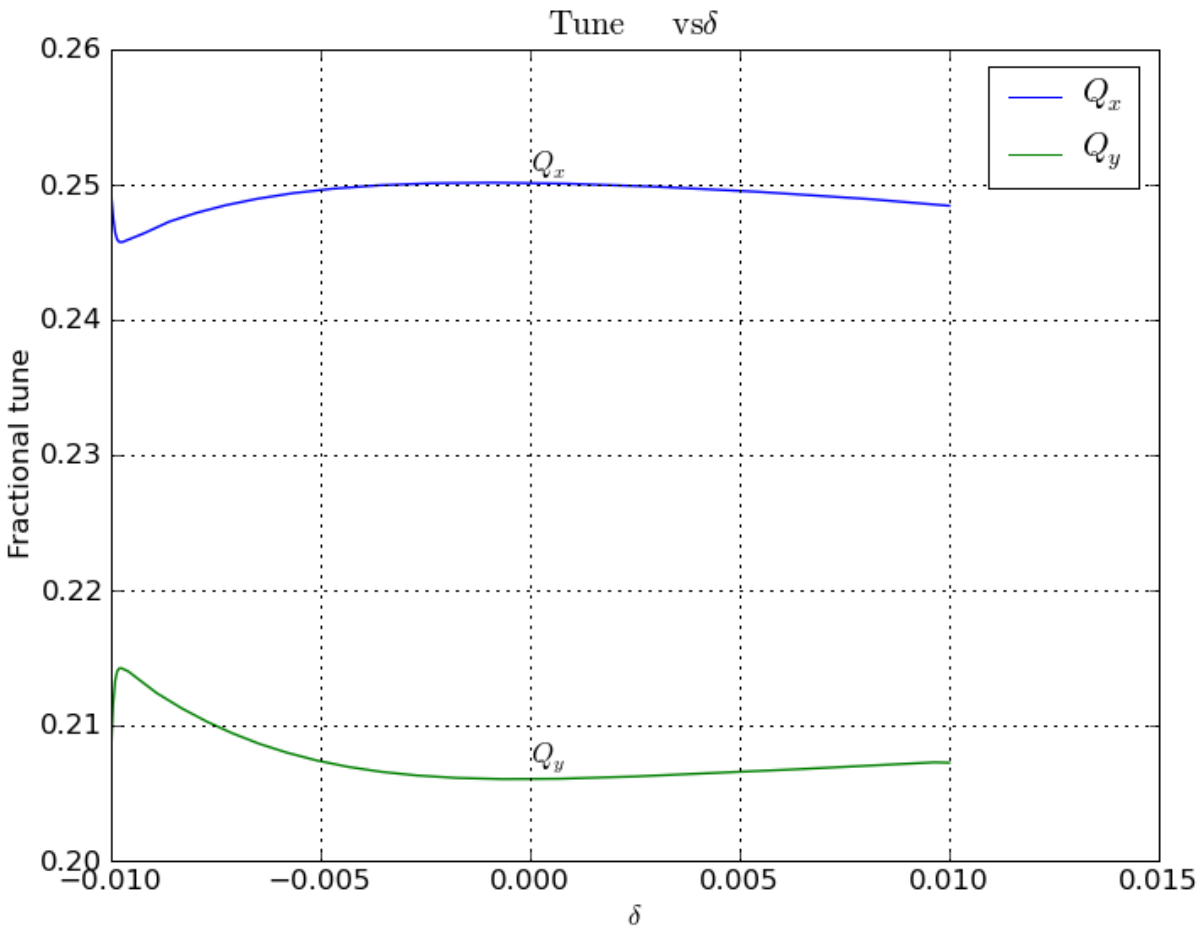
- Distribution of correctors

	10 NMC	4 DS	2 LSS	***Total***
MKH	10x3	4x3	2x6	***54***
MKV	10x4	4x3	2x6	***64***

- A total of **118 correctors** and **118 BPMs** will be installed.

Y. Pappaphilippou, J. Barranco, W. Bartmann

Chromatic aberrations



DA exceed physical aperture.

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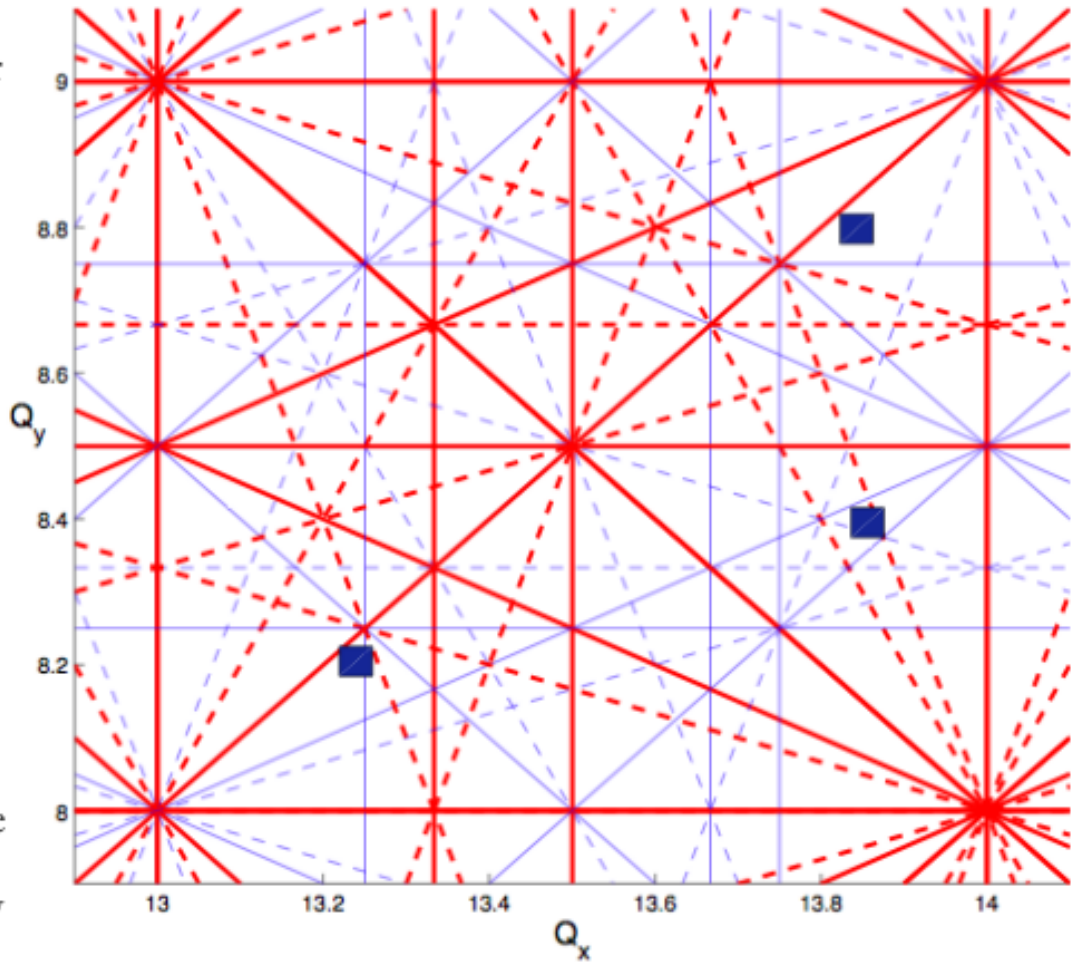
Resonances

Working points

- Tune-diagram plotting all resonances up to 4th order
- Horizontal integer correspond to a systematic 2nd order resonance
- Vertical integer corresponds to systematic 1st order resonances 3rd integer 13.33 is systematic (but not 13.66)
- Horizontal and vertical half integer correspond to systematic 4th order resonance
- Diagonal corresponds to systematic 4th order resonance
- A working point below the diagonal and above the half integers (13.5,8.5) may be better



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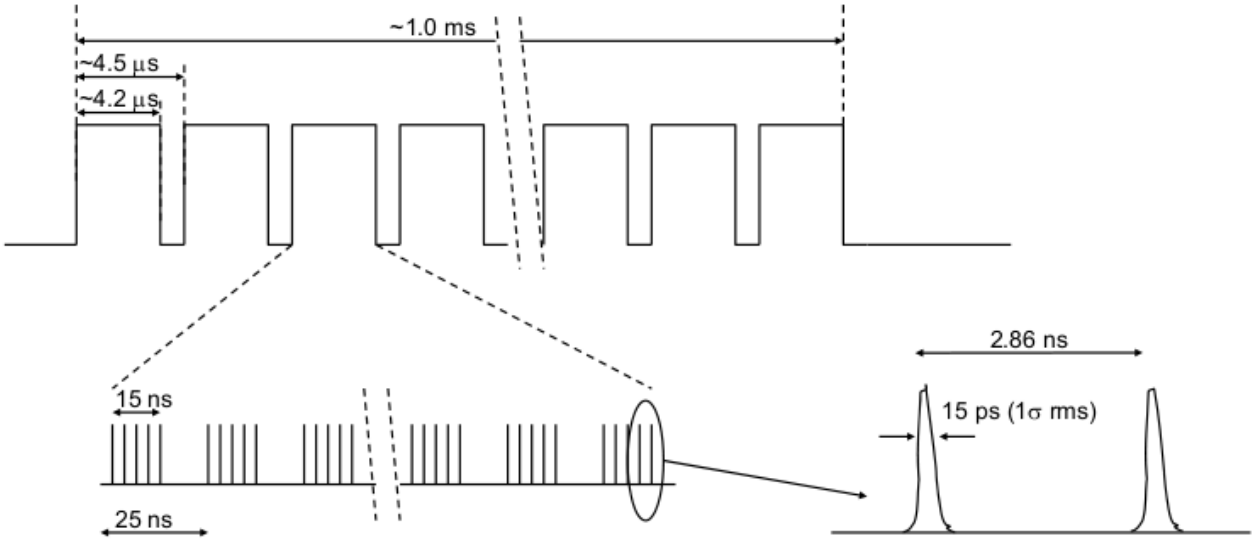
SPL Injections

- Macropulse injection over ~1ms (200-300 turns injected)
- Chop in short gaps for extraction kicker rise-time
- SPL microbunch structure at 352 MHz…15 ps (rms) spaced by 2.86 ns



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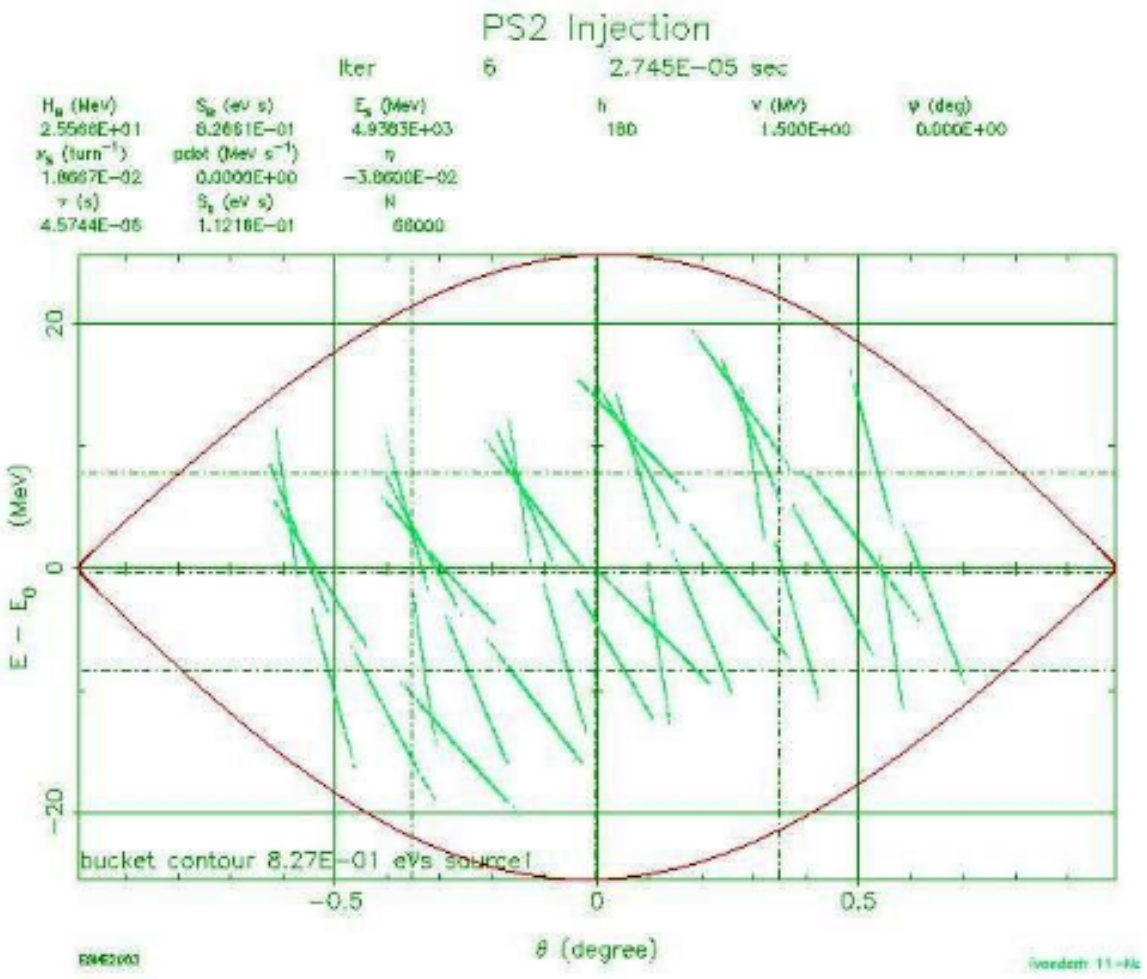
Longitudinal aspect (tentative)



S. Hancock, I. Vonderhaid

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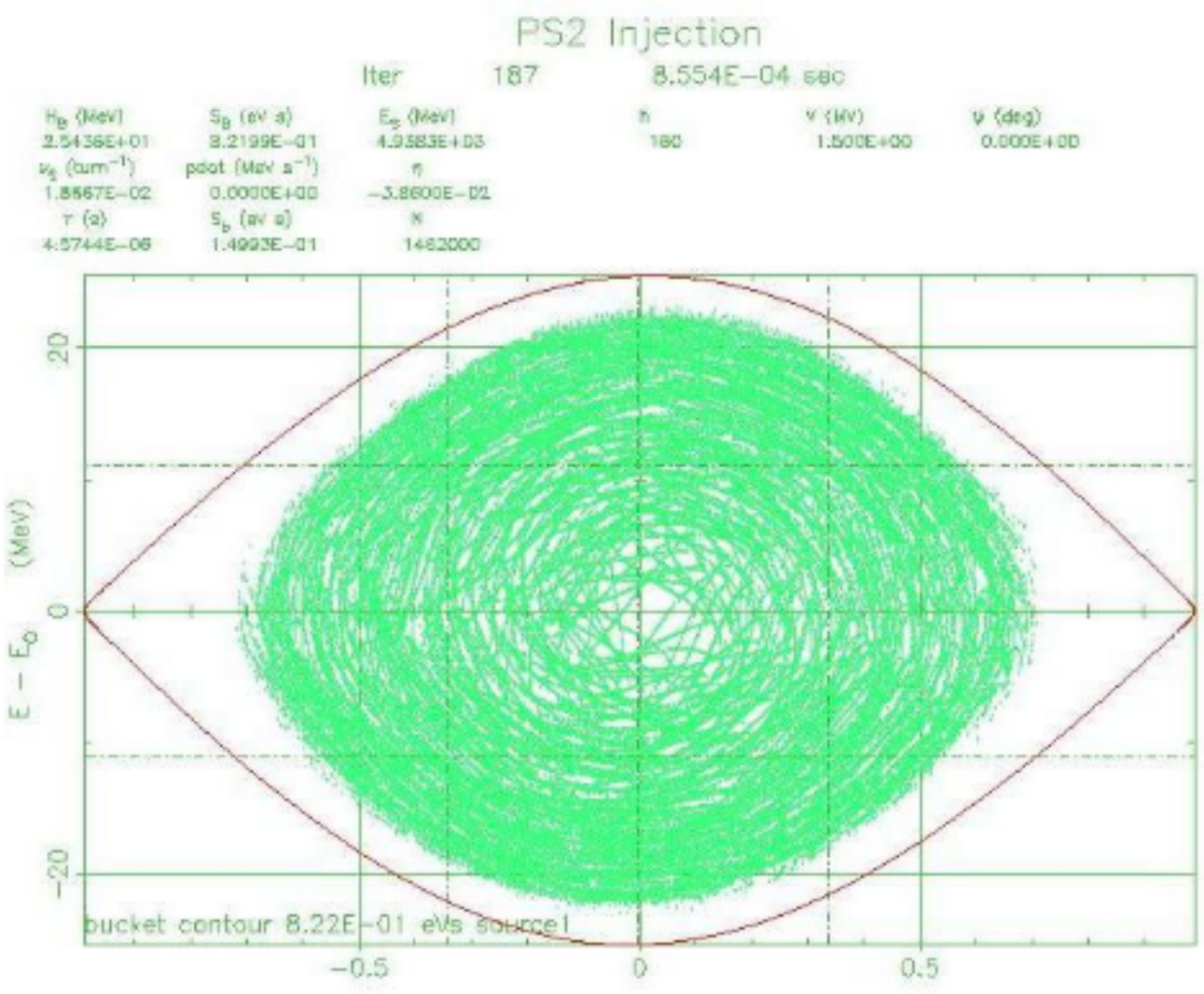

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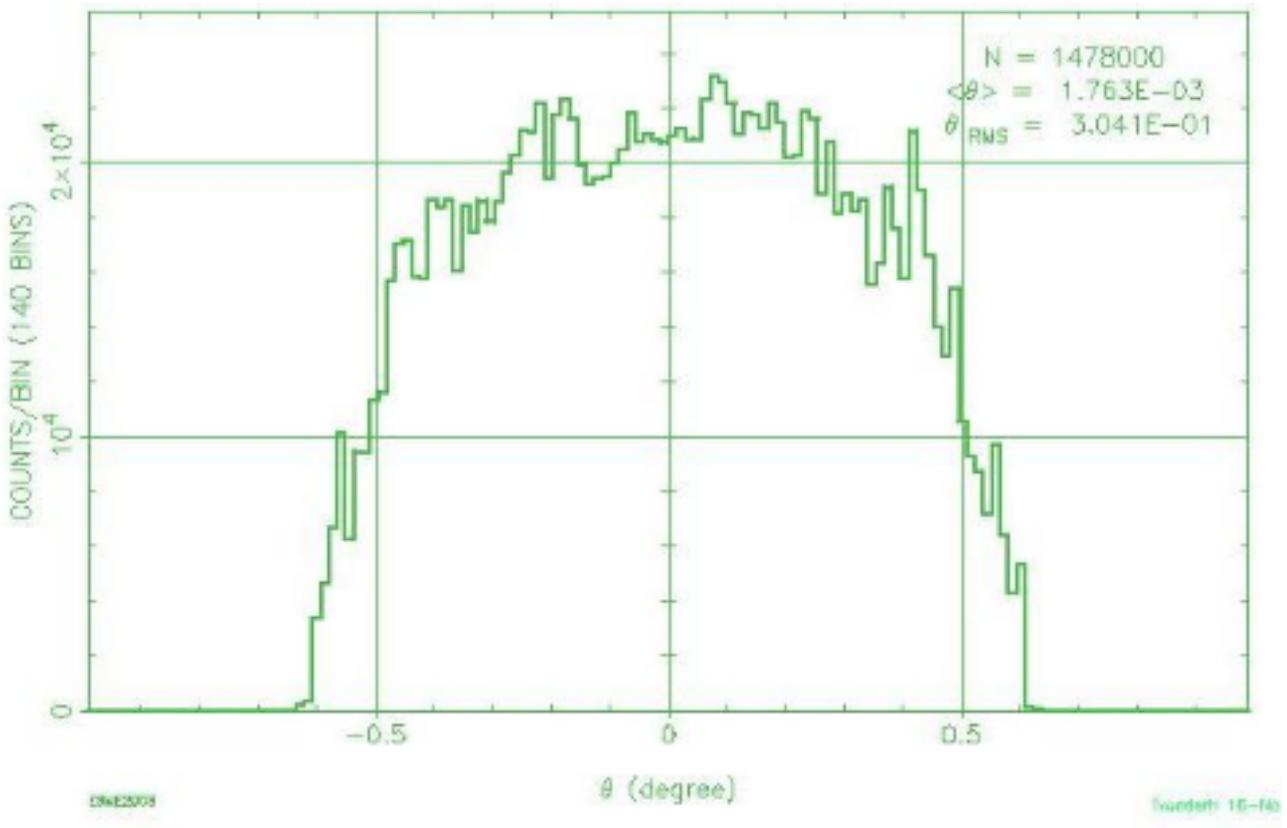

S. Hancock, I. Vonderhaid

Tentative longitudinal parameters after injection.

Tentative longitudinal parameters after injection for LHC beams.

- total longit. emittance: 0.4 eVs
- total bunch length: 17.8 ns
- total energy spread: $6.43 \cdot 10^{-3}$
- Bunching factor: 0.5
- RF Voltage: 650 kV
- Synch. freq: 2.6 kHz

S. Hancock, M. Benedikt

RF system (plan)

Full tunable 20MHz-40MHz system.

E. Jensen

Vacuum (tentative)

1% beam life time in 2.4s. Bake-able system.
$1 \cdot 10^{-9}$mbar should be sufficient for proton.
Critical for ion operations.
Initial studies on ecloud have been started, but waiting for refined aperture model.

E. Mahner, G. Rumolo, C. Carli

Conclusion

Coming soon:

- Longitudinal program
- Aperture model
- RF system

References, updated informations and acknowledgment:
https://twiki.cern.ch/twiki/bin/view/Main/PS2Collaboration