Research progress and plan

CERN-KEK Committee, 2nd meeting
07/Dec/07
Masamitsu AIBA
CERN-Japan fellow, AB/BI

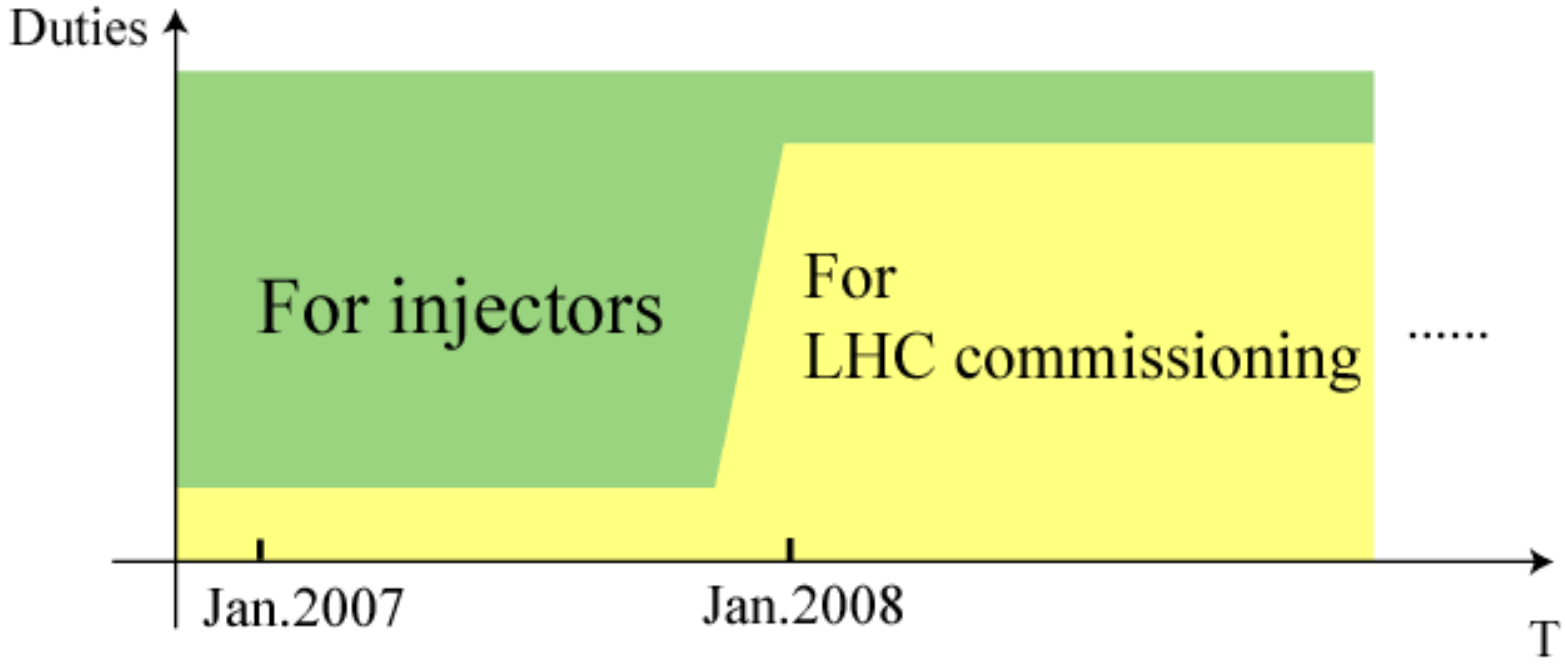
Introduction

- The 3rd CERN-JAPAN fellow:
  Since October 1st, 2006
  The 1st fellow of accelerator researcher
- Department/Group:
  Accelerators and Beams / Beam Instrumentation
- Supervisor:
  Dr. Roland Garoby (BI leader, PAF WG chair)

Slide from 1st CERN-KEK Committee meeting

Work plans

- Not only works for LHC injectors but also works for LHC commissioning

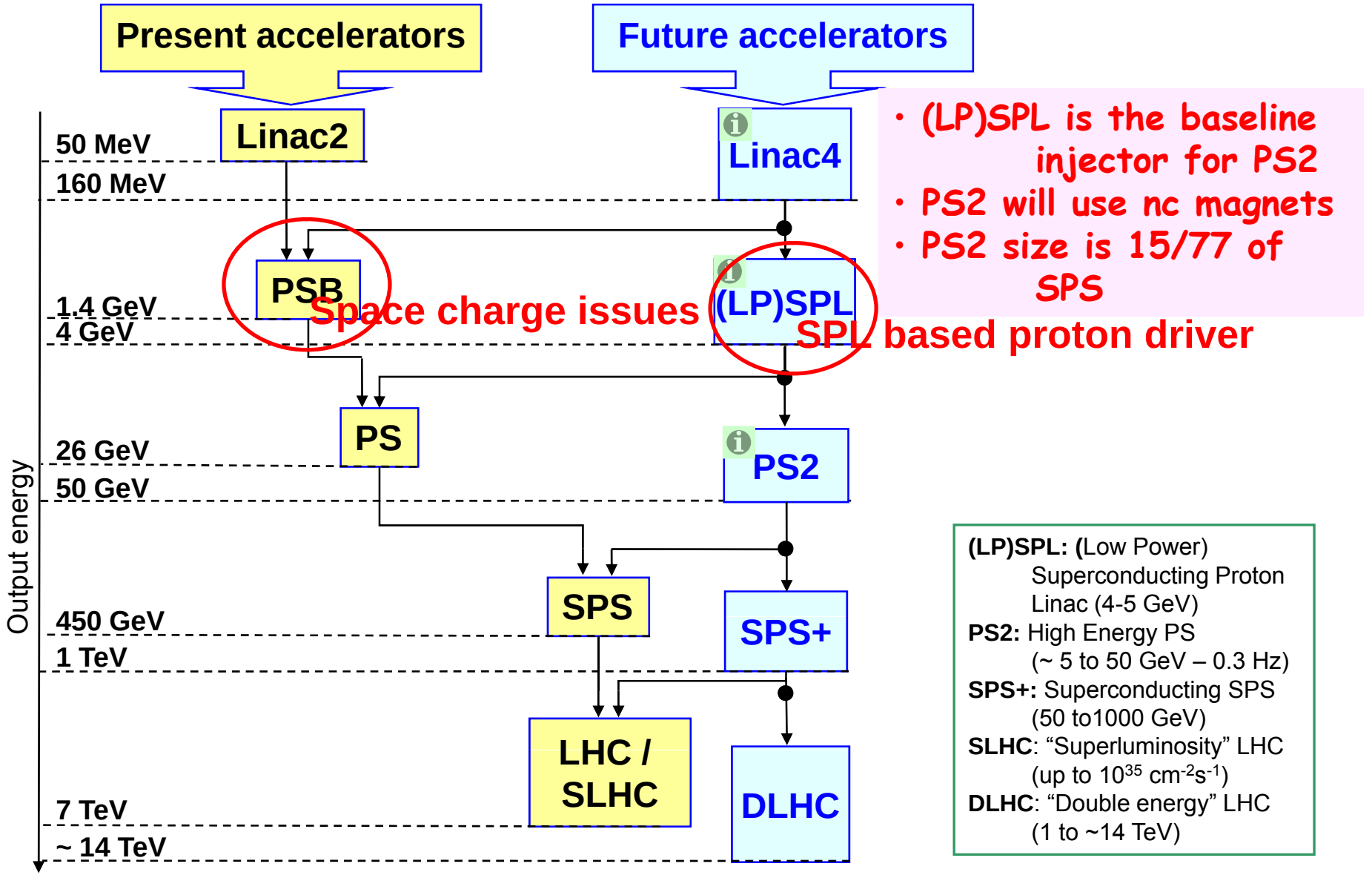


Study items

- For injectors and PAF (Proton Accelerators for the Future)
  - Space charge issues and compensation with e-lens
  - Design of accumulator and compressor for SPL based proton driver
- For LHC
  - Beta-beating in commissioning phase A.4
  - High-beta optics for ATLAS luminosity measurement

Slide from BEAM'07 by R. Garoby

Updated list of future accelerators



- (LP)SPL is the baseline injector for PS2
- PS2 will use nc magnets
- PS2 size is 15/77 of SPS

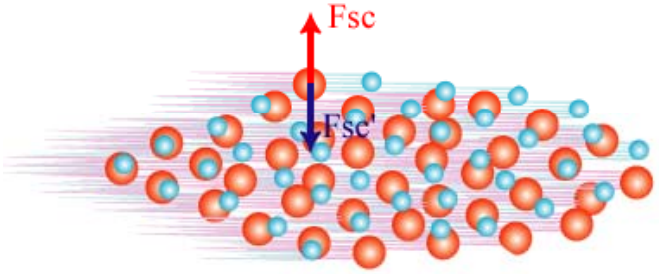
(LP)SPL: (Low Power) Superconducting Proton Linac (4-5 GeV)
PS2: High Energy PS (~ 5 to 50 GeV – 0.3 Hz)
SPS+: Superconducting SPS (50 to1000 GeV)
SLHC: "Superluminosity" LHC (up to 10^{35} $cm^{-2}s^{-1}$)
DLHC: "Double energy" LHC (1 to ~14 TeV)

Space charge issues

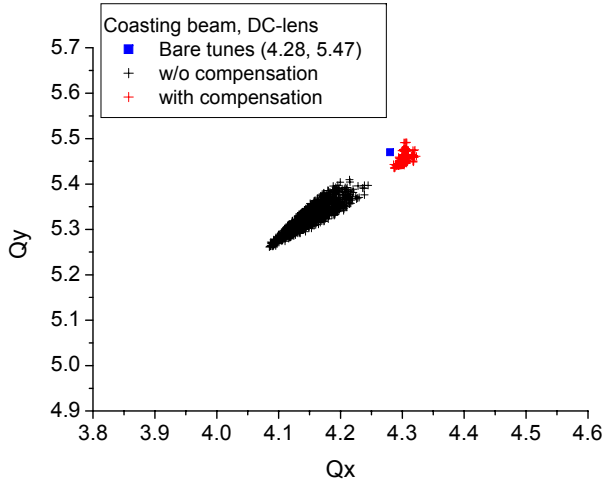
- PS-Booster beam is dominated space charge effects (tune shift ~0.4)
  - Effort from simulation side
    - Benchmark of ACCSIM and ORBIT codes

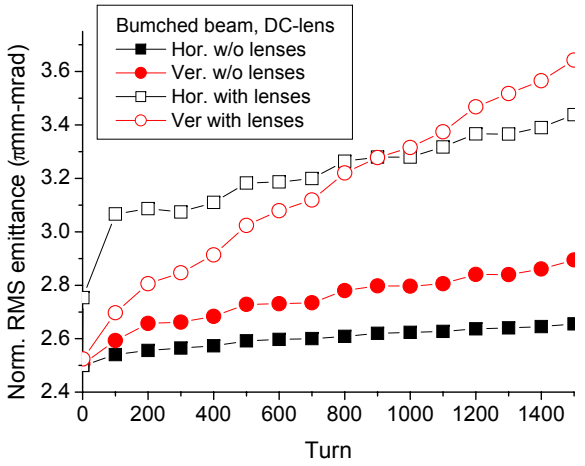
      →Gives similar picture
    - Simulation for new injection scheme with Linac4
  - Investigation on “e-lens compensation”
    - →Next slide

Electron lens compensation

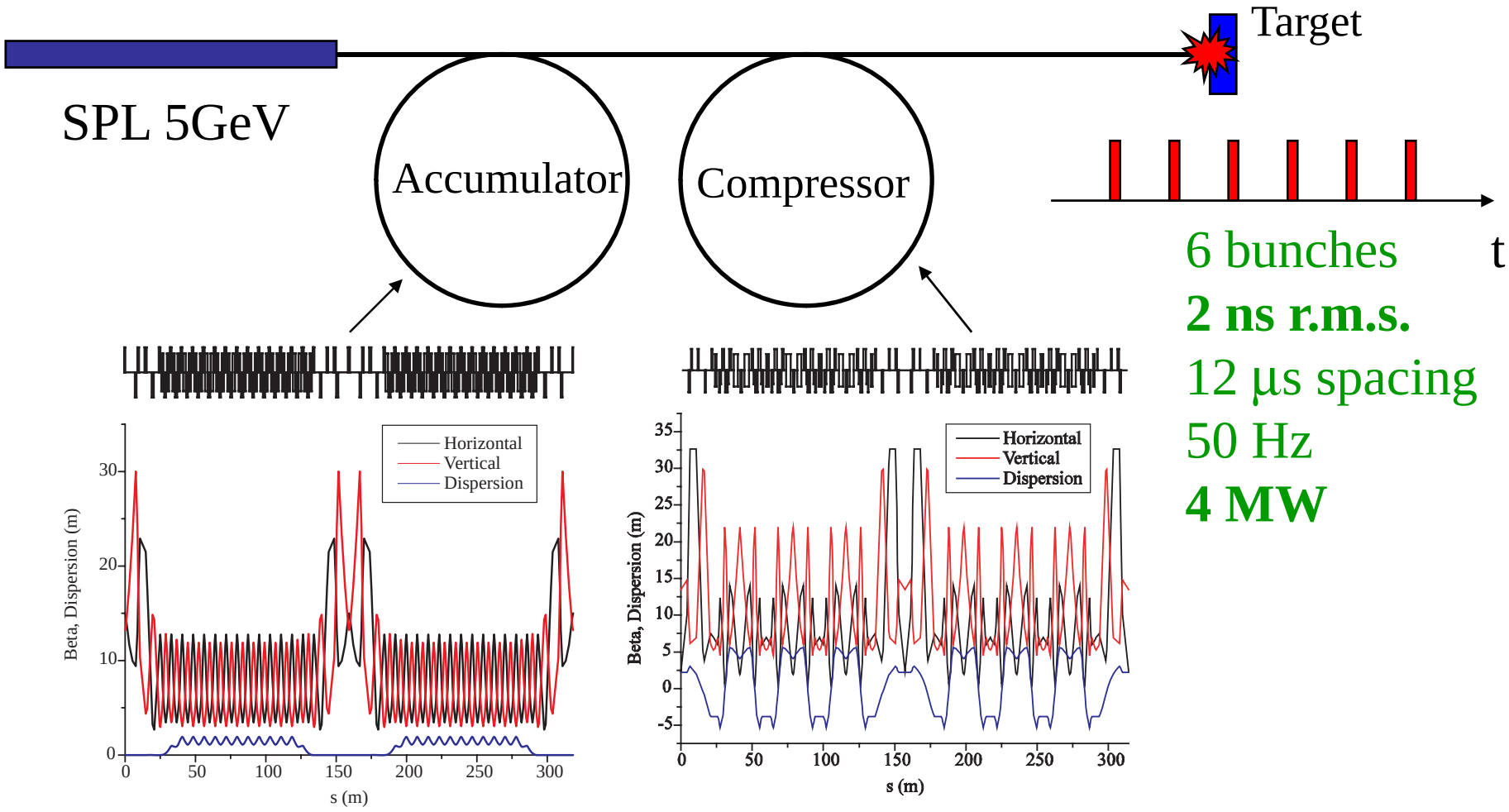


- Idea
  - To neutralize space charge potential with electron beam
  - Ref: A.V.Burov, Q.W.Foster and V.D.Shiltsev, PAC01, P2896
- Simulation with ORBIT
  - New module to introduce e-lens has been developed
  - First results: OK for tune spread but NG for emittance growth





SPL-Based Proton Driver for Neutrino Factory



6 bunches

2 ns r.m.s.

12 μs spacing

50 Hz

4 MW

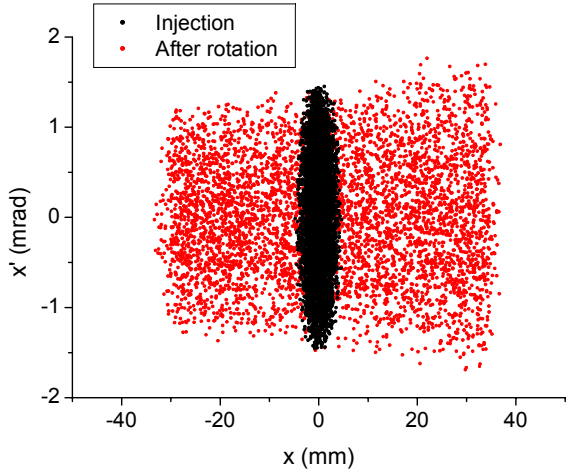
Possible lattices for accumulator and compressor have been found.

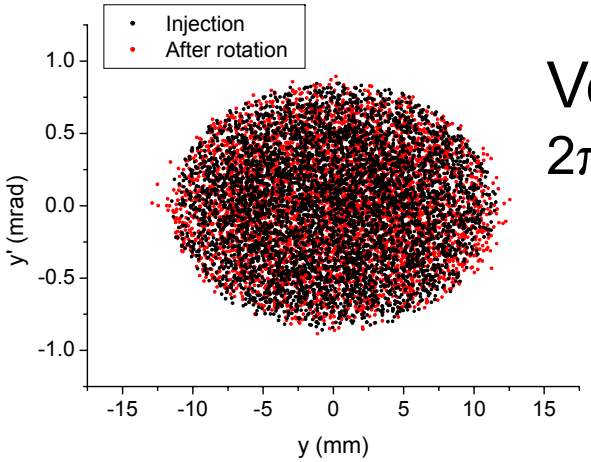
M. Aiba, R. Garoby, M, Meddahi (CERN)

Simulation of bunch compression

- Results: phase space & bunch profile

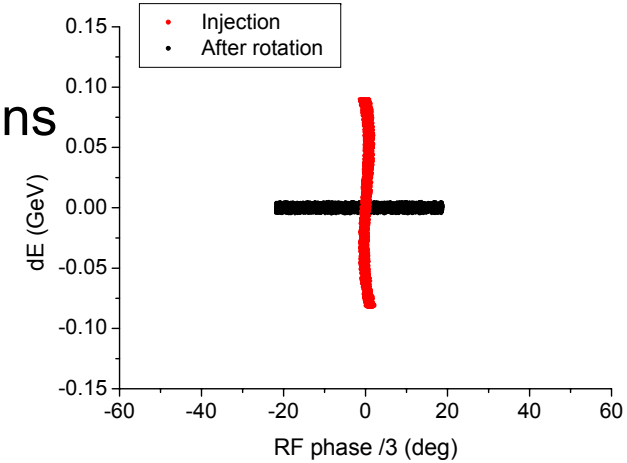
Hor.
1π mm-mrad

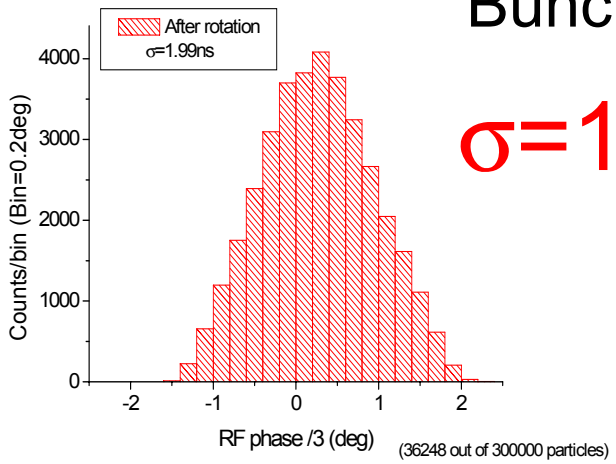




Ver.
2π mm-mrad

Long.
±5MeV*120ns



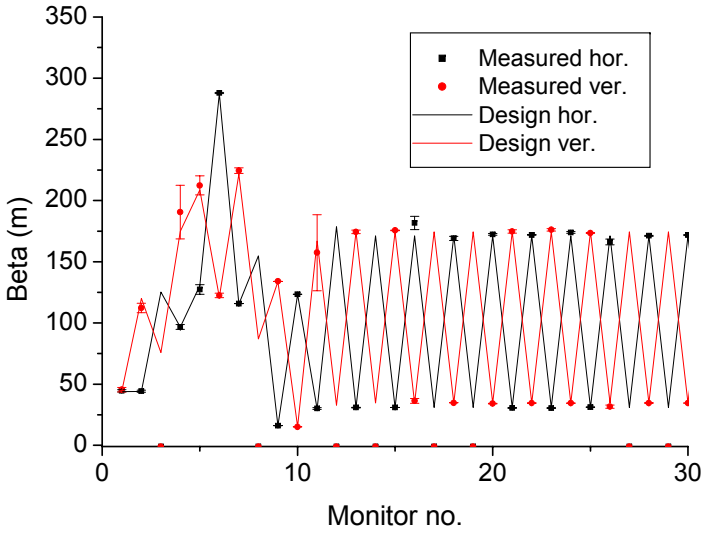


Bunch profile

σ=1.99 ns

Beta-beating in LHC commissioning phase A.4

- Beta-beating
  - Measure and correct LHC optics in early commissioning stage
  - Work with R. Calaga(BNL/AB-ABP), A. Morita(KEK/AB-ABP), R. Tomas(AB/ABP), G. Vanbavinckhove(Technische Universiteit Delft/AB-ABP), F. Zimmermann(AB-ABP)
- Beta-function measurement with phases



- Measure phases for 3 successive monitors

$$\beta(s_1) = \frac{1/\tan\phi_{21} - 1/\tan\phi_{31}}{m_{11}/m_{12} - n_{11}/n_{12}}$$

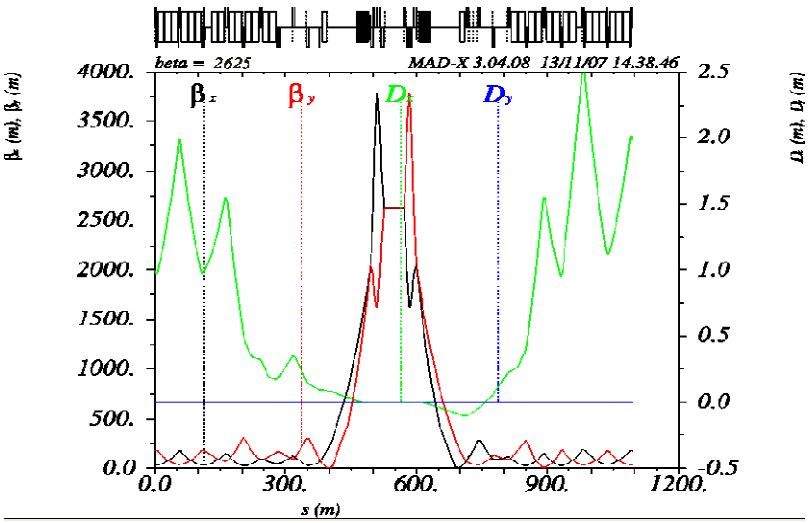
- Measurement error in arcs

$\Delta\beta/\beta \sim 4\%$

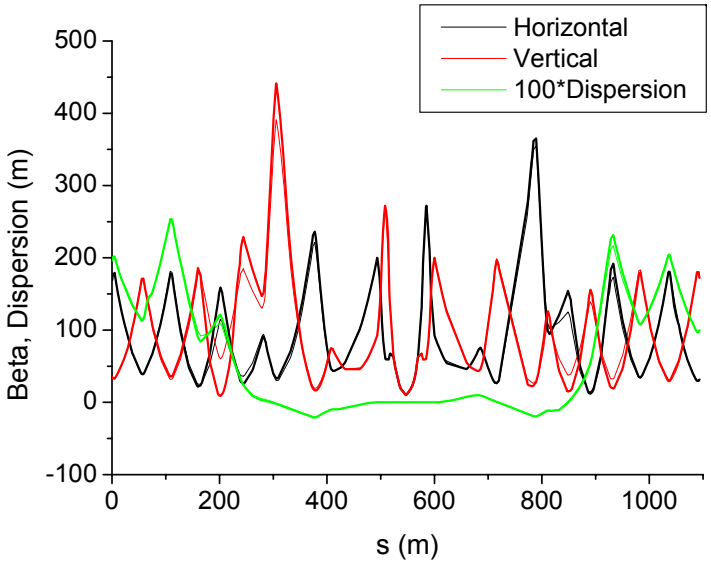
(Allowable in early LHC~20%)

High-beta optics

- High-beta optics β*>2600m
  - For the luminosity measurement at ATLAS and TOTEM
  - Work with H. Burkhardt(AB-ABP), M. Giovannozzi(AB-ABP), S. White(Universite de Paris-Sud/AB-ABP)
  - One of optics issues: compensate the loss in betatron tune dQx~-0.5 and dQy~-1.0



High-beta optics, IR1(ATLAS)
dQx~-0.2, dQy~-0.5 (by S. White)



Compensation, IR2
dQx~0.0, dQy~+0.5

Publications

- AB-BI note:
  - “Memo for scaling-FFAG lattice design”
  - “Accumulator lattice design for SPL beam”
  - “Compressor lattice design for SPL beam”
- PAC07(co-author):
  - “SIMULATION OF THE CERN PS BOOSTER PERFORMANCE WITH 160MeV H− INJECTION FROM LINAC4”, F. Gerigk et. al.
  - “SPACE-CHARGE COMPENSATION OPTIONS FOR THE LHC INJECTOR COMPLEX”, F. Zimmermann et. al.
- NuFact07 (to be published):
  - “Accumulator and Compressor for the CERN SPL Proton Beam”
- Beam07 (to be published):
  - “BENCHMARK OF ACCSIM-ORBIT CODES FOR SPACE CHARGE AND ELECTRON-LENS COMPENSATION”

Remarks

- Studies for injectors and LHC are getting fruits.
- Thank you to Roland, colleagues at CERN, fellowship committee and CERN-KEK committee