# Brainstorming on Possible MDs
# in CERN acc. Complex and for discussion
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# Scope of proposal

- Goal: discuss possible Machine Developments studies relevant for the accumulator/compressor and target beam delivery

- Linac covered by Alessandra

# Relevant studies (not exaustive…)

- Collective effects:
    - transverse and longitudinal instabilities
    - space charge at injection
    - e-cloud
    - ….
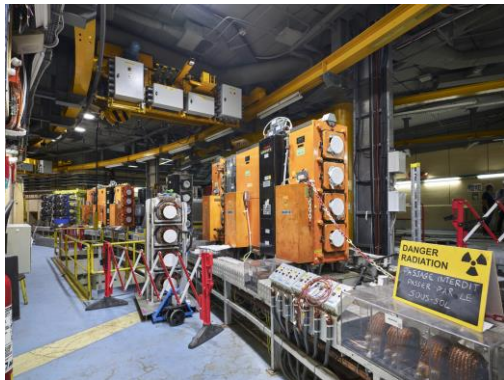- Minimum bunch length in high intensity regime
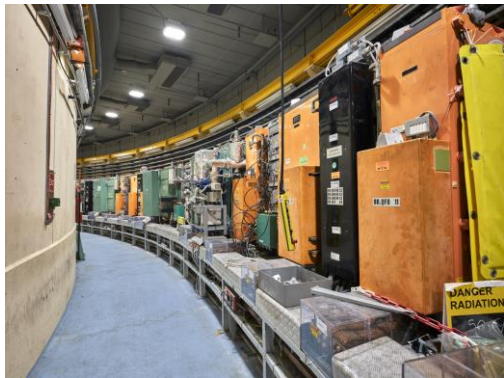- Beam recombination
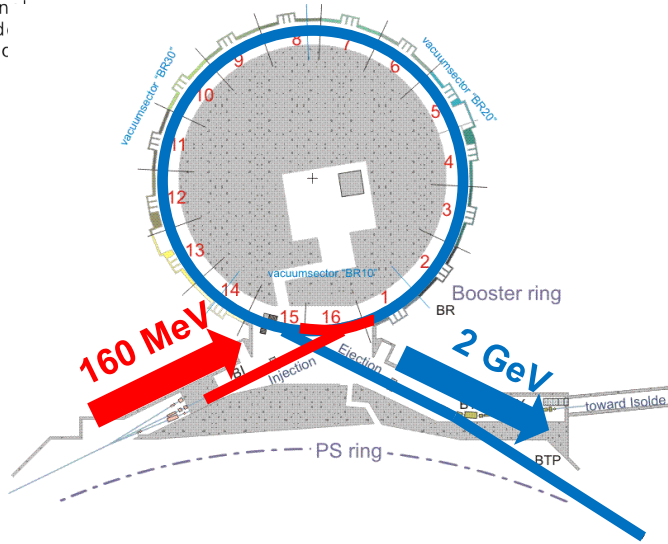
# CERN accelerator complex as today
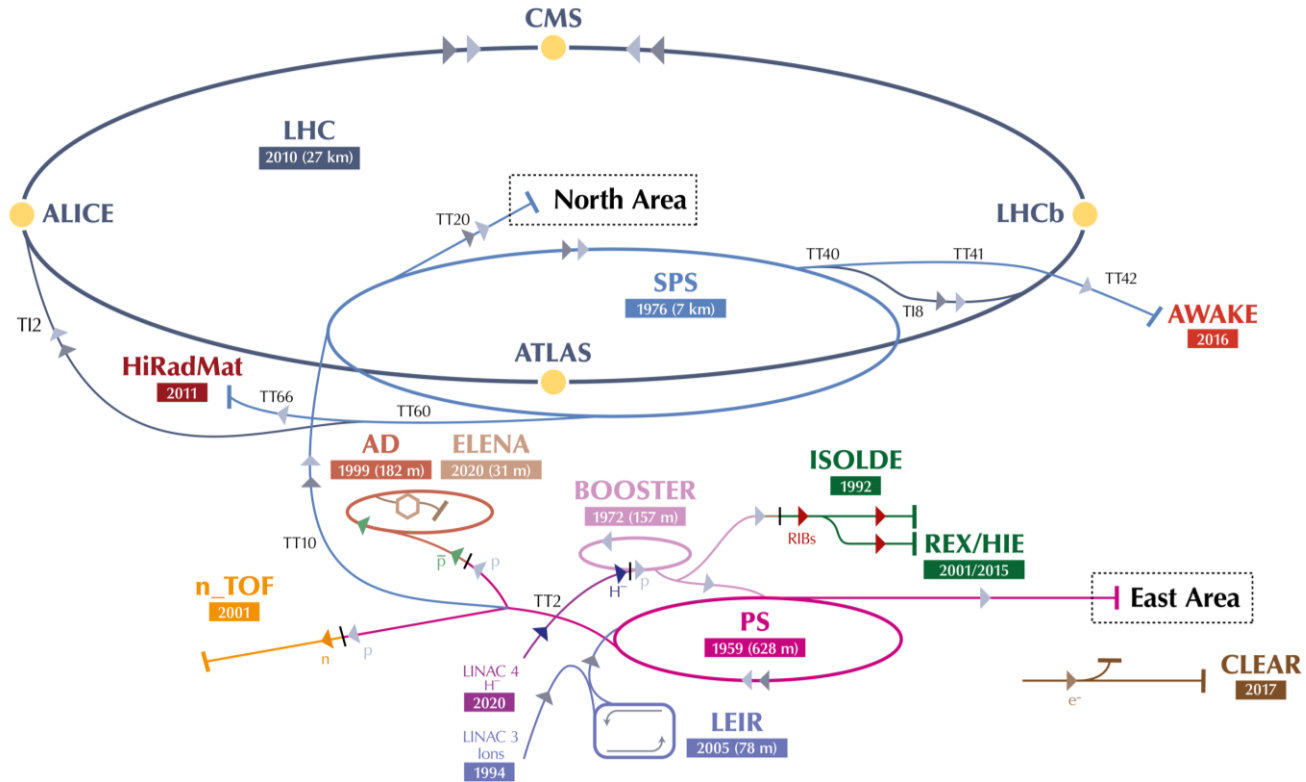
# PSB main features





- Injection
  - 160 MeV H$^-$
  - Multiturn charge exchange injection with transverse and longitudinal painting up to ~120 turns
- 4 superimposed ring magnetically coupled
- Lattice: Triplet, FDF
  - Operating below transition
- Acceleration cycle
  - ~ 700 ms
  - 1.2 cycling period
- RF: Finemet
  - Operation with h=1 and h=2

- Extraction:
  - Max : 2 GeV
  - Single turn fast extraction with vertical recombination
- Particles types:
  - Protons, (Ions - O, S, In, Xe)
- Max total intensity: ~ 4-5e13 ppp
- Intensity per ring : ~ 1.2e13 ppp (h=1)

- Multipoles for resonant compensation
- Fully instrumented

# PSB MD brainstorming

Vertical recombination tests



Booster ring
BR

160 MeV

2 GeV

toward Isolde

BTP

PS ring

PS RING    MEAN RAD. POS.

(a) 20 BUNCH MODE

PS

Vertical addition

(b) 10 BUNCH MODE

PS

Vertical addition

(c) 5 BUNCH MODE

PS

IEEE Transactionson Nuclear Science, Vol.NS-26,No,3,June197

MD@PSB:

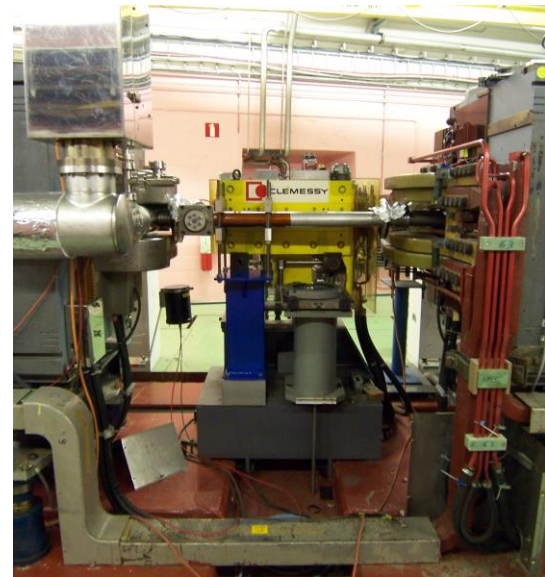- H⁻ injection (to be explored with experts)


- Vertical recombination of bunches from separated rings (up 1e13 per bunch per ring)
    - Final bunch lenght
    - Transverse emitance growth
    - Beam can go on external beam dump or to the PS
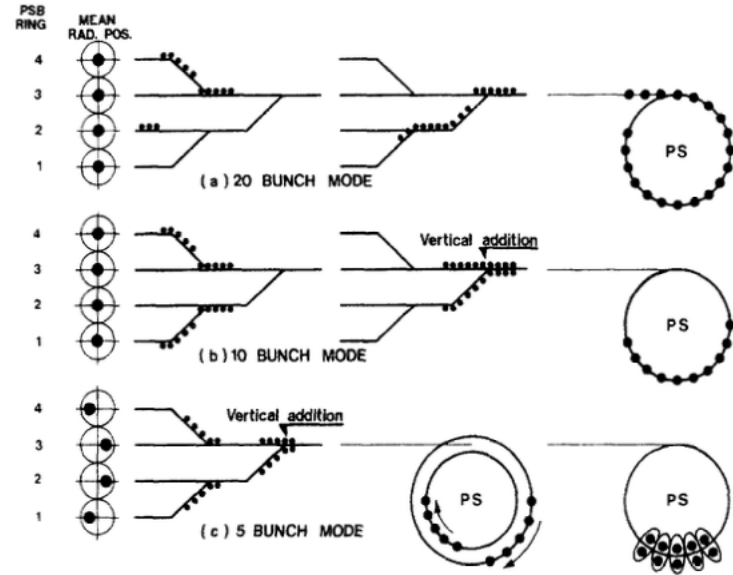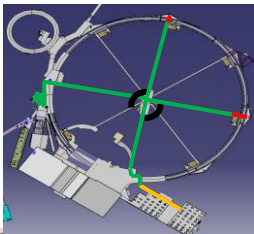
# PS main features



- Injection
    - Max: 2 GeV protons
    - 70 MeV/n lead ions
    - Single turn injections
- Lattice: FODO with combined-function MB
    - Transition crossing with gamma-jump at 6.1 GeV
- Acceleration cycle:
    - Up to 3.6 s depending on final user
    - 1.2 cycling period
- RF:
    - 10 MHz ferrite loaded main RF system
    - 20, 40, 80 MHz for LHC beams production
    - 200 MHz for beam recapture after de-bunching
    - h=7, 8,16, 21, 42, 84,168
    - Finemet as longitudinal feedback system

- Extraction:
    - Fast extraction at 20 GeV and 26 GeV
    - Multiturn (5 turns) extraction at 14 GeV
    - Slow extraction 24 GeV
- Particles types:
    - Protons, Ions (Pb, O, S, In, Xe)
    - In the past: anti-protons, e+, e-
- Max total intensity: ~ 4e13
- External Exp. Area: East hall, AD

- Multipoles for resonant compensation
- Fully instrumented

# Example of measurement of impedance effects at injection

Bunch profile

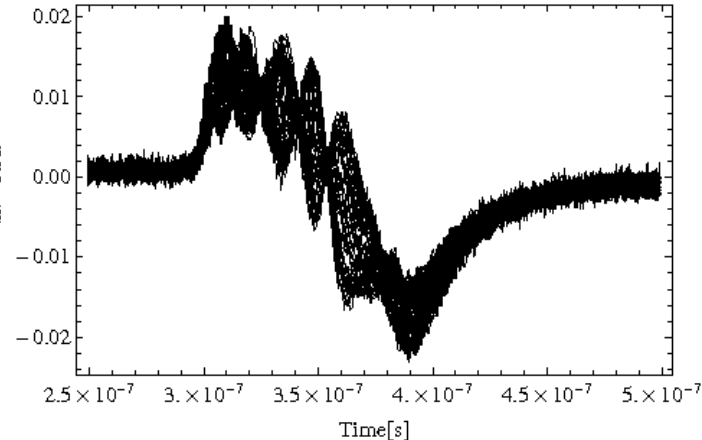Vertical position of the beam within a bunch

Horiz. position of the beam within a bunch
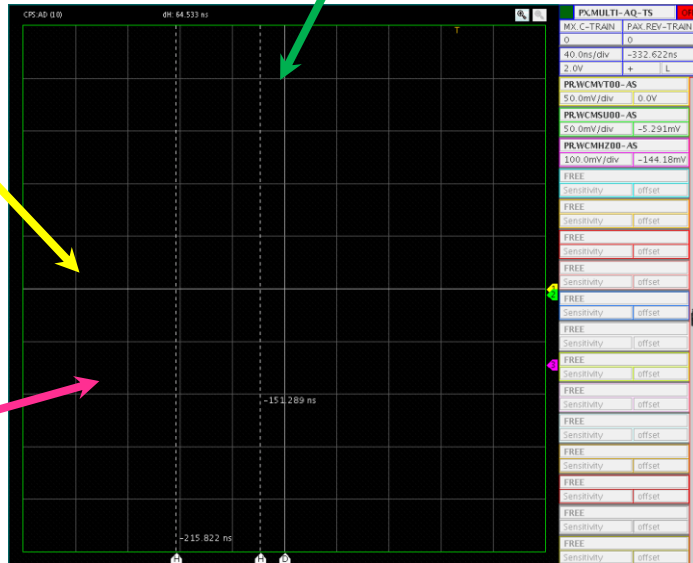
AD beam in the PS at injection (2010)
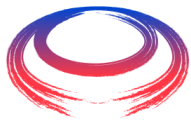1500e10 protons on 4 bunches

Microwave instability

Experiment on High brightness-LHC beam at injection – single bunch – 200e10 protons
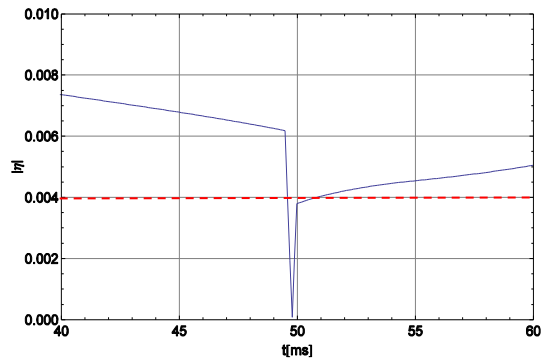Headtail instability m=4,5

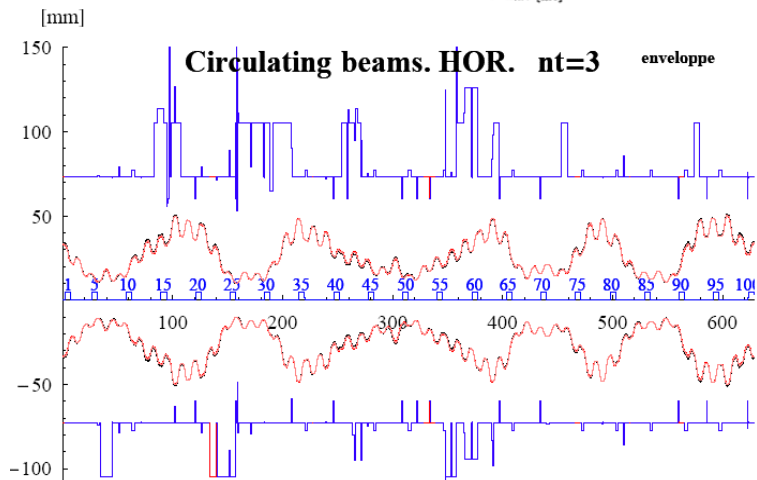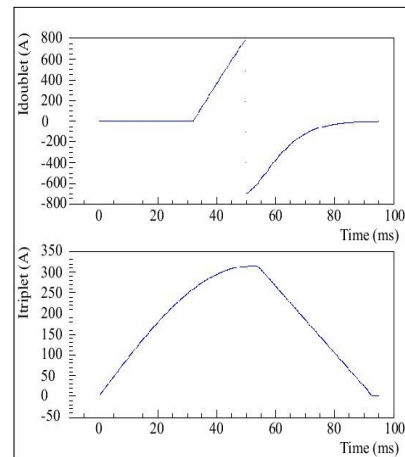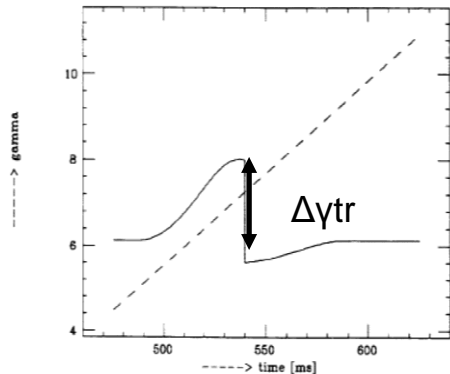See also the work of E.Metral, R.Cappi, B.Salvant (CERN AB-2007-032 and CERN PS-95-02) and
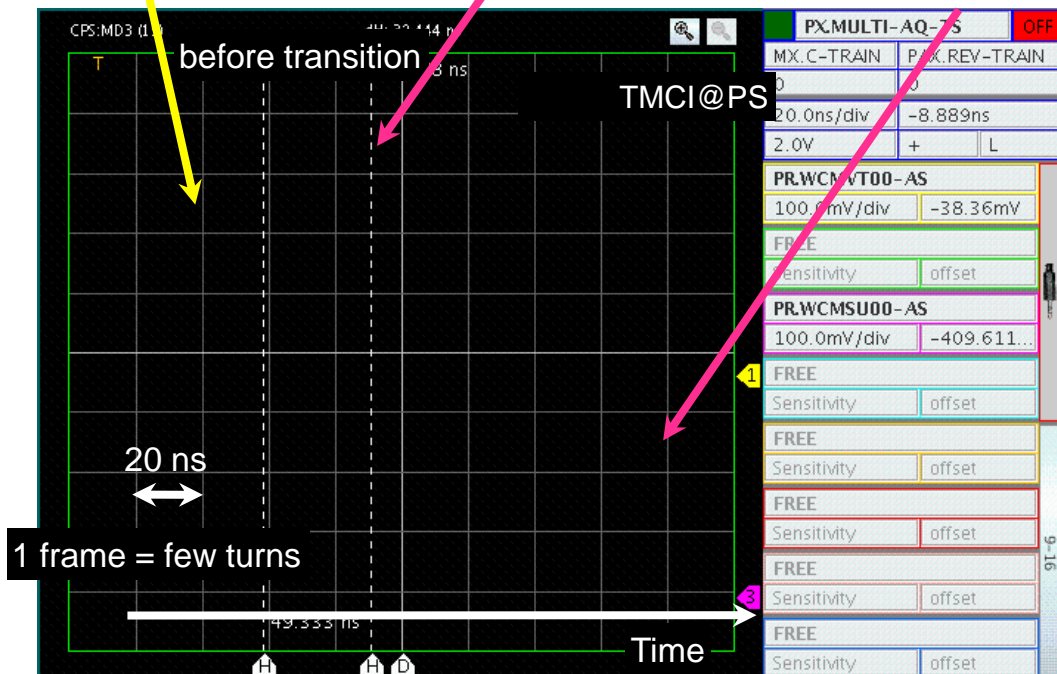S.Aumon thesis

# Gamma jump – transition crossing



See S. Aumon thesis: CERN-THESIS-2012-261

# An example of TMCI meas. at transition crossing
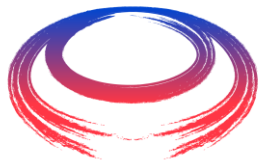
Vertical position
of the beam within a bunch

Bunch profile

Beam losses
A fraction of the beam touched the
vertical aperture

# Some ideas

- Space charge limits at injection are being explored for LHC beams

  - A lot can be learned from there

- Minimum bunch length from bunch rotation interesting also for fixed target applications

  - Today for about 8e12 ppp (single bunch) about 20 ns bunch length

- Could use lattice at transition crossing or close to it exercise/study lattice with very small eta. Or with short bunch length from "isochronous" lattice

- Could study bunch merging in longitudinal AND transverse plane

- e-cloud driven instabilities can be induced by LHC-type beam in very controlled manner

- We could think also to other machines not necessarily at CERN....

*Thank you
very much for the
discussions and inputs*