discussion on injector upgrade

& synthesis

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PS2/PS2+ items

- Construction cost
- Exploitation cost
- Potential for SPS
- Potential for SPS+
- Potential for ions
- Potential for neutrino physics
- Operation risk
- Operation flexibility
- Transfer lines
- SPS injection system
- Why higher extraction energy?
- Normal conducting or superconducting?

construction & exploitation cost

- GSI chose superferric ring for SIS100 in view of vacuum requirement (advantage of cold beam pipe), higher field, weight & mass, operational cost, rather low ac losses [P. Spiller]
- look at complete system including protection [P. Lebrun]
- power consumption was decisive argument for GSI [T. Taylor]
- GSI beam lines are also ramped, same type of magnet [P. Spiller]
- PS2 need to be complemented by other measures, e.g., in the SPS [W. Scandale, F. Zimmermann]
- PS will run for another 10 years; requires consolidation; bottlenecks are in the SPS [T. Taylor]
- need better beams from PS2 to understand limits in SPS [R. Garoby]
- accumulation ring in ISR as alternative? [T. Taylor]
- PS needs thorough consolidation, e.g., for CNGS; radiation requirements require deeper tunnel for PS2 [O. Bruning]
- choose best injection energy for SPS [E. Shaposhnikova]
- lifetime of PS and PS2? Better lifetime of PS2 to be demonstrated [R. Assmann]
- new PS2 is built for higher intensity [R. Garoby]
- smaller aperture of PS2 could be a problem [R. Assmann]
- aperture sufficient even if smaller [M. Benedikt]
- Weak or stronger focusing in PS2? [P. Spiller, F. Zimmermann]
- Vacuum requirements in PS2? [P. Spiller] 1e-9 – 1e-8 mbar [W. Scandale], no problem [M. Benedikt]
- Bake out system may be needed [P. Spiller]
- Ions are injected at much lower momentum than protons
- No convincing demonstration for need of higher PS extraction energy, except in conjunction with SPS+/DLHC [F. Zimmermann]
- Simulations with larger longitudinal emittance for SPS]G. Arduini]
- Simulations optimized for each energy [E. Shaposhnikova, R. Garoby]
- Longituduinal emittance was defined by TMCI requirements [R. Garoby, E. Shaposhnikova]
- Clearing electrodes for PS and SPS

potential for SPS

- Clear potential for SPS, needs to be optimized [G. Arduini?]
- Other modifications needed in order to profit from new potential for LHC [W. Scandale]

potential for SPS+

- Very good, PS2(+) essential
- s.c. version more effective [W. Scandale]
- E-loud heat could be a problem [F. Zimmermann]
- SPS+ energy sweep factor 10-15, 50->800 GeV, or 75 GeV->1 TeV
- >=2x increase in injection energy
- Superferric option
- Aim at VLHC for the future, consequences on PS2?
- PS2+ if we want to keep options open for future, or else a 3rd ring needed [J.-P. Koutchouk, W. Scandale?]
- Question of cost [R. Garoby?]
- Rudiger: 500 GeV ring in SPS tunnel, or rather VLHC LER in LHC tunnel, coexistence with experiments; bypass not showstopper, save on transfer lines instead
- Upgrade must be worth more than factor 2 to be worth ding [S. Peggs]
- If we build new tunnel for PS2, might as well double the energy [R. Garoby]
- New tunnel is mandatory because of radiation level & to avoid shutdown [O. Bruning, P. Lebrun]
- 2 reasons for new tunnel; extraction loss mechanisms, multiturn extraction, space charge limit
- Can one intercept lost particles locally?
- The huge local losses require the shielding, energy 14-26 GeV
- Peter Spiller: why can one not control the losses? Vladimir: impossible based on FNAL experiience
- Cannot make enery decision now, e-cloud open issues, physics at LHC also decisive [T. Linnecar]
- PS2, PS2+ collective effects may decude energy swing

potential for ions

- Requirement: need to have way through cascaded machine [R. Garoby]
- Present injection below transition in SPS [E. Shaposhnikova]
- With PS2, PS2+ ions wil be injected above transition
- N.c. vs. s.c. magnets; swing issues
- Prolems of s.c. approach: dynamic range of s.c. magnets, lack of manpower [W. Scandale, P. Lebrun]
- Questions of lifetime, vacuum, gas components etc [Peter Spiller]
- Ions in PS2 crucial; ions preferably fully stripped
- No lifetime issues in present machines
- Dynamic range an issue even for n.c. magnets [D. Tommasini]
- Upgrade for ions? Needs another accelerator – too expensive [R. Garodby]
- Homework: which kind of performance can we offer for ion performance in the future?
- PS2 nc. 800 G field for ion injection: OK [M. Benedikt]
- Only bare minimum will be guaranteed for ions in future upgrades of the PS [M. Benedikt, R. Garoby]

potential for neutrino physics

- Beta beams? Should not be considered here [W. Scandale]
- Neutrino physics? -> no argument for higher energy
- SPS with new injector -> real limitation is in the SPS
- high power source in front of PS already interesting for neutrinos [R. Garoby]
- no direct concern for PSs [R. Garoby]
- PS2 should not forbid the acceleration of radioactive ions [R. Schmidt?]
- possible implications for collimation [R. Assmann]
- stable ions in LHC are different
- better consider beta beams from the beginning in the design to prevent unacceptable uncontrolled distributed ion losses later on; s.c. option is not possible if beta beams are not taken into account from the start [P. Spiller]
- we should design the new injectors for maximum flexibility [J.-P. Koutchouk]

operation risk

- normal conducting ring is preferred

operation flexibility

- s.c. ring less flexible; cool-down and warm-up for several months?
- correction: cool-down 1 or 2 weeks
- risk can be reduced by conservative magnet design
- how frequent are beam losses in the present PS? [D. Tommasini]
- beam is lost a few times per day, since the PS has no dump system [G. Arduini]
- frequent changes of operating cycle; prone to mistakes
- new ring would follow different construction principles from present PS
- only a question of layout; target requirements to be defined
- superferric design much safer than other s.c. magnets [D. Tommasini]
- conservative design crucial for s.c. magnets
- high-current 4-T nuclotron cable from Dubna is safer than older cables; reaches 2x nominal current [P. Spiller]
- hollow-type nuclotron cable is used for cos theta magnet
- don't be afraid of quenches [R. Assmann]
- PS2 is much more important than LHC; the lower the beam energy the higher a reliability must be achieved [R. Garoby]
- risk can be minimized; PS2+ requires extremely conservative design
- penalty of s.c. design with respect to normalconducting one
- CERN seems to reach opposite conclusion to GSI
- better to use cold vacuum chamber if one wants a cold chamber, not s.c. magnets [P. Lebrun]
- PS2+ s.c. not superferric for higher energy [D. Tommasini]
- if we need higher energy: n.c. magnets -> larger ring; s.c. magnets -> smaller ring
- produce quantitative estimate of beam loss based on SPS (which has a dump); use SPS loss behavior to draw conclusions on PS2 s.c. option [J.-P. Koutchouk]
- why are the losses distributed around the machine, and why not concentrated on collimators? [P. Spiller]
- magnets should not define the acceptance; good orbit correction [P. Spiller]
- FNAL experiennce, Tevatron booster 30 Hz, RCS, simulation predict >90% collimator efficiency, in reality 50% of the losses are spread around the ring [V. Shiltsev]
- design for optimum efficiency; must be prepared for worst case?

operation flexibility cont'd

- controversial issue [W. Scandale]
- more compact ring would have less space-charge limitations
- injection at 3.5 or 4 GeV
- substantial space needed for transfer [M. Benedikt]
- resources & schedule important [P. lebrun]
- for n.c. option only study is needed; mo R&D necessary
- pulsed s.c. option requires R&D effort. perhaps in collaboration with GSI

transfer lines

- from PS2 or PS2+
- s.c. transfer lines?
- no strong arguments
- suggestion to build PS2 and leave space; and later add PS2+ in the same tunnel [T. Taylor]
- however this was not considered a likely or even attractive scenario

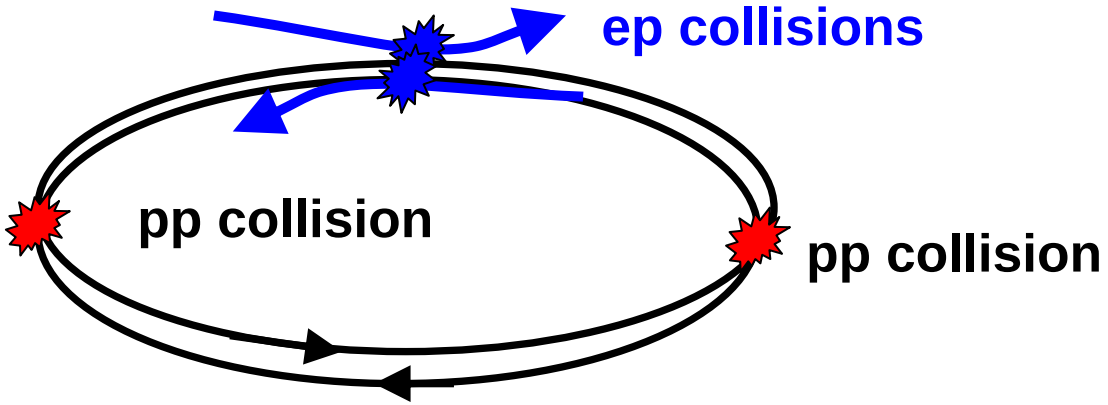
SPS injection system

- space needed

SPS items

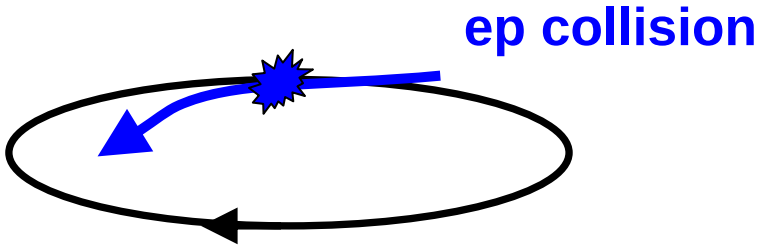
- Is higher SPS injection energy beneficial or a “showstopper”? - verify predictions!?!
- find technological solutions for e-cloud:
  - clearing electrodes based on double enamel coating (Fritz Caspers)?
  - comment by Gianluigi Arduini that electrodes did not help in the SPS (were they long/strong enough?)

schematic of LEL



LHC

using EL for SC compensation



PS
booster
or PS

using EL for SC compensation?

- much easier than head-on beam-beam compensation: 2 beams vs 4 beams, requires much less e- current, even more reduced e- density, easier profile control for larger beams
- huge potential pay off: no need for any injector upgrade!!
- first step towards beam-beam compensation
- test with e- cooler?