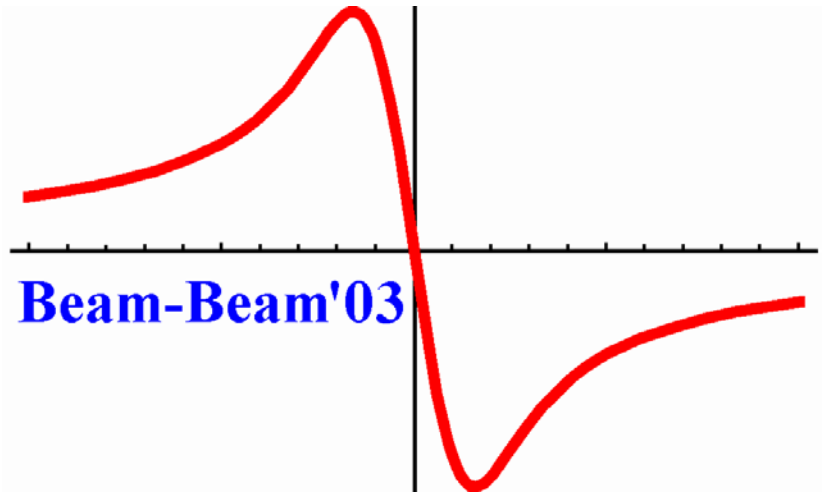
Beam-Beam ’03
Summary

T. Sen and W. Fischer

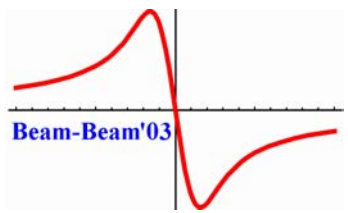


Montauk, Long Island
20 – 23 May 2003

Three questions:

1. Are coherent modes a real danger for hadron colliders?
2. Can long-range compensations schemes work in practice?
3. What can theory and simulations predict for collider performance?

[These questions are geared towards hadron colliders, but we do like to hear experiences from lepton machines and ideas from other fields.]



- Y. Alexahin, FNAL
- J. Ellison, University of New Mexico
- B. Erdelyi, FNAL
- W. Fischer, BNL
- L. Jin, University of Kansas
- W. Kozanecki, Saclay/SLAC
- K. Ohmi, KEK
- J. Qiang, LBNL
- J. Rogers, Cornell
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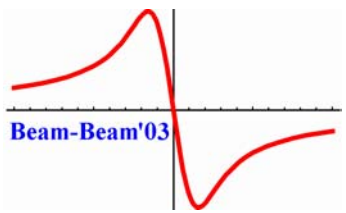
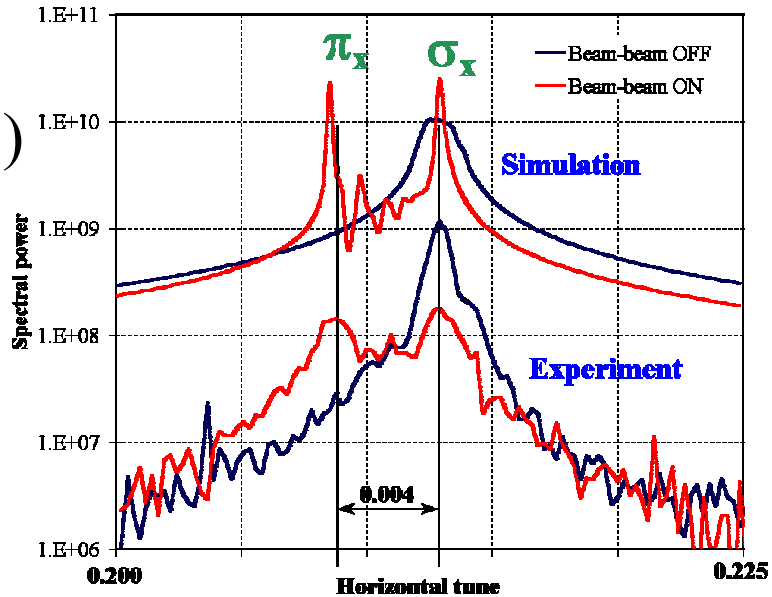
- A. Sobol, University of New Mexico
- J. Shi, University of Kansas
- V. Shiltsev, FNAL
- F. Zimmermann, CERN

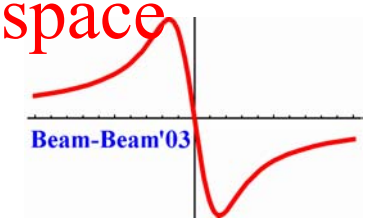


- Observations in hadron colliders:
  - π–modes in RHIC observed at expected frequency (Yokoya et al.)
  - Unstable p-beam in Tevatron blows up pbar-beam
  - Weak e^+-beam near low order resonance in HERA increases strong p-beam emittance

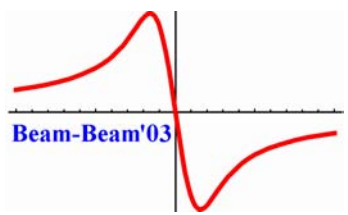
π-modes in RHIC



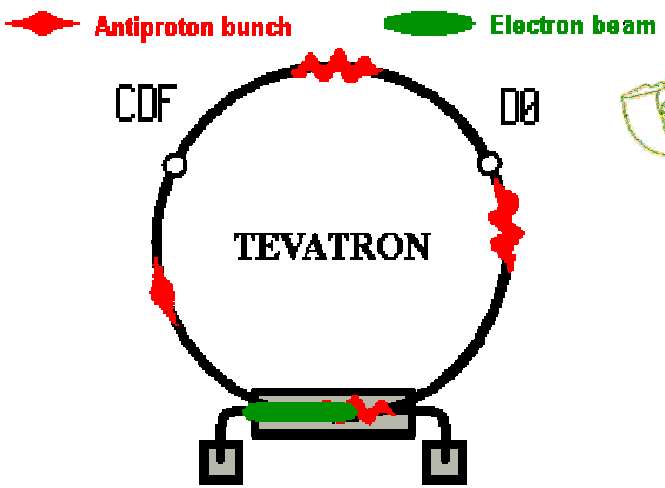
- Potential dangers:
  - π–modes may not be damped in hadron colliders
  - Coupled-beam resonances restrict the tune space

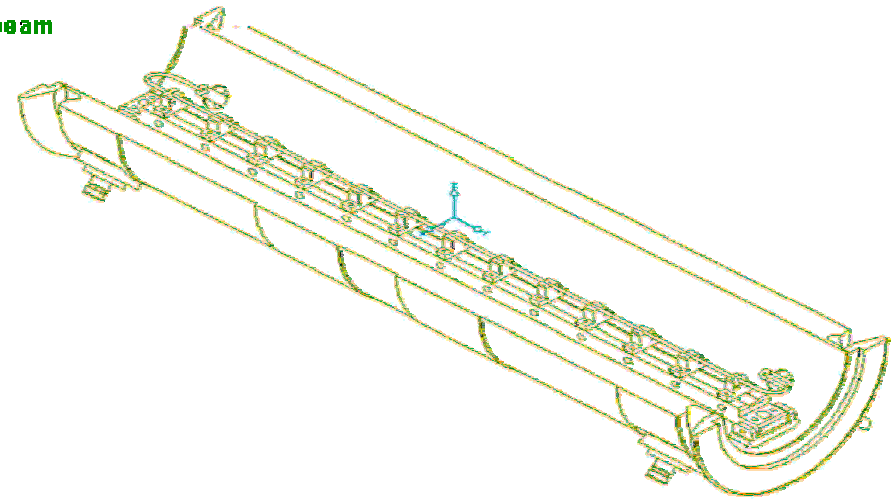


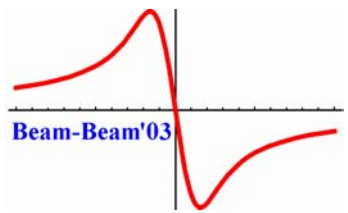
- Plans for the future:
  - Tevatron pbar intensities reach half the p intensity
  - RHIC beam-beam parameter is doubled
  - LHC operation with equal intensities
- π–modes may be suppressed by
  - Tune split between beams (works in RHIC so far)
  - Appropriate phase advances between IPs
  - Different intensities ($r < 0.6$)
  - Long bunches and synchrotron sidebands ($Q_s \sim \xi$)



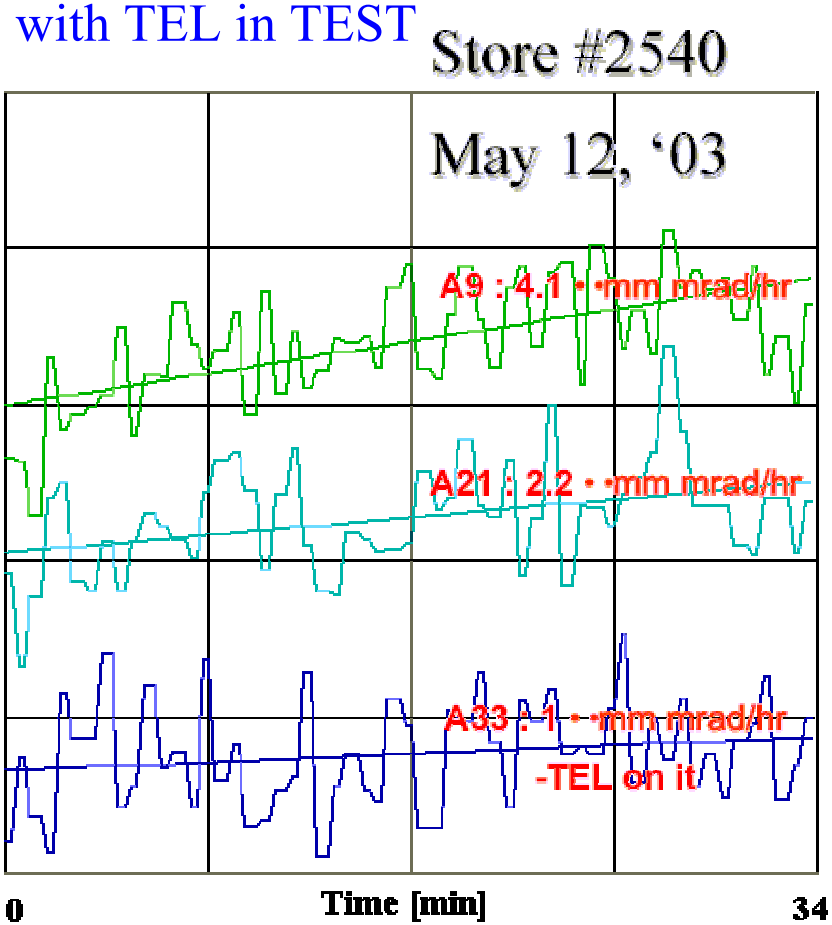
- Long-range interactions
  - Cause pbar losses during injection and ramp in Tevatron
  - Dominate dynamic aperture in LHC
- Two principal approaches:
  - Electron lens to compensate bunch-by-bunch tune shifts (Tevatron, Shiltsev et al.)
  - Wires cancel the 1/r force of other beam (LHC, Koutchouk et al.)





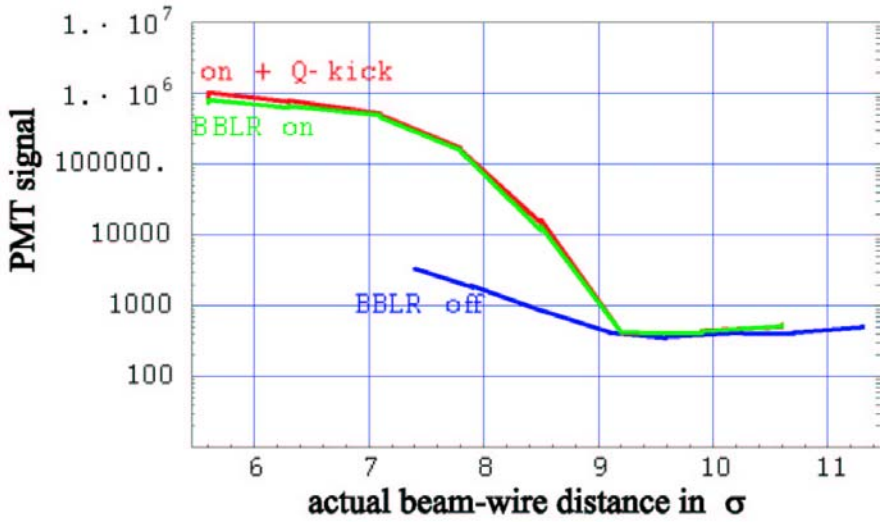


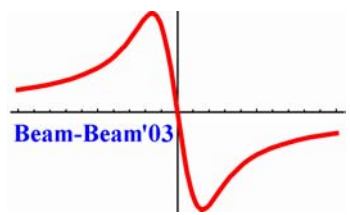
Reduced emittance growth with TEL in TEST



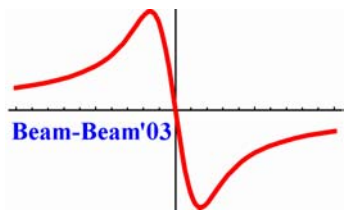
… TEL also used as a DC beam cleaner in HEP operation

SPS beam responds to wire simulating a beam at 9 σ, with increased background production



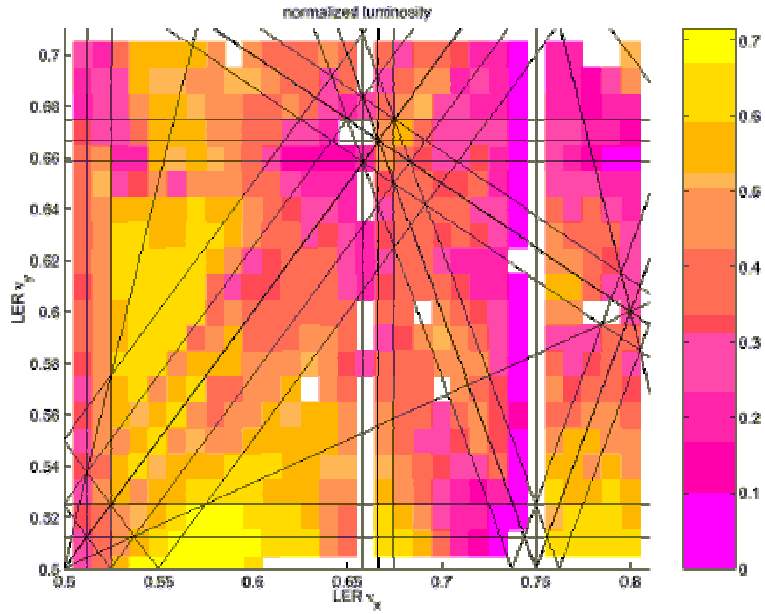


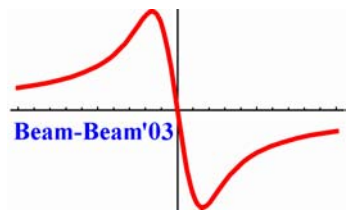
- Compensation effects of TEL must be demonstrated to be reproducible consistently
- With two TELs, tunes can be adjusted in both planes
- Installation of second SPS wire to study cancellation of effects of the first wire
- Wires are also under investigation for the Tevatron



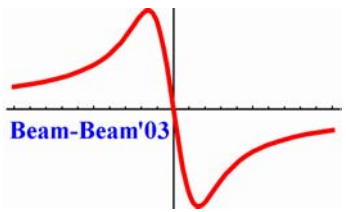
- Weak-strong simulations provide useful guidance for accelerator design
  - KEBK crossing angle decision
  - Reasonable agreement between measured and calculated dynamic aperture at Tevatron injection
  - LHC simulations show severity of long-range interactions
- Strong-strong simulations have gained real predictive power for lepton colliders
  - Luminosities reproduced within 10%
- Strong-strong codes should be benchmarked

PEPII Luminosity vs. (Q_x,Q_y)
Cai, Reichel





- In hadron colliders, large discrepancy between time-scale accessible with strong-strong simulations (~second) and time scales of interest (~hour)
- For comparable time-scales better algorithms and more computing power is needed
- Can averaging techniques be used to develop early indicators?
- To gain confidence in strong-strong simulations, benchmarking with well-designed machine experiments is required



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- M. Campbell, P. Manning,
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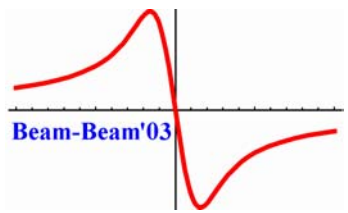
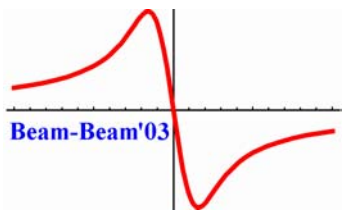
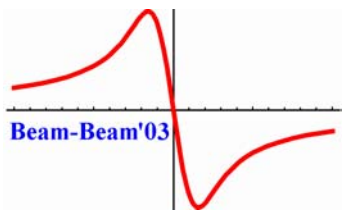
  N. Franco , F. Naase, …
  for quiet but effective support



- F. Zimmermann, CERN
  "Halo formation from beam-beam interaction"
- Y. Alexahin, FNAL
  "Coherent beam-beam effects, theory and observations"
- L. Jin, University of Kansas
  "Collective beam-beam instability in HERA"
- W. Fischer, BNL
  "Strong-strong observations in RHIC"
- W. Kozanecki, CEA-Saclay/SLAC
  "Beam-beam performance of the SLAC b-factory"
- K. Ohmi, KEK-ACC
  "Collision with finite crossing angle"
- W. Fischer, BNL
  "Luminosity in RHIC with six superbunches"



- T. Sen, FNAL
  "Beam-beam interaction at the Tevatron"
- B. Erdelyi, FNAL
  "Simulation and experimental studies at the Tevatron"
- W. Fischer, BNL
  "Tune modulation from unequal radio frequencies"
- V. Shiltsev, FNAL
  "Status of beam-beam compensation with TEL"
- J. Shi, University of Kansas
  "Global and local long-range compensation with magnets"
- K. Ohmi, KEK-ACC
  "Beam-beam effect for neutralized beams"
- J. Ellison, University of New Mexico
  "Weak-strong: averaging and tune diagrams"
- L. Jin, University of Kansas
  "Importance of tune spread for collective instability"



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  "Beam-beam simulations for hadron machines"
- J. Qiang, LBNL
  "Space charge and beam-beam simulations"
- J. Ellison, University of New Mexico
  "A new model for the 2DOF collective beam-beam interaction"
- J. Qiang, LBNL
  "A parallel computational tool for strong-strong / strong-weak beam-beam modeling"
- A. Sobol, University of New Mexico
  "Numerical calculation of the phase space density for the strong-strong beam-beam interaction"