ON THE POSSIBILITY
OF A
DEDICATED
\( \Phi \bar{\Phi} \)-COLLIDER FACILITY
PHYSICS OF 20 TeV $p\bar{p}$

- Jets (QCD) observable to
  $P_T \approx 5000$ GeV
  Structure of Quarks ??

- New Interactions Manifest
  Abnormally ($W'$s, $Z'$s)
  $\sigma_W = 5 \times 10^{-31}$ cm$^2$
  Rate $\approx$ 50/sec

  Search for Sequential $W'$

  - Multiple $W'W$ Production

  - Explore Higgs Sector
    New Particle $\sim 1$ TeV
    Domain, $M_H = 0.5$

  - Instrumentation must be
    Completely Renounced.
    $<m> = 100$; Jet Dominance;

MULTIPLE INTERACTIONS / CROSSING

$\sigma = \frac{1}{x}$

<table>
<thead>
<tr>
<th>$\sigma_{tot}$</th>
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<tbody>
<tr>
<td>10 TeV $\quad$ 90 mb $\quad$ 100 mb</td>
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<tr>
<td>30 TeV $\quad$ 120 mb $\quad$ 160 mb</td>
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\[ p_{T1} = \sigma \cdot \frac{1}{m} \cdot \frac{1}{2} = \frac{4 \times 10^{-20} \sigma}{m} \]

For $p_{T1} \approx 1$

\[ \frac{p}{m} = 2.3 \times 10^{-8} \quad \text{or} \quad m \approx 430 \]

- Very Large # of Bunches $= 430$
- Bunch Distance for $m = 430 = 60 \mu s$
  or $18 \mu s$
- Bunch Density $n_b = 7 \times 10^3$/bunch

Need Farsky Separation Scheme
**Very small aperture magnets?**

The maximum transverse excursion of a particle beam in an accelerator is given as

\[ \Delta x = \sqrt{E} \frac{B}{f} \]

as a function of (raising) energy E.

The emittance is dimensionally defined as

\[ \epsilon = \frac{E_0}{\epsilon} \]

Time force \[ \Delta x = \frac{1}{\sqrt{E}} \] or "area"

\[ \sigma = \frac{E}{(\Delta x)^2} \sim \frac{1}{E} \quad \text{at higher energies, bettas become smaller.} \]

In order to keep both small, \( \beta \) must also be small. In turn this means strong focussing.

Gradients \[ K = \frac{1}{\beta} \frac{d\beta}{dx} \]

small alignment & gradient errors become more important and closed orbit for equilibrium particle is distorted.

This needs additional aperture.
Clearly, the advantage of producing the aperture is lost.

Assume a constant ratio between machine errors and closed orbit deviations:

\[ \beta \sim \sqrt{R} \quad \text{K = Const.} \]

Tune = \( \alpha \sim \sqrt{R} \quad \Delta \chi_{\text{beam}} \sim 2 \alpha \frac{g}{\beta} \]

For a cascaded sequence of accelerators with same beam and same fields \( E \sim R \)

\[ \Delta x_{\text{beam}} \sim E^{1/4} \Delta x_{\text{machine}} = \text{const.} \]

Ways out:

- Use stronger magnetic fields, thus rise \( E \) without changing \( R \)
- Use beam itself to correct orbit dimensions (cybernetic accelerator)

**Basic Formula**

\[
\begin{align*}
L &= \frac{1}{4 \alpha} \frac{N_s N_w f_1}{\Delta \alpha g} \quad \text{(From Basic Limit)} \\
R &= f_1 \frac{\alpha}{4 \alpha} \left( N_s N_w f \right) \\
\text{Beam - Beam Tune Start Limit} \\
D_q &= \frac{N_s}{\beta} \leq D_c \\
L &= \frac{\frac{1}{4} D_c N_w}{f_1} \\
D_c &= \frac{2 \Delta \alpha g}{f_1 \beta^2} \\
\text{From SPS Collider we know } \Delta \alpha &\approx 3 \times 10^{-3}
\end{align*}
\]

Take \( f_1 = 11.5 \text{kHz} \) (LPC Tunnel)

\[
N_w = N_s = 2 \times 10^{12}, \quad \beta^* = 0.3 \text{ m} \\
\text{(accelerating energy)}
\]

\[
L = 1.5 \times 10^{-3} \text{ E(TeV)} \text{ cm}^{-1} \text{ sec}^{-1}
\]