CLIC Magnet Stabilization Studies

(TUP88)

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1. Introduction
2. CLIC Stability Study - experimental setup
3. Highlights of experimental achievements
4. Conclusions
1. Introduction - Stability issues in linear colliders

The luminosity depends strongly on the relative beam-beam offset:

\[
L \approx L_0 e^{-\frac{\Delta y^2}{4\sigma_y^2}}
\]

Final focus quads must be stable to a fraction of the colliding beam size!!

**Tolerances for 2% luminosity reductions**

<table>
<thead>
<tr>
<th>Magnet</th>
<th>(N_{magnet})</th>
<th>(f_{min})</th>
<th>(I_x)</th>
<th>(I_y)</th>
<th>Is this really achievable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linac</td>
<td>2600</td>
<td>4 Hz</td>
<td>14 nm</td>
<td>1.3 nm</td>
<td></td>
</tr>
<tr>
<td>Final Focus</td>
<td>2</td>
<td>4 Hz</td>
<td>4 nm</td>
<td>0.2 nm</td>
<td></td>
</tr>
</tbody>
</table>

**CLIC:**

\(E_{cm} = 3 - 5\) TeV  
\(L = 0.8 \times 10^{35}\) cm\(^{-2}\)s\(^{-1}\)  
\(P_b \approx 2 \times 15\) MW  
\(\sigma_x \times \sigma_y = 60\) nm \(\times 0.7\) nm
2. CLIC Stability Study

Activities from January 2001 to December 2003
People: R. Assmann, W. Coosemans, G. Guignard,
S. Redaelli, D. Schulte, I. Wilson, F. Zimmermann

Goal:
Demonstrate the feasibility of colliding nanometre-size particle beams in CLIC

How well can we stabilize magnets in a real accelerator environment?

Our approach: use state-of-the-art stabilization devices to stabilize CLIC prototype quadrupoles in a normal working environment.
The CLIC test stand for vibration measurements and magnet stabilization:

The experimental setup includes:

- **Sensors for vibration measurements** (geophones)
- Honeycomb table (virtually) with no internal resonances
- Prototypes accelerator magnets
- **State-of-the-art stabilization equipment**
- Stretched-wire system for alignment measurements
3. Achieved quadrupole stability

CLIC prototype magnets stabilized to the sub-nanometre level !!

**Above 4Hz:** 0.43 nm on the quadrupole instead of 6.20 nm on the ground.
Ok, this is good. But is it **stable?**

Quadrupole vibrations kept below the 1 nm level over a period of 9 consecutive days!
4. Conclusions

The CLIC Stability Team has demonstrated the principle feasibility of colliding nanometre-size beams in future linear accelerators like CLIC:

✓ For the first time, a prototype quadrupole was stabilized to 0.5 nm above 4 Hz in a normal working area.

✓ Stabilization below 1 nm continuously for several days.

✓ Horizontal stability within tolerances.

✓ Simulations of time-dependent CLIC luminosity indicate that 70% of the nominal luminosity can be achieved!

Outlook

✓ Stabilization performance on more realistic quadrupole prototypes

✓ Study integration of tested devices in the CLIC detector region