LINAC 2004
XXII International Linear Accelerator Conference
Lübeck, Germany, 17 August 2004

CLIC Magnet Stabilization Studies

(TUP88)

R. Assmann, W. Coosemans, G. Guignard,
S. Redaelli, D. Schulte, I. Wilson, F. Zimmermann

CERN AB-ABP
Geneva, Switzerland

1. *Introduction*
2. *CLIC Stability Study - experimental setup*
3. *Highlights of experimental achievements*
4. *Conclusions*

1. Introduction - Stability issues in linear colliders

N_e = particles per bunch
N_b = number of bunches
f_{rep} = repetition frequency
σ_x,σ_y = colliding beam sizes
P_b = beam power

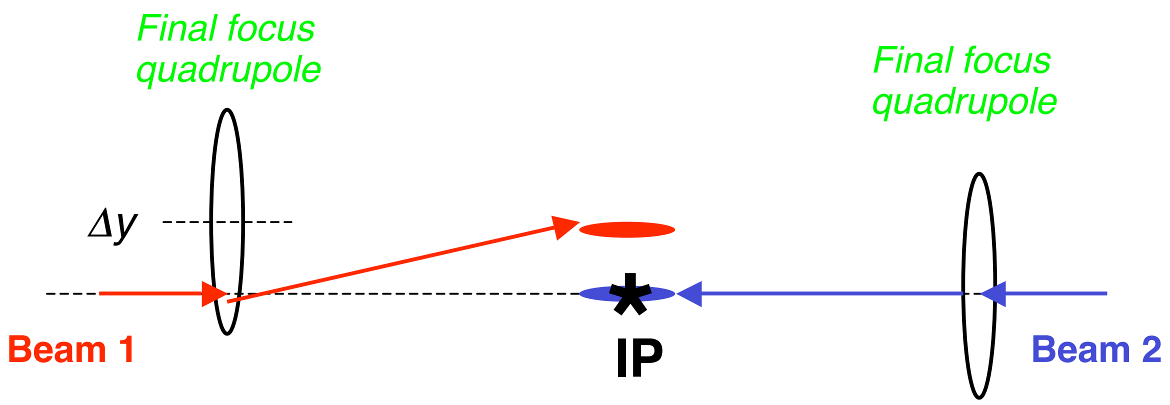
Luminosity in linear colliders:

$$\mathcal{L} = \frac{N_e^2 N_b f_{\mathrm{rep}}}{4\pi\sigma_x^*\sigma_y^*}\mathcal{H}_d \approx \frac{P_b}{\sigma_x^*\sigma_y^*}$$

CLIC:

E_{cm} = 3 - 5 TeV
L = 0.8 x 10^{35} $cm^{-2}s^{-1}$
$P_b \approx$ 2 x 15 MW
σ_x x σ_y = 60 nm x **0.7 nm**

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



$$\mathcal{L} \approx \mathcal{L}_0 e^{-\frac{\Delta y^2}{4\sigma_y^{*2}}}$$

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

Tolerances for 2% luminosity reductions

Magnet	N_{magnet}	f_{min}	I_x	I_y
Linac	2600	4 Hz	14 nm	1.3 nm
Final Focus	2	4 Hz	4 nm	0.2 nm

Is this *really* achievable?

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:

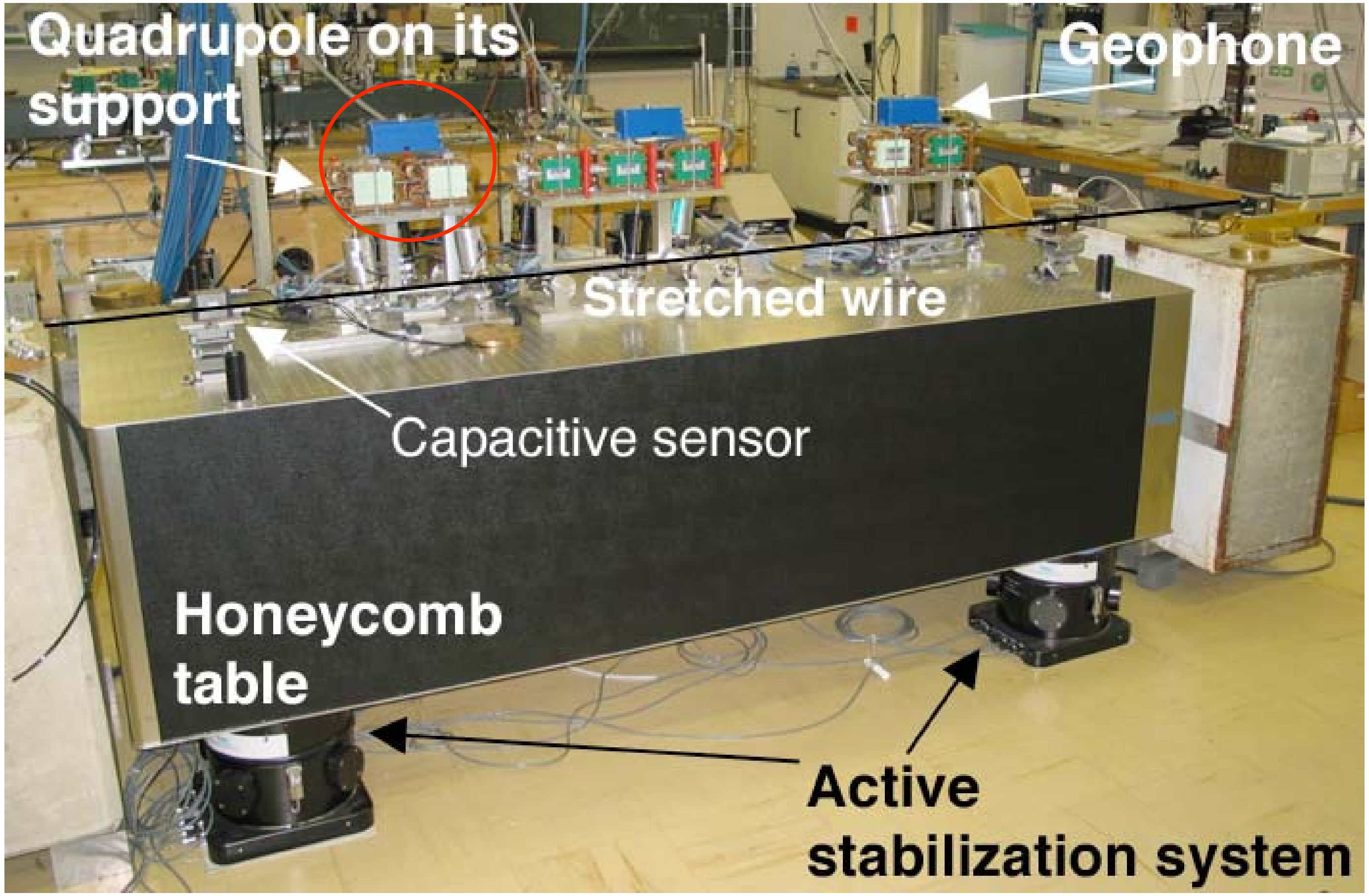
Demonstrate the feasibility of colliding nanometre-size particle beams in CLIC

⇩

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:

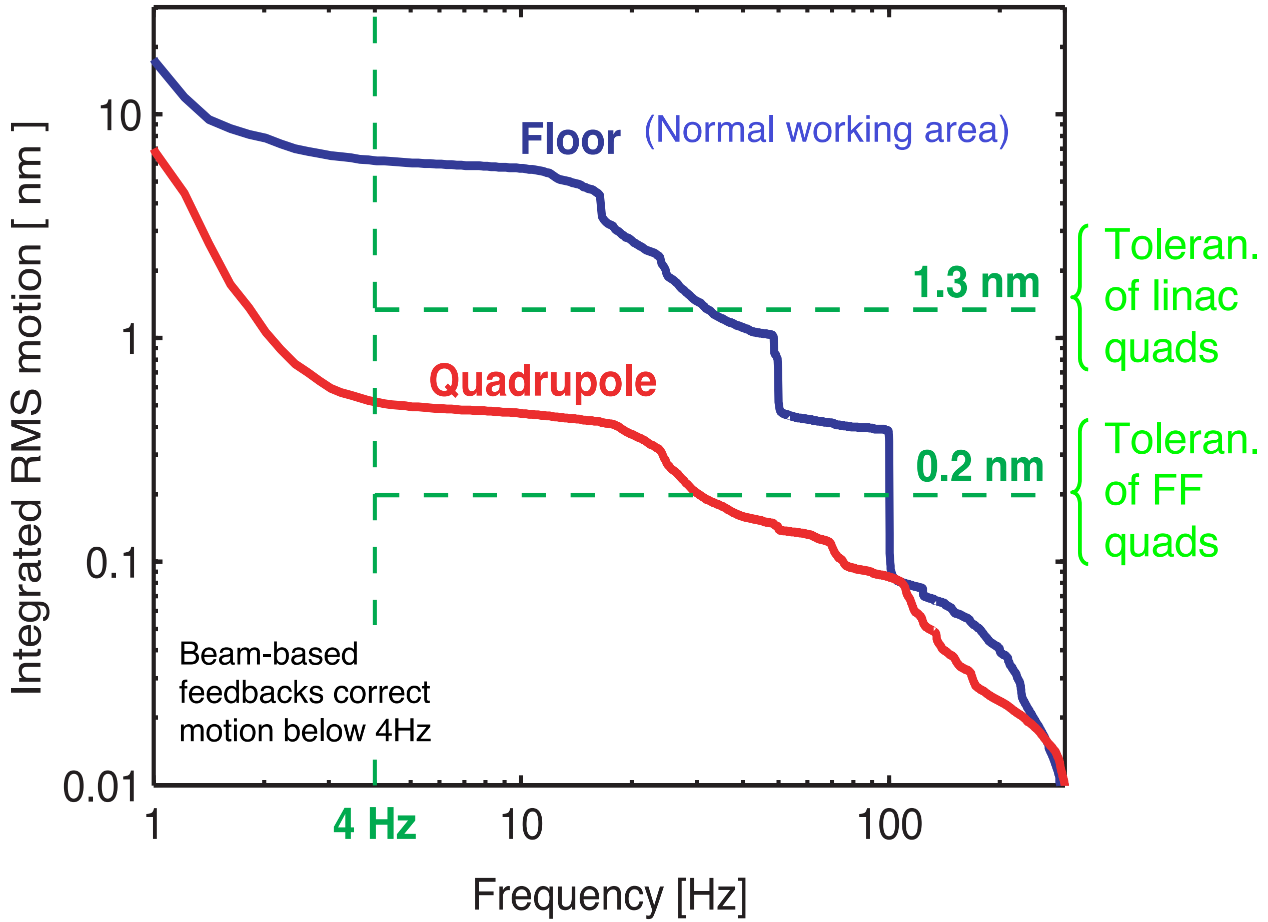
- **Sensors for vibration measurements** (geophones)
- Honeycomb table (virtually) with no internal resonances
- Prototypes accelerator magnets
- **State-of-the-art stabilization equipment**
- Stretched-wire system for alignment measurements

3. Achieved quadrupole stability

RMS vibrations above 4 Hz

	Quad [nm]	Ground [nm]
Vertical	**0.43**	**6.20**
Horizontal	**0.79**	**3.04**
Longitud.	4.29	4.32

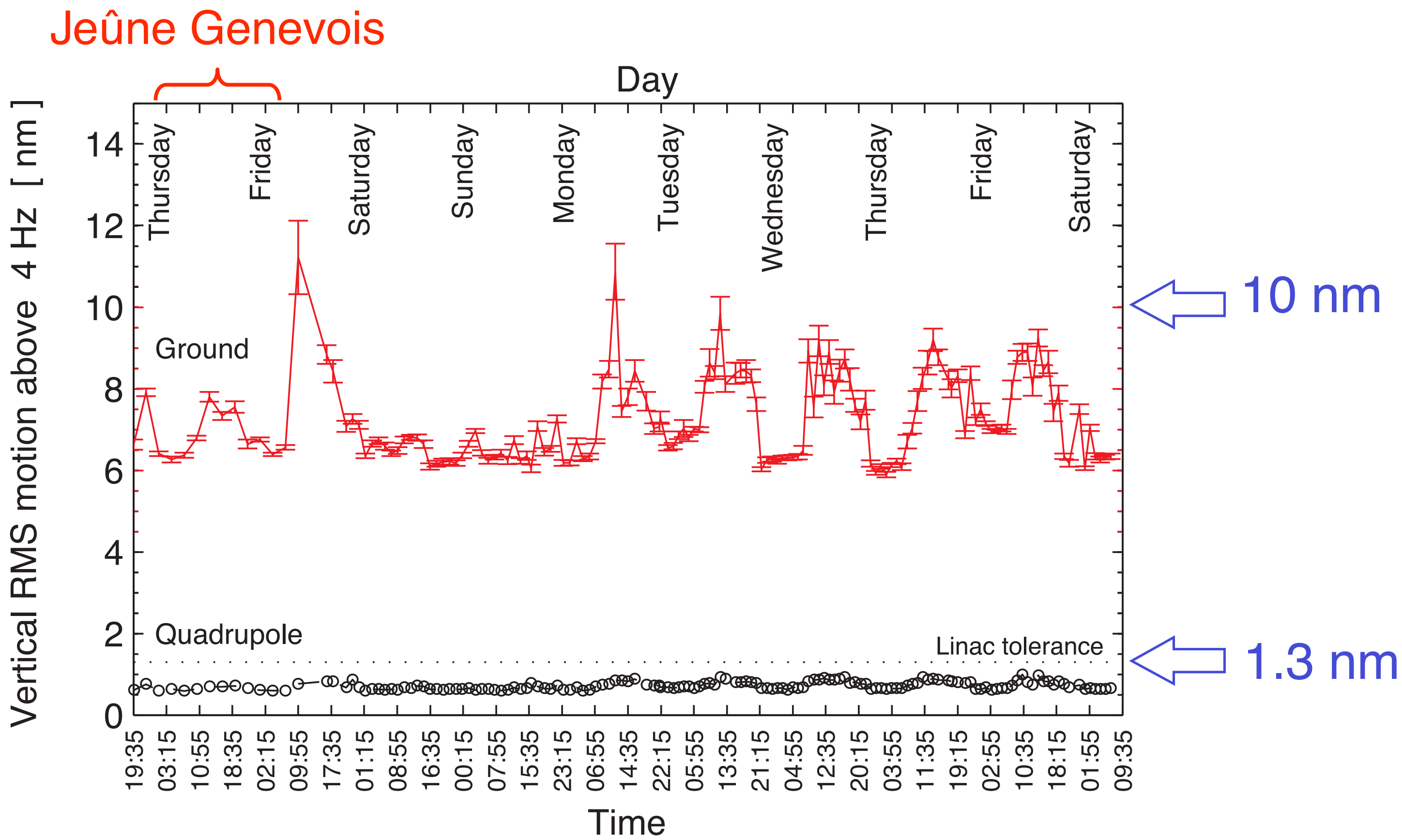
Integrated *vertical* RMS motion versus frequency



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