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or

from Two-To-One beam test stand

M. Jacewicz, M. Olvegård, R. Ruber, V. Ziemann, J. Ögren

With many thanks to Wilfrid Farabolini and
all other CTF colleagues who help us over the years

CALIFES Workshop 10-12/10/2016

Outline

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- Two-beam Test Stand
  - Effects of high-gradient on beam
  - Mutipolar components – octupole
- Increase in Califes capabilities – ideas

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Two-Beam Test Stand

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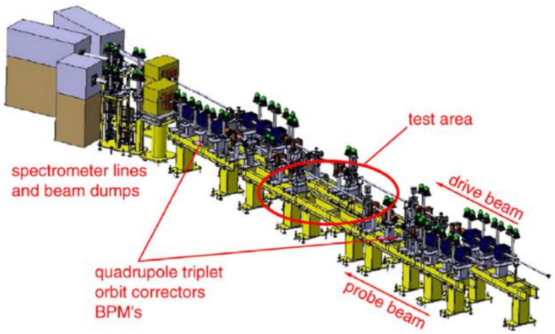
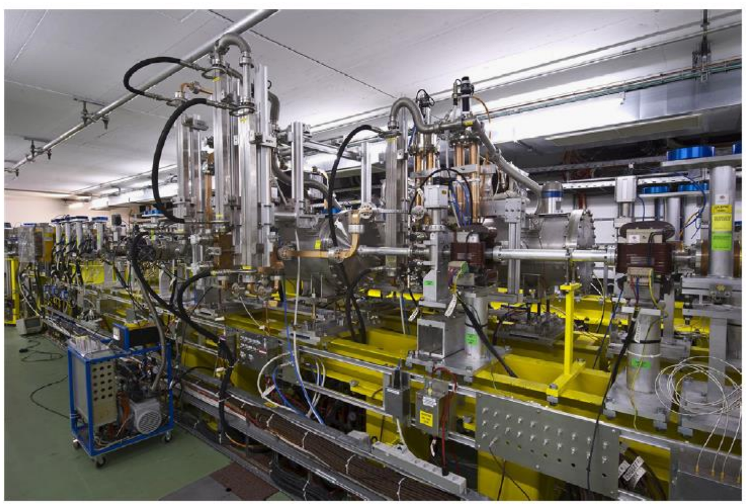
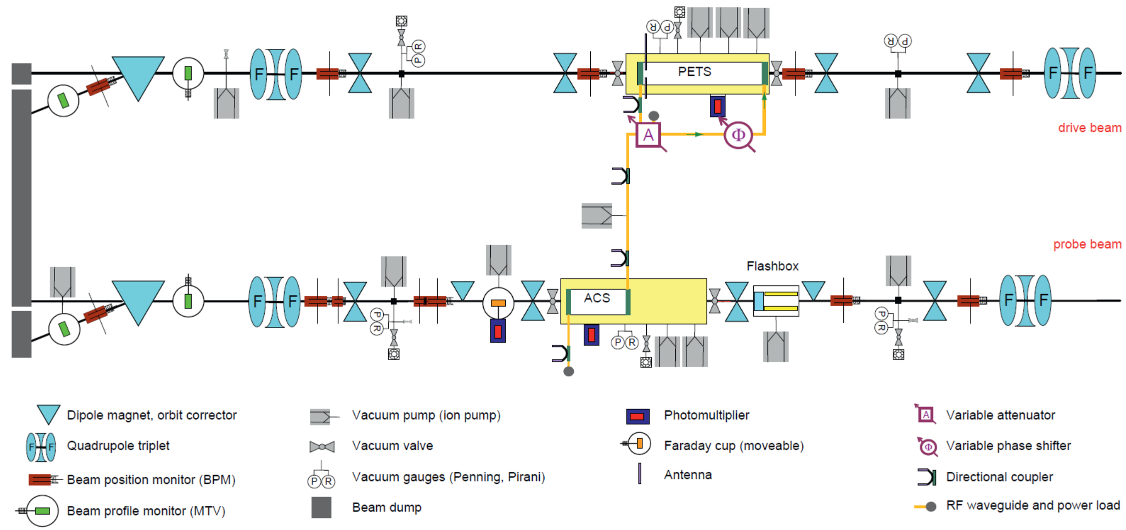
Uppsala's main contribution

- from planning via realization to experimental results
- funding from Swedish VR and Wallenberg Foundation







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Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

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The CTF3 Two-beam Test Stand

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[a] Uppsala University, Uppsala, Sweden
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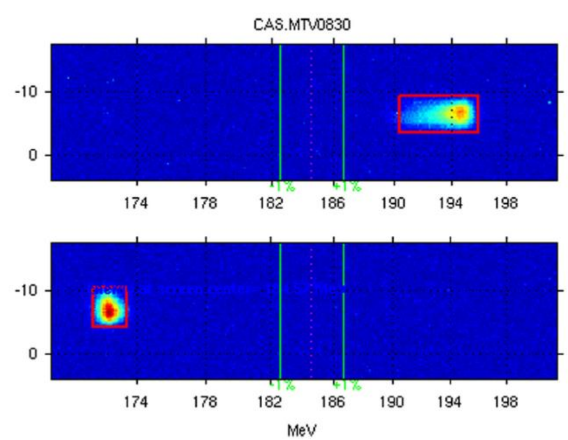

CTF3-Note-095

Upgrade Scenarios for the TBTS

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Department of Physics and Astronomy
Uppsala University

Roberto Corsini, Germana Riddone
Beams Department
CERN

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RF Breakdown Studies

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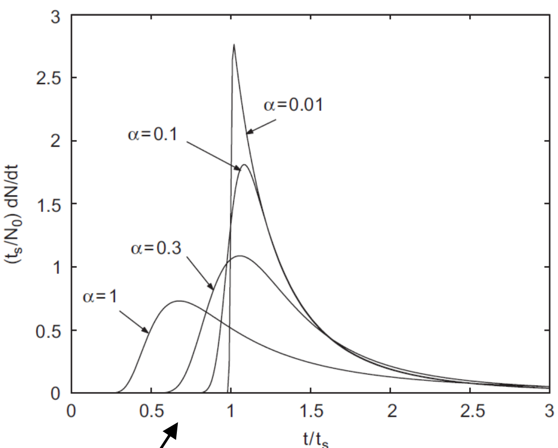
Hot Coulomb Explosions

Magnus Johnson's Licentiate thesis



Theory:

- **electrons are removed from plasma created during RF breakdown**
- **the remaining ions to undergo a Coulomb explosion.**

Theoretical and experimental verification at 30GHz test stand

Model of arrival time spectrum for ions with different temperature with 3 free parameters fitted to data

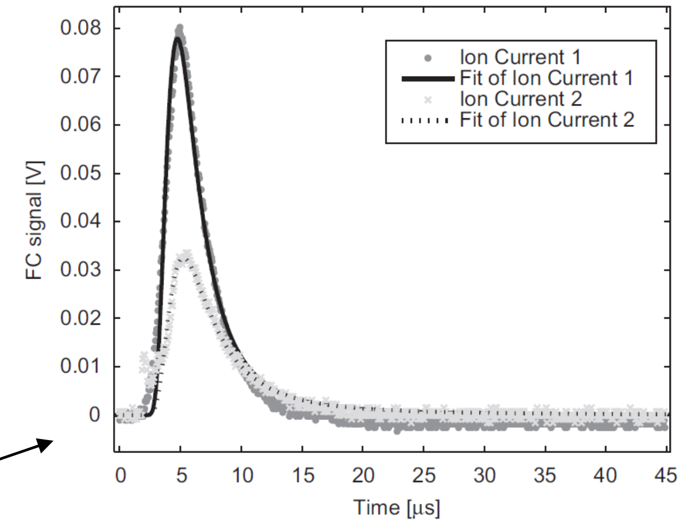


Fig. 2. Fit of theory to two ion current events. The signal from breakdown

Table 1
Resulting fit parameters

Ion current event	ηN_0	α	t_s (μs)	T (K)	v_s (m/s)
1	4.3×10^{10}	0.34	4.6	8.4×10^5	2.2×10^4
2	3.6×10^{10}	0.49	5.5	12×10^5	1.8×10^4

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Nuclear Instruments and Methods in Physics Research A 575 (2007) 539–541
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A
www.elsevier.com/locate/nima

Technical note

The arrival-time spectrum of hot Coulomb explosions

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Received 3 January 2007; received in revised form 25 February 2007; accepted 26 February 2007
Available online 5 March 2007

Nuclear Instruments and Methods in Physics Research A 595 (2008) 568–571
Contents lists available at ScienceDirect
Nuclear Instruments and Methods in Physics Research A
journal homepage: www.elsevier.com/locate/nima
ELSEVIER

Arrival time measurements of ions accompanying RF breakdown

M. Johnson [a,*], R. Ruber [a], V. Ziemann [a], H. Braun [b]

[a] Uppsala University, Sweden
[b] CERN, Geneva

RF Breakdown Studies

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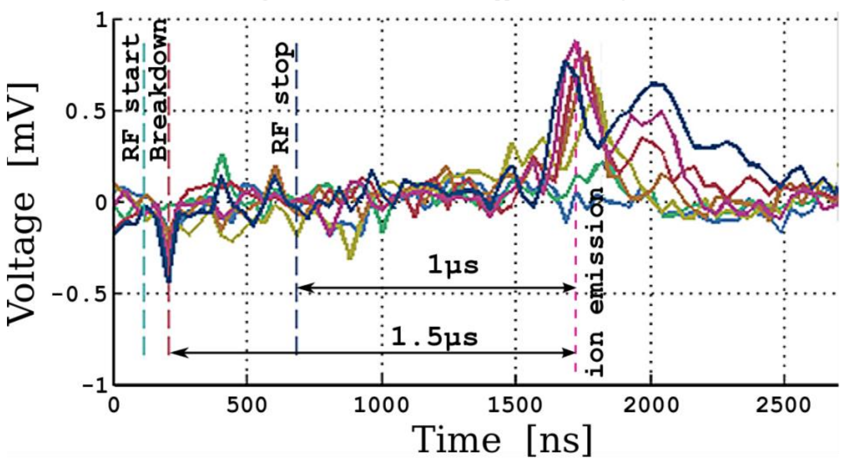
Spectrometers

Flashbox at TBTS: Time resolve spectra of electron and ion emission from RF breakdowns

Proceedings of IPAC2013, Shanghai, China MOPWA038

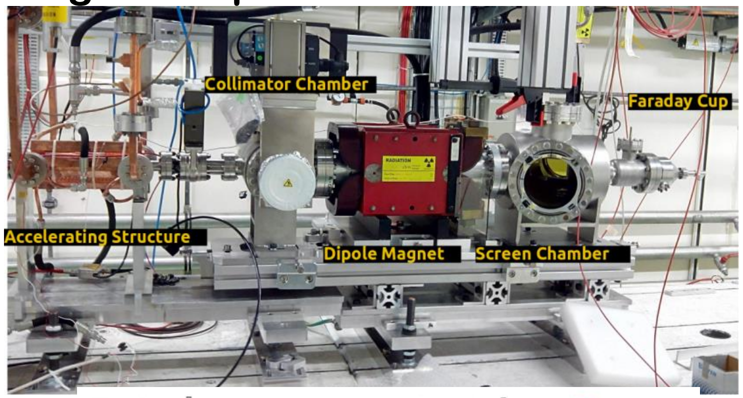
FLASHBOX COMPACT BEAM SPECTROMETER AND ITS APPLICATION TO THE HIGH-GRADIENT ACCELERATION STUDY

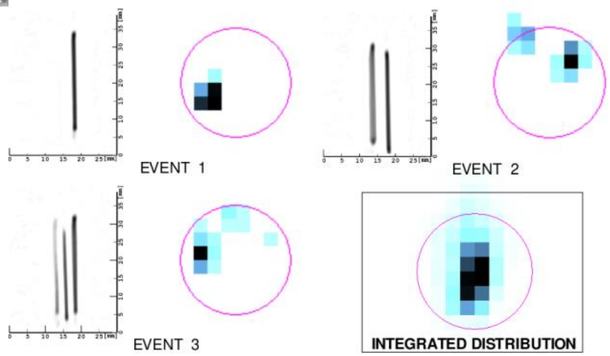
Alexey Dubrovskiy, JINR, Dubna, Russia and CERN, Geneva, Switzerland
Frank Tecker, CERN, Geneva, Switzerland
Marek Jacewicz, Roger Ruber, Volker Ziemann, Uppsala University, Sweden



Needs klystron powered structure

Magnetic spectrometer at XBOX2





Transverse position reconstruction of BD locations

THPME171 Proceedings of IPAC2014, Dresden, Germany

GENERAL-PURPOSE SPECTROMETER FOR VACUUM BREAKDOWN DIAGNOSTICS FOR THE 12 GHZ TEST STAND AT CERN*

M. Jacewicz†, Ch. Borgmann, J. Ögren, R. Ruber, V. Ziemann, Uppsala University, Uppsala, Sweden

Nuclear Instruments and Methods in Physics Research A 828 (2016) 63–71

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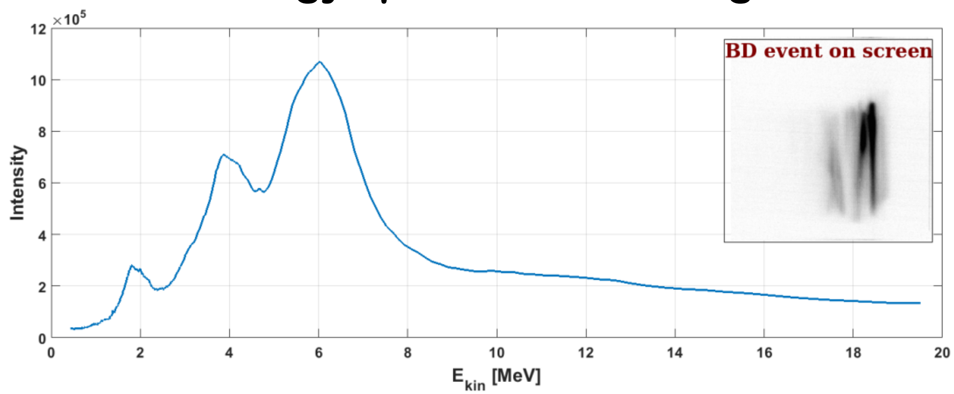
Spectrometers for RF breakdown studies for CLIC

CrossMark

M. Jacewicz [a,*], V. Ziemann [a], T. Ekelöf [a], A. Dubrovskiy [b], R. Ruber [a]

[a] Uppsala University, Uppsala, Sweden
[b] CERN, Geneva, Switzerland

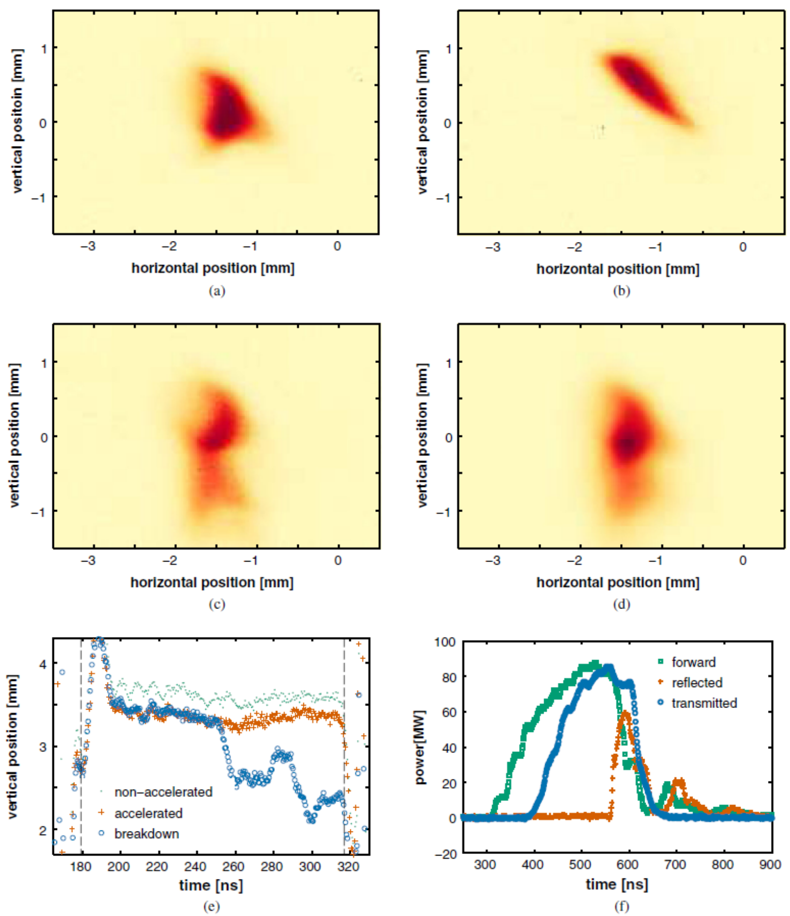
Electron energy spectrum from single BD



RF Breakdown Studies

Breakdown-kicks

Transverse momentum kick to the beam will lead to beam emittance growth, with subsequent degradation of the collider luminosity



PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 16, 081004 (2013)

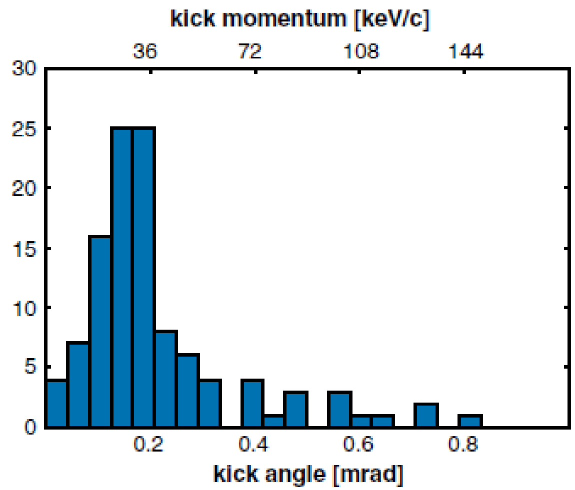
Effects of rf breakdown on the beam in the Compact Linear Collider prototype accelerator structure

A. Palaia,* M. Jacewicz, R. Ruber, and V. Ziemann
Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden

W. Farabolini
CEA IRFU Centre d'Etudes de Saclay, France

(Received 18 January 2013; published 27 August 2013)

Andrea Palaia's PhD thesis



Worst case scenario
RF breakdown in first part of CLIC linac → 4 μrad
Up to 90% geometrical luminosity loss but far from hitting sensitive structures

The study worth continue with the following improvements:

- Better structure alignment
- Stable conditions and higher statistics (klystron driven cavity at 25Hz)
- Measurement of beam energy
- Dependence on power level/pulse length

Two-Beam Test Stand

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RF octupole component

Jim Ögren's forthcoming PhD thesis

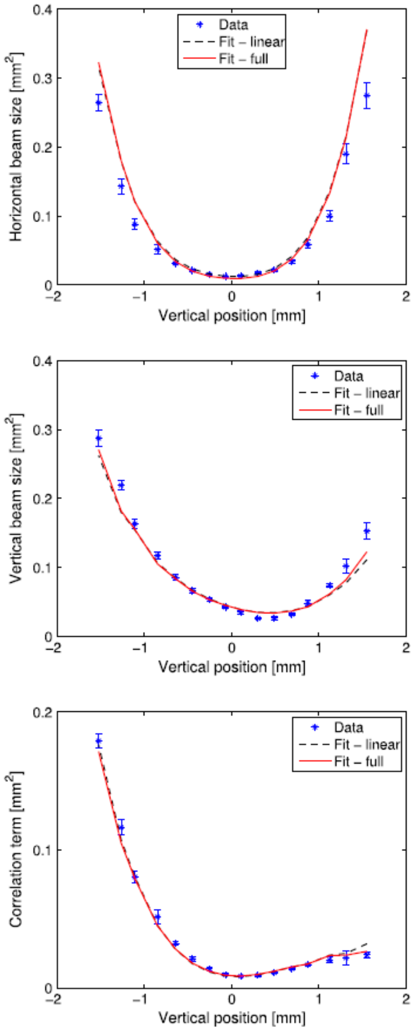
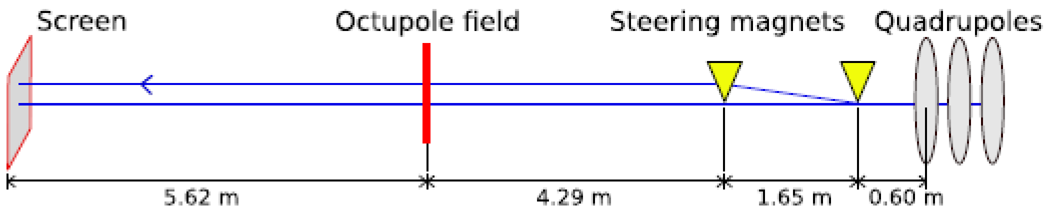


FIG. 8. The horizontal beam size (top), vertical beam size (middle) and correlation term (bottom) at different vertical positions and the fit of the linear expressions in (10)–(12) and the full analytical expressions (A11)–(A13). From the fits we retrieve the full transverse beam matrix just upstream the octupole, including all correlations. Furthermore, we can see a slight improvement using the full analytical expressions.

RF fields in the CLIC structure have an octupolar component 90° out of phase of the main accelerating field



Transverse scan of the beam

change in beam position gives strength of the octupole component

change in beam size gives incoming transverse beam matrix

PHYSICAL REVIEW SPECIAL TOPICS—ACCELERATORS AND BEAMS **18,** 072801 (2015)

Measuring the full transverse beam matrix using a single octupole

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Department of Physics and Astronomy, Uppsala University, S-75120, Uppsala, Sweden

W. Farabolini

CERN, CH-1211 Geneva-23, Switzerland and CEA, IRFU Centre d'Etudes de Saclay, F-91191, France

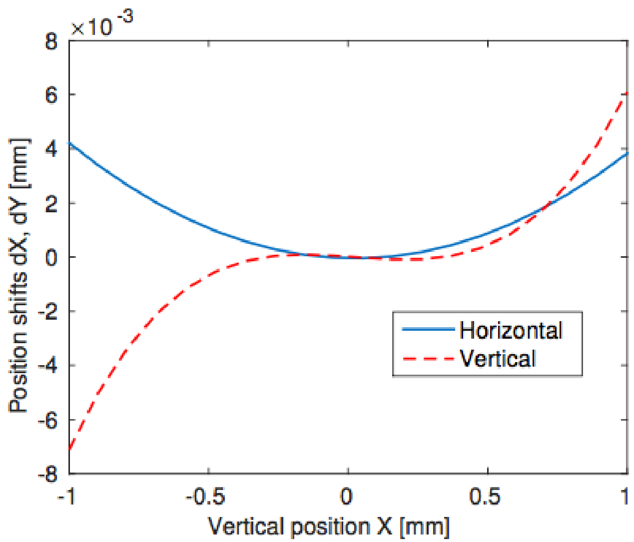
(Received 6 March 2015; published 9 July 2015)

Two-Beam Test Stand

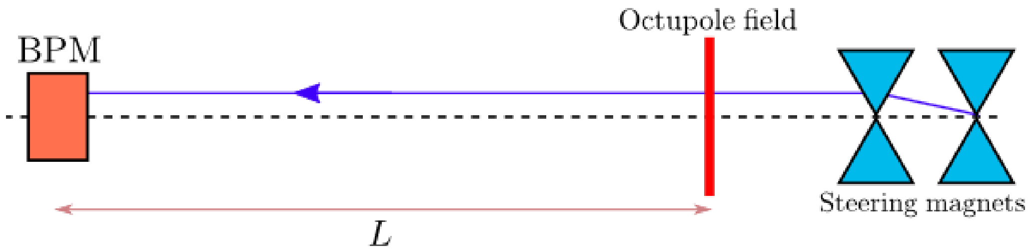
Beam based alignment

From the beam position shifts due to the octupole component of the RF fields we can also determine the center of accelerating cells.

This can be used as a beam-based alignment method.



Beam position shifts due to octupole kicks



Scan the beam transversely using steering magnets or by moving the girder

MOPMR022 Proceedings of IPAC2016, Busan, Korea

BEAM-BASED ALIGNMENT OF CLIC ACCELERATING STRUCTURES UTILIZING THEIR OCTUPOLE COMPONENT

J. Ögren * and V. Ziemann, Uppsala University, Uppsala, Sweden

ONGOING experimental work …

Ideas for extension

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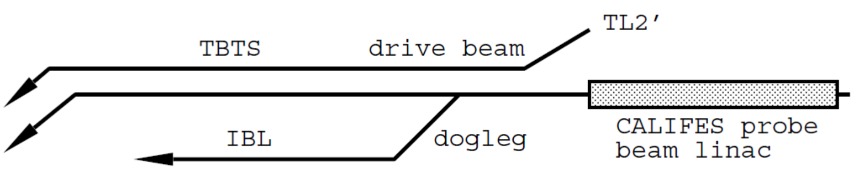
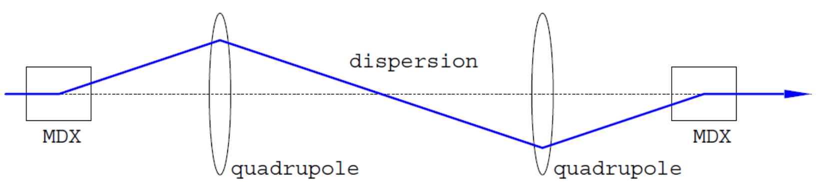
Short Pulse Capabilities of the Instrumentation Beam Line

V. Ziemann
Department of Physics and Astronomy
Uppsala University, Uppsala, Sweden

Draft of May 6, 2010



Use dog-leg as bunch-compressor

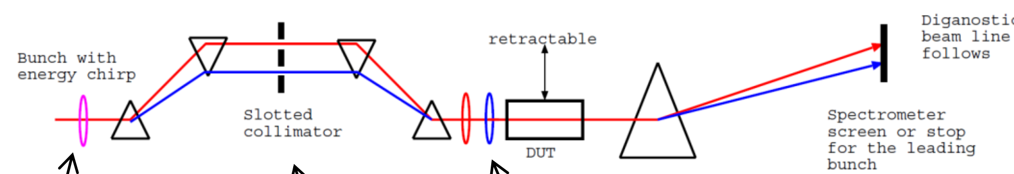


$$\sigma_{z1}^2 = (1 - R_{56} k \tan\phi_0)^2 \sigma_{z0}^2 + R_{56}^2 \sigma_{p0}^2$$

Optimize R_{56}, k, ϕ_0 to get a few tens of μm long bunches

CTF-Note-105 (RR+VZ) (2014)

Ideas about measuring short range wake fields in accelerating structures for high-energy and free-electron laser linear accelerators



'Long' bunch with energy chirp

Blue: makes wake-field
Red: is affected by w.f.

Slotted collimator projects out short bunchlets (idea from LCLS)

Supporting idea presented by Andrea Latina on Monday

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Diagnostics of large momentum spread beams

Maja Olvegård's PhD thesis

Segmented beam dump

Nuclear Instruments and Methods in Physics Research A 707 (2013) 114–119

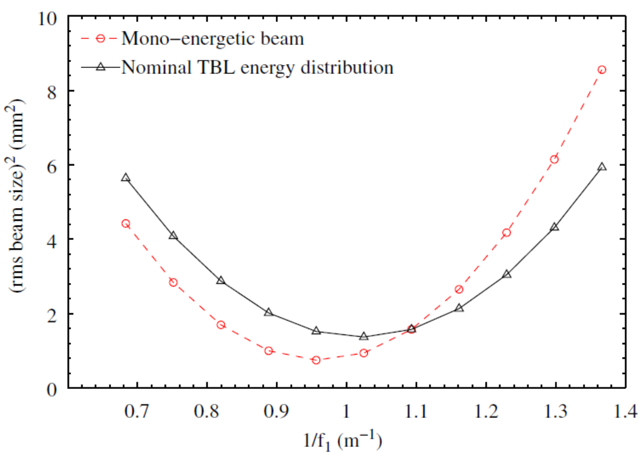
Contents lists available at SciVerse ScienceDirect

Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

Effect of large momentum spread on emittance measurements

M. Olvegård*, V. Ziemann



- Higher emittance
- Change in the Twiss parameters.

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 16, 082802 (2013)

Beam profile monitoring at the test beam line at the Compact Linear Collider test facility

M. Olvegård,[1,2,*] E. Adli,[1,3] W. Andreazza,[1] B. Bolzon,[1] E. Bravin,[1] N. Chritin,[1] A. Dabrowski,[1] S. Döbert,[1] M. Duraffourg,[1] T. Lefèvre,[1] R. Lillestøl,[1,3] and V. Ziemann[2]

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(Received 30 March 2012; revised manuscript received 18 January 2013; published 27 August 2013)

Nuclear Instruments and Methods in Physics Research A 797 (2015) 234–246

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

Time-resolved momentum and beam size diagnostics for bunch trains with very large momentum spread

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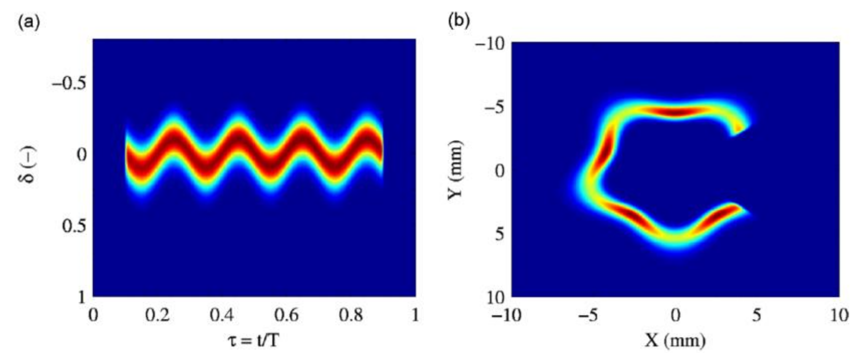
[a] Uppsala University, Department of Physics and Astronomy, Box 516, 751 20 Uppsala, Sweden
[b] CERN, European Organization of Nuclear Research, 1211 Genève 23, Switzerland



Method related to using time-varying transverse fields to obtain information about the beam
Two kicker magnets 'paint' beam on OTR screen
Two sweeps: circular and linear

Use at CLIC main beam after IP or end of drive beam

Could it be tested in Califes?
Need many bunches with high charge per bunch
Need kicker magnets – reuse from CTF?

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Conclusions

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<u>**Cavity test stand with klystron**</u>

would allow us to revisit

- **High gradient experiments**
  - **More kicks**
  - **More ion studies**
- **Diagnostics with octupole fields**

Bigger ideas, more investments required

- **Extending CALIFES with short bunch capabilities**
- **Creating drive and witness beamlets to study effects of short-range wakefields**
- **Large momentum spread beams: Maja's idea never proven experimentally, maybe can be done at Califes…**

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