RF-breakdown Experiments at the CTF3 Two-beam Test-stand

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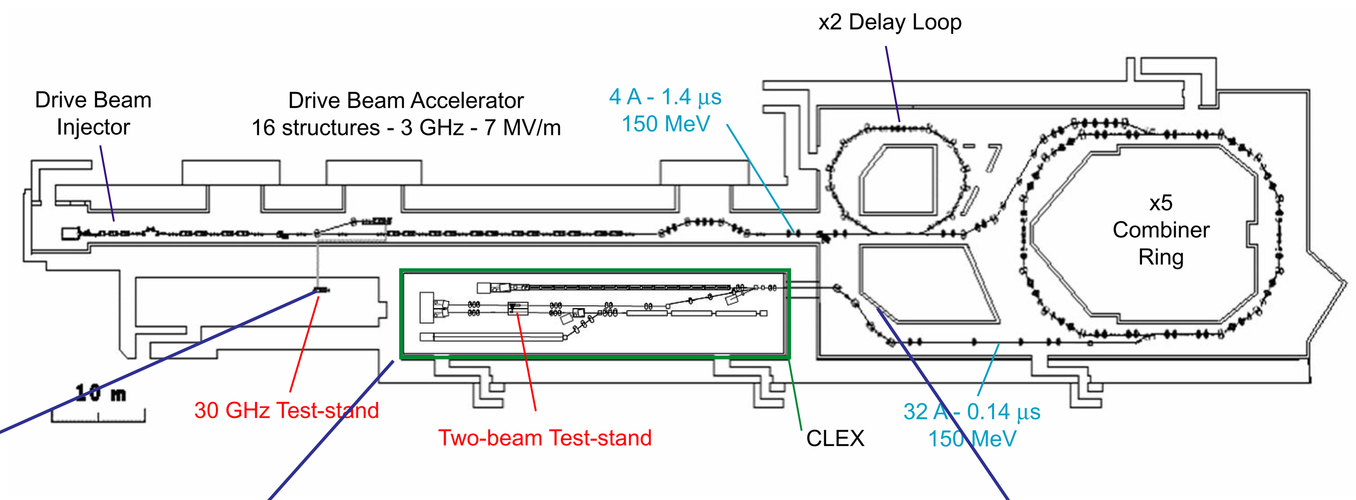
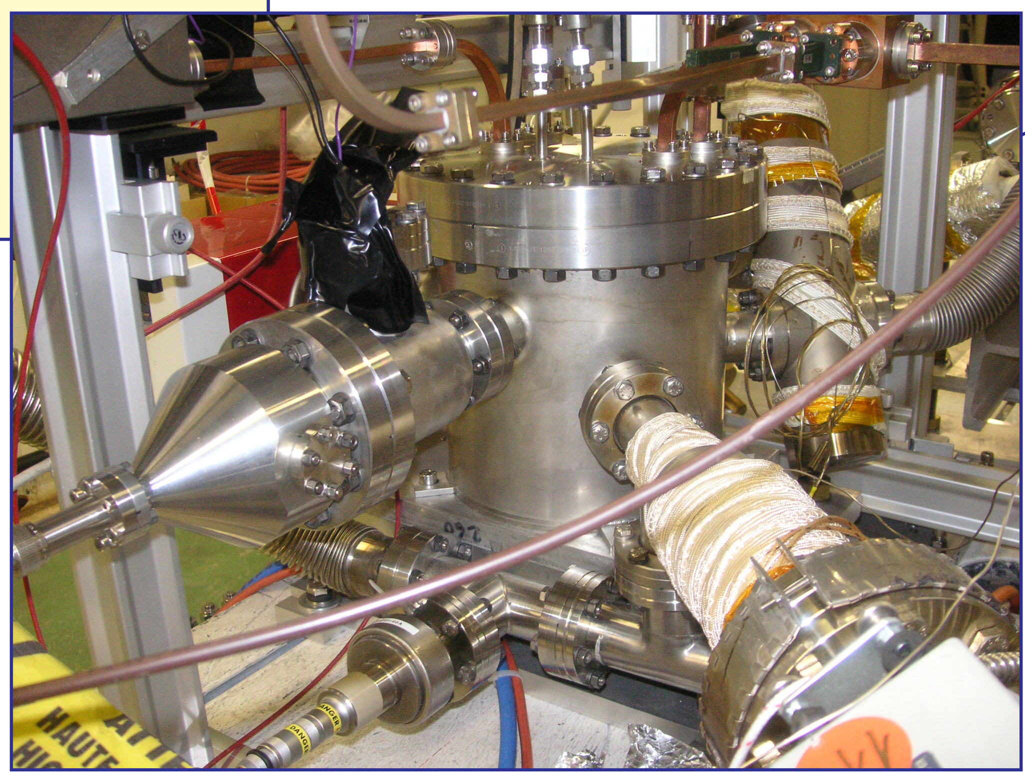
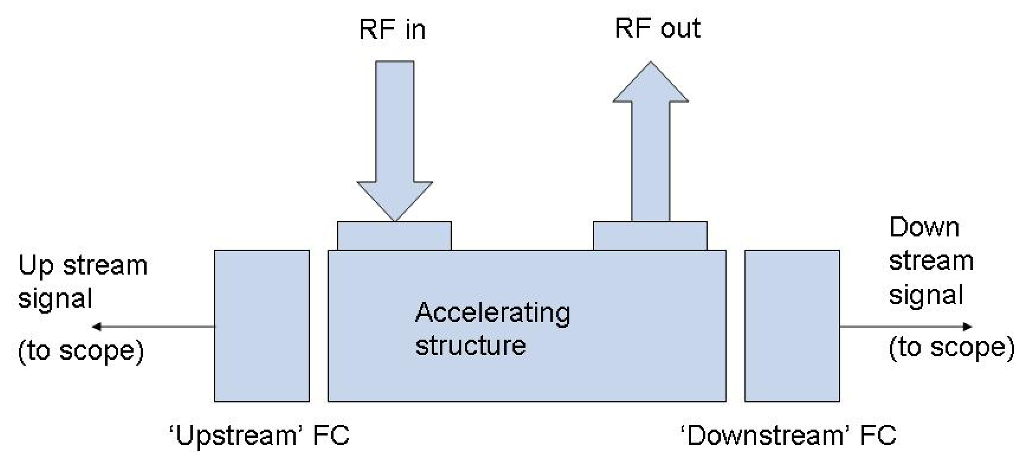


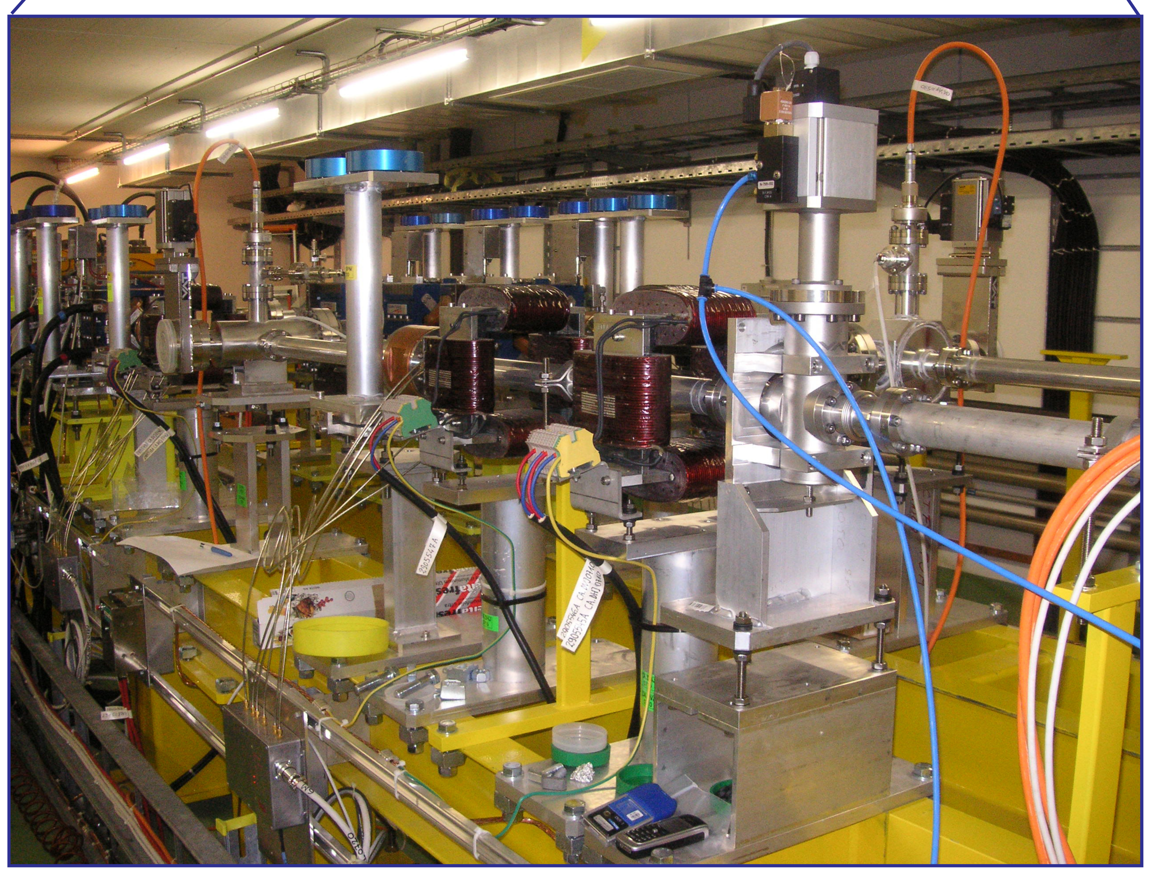
RF-BREAKDOWN STUDIES

Influence of RF-breakdown on CLIC operation
- effects of the breakdown on the beam

Physics of the RF-breakdown
- origin of breakdown currents
- temperature of breakdown





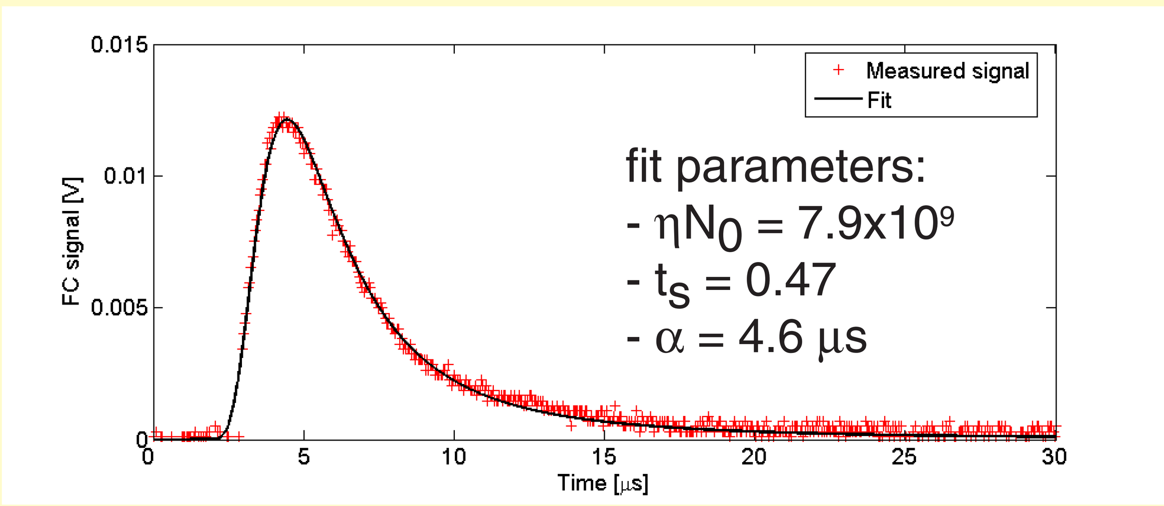


ION CURRENT MEASUREMENTS

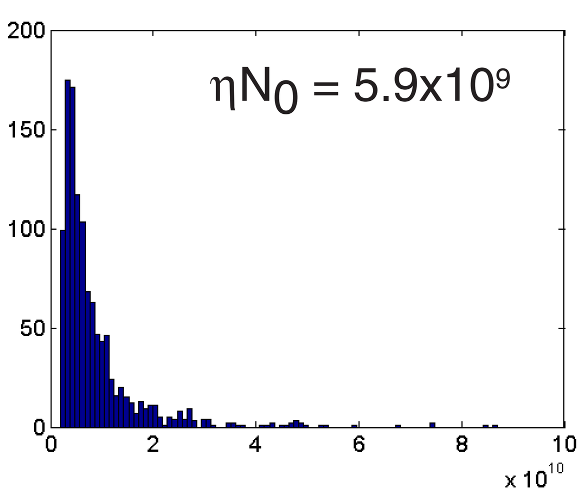
RF-breakdown current
- burst of electrons
- positively charged particles: ions because slow arrival time

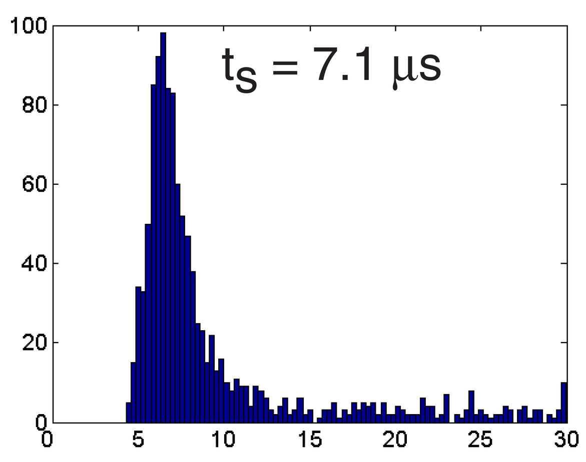
Working hypothesis
- microscopic amount of material evaporates and is ionized
- RF field carries away the electrons
- remaining ions undergo hot coulomb explosion

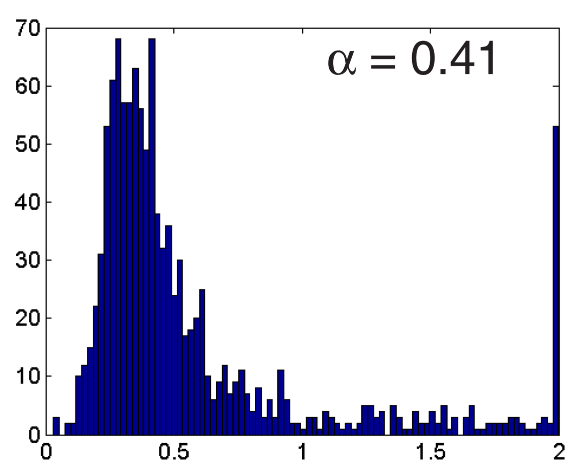
Hot coulomb explosion, sperical homogeneous distribution.
Arrival time spectrum: $dN/dt = f(\eta N_0, t_S, \alpha)$
- ηN_0 = number of particles arriving at the detector (Faraday cup)
- t_S = arrival time parameter
- α = thermal motion parameter



Statistics on 1146 events, median values shown in plot.
Median temperature $T = 5.1 \times 10^5$ K (assuming copper ions).







MULTPLE PEAK EVENTS

Above statistics for "nice" single peak events.

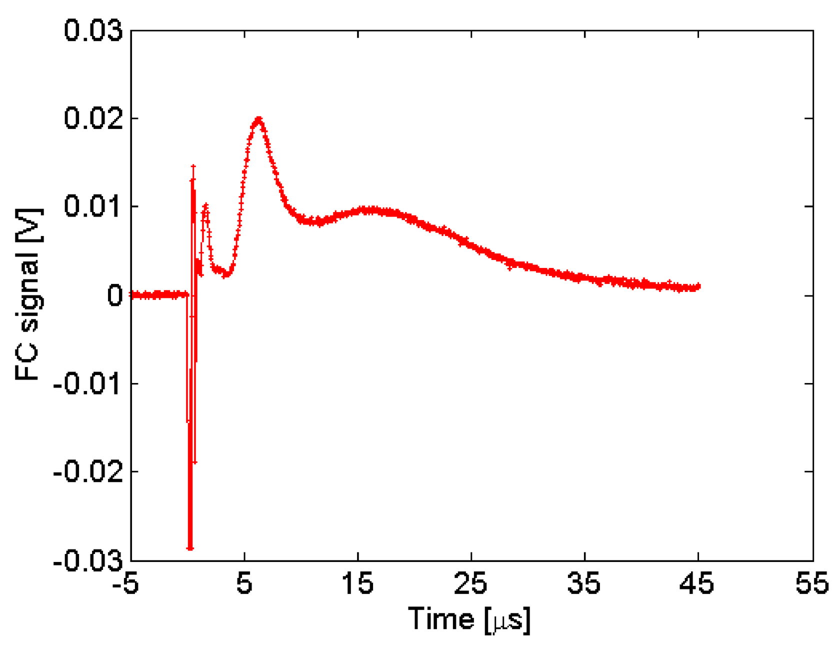
Majority has multiple peaks visible:

Fast peaks: overlap with breakdown electrons

Medium peaks: arrive between 5 - 10 µs

Slow peaks: arrival after 15 µs
(generally wider than "medium" peaks)

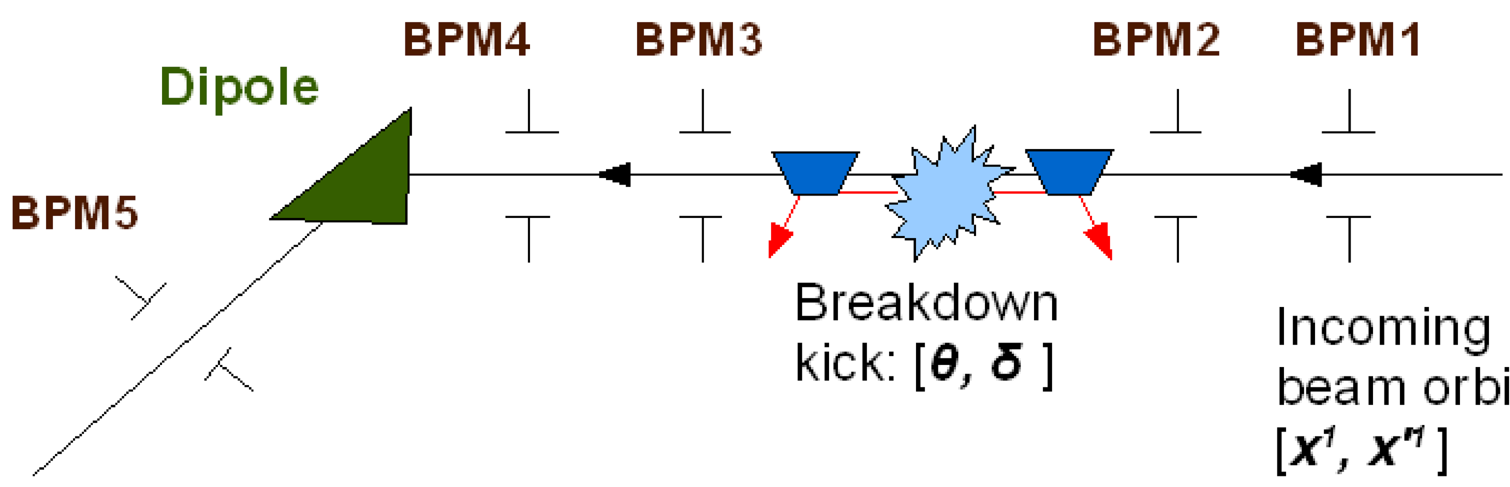
Possible explanation
- multiple breakdown sites
- multiple charge states



TRANSVERSE KICK MEASUREMENTS

Beam receives transverse kick and energy loss during RF breakdown
- may cause the beams to miss each other at the IP, reducing luminosity,
- may cause beam oscillations that can become unstable
- may steer the beam into collimators, causing extensive downtime.

Magnitude of the kicks to be addressed in order to assess its severity
- beam stability
- operational reliability



$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ R_{11}^{12} & R_{12}^{12} & 0 & 0 \\ R_{11}^{13} & R_{12}^{13} & R_{12}^{c3} & 0 \\ R_{11}^{14} & R_{12}^{14} & R_{12}^{c4} & 0 \\ R_{11}^{15} & R_{12}^{15} & R_{12}^{c5} & D^5 \end{pmatrix} \begin{pmatrix} x_1 \\ x_1' \\ \theta \\ dp/p \end{pmatrix}$$

abbreviation: $$\vec{x} = A\vec{\theta}$$

solution: $$\vec{\theta} = (A^t A)^{-1} A^t \vec{x}$$

error bars: $$\sigma(\theta_i) = (A^t A)_{ii}^{-1} \sigma_{\mathrm{BPM}}$$

RESULTS

Use 5 BPM's, assume	*resolution*
- incoming beam position (x, x')	~10 µm
- transverse kick angle (θ)	~10 µrad
- relative energy change (Δp/p)	$\sim 4 \times 10^{-5}$

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