Measurements of the RF breakdown influence on the probe beam

CTF3 working meeting – CERN, 9 Feb 2012

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on behalf of Uppsala group

Outline

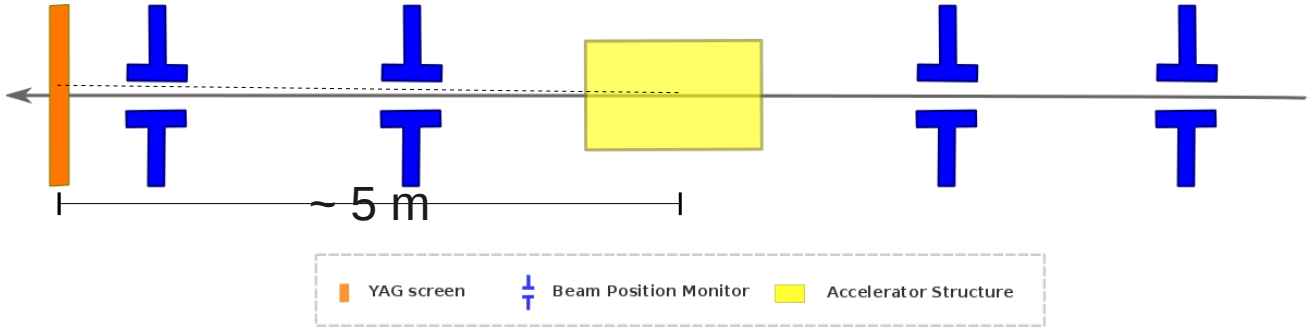
- RF-breakdown kick to the beam: first results
- TBTS Beam Position Monitors: status and upgrade
- Flashbox

- Drive Beam Phase Measurement
  using RF data from the PETS

RF-breakdown kick to the beam

example of YAG screen based measurement

29 August 2011: first attempt to measure the effect of RF-breakdown on the probe beam



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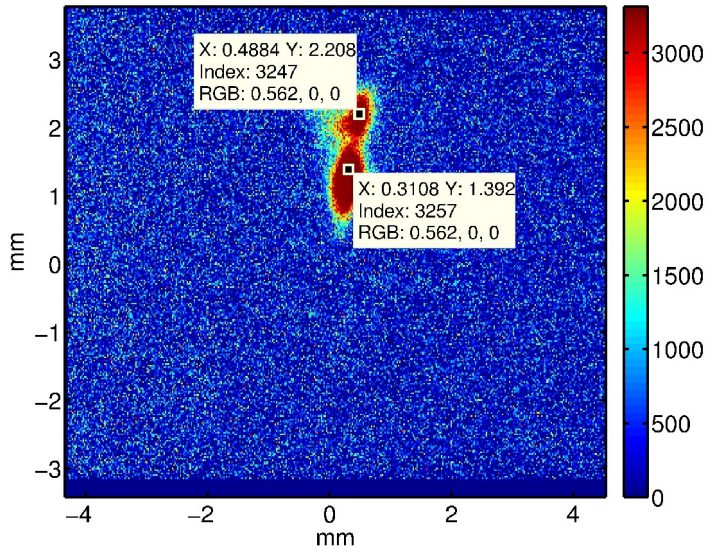
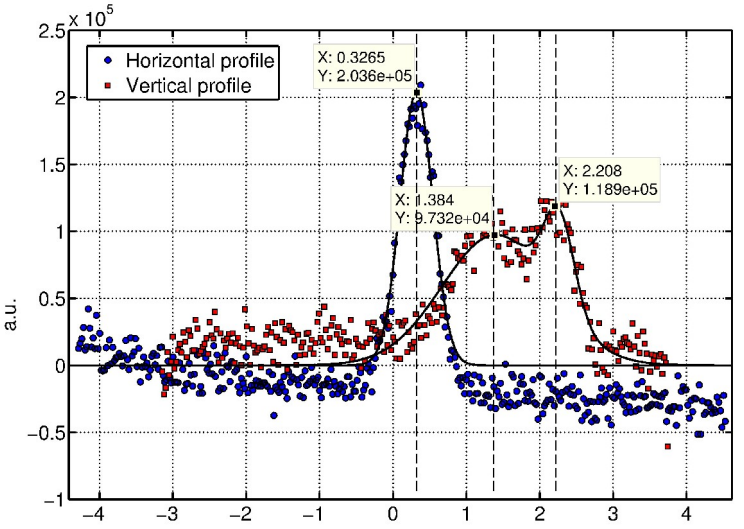
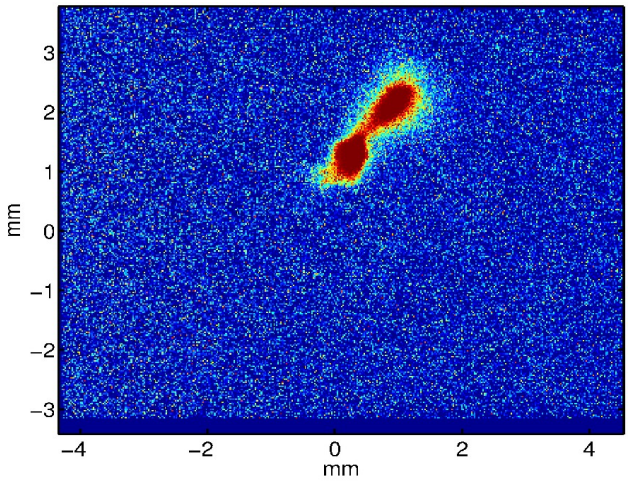


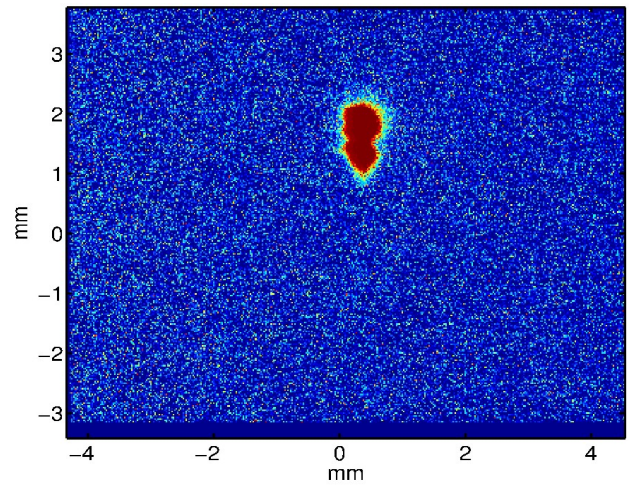


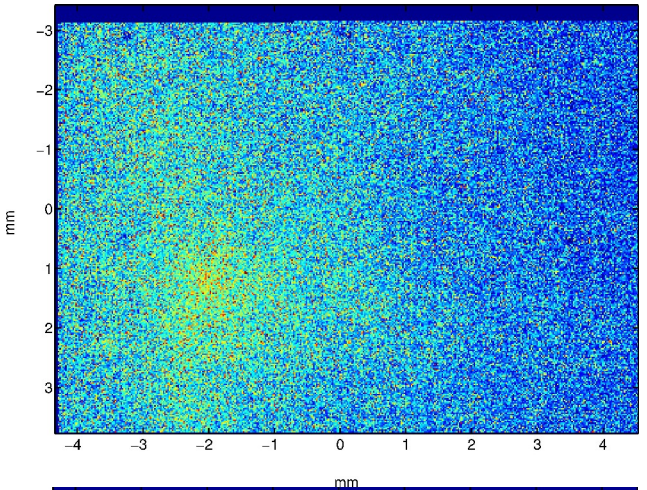
Kicked beam or breakdown current?

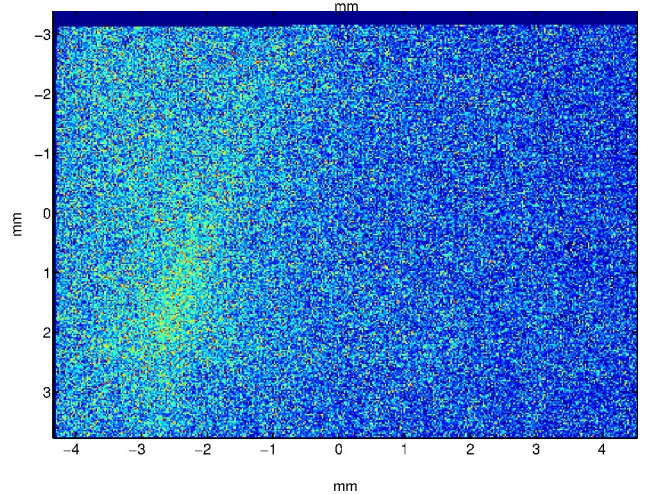
Measurements with (left) and without (right) probe beam,
same input power in the ACS (~80 MW)

kicked beam









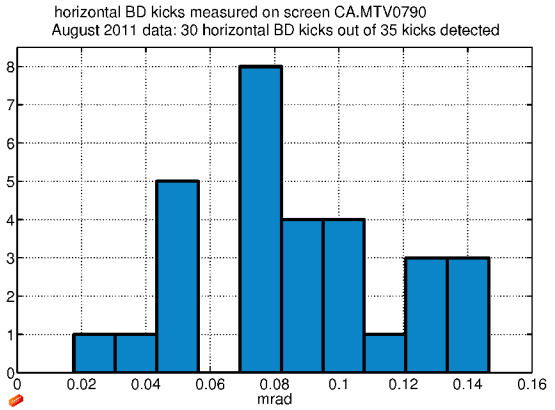
breakdown current

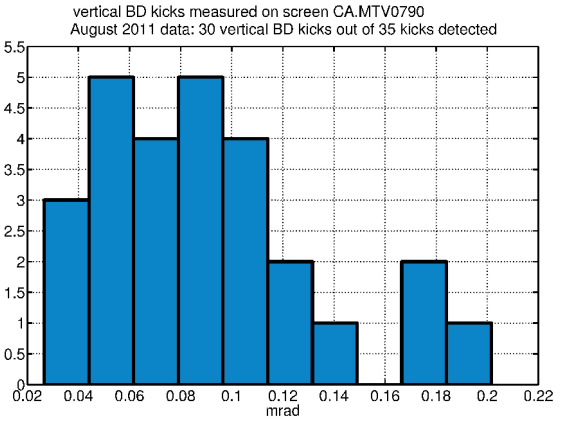
RF-breakdown kick to the beam

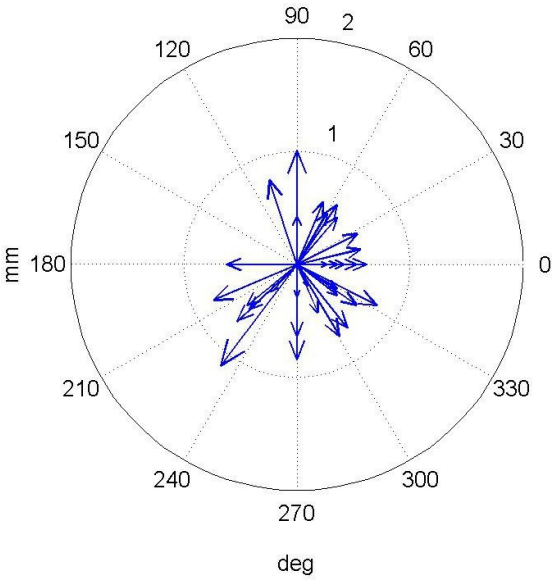
statistics of YAG screen based measurements

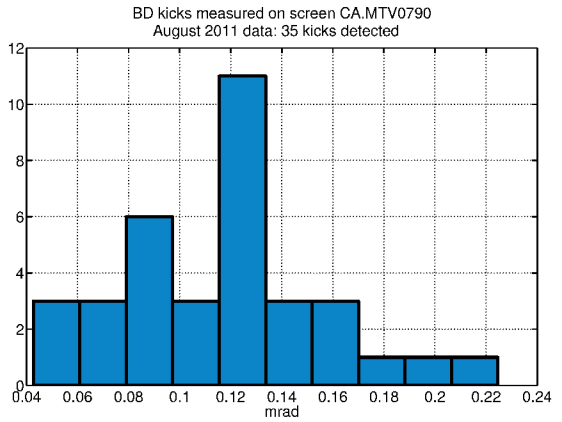
AUG 2011

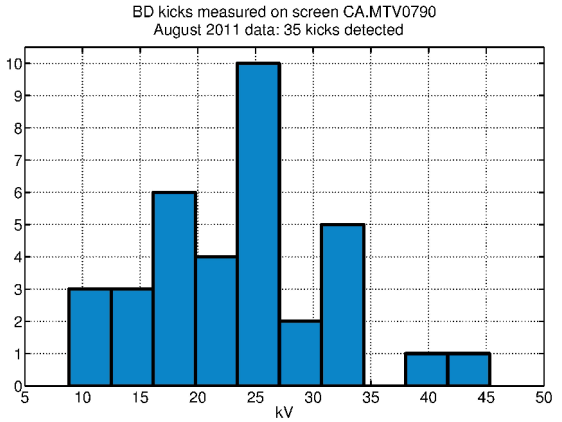
- kicks on horizontal and vertical planes between 0.02 and 0.2 mrad;
- kicks corresponding to a transverse momentum between 10 and 40 keV/c (measurements at NLCTA within 30 keV/c, Dolgashev et al., LINAC 2004);





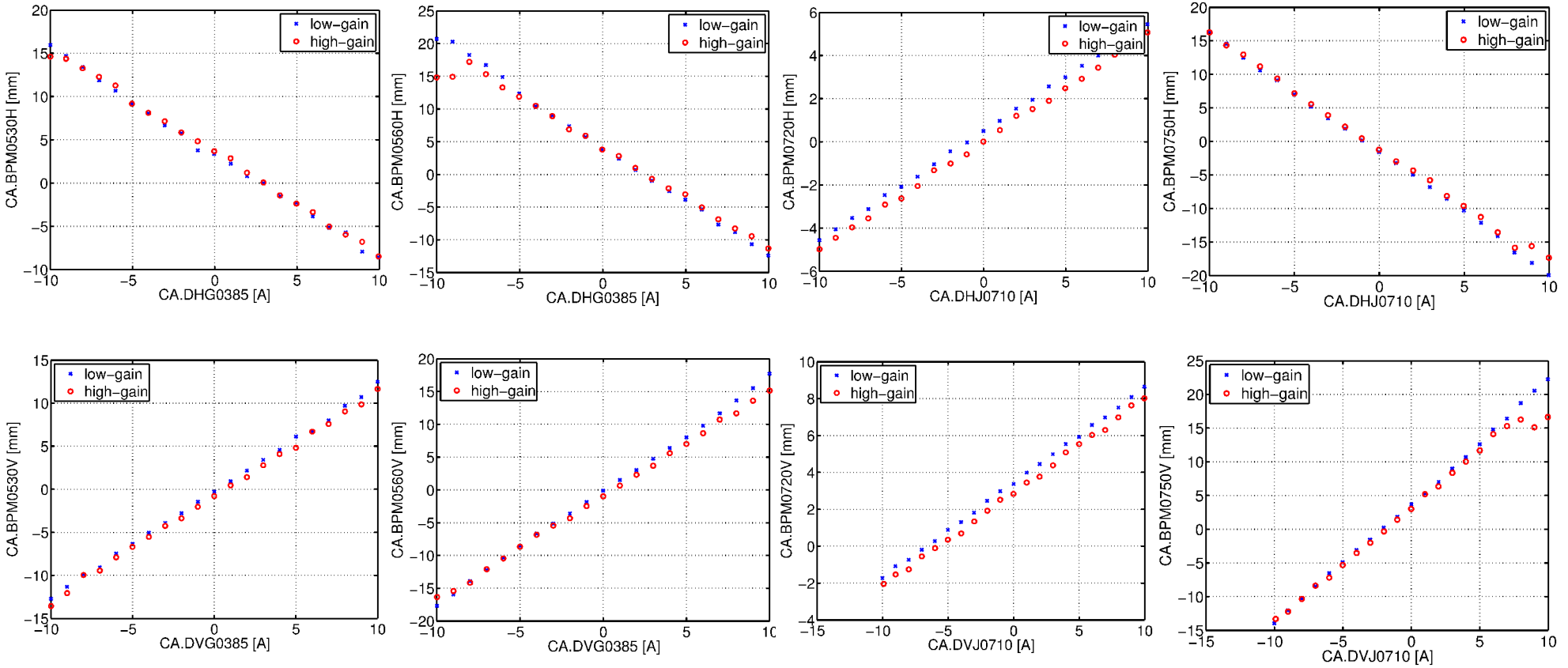






BPMs: linear response and calibration

- consistency between high-gain and low-gain calibration;
- BPM response linear in the whole range (beam pipe diameter is 40 mm);



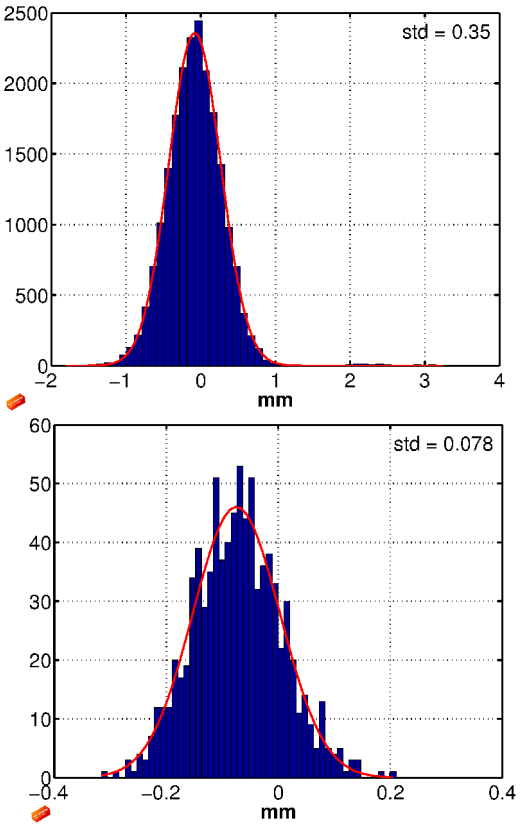
BPMs: resolution

Resolution = standard deviation of the distribution of the residuals given by comparing the beam position measured at one BPM with the beam position expected at the same BPM

Two methodologies used:

1. beam position *sample-by-sample* (interesting for the kick measurement);
2. *average* beam position over a beam pulse (always give a resolution smaller by a factor √beam pulse length in #samples)

Best resolution *sample-by-sample* measured so far is ~0.35 mm (August 2011);

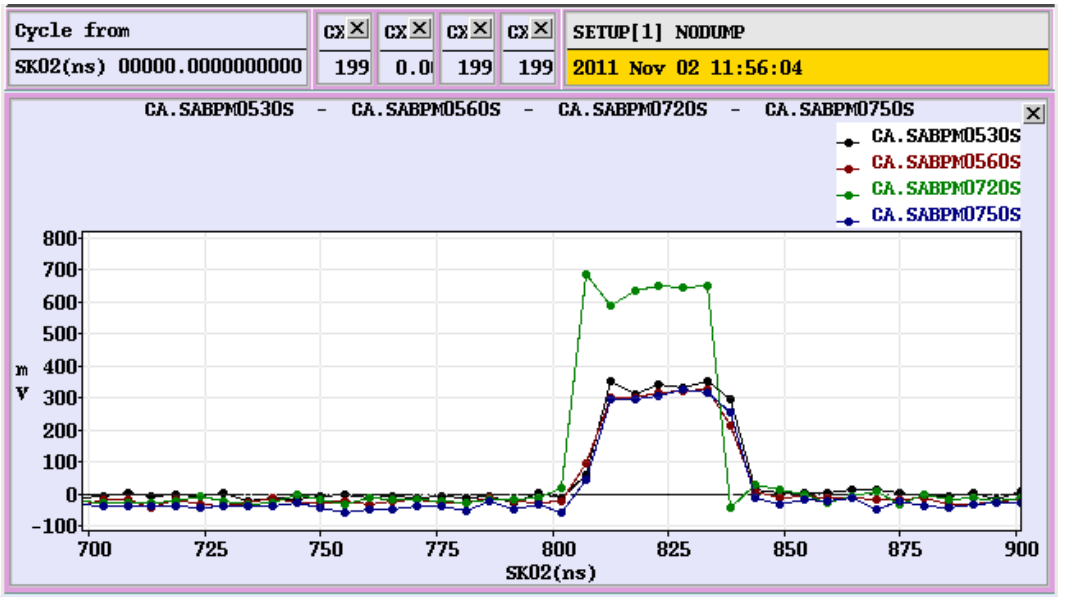


Reference: EDMS document 1175749

TBTS BPMs: modifications Nov2011

- Limitation to the resolution identified in a too small signal-to-noise ratio (SNR)
- Modification on BPM CA.BPM0720 (downstream of the ACS) results in a bigger SNR (Nov 2011)

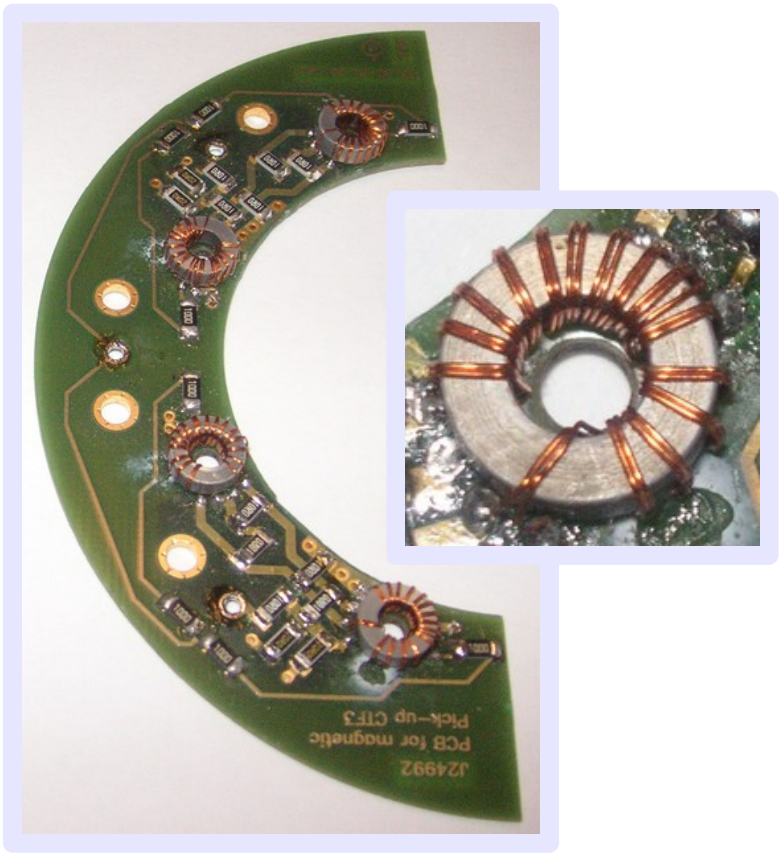
Number of turns in the secondary winding of the transformer of CA.BPM0720 reduced from 30 to 16, gives a SNR higher by a factor ~1.8, keeping the noise level unaltered (~8 mV)



Reference: CTF3 e-log on 2 Nov 2011 at 11.54

TBTS BPMs: on-going modifications

Improvement of the signal-to-noise ratio for all five probe beam BPMs reducing the number of turns in the secondary winding of the transformer



- 40 new toroids (8 toroids per BPM x 5 BPMs) with 10 turns each (currently 30) are being produced at Uppsala and will be assembled at CERN on the existing PCBs
- we expect a signal-to-noise ratio 3 times higher, (noise unchanged) with a slightly higher low cut-off frequency

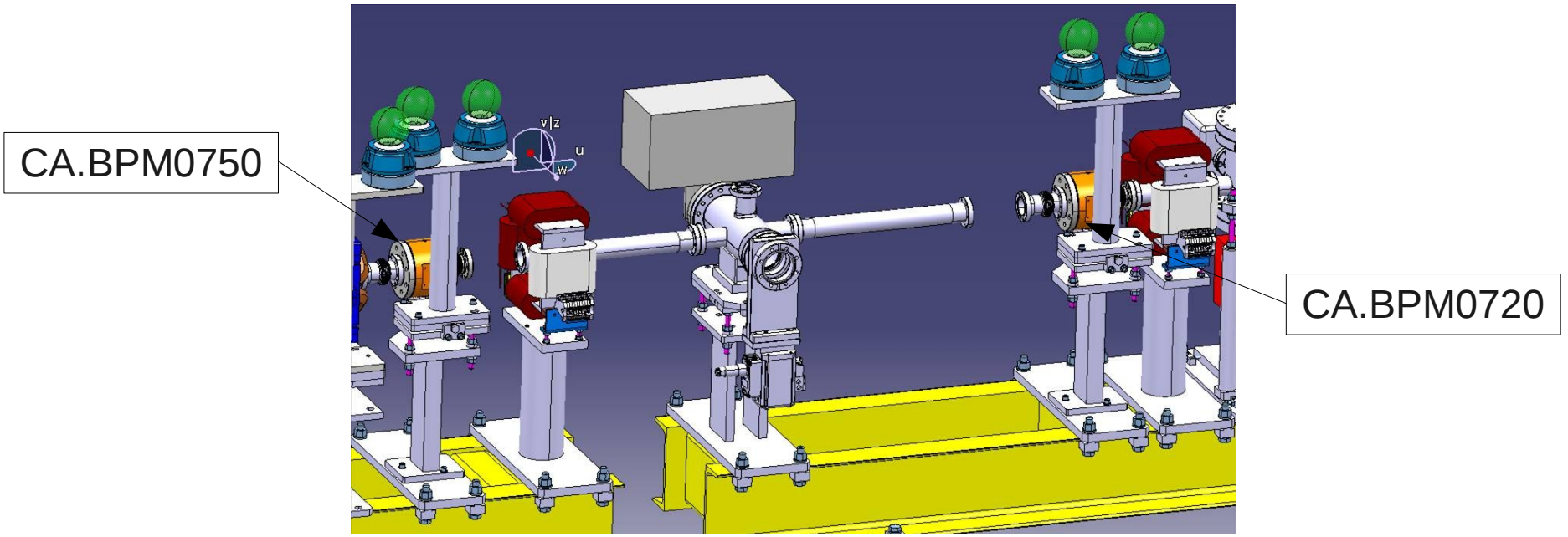
	Σ	Δ
currently	150 Hz	10 kHz
expected	1.35 kHz	90 kHz

Expected droop at percent level, tolerable as we are looking for fast signals in the BPM trace

TBTS BPMs: cavity BPMs

Installation of 2 re-entrant cavity BPMs (CALIFES spares) in TBTS

- Cabling needed (6 cables from CLEX to the gallery for 5 GHz signals)
- Read-out with CALIFES electronics (down-mixing and ADCs)

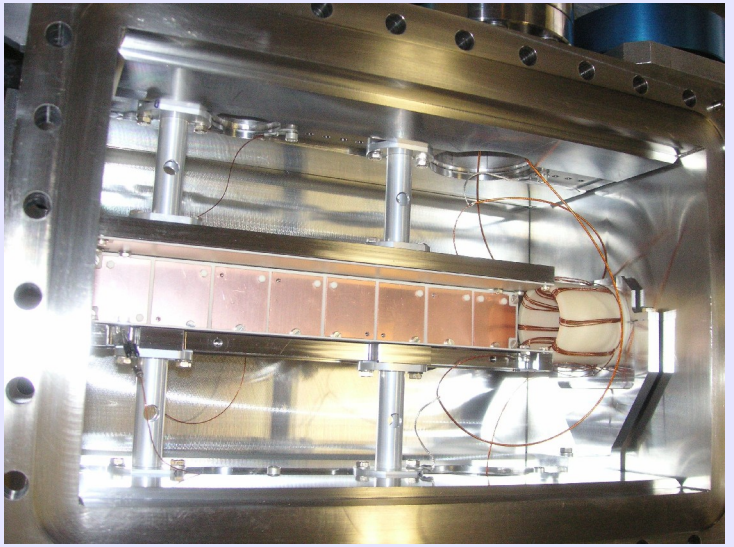


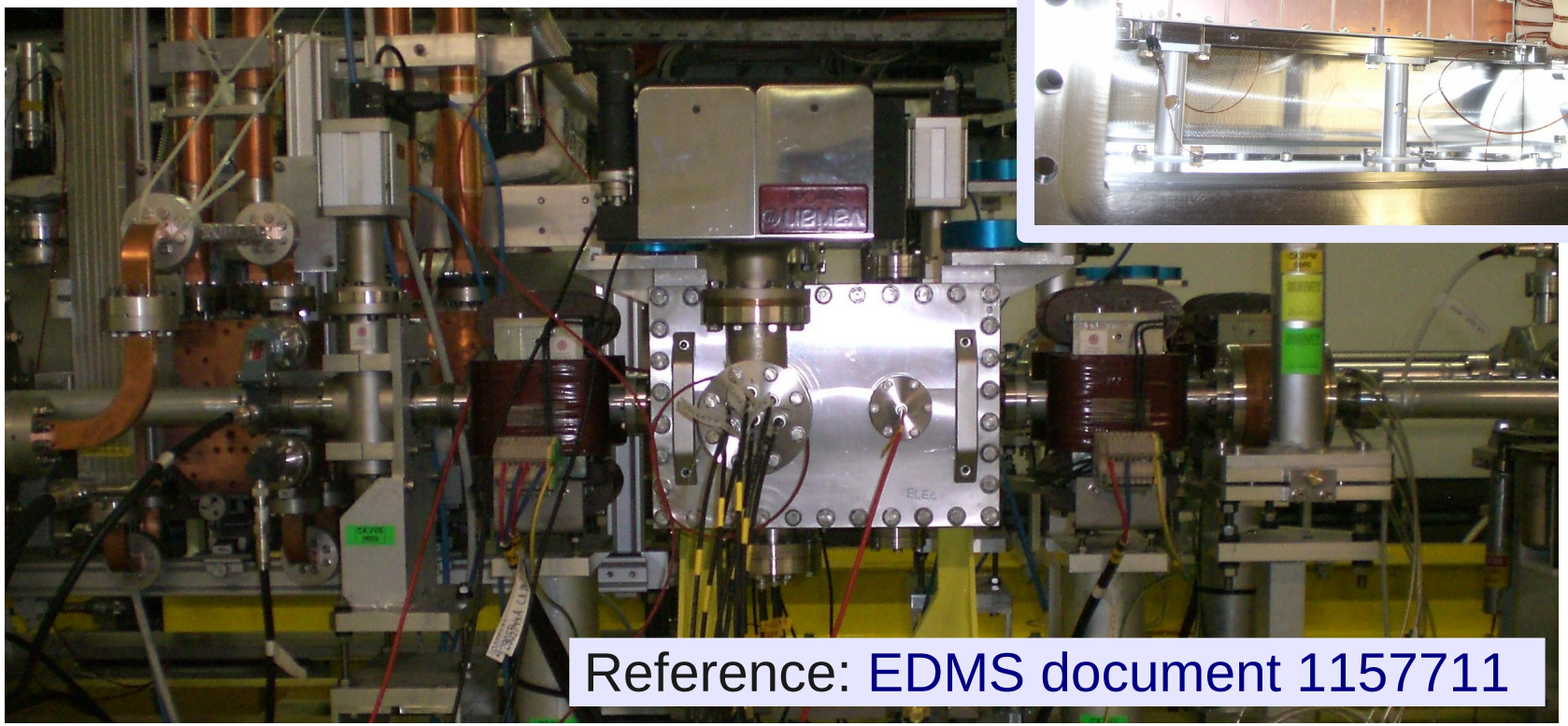
These BPMs are likely to be immune to the low-freq (<100 MHz) noise induced by the drive beam on the diagnostics → back-up solution for the the kick measurement

Flashbox

Installed in the probe beam on 28-29 July 2011, upstream of the ACS

ICT followed by two parallel 8-electrodes plates on the horizontal plane





Reference: EDMS document 1157711

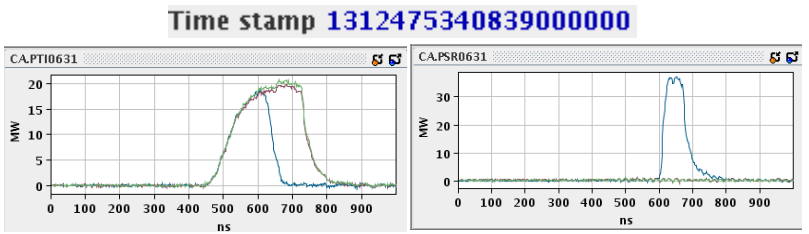
Flashbox

All channels operational

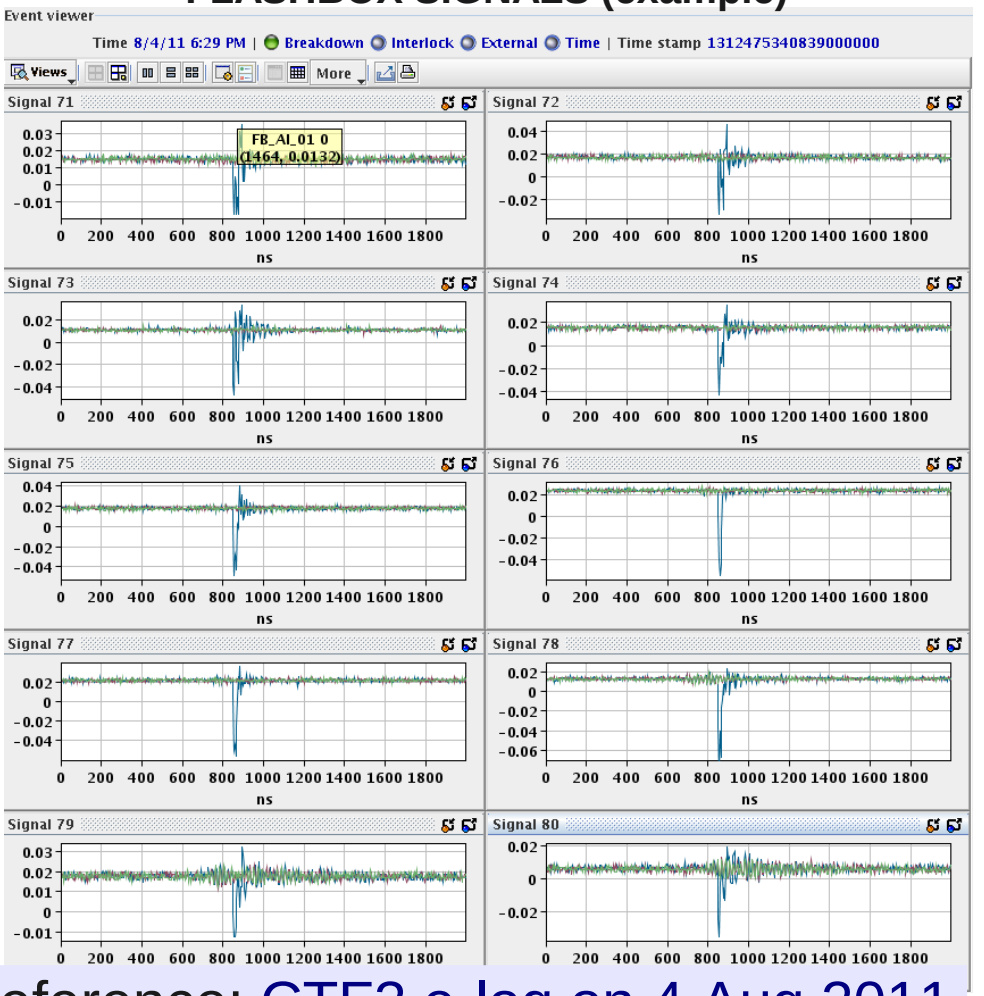
Able to detect signals in correspondence of RF-breakdown in the ACS

Read-out:

- test phase with (2011) ADCs kindly borrowed from AB/CO (Anastasiya Radeva)
- 2x Acqiris ADC + 1x Spectrum ADC ordered



FLASHBOX SIGNALS (example)

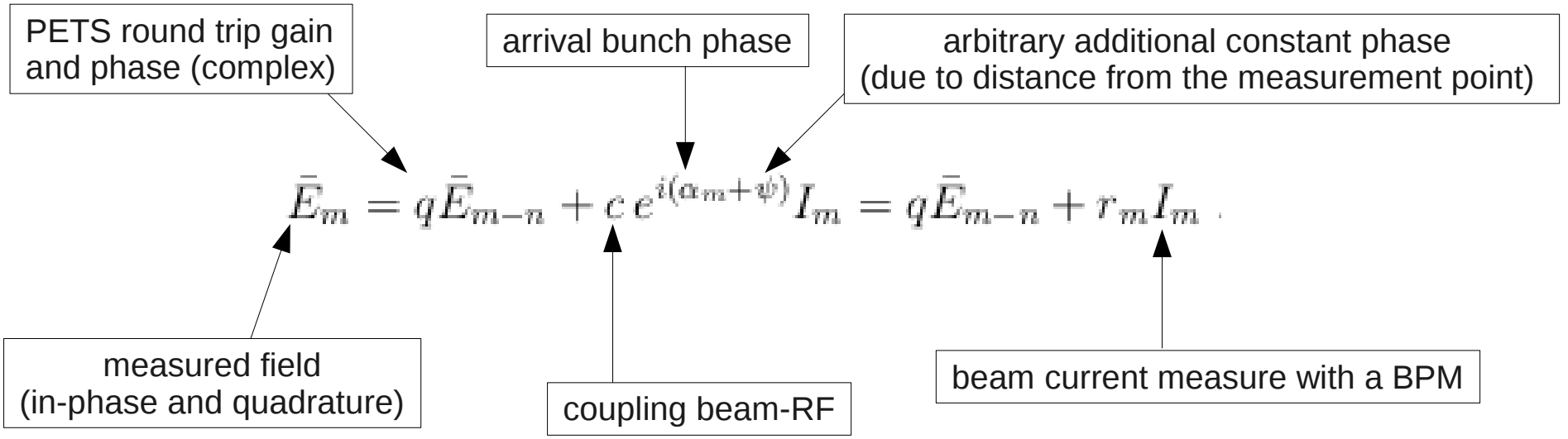


Reference: CTF3 e-log on 4 Aug 2011

Drive Beam Phase Measurement using RF data from the PETS

Measurement of the arrival time of drive beam bunches using RF data in the TBTS PETS recirculation loop (before ON/OFF mechanism)

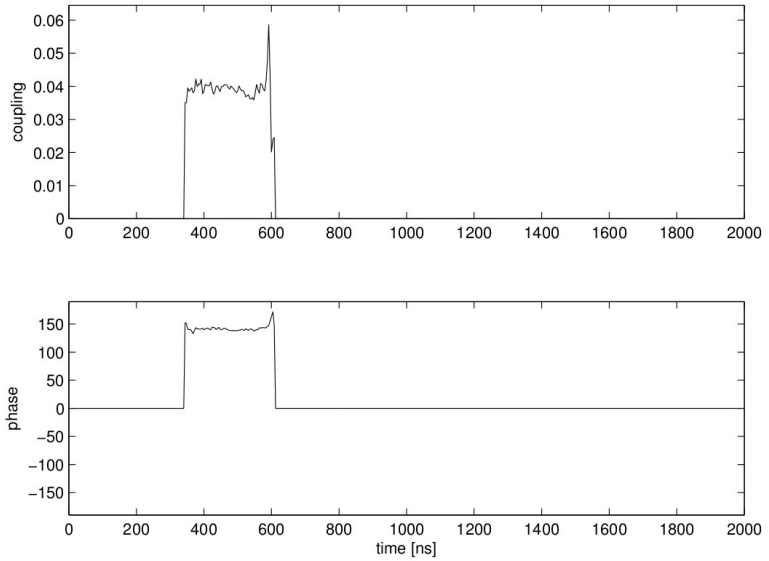
Developed as summer student project in summer 2011 (D.Ogburn) and published in EuCard note EuCARD-REP-2011-006 (September 2011)



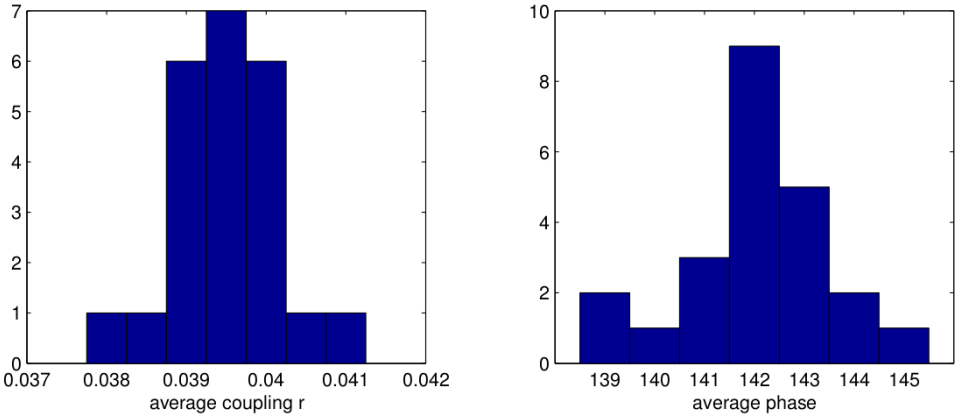
Drive Beam Phase Measurement using RF data from the PETS

We estimate the coupling between beam current and RF at the percent level and the phase along the pulse with the resolution of one degree

COUPLING AND PHASE FOR ONE EVENT



AVERAGE COUPLING AND PHASE FOR 23 EVENTS



Reference: EuCARD-REP-2011-006

Conclusions

RF-breakdown kick to the beam:

- first results kicks within 40 keV/c

TBTS Beam Position Monitors:

- modification to increase SNR on-going
- installation of two re-entrant cavity BPMs (CALIFES spares) in TBTS

Flashbox

- first tests successful

Drive Beam Phase Measurement

- published EuCard-REP-2011-006 (September 2011)

For 2012 Run

- drive beam phase measurement with TBL PETS and compare with other measurements (streak camera)
- how can we achieve 24 hours operation with laser?
- absolutely need coherent timestamp on signals from different hardware
  →otherwise NO WAY to align the data