Double-pulse generation with the injector laser for pump/probe experiments

O. Grimm, K. Klose, S. Schreiber

21/3/2006

Motivation: Pump-probe experiments with VUV and FIR (from new undulator in 2007)

Optical path length about 80 cm longer for infrared radiation due to construction constraints

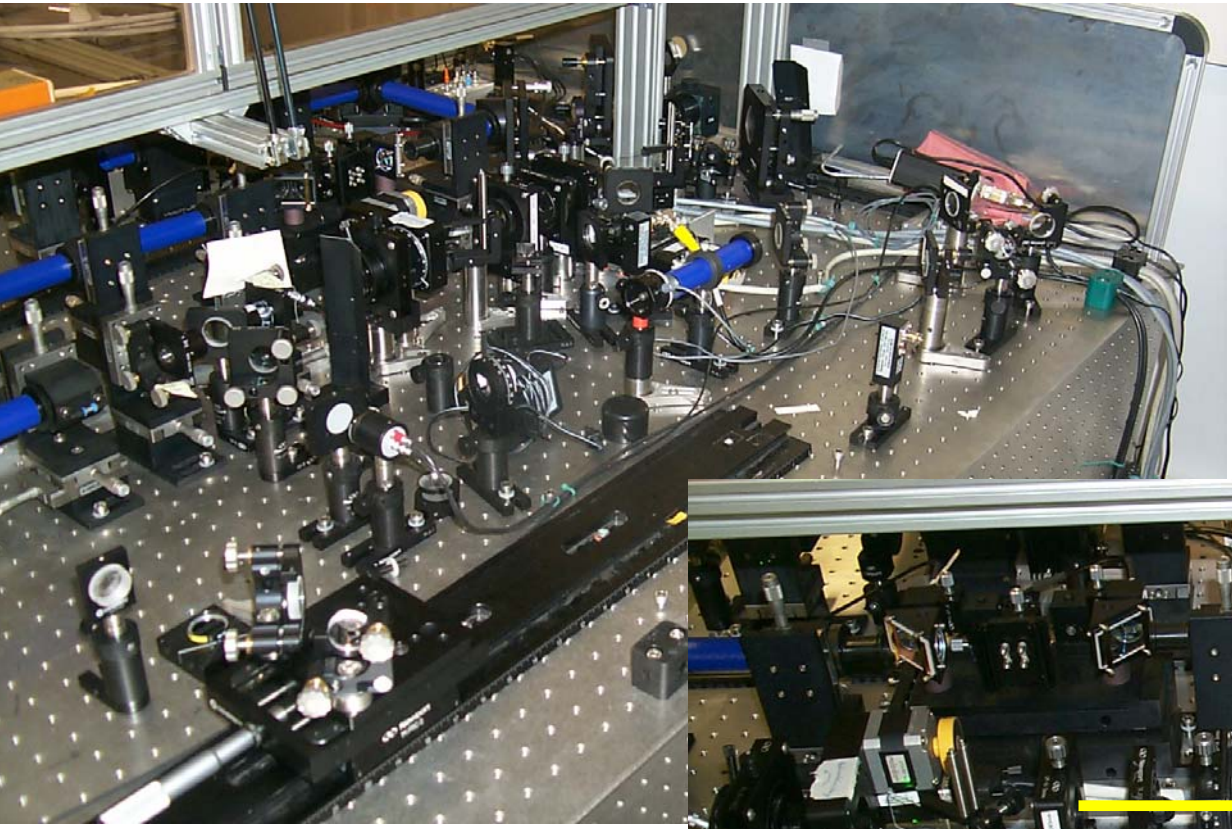
Concept: Generate double laser pulses separated by several cycles of 1.3 GHz

1. Splitting, delaying and recombining in the UV
2. Allowing 2 pulses to leave the 27 MHz oscillator by modification of Pockels cell gating

Need finally to generate SASE with second bunch!

These measurements: Method 1, separation of 10 RF periods (7.69 ns)

Setup on laser table



- λ/2 plate to rotate polarization
- Brewster-angle beam splitter and recombiner
- Arbitrary relative intensity of direct and delayed pulse

No lateral offset of direct beam

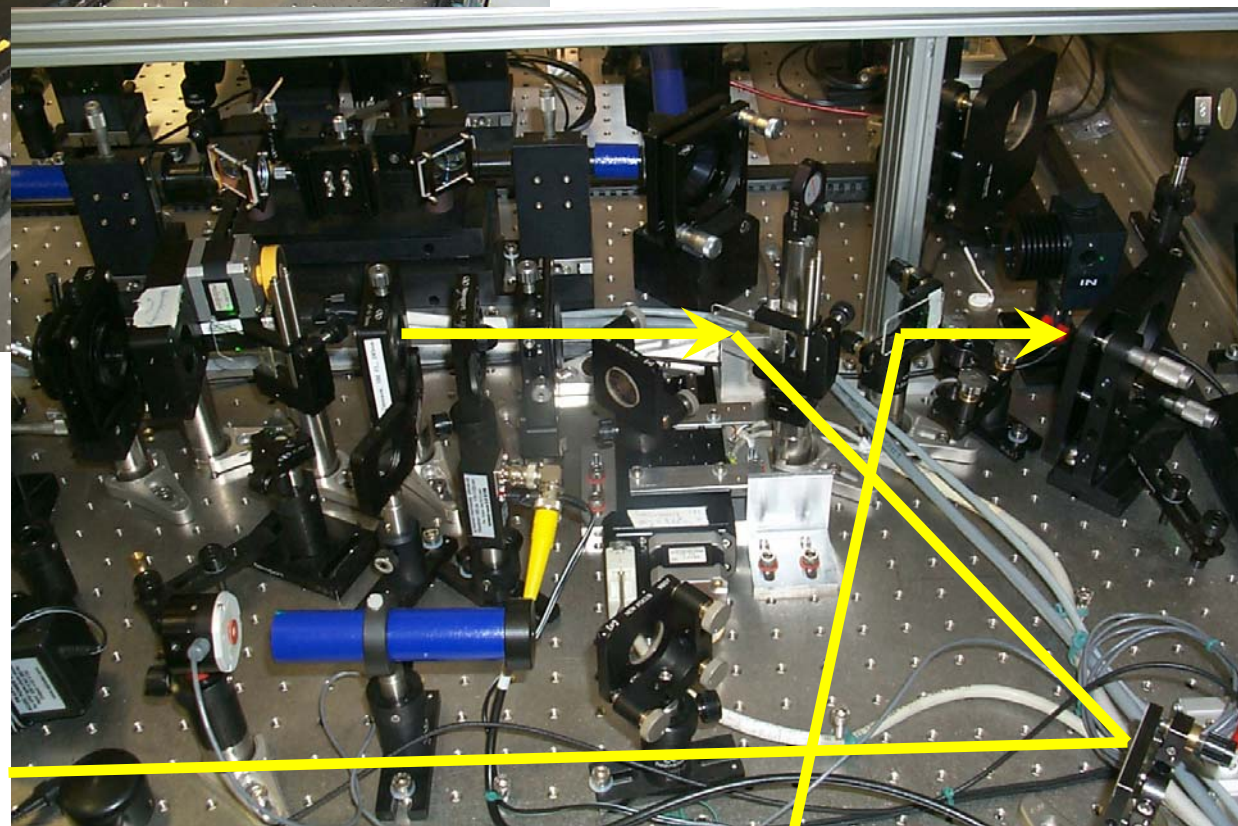
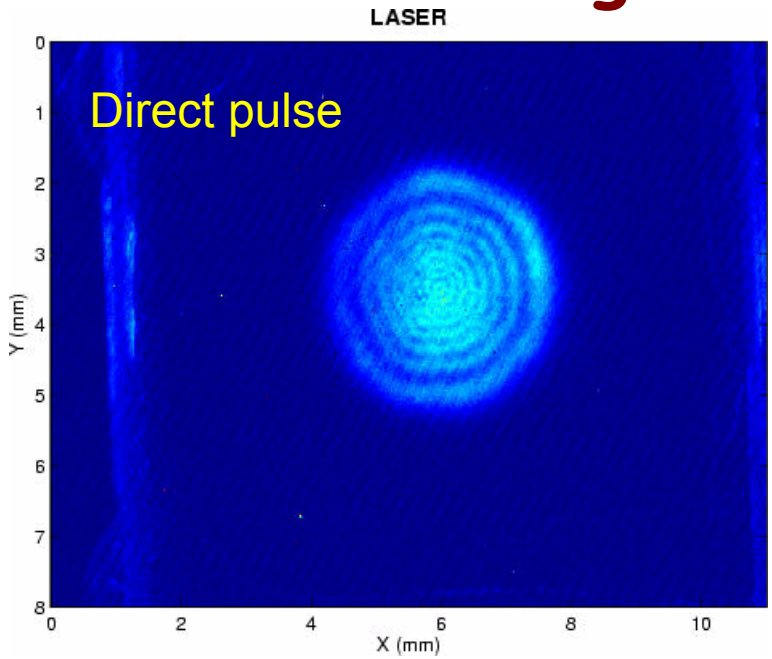
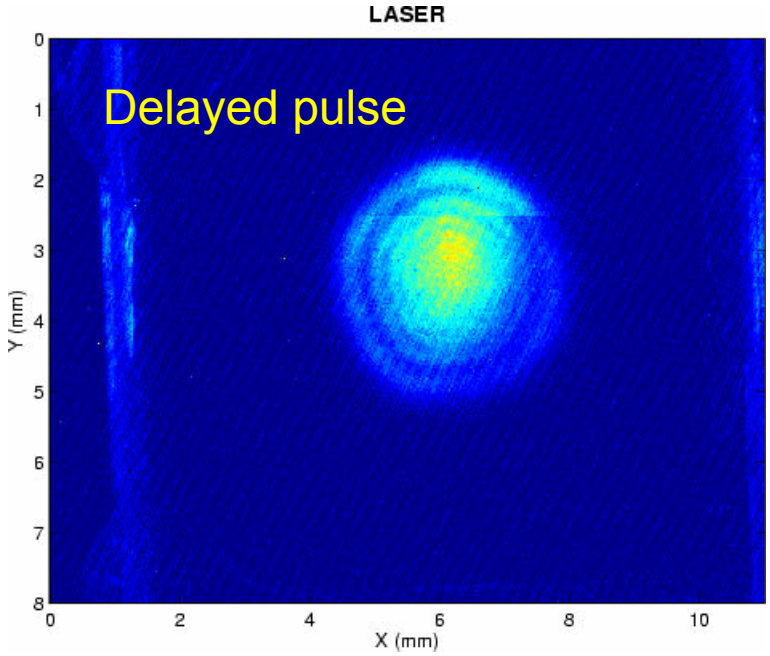
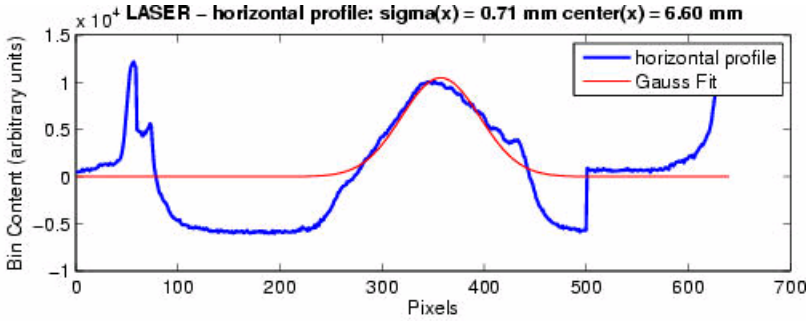
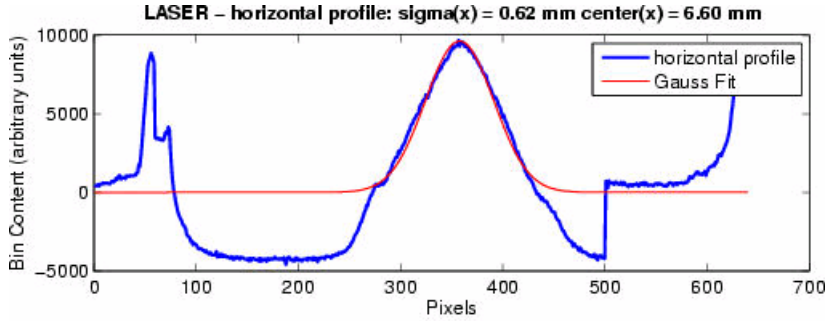


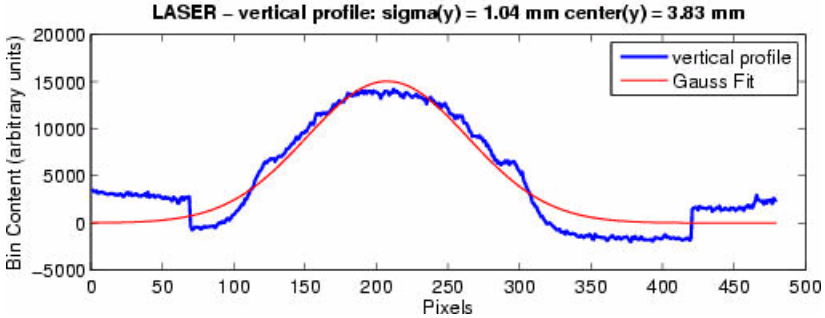
Image on virtual cathode

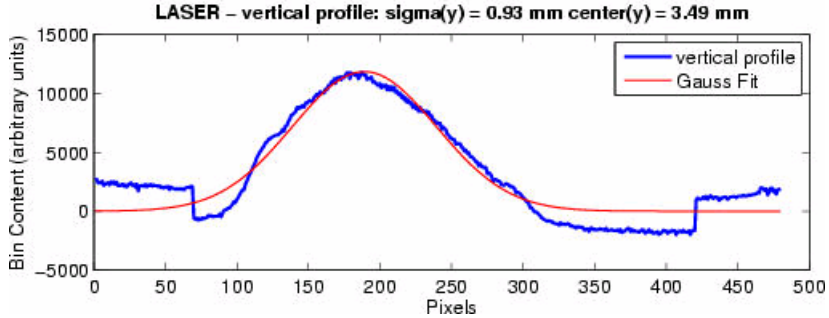








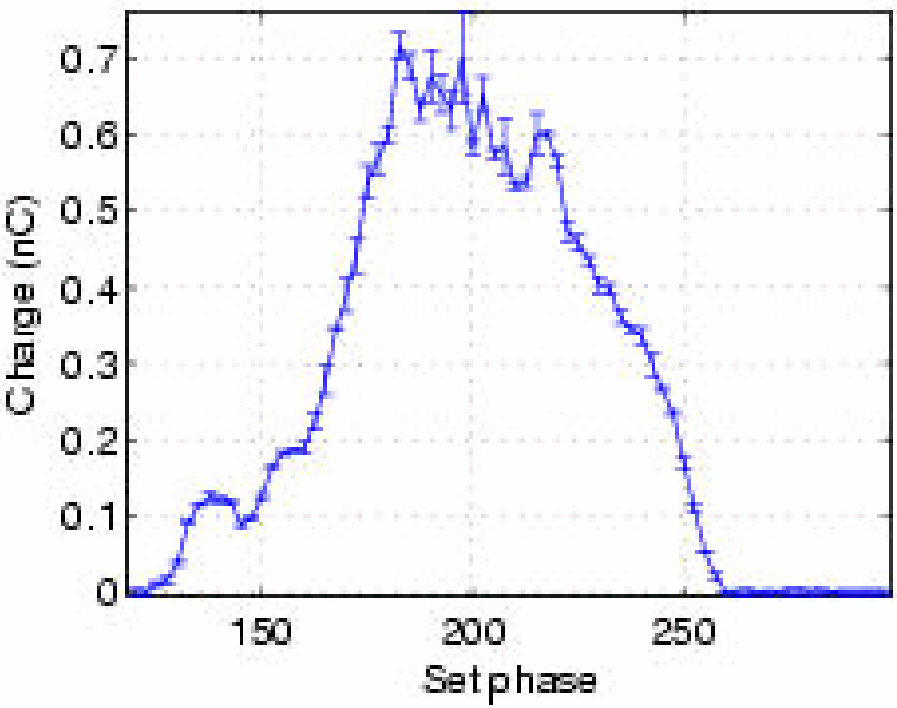




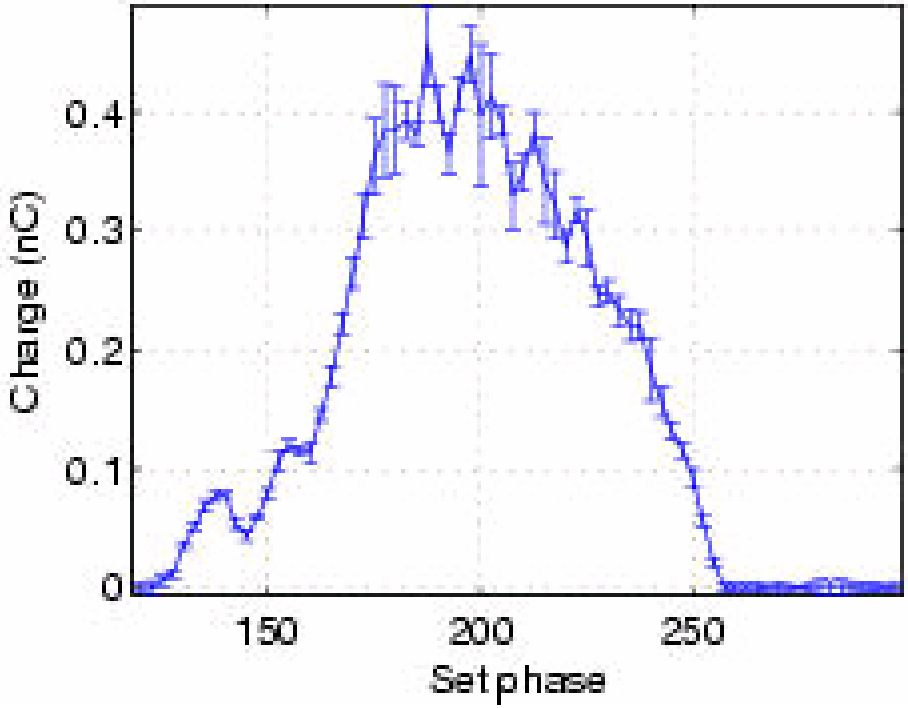
Delay adjustment, phase scan with Gun

- Rough delay adjusted with fast photodiode to about 0.1 ns (≈45° RF)
- Fine delay to better than 1° with phase scans (1°↔ 641 μm path length).

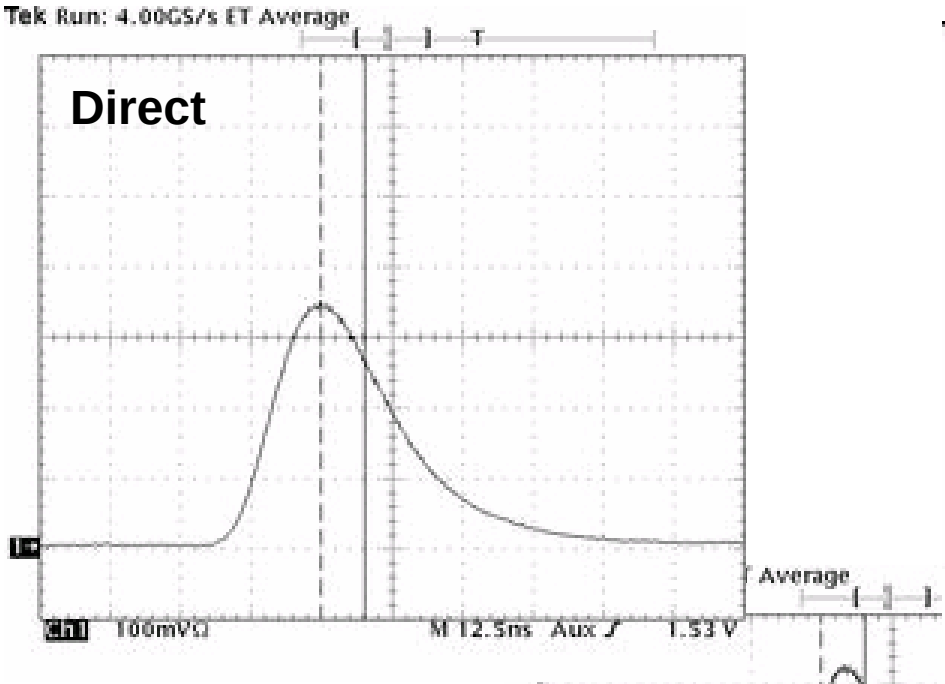
Direct pulse
Start of charge 259 deg

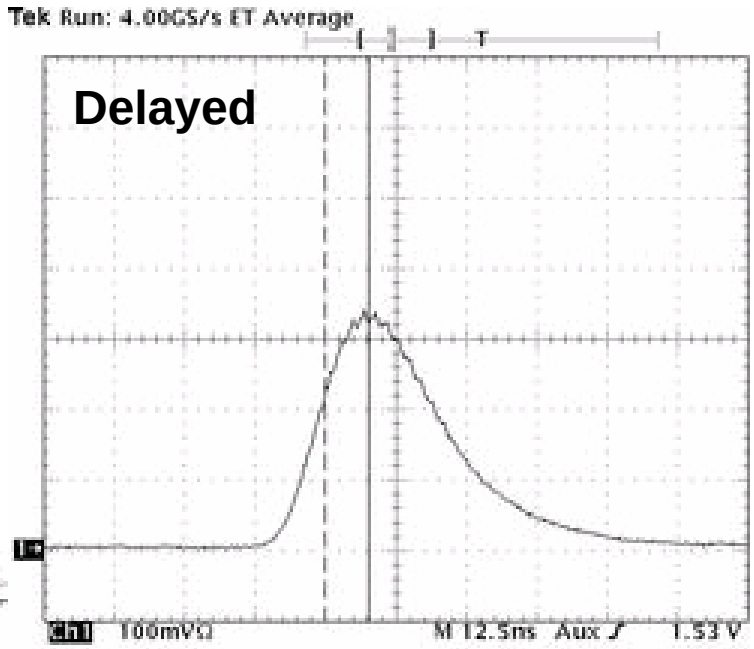


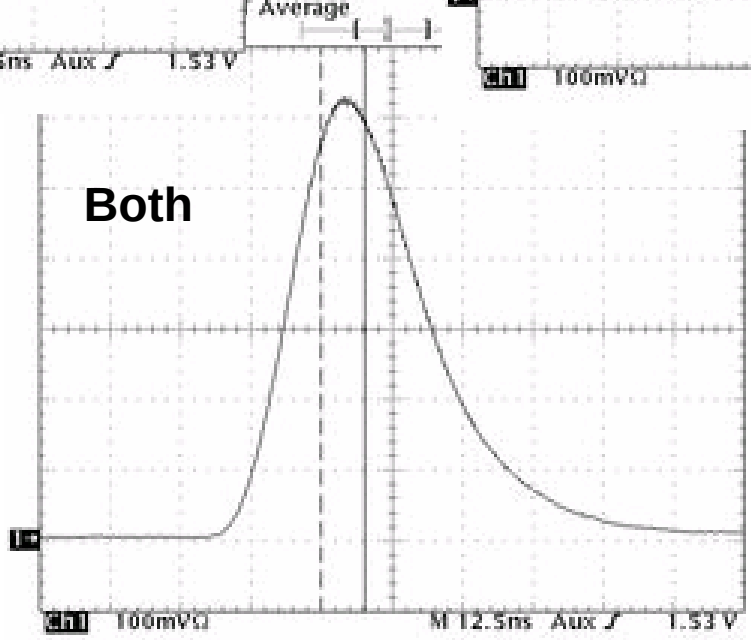
Delayed pulse
Start of charge 257 deg



Toroid 3GUN response



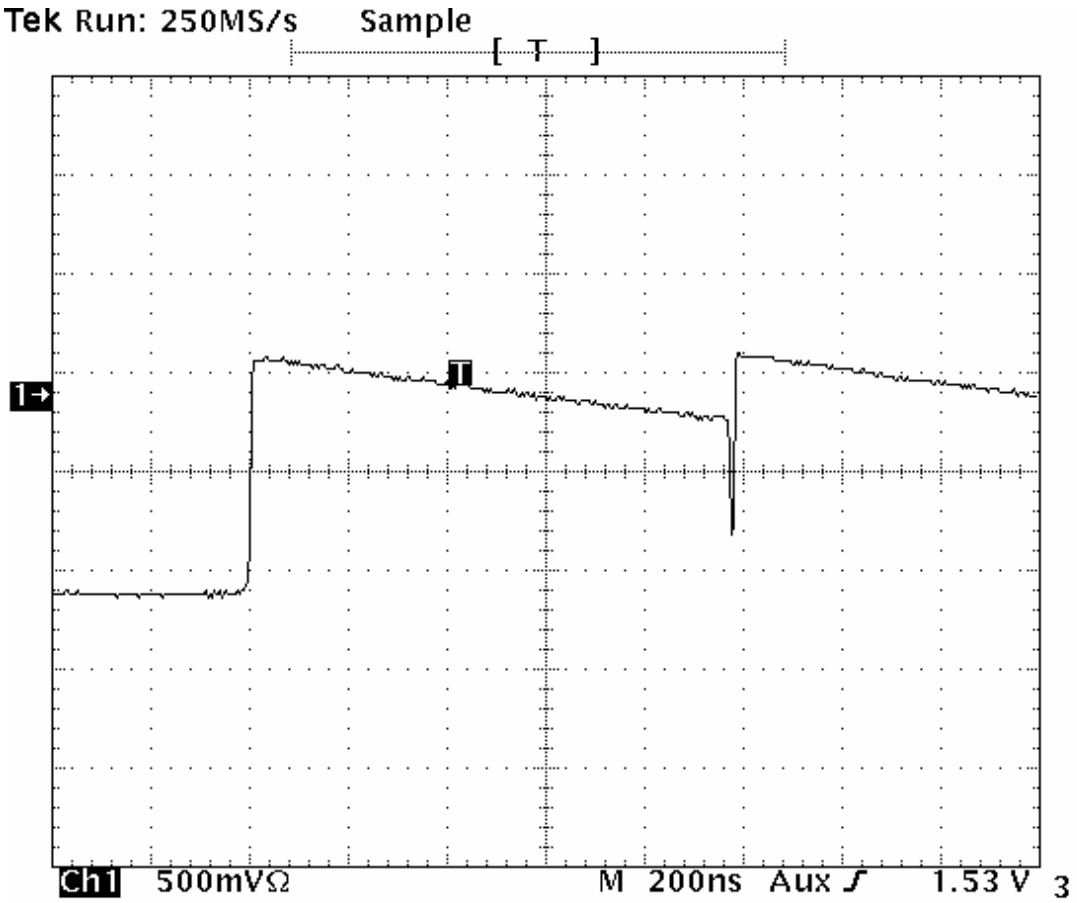




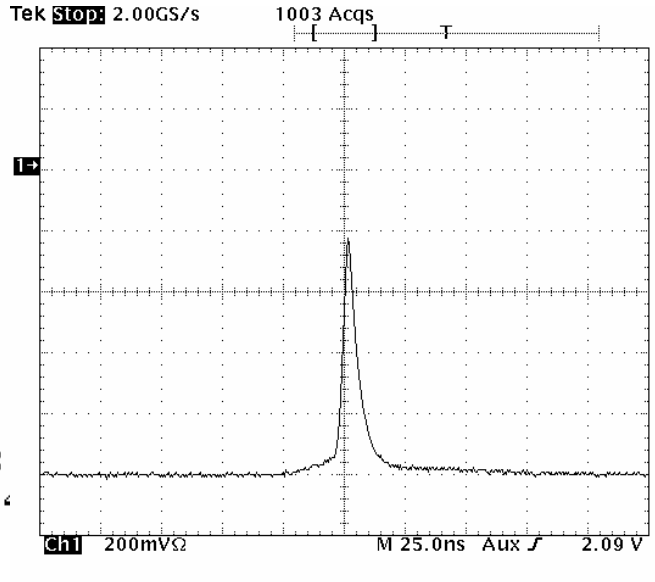
Cursors spaced
7.7 ns

BPM 1GUN/X response

(self-triggered button)



Problem at large charge:

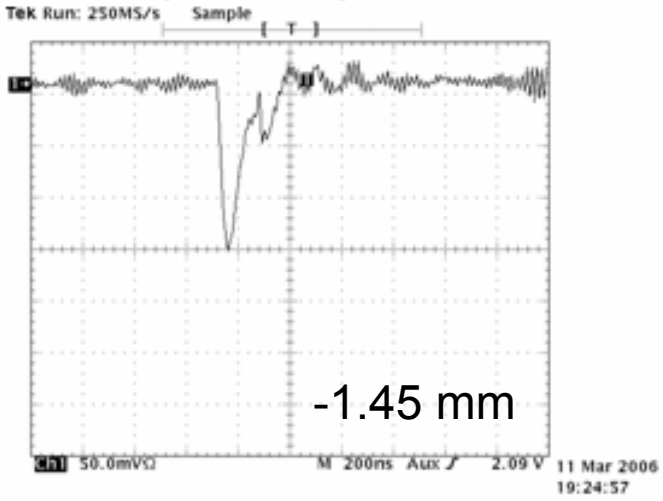


Almost insensitive to double pulse
(except 7.7 ns delay)

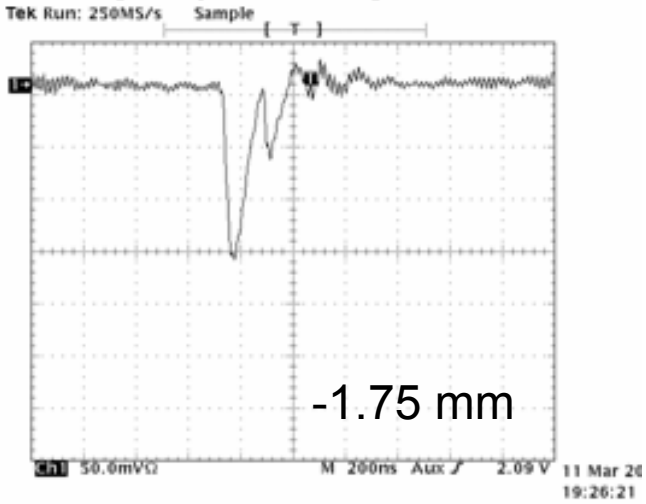
BPM 9ACC1/X response

(reentrant cavity)

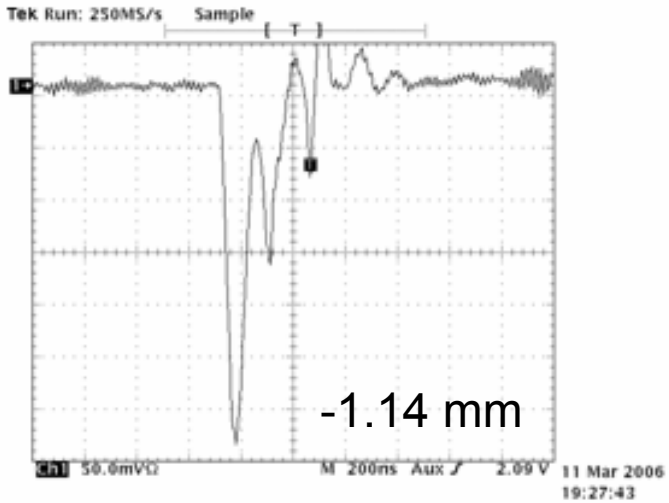
Direct pulse only



Delayed pulse only



Direct and delayed pulse

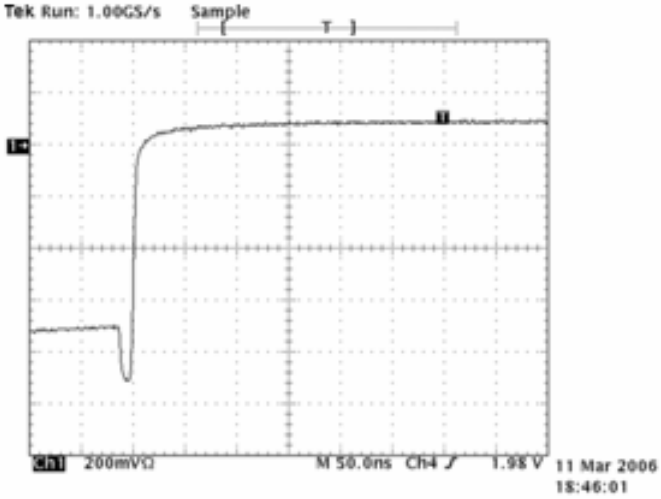


Final calculated signal in DOOCS somewhat sensitive to double pulse

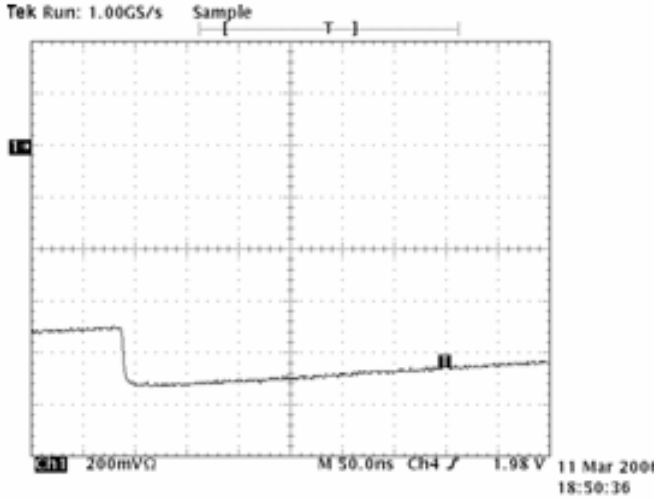
BPM 1UBC2/X response

(externally-triggered button)

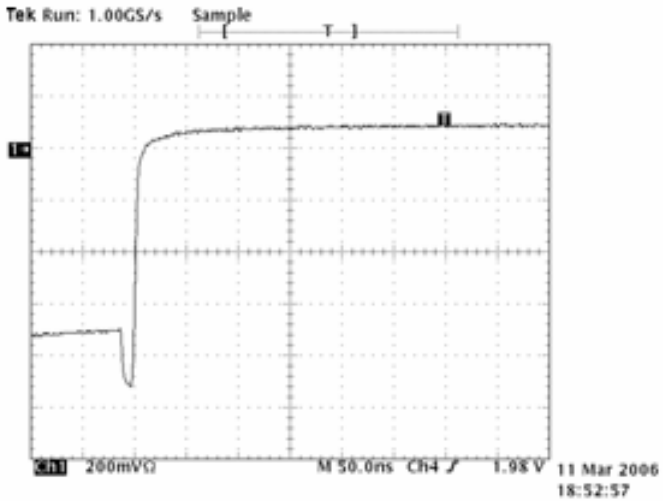
Direct pulse only



Delayed pulse only



Direct and delayed pulse

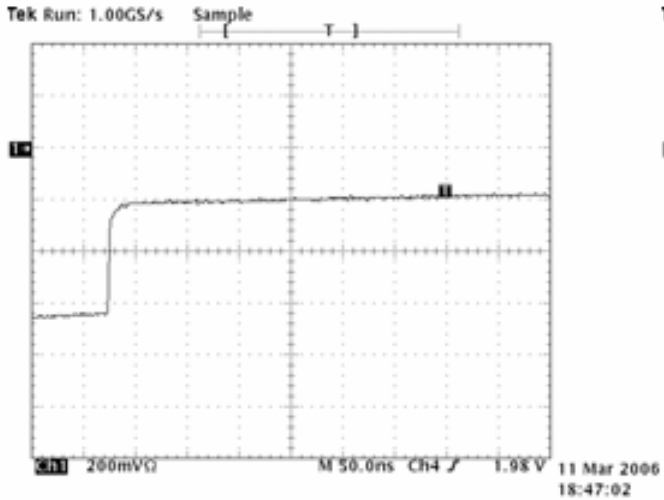


Does not see second pulse

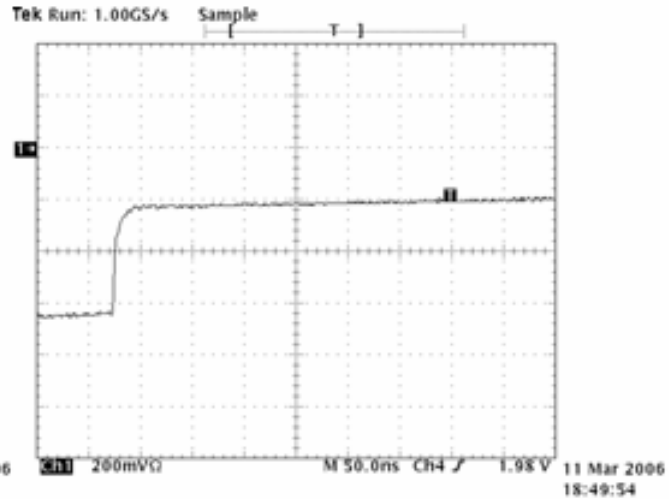
BPM 2DBC2/X response

(strip-line)

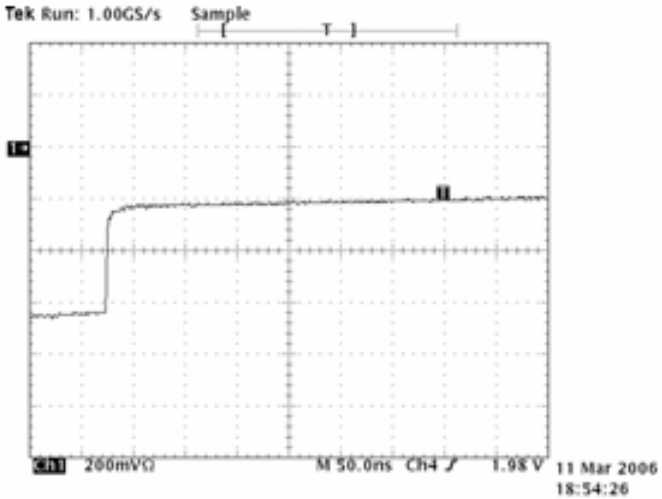
Direct pulse only



Delayed pulse only

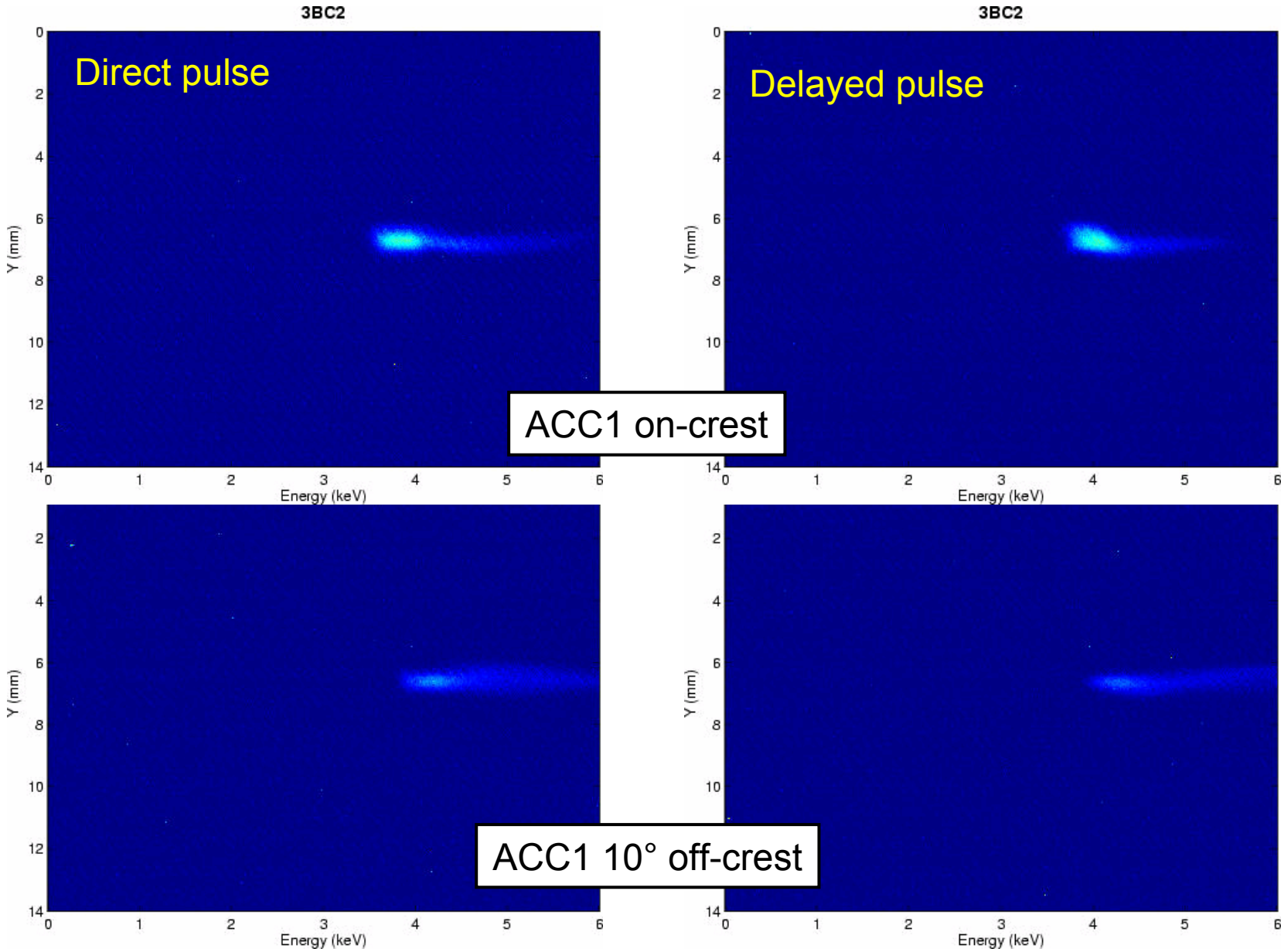


Direct and delayed pulse

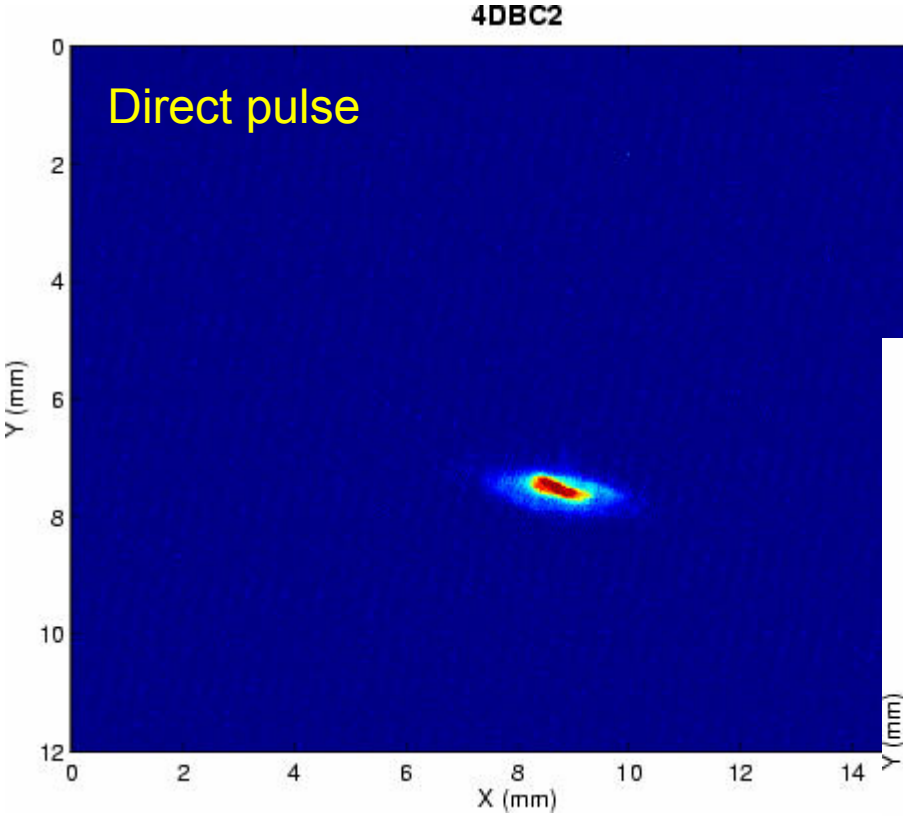


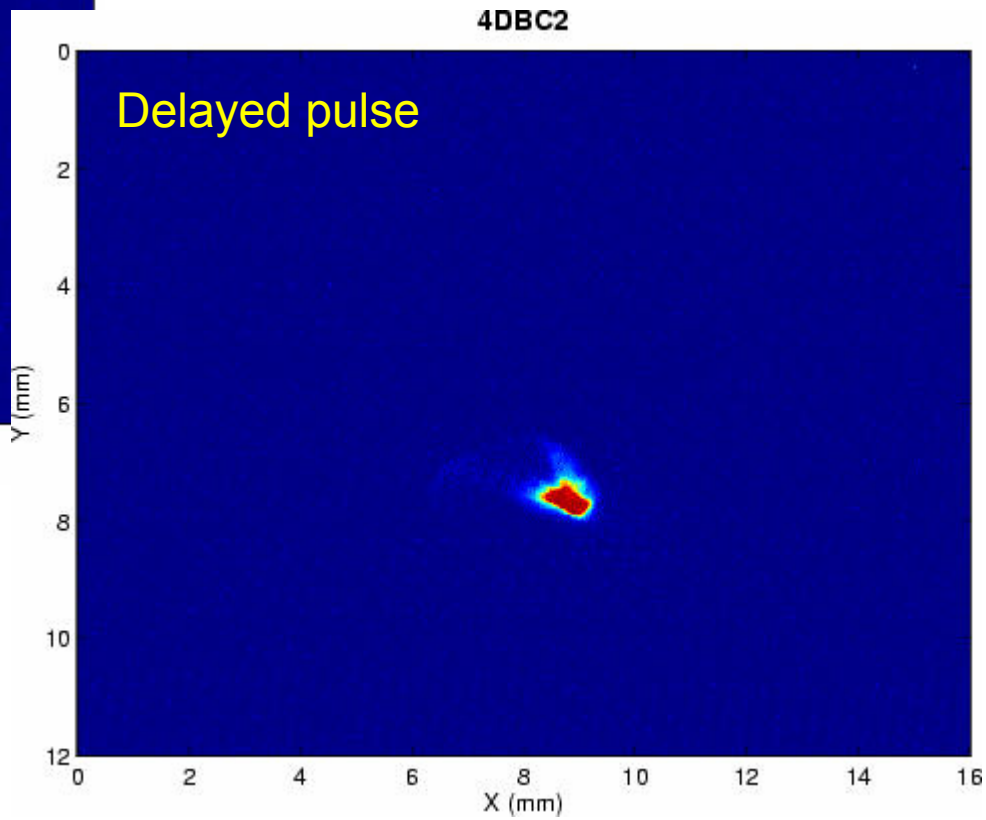
Insensitive to double pulse

Screen 3BC2


3BC2
Direct pulse
Y (mm)
Energy (keV)
3BC2
Delayed pulse
Y (mm)
Energy (keV)
ACC1 on-crest
Y (mm)
Energy (keV)
Y (mm)
Energy (keV)
ACC1 10° off-crest

Screen 4DBC2





Next steps
(the difficult ones…)

- Insert compensation optics into delayed path
- Check and improve quality of second bunch
  Emittance, longitudinal profile
- Lasing with second bunch only
- Lasing with second bunch of double bunch
  Wake fields might determine optimum delay, beam loading
- Measure time delay jitter of the two bunches

- Investigate generation of double pulses with Pockels cell gating