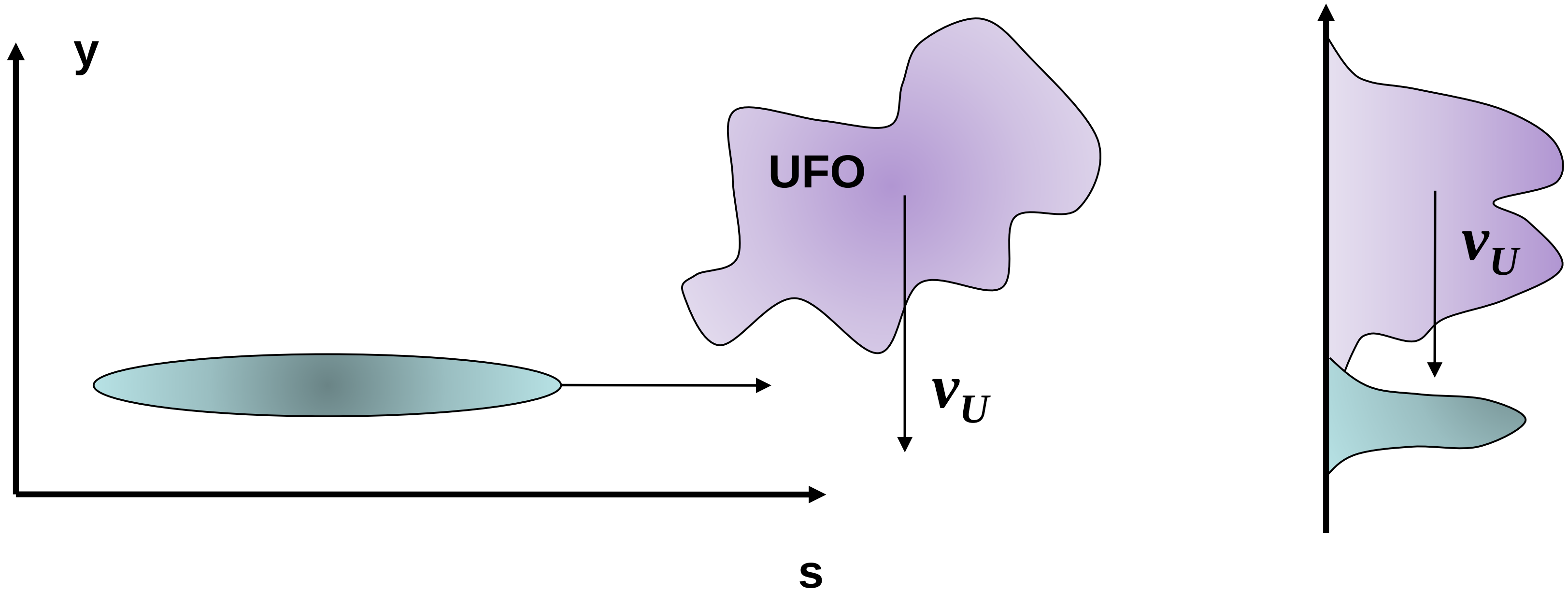
Analysis attempt of dump UFOs

On UFO duration and speed

What follows in based on the assumption that the UFO event is induced by an 'object' falling into the beam

UFO shape



- The density profile (in 3D !) of the UFO can be complicated, the BLMs allow us to get a glimpse at the overlap of beam and UFO distributions.
- Extreme cases:
  - If the UFO << smaller than the beam, the UFO is 'imaging' the beam and we see essentially the beam profile.
  - If the beam << smaller than the UFO, the beam is 'imaging' the UFO.

Analysis step 1

- When looking at the UFO data (BLM versus time) and after some trial and error, it turns out that a Gaussian shape fits reasonably well (sometimes very well) the time evolution of the signal in ~all cases.

  >> Generalizes a fit that B. Goddard did on a selected UFO last year.

This is actually quite surprising when one thinks about the possible complicated shape of the UFO.

Fit assumptions

- Let us assume here that the projection of the UFO density on the y axis is Gaussian. If the UFO moves at a constant vertical speed v_U. the loss rate *N(t)* would be:

$$N(t) \propto e^{-\frac{(y_0 - v_U t)}{2(\sigma_b^2 + \sigma_U^2)}}$$

σ_U: vertical UFO size

σ_b: vertical beam size

- A fit to the loss rate using:

$$N(t) \propto e^{-\frac{(t - t_0)}{2\sigma_T^2}}$$

σ_T: temporal width

can be used to deduce the average UFO speed :

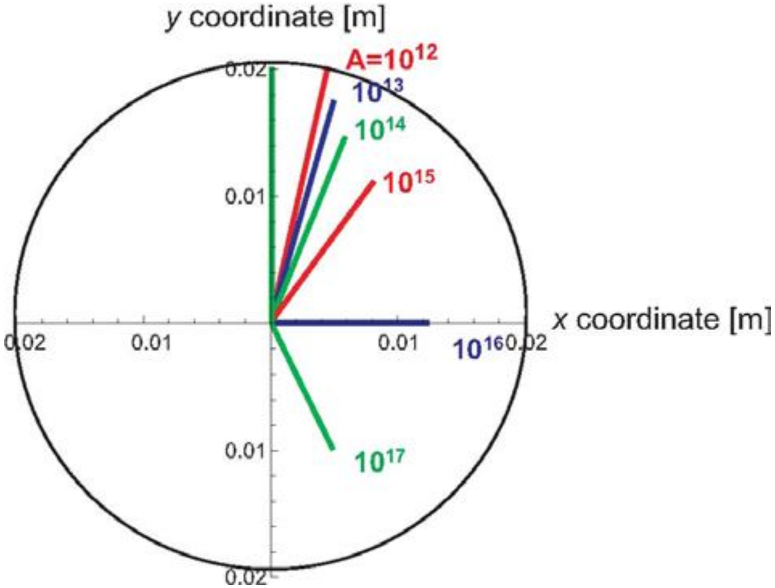
$$v_U = \frac{\sqrt{\sigma_b^2 + \sigma_U^2}}{\sigma_T} > \frac{\sigma_b}{\sigma_T}$$

UFO speed

- If the UFO speed is due to free fall in vacuum, it should be (for a height h = 0.02 m) :

$$v_U = v_g = \sqrt{2gh} = 0.63\,(\mathrm{m/s})$$

- If the UFO is charging up from ionization when it hits the beam, then the speed may change. The UFO may even be expelled out of the beam (vertically and horizontally) – model by F. Zimmermann et al at PAC09 (MOPEC019).

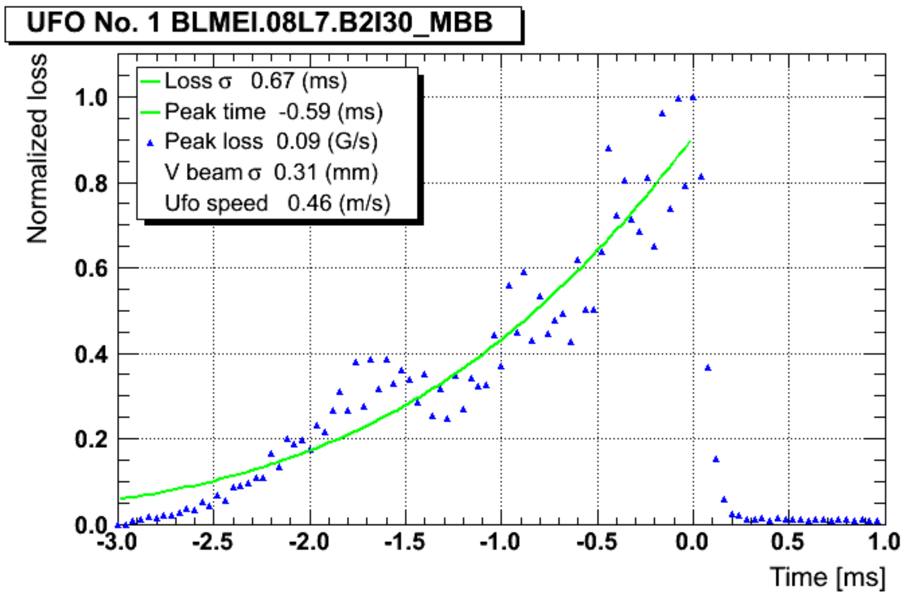


Round Al UFO trajectories (X-Y) as a function of the no. of atoms (A) of the UFO for 2.3E12 p. (F. Zimmermann)

Event types

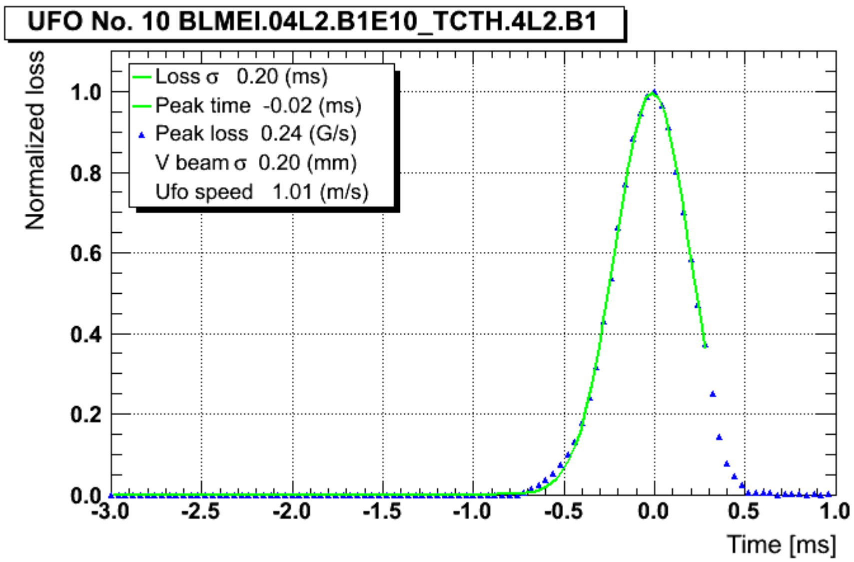
There are 2 types of UFOs that dumped.

Dump triggered while N(t) still increasing



Dump triggered while N(t) was decreasing, i.e. maximum was passed.

Analysis will be concentrated on those events.



Fit procedure

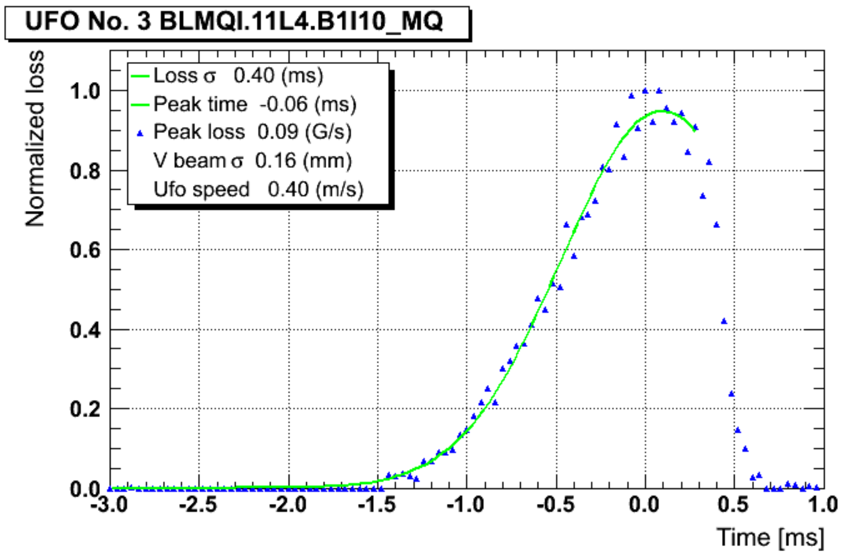
- The analysis covers the 18 UFOs that dumped the beam and the (last) precursor from the first event.
- The 40 μs data points for (one of) the BLMs with the largest loss are used for the fits.
  - First the highest loss point is determined. This defines t = 0. The data points are normalized to the highest loss.
  - The data is then fitted with a Gaussian from -3 ms to xx ms (xx ≥ 0). The last fit time depends on the event (see next slides).
  - For the precursor the data is fitted from -5 ms to +5 ms.
  - The UFO speed is (under-)estimated as:

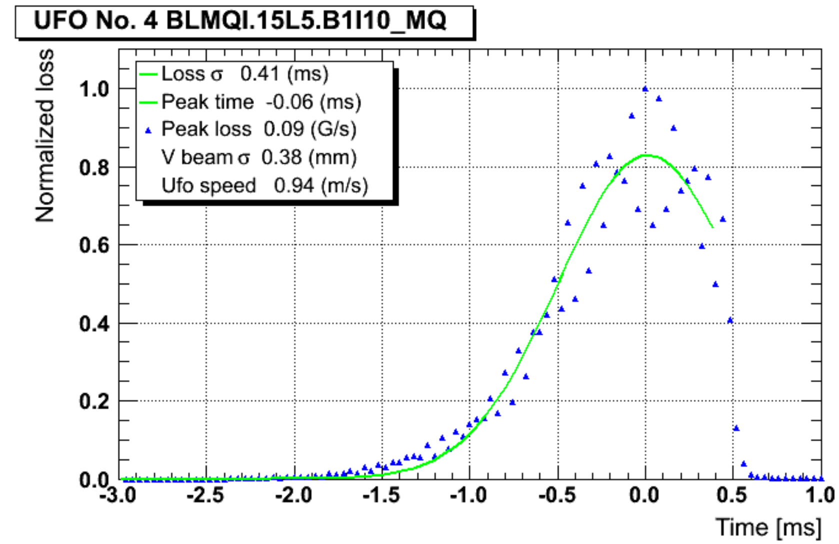
$$v_U = \frac{\sigma_b}{\sigma_T} < \frac{\sqrt{\sigma_b^2 + \sigma_U^2}}{\sigma_T}$$

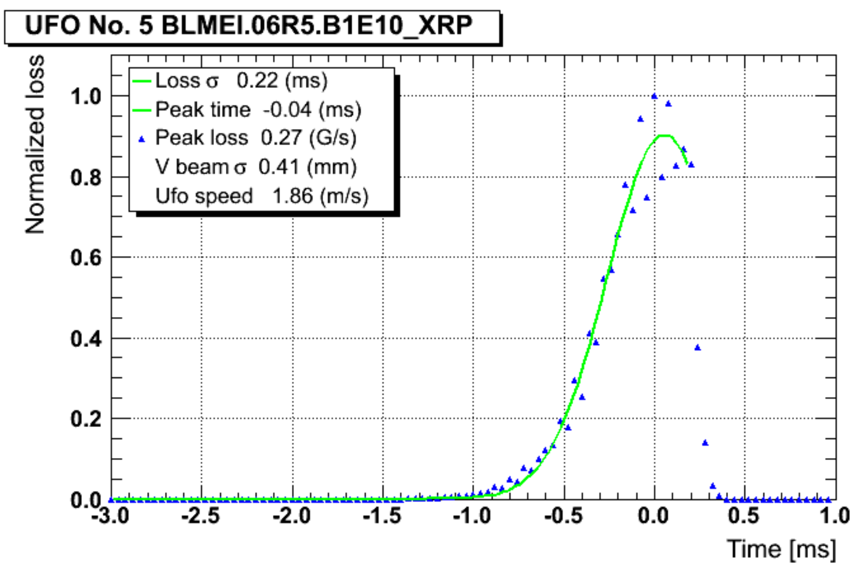
The beam size is estimated from the magnetic element at the first BLM of the UFO.

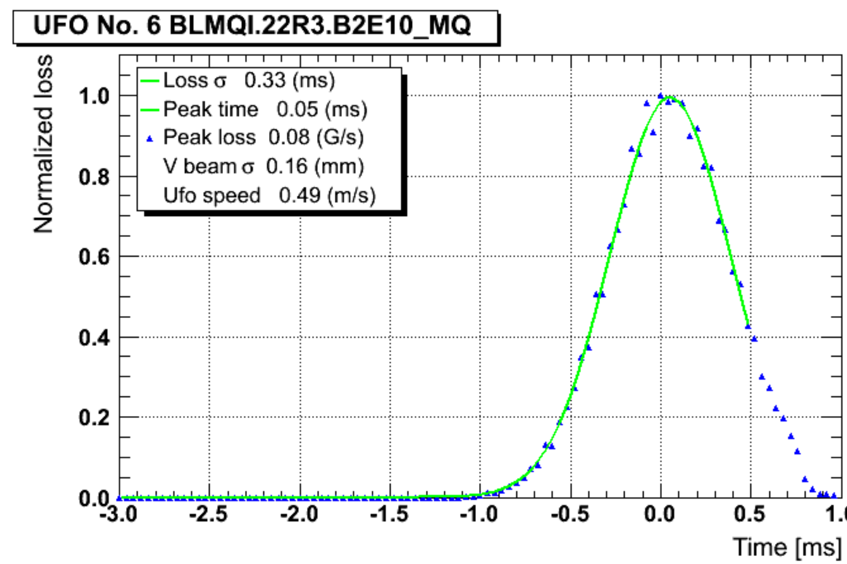
Assumption for emittance: 3.5 μm.

Events

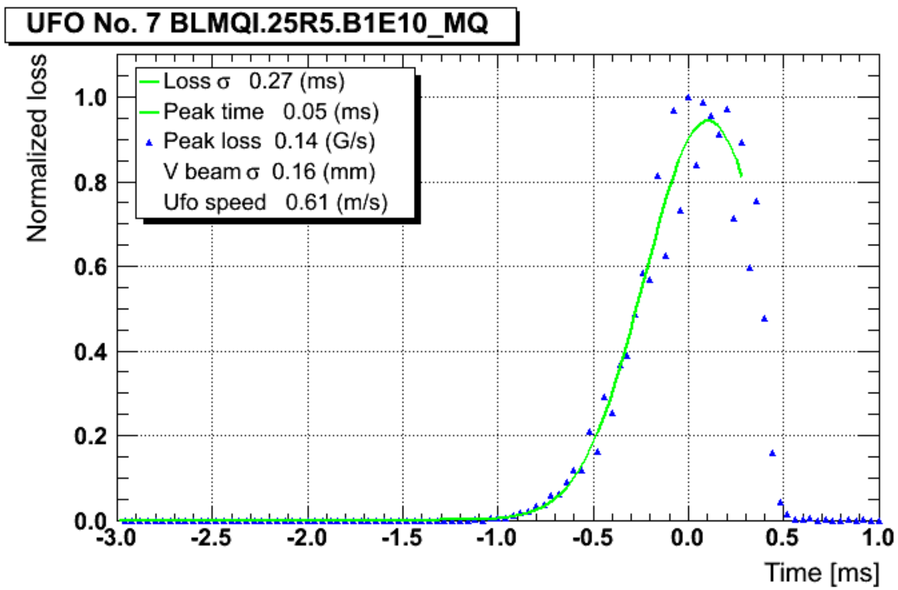

UFO No. 3 BLMQI.11L4.B1I10_MQ
Loss σ 0.40 (ms)
Peak time -0.06 (ms)
Peak loss 0.09 (G/s)
V beam σ 0.16 (mm)
Ufo speed 0.40 (m/s)
Normalized loss
Time [ms]


UFO No. 4 BLMQI.15L5.B1I10_MQ
Loss σ 0.41 (ms)
Peak time -0.06 (ms)
Peak loss 0.09 (G/s)
V beam σ 0.38 (mm)
Ufo speed 0.94 (m/s)
Normalized loss
Time [ms]

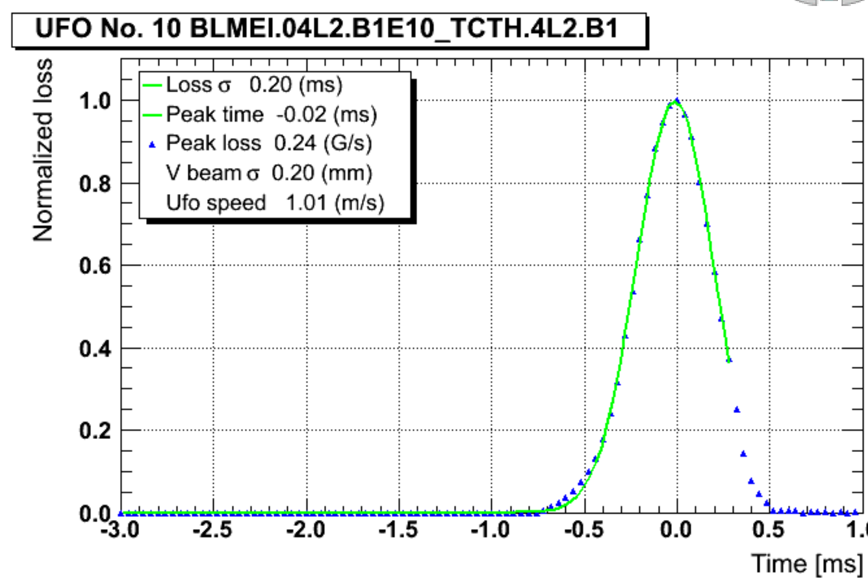

UFO No. 5 BLMEI.06R5.B1E10_XRP
Loss σ 0.22 (ms)
Peak time -0.04 (ms)
Peak loss 0.27 (G/s)
V beam σ 0.41 (mm)
Ufo speed 1.86 (m/s)
Normalized loss
Time [ms]


UFO No. 6 BLMQI.22R3.B2E10_MQ
Loss σ 0.33 (ms)
Peak time 0.05 (ms)
Peak loss 0.08 (G/s)
V beam σ 0.16 (mm)
Ufo speed 0.49 (m/s)
Normalized loss
Time [ms]

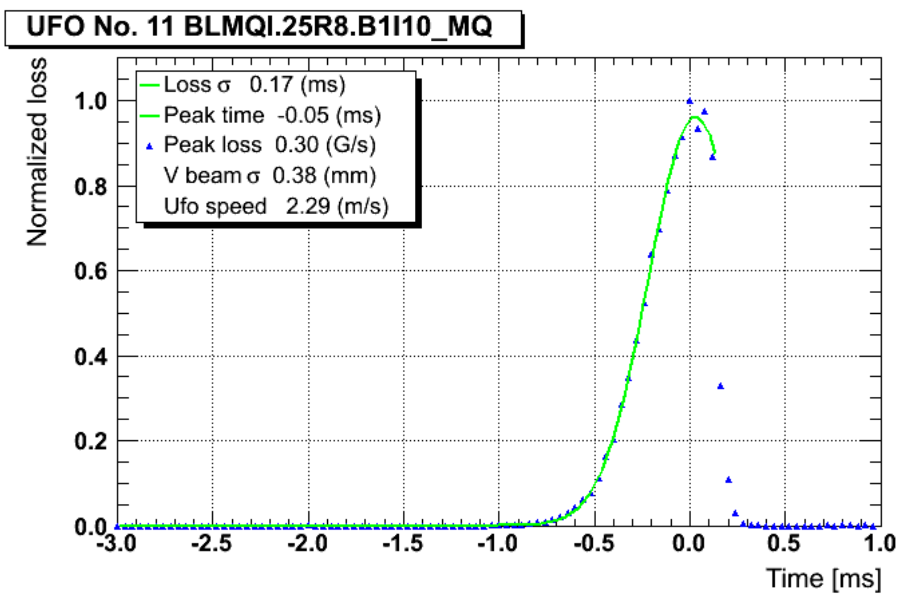
Events



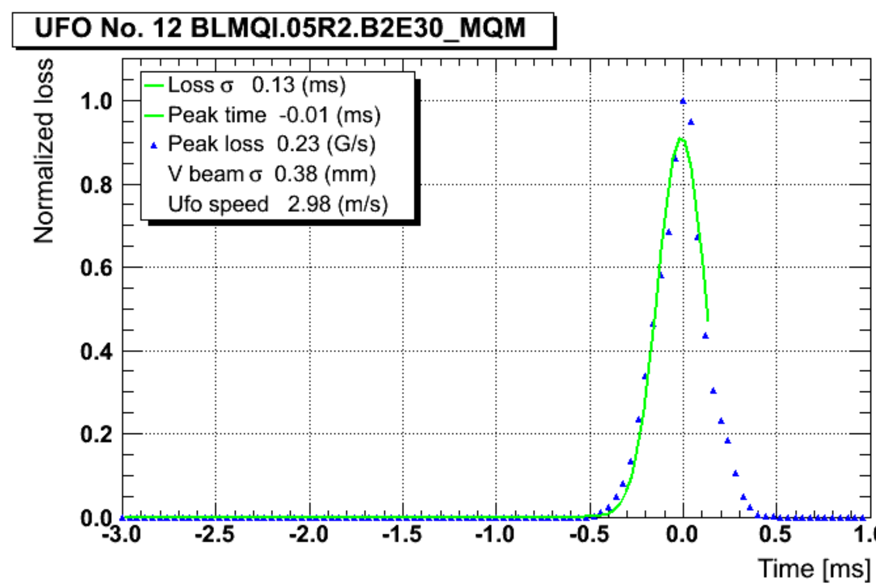
UFO No. 7 BLMQI.25R5.B1E10_MQ
Loss σ 0.27 (ms)
Peak time 0.05 (ms)
Peak loss 0.14 (G/s)
V beam σ 0.16 (mm)
Ufo speed 0.61 (m/s)
Normalized loss
Time [ms]



UFO No. 10 BLMEI.04L2.B1E10_TCTH.4L2.B1
Loss σ 0.20 (ms)
Peak time -0.02 (ms)
Peak loss 0.24 (G/s)
V beam σ 0.20 (mm)
Ufo speed 1.01 (m/s)
Normalized loss
Time [ms]

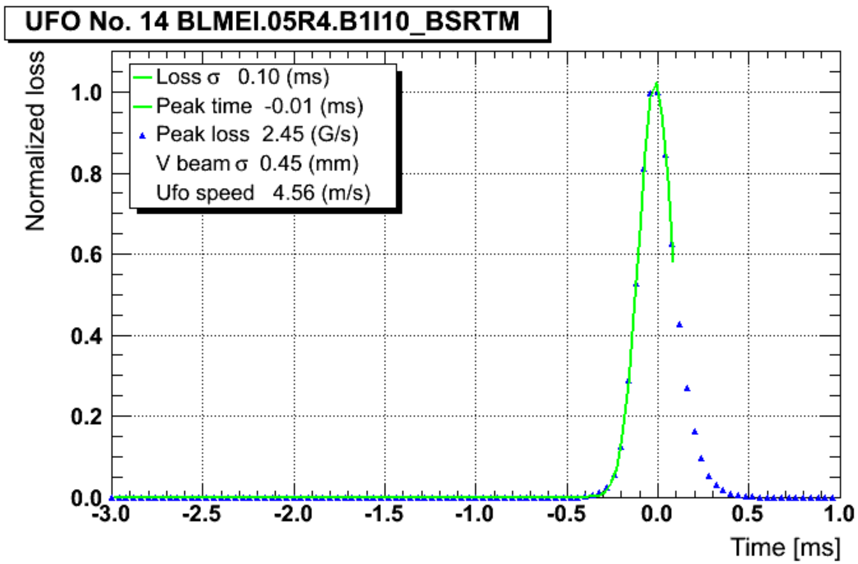


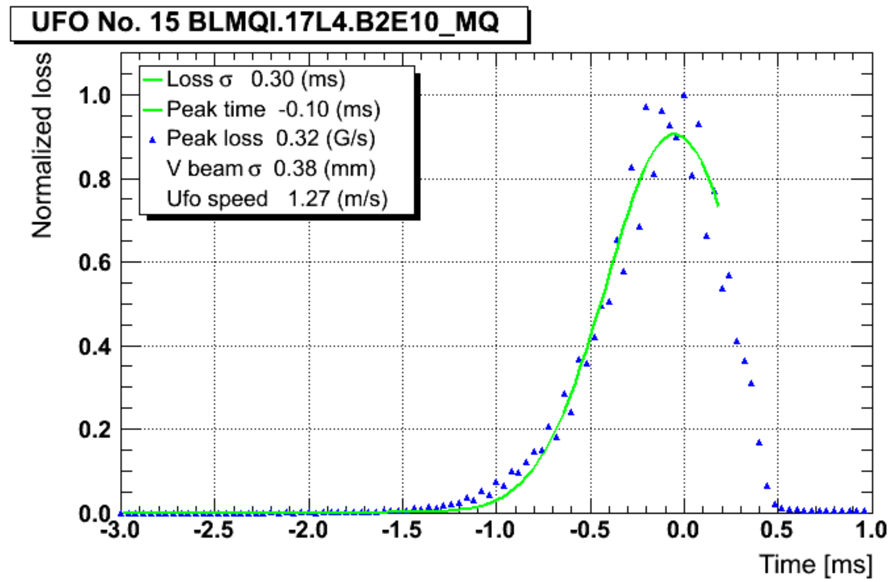
UFO No. 11 BLMQI.25R8.B1I10_MQ
Loss σ 0.17 (ms)
Peak time -0.05 (ms)
Peak loss 0.30 (G/s)
V beam σ 0.38 (mm)
Ufo speed 2.29 (m/s)
Normalized loss
Time [ms]

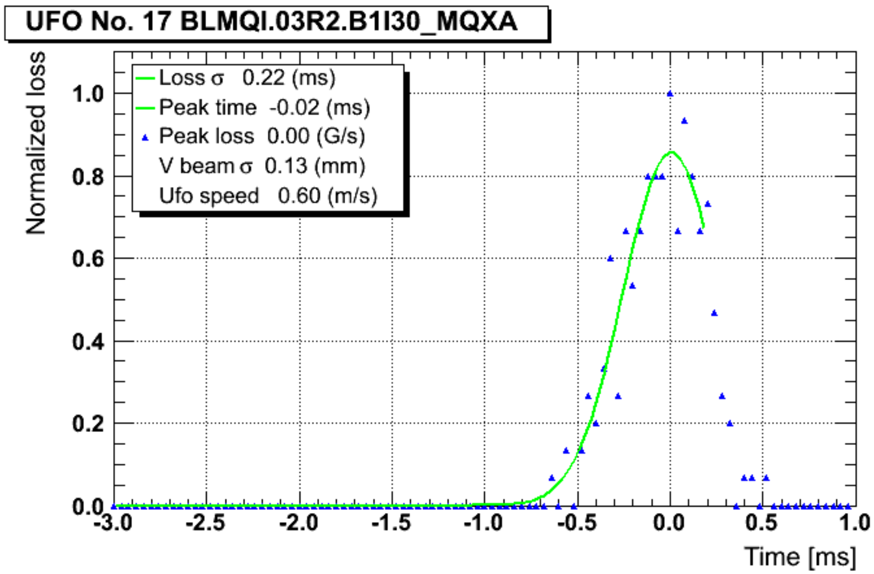


UFO No. 12 BLMQI.05R2.B2E30_MQM
Loss σ 0.13 (ms)
Peak time -0.01 (ms)
Peak loss 0.23 (G/s)
V beam σ 0.38 (mm)
Ufo speed 2.98 (m/s)
Normalized loss
Time [ms]

Events



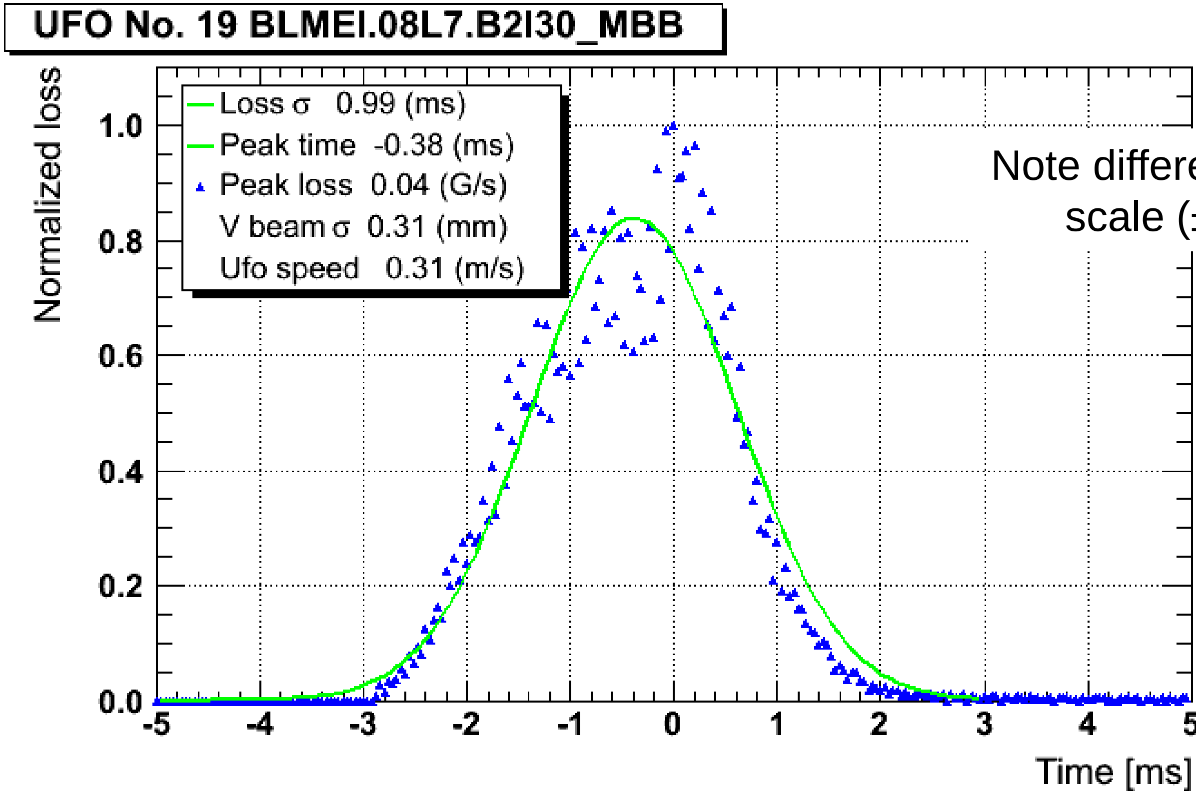




In many cases the estimated UFO speed is significantly larger than v_g !!

=> 0.4 to 4.5 m/s

Last precursor of Event 1

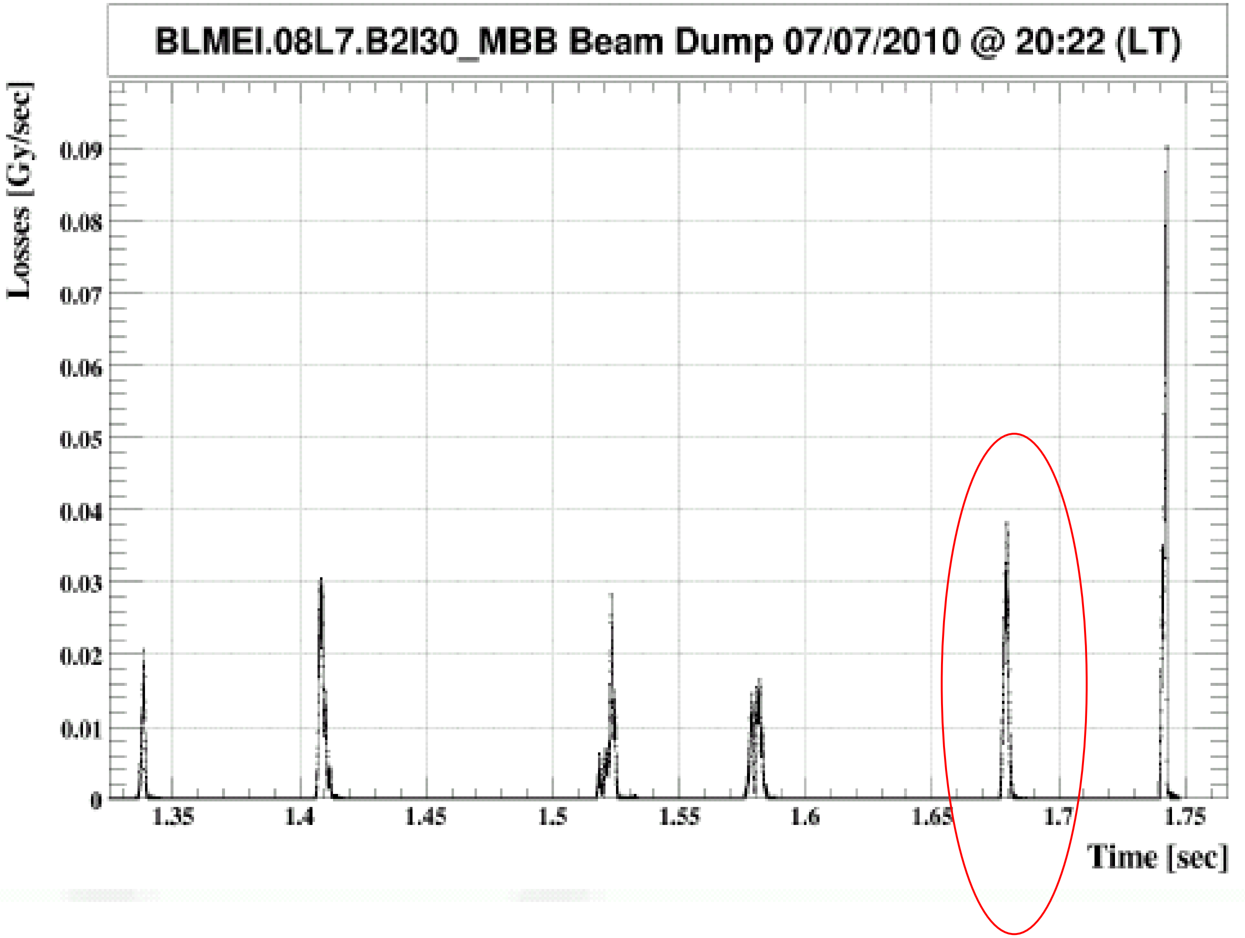


Note difference in hor. scale (± 5 ms)

- Overall shape not 'too different' from a Gaussian. Multiple peaks probably due to UFO shape.
- Average speed of this precursor 0.31 m/s < v_g : could indicate that the UFO was larger than the beam, and that it fell across the beam…

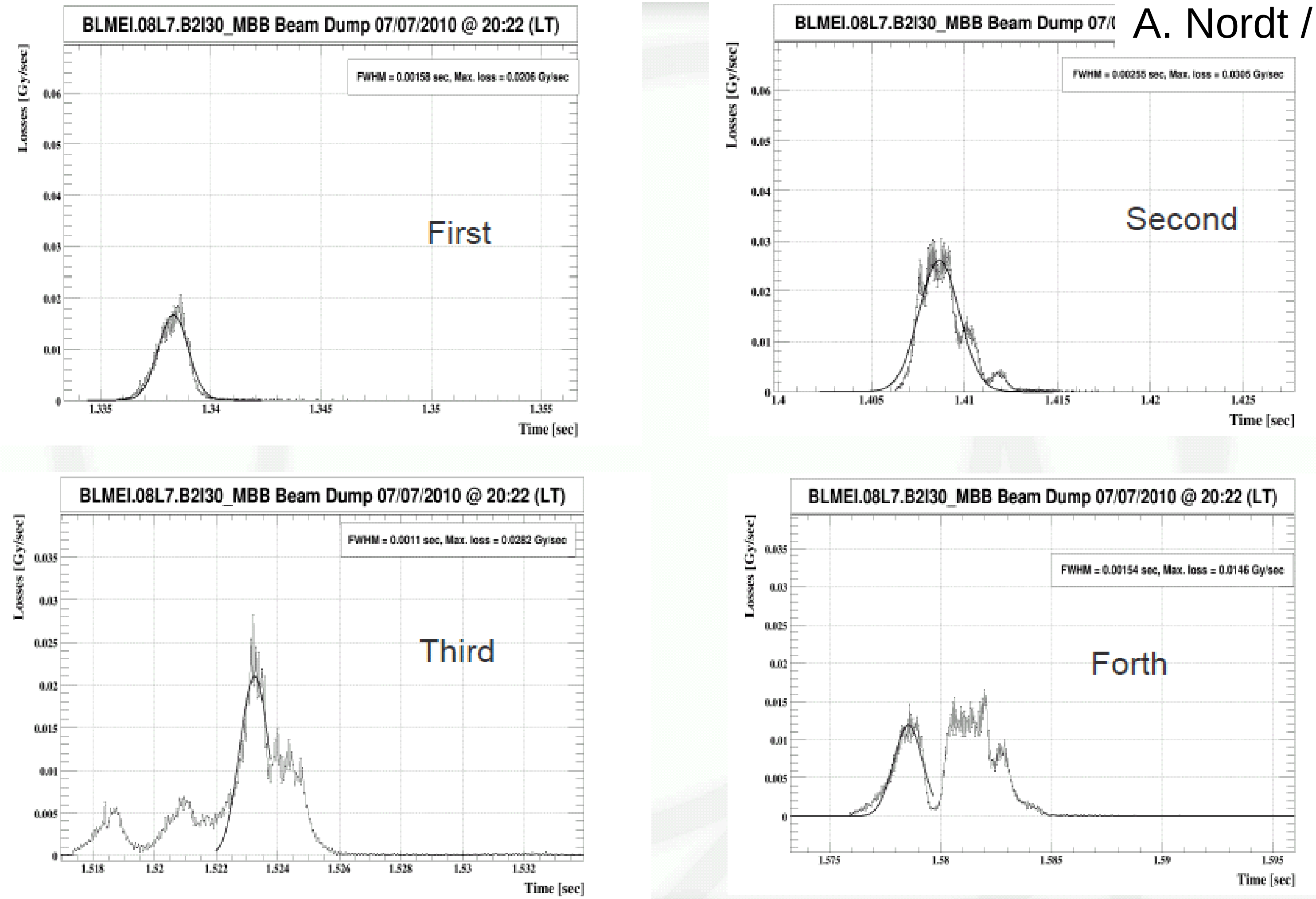
Event 1 precursors

A. Nordt / July 2010



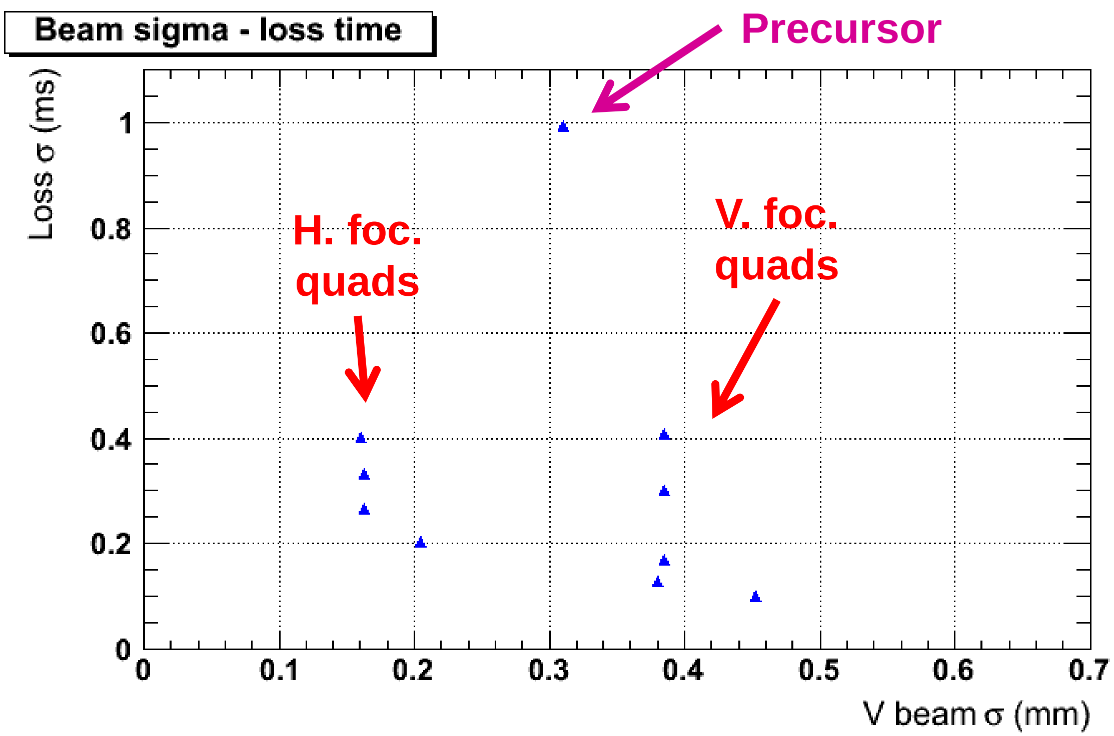
Event 1 – first 4 precursors

A. Nordt / July 2010



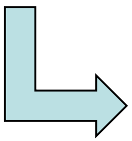
A simple Gaussian approximates 3 of 5 precursors…

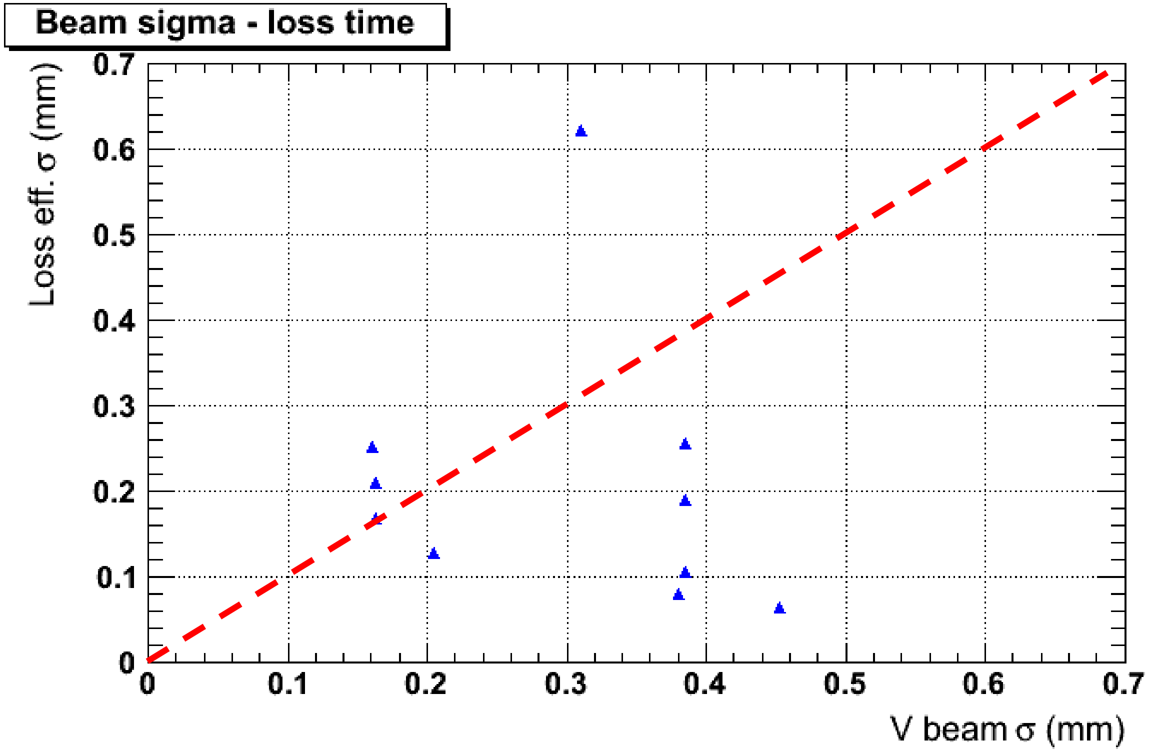
Duration versus beam size



- There is no significant difference between locations of small (H. focusing) and large (V. focusing) beam size.
- The real sizes could be larger for the H. focusing locations, smaller for the V. focusing locations (UFO source upstream of quadrupole).

$$\sigma_{eff} = \sigma_T v_g$$





- The effective size should be larger than the beam size – not the case of the UFOs where beam size is large.
  - This reflects the fact that the UFO speed estimated from the beam sizes are much too large (wrt gravity). A sign that the UFO is subject to electromagnetic forces, expelled … ?

Next?

- As a next step one could repeat the exercise for the sub-threshold UFOs from Eduardo.
  - From the dcum obtain the betatron function.
  - Correlate again Eduardo’s UFO duration estimate with the beam size, respectively estimate a speed.