MERIT beam spot size

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How to extract a beam size?

Camera positions:

1st approach: To fit projections*

- Mean = 0.22(5) mm
- Sigma = 4.54(9) mm

2nd approach: To fit shadows**

- Mean = -4.64(3) mm
- Mean = 0.11(4) mm
- Sigma = 2.21(3) mm
- Sigma = 2.22(4) mm
- Sigma = 3.41(5) mm

We have 3 beam 'cameras' -> 3 images for every beam pulse

Camera positions:

- Camera 414
- Camera 454
- Camera 484

TARGET

BEAM

Shot from Camera 484

How to extract a beam size?

* Projection for X is 
\[ P(x) = \frac{1}{n_y} \sum_{i=1}^{n_y} z(x, y_i) \],

similarly for Y.

** Shadow for X is 
\[ S(x) = \max[z(x, y_i)], (i = 1, n_y) \],

similarly for Y.
**Fitting: Projections**

Simple fitting function: Gaussian + 'background'

Fitting algorithm (how to avoid gaps; how to choose initial value of the 'background' term, etc...) was based on the analysis of the 15-20 randomly selected images (after this, completely 'blind' analysis -> no parameters tuning)

In total: 520 beam pulses* x 3 cameras x 2 projections = 3120 distributions have been fitted

Result: Table - ntuple (part of it shown below)

```
| Camera | 414 | | Camera | 454 | | Camera | 484 |
|--------|-----|----|--------|-----|----|--------|
| Date   | Time (ddmmyyyy) (hhmms) | X_{mean} (mm) | Sigma_{x} (mm) | Y_{mean} (mm) | Sigma_{y} (mm) | X_{mean} (mm) | Sigma_{x} (mm) | Y_{mean} (mm) |
| 11112007 | 122348 | 9.204 | 6.081 | 5.331 | 5.723 | -1.234 | 6.671 | -10.043 |
| 11112007 | 123724 | 9.851 | 5.720 | 5.490 | 4.750 | -0.695 | 5.703 | -10.521 |
| 11112007 | 124959 | 10.288 | 5.508 | 5.880 | 3.615 | 0.270 | 4.599 | -10.108 |
| 11112007 | 125545 | 12.105 | 4.446 | 5.808 | 3.516 | -1.036 | 5.781 | -10.194 |
| 11112007 | 125829 | 13.043 | 3.803 | 5.821 | 3.545 | -1.424 | 5.613 | -10.246 |
| 11112007 | 130436 | 8.399 | 6.587 | 6.164 | 3.939 | 1.542 | 4.026 | -10.022 |
| 11112007 | 130618 | 11.813 | 4.675 | 5.870 | 3.730 | -1.200 | 5.505 | -10.205 |
```

This will be used to reconstruct the Run number and to attach this table to the 'global' table with experimental results.

This will be used to recognize a shot with the 'suspicious' fitting result and to fit it 'manually'.

Fitting: Projections

Distributions of the Gaussian means

These distributions could be used for projections vs shadows cross-checking.
Fitting: Projections

Distributions of the Gaussian sigmas

- Suspicious results
  (empty shots, beam on the edge of the 'visible field', etc..)

Find the corresponding event in the table (Slide 3) and fit it manually (if possible)
Fitting: Projections

Distributions of the ratios of the Gaussian sigmas

\[
\begin{align*}
\frac{\sigma^414}{\sigma^454} & \quad \frac{\sigma^454}{\sigma^484} \\
\frac{\sigma^x_{414}}{\sigma^x_{454}} & \quad \frac{\sigma^x_{454}}{\sigma^x_{484}} \\
\frac{\sigma^y_{414}}{\sigma^y_{454}} & \quad \frac{\sigma^y_{454}}{\sigma^y_{484}}
\end{align*}
\]

Looks reasonable
Showing collimation of the beam when travelling from Camera_414 position towards the target

These distributions could be used for projections vs shadows cross-checking
When discussed possible results of this analysis a month ago at Oxford, the conclusion was that it will be a very good progress if we are able to obtain the ratios shown here.

But, maybe the fitting of the 'shadows' will give us a better estimate of the beam size. So the next steps are:
- repeat procedure for the 'shadows';
- compare two sets of the results;
- discuss the results at one of the following MERIT meetings and decide which approach should be used;
- attach the corresponding beam-spot datafile to the 'global' MERIT datafile and start analysis using integrated data.