Location Efficiency - 1

Study the Location efficiency by analyzing the spatial distributions of found vertices

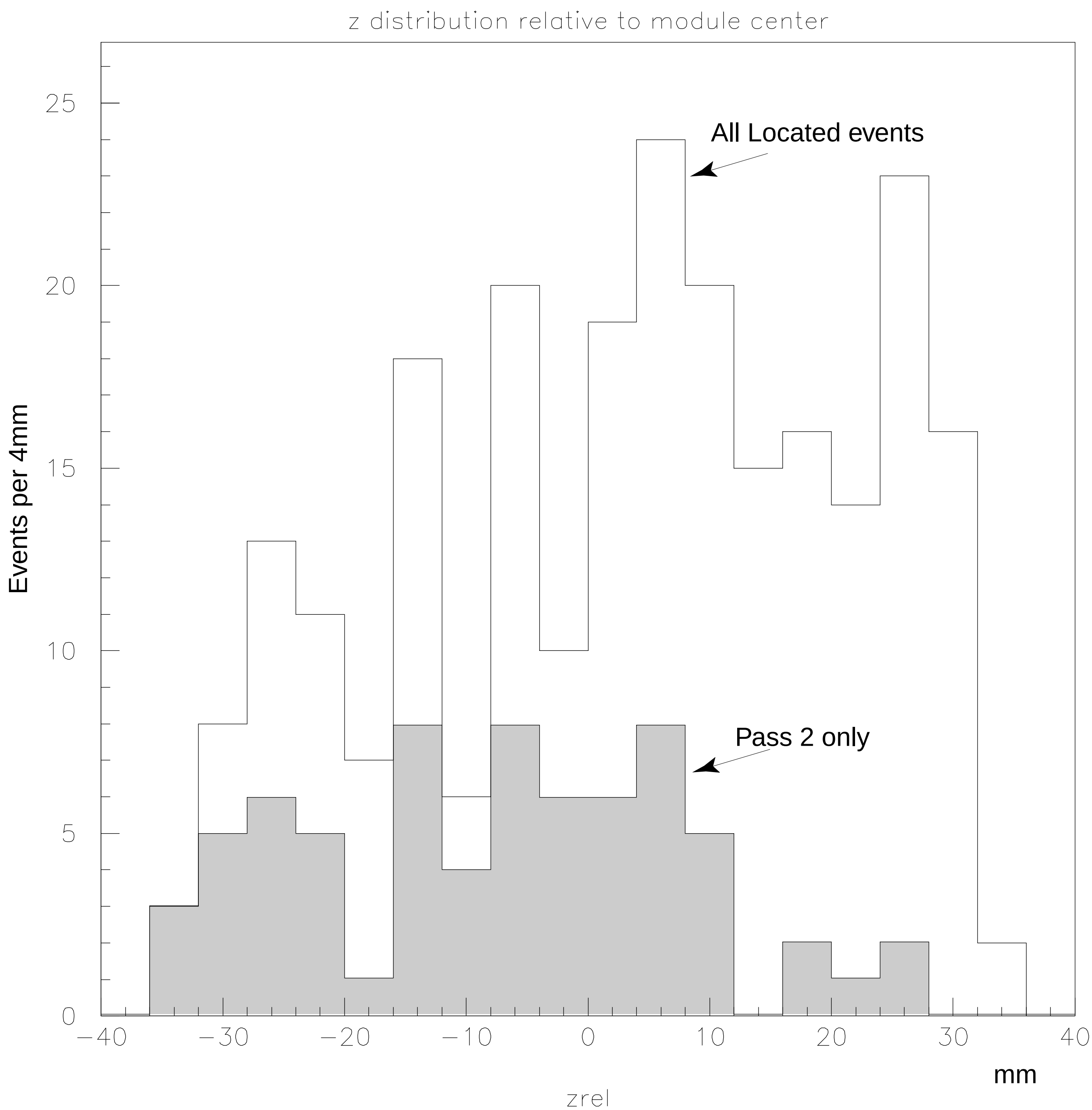
Sample includes :

- All located events ~210
- Pass 2 located events (Net scan only)

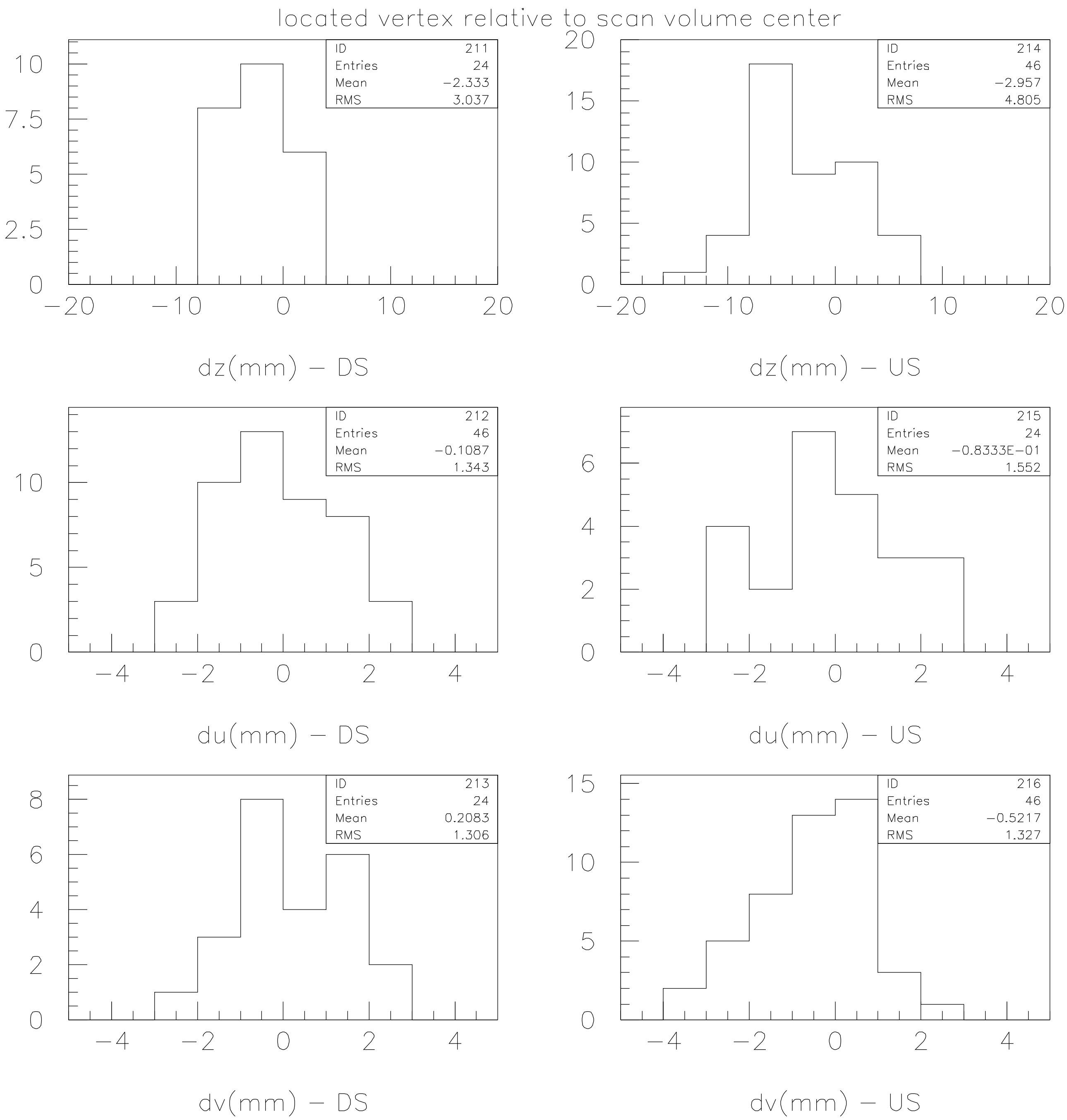
We will attempt to use shape and properties of vertex distributions to compare the accuracy of the prediction to the size of the scan volume.

An estimate for the likely (or average) needed scan volume can be deduced.

First, the distributions of the vertex z position, with the data for all modules superposed defining z=0 to be the center of each module.



found - (cntr of vol) in mm



Vtx found in **downstream**
30mm

Vtx found in **upstream**
30mm

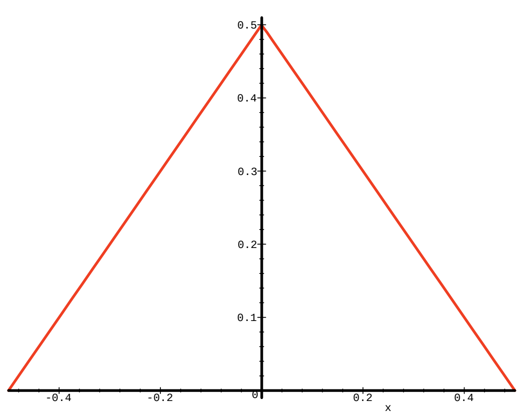
The typical Δz = 15mm

Next, a digression about the shapes of distributions...

The previous plots were made using the difference between two distributions $f_1 - f_2$; what do we expect them to look like?

Case 1: f_1 is a uniform distn. and f_2 is a fixed value, i.e. $\delta(x - x_0)$
The convolution $f_1 \circledast f_2 = f_1$ a *constant* function;
with an rms $\rightarrow (x_{max} - x_{min})\,(12)^{-1/2}$

Case 2: Both f_1 and f_2 are uniform distns.
The convolution $f_1 \circledast f_2$ is a *ramp* function;



with an rms $\rightarrow (x_{max} - x_{min})\,(24)^{-1/2}$

Case 3: f_1 is a Gaussian and f_2 is a fixed value or is also Gaussian.

The convolution $f_1 * f_2 = f_1$ a *Gaussian* function; with an rms $\rightarrow F(\mathrm{erf}(x);\sigma)$

Distribution	σ	RMS for unit interval
Uniform	NA	1/÷12 = 0.29
Ramp	NA	1/÷24 = 0.20
Gaussian	1.0	0.28
	0.5	0.27
	0.3	0.24
	0.2	0.19
	0.1	0.10

The table shows the measured rms value for the different cases for a unit interval.

The worst we should expect is Case 1, where our vertex position is such a poor guess that it shows little correlation. The rms is $0.29(\Delta z) \sim 4.5$mm. Of course, statistical fluctuations can make this worse.

The best case would be a small symmetric error about the true vertex, i.e. a Gaussian with small σ.

The Data

Looking at the histograms of the z distributions on pg. 3 we see that the downstream data (DS) is clearly correlated, although not symmetric.
$\mathrm{rms}/\Delta z \sim 0.2 - 0.3$

The upstream data (US) is rather poor, with an rms indicative of little correlation. For a Gaussian distribution we can set an approximate lower limit:
$\sigma/\Delta z > 0.5$

The transverse distributions can be analyzed in the same manner. They are somewhat "peaked". Typically for DS: $\mathrm{rms}/\Delta u \sim 0.25 \Rightarrow \sigma/\Delta z \sim 0.3 - 0.5$

The US sample is not as symmetric.

The Results

For normally distributions there is a "threshold" effect where little information is gained for $\sigma/\Delta z > 0.5$.

$\sigma/\Delta z$	$\int f\, dx$
1.	0.38
0.5	0.68
0.3	0.89
0.2	0.99

Fraction of a data within Δz for values of the relative standard deviation.

We can conclude that is likely that most of the location **in**efficiency is due to insufficient scan volume instead of poor vertex recognition.