

Status of beam monitors/triggers

Inaki Ortega

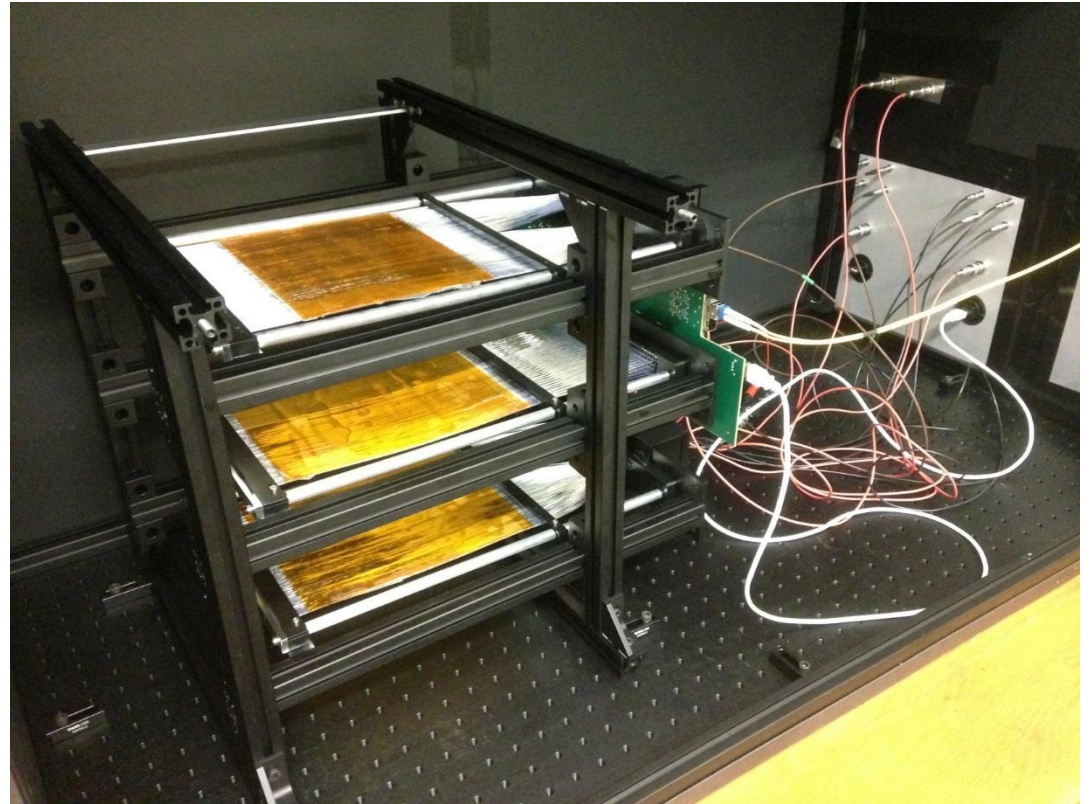
BIG Meeting, CERN - 11/04/2018

Summary (or what's new since January's DUNE CM):

- Cosmic setup
- Production status

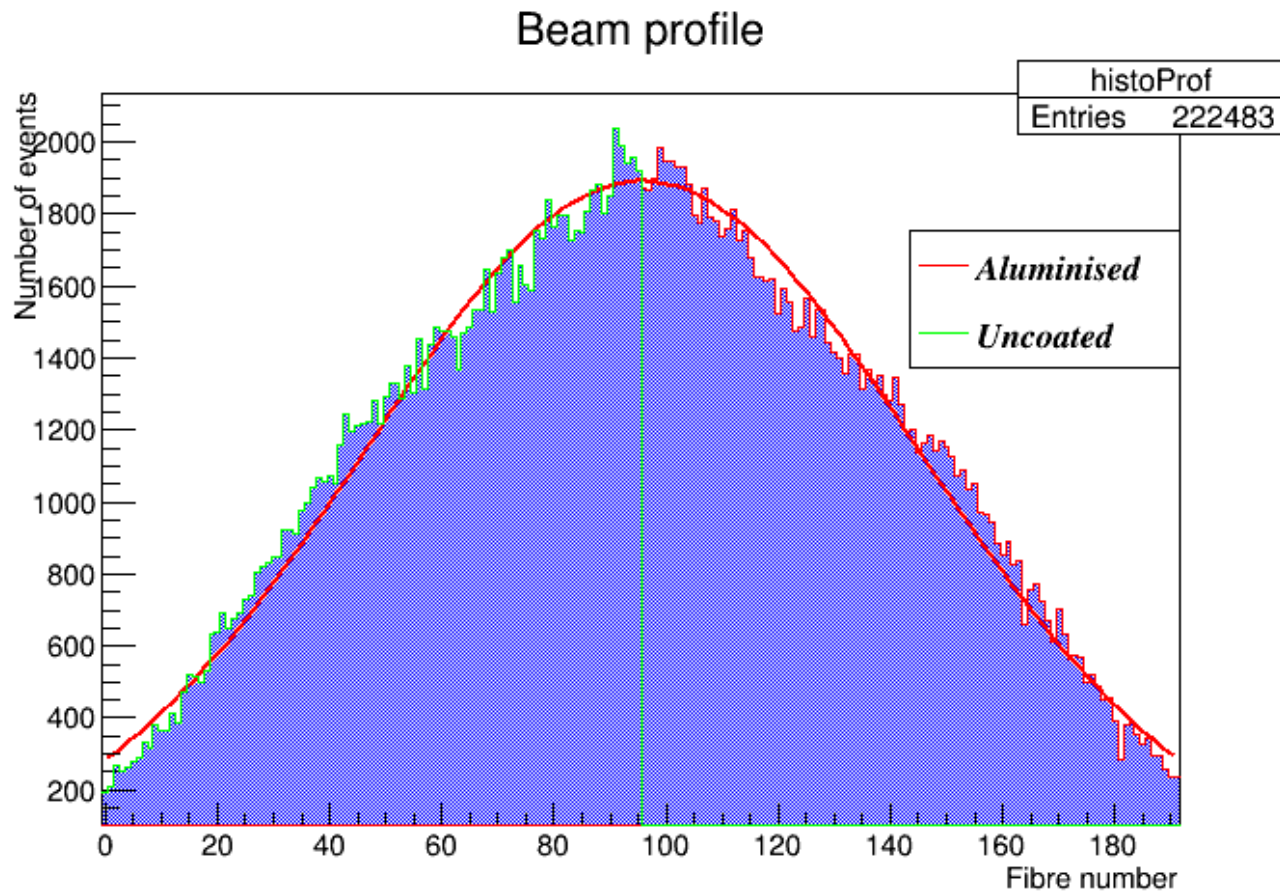
Cosmic setup

- Sandwich of 2 Triggers and 1 XBPF.
- Excellent way of measuring the performance of our detector.
- Generates data uninterruptedly → When the DIP server is ready, the people working on the protoDUNE DAQ can access real data from cosmics.
- The FESA should be ready this week → after that the DIP team can start working on the server.

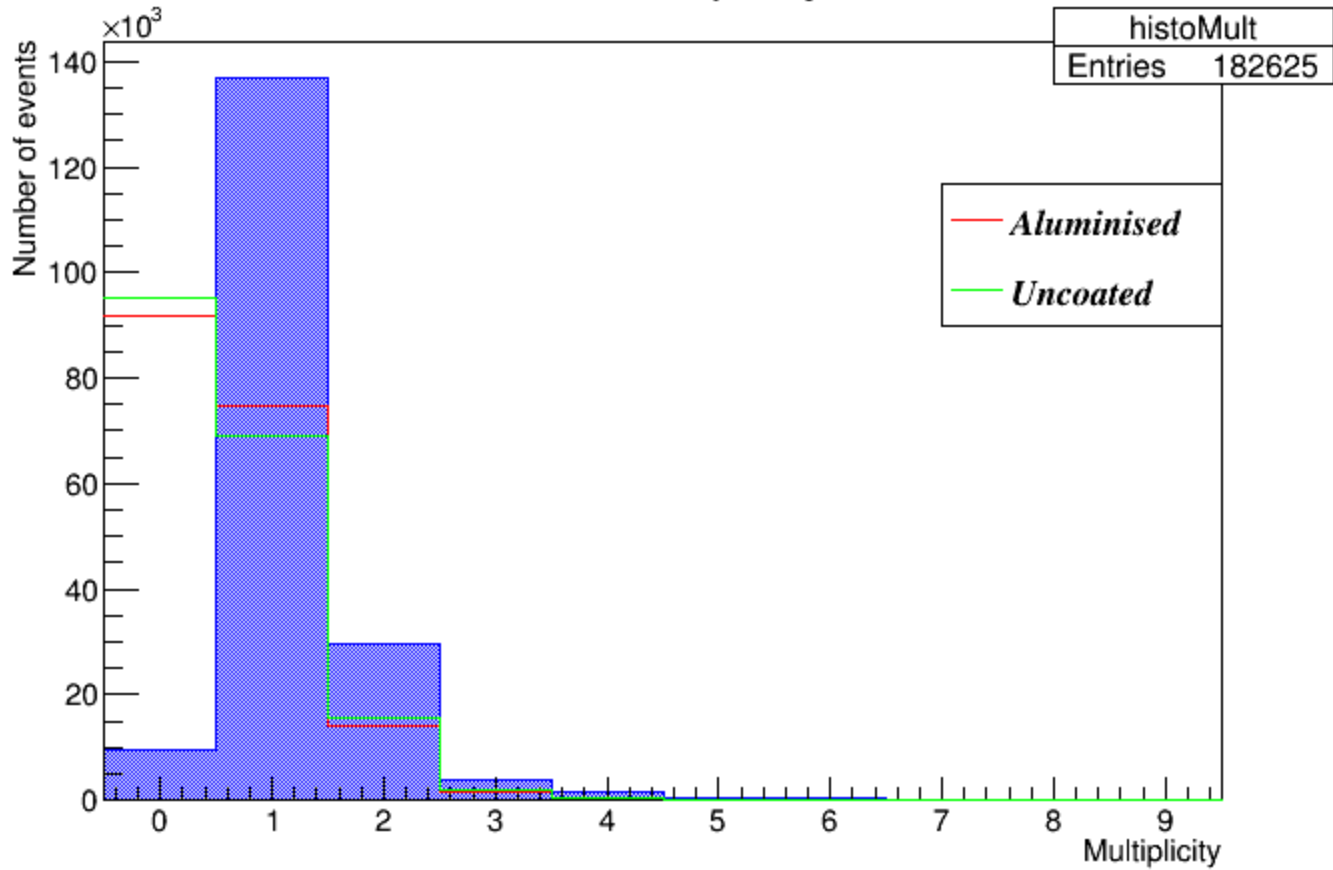


We have measured the performance of the monitors after varying several parameters, such as discriminator's threshold, SiPM overvoltage and preamplifiers value.

Example measurement with the SiPM overvoltage = 3V, preamp value 16 (x 12.8), discriminator's threshold to 3.5 photons:



Fibre multiplicity



inaki@pcbe13594-ubuntu: /afs/cern.ch/work/i/iortegar/xbpf/lab_setup\$ root -l analyse_data_root.c+

root [0]
Processing analyse_data_root.c+...

Files found:

- [0] discrit235-16h-55V-tfs-preamp16.root
- [1] discrit-235_22h_55V-tfs_preamp32.root
- [2] discrit_240_56V-tfs.root

Select file to analyse.

File number: 0

Processing... It may take a while.

FCN=1060.41 FROM MIGRAD STATUS=CONVERGED 72 CALLS 73 TOTAL
EDM=6.63322e-11 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	Constant	1.89157e+03	5.20245e+00	6.39478e-02	2.53174e-06
2	Mean	9.57010e+01	1.20373e-01	1.91437e-03	-4.48382e-05
3	Sigma	4.92137e+01	1.13751e-01	1.02237e-05	1.05713e-02

	Full	Aluminised	Uncoated
Processed events:	182625		
Detected events:	173020	90850	87485
Efficiency:	94.74%	52.51%	50.56%
Total multiplicity:	20.87%	44.67%	51.09%
Multiplicity 2:	17.15%	46.96%	52.99%
Multiplicity 3:	2.28%	35.67%	44.70%
Higher Mult:	1.45%	31.71%	38.58%
Adjacent fibres:	19.02%	45.67%	52.20%

Analysis of the aluminised and uncoated fibres as individual detectors:

	Aluminised	Uncoated
Total multiplicity:	17.76%	21.09%
Multiplicity 2:	15.34%	17.97%
Multiplicity 3:	1.55%	2.02%
Higher Mult:	0.87%	1.10%
Adjacent fibres:	16.54%	19.64%

Gaussian fit of the profile:

Mean = 95.70; Sigma = 49.21

Output file name: discrit235-16h-55V-tfs-preamp16.analysis.txt

Plots saved in PNG format

Elapsed time: 1.00s

root [1]

```
inaki@pcbe13594-ubuntu: /afs/cern.ch/work/i/iortegar/xbpf/lab_setup
inaki@pcbe13594-ubuntu: /afs/cern.ch/work/i/iortegar/xbpf/lab_setup$ root -l analyse_data_root.c+
root [0]
Processing analyse_data_root.c+...

Files found:
[0] discrit235-16h-55V-tfs-preamp16.root
[1] discrit-235_22h_55V-tfs_preamp32.root
[2] discrit_240_56V-tfs.root

Select file to analyse.
File number: 0
Processing... It may take a while.
FCN=1060.41 FROM MIGRAD      STATUS=CONVERGED      72 CALLS      73 TOTAL
          EDM=6.63322e-11  STRATEGY= 1      ERROR MATRIX ACCURATE

EXT PARAMETER
NO.   NAME      VALUE      ERROR      STEP      FIRST
 1   Constant  1.89157e+03  5.20245e+00  6.39478e-02  2.53174e-06
 2   Mean     9.57010e+01  1.20373e-01  1.91437e-03  -4.48382e-05
 3   Sigma    4.92137e+01  1.13751e-01  1.02237e-05  1.05713e-02

Processed events:      Full      Aluminised      Uncoated
182625
Detected events:      173020      90850      87485
Efficiency:           94.74%      52.51%      50.56%
Total multiplicity:  20.87%      44.67%      51.09%
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Analysis of the aluminised and uncoated fibres as individual detectors:
Total multiplicity:  Aluminised      Uncoated
Multiplicity 2:      15.34%      17.97%
Multiplicity 3:      1.55%      2.02%
Higher Mult:         0.87%      1.10%
Adjacent fibres:     16.54%      19.64%

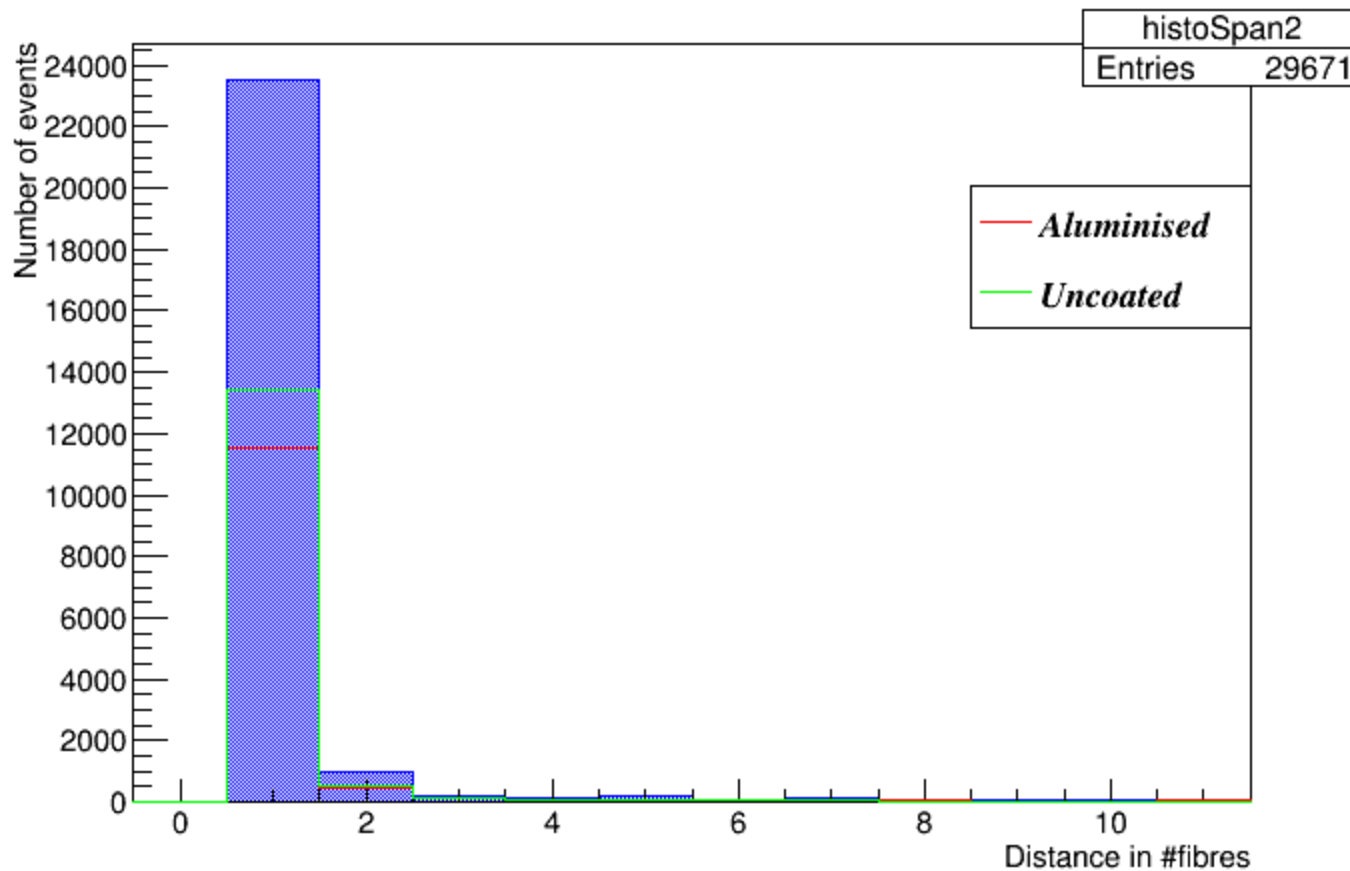
Gaussian fit of the profile:
Mean = 95.70; Sigma = 49.21

Output file name: discrit235-16h-55V-tfs-preamp16.analysis.txt
Plots saved in PNG format

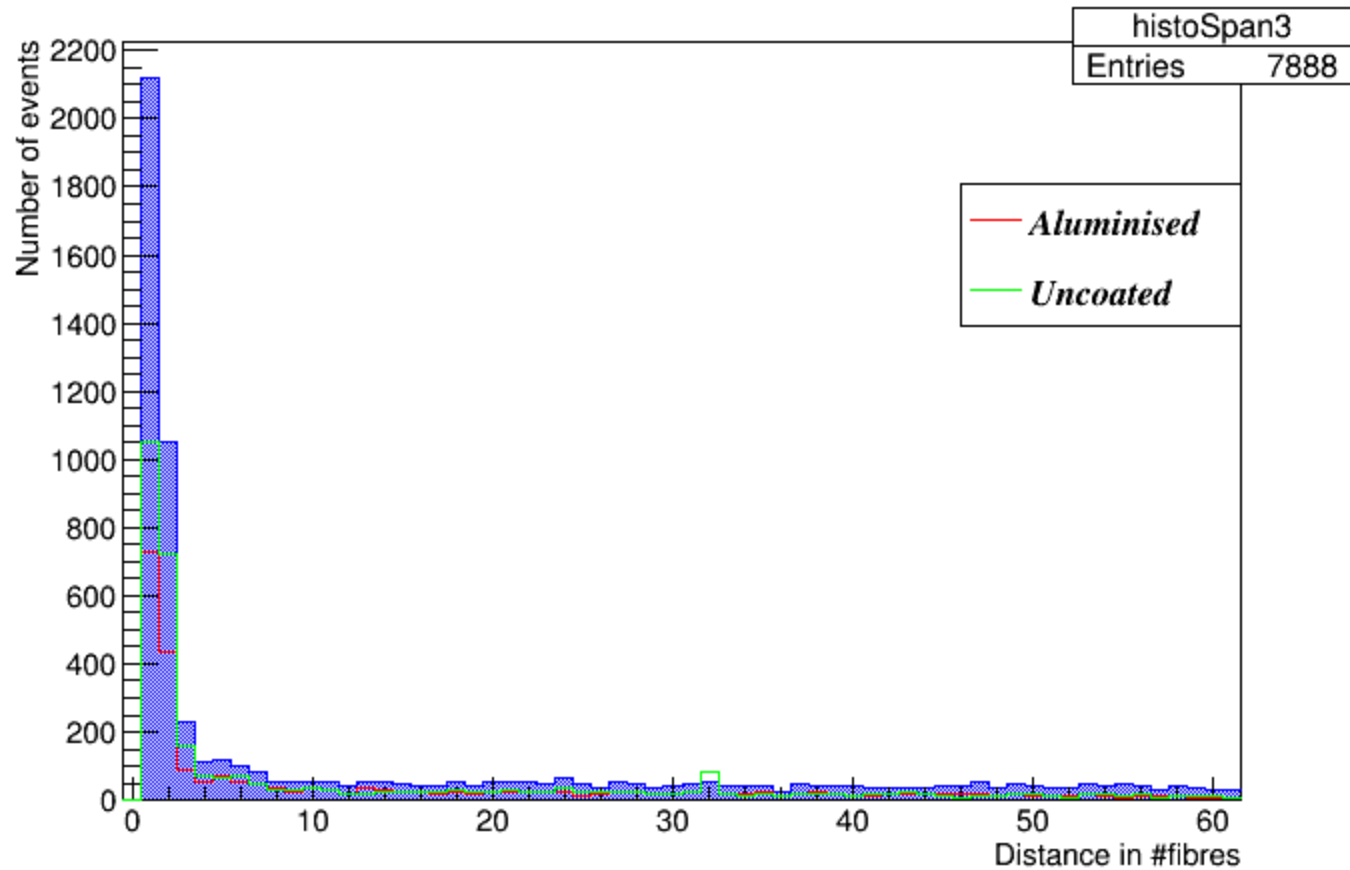
Elapsed time: 1.00s

root [1]
```

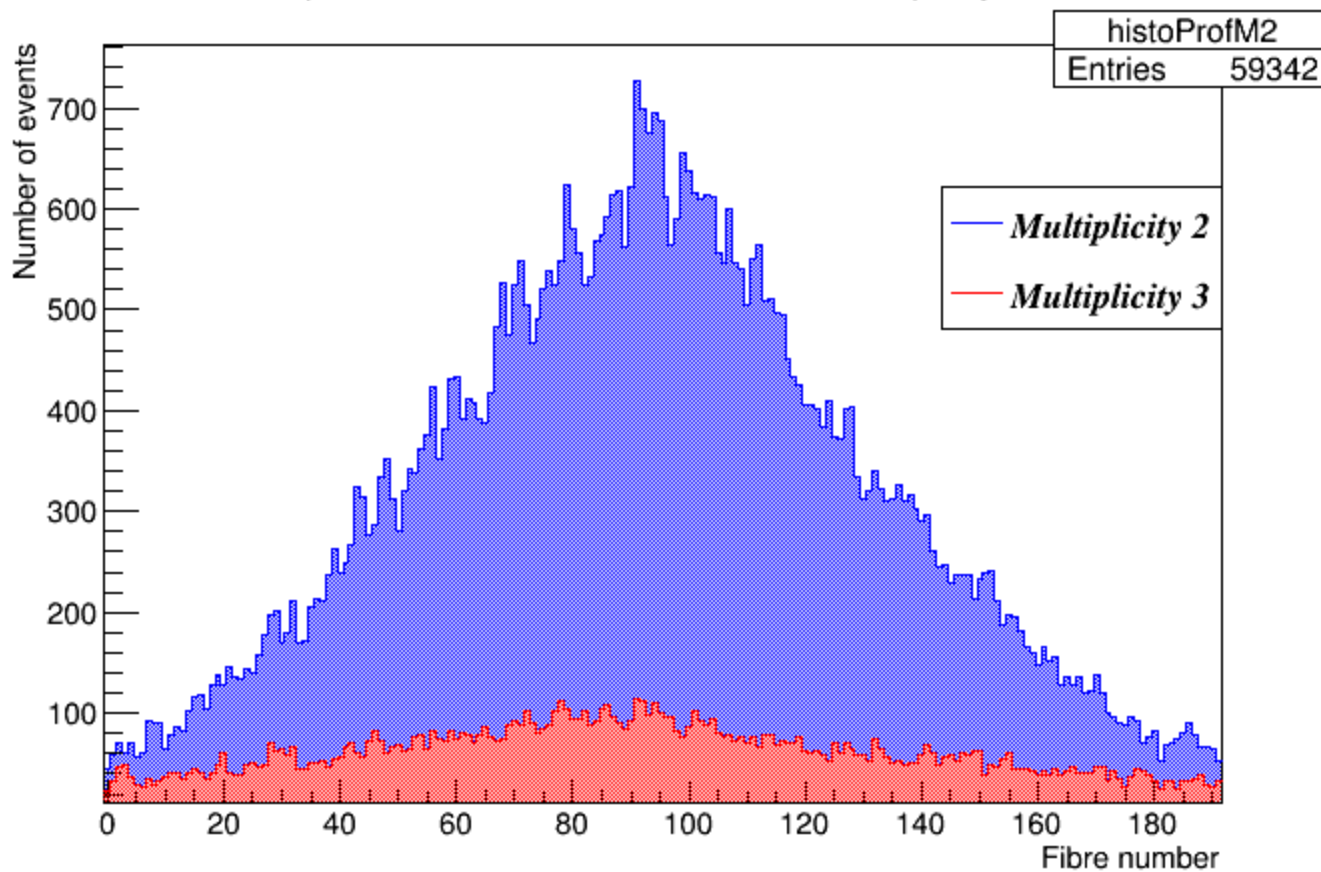
Distance between two activated fibres



Distance between three activated fibres

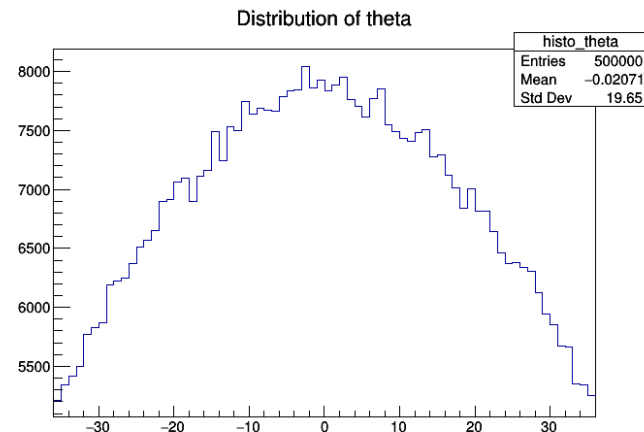
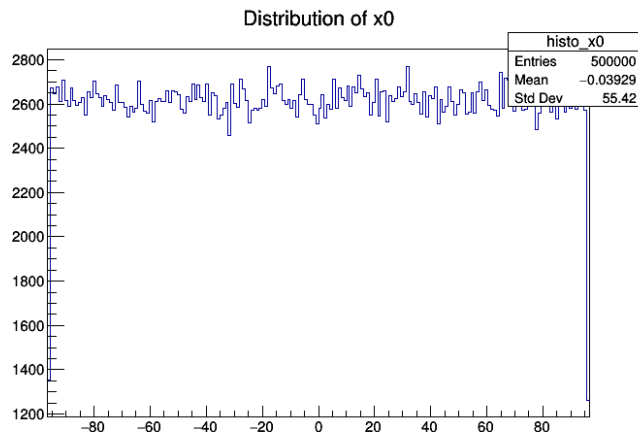


Beam profile reconstructed with events of multiplicity 2 and 3



Monte Carlo simulation of the cosmic setup

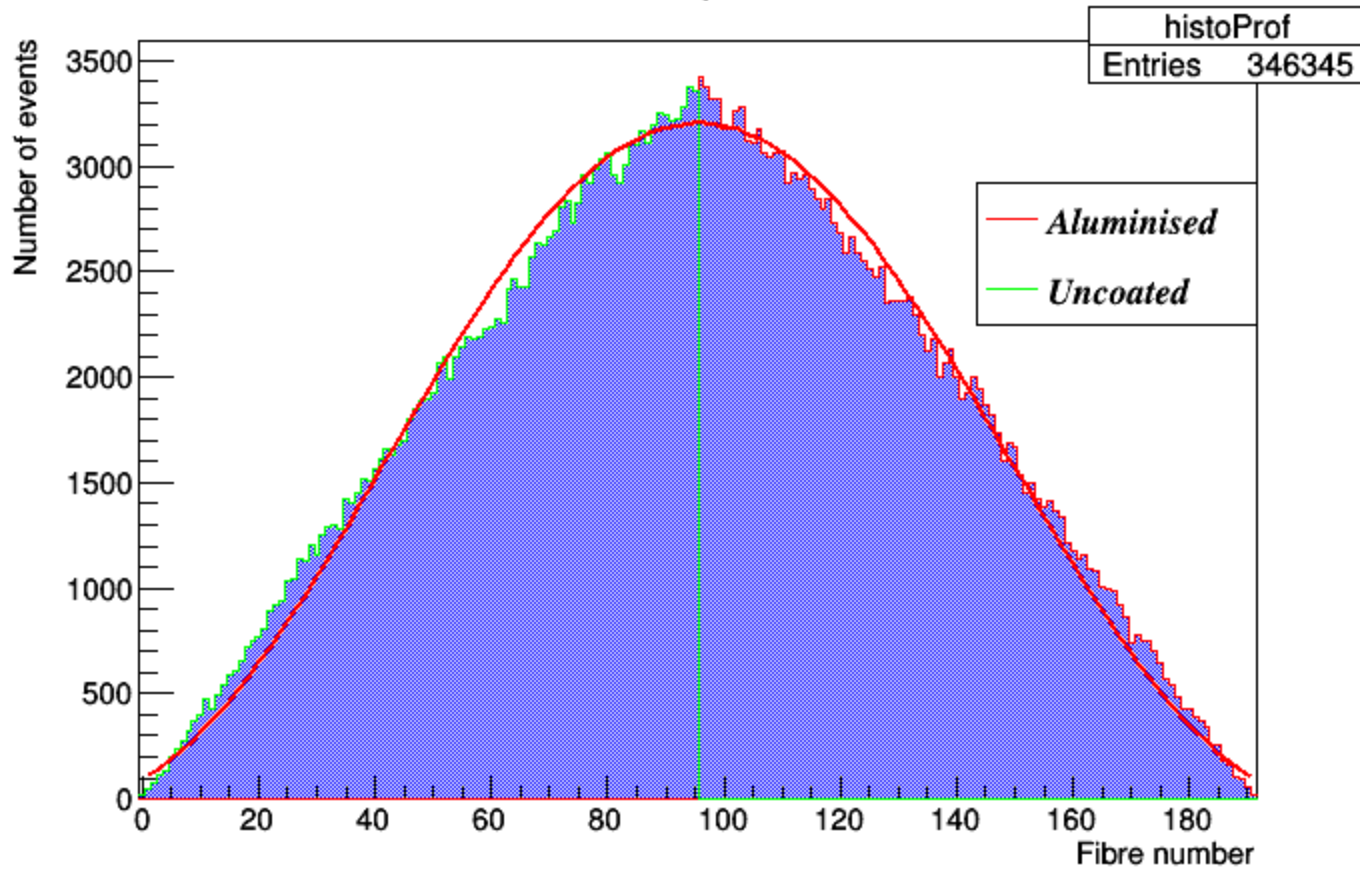
- Recreates geometry of the setup.
- Generates data file identical to XBPF monitor, so it can be analysed with the same program.
- Uses random generator to create cosmic's tracks.



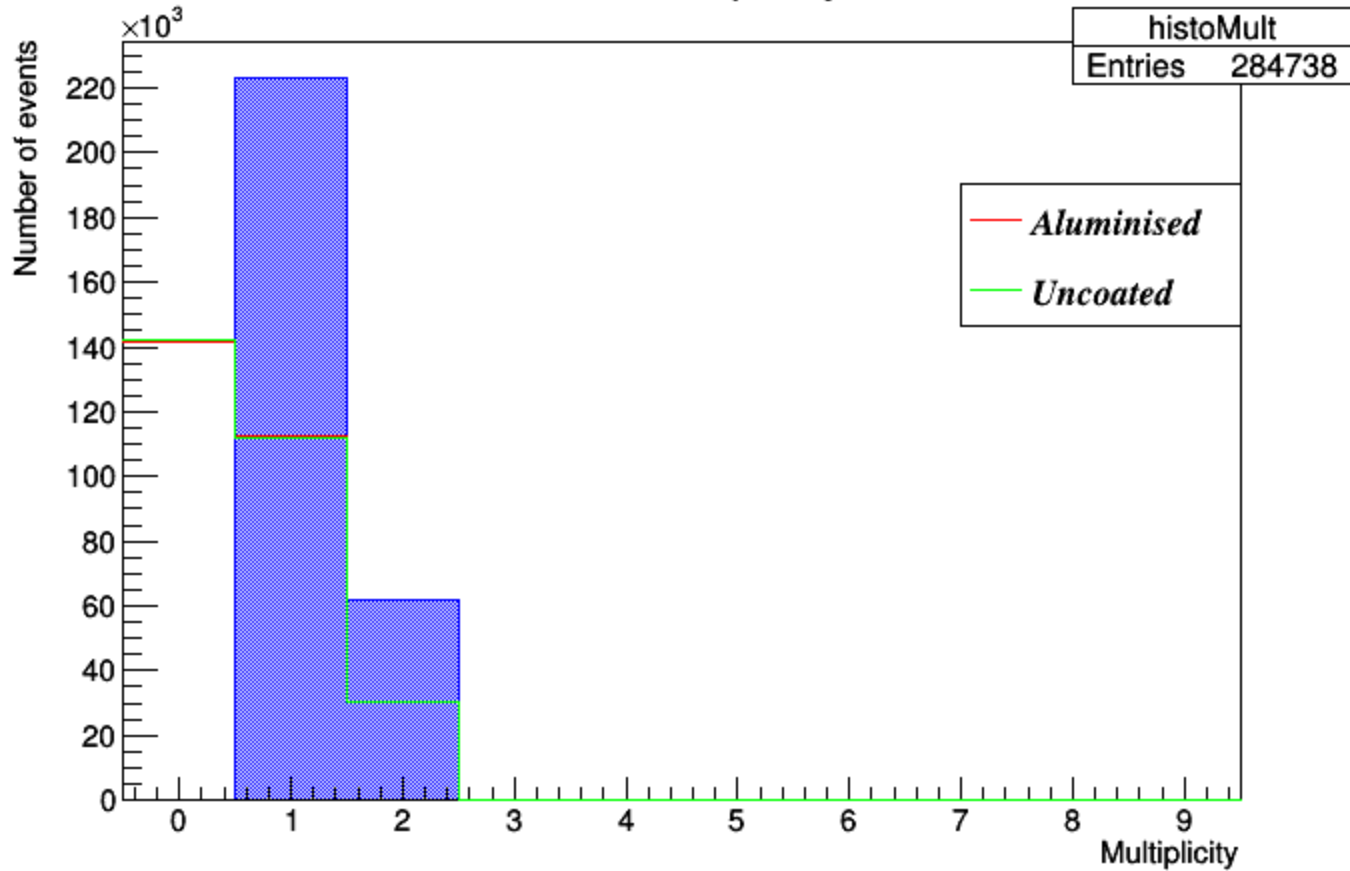
Straight tracks are originated at a fixed altitude, with an arbitrary x0 and an arbitrary angle distribution according to $\cos^2\theta$.

Data analysis of the simulation

Beam profile



Fibre multiplicity



```
[2] discrit_240_56V-tfs.root
[3] simulated_data_500k.dat.root
```

Select file to analyse.

File number: 3

Processing... It may take a while.

```
FCN=10292.2 FROM MIGRAD      STATUS=CONVERGED      65 CALLS      66 TOTAL
      EDM=3.07927e-11      STRATEGY= 1      ERROR MATRIX ACCURATE
```

EXT	PARAMETER	VALUE	ERROR	STEP	FIRST
NO.	NAME			SIZE	DERIVATIVE
1	Constant	3.42502e+03	7.04391e+00	2.92687e-01	-1.24529e-07
2	Mean	9.56620e+01	7.25693e-02	3.59499e-03	-7.66938e-05
3	Sigma	3.97708e+01	4.98167e-02	1.73954e-05	-1.41963e-02

```
FCN=2491.17 FROM MIGRAD      STATUS=CONVERGED      93 CALLS      94 TOTAL
      EDM=6.40501e-09      STRATEGY= 1      ERROR MATRIX ACCURATE
```

EXT	PARAMETER	VALUE	ERROR	STEP	FIRST
NO.	NAME			SIZE	DERIVATIVE
1	Amplitude	3.20496e+03	6.13230e+00	1.33229e-01	-4.83519e-06
2	X-scale	1.46117e-02	1.33465e-05	2.89969e-07	2.40632e+00
3	X-shift	9.55857e+01	6.20752e-02	1.51312e-03	-1.74510e-03

	Full	Aluminised	Uncoated
Processed events:	284738		
Detected events:	284738	143147	142365
Efficiency:	100.00%	50.27%	50.00%
Total multiplicity:	21.64%	49.40%	49.34%
Multiplicity 2:	21.64%	49.40%	49.34%
Multiplicity 3:	0.00%	-nan%	-nan%
Higher Mult:	0.00%	-nan%	-nan%
Adjacent fibres:	21.64%	49.40%	49.34%

Analysis of the aluminised and uncoated fibres as individual detectors:

	Aluminised	Uncoated
Total multiplicity:	21.26%	21.35%
Multiplicity 2:	21.26%	21.35%
Multiplicity 3:	0.00%	0.00%
Higher Mult:	0.00%	0.00%
Adjacent fibres:	21.26%	21.35%

Gaussian fit of the profile:

Mean = 95.66; Sigma = 39.77

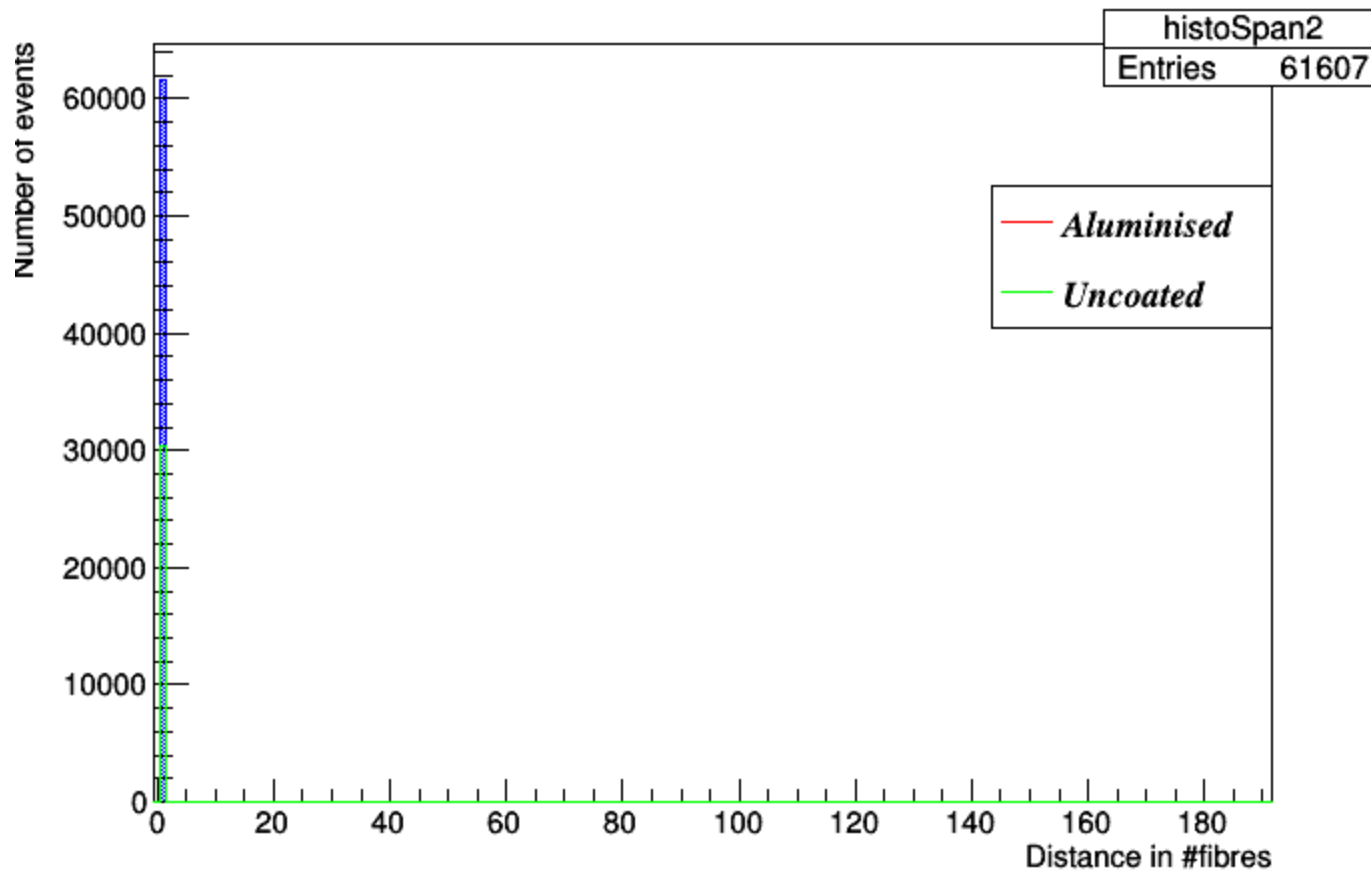
Output file name: simulated_data_500k.dat.analysis.txt

Plots saved in PNG format

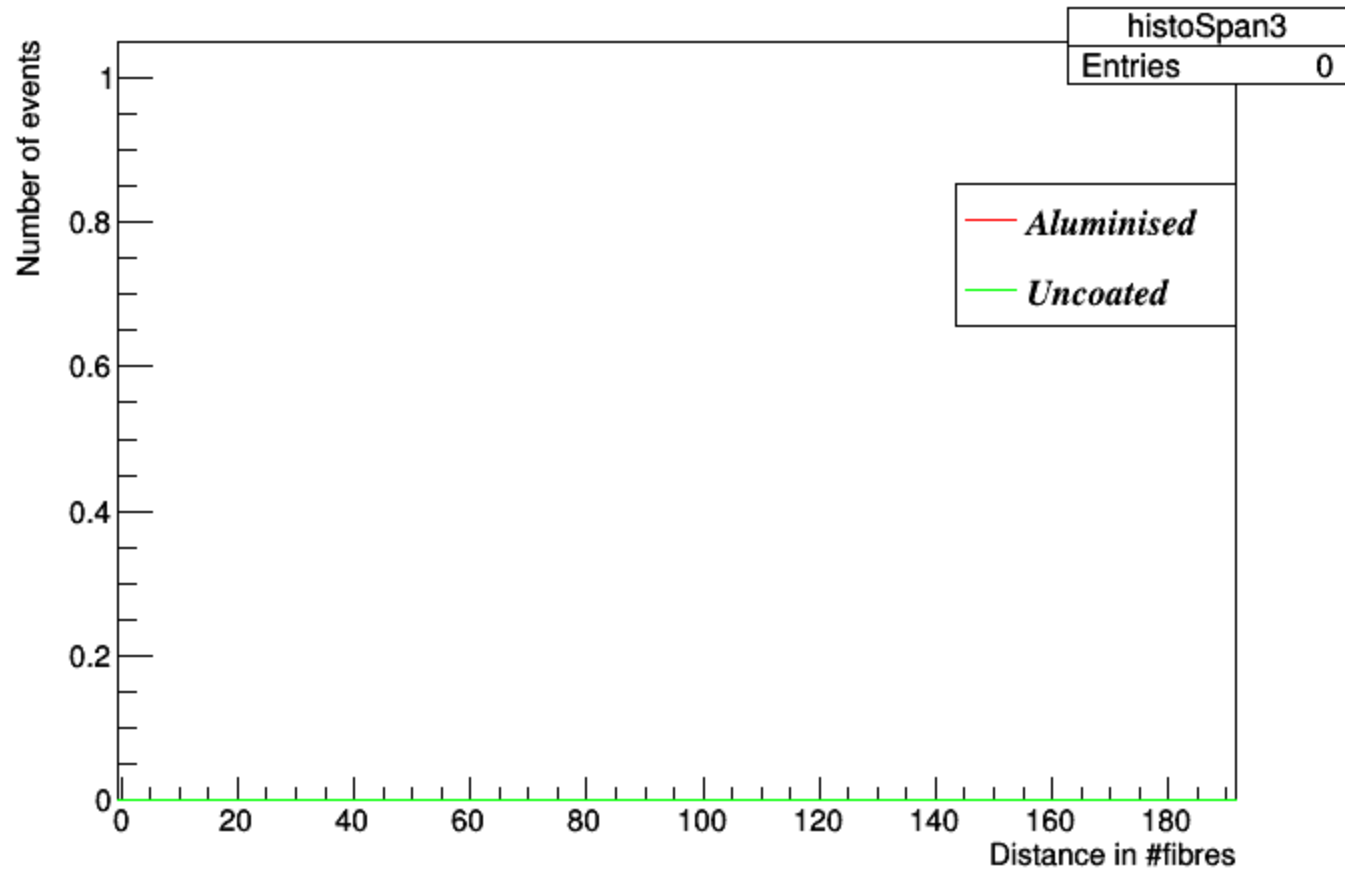
Elapsed time: 1.00s

root [1] █

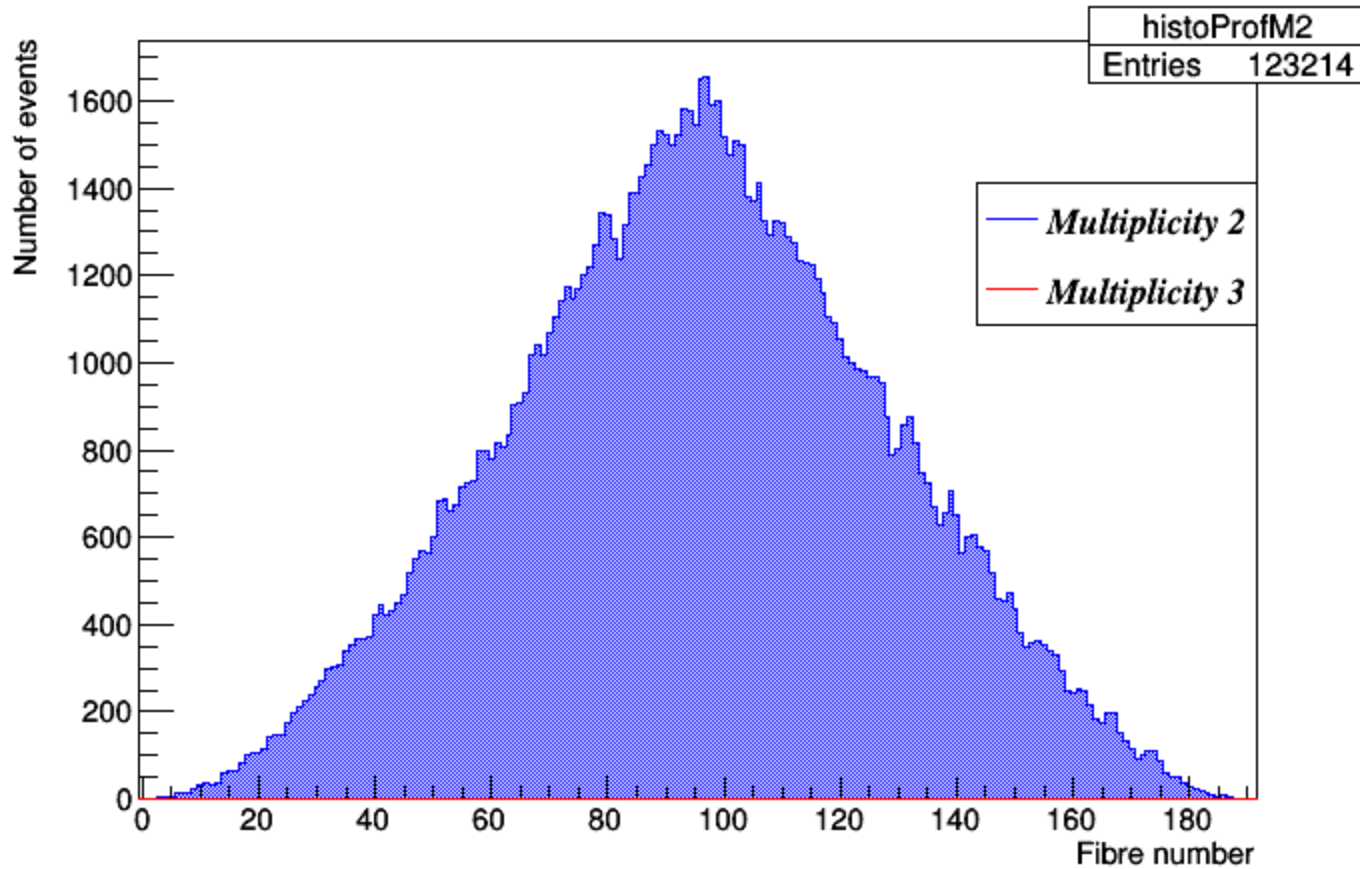
Distance between two activated fibres



Distance between three activated fibres



Beam profile reconstructed with events of multiplicity 2 and 3



Performance conclusions:

- Efficiency = ~95%
- Crosstalk < 1% for aluminised fibres; = ~3% for uncoated fibres.
- Aluminised fibres perform better in general (less crosstalk, higher efficiency).
- Multiplicity 2 events are due to actual particles crossing 2 fibres.
- Higher multiplicity events are produced by real particles: secondaries? Showers?
- Tests with the Sr90 source support these results.
- A finer analysis of the East Area also agrees. Unfortunately they were the first tests with the XBPF and we did not have time to do thorough measurements.

Production schedule

