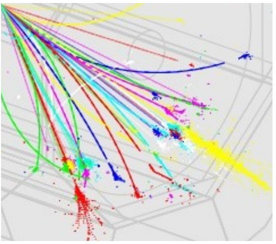
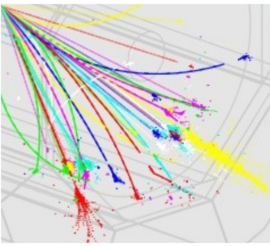


TPAC 1.X ^{55}Fe results

Marcel Stanitzki

RAL 16.01.2009

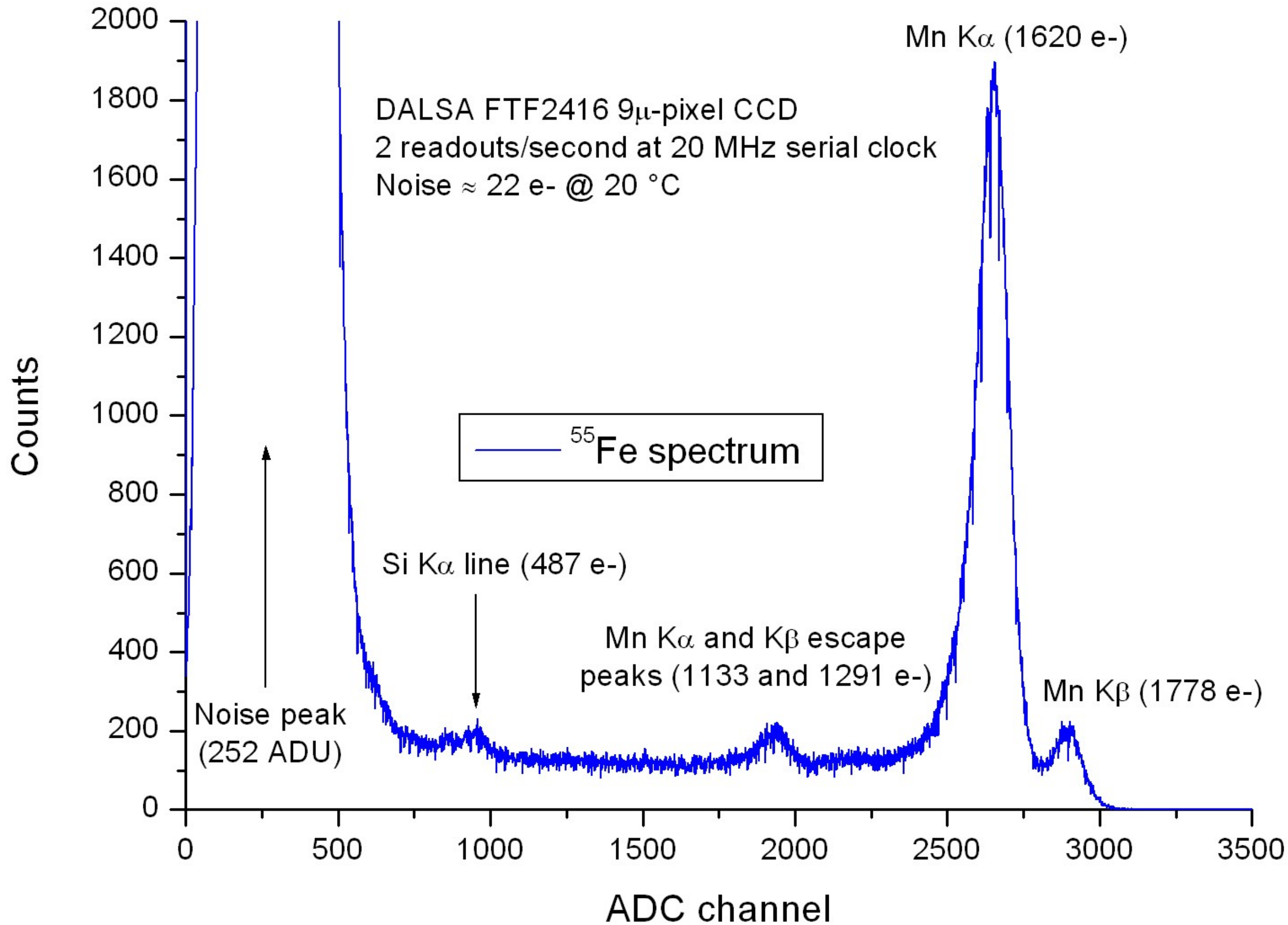


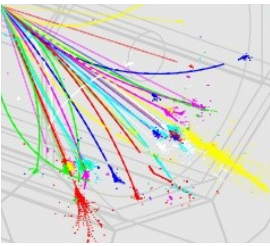
Some details about ^{55}Fe

Gamma and X-ray radiation:

	Energy (keV)	Intensity (%)
XR l	0.64	0.66 % 10
XR kα2	5.888	8.2 % 4
XR kα1	5.899	16.2 % 7
XR kβ3	6.49	0.96 % 5
XR kβ1	6.49	1.89 % 9

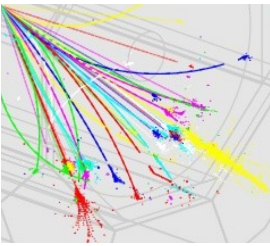
Spectrum from Konstantin





Analog pixel scans

- Done with TPAC 1.2 (old data sets with 1.1 as well)
- Two data sets each
  - -30 mV Threshold (entire spectrum)
  - -120 mv Threshold (tail)
- There is a 1/0.81 gain correction (only applied if explicitly stated)
- Using a fixed setup now
  - takes ~ 3 days for one pixel
  - 150 GB of data
- Available data sets
  - see https://heplnm061.pp.rl.ac.uk/display/spider/TPAC+55Fe+Spectra



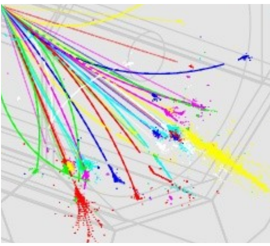
Fit models

- For the 120 mV data set
  - Exponential+Crystal Ball (K_α) +Gauss (K_β)
  - Crystal Ball

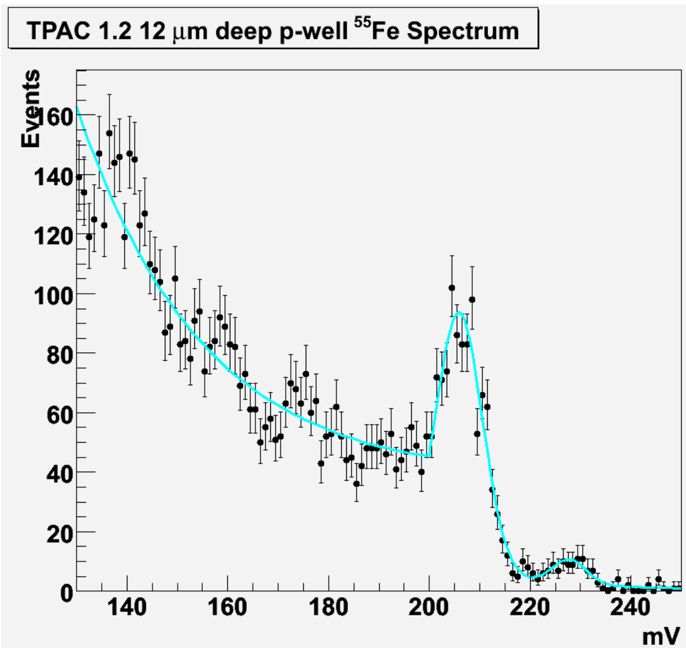
$$f(x;\alpha,n,\bar{x},\sigma) = N \cdot \begin{cases} \exp(-\frac{(x-\bar{x})^2}{2\sigma^2}), & \text{for } \frac{x-\bar{x}}{\sigma} > -\alpha \\ A \cdot (B - \frac{x-\bar{x}}{\sigma})^{-n}, & \text{for } \frac{x-\bar{x}}{\sigma} \leqslant -\alpha \end{cases}$$

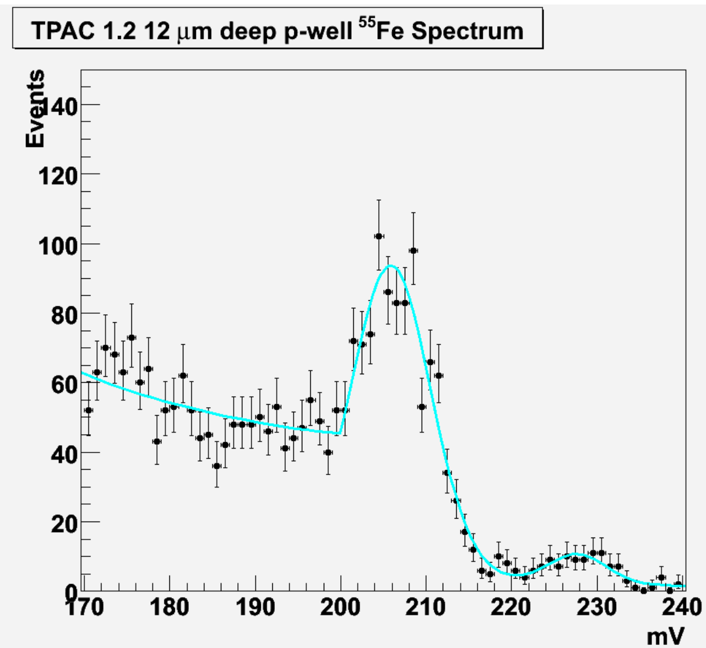
$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right) \qquad B = \frac{n}{|\alpha|} - |\alpha|$$

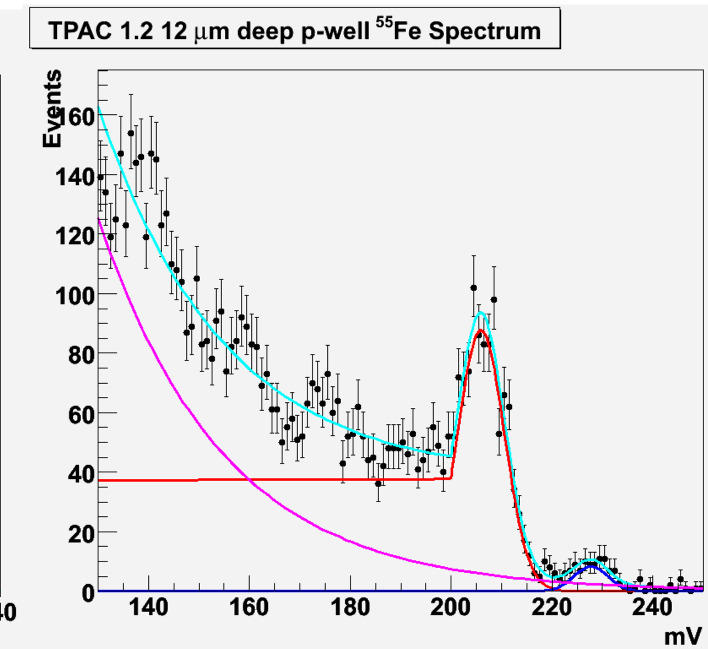
- For the 30 mv data set
  - Exponential +Gauss (FakePeak) + Gauss(K_α)
  - K_α has two low stats to be sensitive in this data set
- New fitter using RooFit (much better ...)



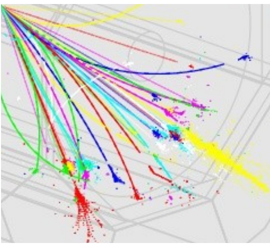
TPAC 1.2 +DPW 12 µm







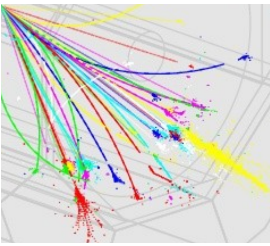

```
Fitted Values
Crystal Barrel FKT for K_alpha
     ka_mean : 205.918 0.22371385
    ka_sigma : 4.6170221 0.20512349
    ka_alpha : 1.2884144 0.13555629
        ka_n : 0.0026548376 0.083639886
Gauss for K_beta
     kb_mean : 227.73171 0.70361675
    kb_sigma : 3.3479737 0.65209354
Exponential Background
   exp_coeff : -0.040348041 0.0019318991
```



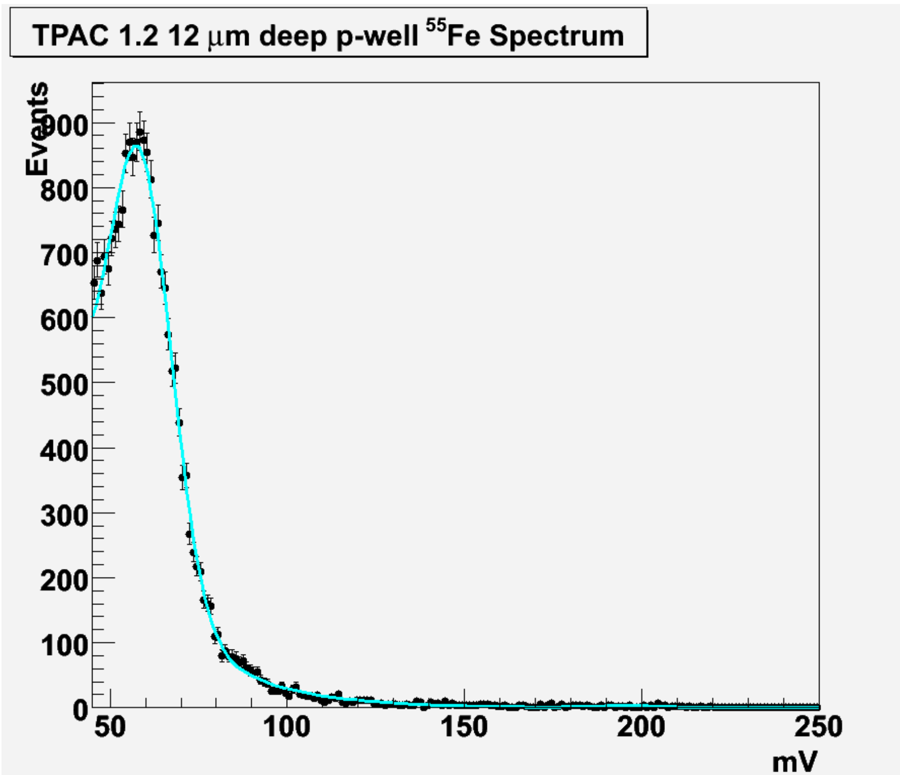
More on …

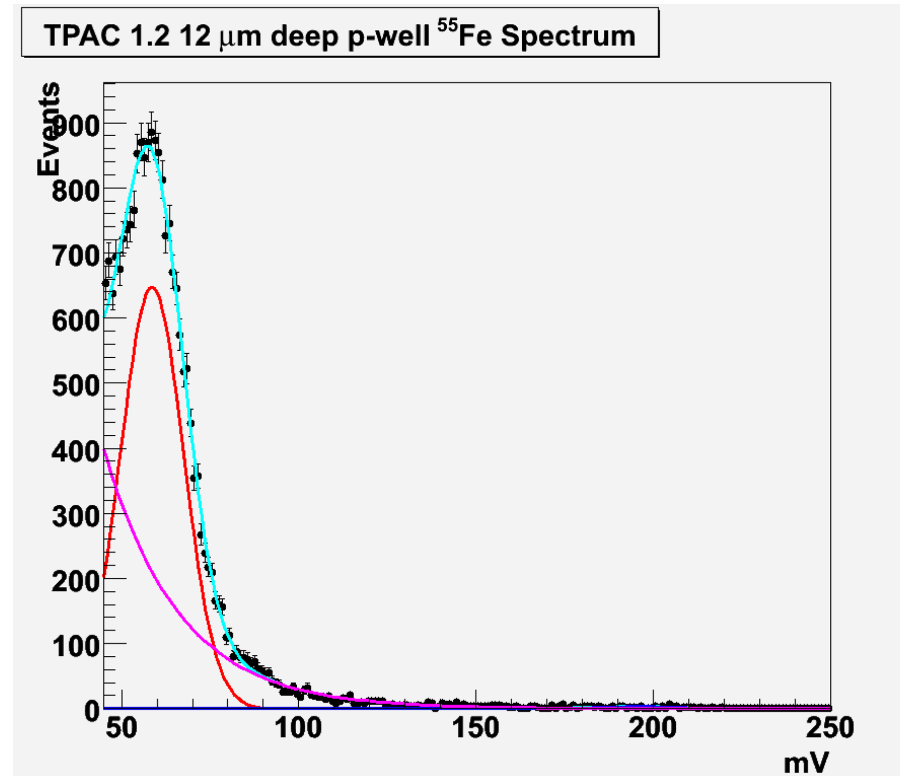
```
K_beta/K_alpha Ratio observed :1.105934
K_beta/K_alpha Ratio expected :1.0975309
K_alpha      :205.918  corrected:254.21975 mV
K_alpha width:4.6170221  corrected:5.7000273 mV
K_beta       :227.73171  corrected:281.15026 mV
K_beta width :3.3479737  corrected:4.1333008 mV

---------------
Gain from K_alpha mV/e:0.15692577
Gain from K_beta  mV/e:0.15812726
Noise from K_alpha mV :5.7000273
Noise from K_beta  mV :4.1333008
Noise from K_alpha e  :36.323079
Noise from K_beta  e  :26.139079
```

Applying 1/0.81 correction



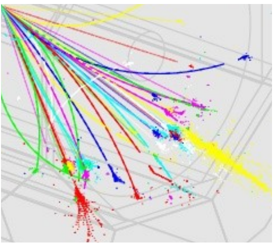
Fake peak





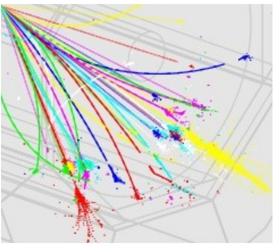

```
Fitted Values
Gauss for the Fake peak
     fp_mean : 58.601428 0.35430359
    fp_sigma : 8.8903209 0.3239019
Gauss for K_alpha
     ka_mean : 196.49425 1.9331505
    ka_sigma : 10 0.12398403
Exponential Background
   exp_coeff : -0.047306252 0.0017584892
```

```
Fake peak       :58.601428
corrected:72.347442 mV
Fake peak width :8.8903209
corrected:10.975705 mV
---------------
```

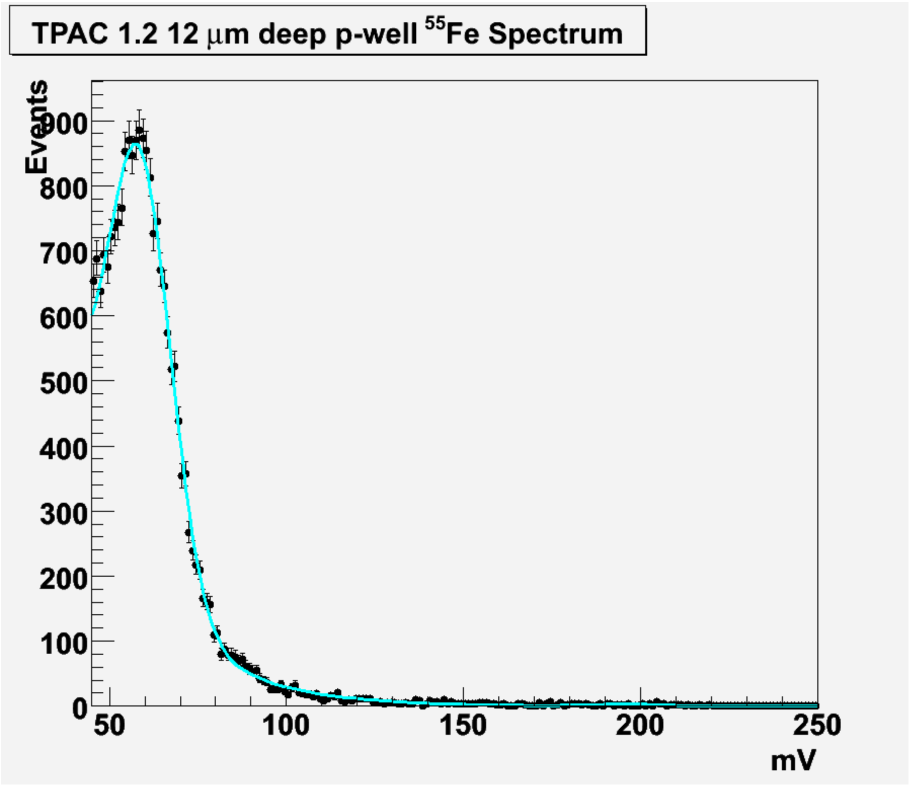


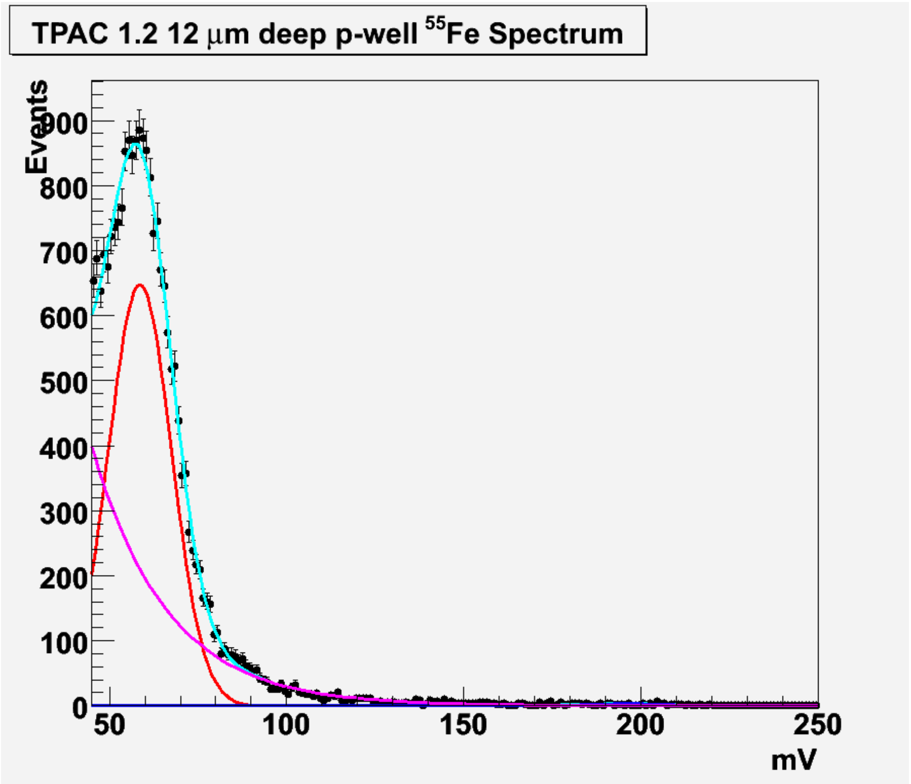
Stitching

- Trying to combine both spectra …
- This is still beta
  - more stable normalization
  - check errors again
- Using same model as for the Fake peaks
- Trying to derive fractions of fake-peak to real peak

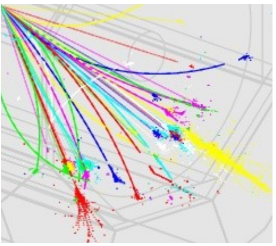


"Stitched Spectrum"

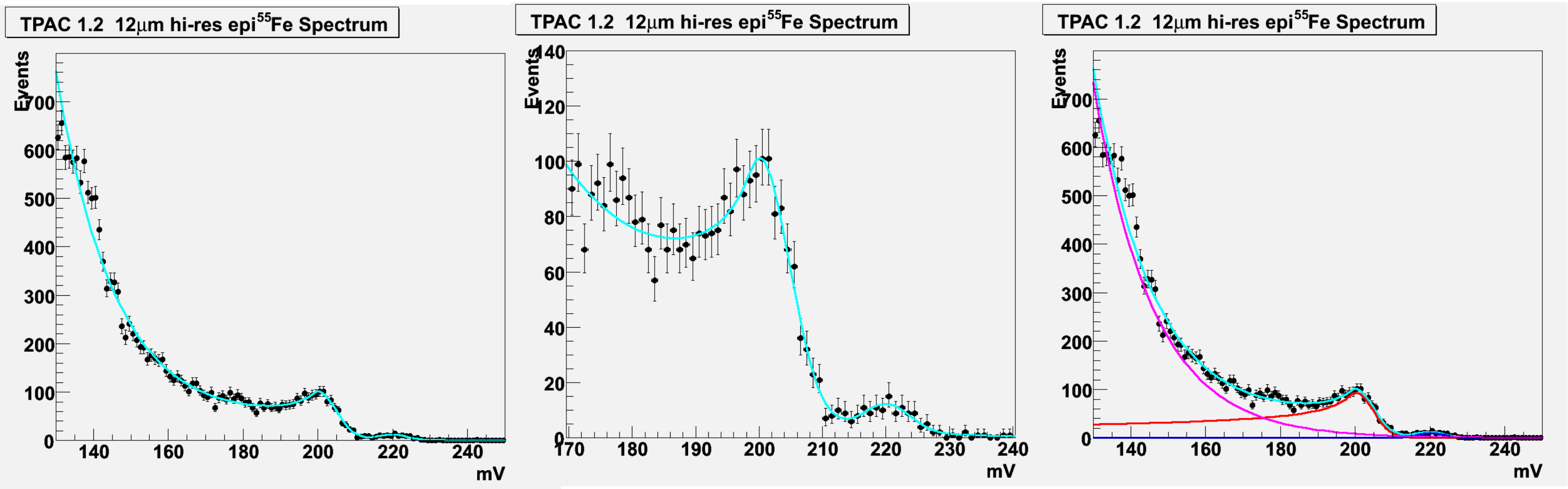




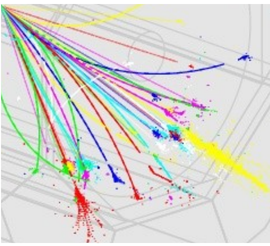

```
Fake peak fraction :0.61345738
K_alpha  fraction :0.0034473355
Ratio :0.0056195192
```



TPAC 1.2 highres 12 μm




```
Fitted Values
Crystal Barrel FKT for K_alpha
     ka_mean : 200.2132 0.34410319
    ka_sigma : 4.6019026 0.27889855
    ka_alpha : 0.39205586 0.097359728
        ka_n : 0.41106072 0.17457918
Gauss for K_beta
     kb_mean : 220.17943 0.60013773
    kb_sigma : 3.5907866 0.48640374
Exponential Background
   exp_coeff : -0.063199093 0.0016797816
```

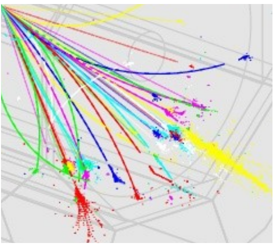


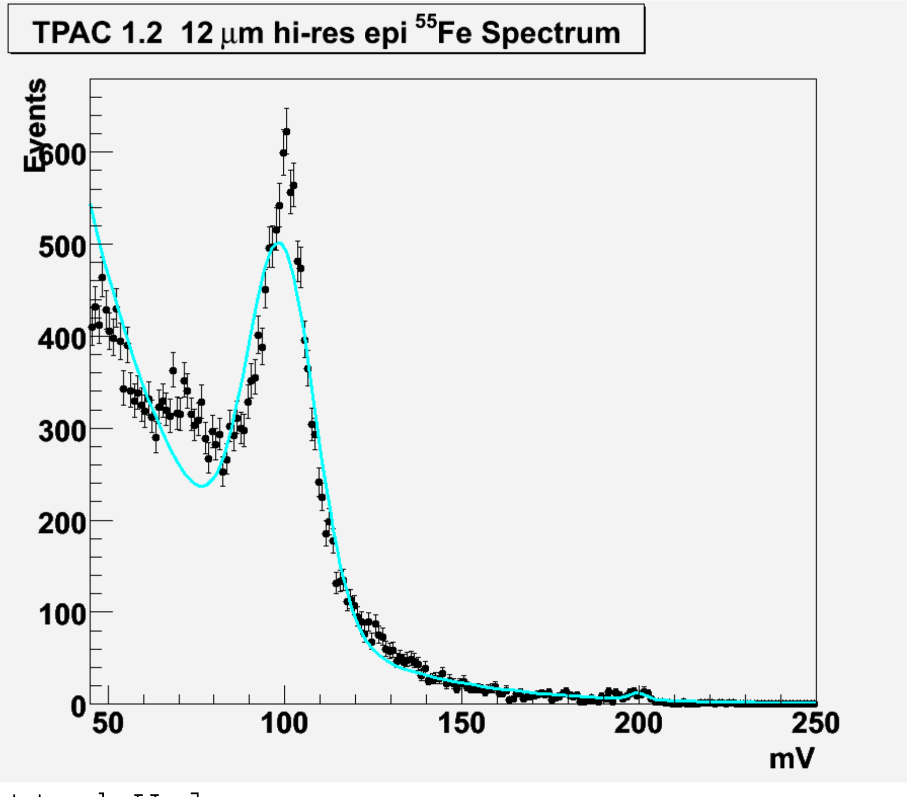
More on ...

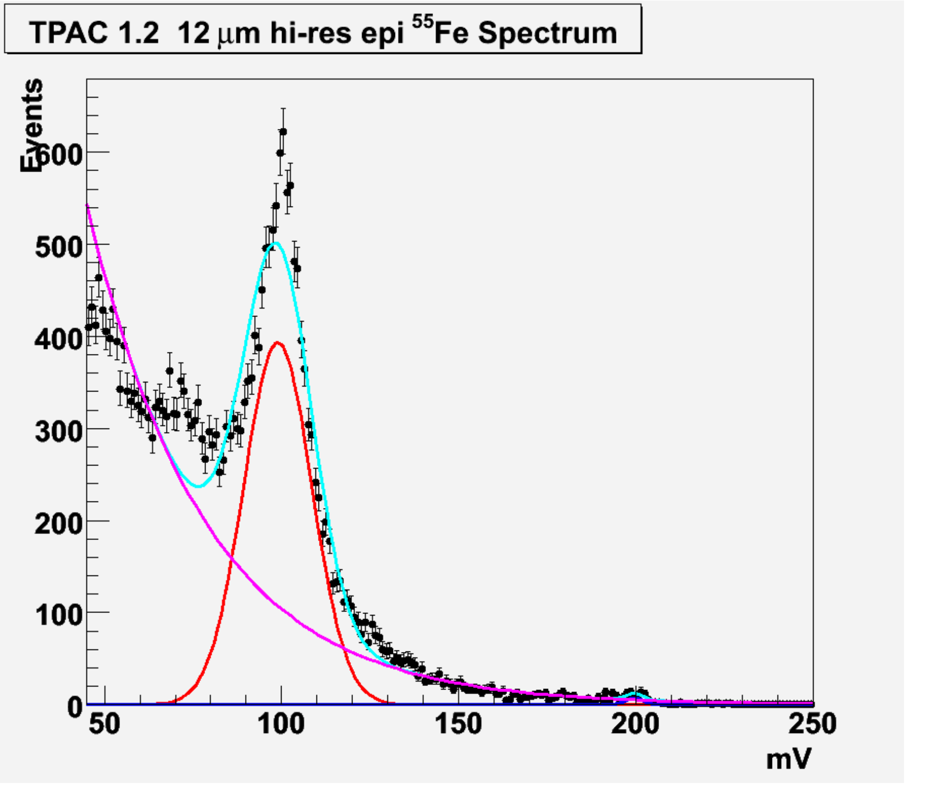
```
K_beta/K_alpha Ratio observed :1.0997248
K_beta/K_alpha Ratio expected :1.0975309
K_alpha       :200.2132  corrected:247.17679 mV
K_alpha width:4.6019026  corrected:5.6813612 mV
K_beta        :220.17943  corrected:271.82645 mV
K_beta width :3.5907866  corrected:4.4330699 mV

---------------
Gain from K_alpha mV/e:0.15257826
Gain from K_beta  mV/e:0.15288327
Noise from K_alpha mV :5.6813612
Noise from K_beta  mV :4.4330699
Noise from K_alpha e  :37.235718
Noise from K_beta  e  :28.996436
```

Applying 1/0.81 correction

Fake peak



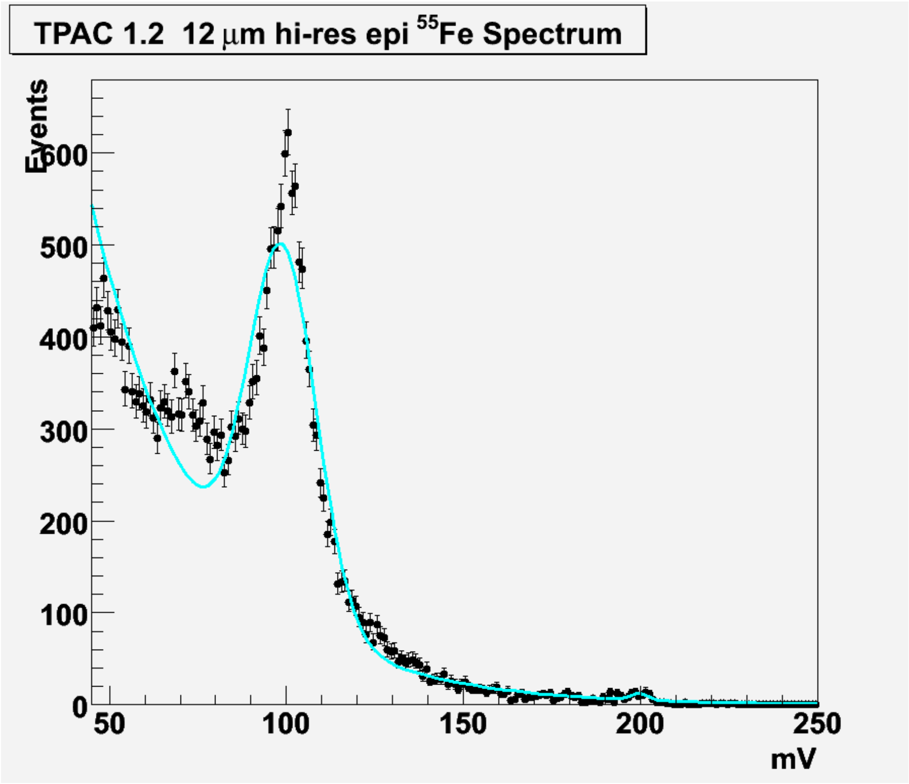


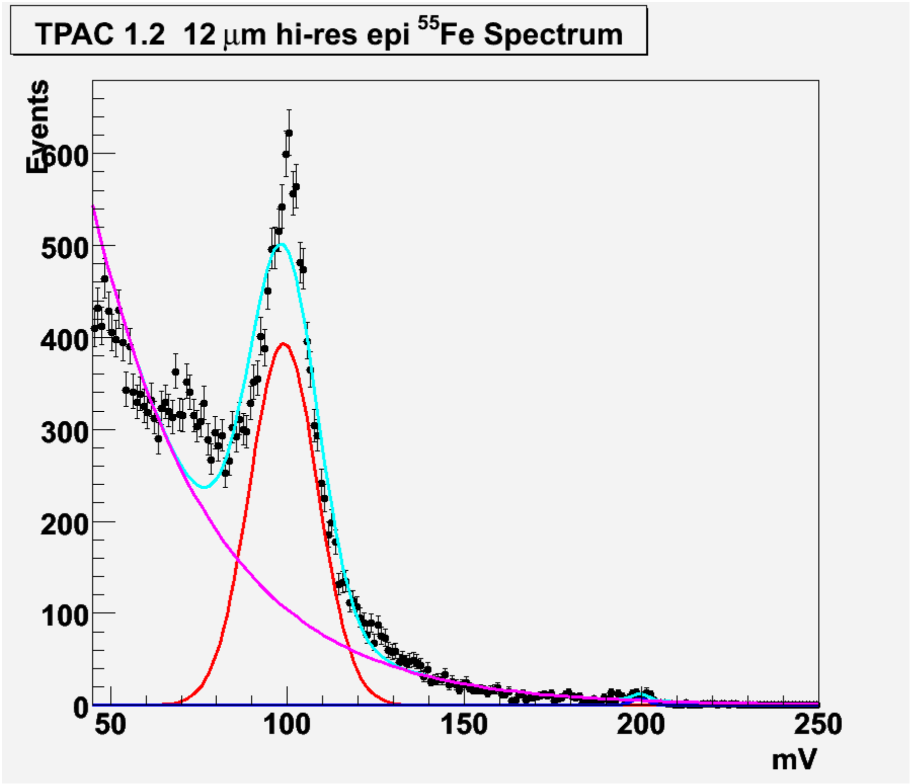



```
Fitted Values
Gauss for the Fake peak
     fp_mean : 98.910429 0.16926532
    fp_sigma : 9.6201518 0.22942849
Gauss for K_alpha
     ka_mean : 199.53495 0.85862334
    ka_sigma : 2.450916 0.66738968
Exponential Background
   exp_coeff : -0.030080472 0.00028527005
```

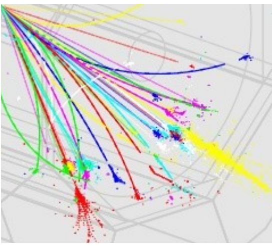
```
Fake peak       :98.910429
corrected:122.11164 mV
Fake peak width :9.6201518
corrected:11.876731 mV
---------------
```

“Stitched Spectrum”

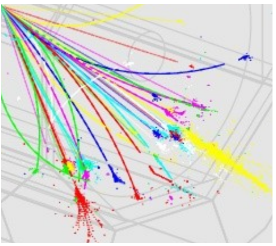




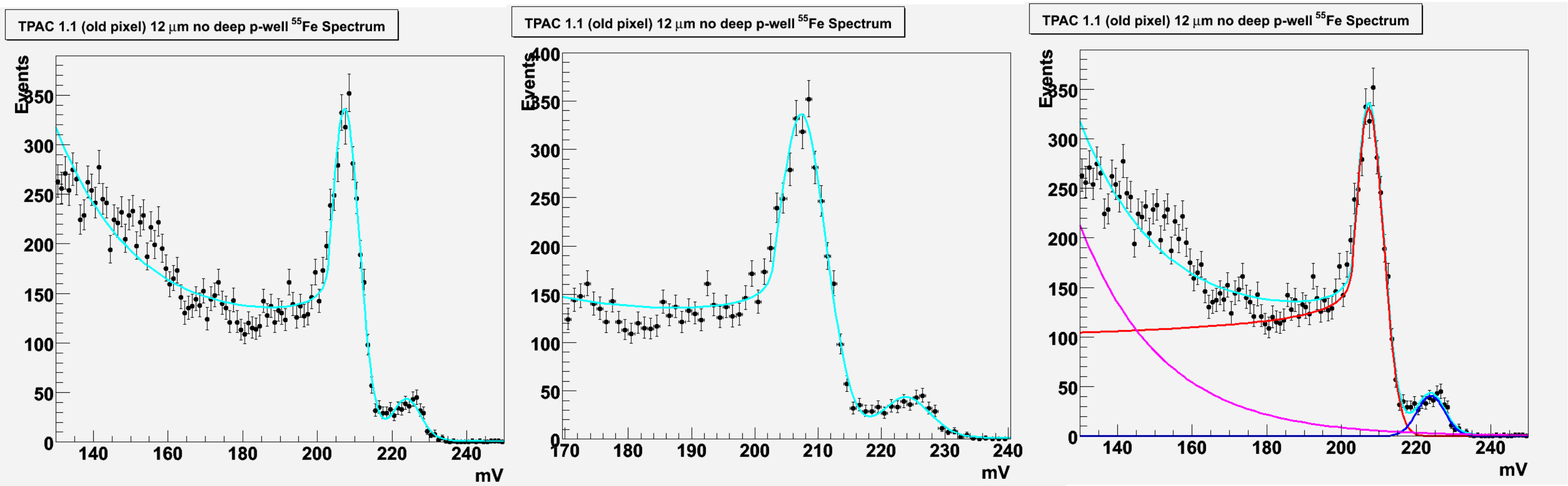

```
Fake peak fraction :0.34395865
K_alpha  fraction :0.0016250091
Ratio :0.0047244316
```



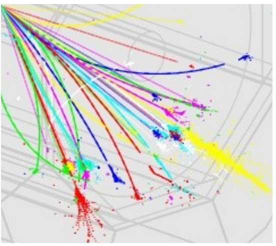
TPAC 1.2 highres 18 µm



TPAC 1.1 -DPW 12 µm (old)




```
Fitted Values
Crystal Barrel FKT for K_alpha
     ka_mean : 207.32391 0.11780295
    ka_sigma : 3.9058313 0.11532728
    ka_alpha : 1.1355633 0.048686145
        ka_n : 0.093029556 0.020265332
Gauss for K_beta
     kb_mean : 223.88193 0.28681614
    kb_sigma : 3.7272012 0.22738122
Exponential Background
   exp_coeff : -0.0456119 0.0017876693
```

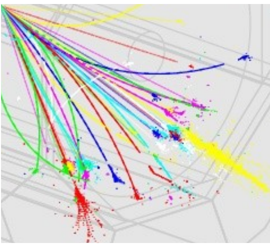


More on …

```
K_beta/K_alpha Ratio observed :1.0798655
K_beta/K_alpha Ratio expected :1.0975309
K_alpha       :207.32391  corrected:255.95545 mV
K_alpha width:3.9058313  corrected:4.8220139 mV
K_beta        :223.88193  corrected:276.39745 mV
K_beta width :3.7272012  corrected:4.601483 mV
```

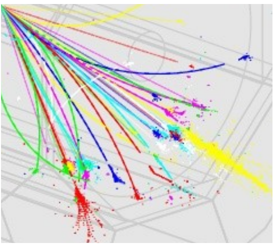
```
Gain from K_alpha mV/e:0.15799719
Gain from K_beta  mV/e:0.15545413
Noise from K_alpha mV :4.8220139
Noise from K_beta  mV :4.601483
Noise from K_alpha e  :30.519618
Noise from K_beta  e  :29.600262
```

Applying 1/0.81 correction

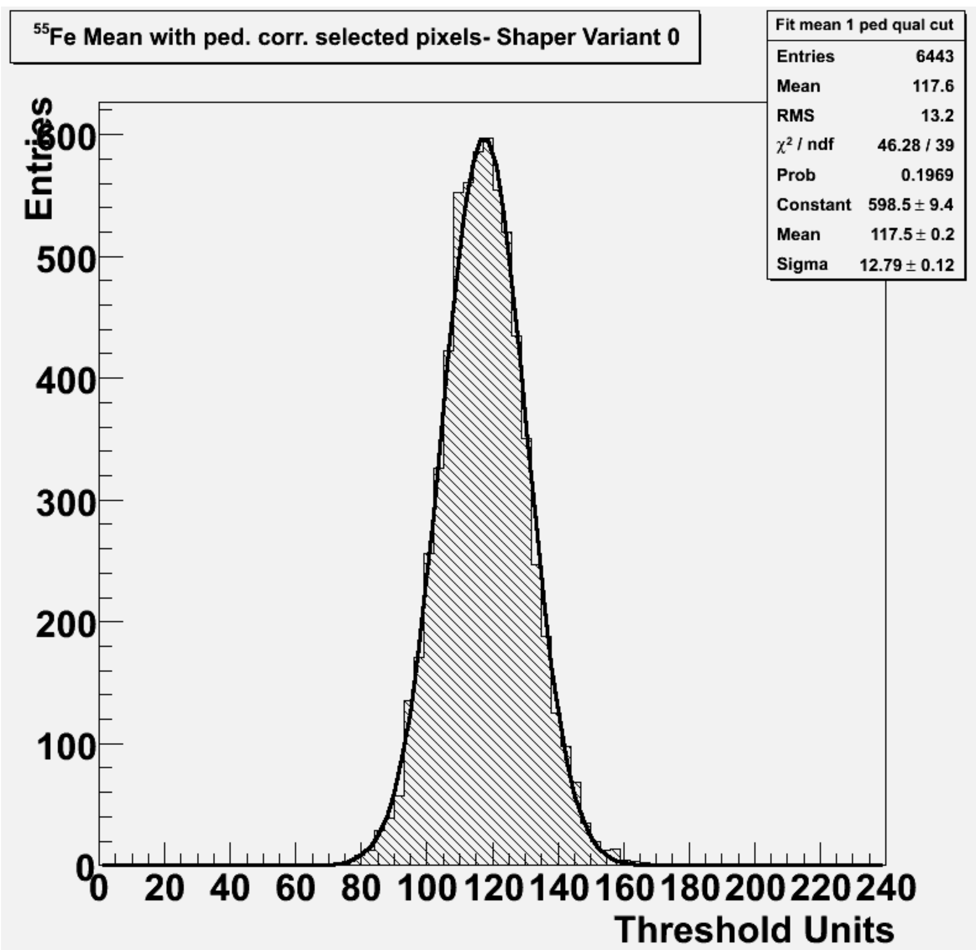


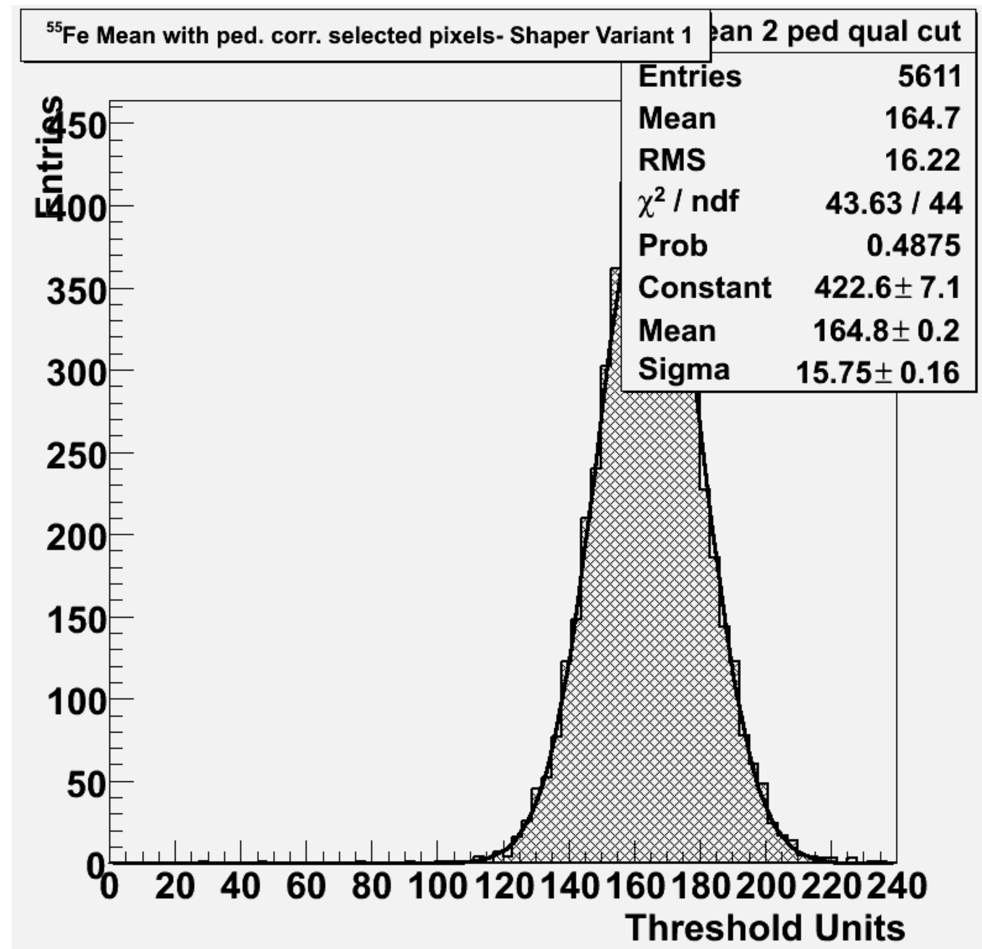
Summary

- Gain with correction is
  - 153-157 mV (corrected)
- Noise is
  - 30-37 electrons
- K_α is between
  - 200-208 mV (not corrected)
- K_β is between
  - 220-227 mV (not corrected)
- Fake peak vary widely (we expect that)

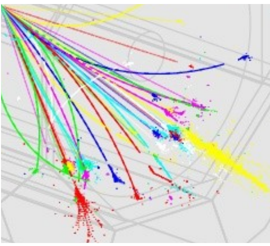


TPAC 1.0

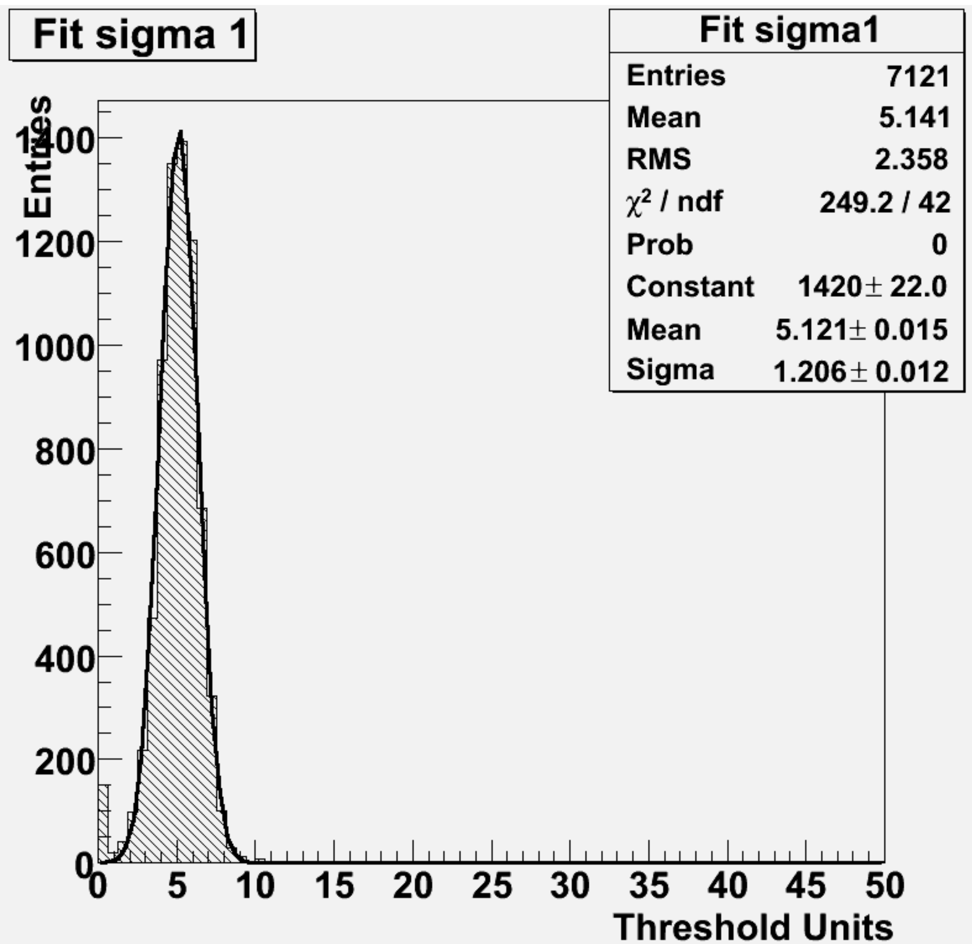




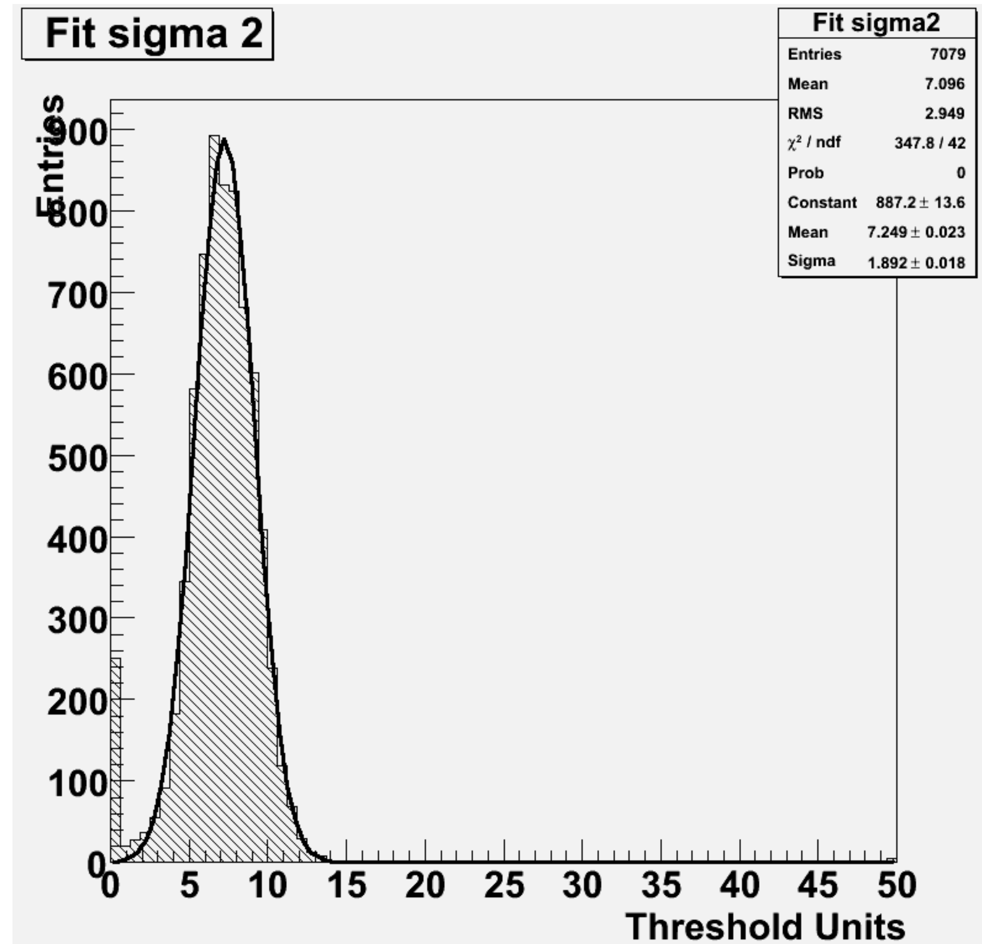
Sensor 13



TPAC 1.0 (cont)

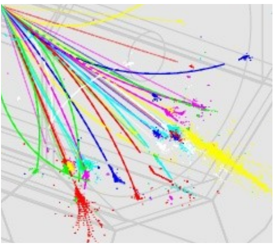


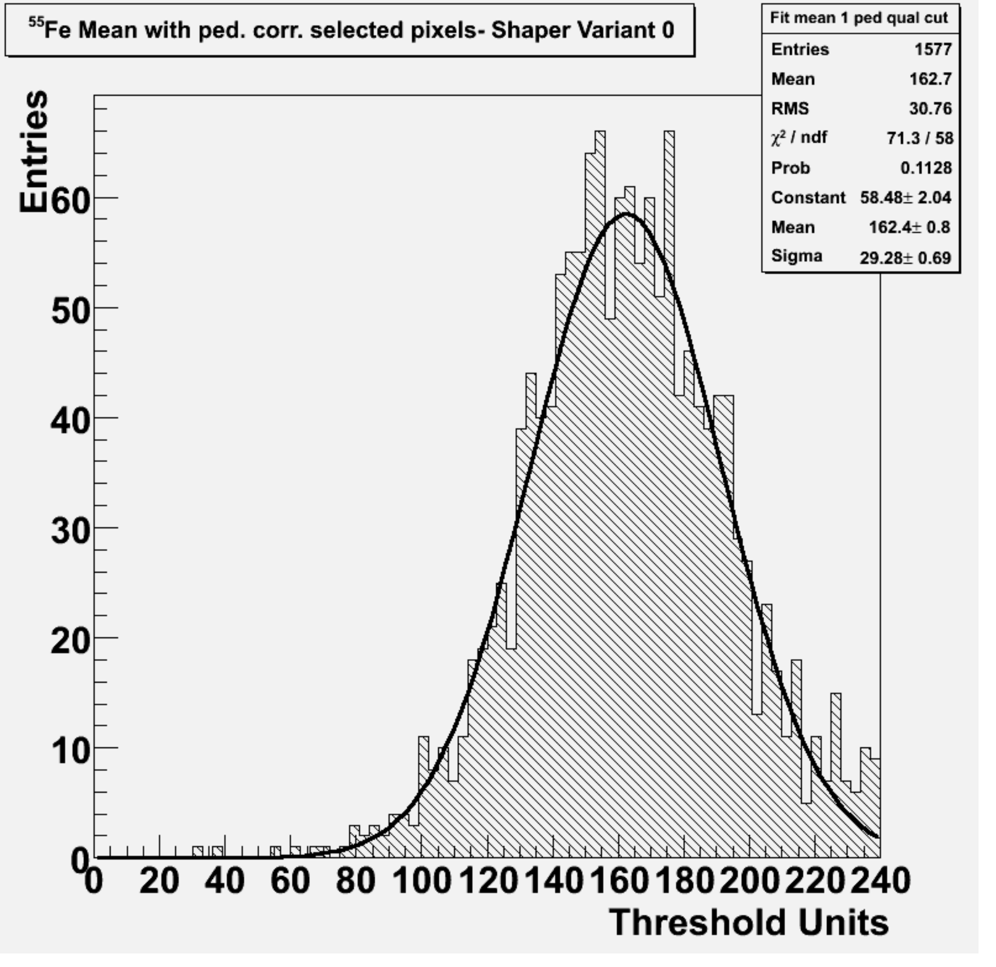
Fit sigma 1
Fit sigma1
Entries 7121
Mean 5.141
RMS 2.358
χ^2 / ndf 249.2 / 42
Prob 0
Constant 1420± 22.0
Mean 5.121± 0.015
Sigma 1.206± 0.012
Entries
0
200
400
600
800
1000
1200
1400
0 5 10 15 20 25 30 35 40 45 50
Threshold Units



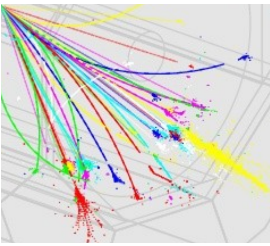
Fit sigma 2
Fit sigma2
Entries 7079
Mean 7.096
RMS 2.949
χ^2 / ndf 347.8 / 42
Prob 0
Constant 887.2 ± 13.6
Mean 7.249 ± 0.023
Sigma 1.892 ± 0.018
Entries
0
100
200
300
400
500
600
700
800
900
0 5 10 15 20 25 30 35 40 45 50
Threshold Units

TPAC 1.1



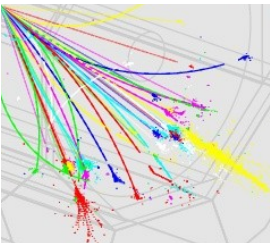


Sensor 25 untrimmed



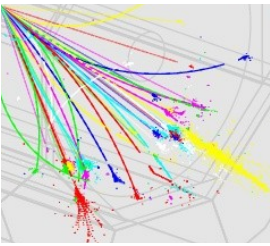
So ...

- Fake peak 12 μm +DPW
  - 72.3 mV (analog)
  - 165 TU (bulk)
  - 2.3 mV /TU
- Noise then (including comparator)
  - Width of Peak is 7.2 TU (from the fit ...)
  - That is 16.6 mV (or 106 electrons)
  - however, the fake peak isn't infinitely small

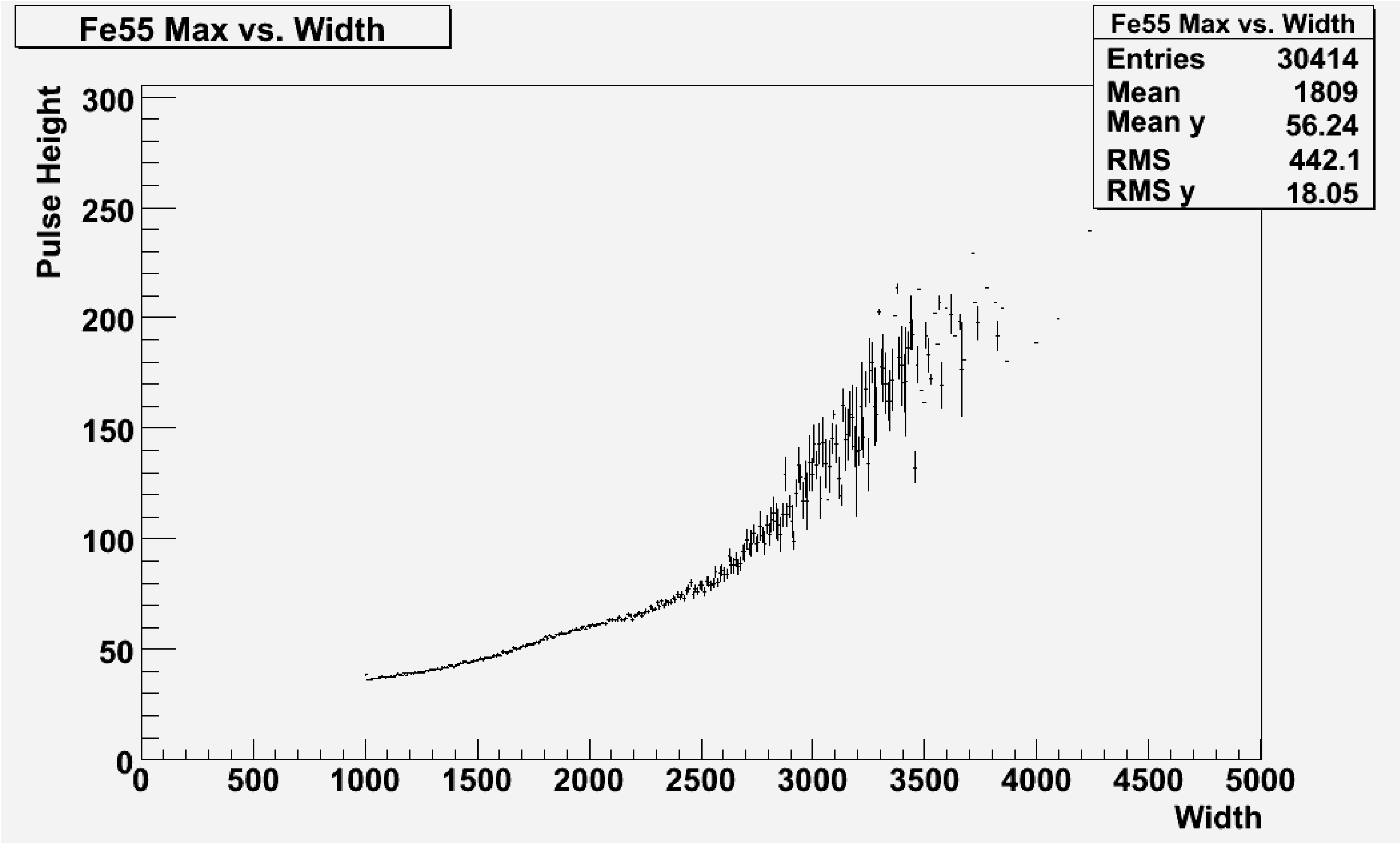


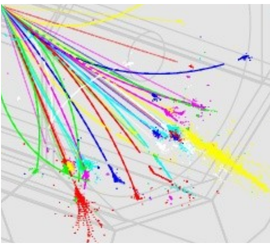
Fake peak width

- Is about 11 mV
- Noise the same for both fake and K_α
  - Width of fake peak ~ 9.4 mV
  - or 4.1 TU
- Using that
  - 6.6 TU noise …
  - or 15.8 mV
  - still too much (100 electrons)



Some other items





Upshot

- Calibrating with the fake peak is still tricky
- Analog test pixel performance is very consistent with simulation
- Bulk is still mystery