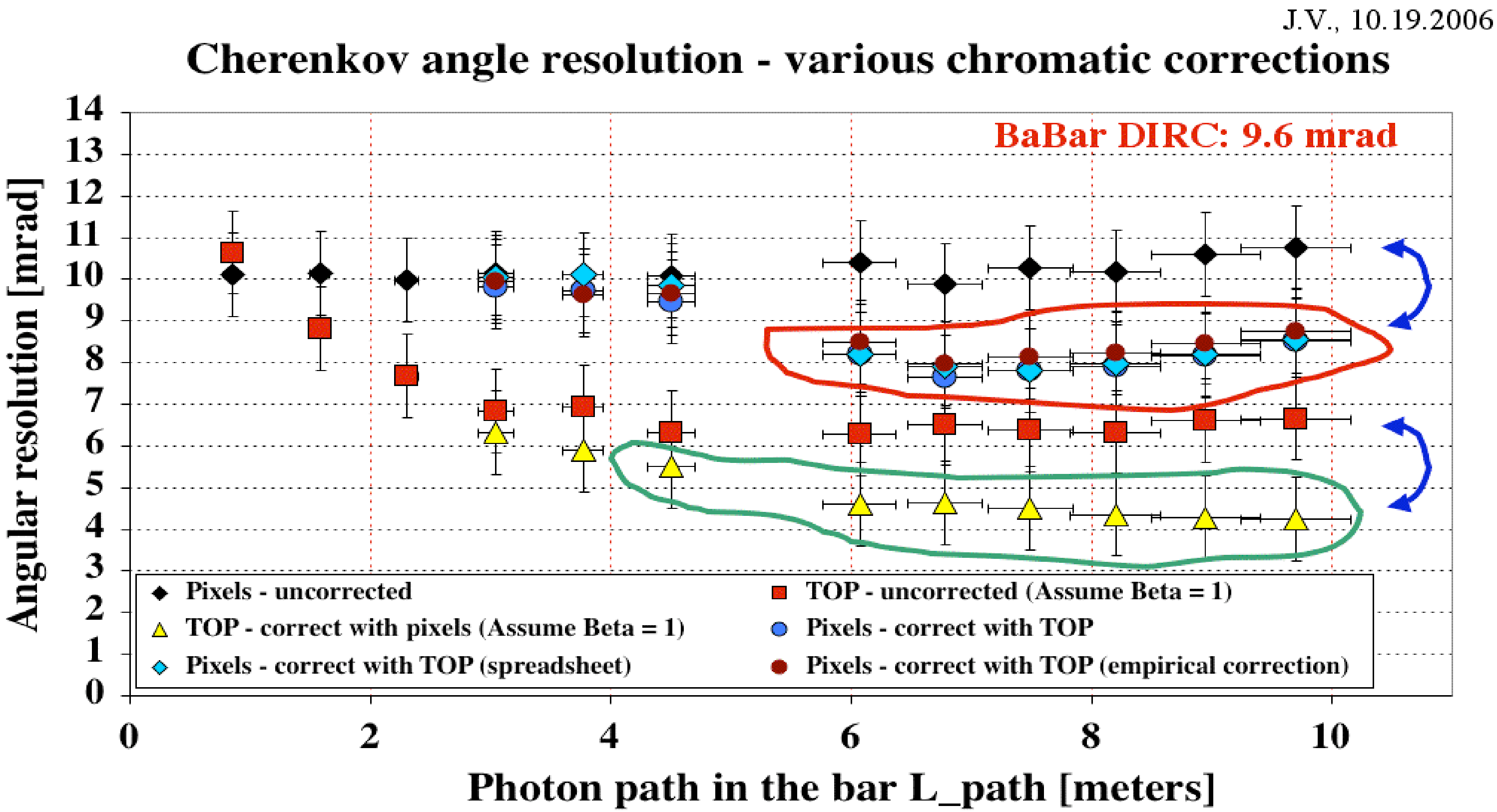
Analysis of runs 16-22

- Use time epsilons constants from the "variable lambda" analysis
- All constants from Geant 4 MC (Joe)
- Use only sigma from narrow Gaussian in quoting the resolution
- Assign 1mrad systematic error to angles (needs to be determined by more detailed study).

Cherenkov angle resolution in runs 16-22



- **Assumptions:**

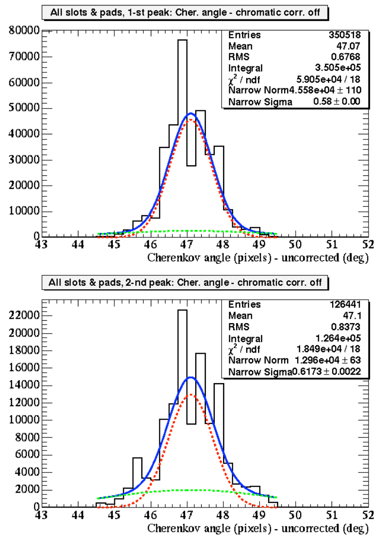
  a) Double Gaussian fit.

  b) Assume that the 2-nd Gaussian is either background or Cherenkov photons scattered out of the correct direction. Both types are useless for the resolution of the final device.

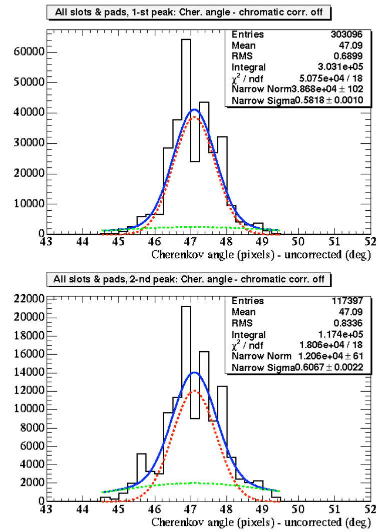
  c) Therefore, plot only sigma from the narrow Gaussian.

Cherenkov angle based on pixels - uncorrected

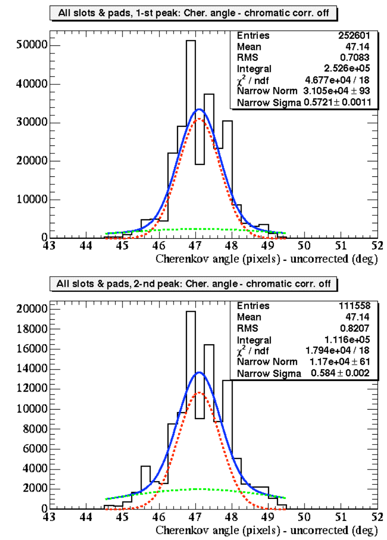
Position 1



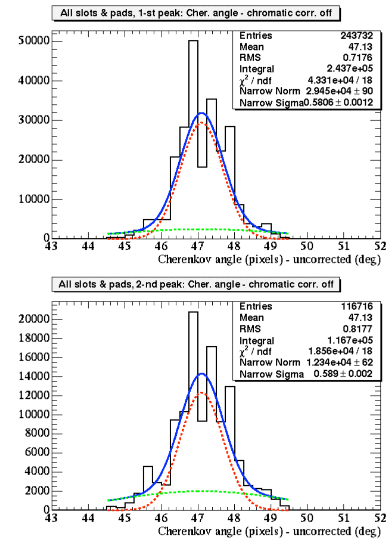
Position 2



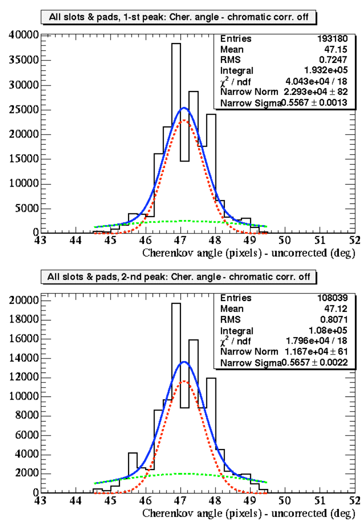
Position 3



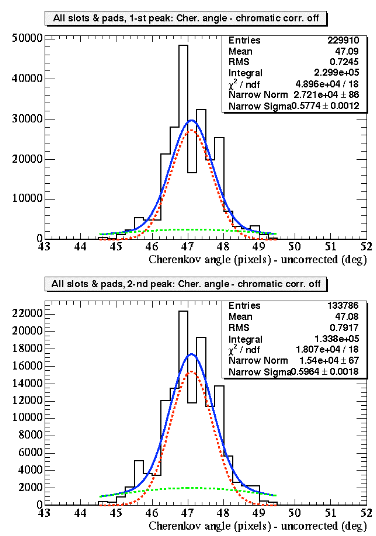
Position 4



Position 5



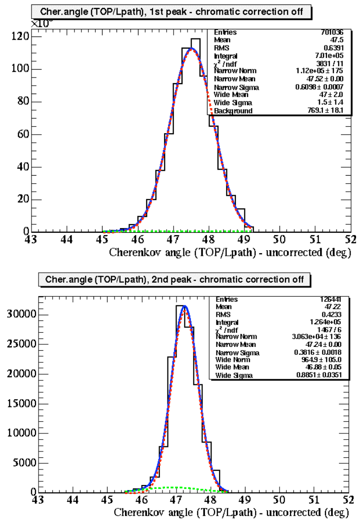
Position 6



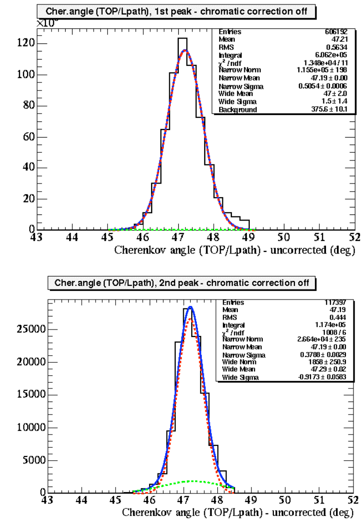
- Double Gaussian fit.
- Fix peak normalizations by eye.
- Fix the 2-nd Gaussian sigma to 2.2^{o}.
- Pixilization pattern is remarkeably repetitive.
- We clearly suffer from not enough instrumented pads to know the background shape, and the pixilization effects.

Cherenkov angle based on TOP - uncorrected

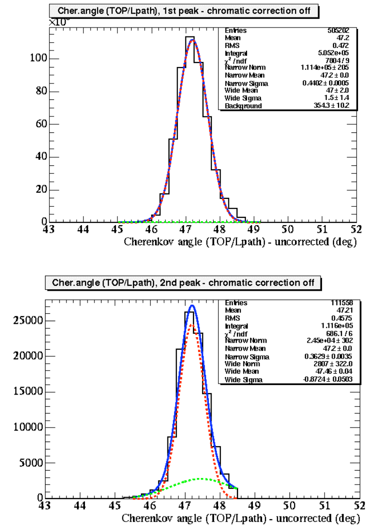
Position 1



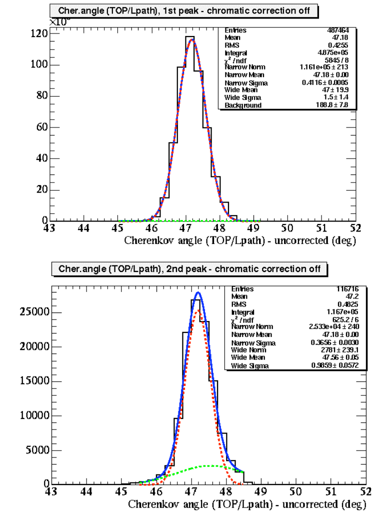
Position 2



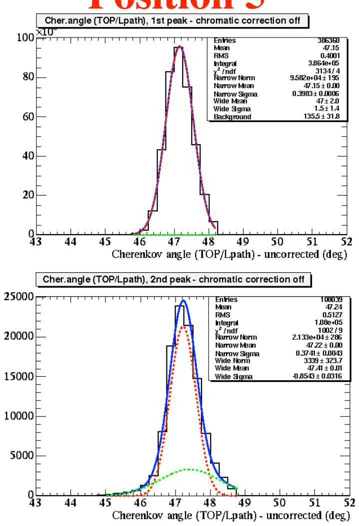
Position 3



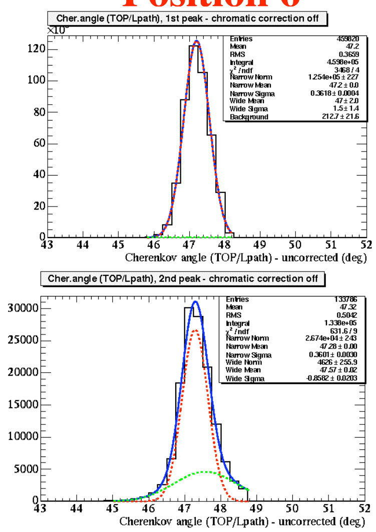
Position 4



Position 5



Position 6

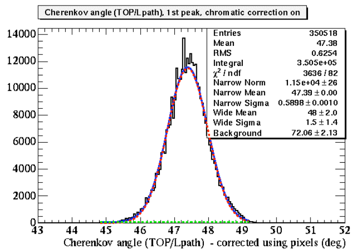


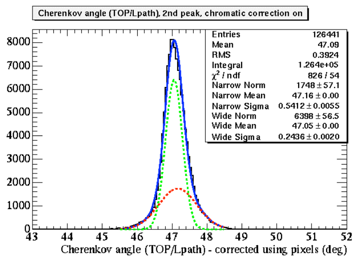
- Double Gaussian fit.
- Less tail than in the pixel domain.
- Do not fix the 2-nd Gaussian sigma.
- No pixilization effects in time domain.

(Assume β=1)

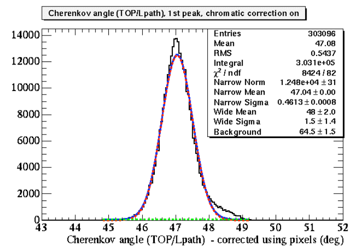
Cherenkov angle based on TOP - corrected with pixels

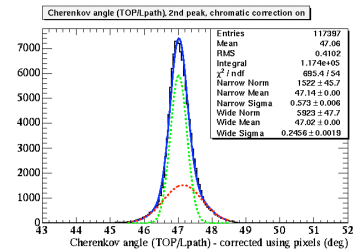
Position 1



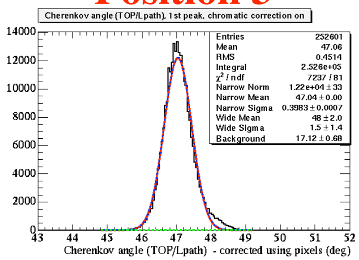


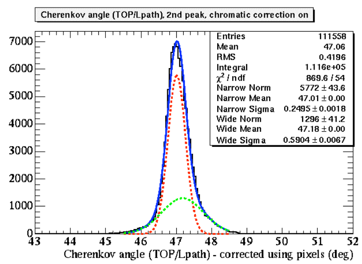
Position 2



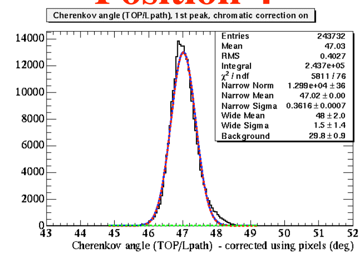


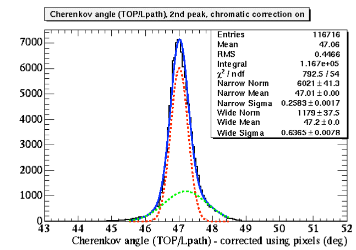
Position 3



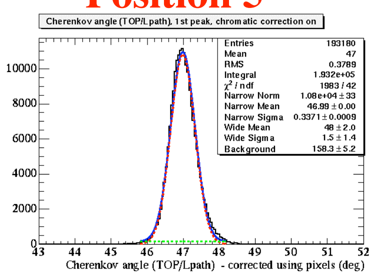


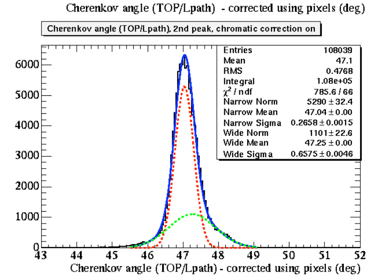
Position 4



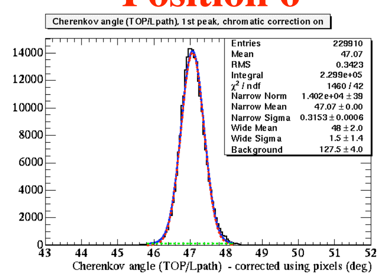


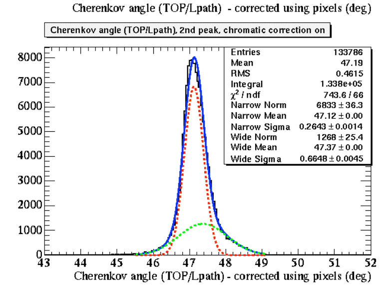
Position 5





Position 6

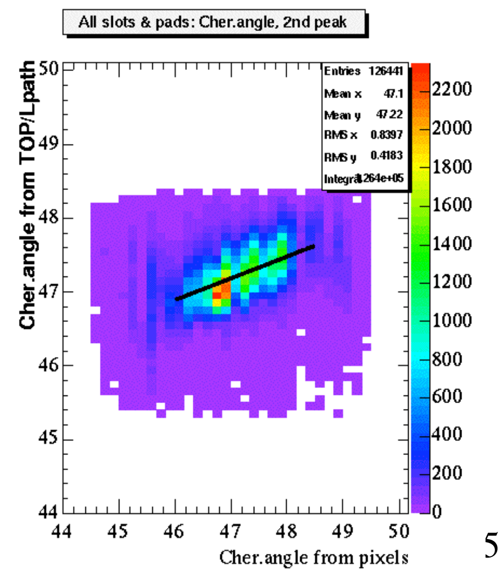




Method of chromatic correction:

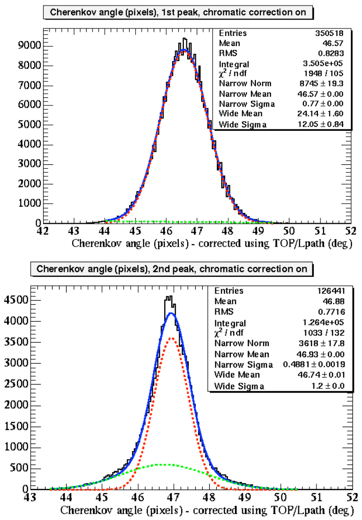
Use the correlation between Θ_{Pixels} & Θ_{TOP} as driven by data:

(Assume β=1)

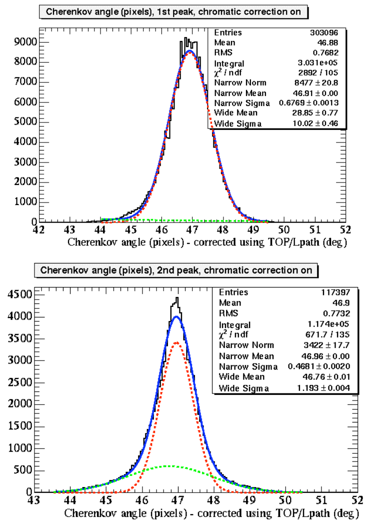


Cherenkov angle based on pixels - corrected with TOP

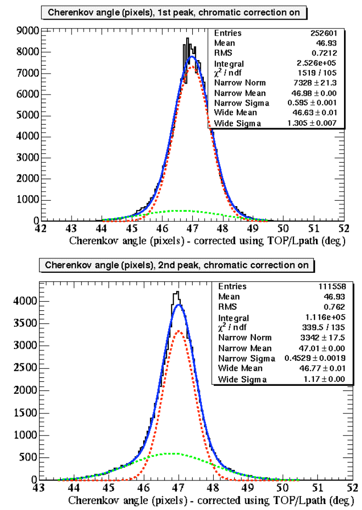
Position 1



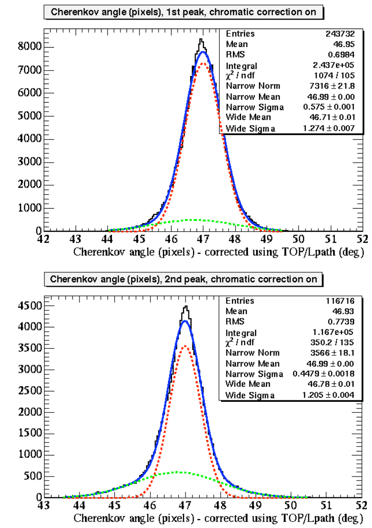
Position 2



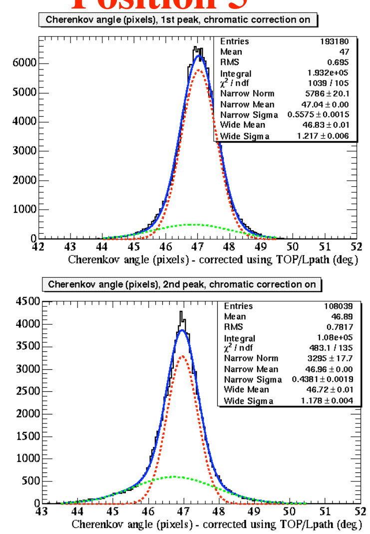
Position 3



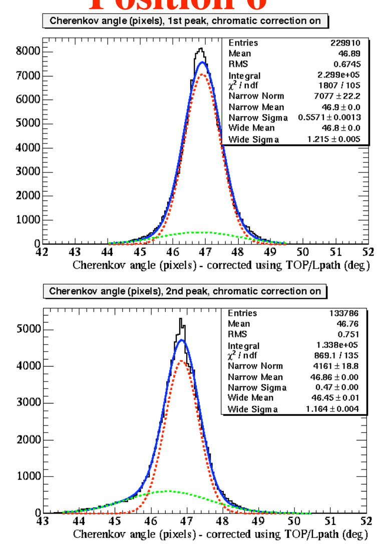
Position 4



Position 5



Position 6

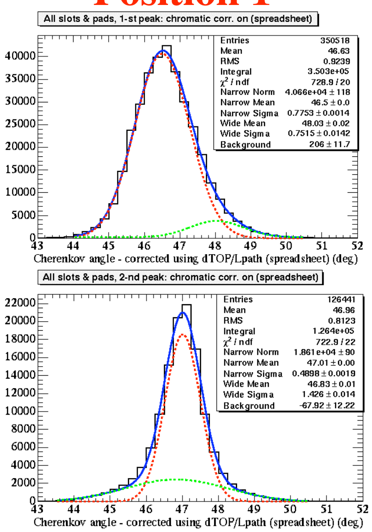


Method of chromatic correction:

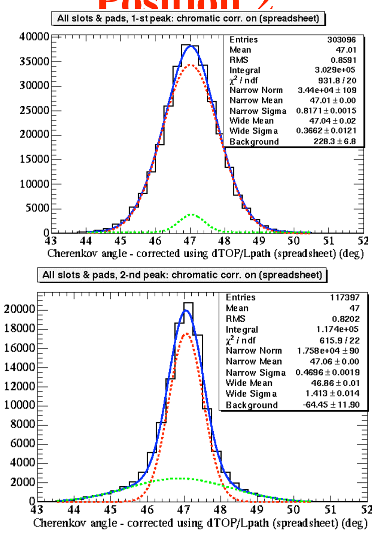
Use the “expected” 45^{o} correlation between Θ_{Pixels} & Θ_{TOP}

Cherenkov angle based on pixels - corrected with TOP

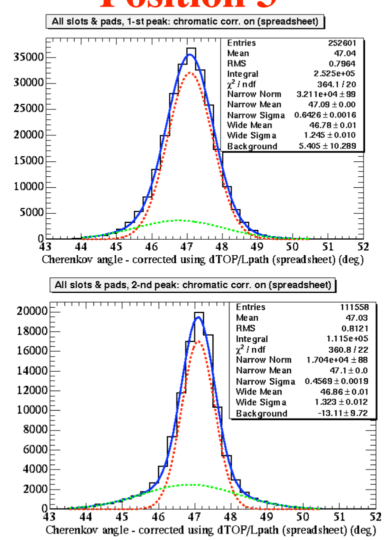
Position 1



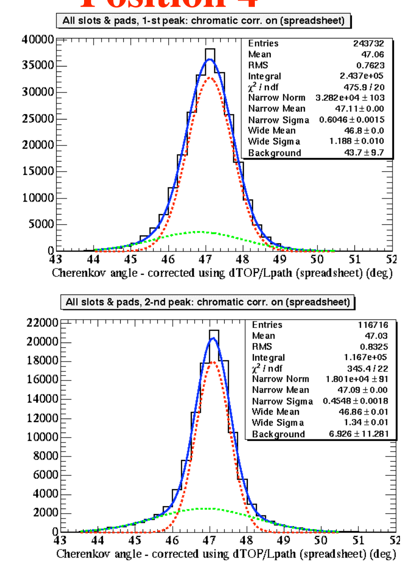
Position 2



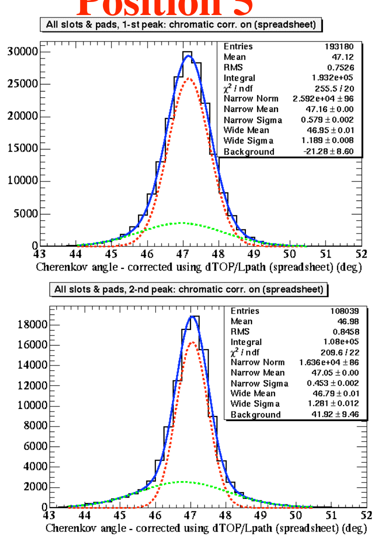
Position 3



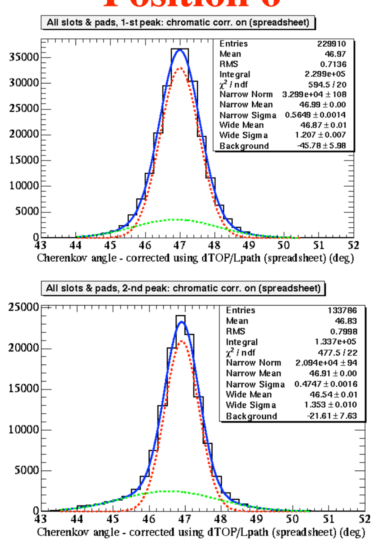
Position 4



Position 5

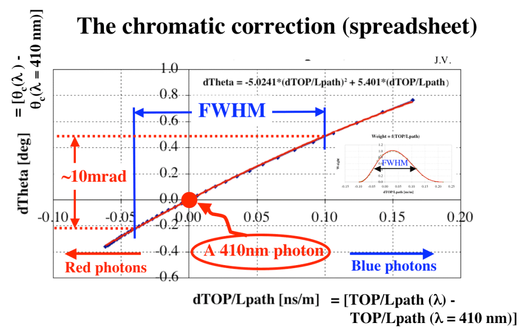


Position 6



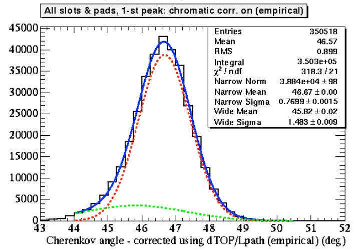
Method of chromatic correction:

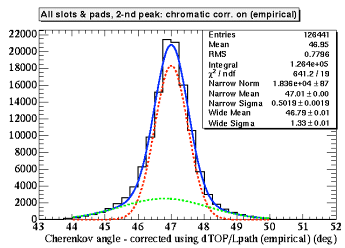
Use the correlation between $d\Theta_{Pixels}$ & $d(TOP/L_{path})$ driven by the refraction index shape (spreadshhet):



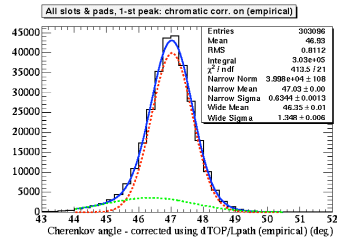
Cherenkov angle based on pixels - corrected with TOP

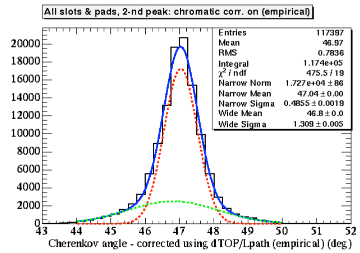
Position 1



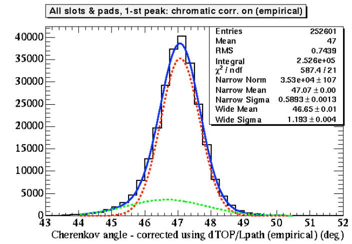


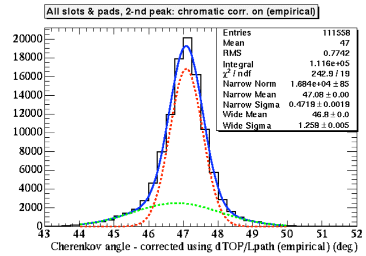
Position 2



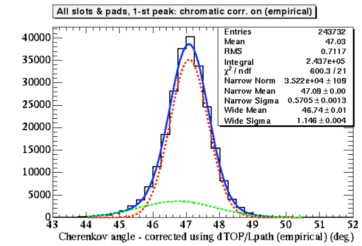


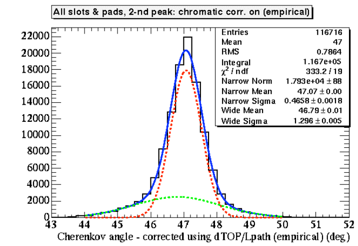
Position 3



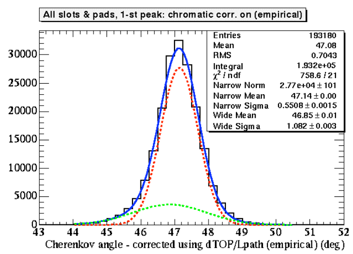


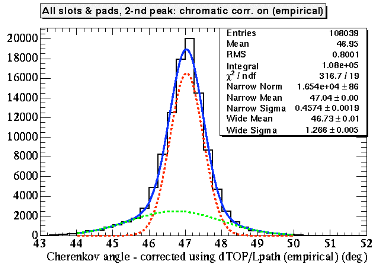
Position 4



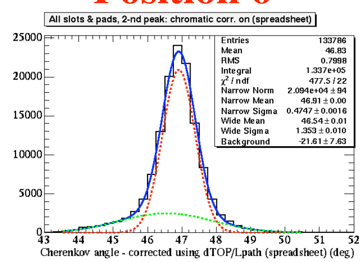


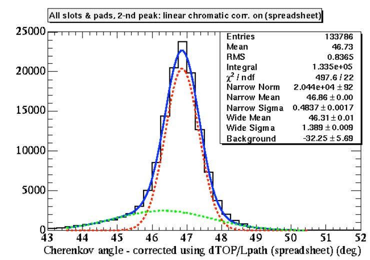
Position 5





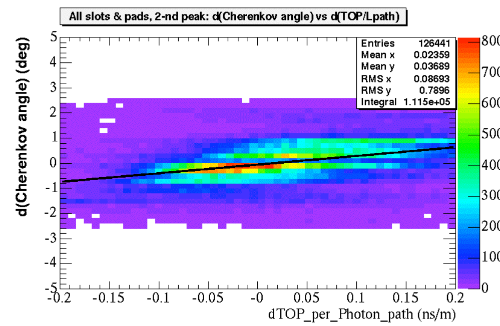
Position 6





Method of chromatic correction:

Use the correlation between $d\Theta_{Pixels}$ & $d(TOP/L_{path})$ driven by the actual data from peak 2, position 1 (run 15):



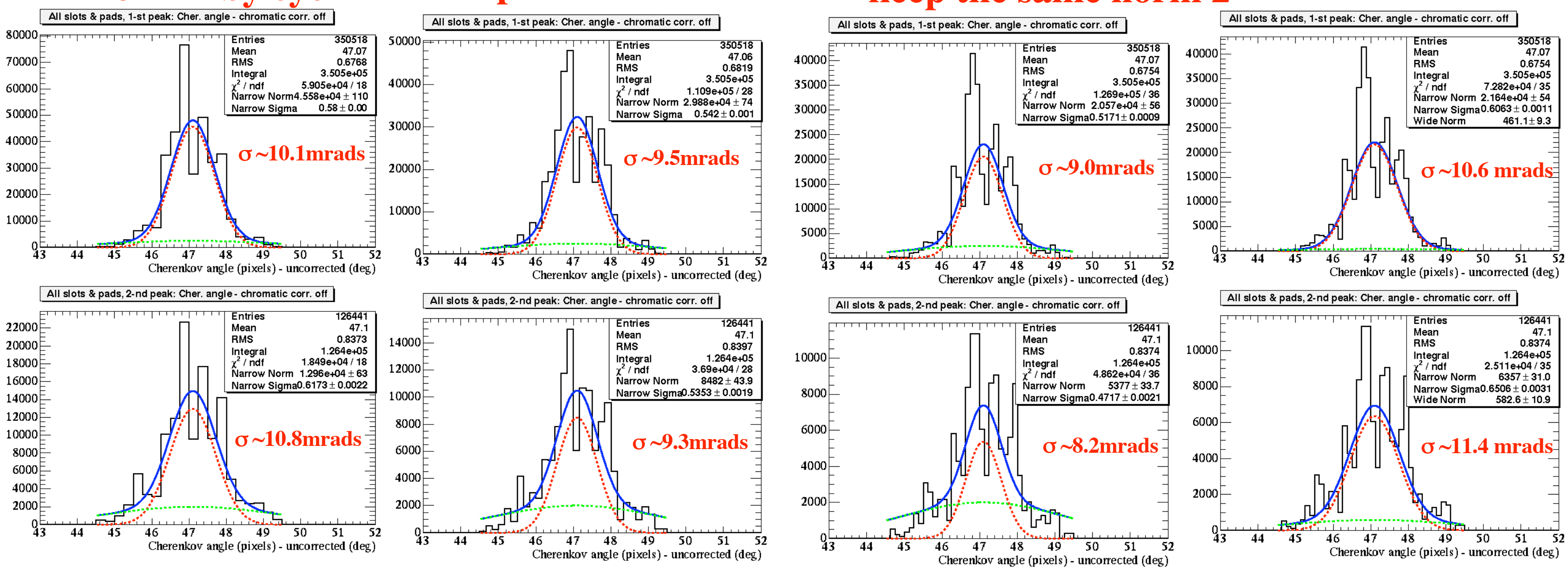
Cherenkov angle based on pixels - uncorrected

~ 4.4 mrad/bin
- vary norm 1
- fix norm 2 by eye

~ 2.9 mrad/bin
- vary norm 1
- keep the same norm 2

~ 2.2 mrad/bin
- vary norm 1
- keep the same norm 2

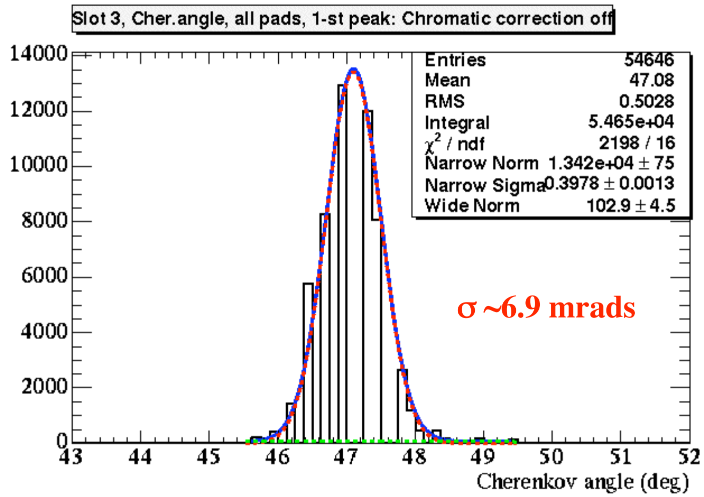
~ 2.2 mrad/bin
- vary norms 1&2

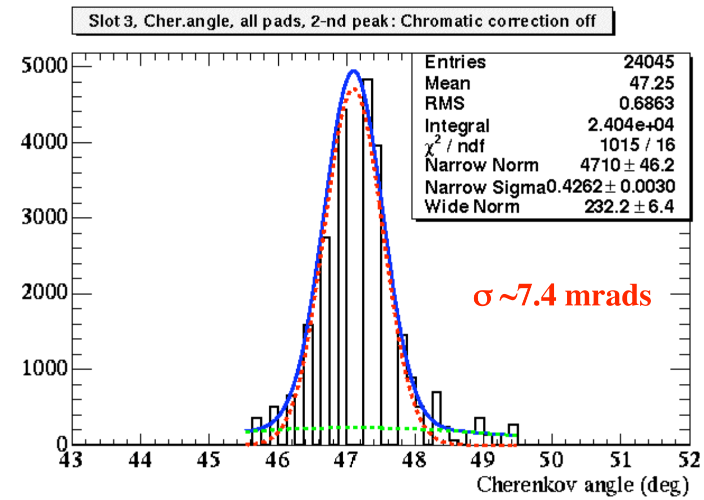


- **Position 1, run 22**
- Double Gaussian fit.
- Fix the 2-nd Gaussian sigma to 2.2°.
- Fix mean of both Gaussians to 47.1°.
- There are time epsilon offsets and slot-to-slot Cherenkov angle offsets

Slot 3 Cherenkov angle based on pixels - uncorrected

~ 2.2 mrad/bin
- vary norms 1&2

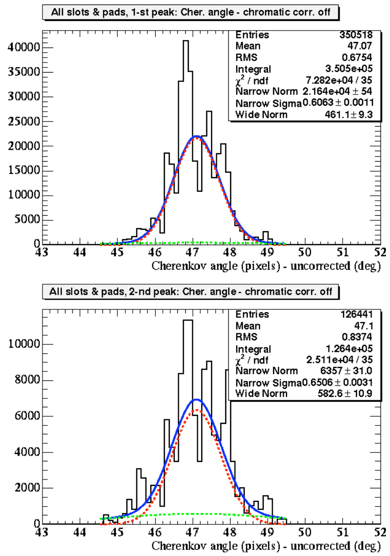




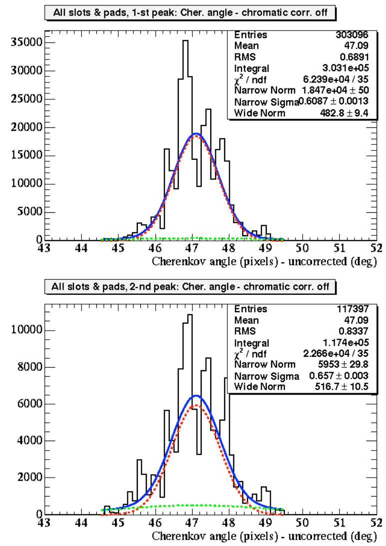
- **Position 1, run 22, Slot 3**
- Double Gaussian fit.
- Fix the 2-nd Gaussian sigma to 2.2°.
- Fix mean of both Gaussians to 47.1°.

Cherenkov angle based on pixels - uncorrected

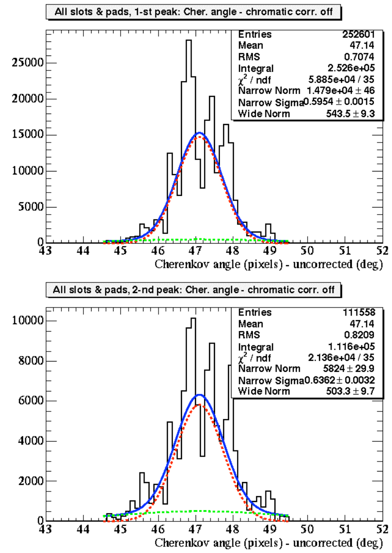
Position 1



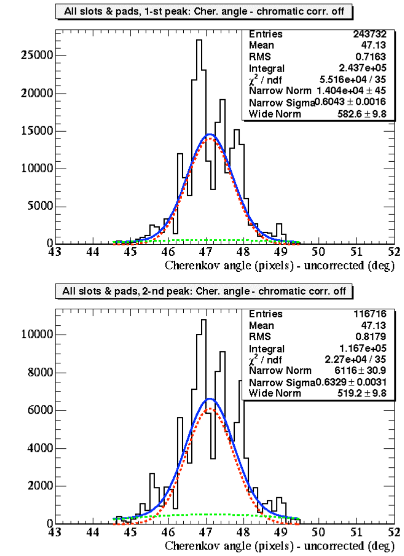
Position 2



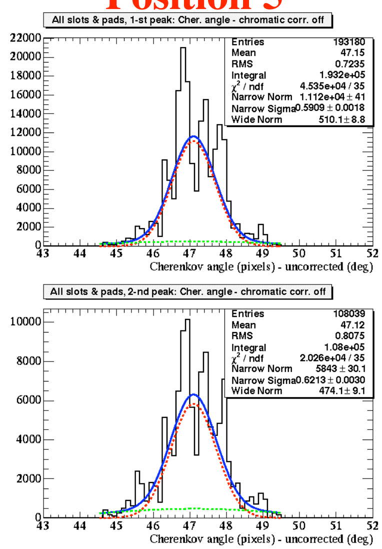
Position 3



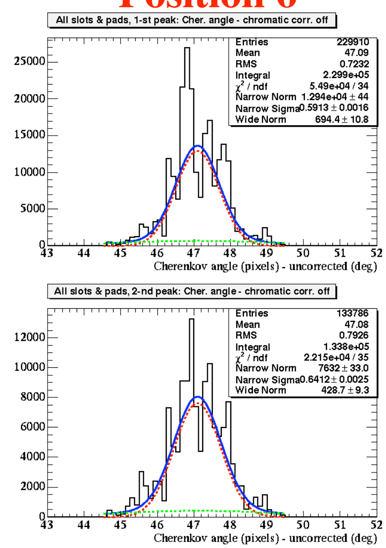
Position 4



Position 5



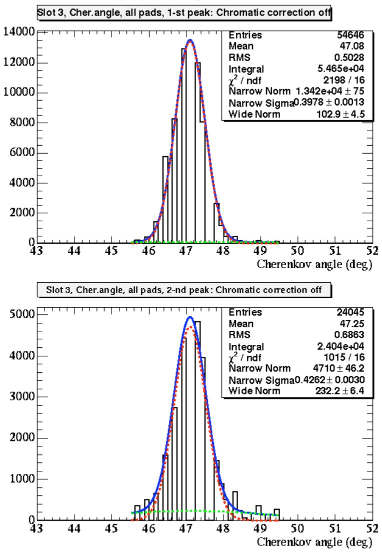
Position 6



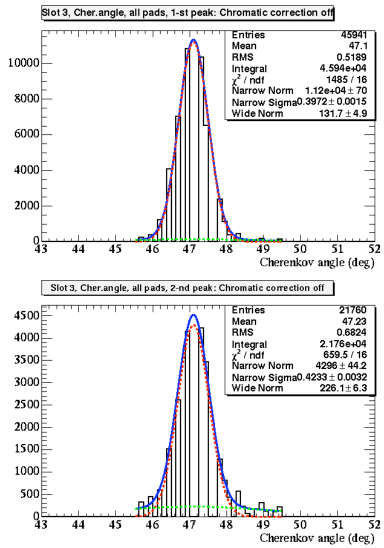
- Double Gaussian fit.
- Bin size: 2.2 mrads/bin
- Float both normalizations, fix the mean values.
- Fix the 2-nd Gaussian sigma to 2.2^o.

Slot 3 Cherenkov angle based on pixels - uncorrected

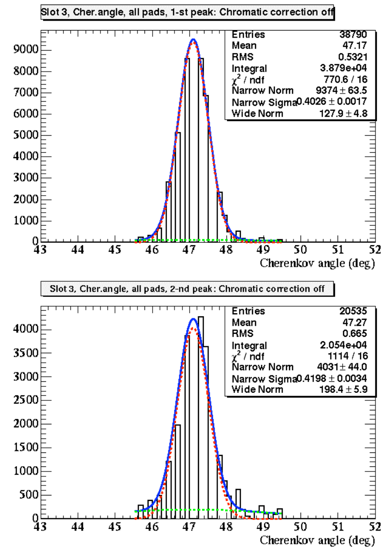
Position 1



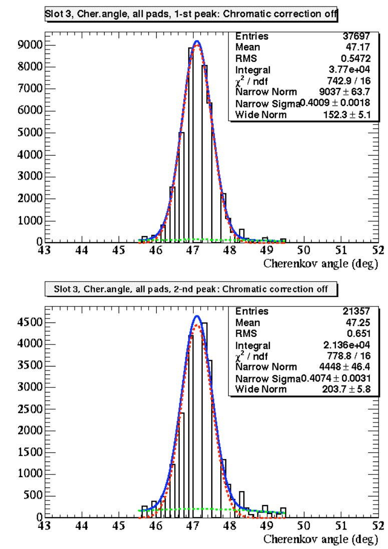
Position 2



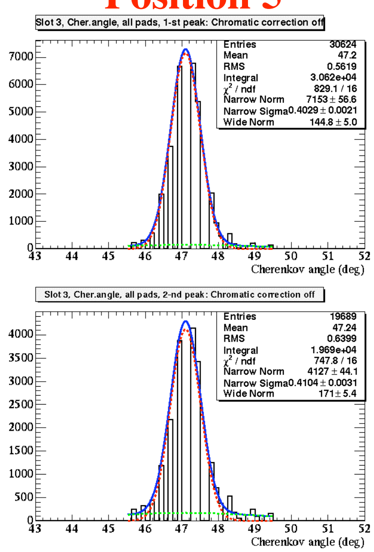
Position 3



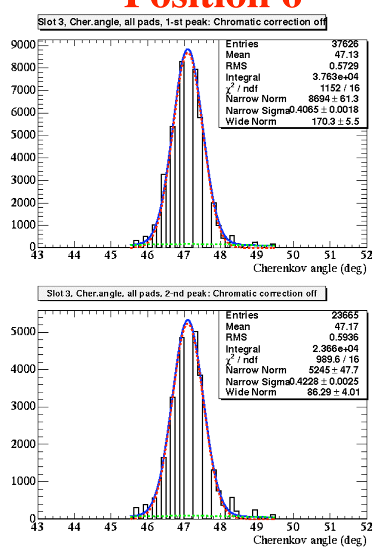
Position 4



Position 5



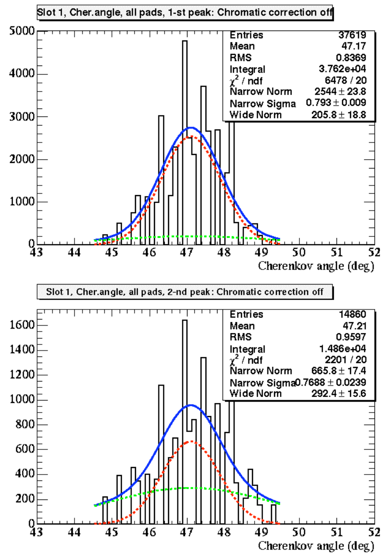
Position 6



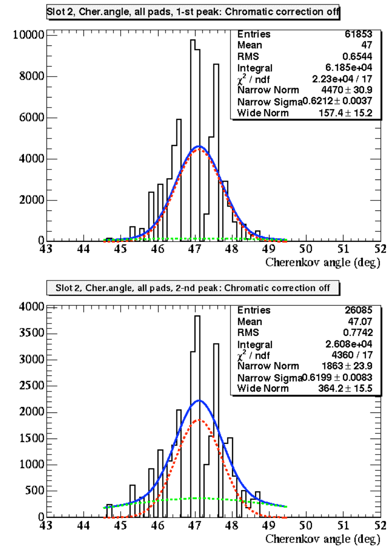
- Double Gaussian fit.
- Bin size: 2.2 mrads/bin
- Float both normalizations, fix the mean values.
- Fix the 2-nd Gaussian sigma to 2.2^{o}.

Cherenkov angle based on pixels - uncorrected

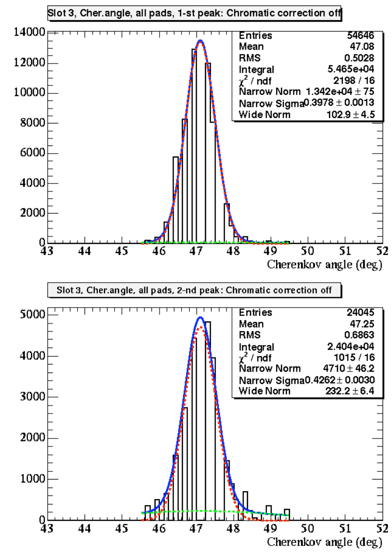
Slot 1



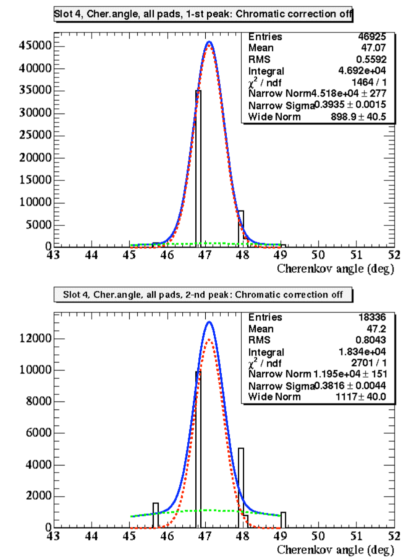
Slot 2



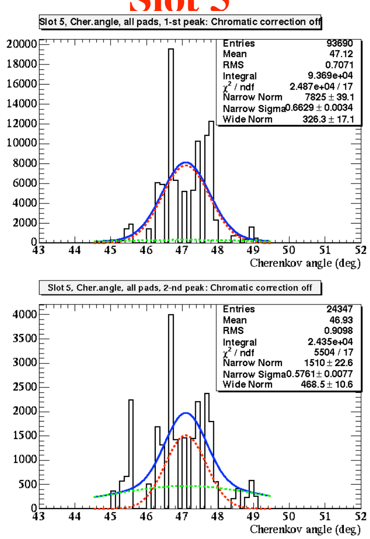
Slot 3



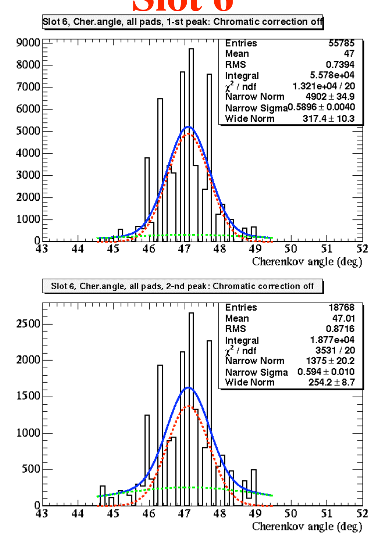
Slot 4



Slot 5



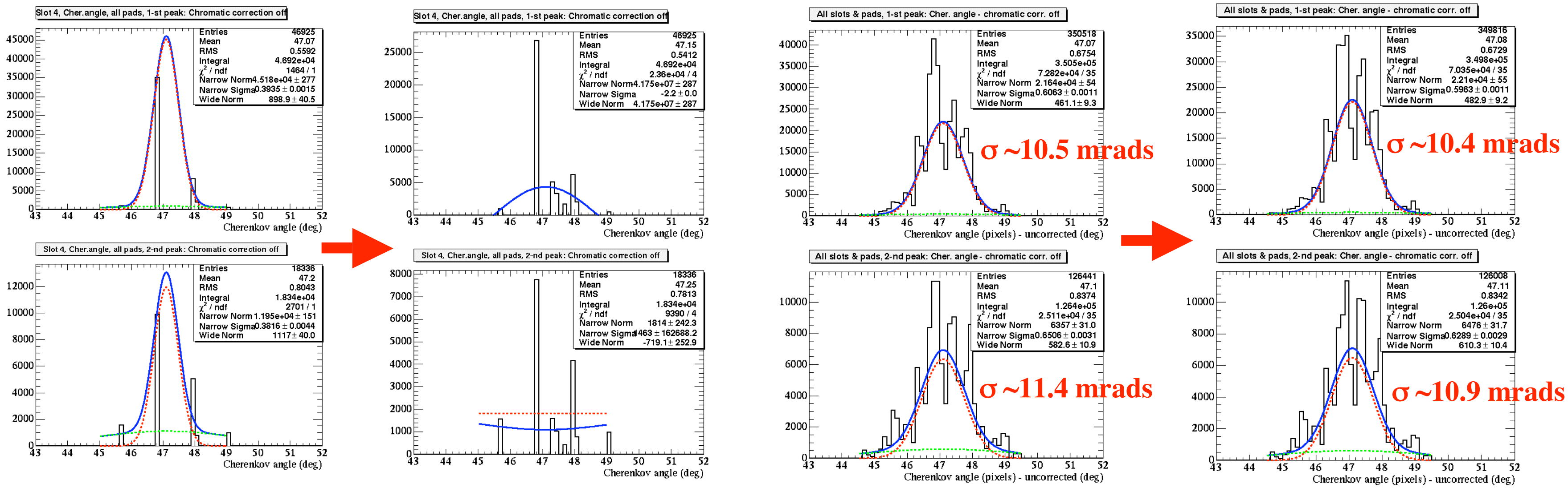
Slot 6



- **Position 1, run 22, vary slot number**
- Double Gaussian fit.
- Bin size: 2.2 mrads/bin
- Float both normalizations, fix the mean values.
- Fix the 2-nd Gaussian sigma to 2.2^o.

Slot 4 Cherenkov angle based on pixels - ADC correction

Slot 4 - before | **Slot 4 - after correction** | **All slots - before** | **All slots with slot 4 corrected**



A very simple code:

Position 1, run 22

```
if (good_hit && (tdc_slot4_phillips[i] > low_cut_2nd) && (tdc_slot4_phillips[i] < high_cut_2nd))
{
if (i == 25 && (dat25adc > 5) && (dat27adc > 5)) cherenkov_angle_slot4_corr[25] = (cherenkov_angle_slot4_corr[25] + cherenkov_angle_slot4_corr[27])/2;
if (i == 27 && (dat25adc > 5) && (dat27adc > 5)) cherenkov_angle_slot4_corr[27] = (cherenkov_angle_slot4_corr[25] + cherenkov_angle_slot4_corr[27])/2;
if (i == 26 && (dat26adc > 5) && (dat28adc > 5)) cherenkov_angle_slot4_corr[26] = (cherenkov_angle_slot4_corr[26] + cherenkov_angle_slot4_corr[28])/2;
if (i == 28 && (dat26adc > 5) && (dat28adc > 5)) cherenkov_angle_slot4_corr[28] = (cherenkov_angle_slot4_corr[26] + cherenkov_angle_slot4_corr[28])/2;
if (i == 41 && (dat41adc > 5) && (dat43adc > 5)) cherenkov_angle_slot4_corr[41] = (cherenkov_angle_slot4_corr[41] + cherenkov_angle_slot4_corr[43])/2;
if (i == 43 && (dat41adc > 5) && (dat43adc > 5)) cherenkov_angle_slot4_corr[43] = (cherenkov_angle_slot4_corr[41] + cherenkov_angle_slot4_corr[43])/2;
if (i == 42 && (dat42adc > 5) && (dat44adc > 5)) cherenkov_angle_slot4_corr[42] = (cherenkov_angle_slot4_corr[42] + cherenkov_angle_slot4_corr[44])/2;
if (i == 44 && (dat42adc > 5) && (dat44adc > 5)) cherenkov_angle_slot4_corr[44] = (cherenkov_angle_slot4_corr[42] + cherenkov_angle_slot4_corr[44])/2;
```

Conclusion:

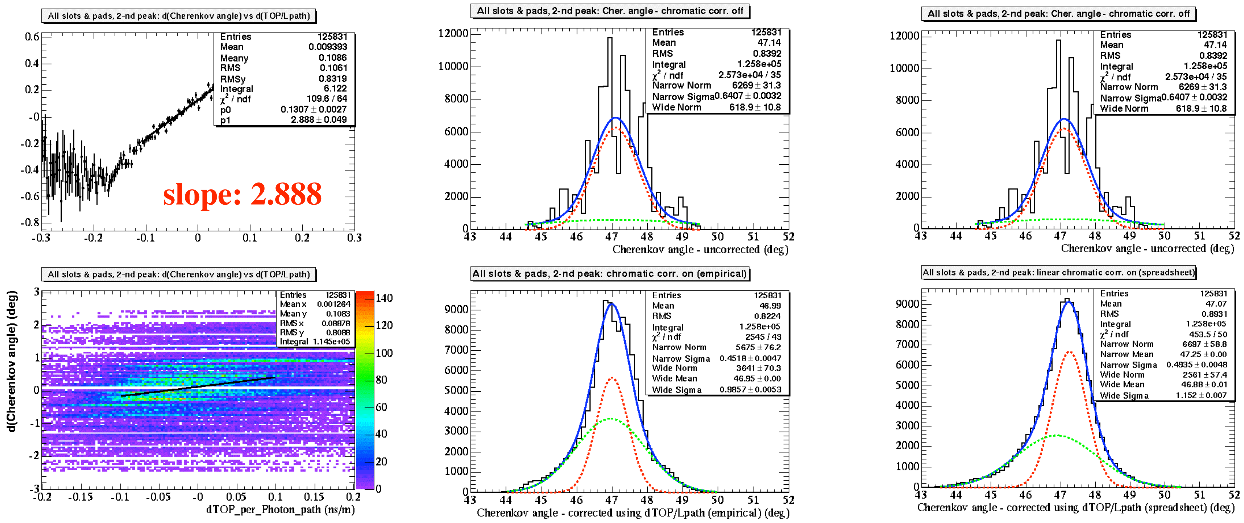
- **There is a migration of hits from 48^o towards 47^o.**
- **The result would be even better if all 8 pairs are instrumented in the slot 4**

Comparison of time epsilons to be off & on

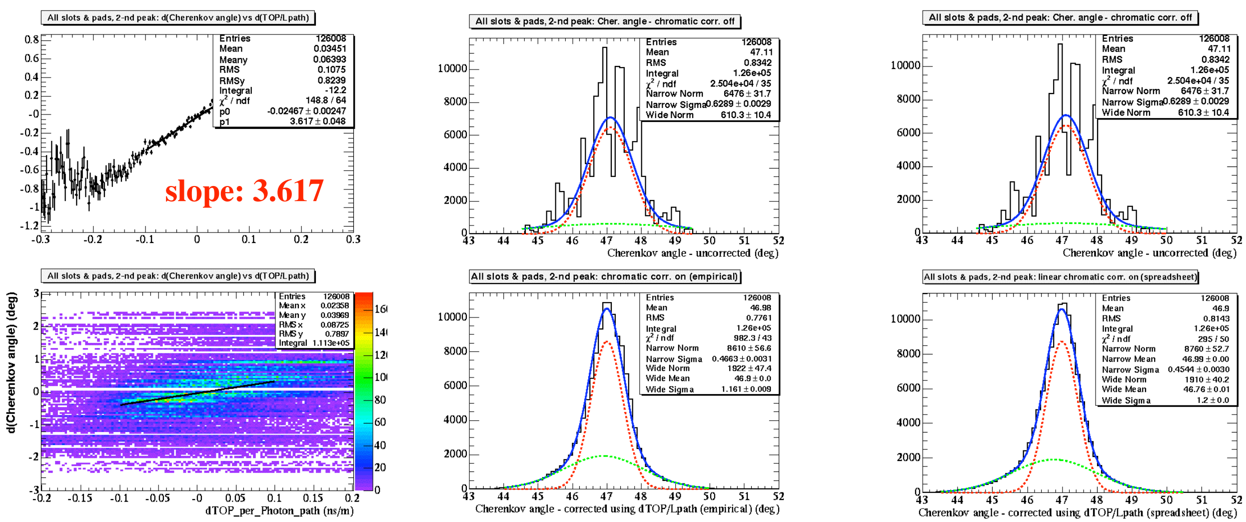
Position 1, run 22

Empirical correction | **Spreadsheet correction**

1) Time epsilon off:



2) Time epsilon on:



Conclusion: **time epsilon correction plays a very important role.**