Update on HV Data Analysis

Low Intensity Signals Investigations

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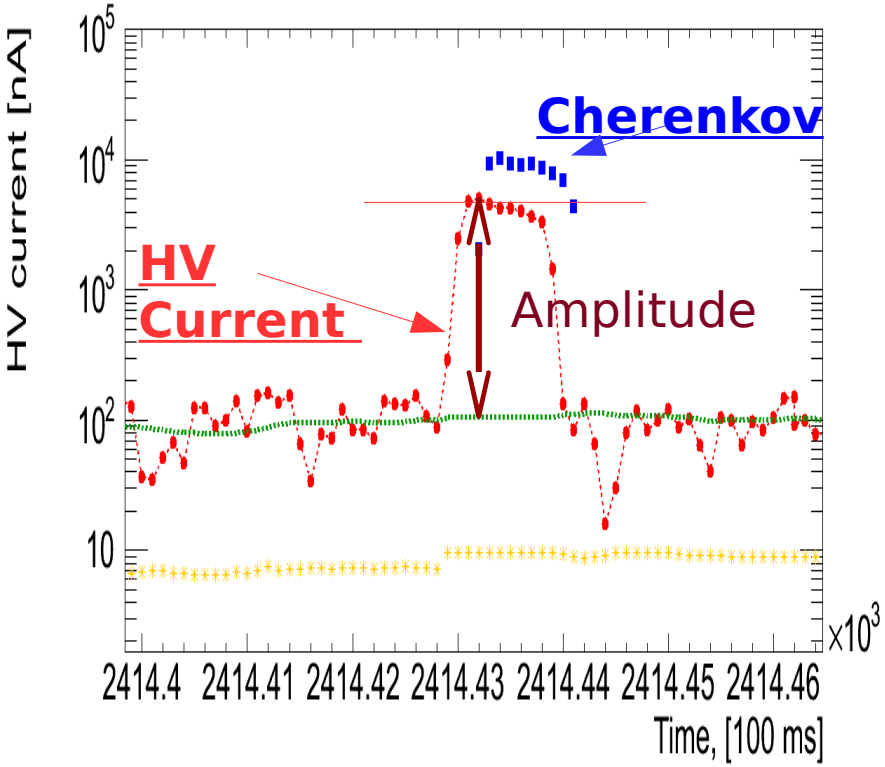
1200 V Runs

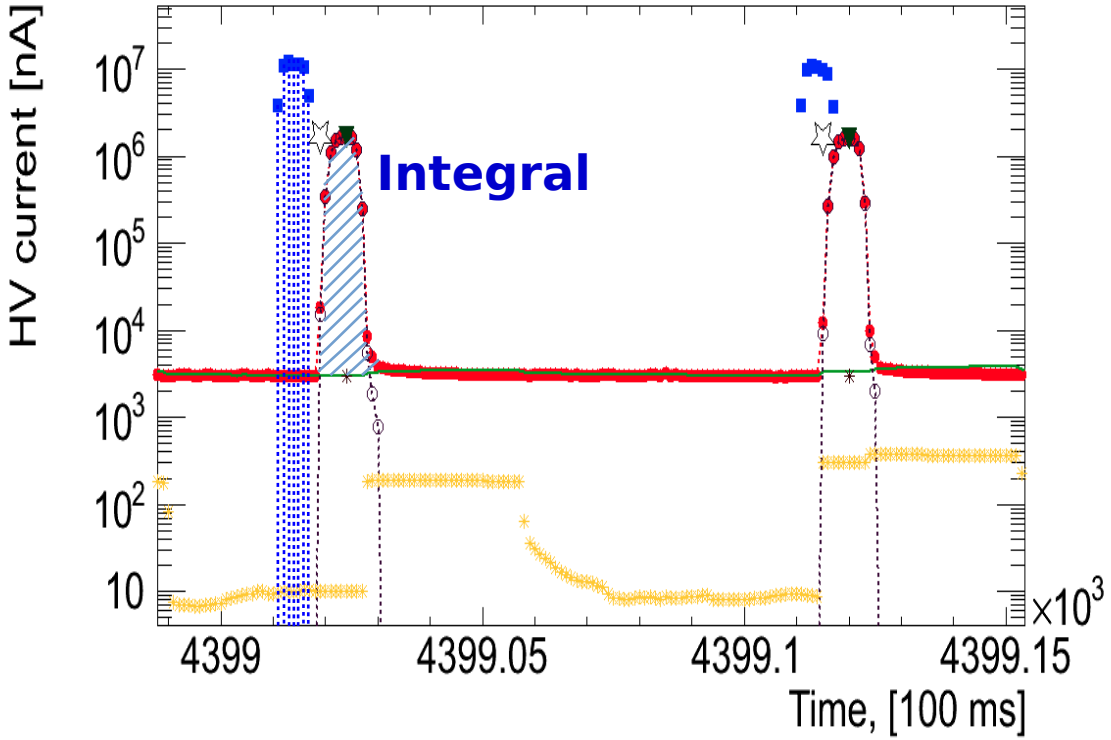
Run	Status	Comments
1152	added	Shift in low intensity
1181	removed	HV adjustments
1186	removed	Only for degradation studies
1108	tried	Gave two entries not in the expectation range - removed
1170	added	Kept (only few entries)
1181	added	Kept – does not contradict with other runs around
1157	removed	Wrong HV
1098	removed	Due to position information

43 runs used in analysis now:

1074, 1080, 1083, 1084, 1085, 1087, 1089, 1090, 1092, 1093, 1099, 1102, 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1116, 1117, 1130, 1131, 1137, 1140, 1141, 1142, 1165, 1169, 1170, 1172, 1175, 1176, 1177, 1178, 1179, 1180, 1181, 1182, 1183, 1184, 1185

Introduction



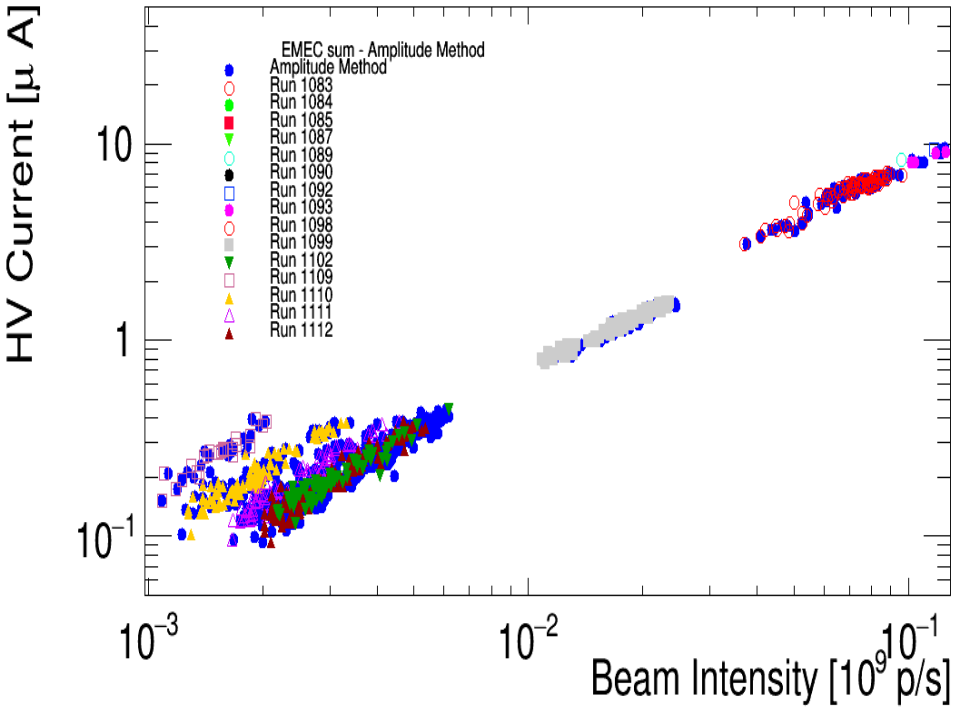


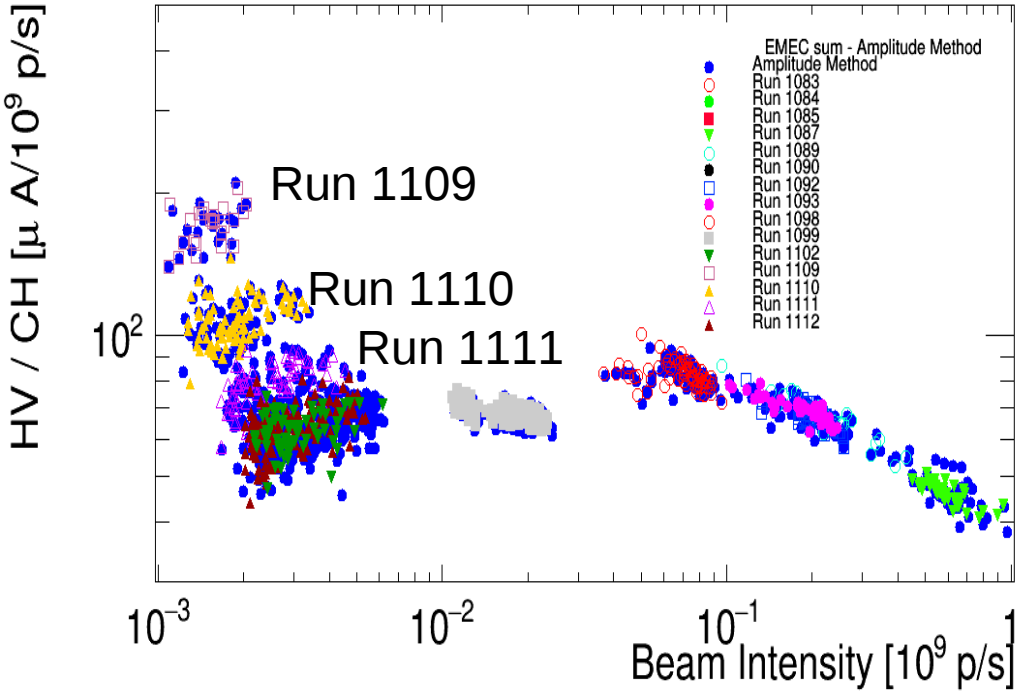
HV Current signal: Sliding average algorithm for calculating the baseline and sigma over 30 samples → use 5 sigma threshold to find HV signal → find maximum value and integrate over 5 sigma threshold; Signals have to be longer then 0.4 s

Cherenkov signal: Synchronization within 3 s with HV current; Find maximum and calculate integral value; Baseline was subtracted by A. Kozelov; Calculate Intensity → Ch Integral / spill length

Filters: Plateau flatness, Chi square, Correlation factors

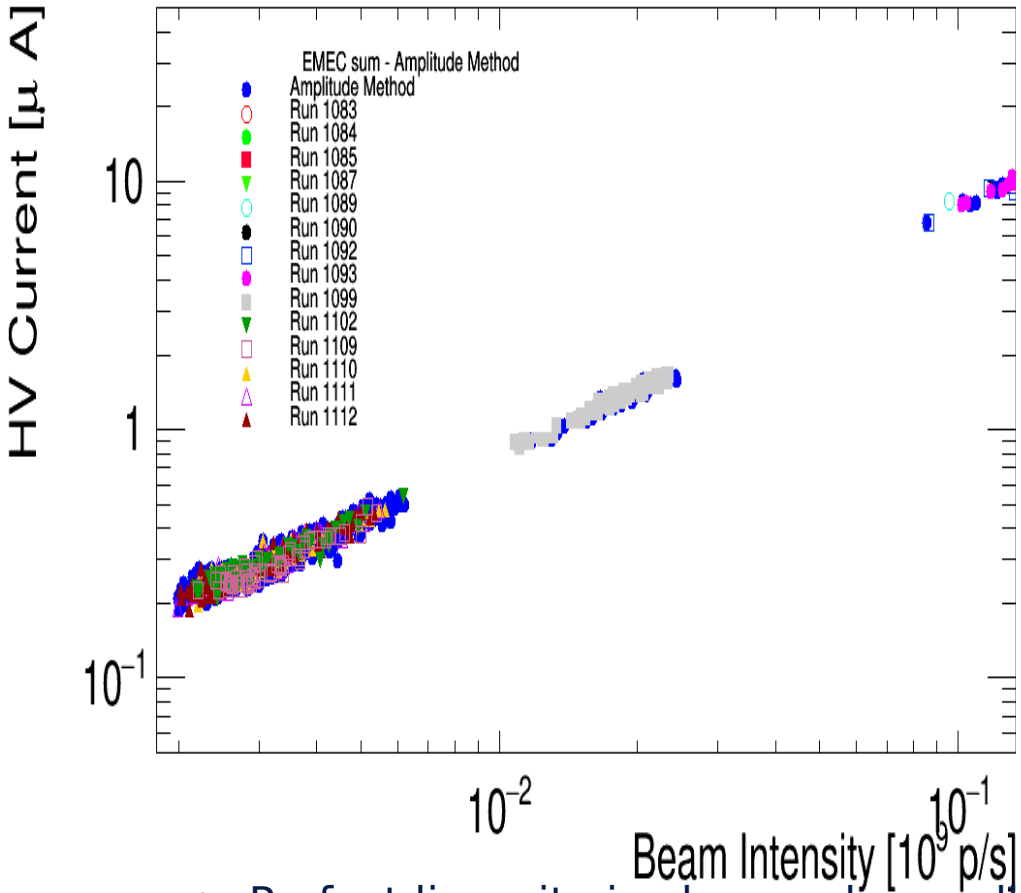
OLD: Low Intensity HV vs CH

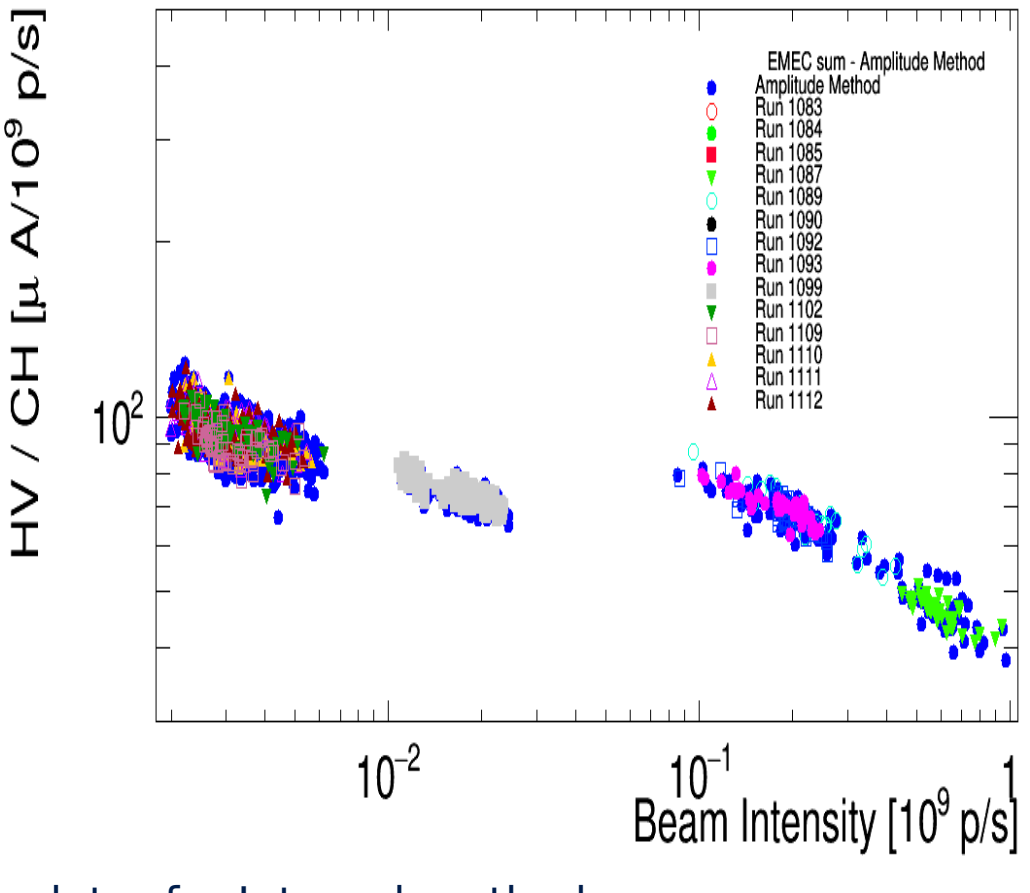




- At low intensities every run looks linear, but with a shift
- Shifts were explained by the different Cherenkov pressure – which was not corrected (checked for stability of other runs pressure)
- Run 1098 – was shown to have position shift and will be removed
- Implemented factors 2.6, 1.7 and 1.2 for highest 3 runs (I had to exclude offset subtraction first)

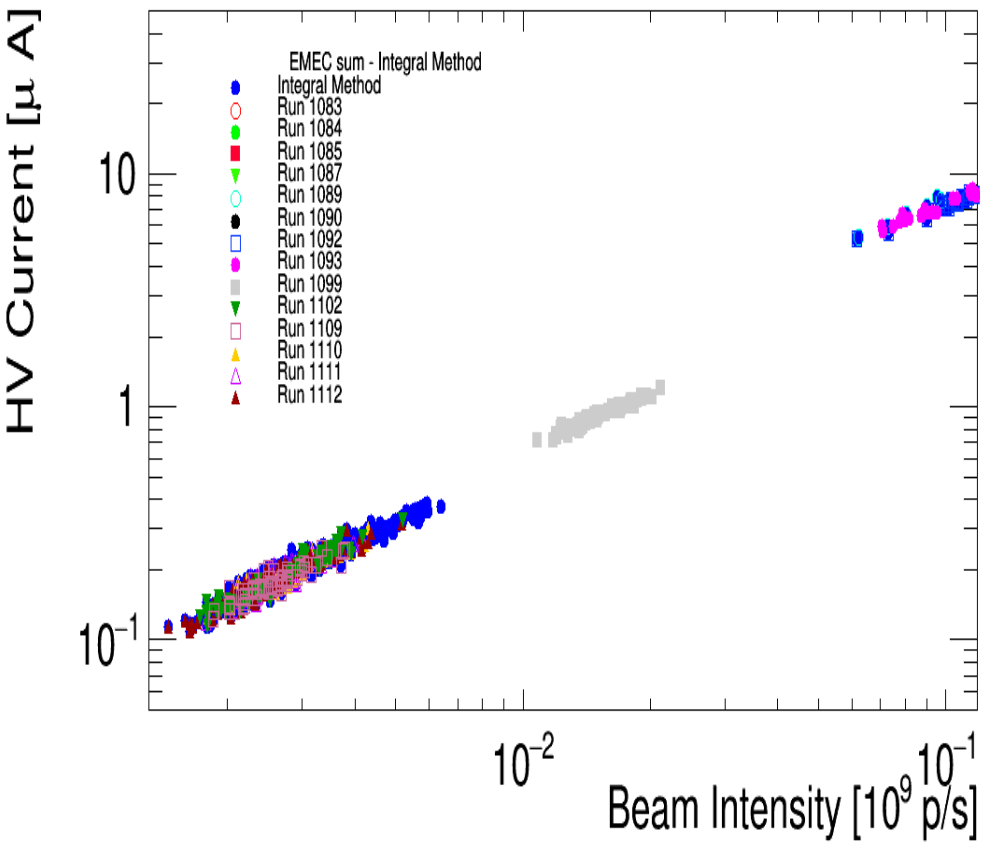
Amplitude Method

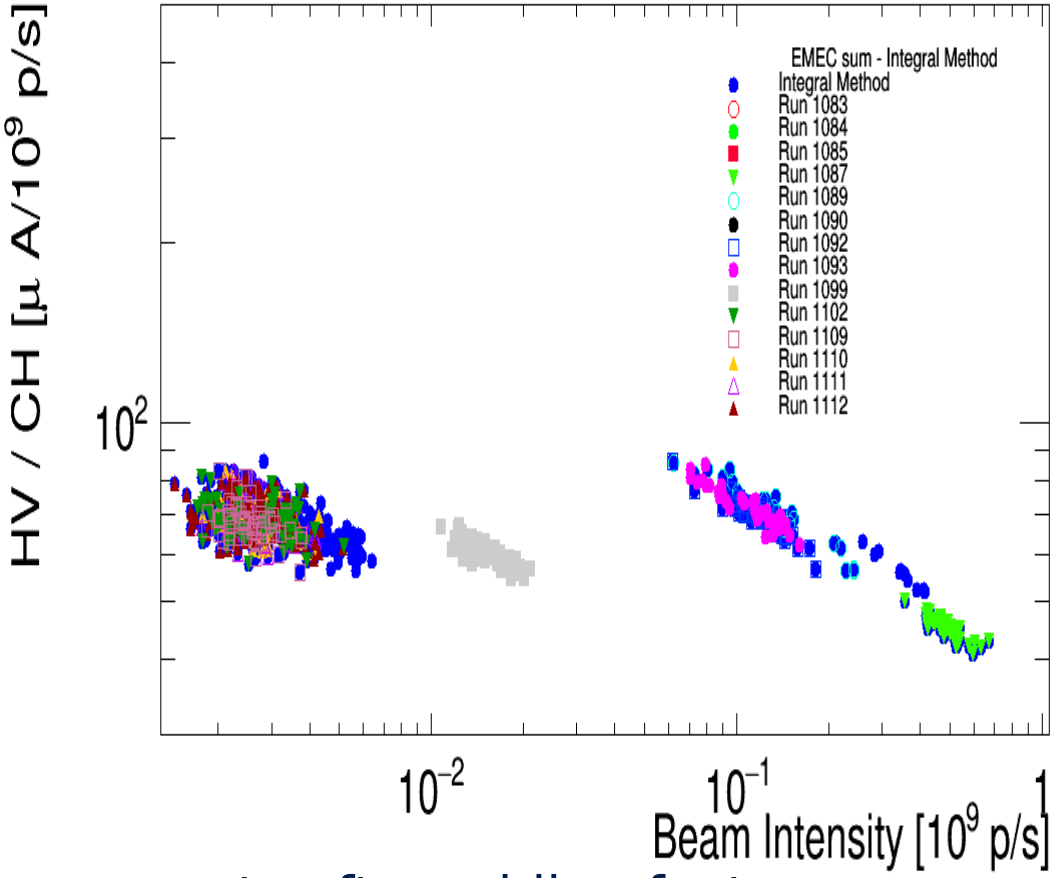




- Perfect linearity is observed as well as later for Integral method
- No offsets were subtracted – see slight increase at low intensities (position, pressure dependence during runs?)
- All added and removed runs fit to the picture well
- Good correspondence between runs to the final plot

Integral Method

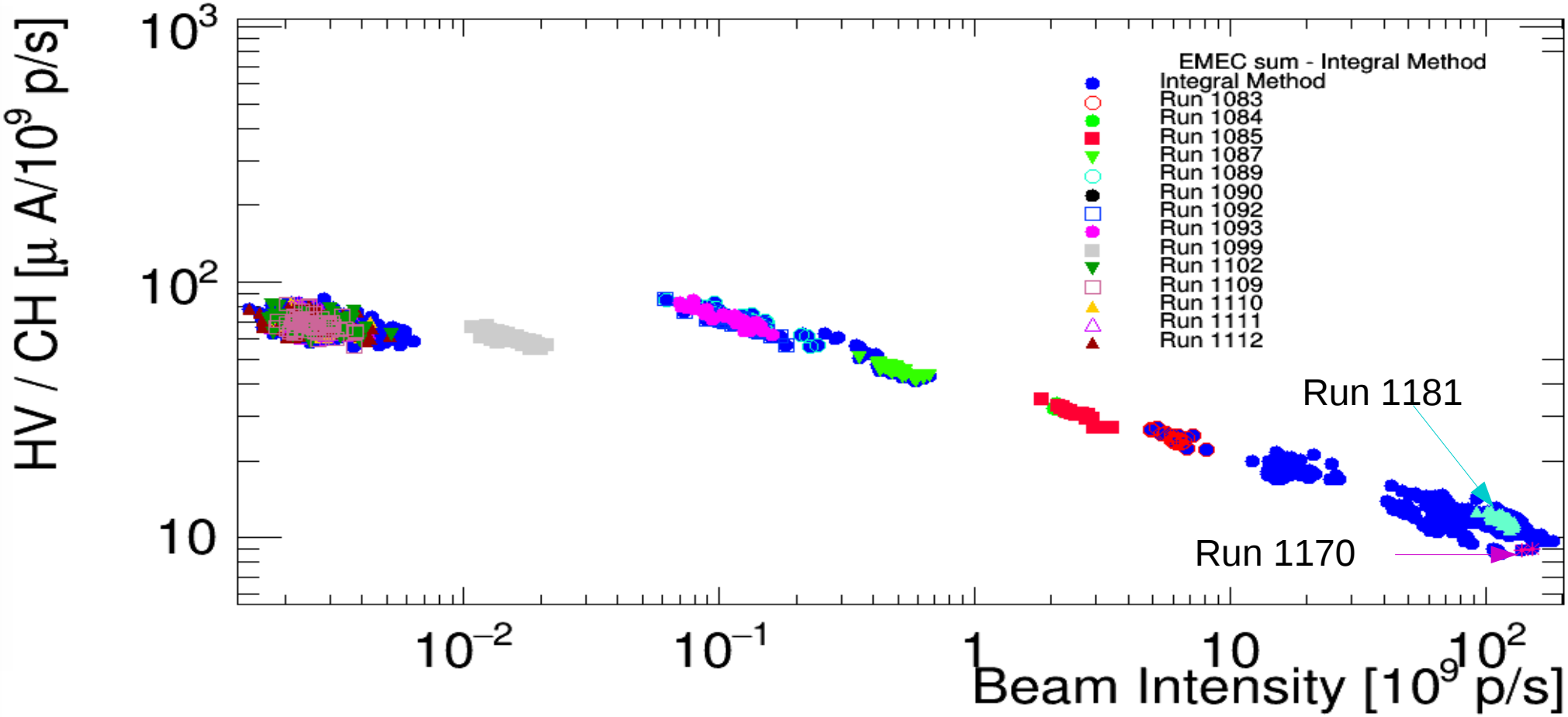




- Integral Method also showed improvements after adding factors
- No offsets were subtracted – see slight increase at low intensities
- Now We need to refit the functions

New Runs

- Runs 1170 and 1181 have been added



Part II

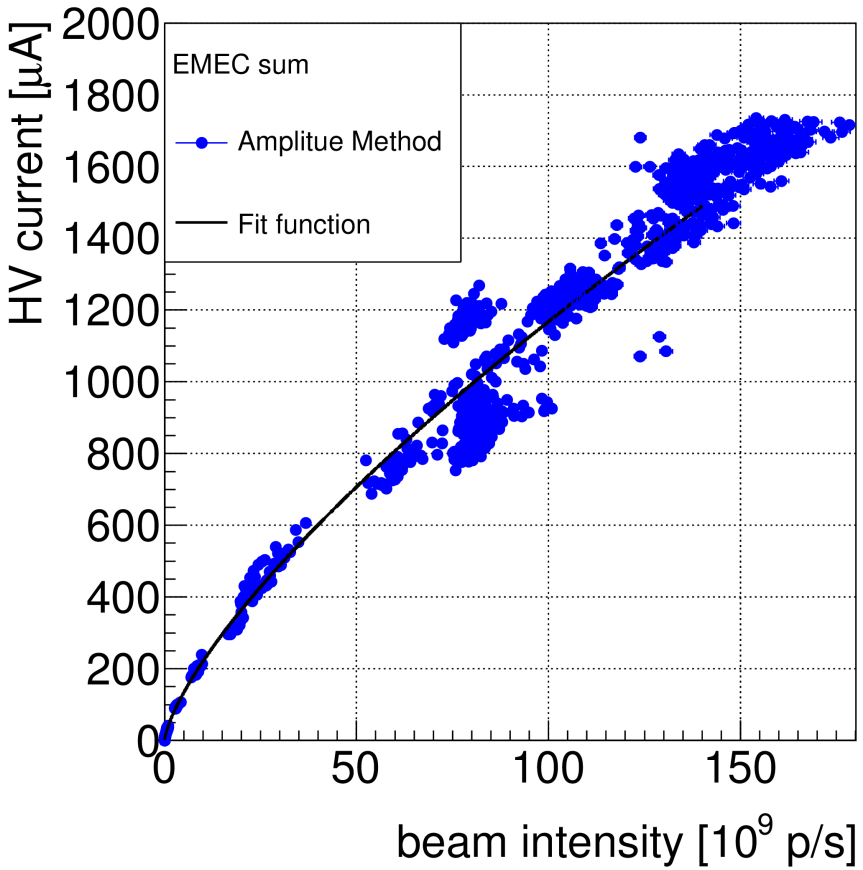
- Refitting all channels for different statistics and different ranges
- Use two representation of data (normal HV current signal as a function of Cherenkov signal and ratio HV curve – as a HV current/Cherenkov signals as a function of Cherenkov signal) with corresponding fit functions, which are shown on the next slides.
- Calculate offset and subtract it – which as will be seen is good for one of two methods only
- Use fits with and without offset
- Plot final plots for Critical intensity and critical current and obtained uncertainties
- Careful the channel numbering is reversed (plots are just to prove the final numbers)

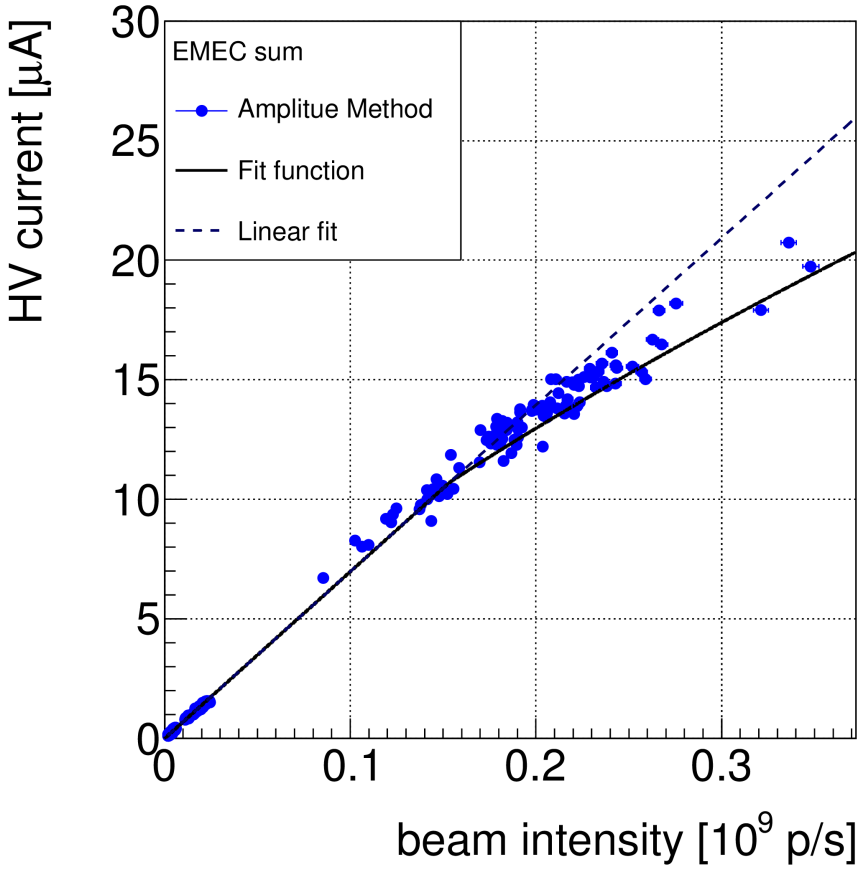
Fit Functions

- Normal HV curve fit : parameters – Critical current (ic), Critical intensity (Ic), power term (p) and offset
- One can also fit by using slope as a parameter(k)
- Fits were made with offset and without offset for final results

$$\mathrm{i} = \begin{cases} i_c * \frac{I}{I_c} + Offset & \text{for } I < I_c \\ i_c * (\frac{I}{I_c})^p + Offset & \text{for } I > I_c \end{cases}$$

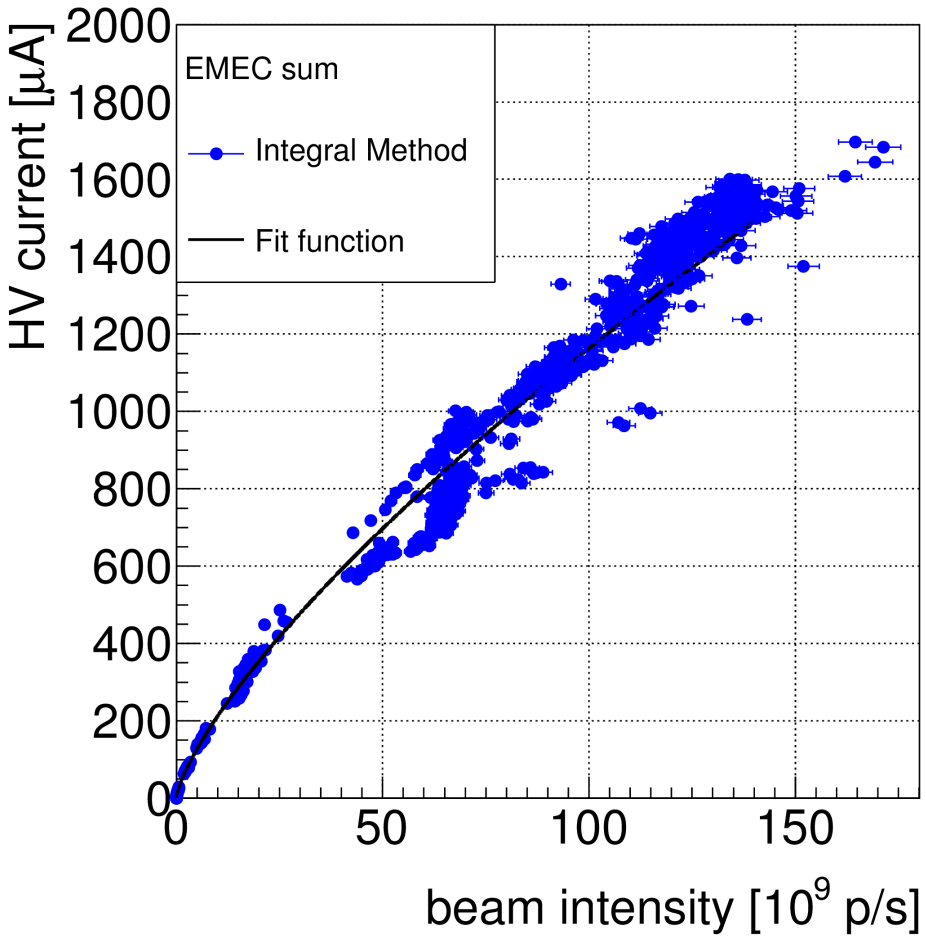
$$\mathrm{i} = \begin{cases} k*I & \text{for } I < I_c \\ k*\frac{I^p}{I_C^{p-1}} & \text{for } I > I_c \end{cases}$$

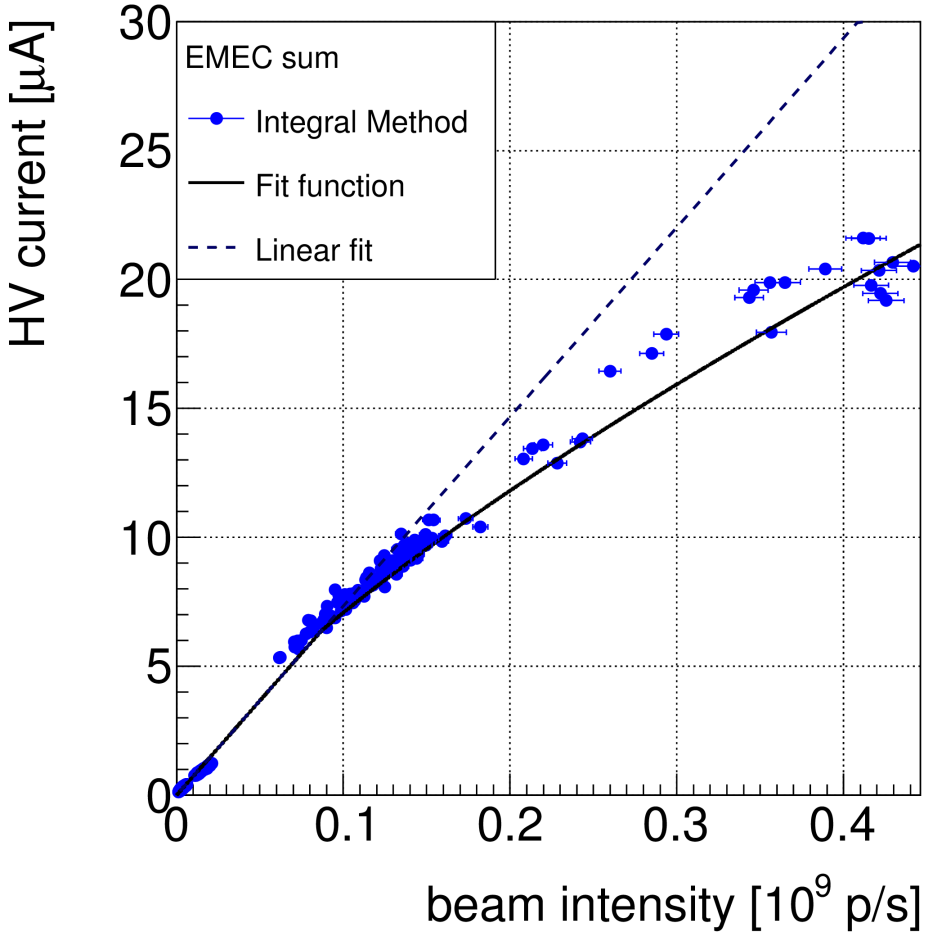




Integral method

- Integral Method is using the same fit functions, but as later will be seen the method with slope as parameter is more stable fit function



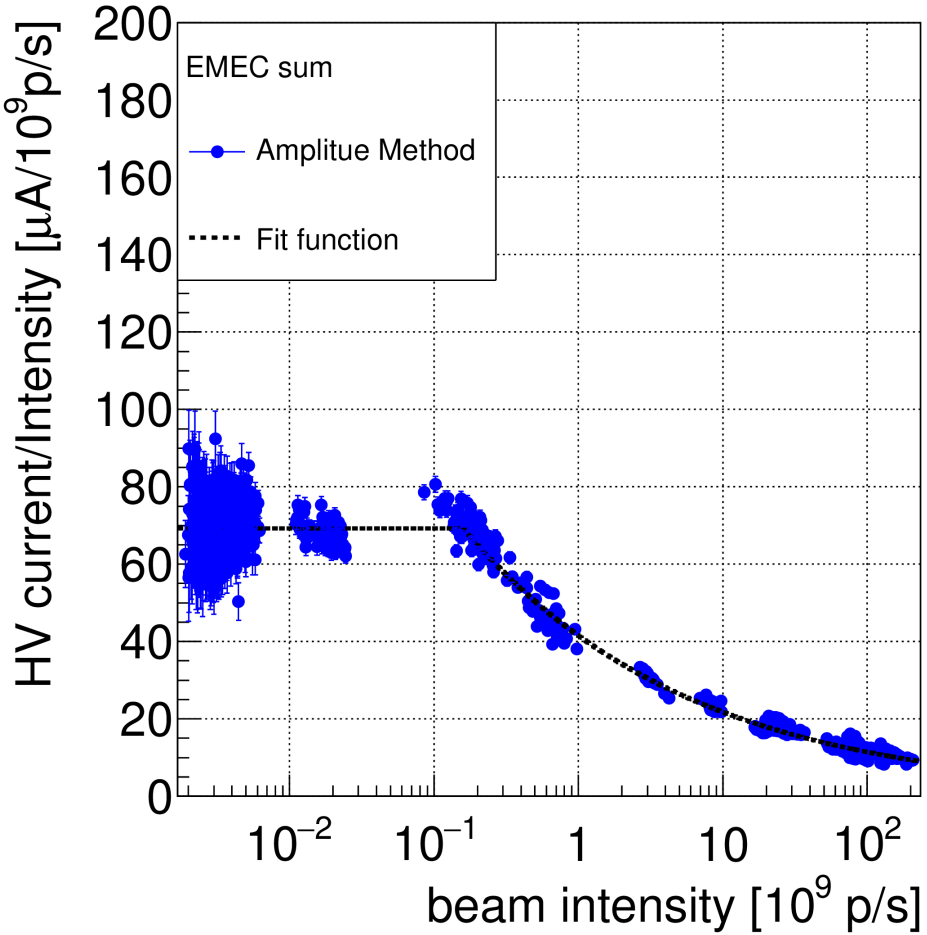


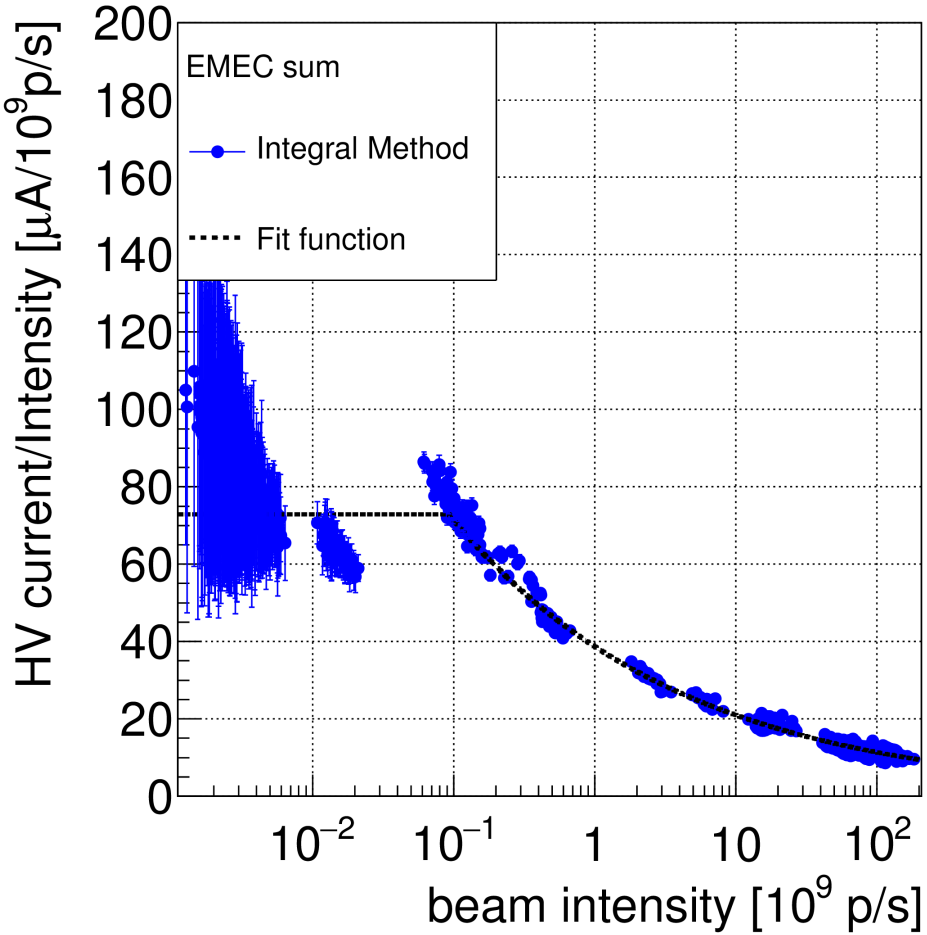
Ratio HV curve fit functions

- Ratio HV curve fit : parameters – Critical current (ic), Critical intensity (Ic), power term (p) and offset
- One can also fit by using slope as a parameter(k)

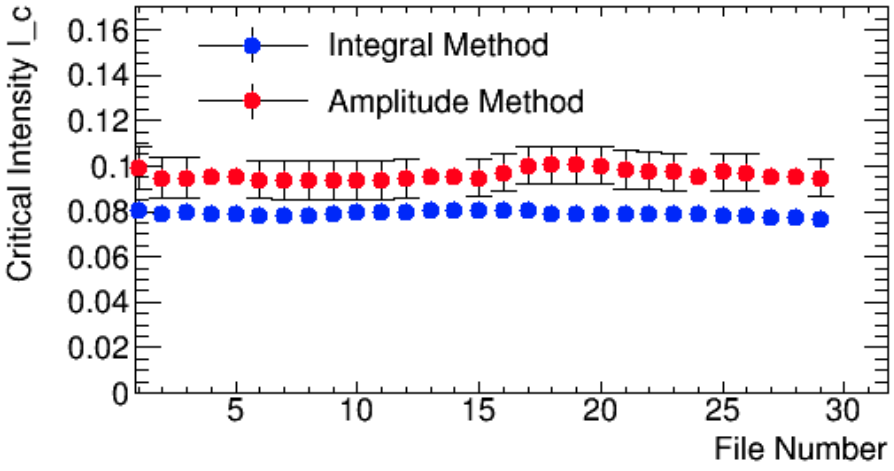
$$\mathrm{i} = \begin{cases} \frac{i_C}{I_C} + \frac{offset}{I} & \text{for } I < I_c \\ i_C * \frac{I^{p-1}}{I_C^p} + \frac{offset}{I} & \text{for } I > I_c \end{cases}$$

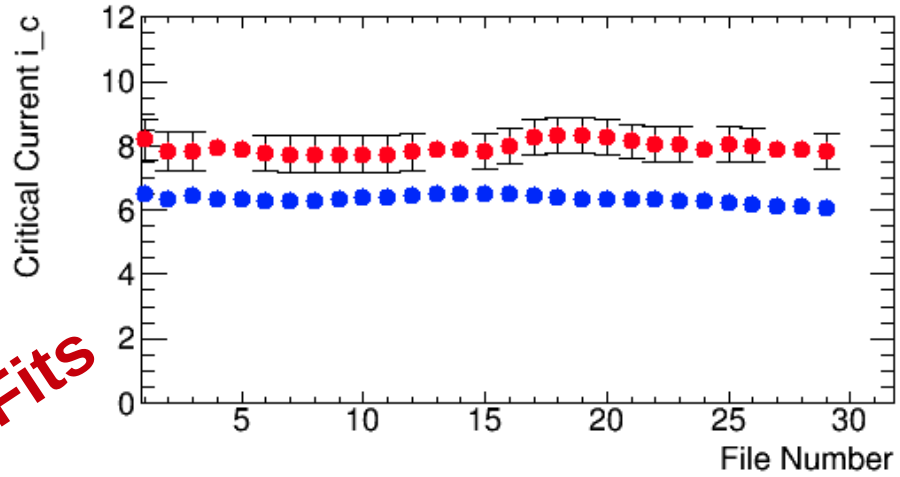
$$\mathrm{i} = \begin{cases} k + \frac{offset}{I} & \text{for } I < I_c \\ k(\frac{I}{I_C})^{p-1} + \frac{offset}{I} & \text{for } I > I_c \end{cases}$$



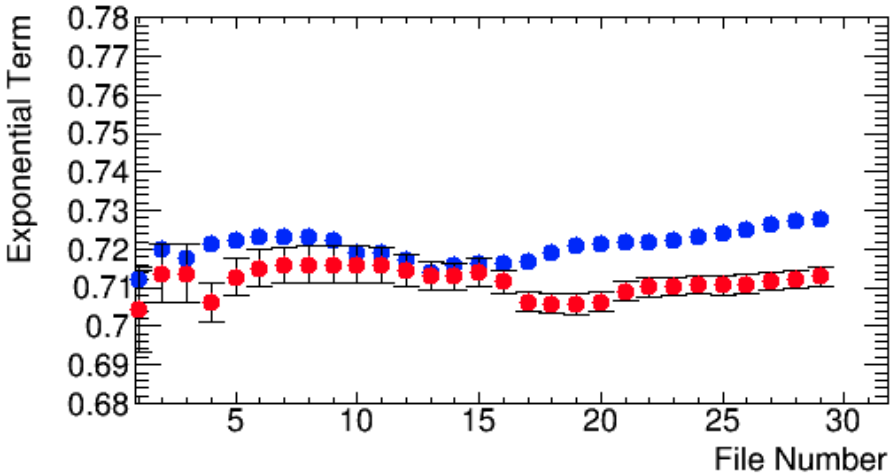


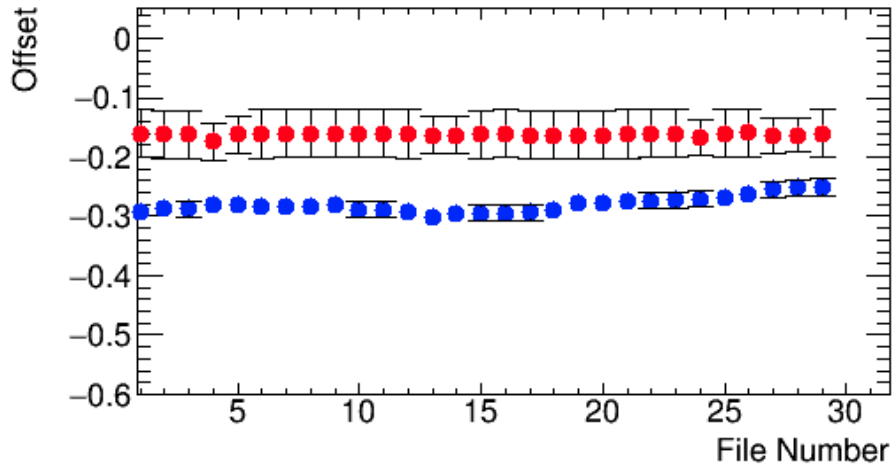
Different Ranges – Sum





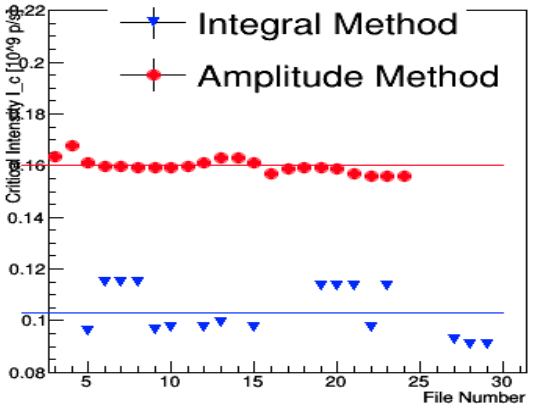
OLD Fits

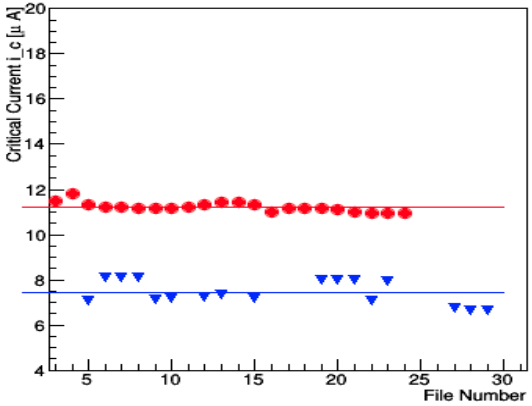


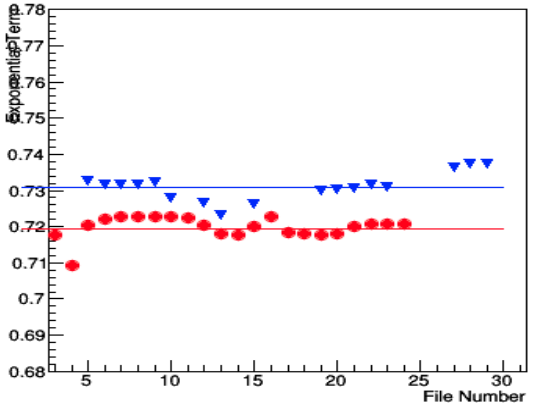


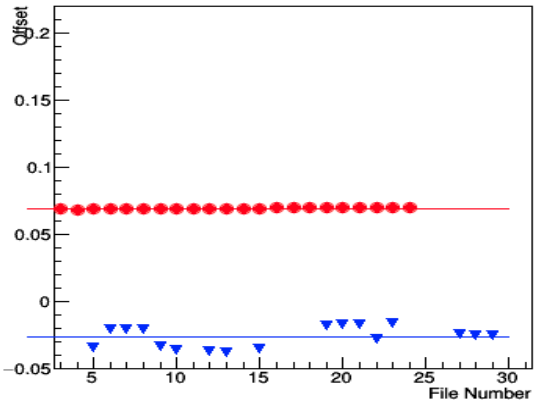
- Old plots for later comparison
- Amplitude Method shows higher critical values and higher errors, but methods show compatible values.

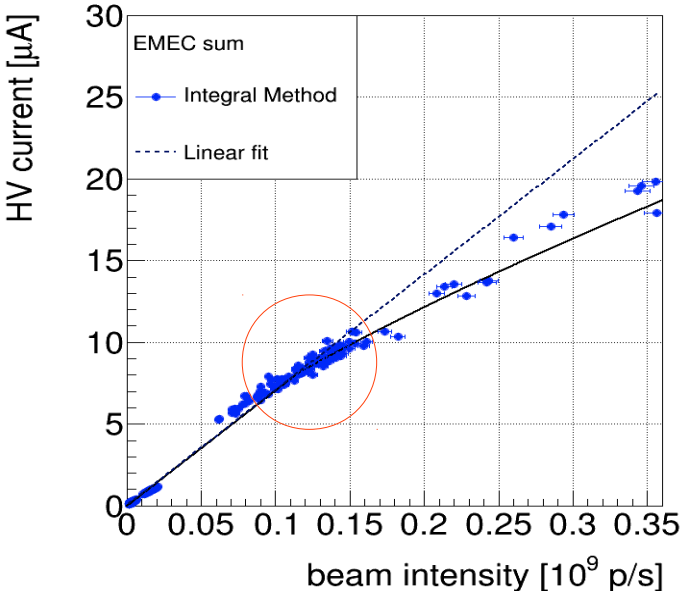
New results for CH factors

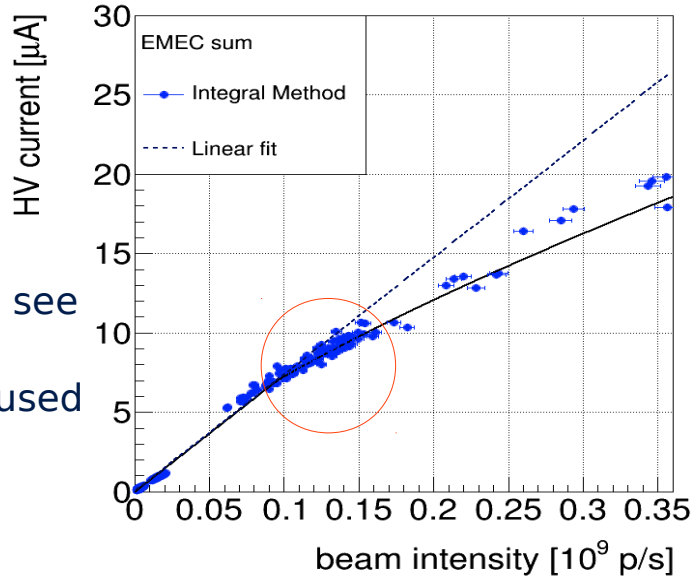






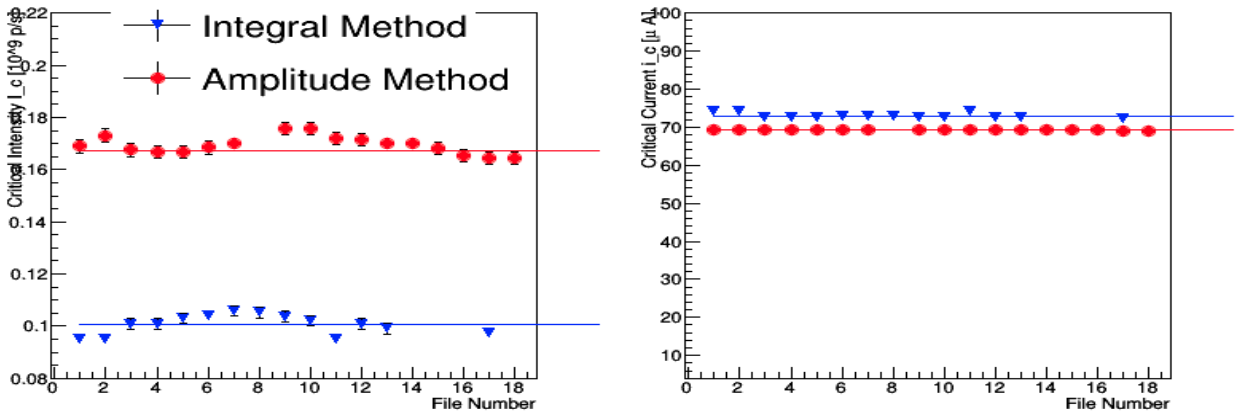


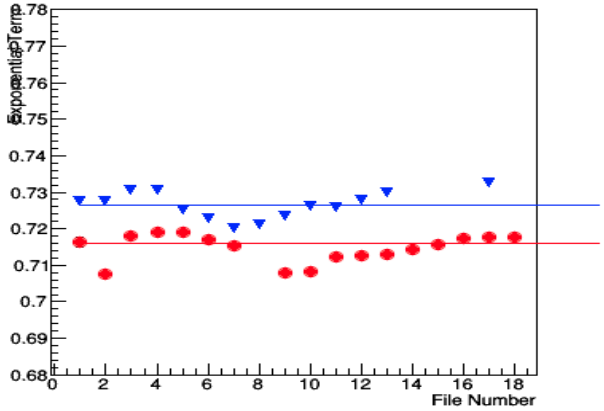


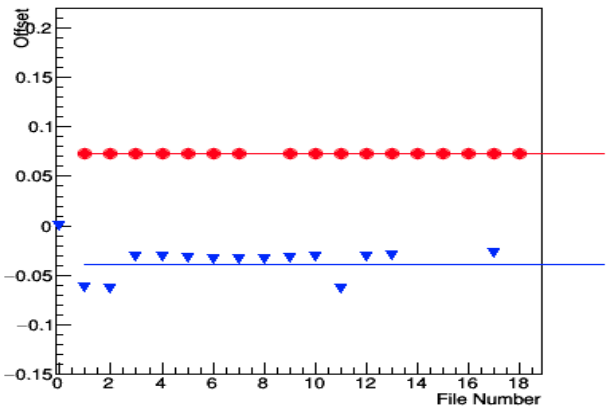


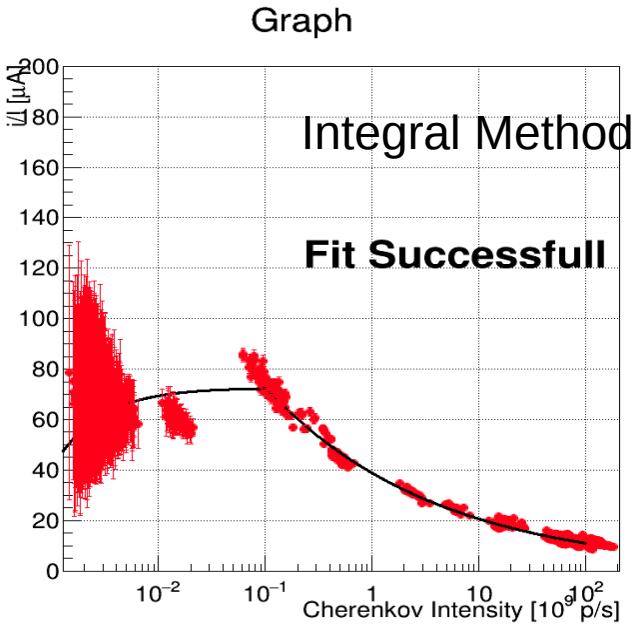
- Integral Method has larger variation for critical values now → see right plots as examples
- Integral method has smaller offset – offset from these fits is used for later subtraction
- Amplitude method showed good stability – values got larger

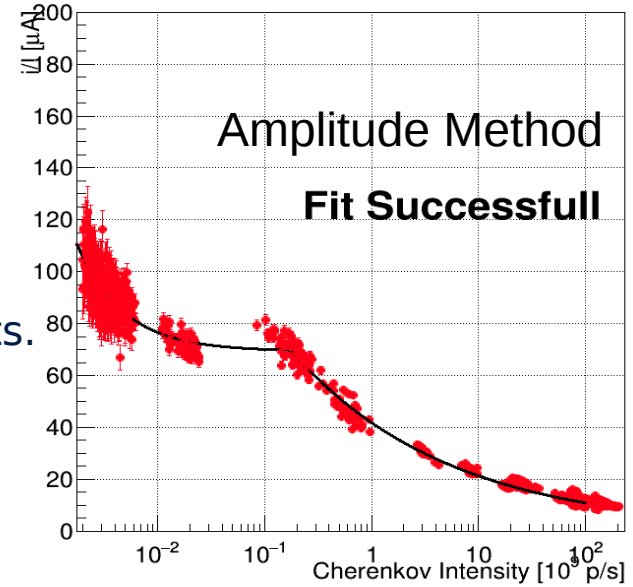
Ratio HV/CH results





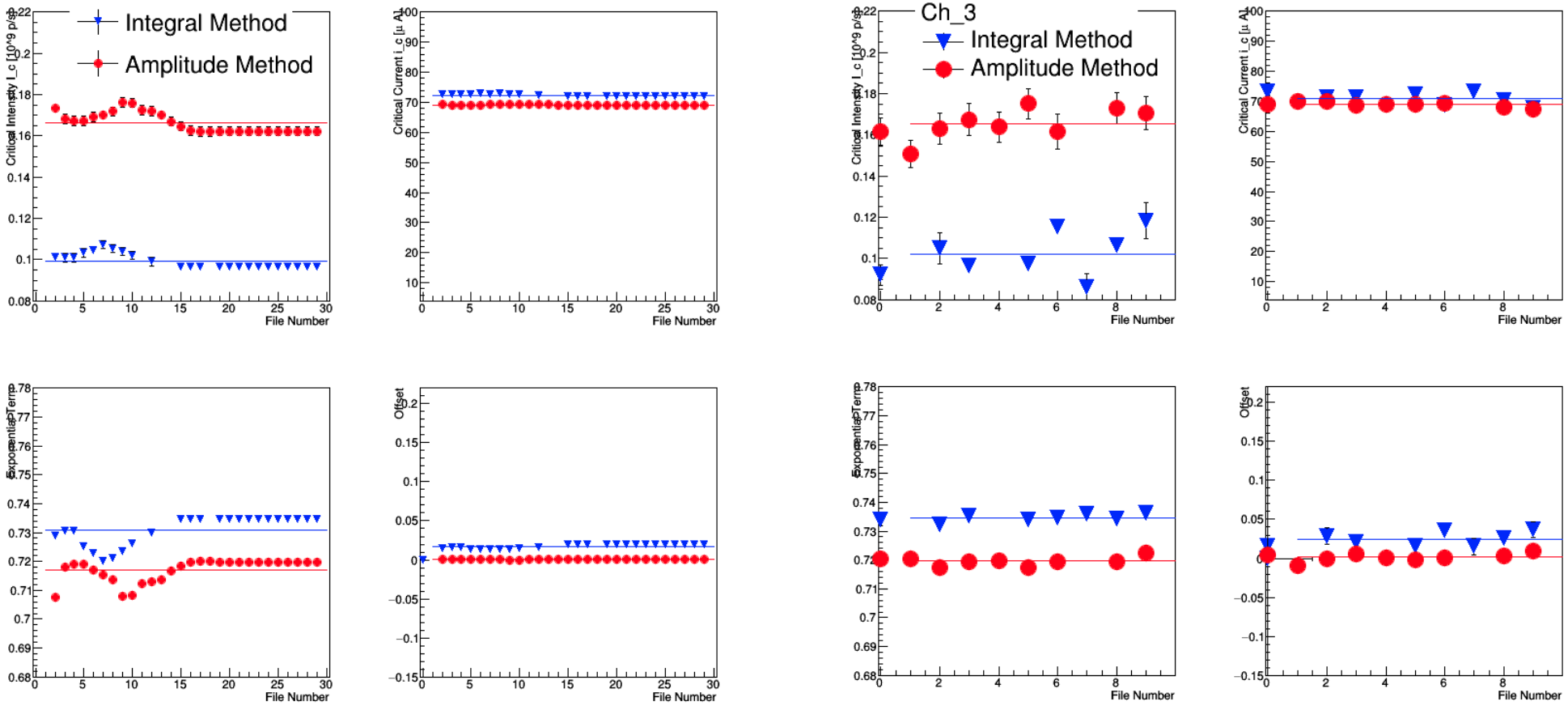






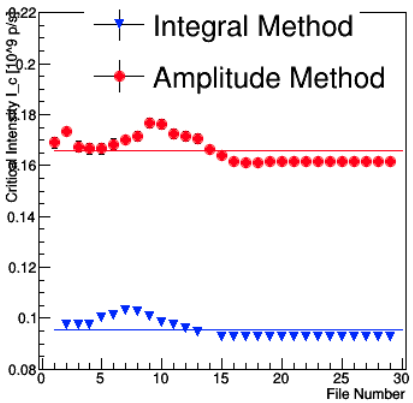
- Offsets are still present and are similar to normal fit results.
- Larger difference in critical intensity without 1098 and after corrections.

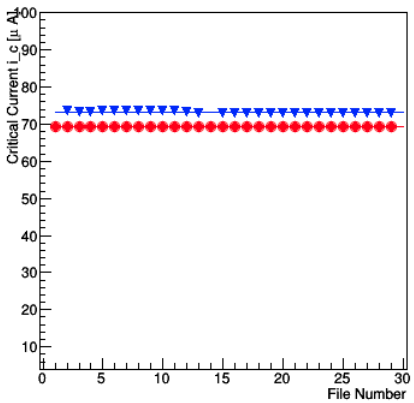
Channel 3 – Ratio Fit - with Offset

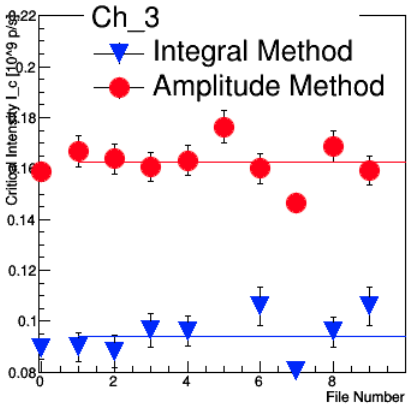


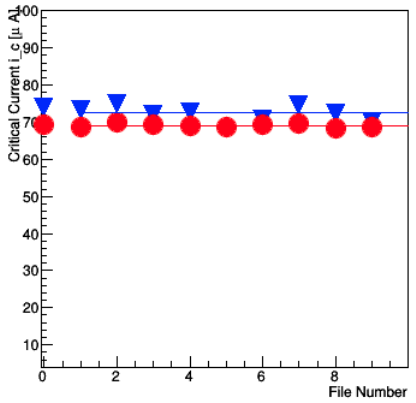
- Now subtract offset and refit:
- Amplitude method shows low offset after offset subtraction, integral method also has reduces offset (could be due to unstable fit results)

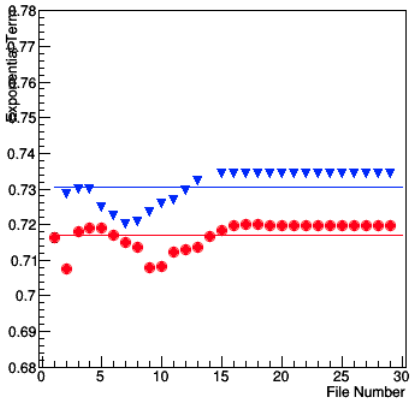
Channel 3 – Ratio Fit - no Offset

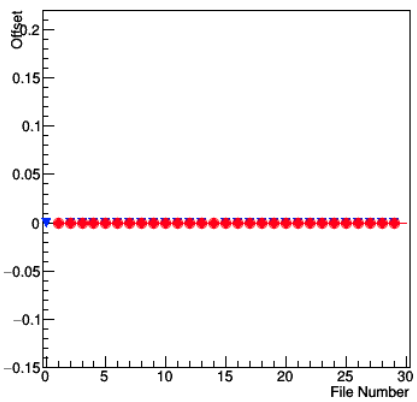


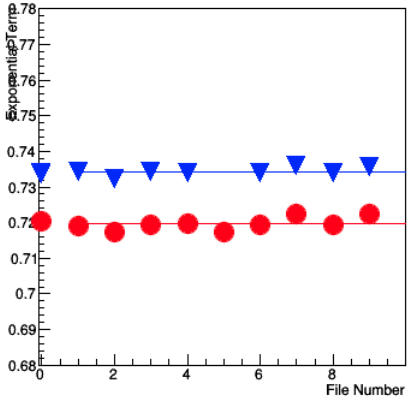


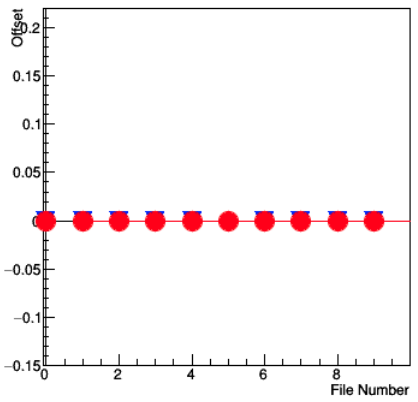






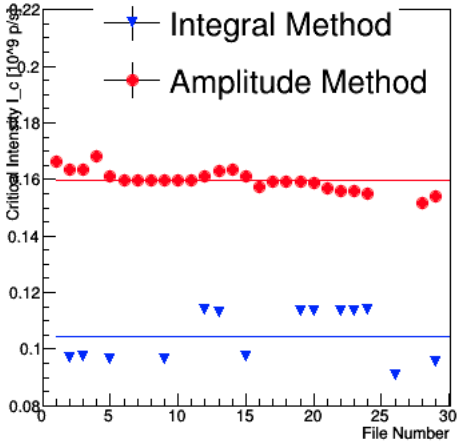


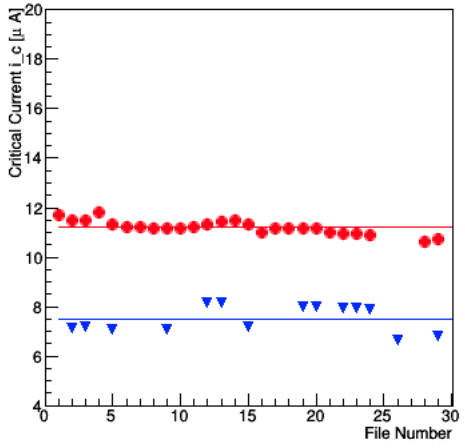


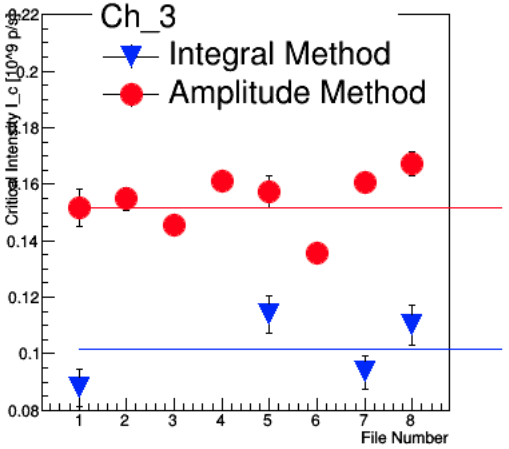


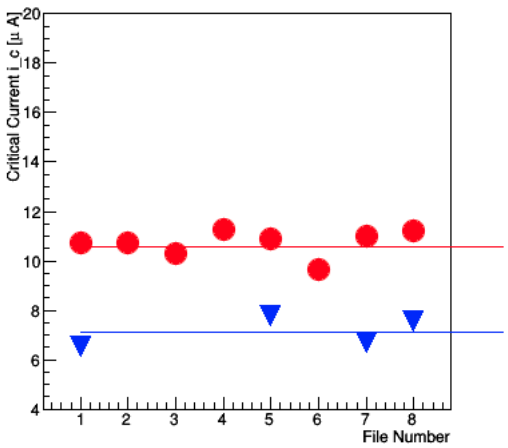
- Results are similar
- Fits are stable and only few did not fit correctly

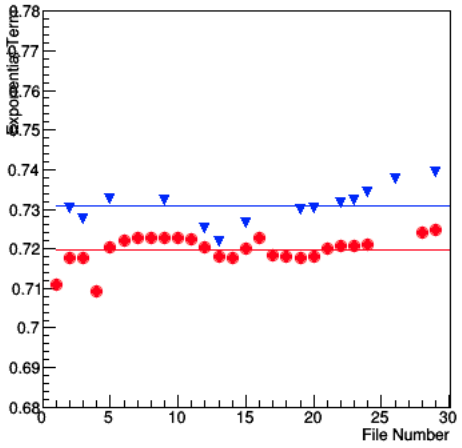
Channel 3 – Normal Fit - with Offset

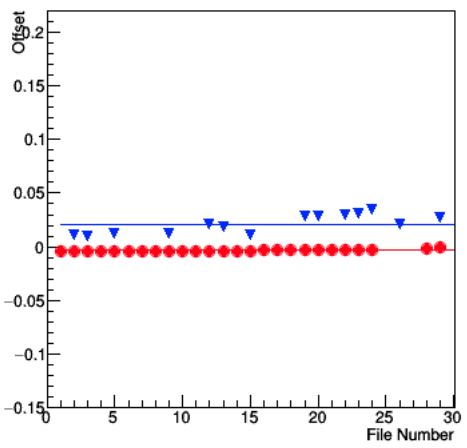


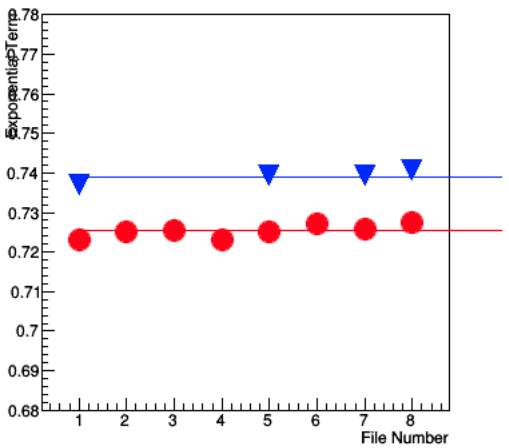


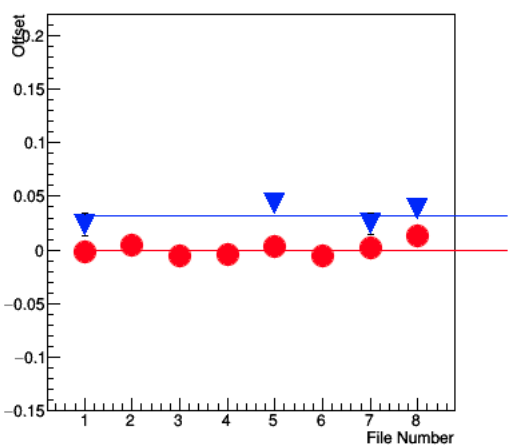






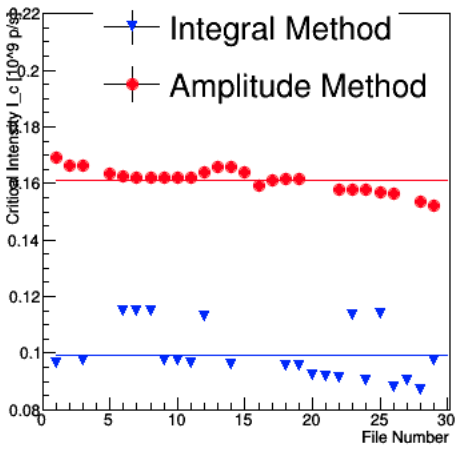


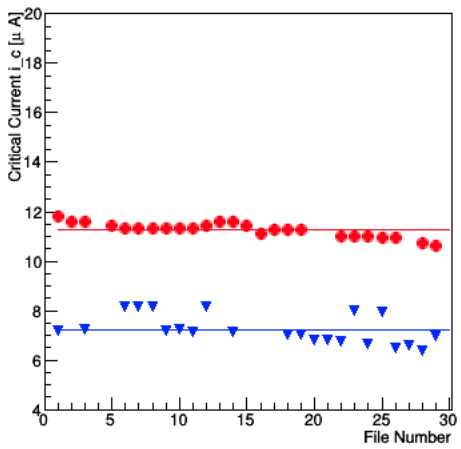


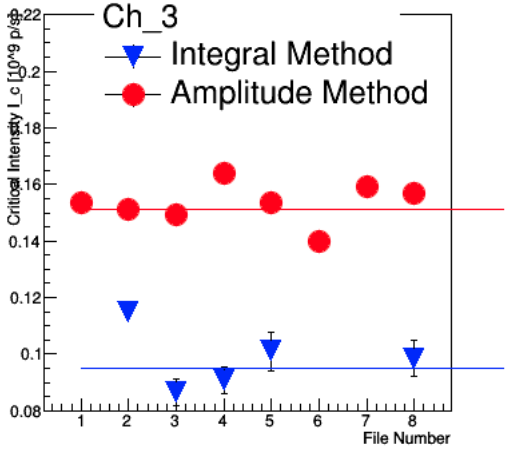


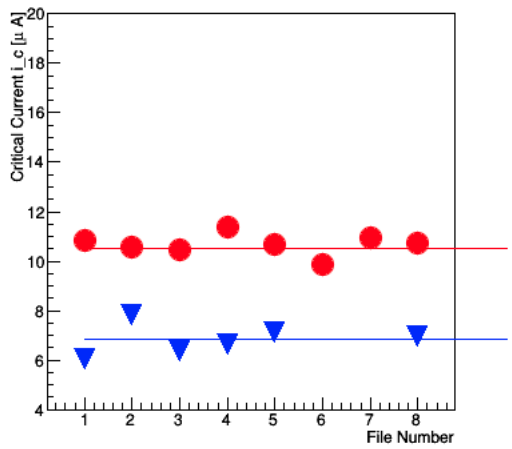
- Integral method is less stable as also showed before – the critical region is not well described by the data

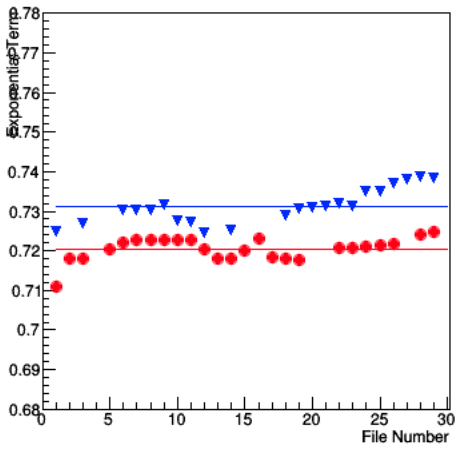
Channel 3 – Normal Fit - no Offset

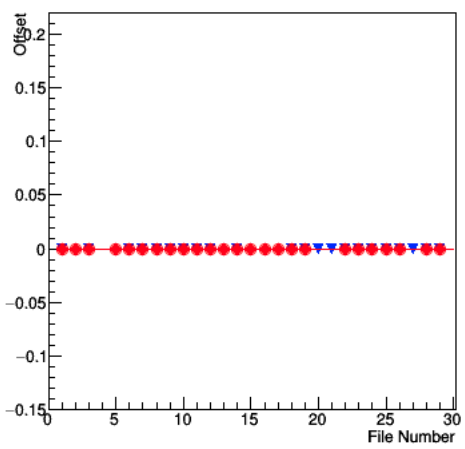


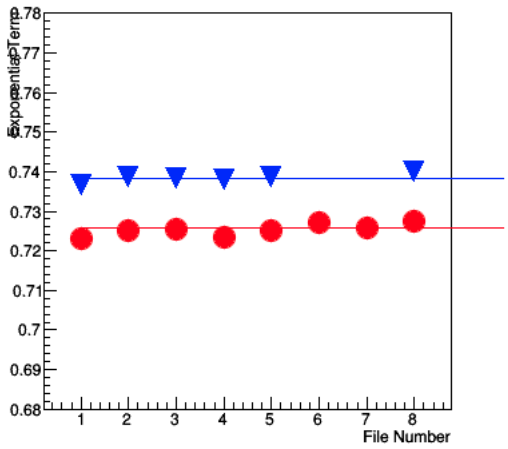


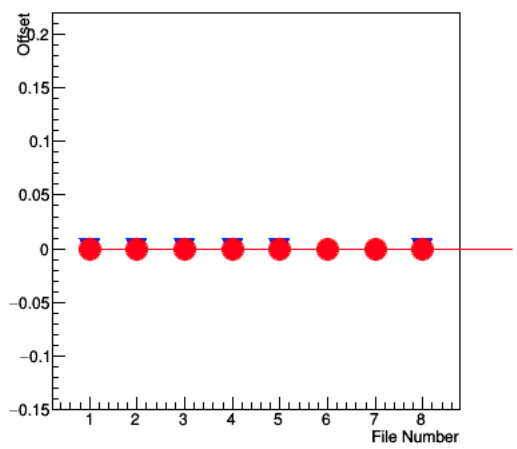








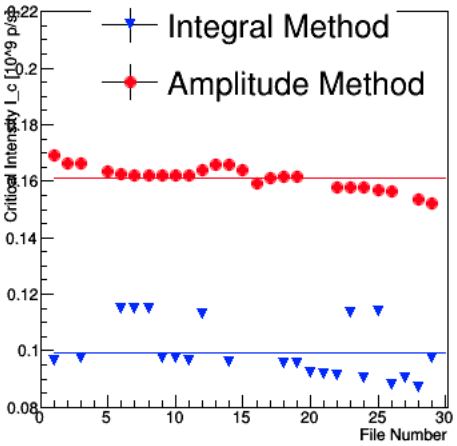


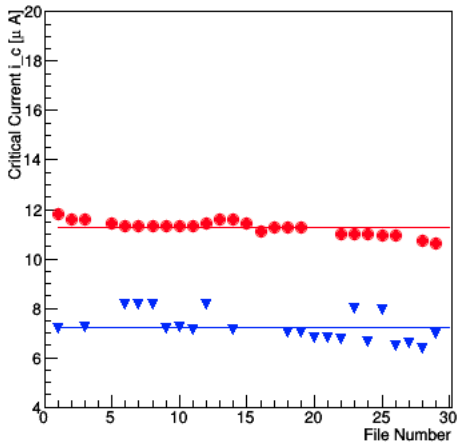


- More stable integral method fit, but the jumps in the critical values are observed

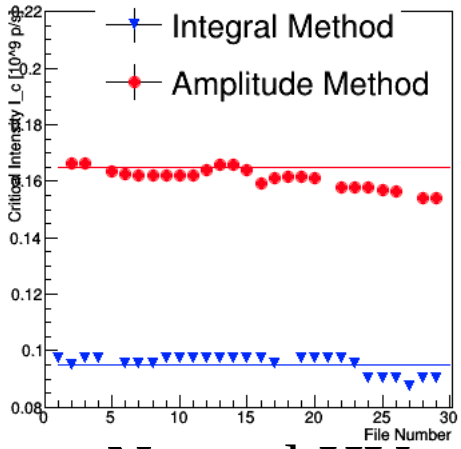
Comparing two fits

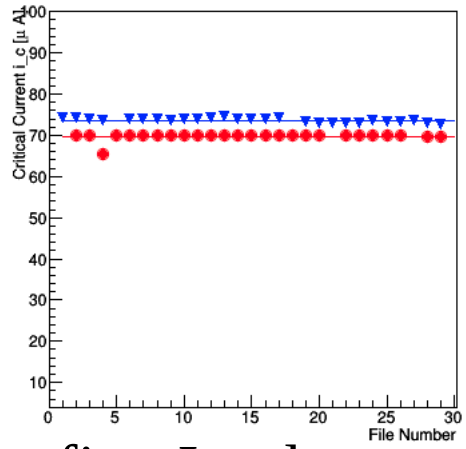
- Included fit with slope for normal fit (instead of Ic, ic → Ic, slope → Critical intensity got more stable)
- Also included changing initial values for refitting (and larger loop for refitting)
- Critical intensity increased slightly – but one outlier is also higher



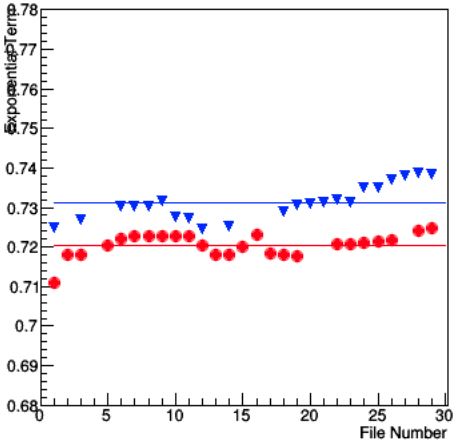


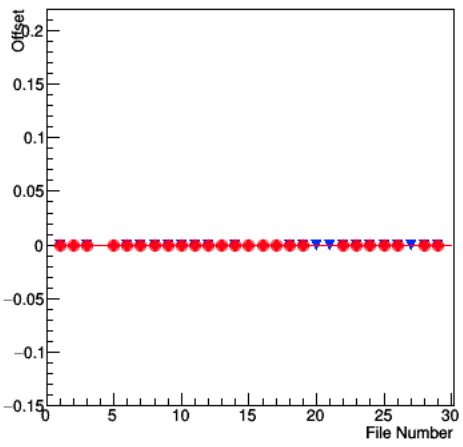
Normal fit – Ic,ic

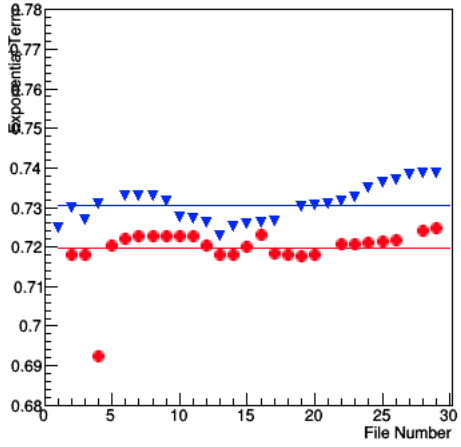


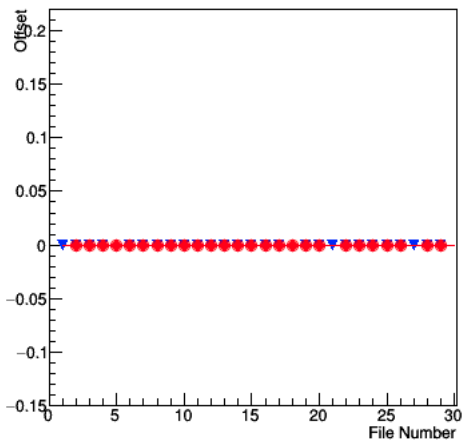


Normal HV curve fit – Ic, slope







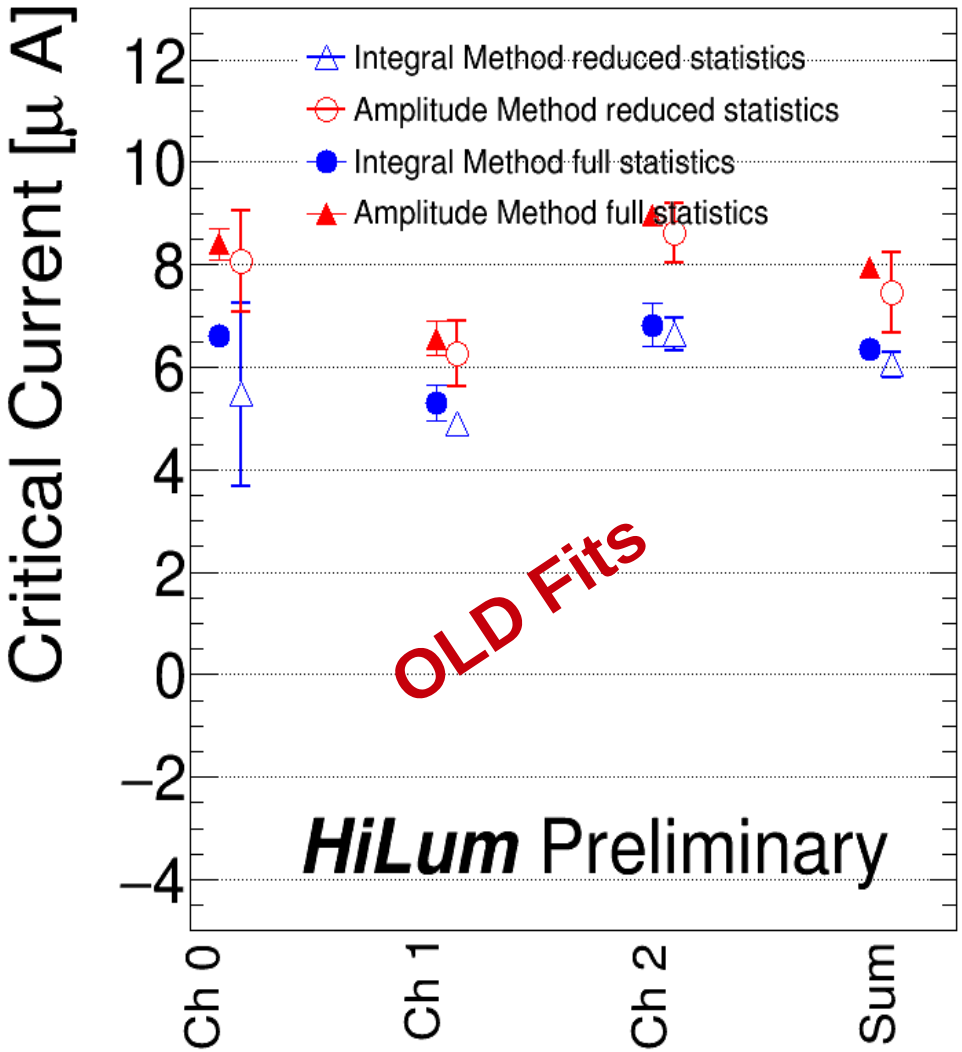


Part III

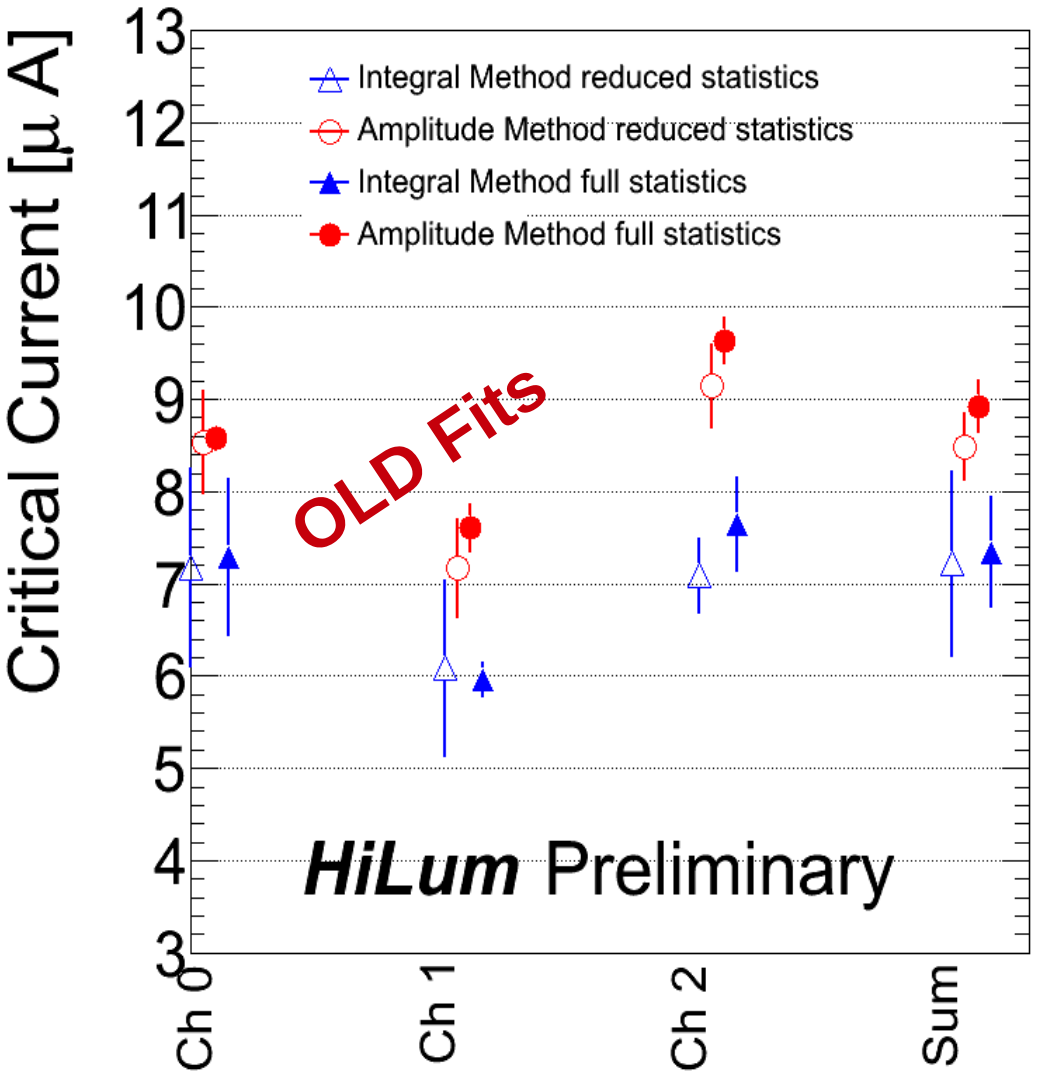
	Method	Fit Method	Offset	values	error
Intensity c	Integral	Normal	yes	1.04569	0.0895707
Intensity c	Amplitude	Normal	yes	1.59713	0.0358228
power	Integral	Normal	yes	0.730766	0.00446178
power	Amplitude	Normal	yes	0.719792	0.00354529
Intensity c	Integral	Ratio	yes	0.991842	0.0344422
Intensity c	Amplitude	Ratio	yes	1.66281	0.0472418
power	Integral	Ratio	yes	0.730919	0.00495019
power	Amplitude	Ratio	yes	0.717063	0.00392685
Intensity c	Integral	Normal	no	0.992368	0.0953892
Intensity c	Amplitude	Normal	no	1.6133	0.0402491
power	Integral	Normal	no	0.73108	0.00424034
power	Amplitude	Normal	no	0.720454	0.00286127
Intensity c	Integral	Ratio	no	0.953449	0.0353039
Intensity c	Amplitude	Ratio	no	1.65829	0.0500069
power	Integral	Ratio	no	0.730566	0.00468233
power	Amplitude	Ratio	no	0.717023	0.00386666

Final results for 3 channels for different methods are shown in the same plots

Results of ratio plots

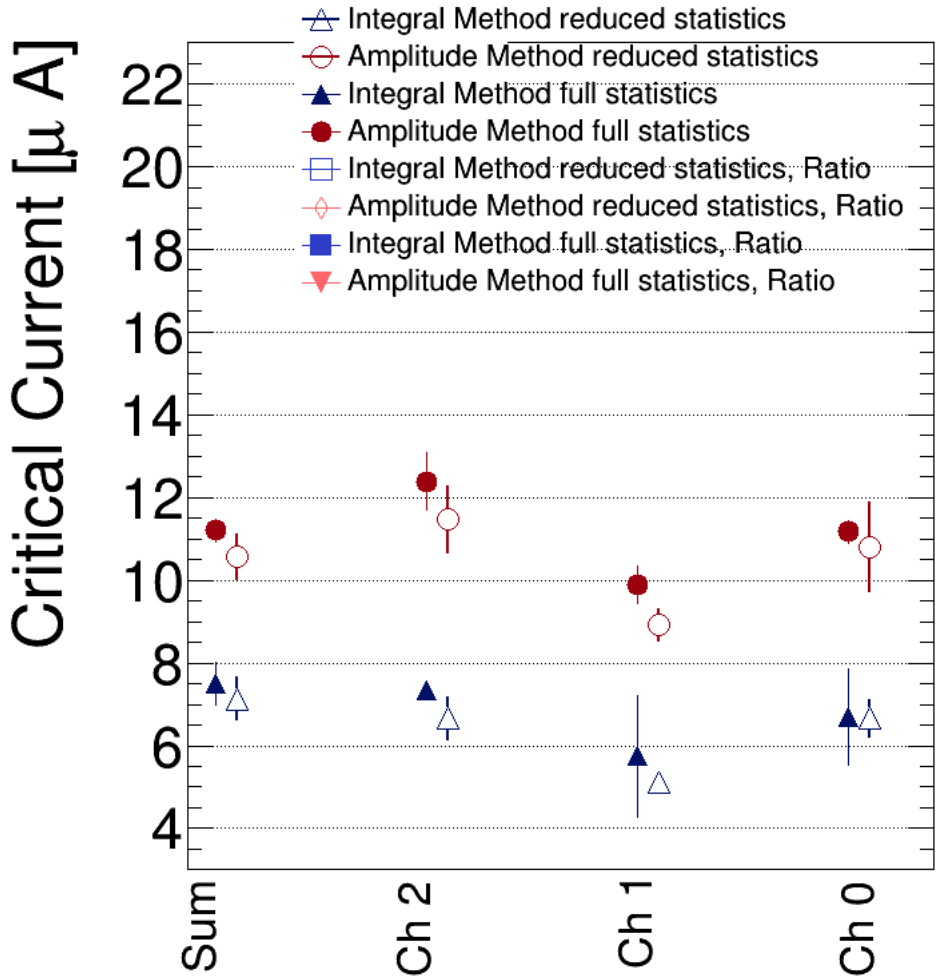


Ratio HV curve

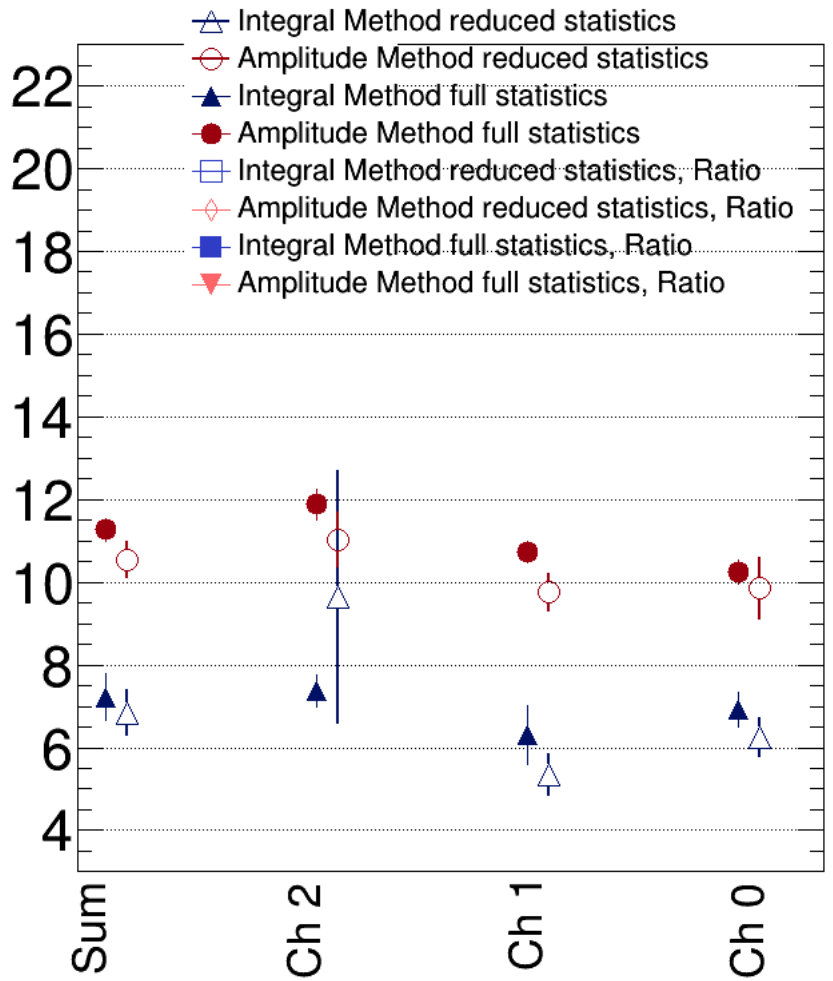


HV Curve

New Results



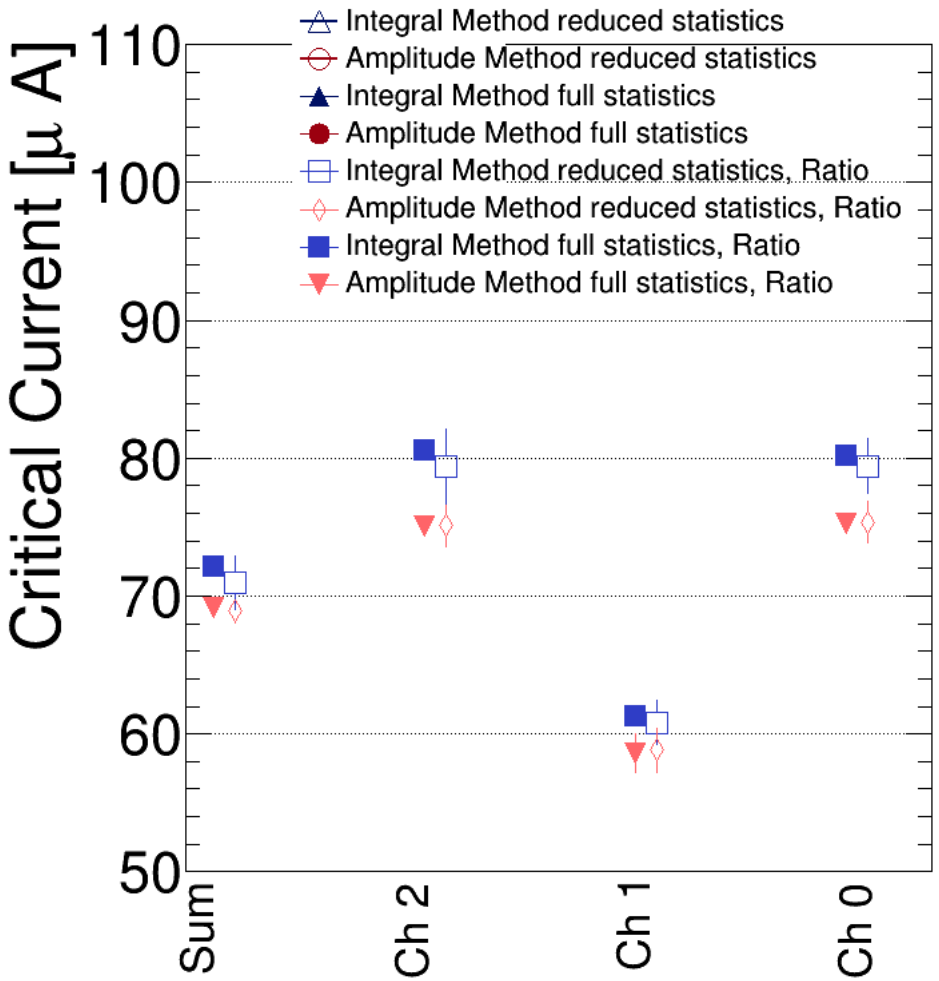
With Offset in the fit



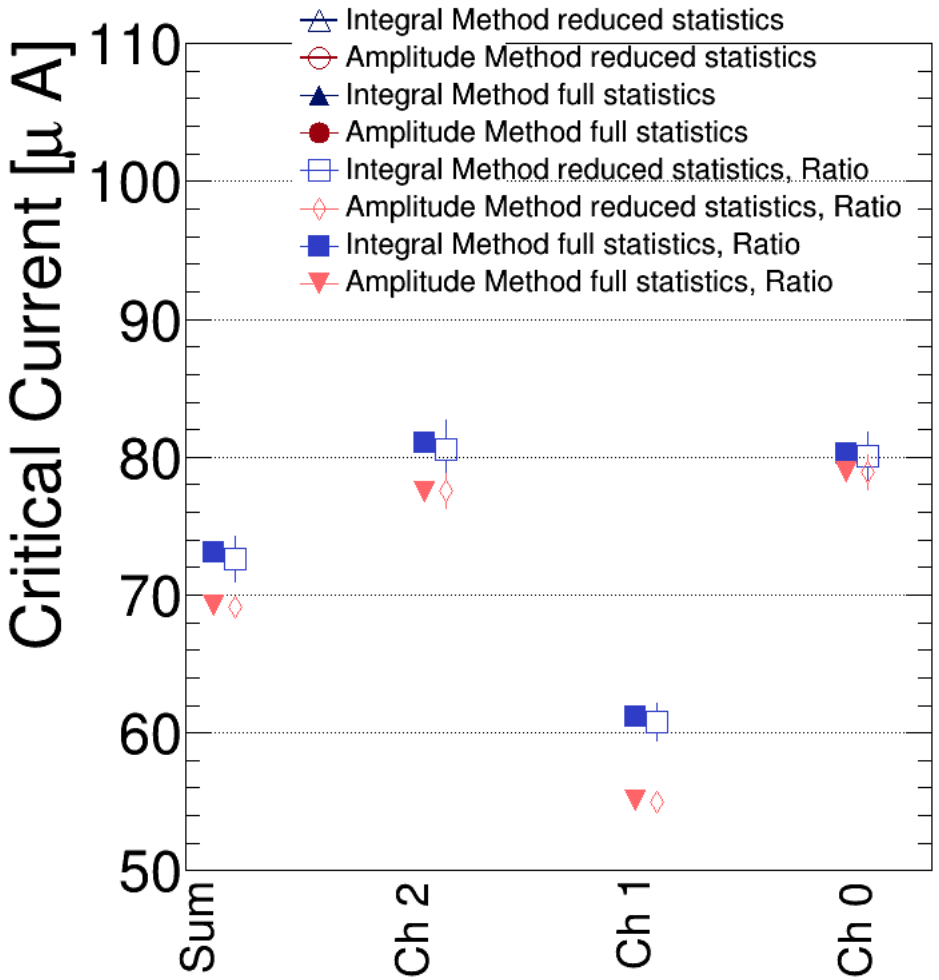
No Offset in the fit

Both methods got increased values of critical current after the low intensities corrections, amplitude method has larger increase

New Results

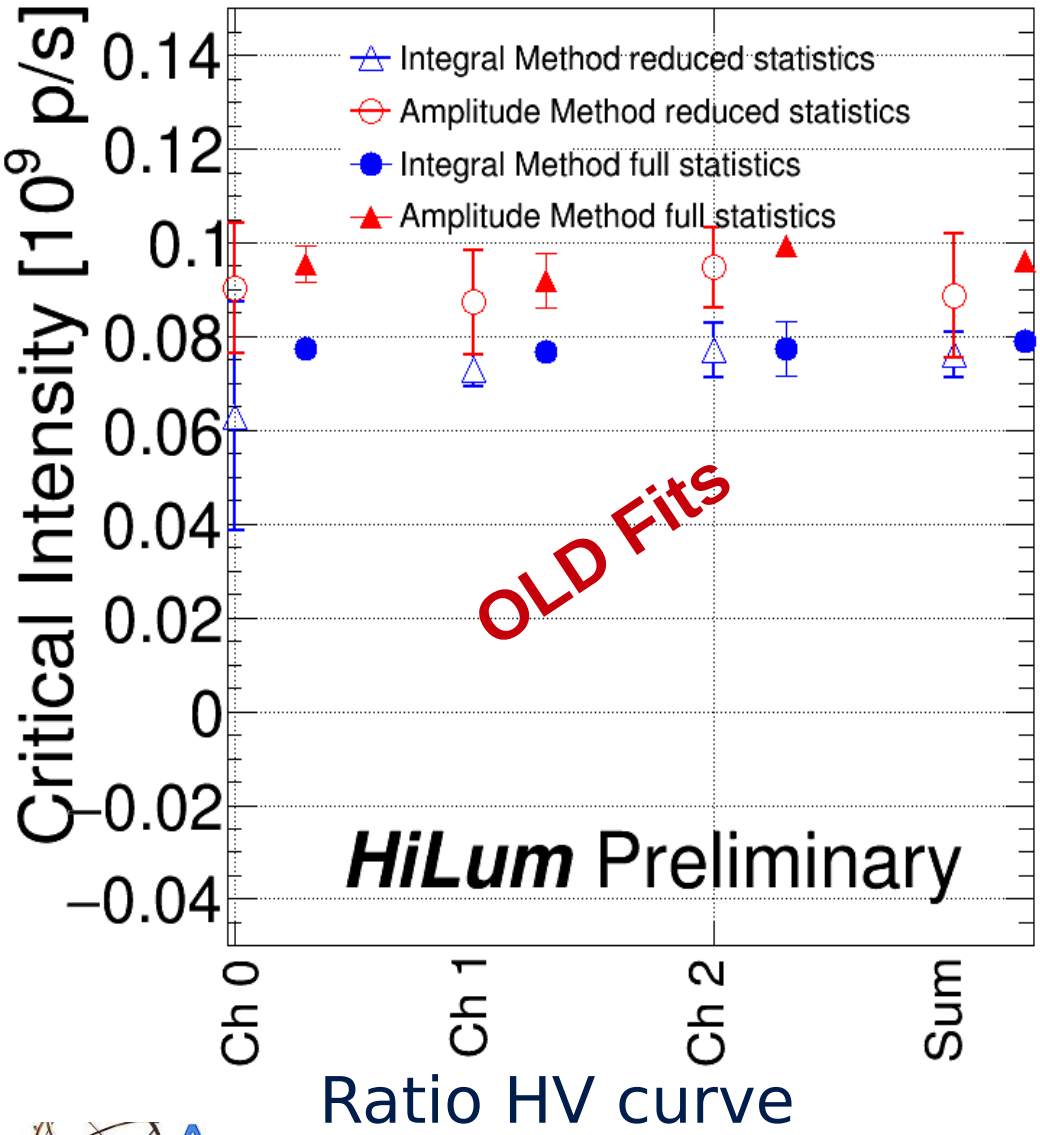


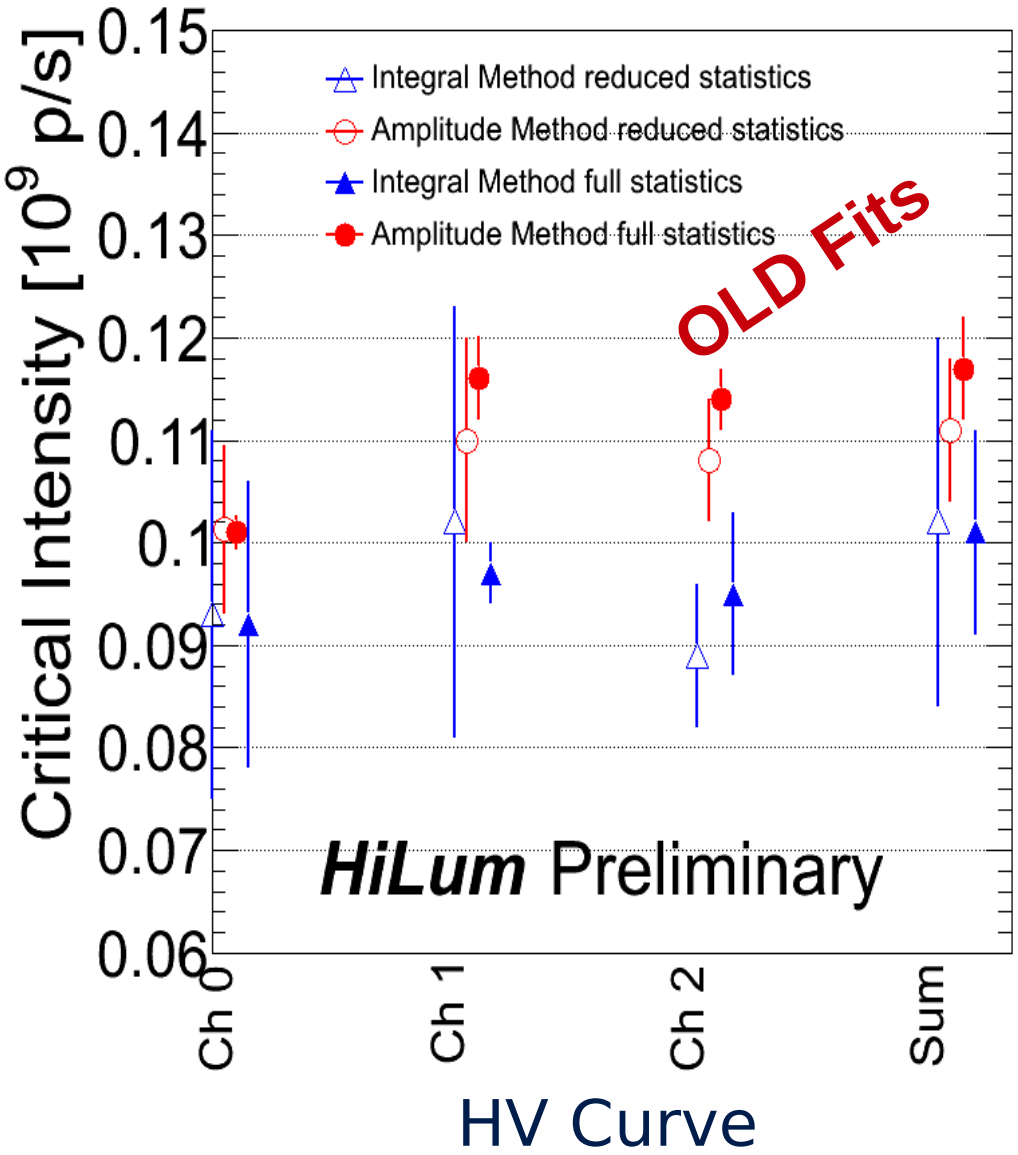
With Offset in the fit



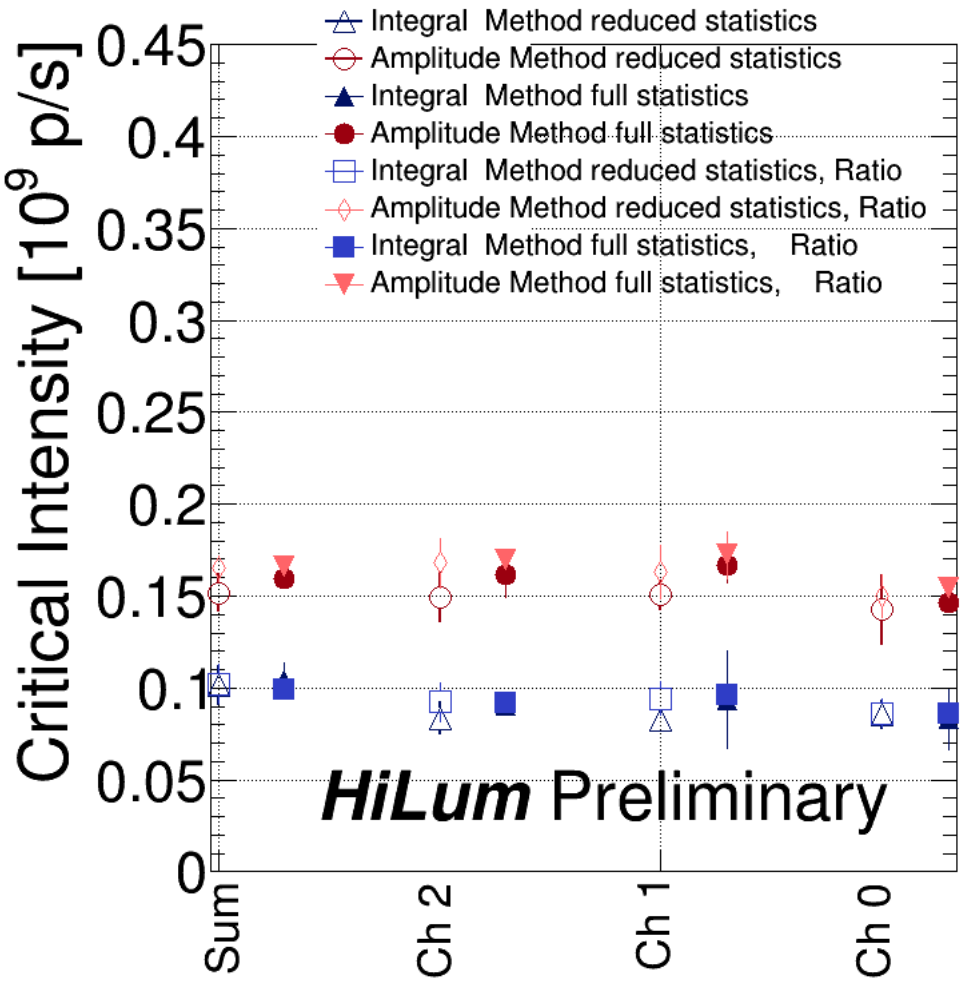
No Offset in the fit

Previous results for HV curve fit

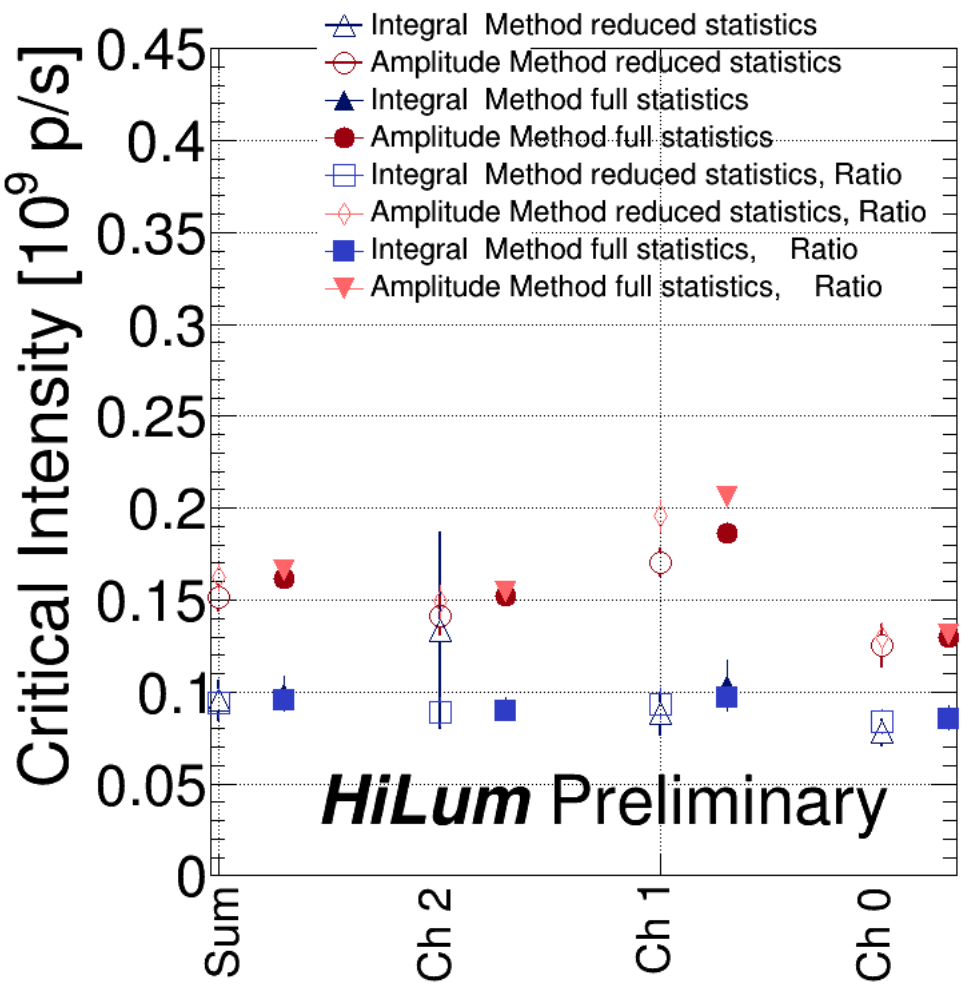




New Results



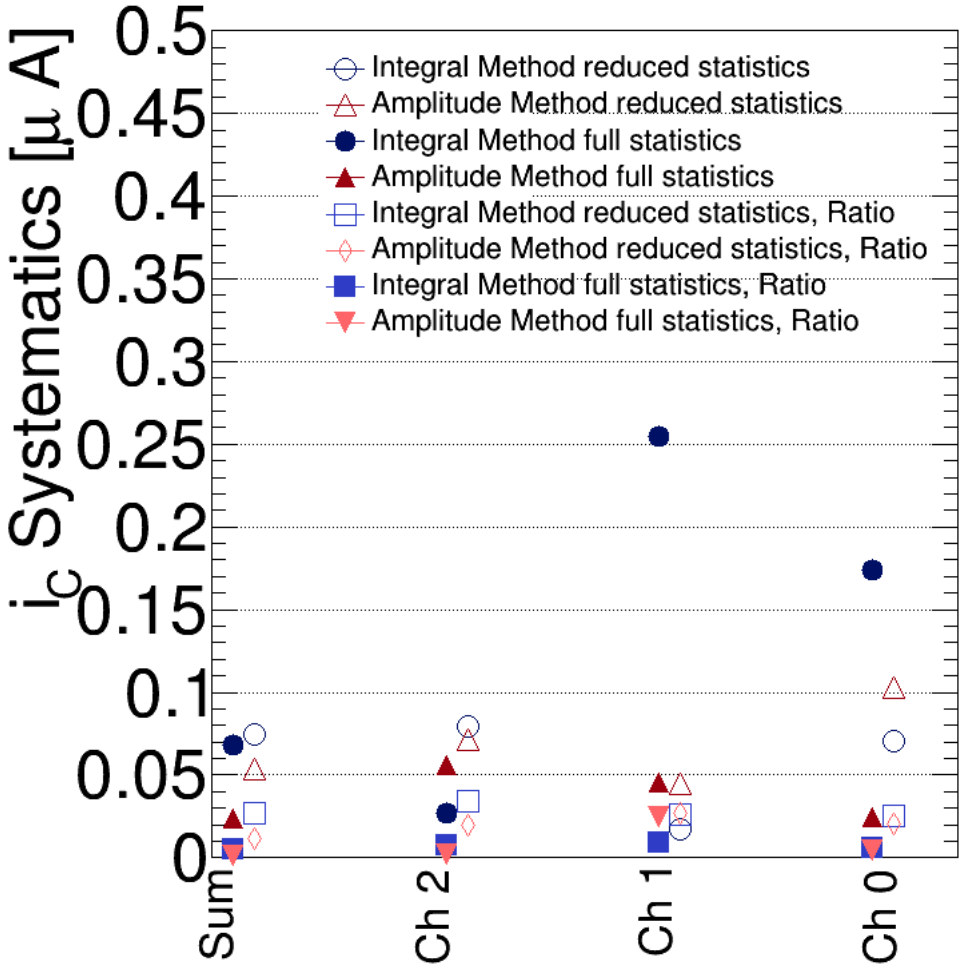
With Offset in the fit

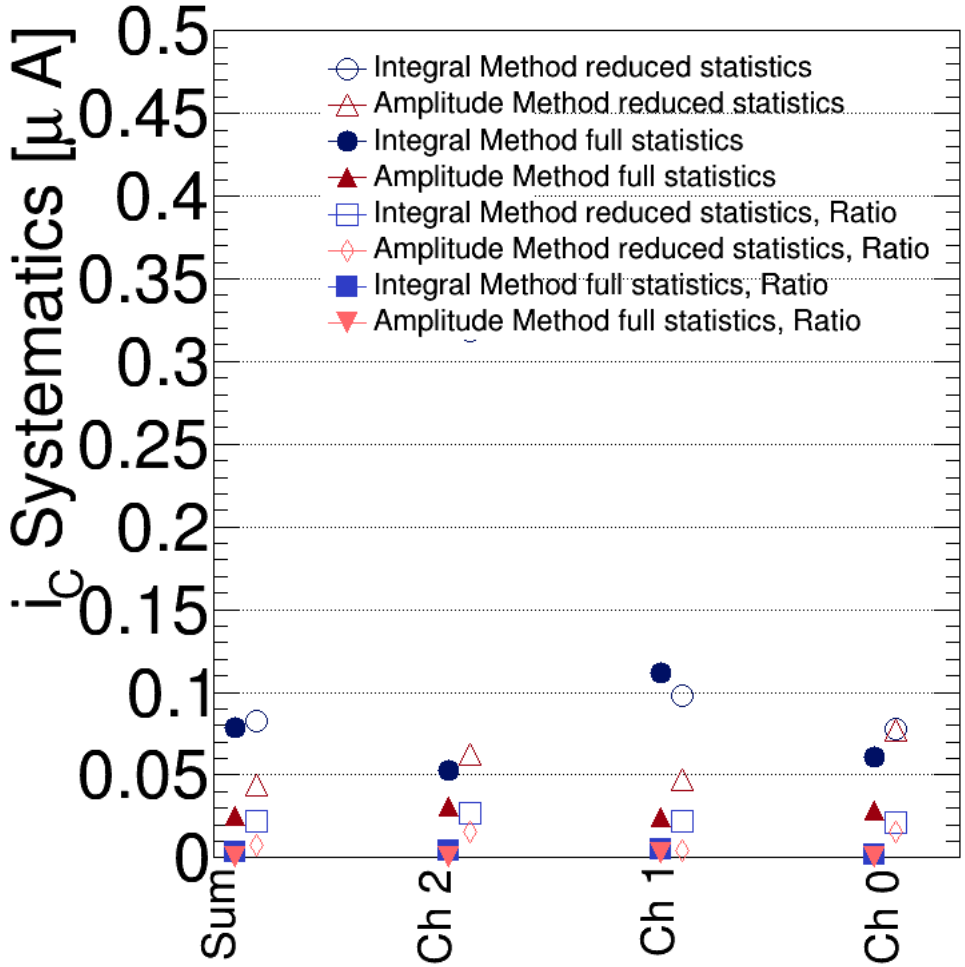


No Offset in the fit

Critical intensity got larger and offset included or not - does not change the results

New Results





- With Offset in the fit
- Without offset systematics gets smaller and always below 10%

No Offset in the fit

Conclusions

- Few runs were checked and run 1098 was excluded – cleaned the critical range
- Runs 1109-1111 were corrected and showed good linearity at low intensities
- Two types of fits used – with offset and without offset
- For two types of curves – normal and ratio curves
- Compared thinned data and the different ranges
- New HV vs Cherenkov curves are shown – also the ratio plot – offset was still corrected, but is still observed in the final fits – but for the final results fits without offset were used as results showed to be consistent
- Amplitude method showed increase in the critical intensity and good stability
- Integral method showed slight increase in the critical intensity
- Final parameters are shown and also values for sum of 3 channels are in the table for the paper

Thank you for your attention