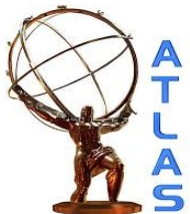


# Update on HV Data Analysis

## Low Intensity Signals Investigations

Olga Novgorodova  
LAr Endcap Hilum Meeting

CERN  
30.11.2015

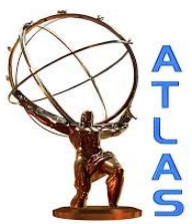


# 1200 V Runs

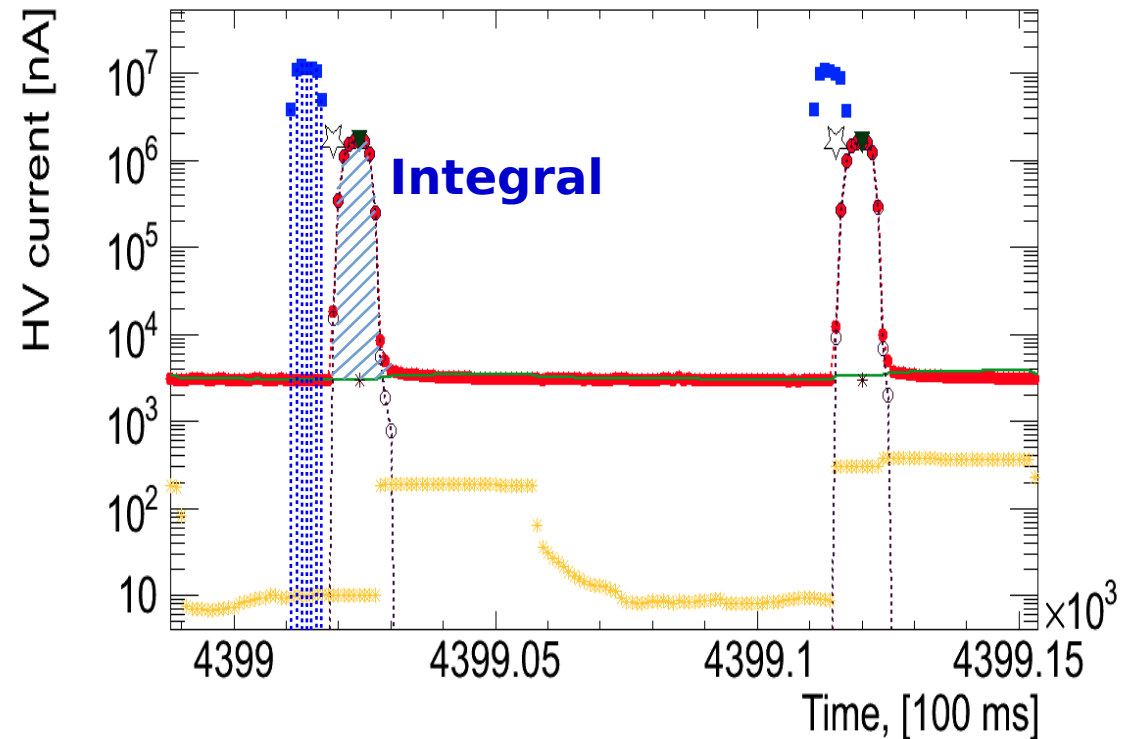
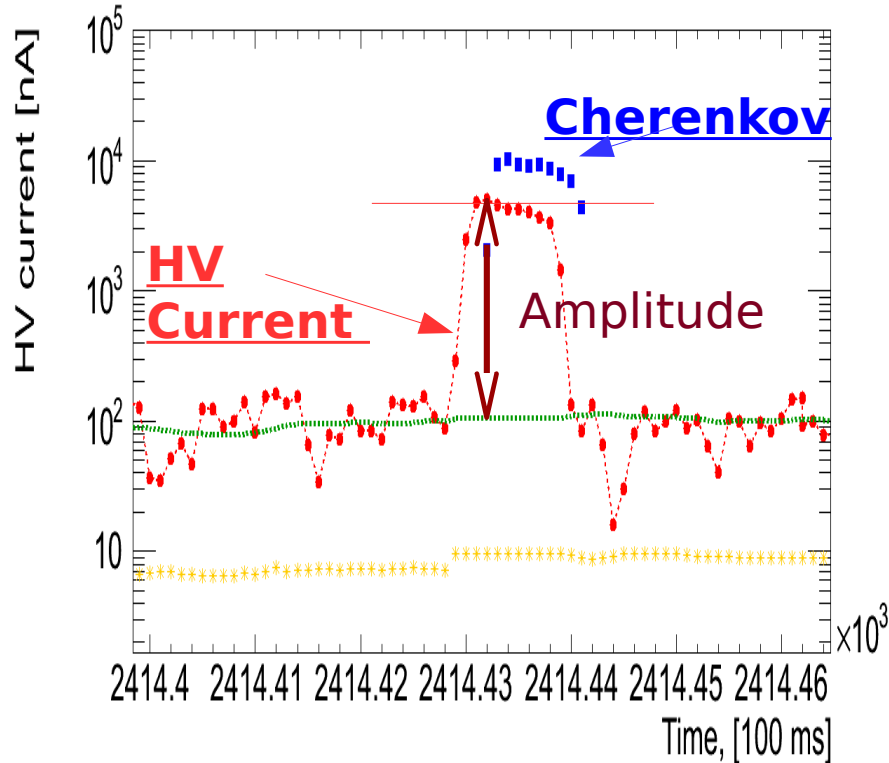
Run	Status	Comments
1152	added	Shift in low intensity
1181	removed	HV adjustments
1186	removed	Only for degradation studies
1108	tried	Gave two entries not in the expectation range - removed
1170	added	Kept (only few entries)
1181	added	Kept – does not contradict with other runs around
1157	removed	Wrong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

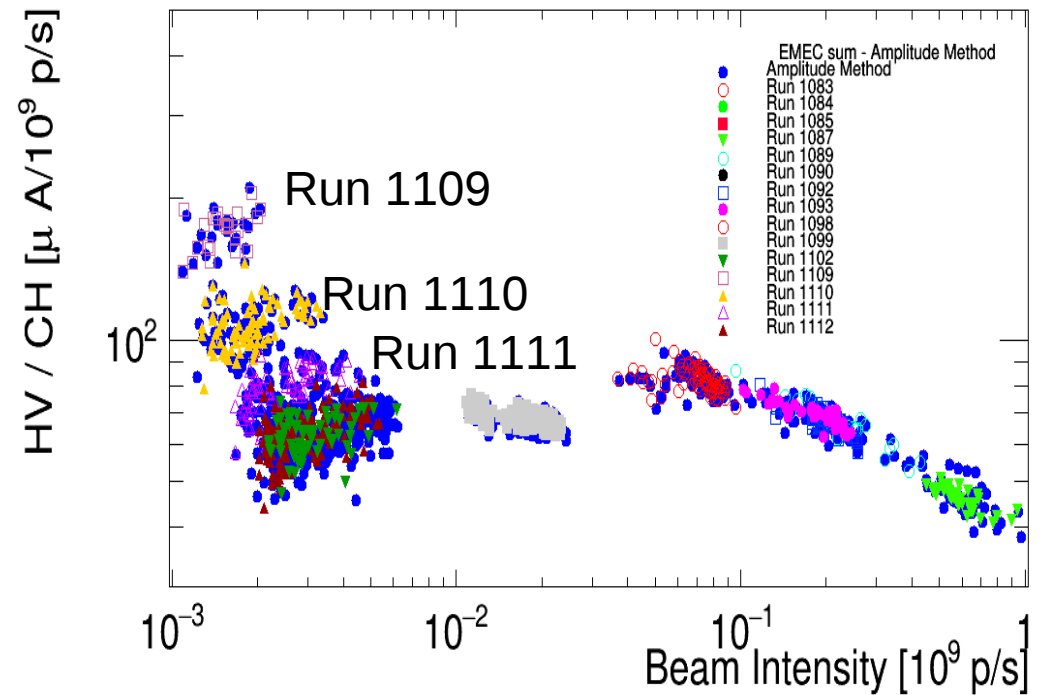
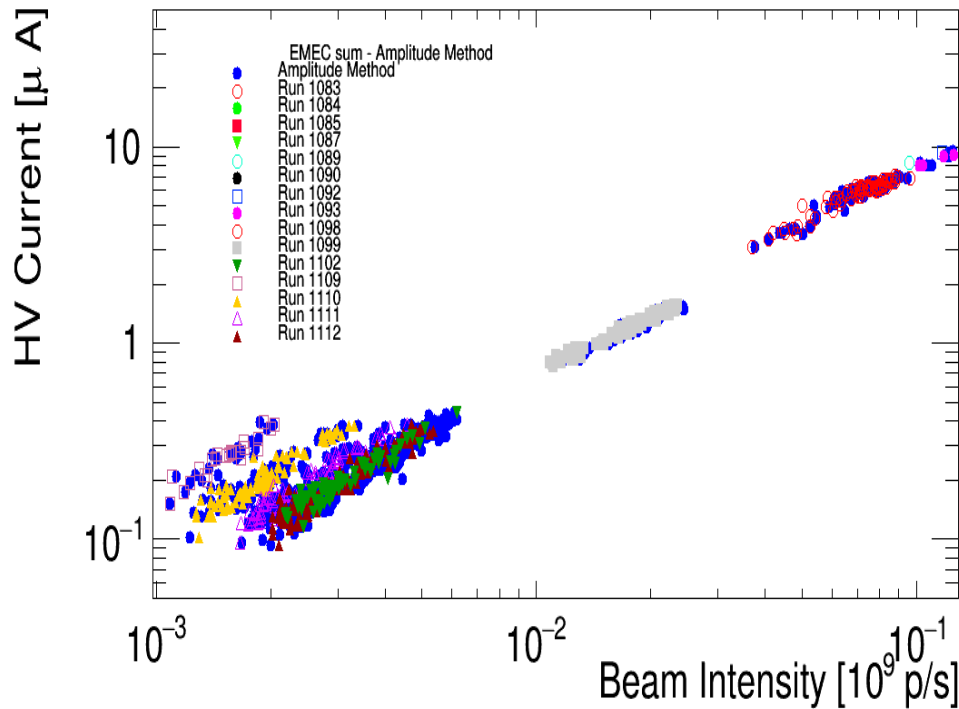


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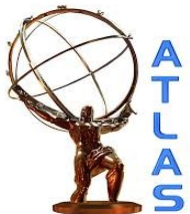
**Filters:** Plateau flatness, Chi square, Correlation factors



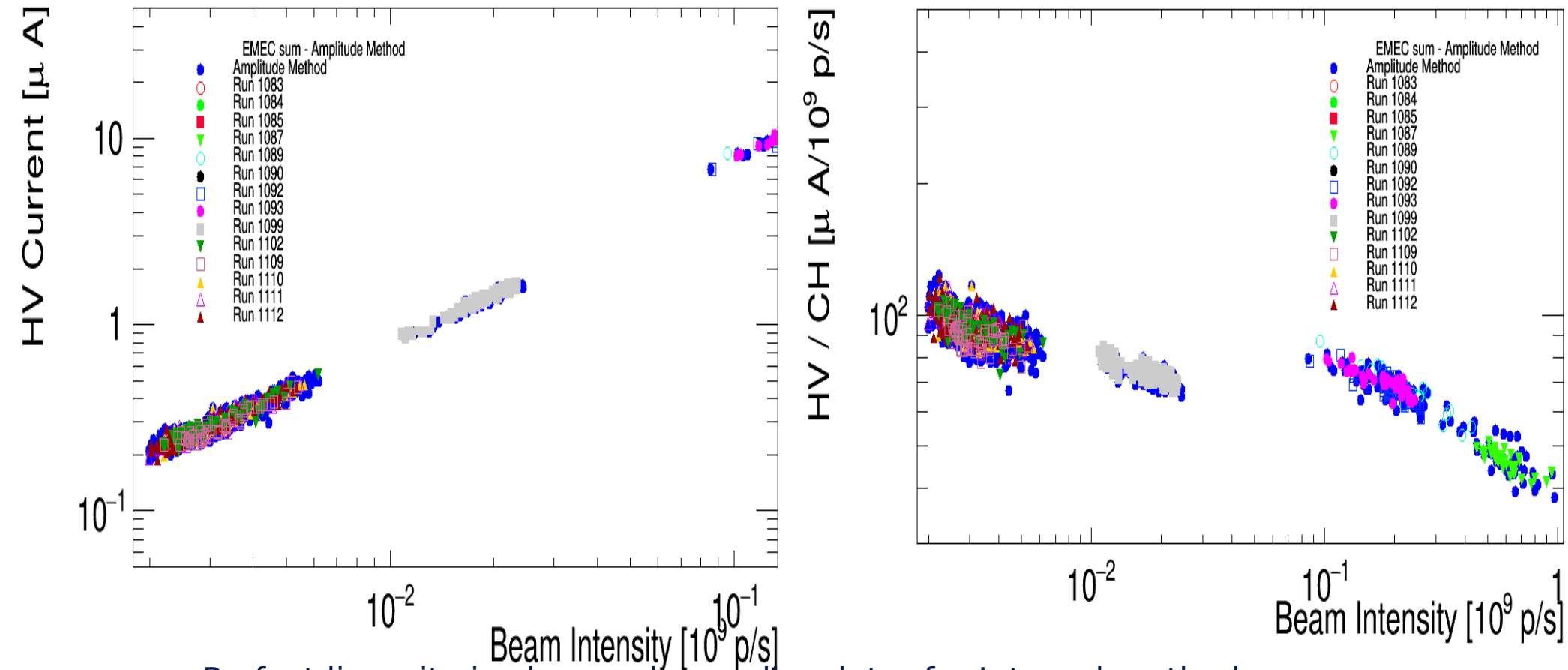
# OLD: Low Intensity HV vs CH



- 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



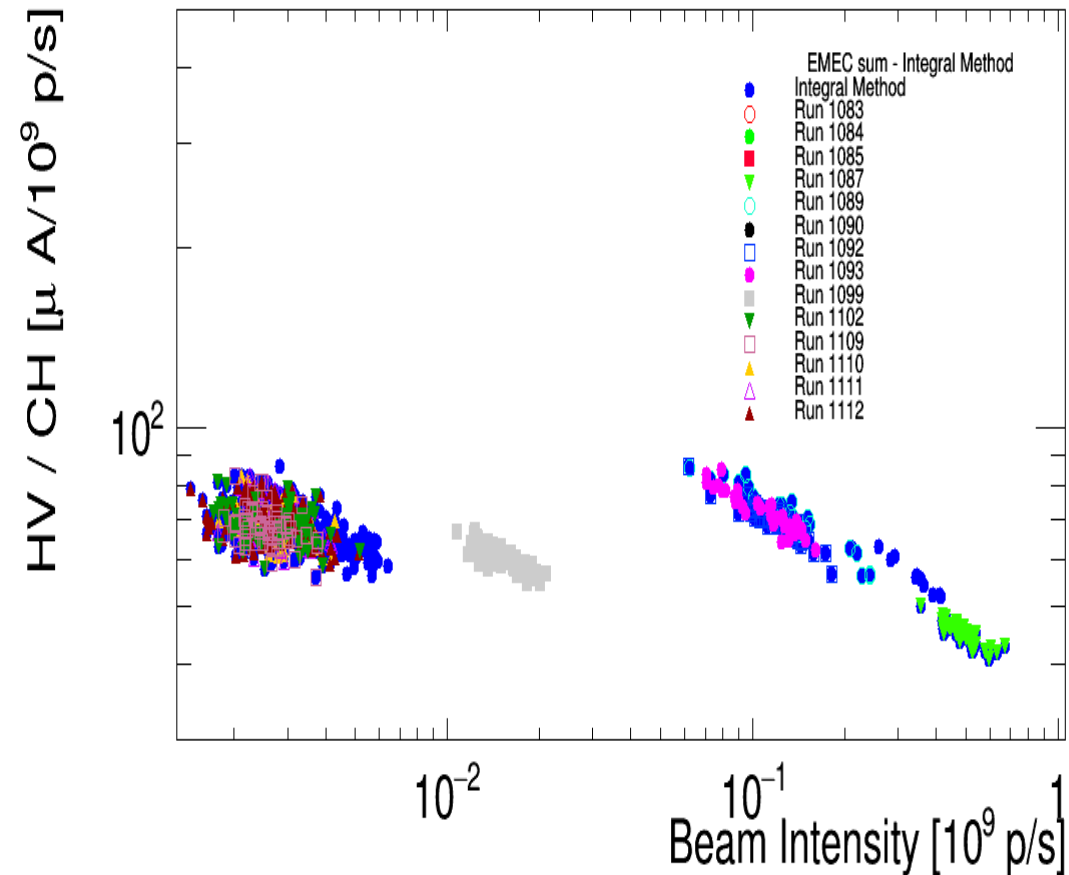
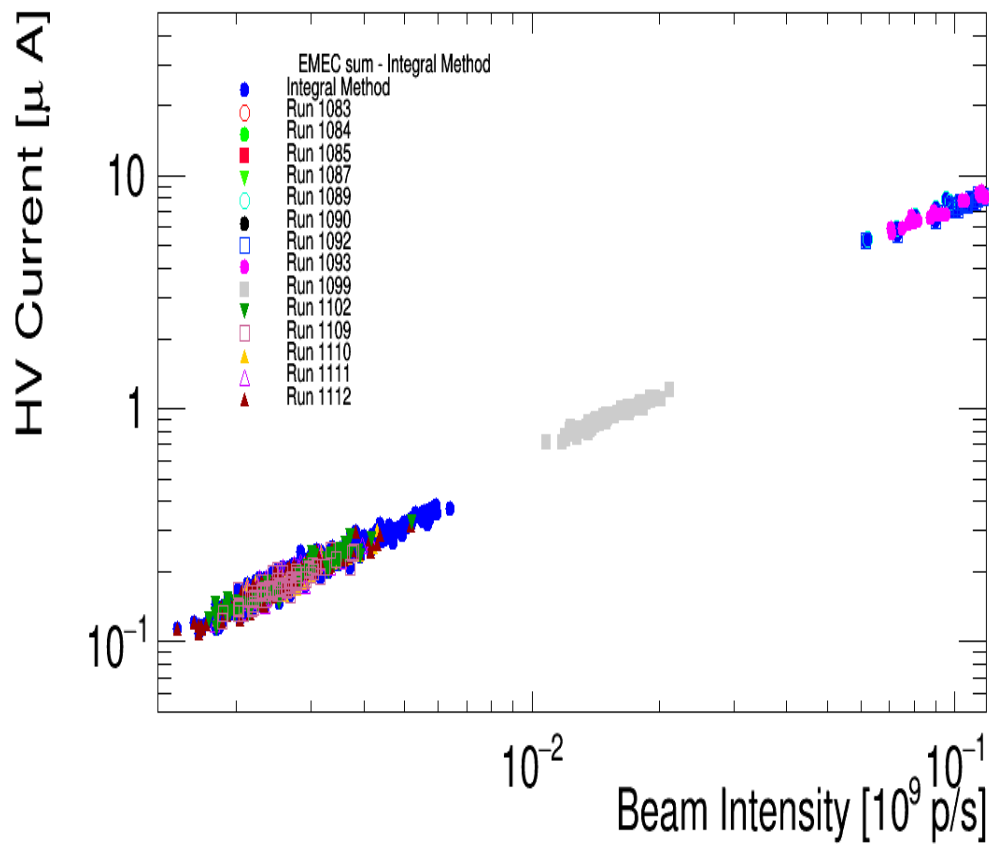
- Perfect linearity is observed as well as later for Integral method
- No offsets were subtracted – see slight increase at low intensities (position, pressure dependence during runs?)
- All added and removed runs fit to the picture well
- Good correspondence between runs to the final plot



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# Integral Method

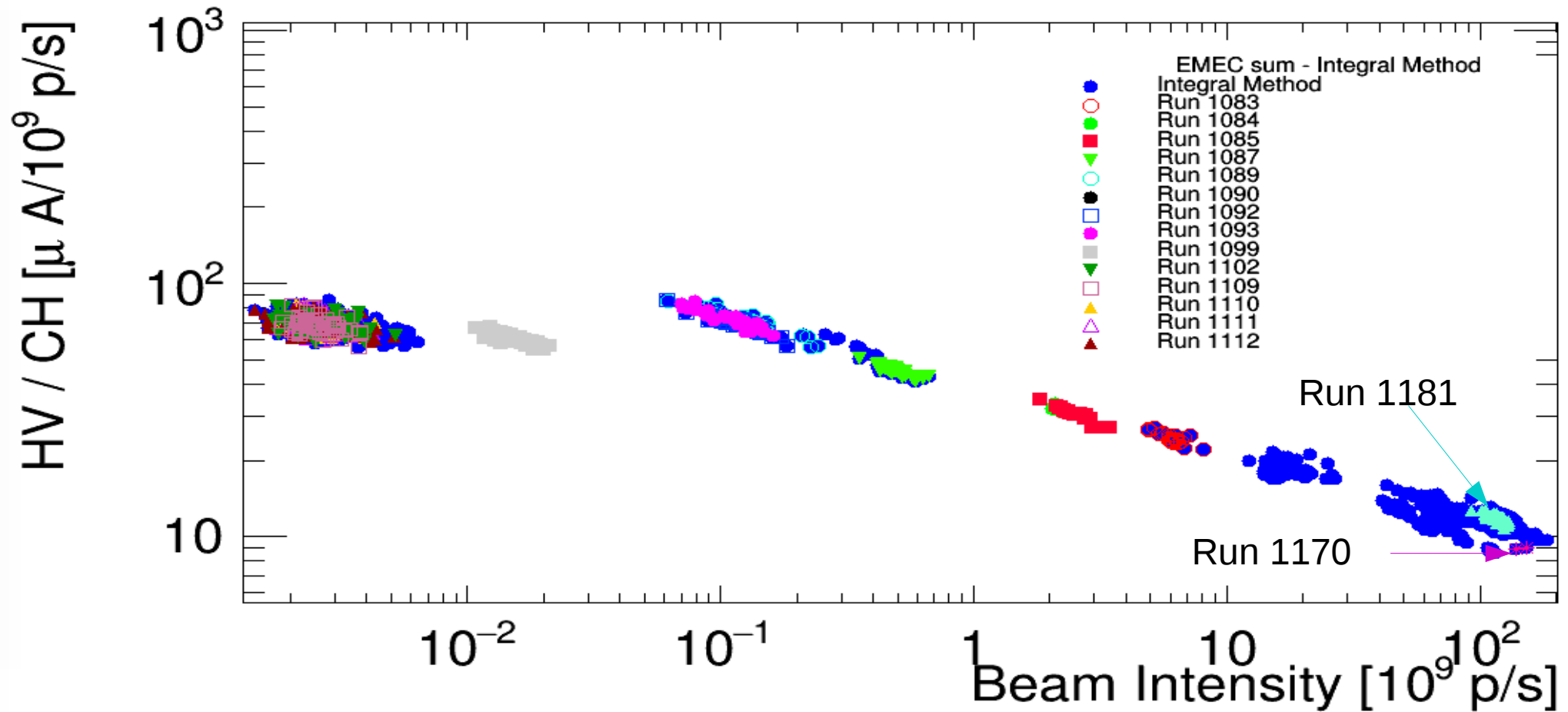


- Integral Method also showed improvements after adding factors
- No offsets were subtracted – see slight increase at low intensities
- Now We need to refit the functions



# 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)



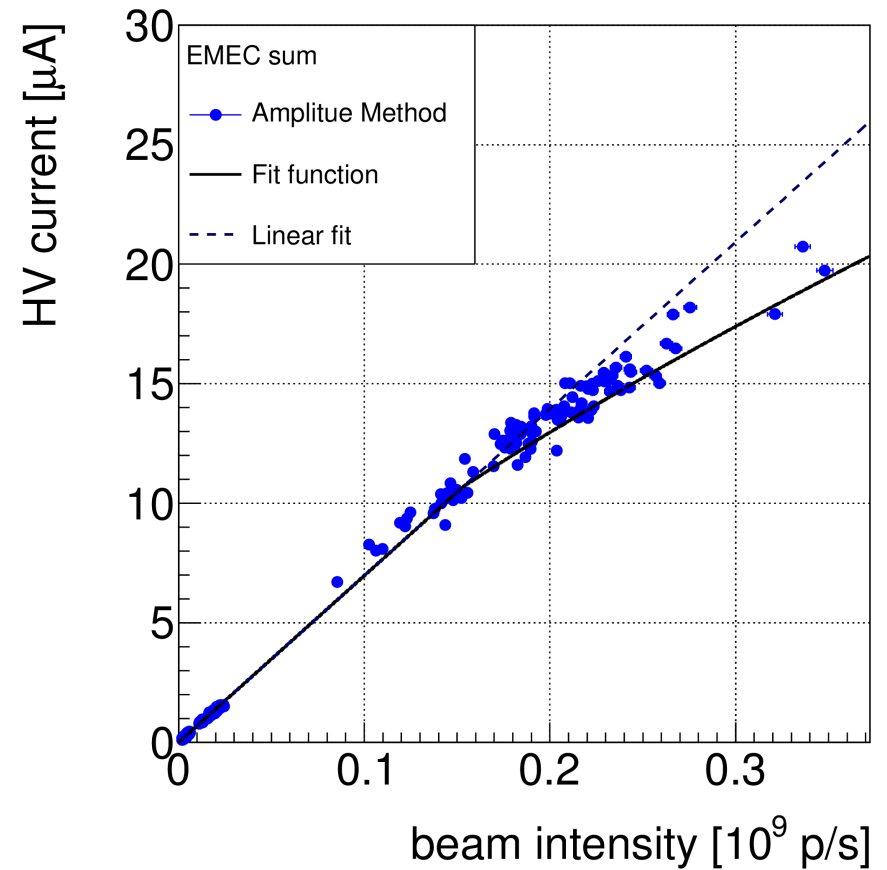
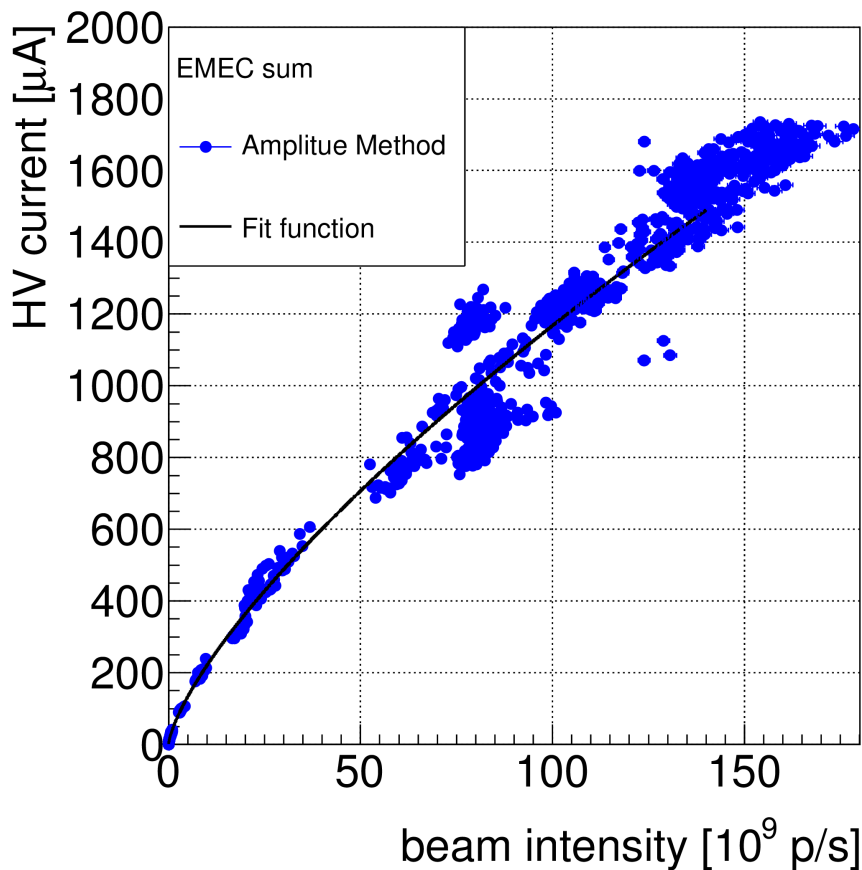


# Fit Functions

- Normal HV curve fit : parameters - Critical current ( $i_c$ ), Critical intensity ( $I_c$ ), 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

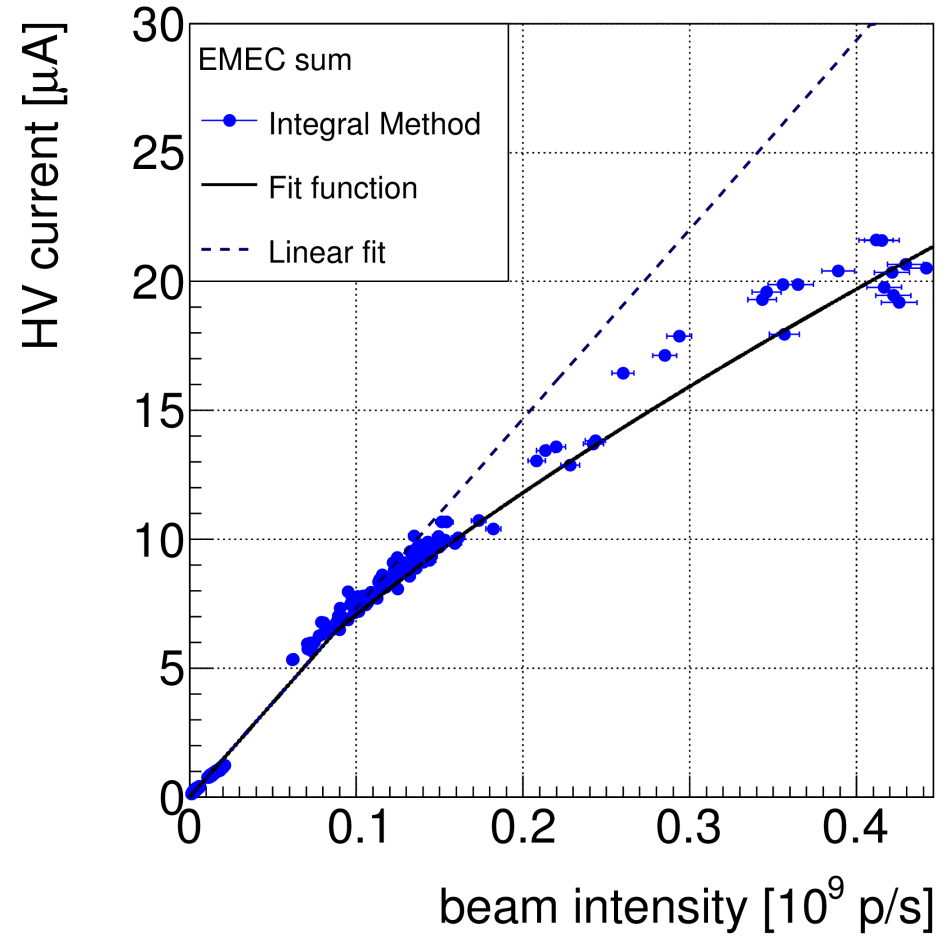
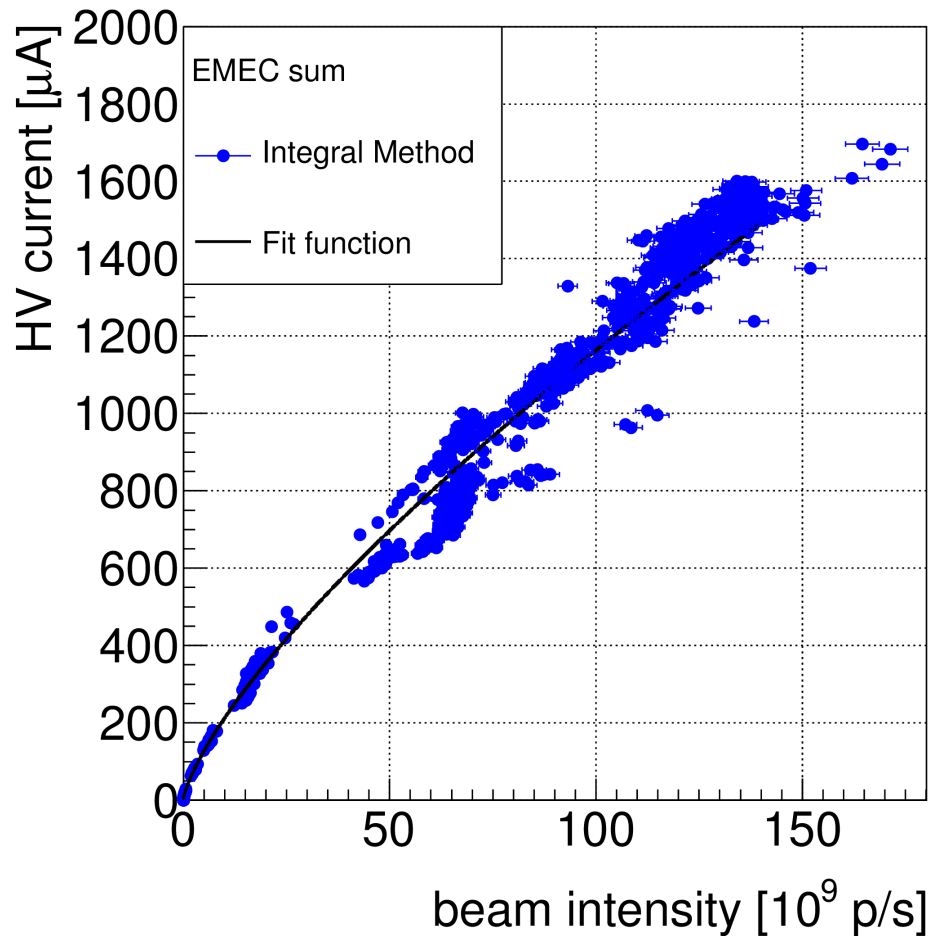
$$i = \begin{cases} i_c * \frac{I}{I_c} + Offset & \text{for } I < I_c \\ i_c * \left(\frac{I}{I_c}\right)^p + Offset & \text{for } I > I_c \end{cases}$$

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



# 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

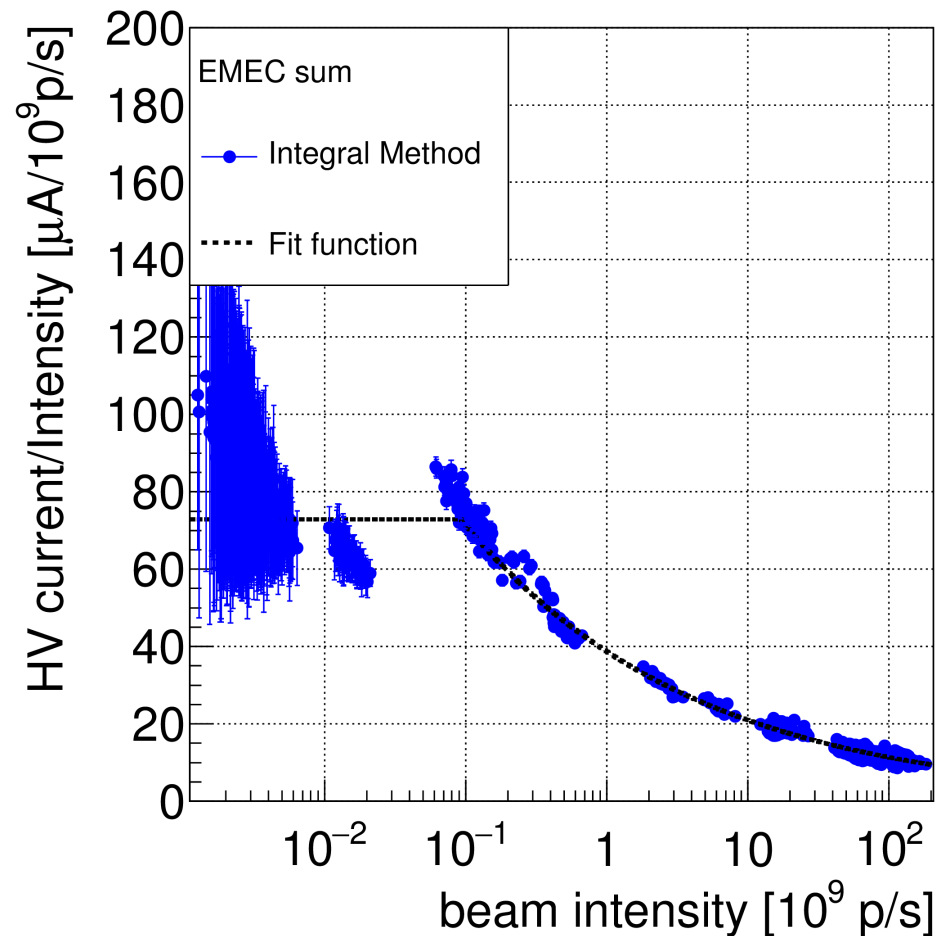
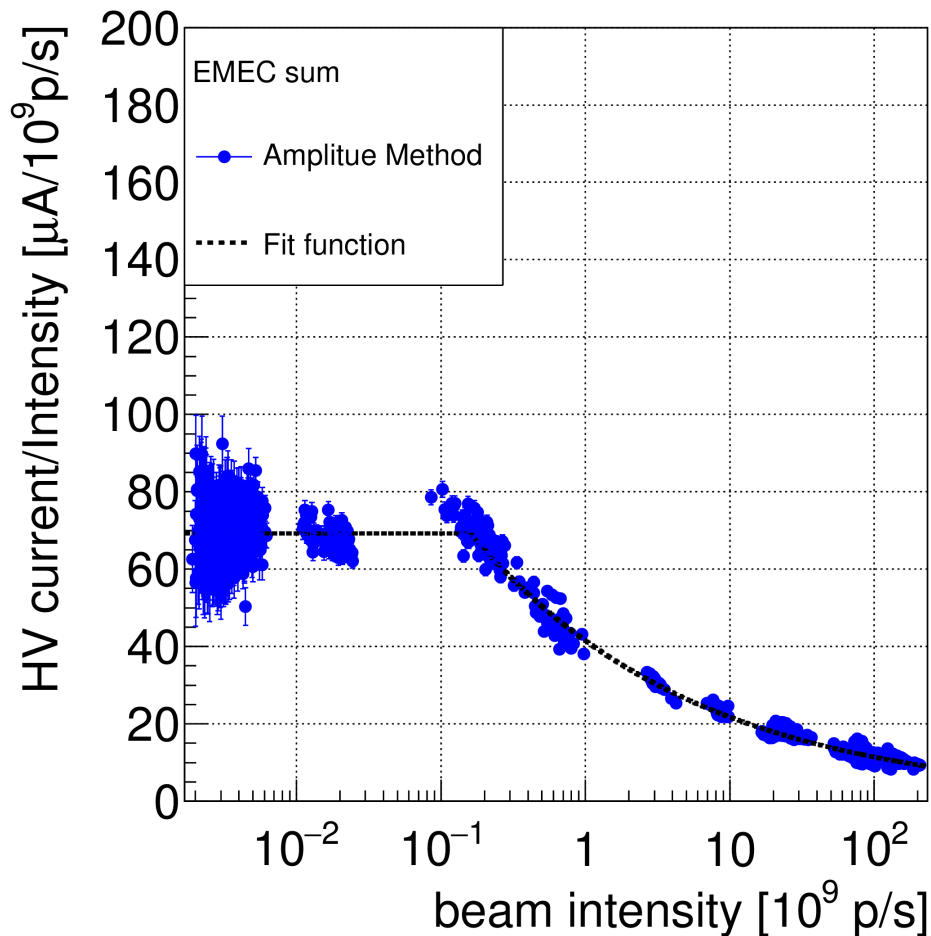


# Ratio HV curve fit functions

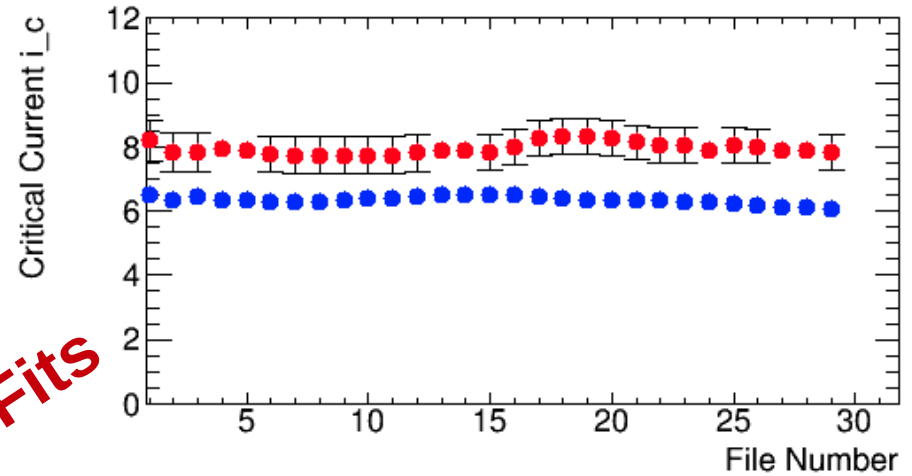
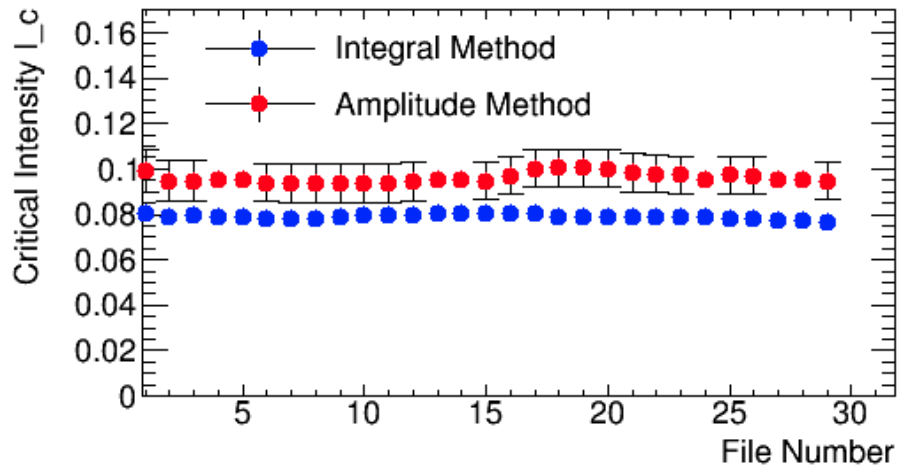
- Ratio HV curve fit : parameters - Critical current ( $i_c$ ), Critical intensity ( $I_c$ ), power term ( $p$ ) and offset
- One can also fit by using slope as a parameter ( $k$ )

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

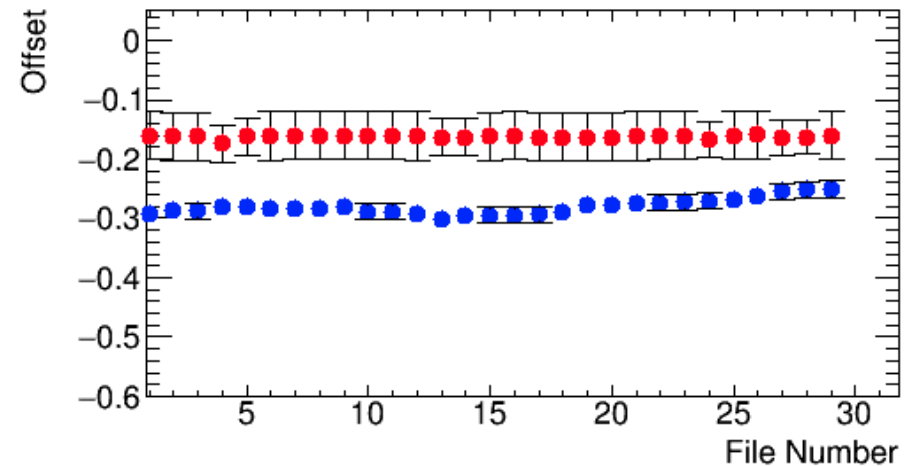
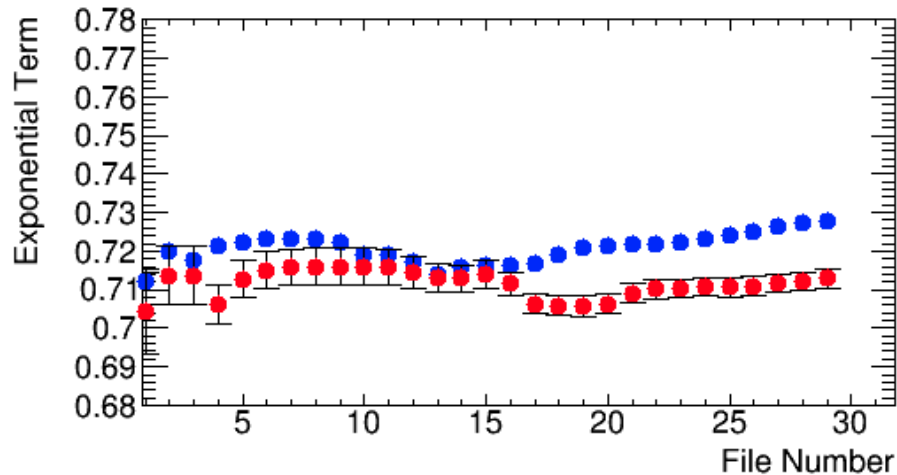
$$i = \begin{cases} k + \frac{offset}{I} & \text{for } I < I_c \\ k \left(\frac{I}{I_c}\right)^{p-1} + \frac{offset}{I} & \text{for } I > I_c \end{cases}$$



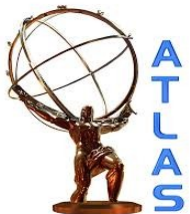
# Different Ranges - Sum



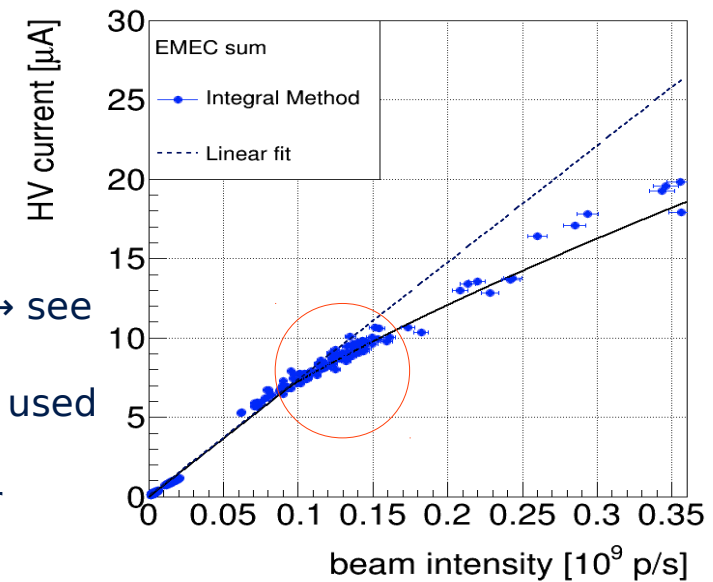
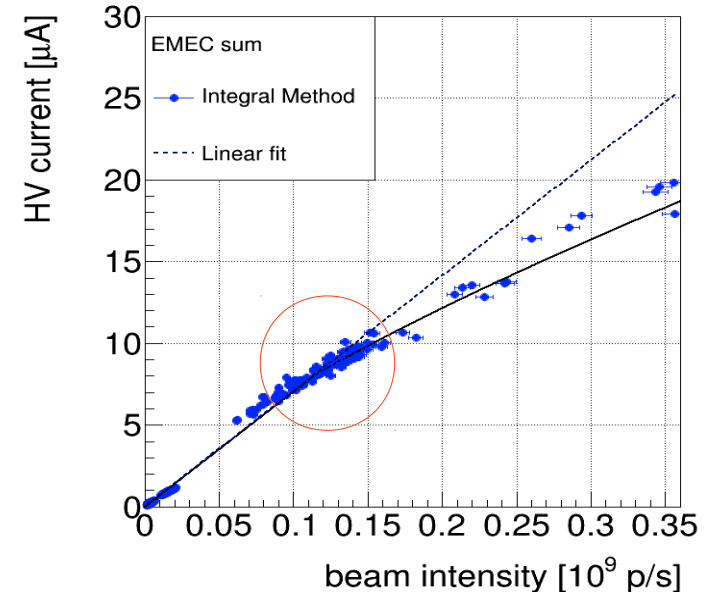
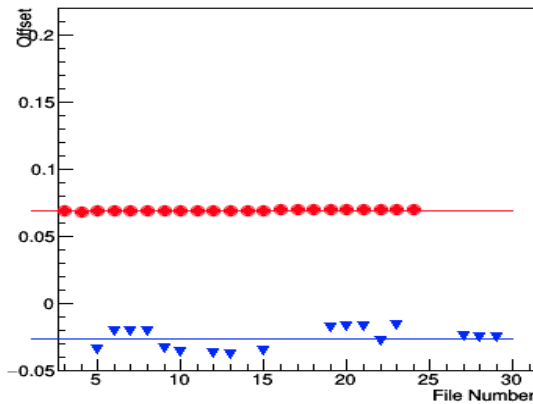
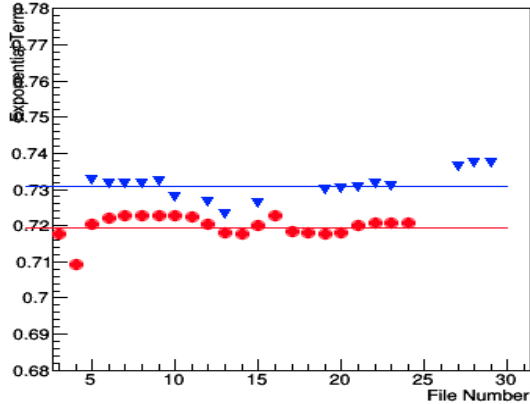
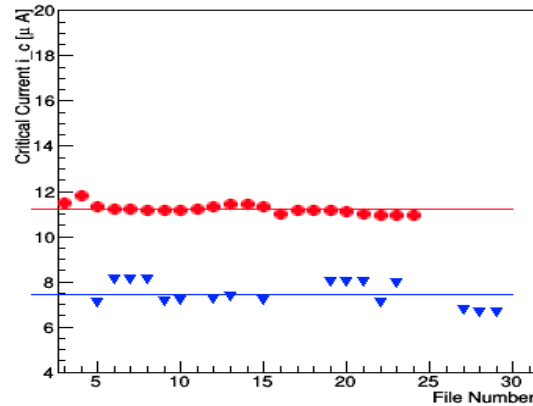
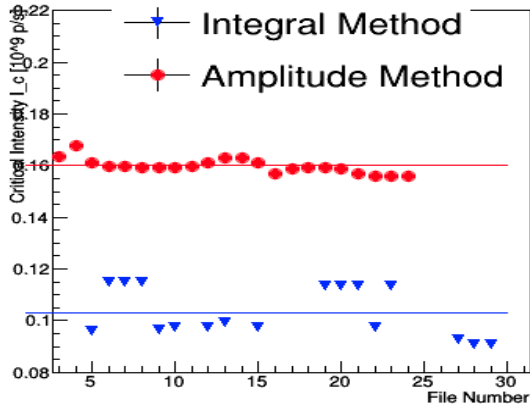
OLD Fits



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



# New results for CH factors

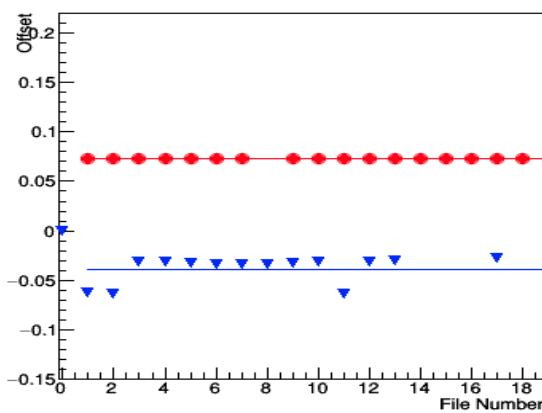
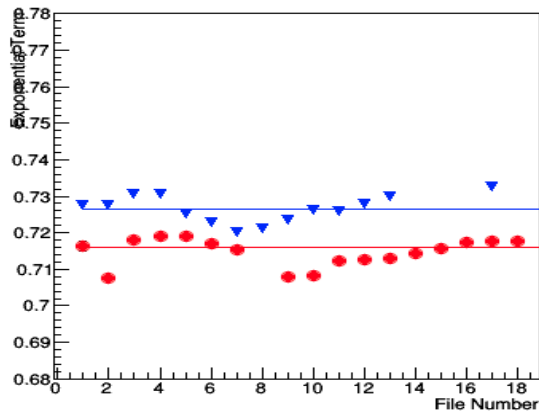
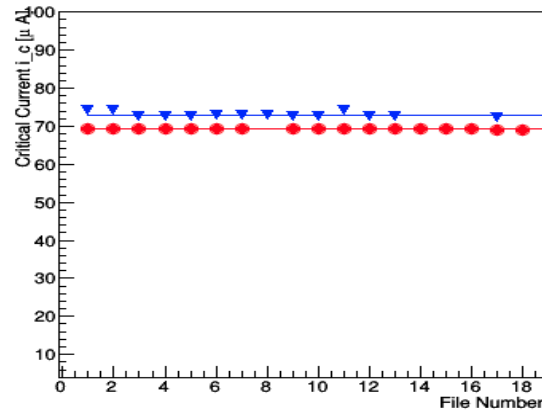
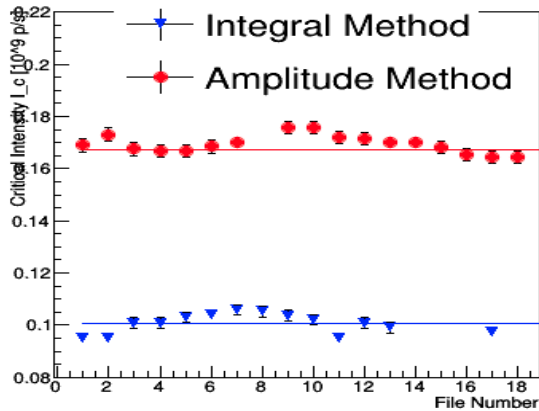


- Integral Method has larger variation for critical values now → see right plots as examples
- Integral method has smaller offset - offset from these fits is used for later subtraction
- Amplitude method showed good stability - values got larger

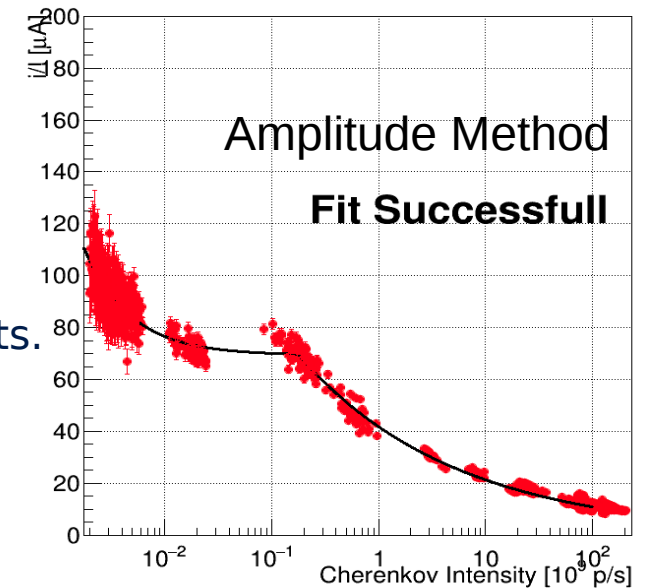
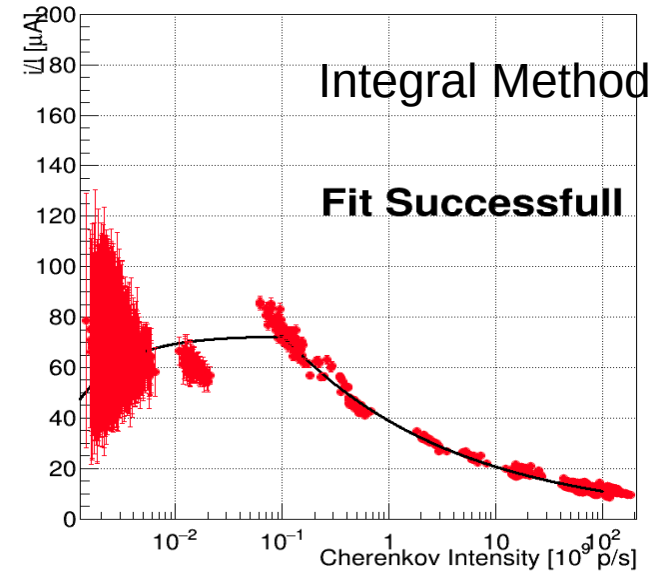


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# Ratio HV/CH results



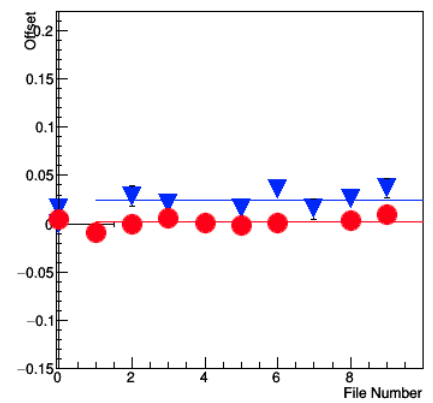
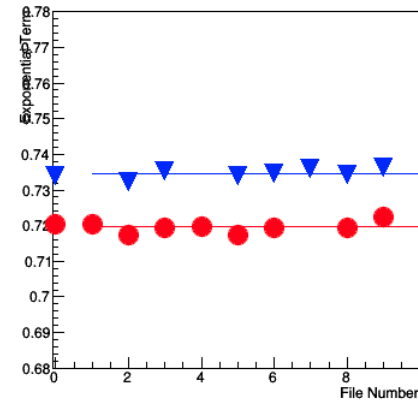
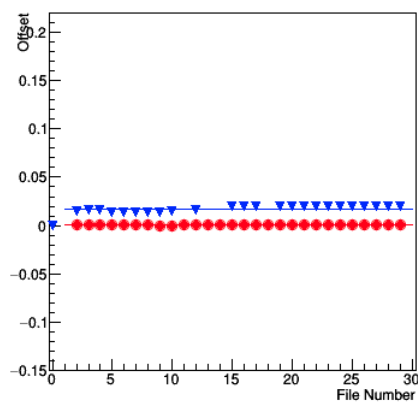
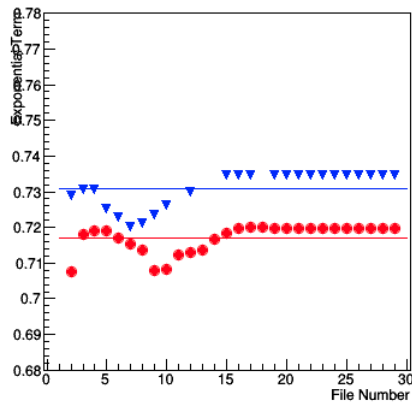
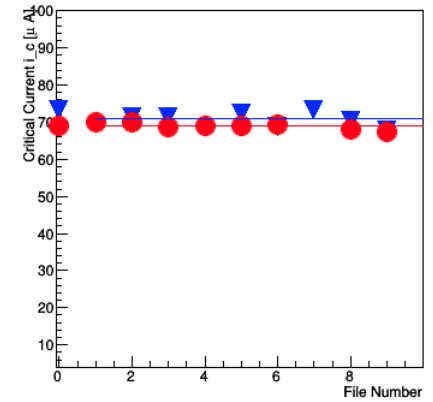
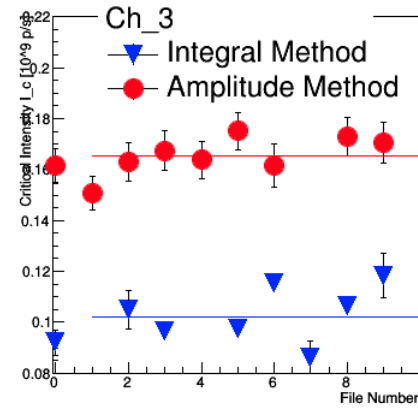
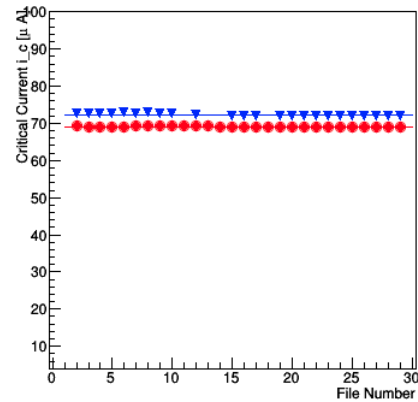
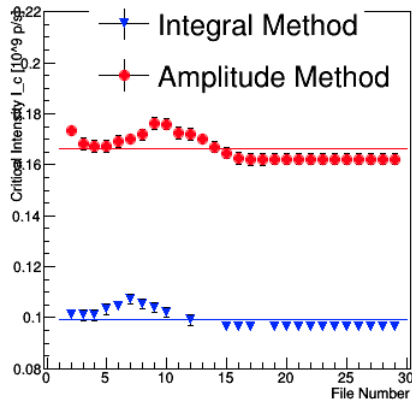
Graph



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



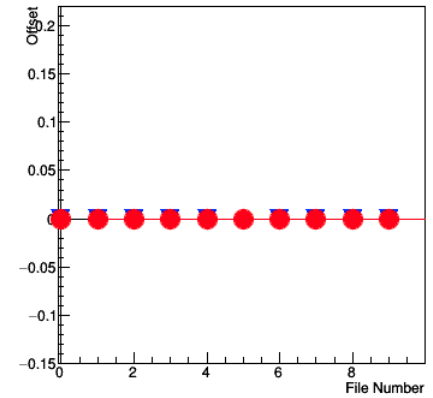
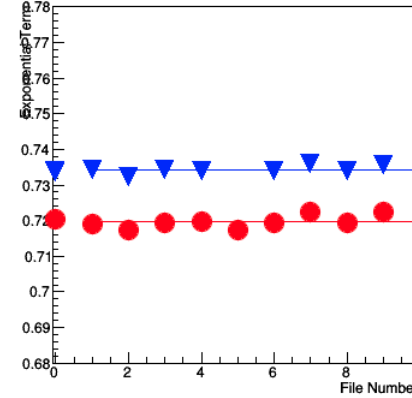
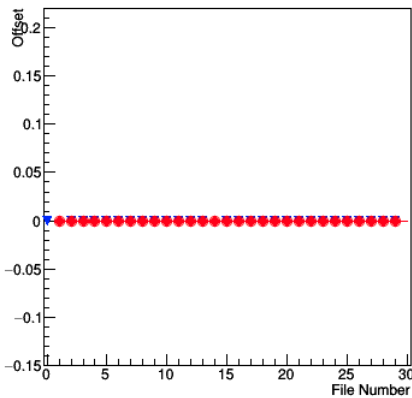
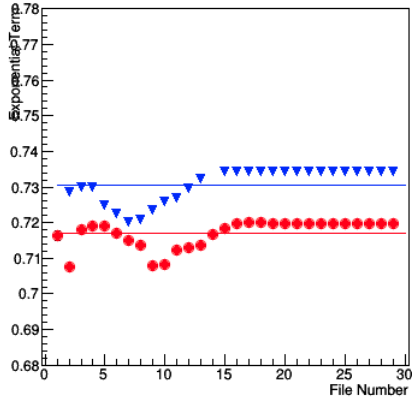
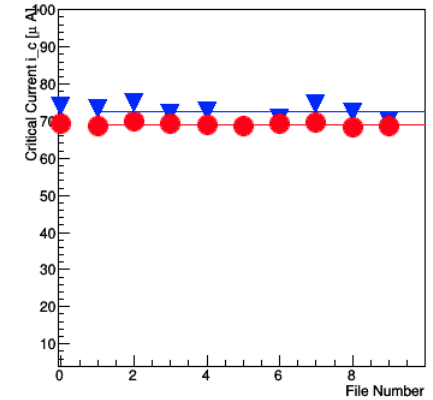
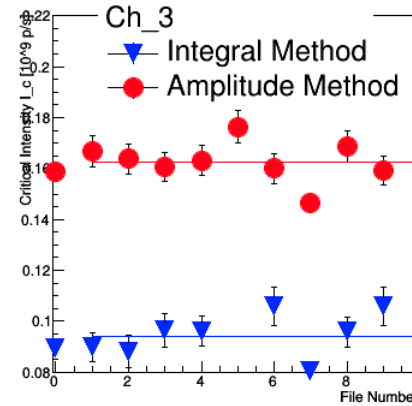
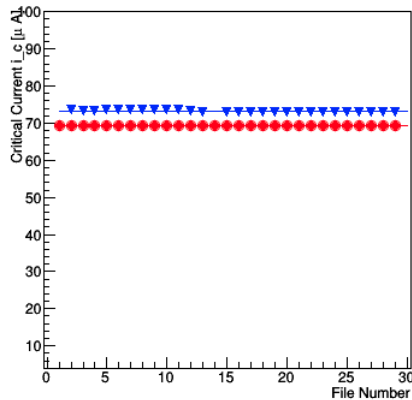
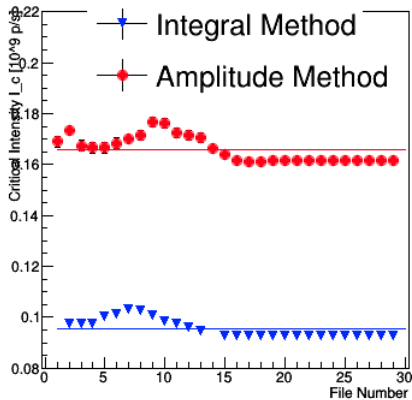
# Channel 3 - Ratio Fit - with Offset



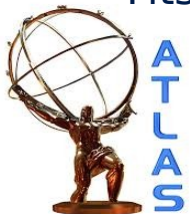
- Now subtract offset and refit:
- Amplitude method shows low offset after offset subtraction, integral method also has reduces offset (could be due to unstable fit results)



# Channel 3 - Ratio Fit - no Offset

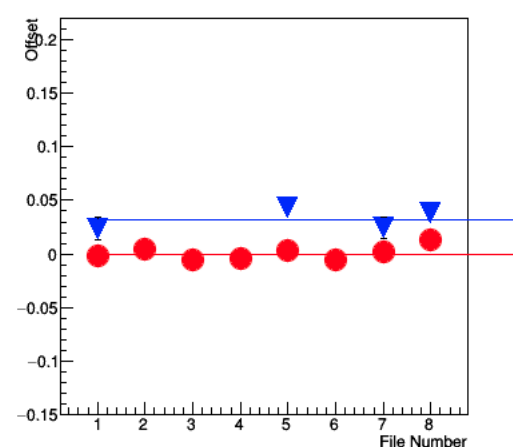
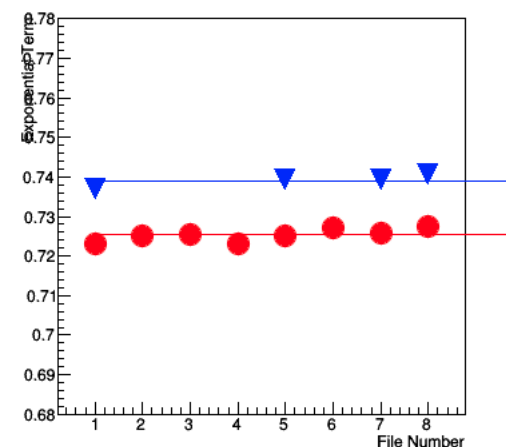
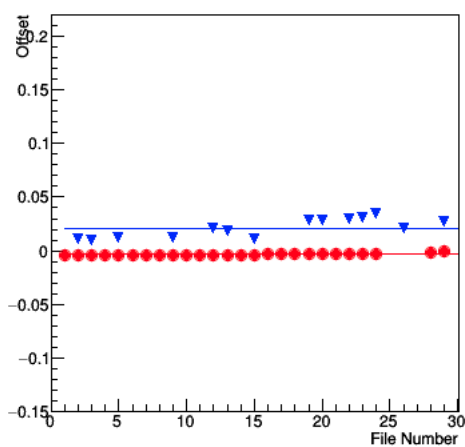
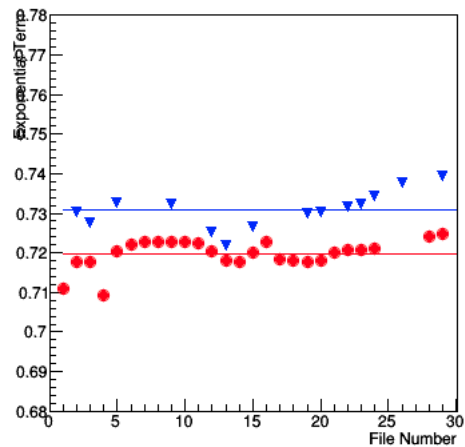
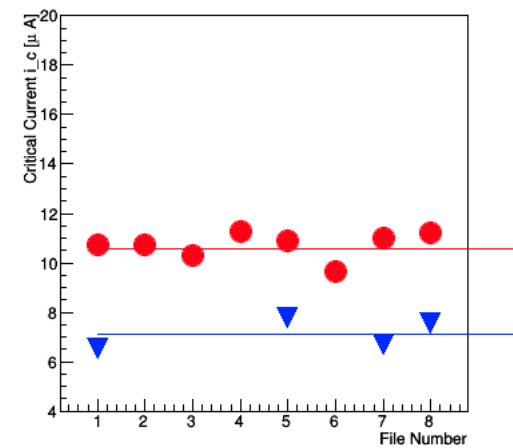
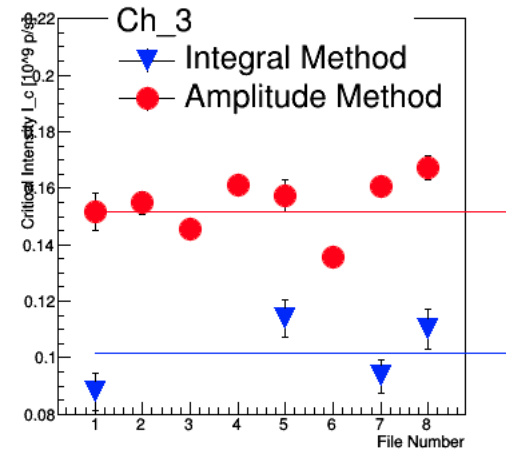
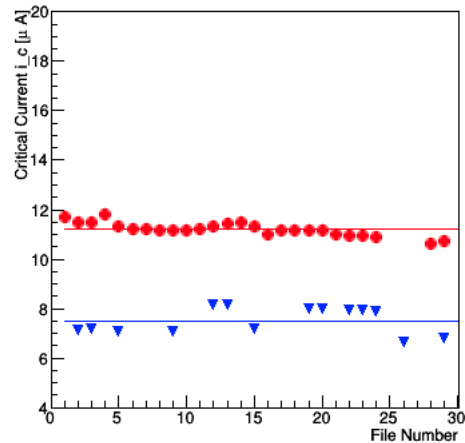
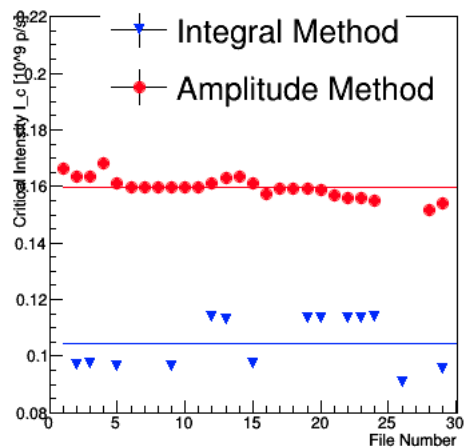


- Results are similar
- Fits are stable and only few did not fit correctly





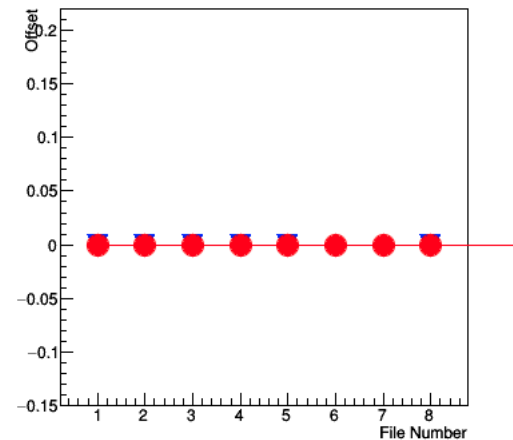
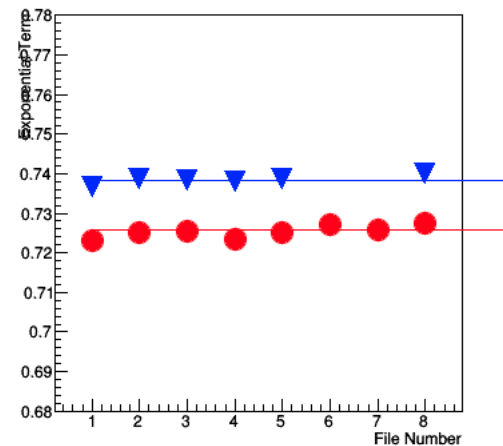
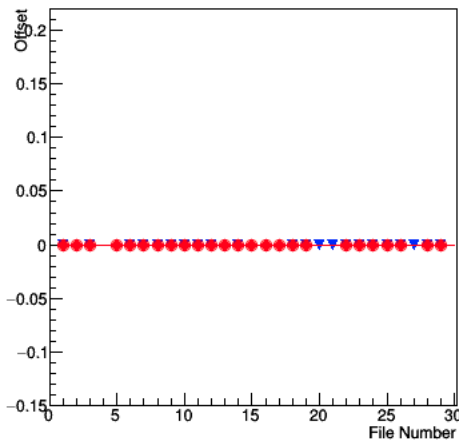
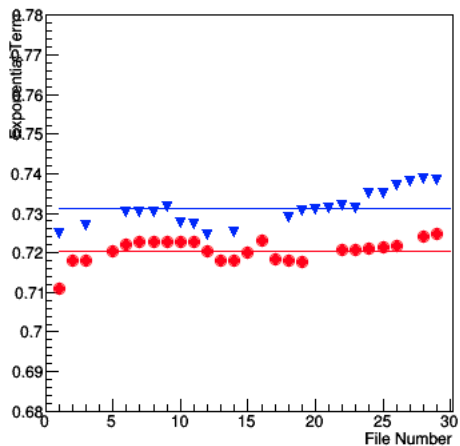
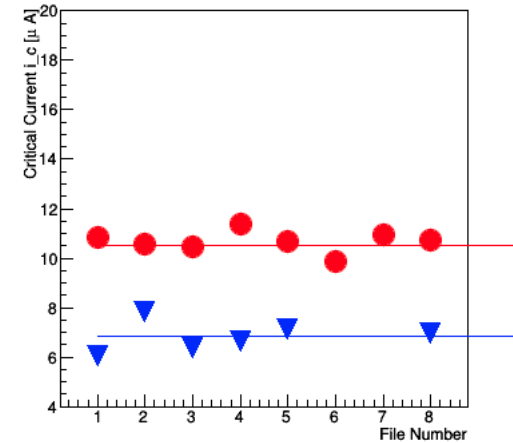
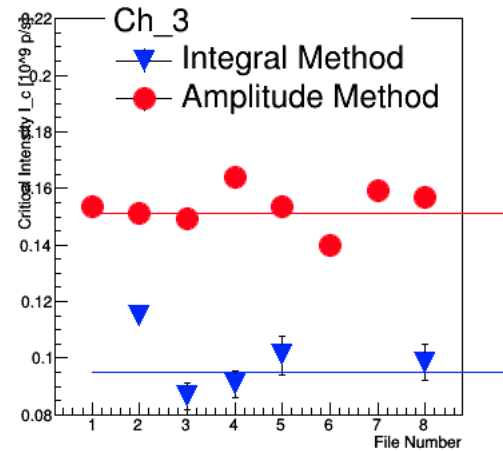
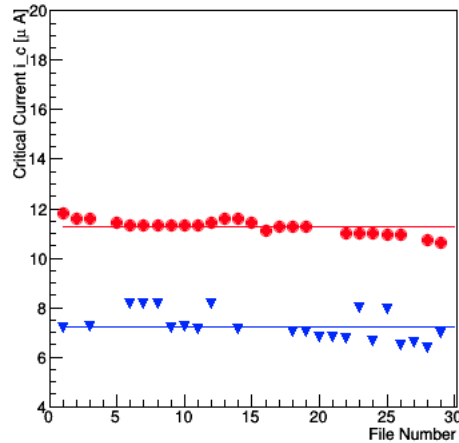
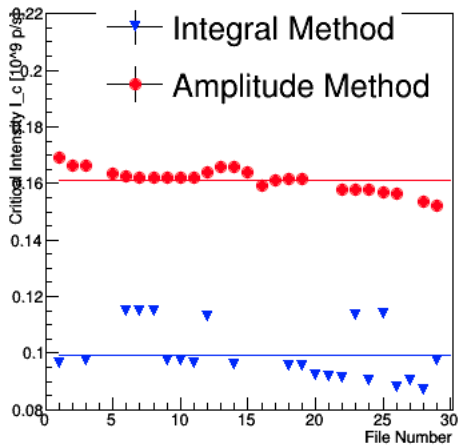
# Channel 3 - Normal Fit - with Offset



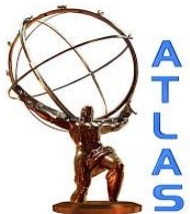
- Integral method is less stable as also showed before – the critical region is not well described by the data



# Channel 3 - Normal Fit - no Offset

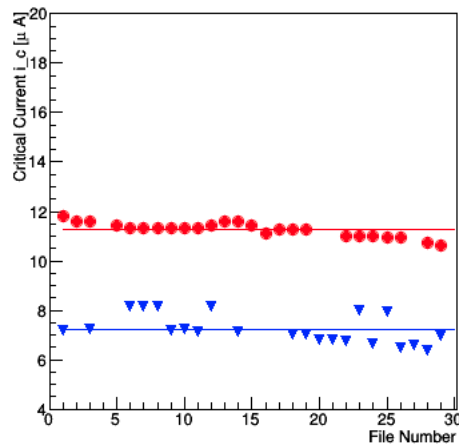
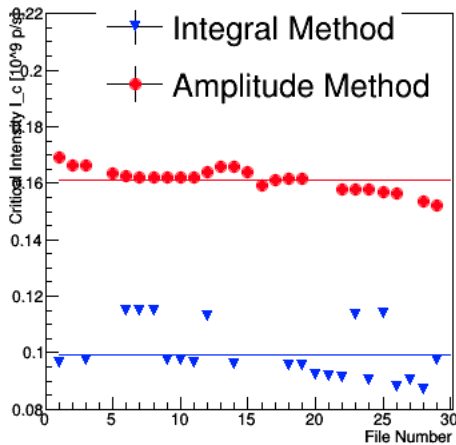


- More stable integral method fit, but the jumps in the critical values are observed

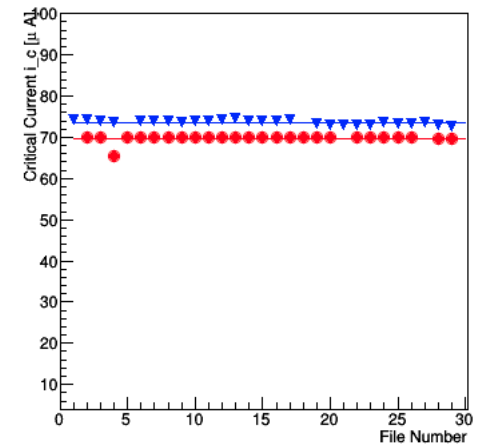
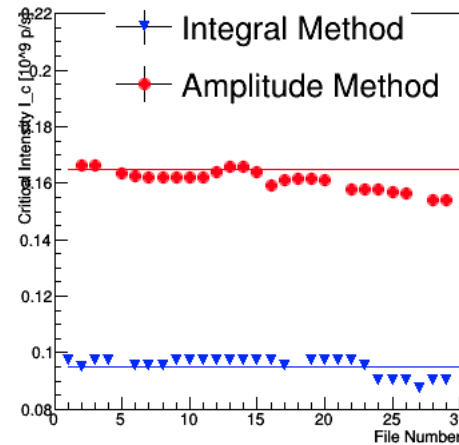


# Comparing two fits

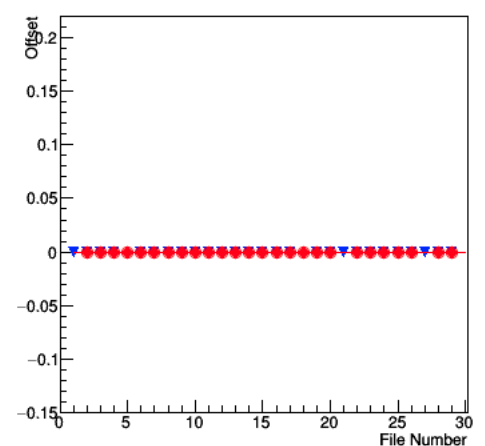
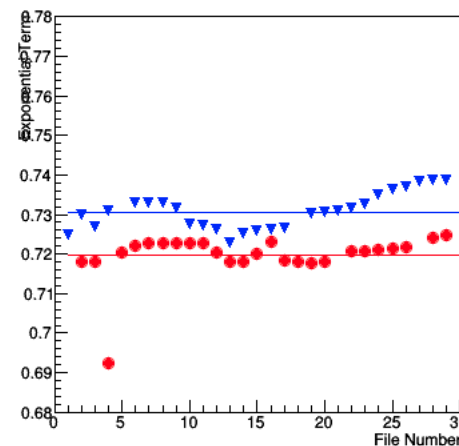
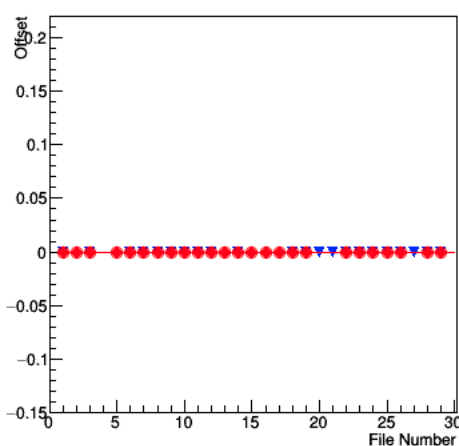
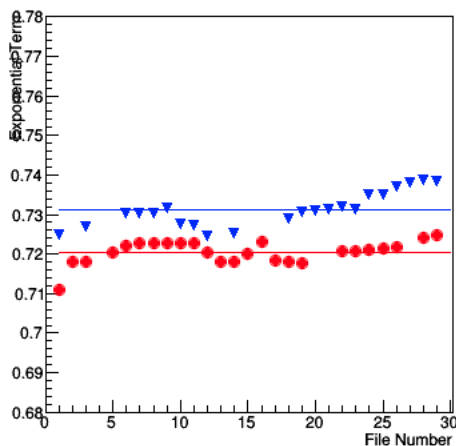
- Included fit with slope for normal fit (instead of  $I_c$ ,  $i_c \rightarrow I_c$ , slope  $\rightarrow$  Critical intensity got more stable)
- Also included changing initial values for refitting (and larger loop for refitting)
- Critical intensity increased slightly - but one outlier is also higher



Normal fit –  $I_c, i_c$



Normal HV curve fit –  $I_c$ , slope



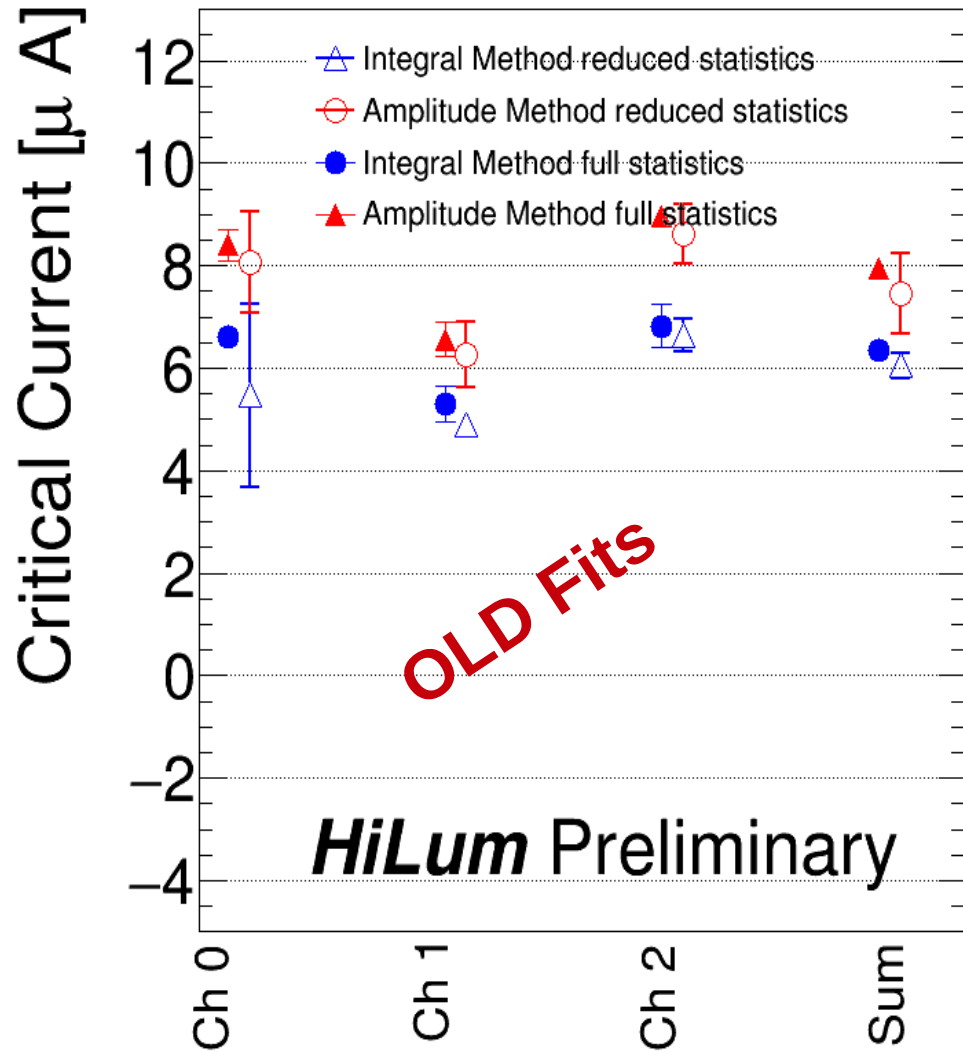
# Part III

	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

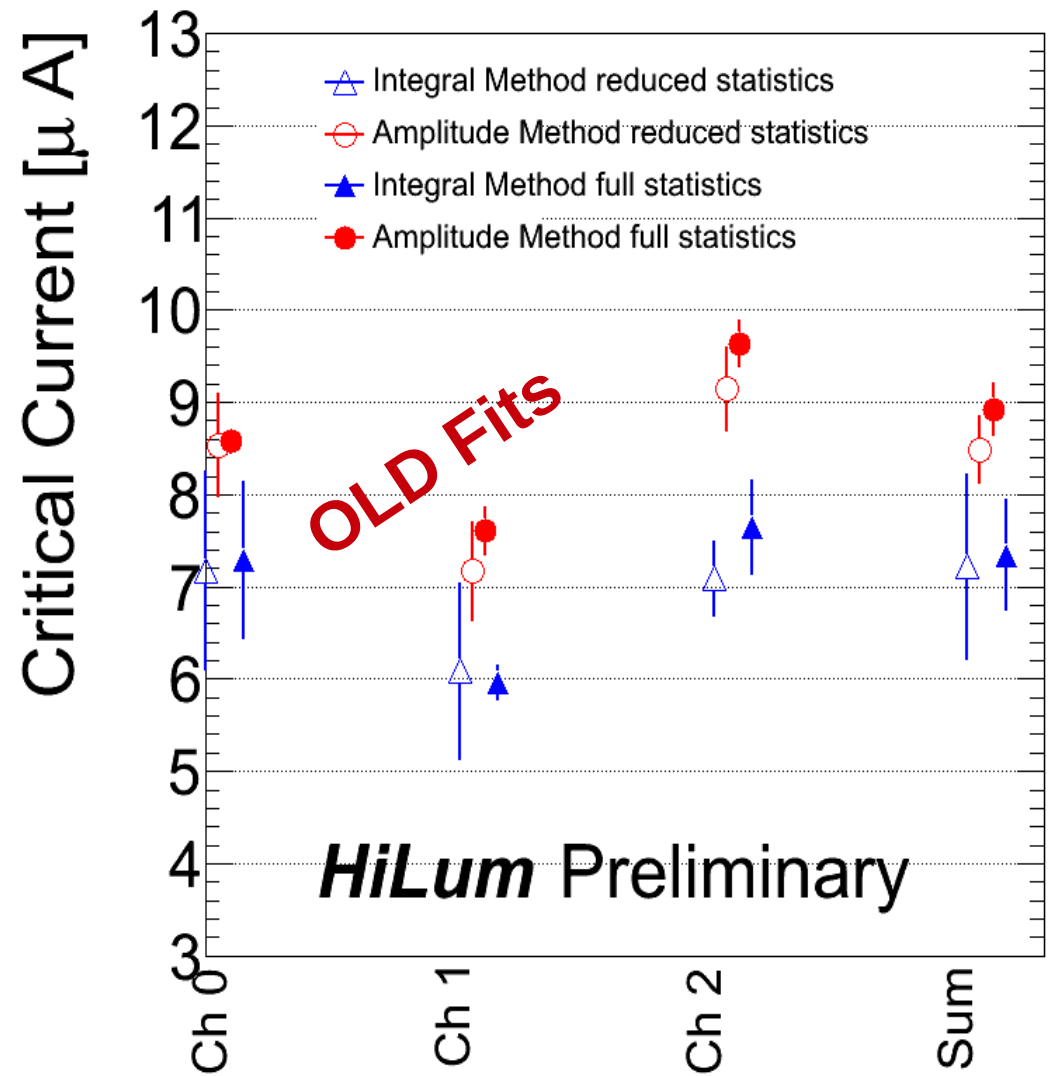
Final results for 3 channels for different methods are shown in the same plots



# Results of ratio plots



Ratio HV curve



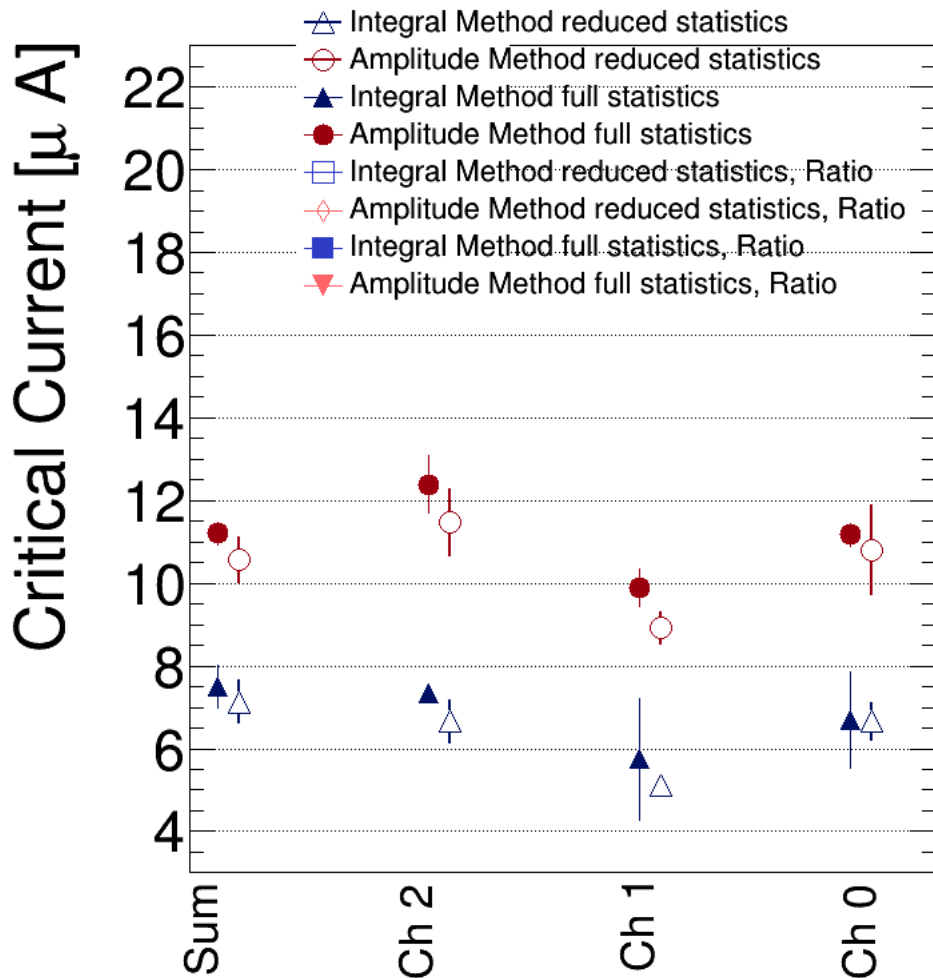
HV Curve



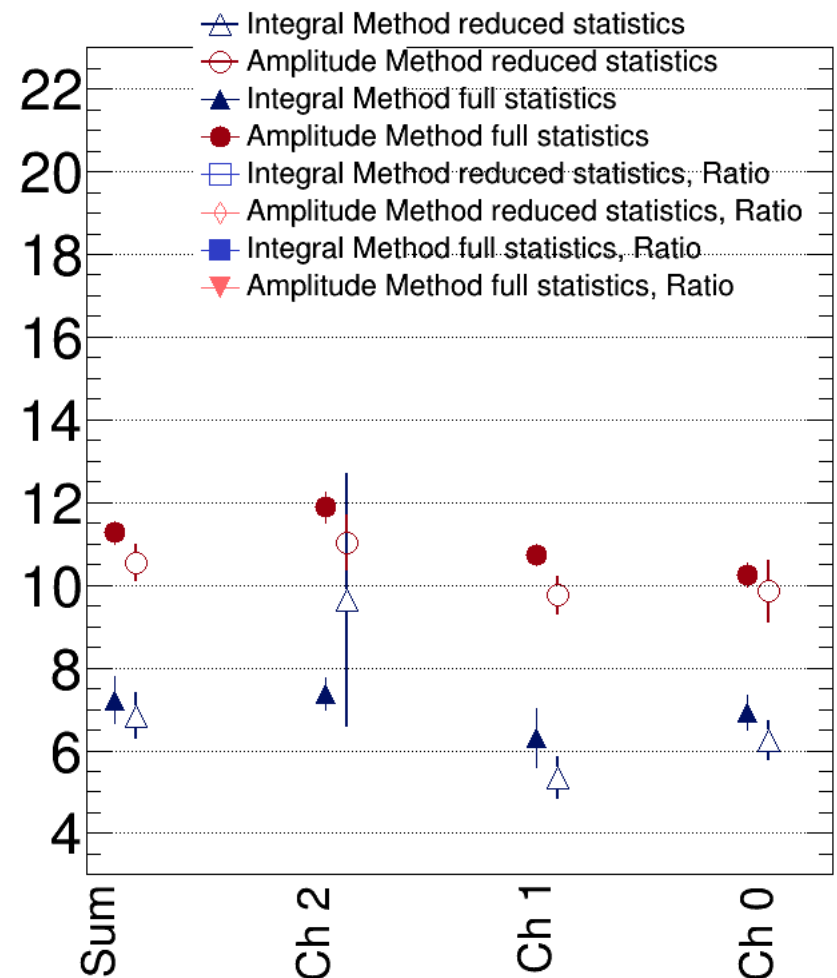
ATLAS



# New Results

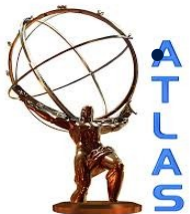


With Offset in the fit

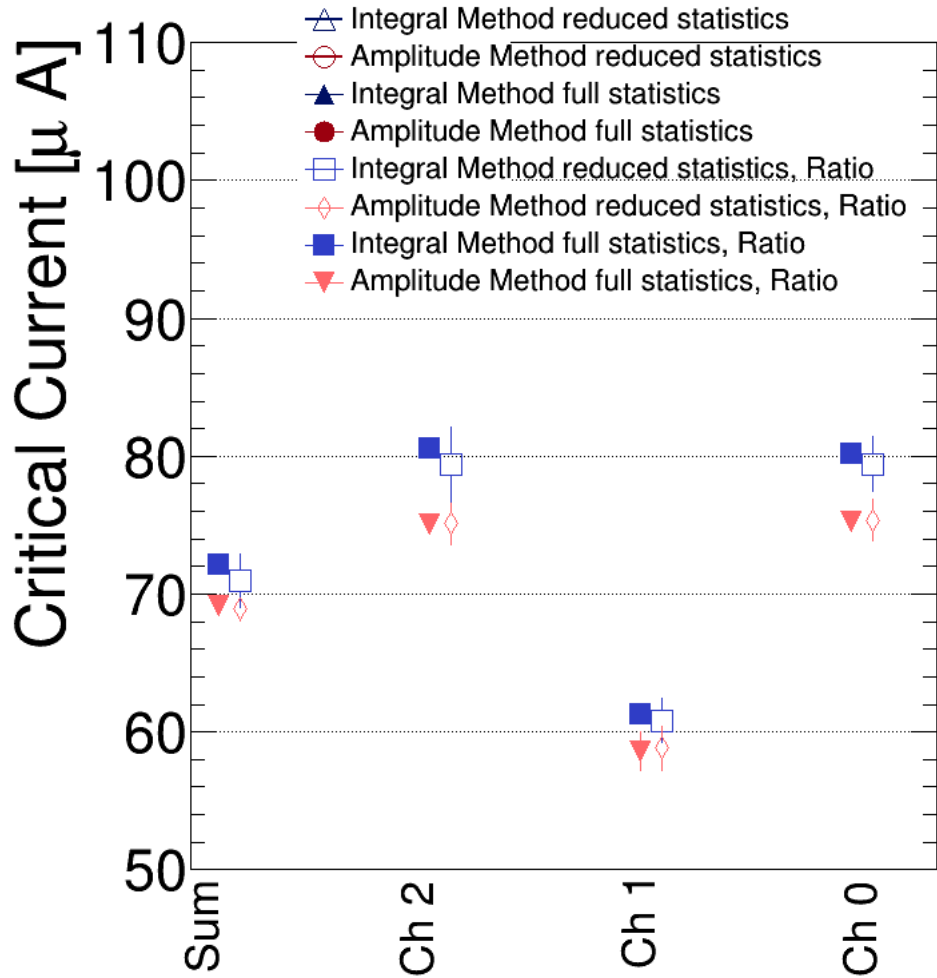


No Offset in the fit

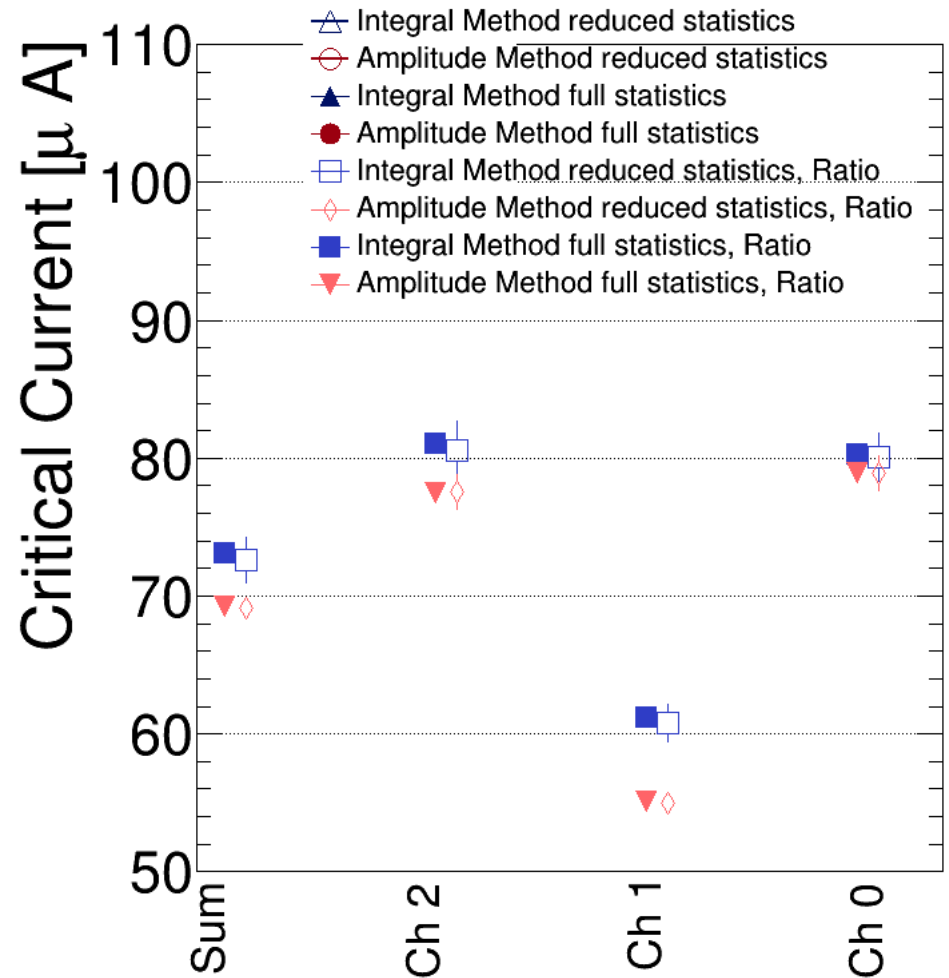
Both methods got increased values of critical current after the low intensities corrections, amplitude method has larger increase



# New Results



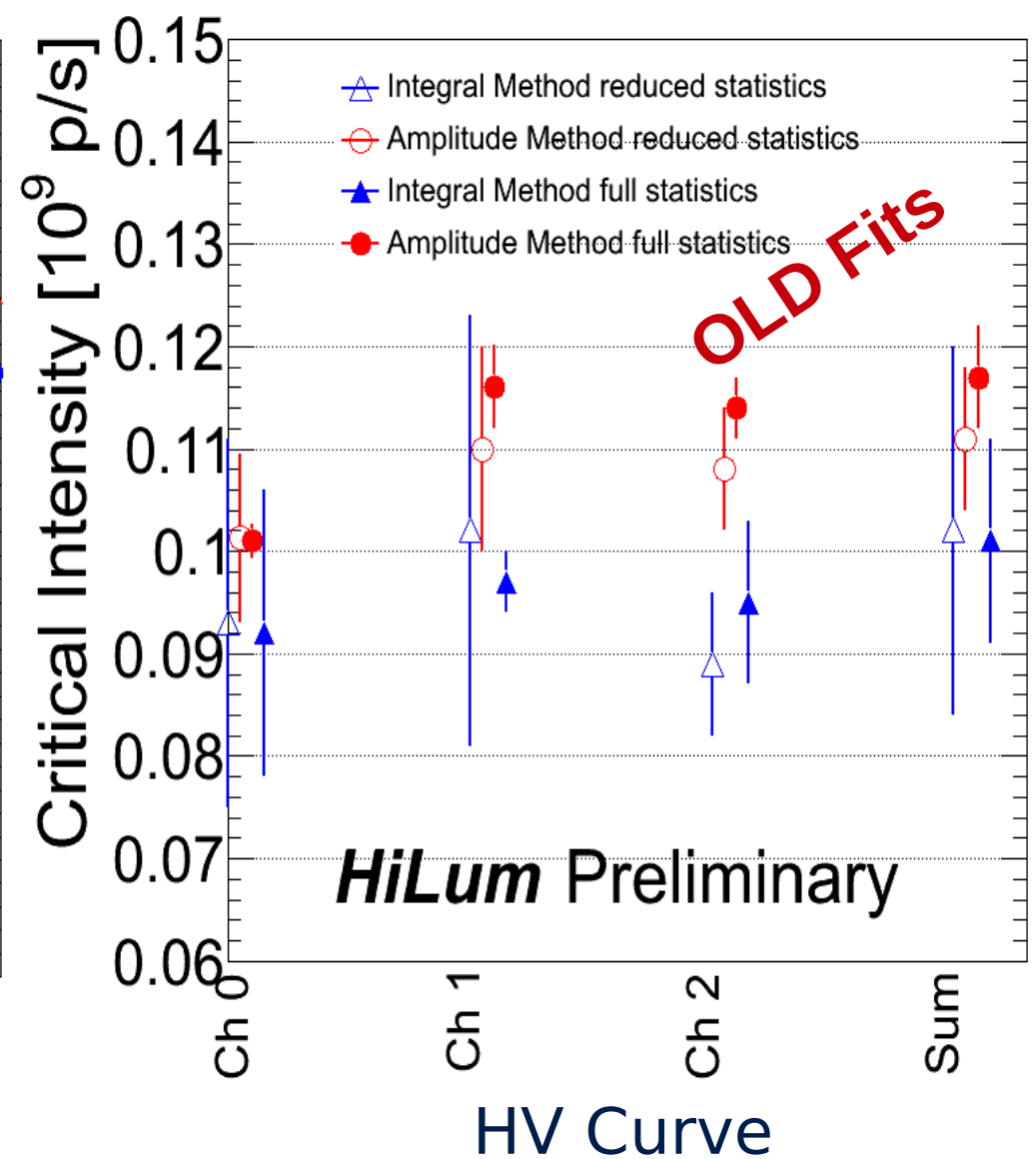
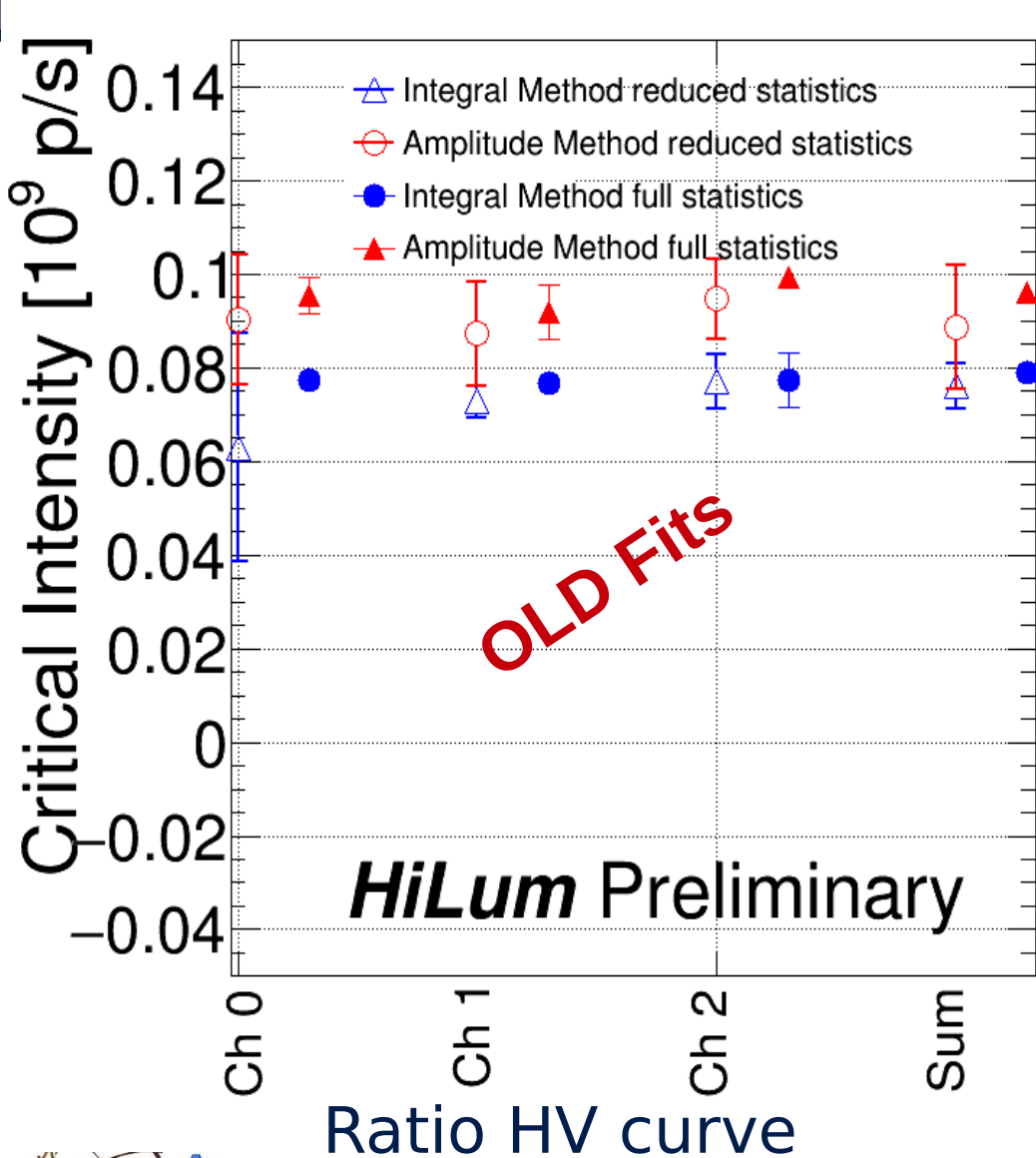
With Offset in the fit



No Offset in the fit

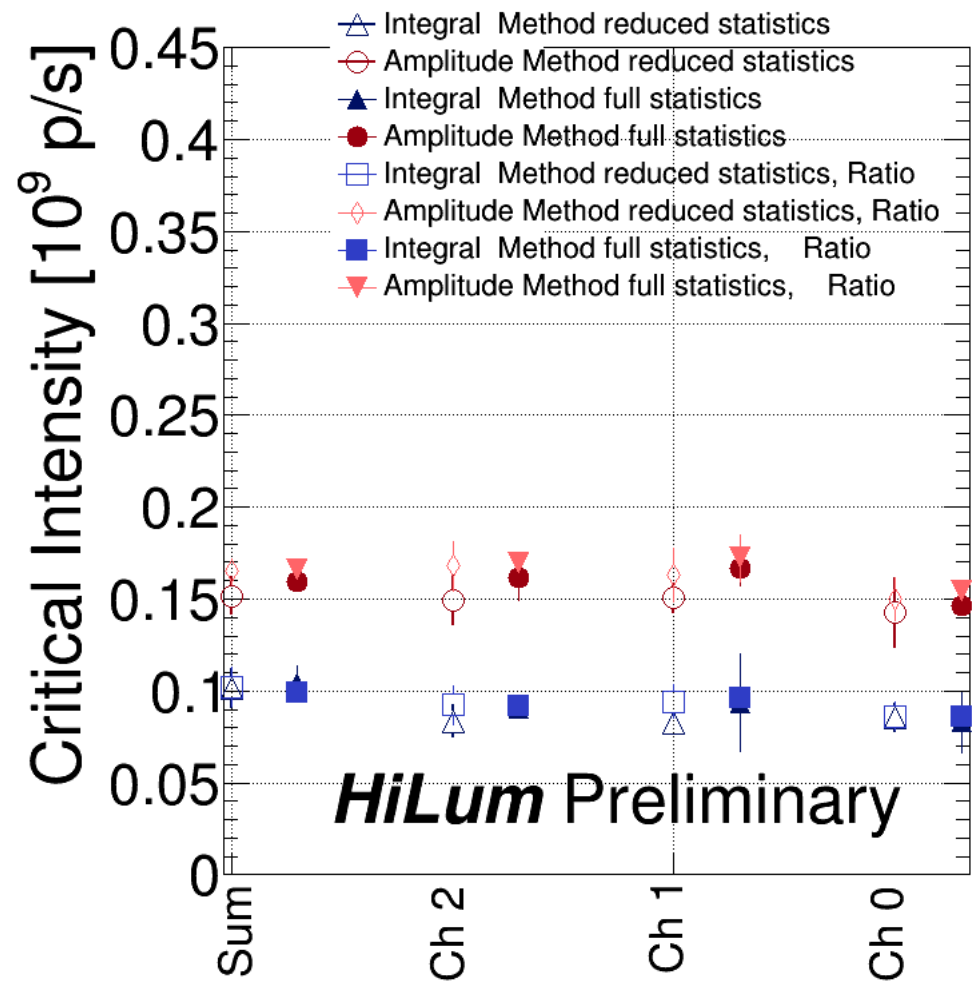


# Previous results for HV curve fit

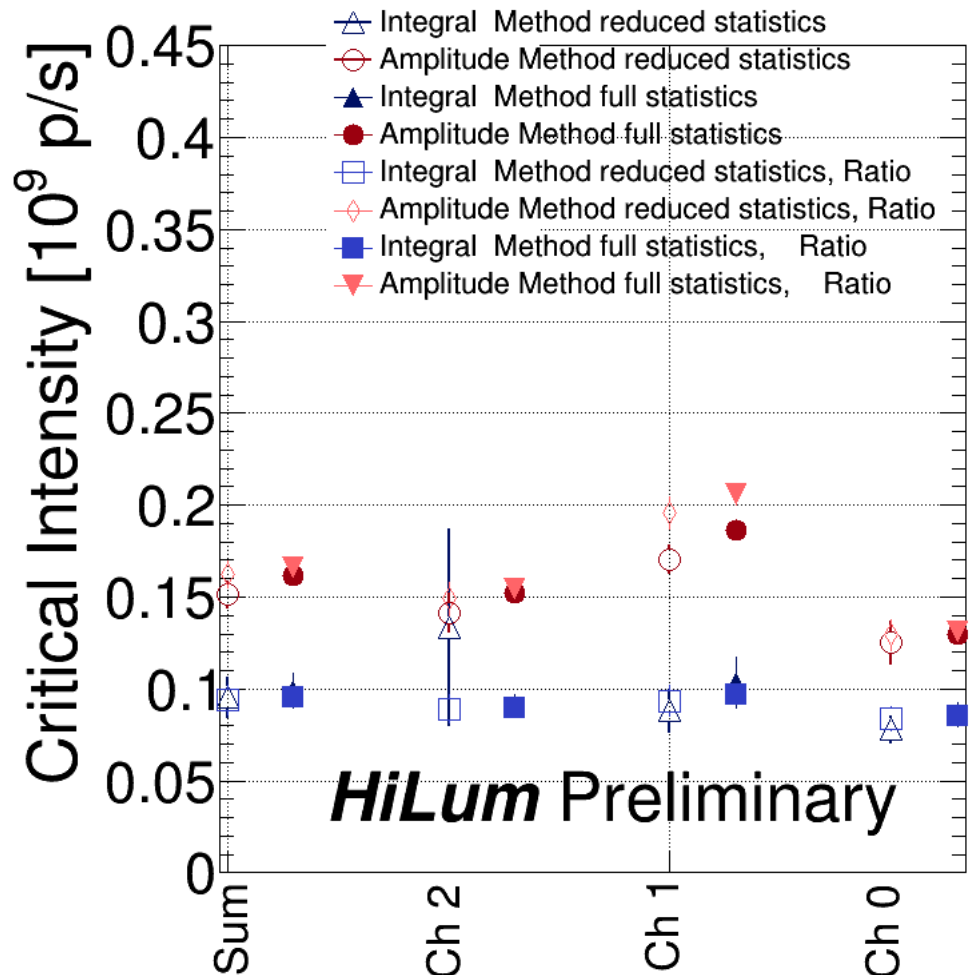




# New Results

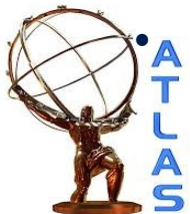


With Offset in the fit

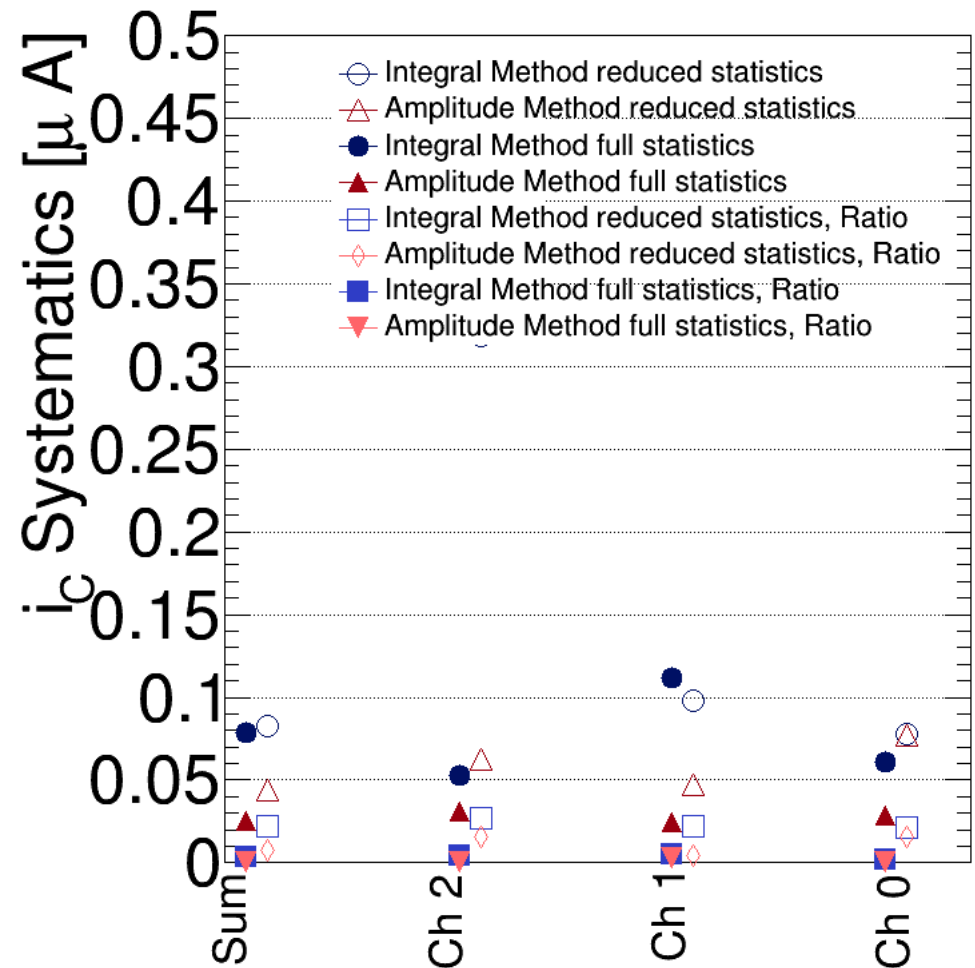
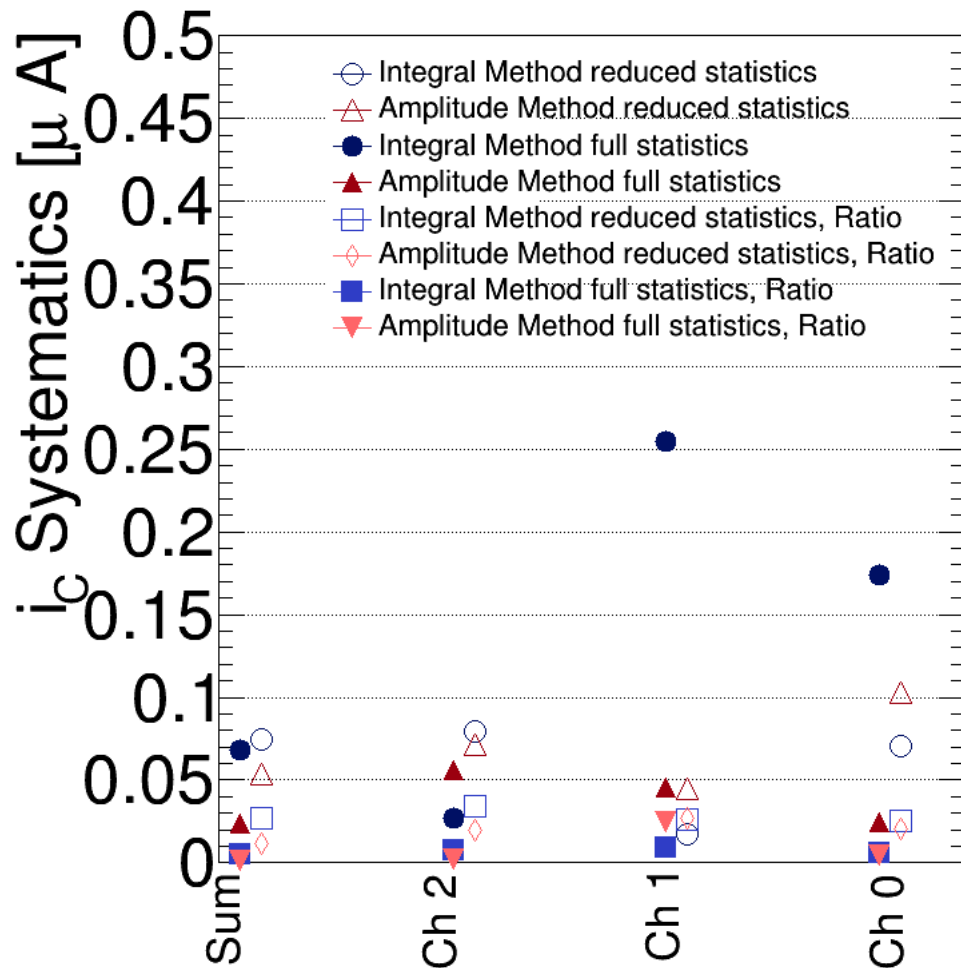


No Offset in the fit

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



# New Results



- With Offset in the fit

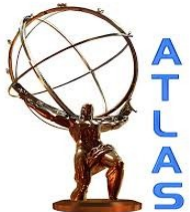
No Offset in the fit

- Without offset systematics gets smaller and always below 10%



# 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

