

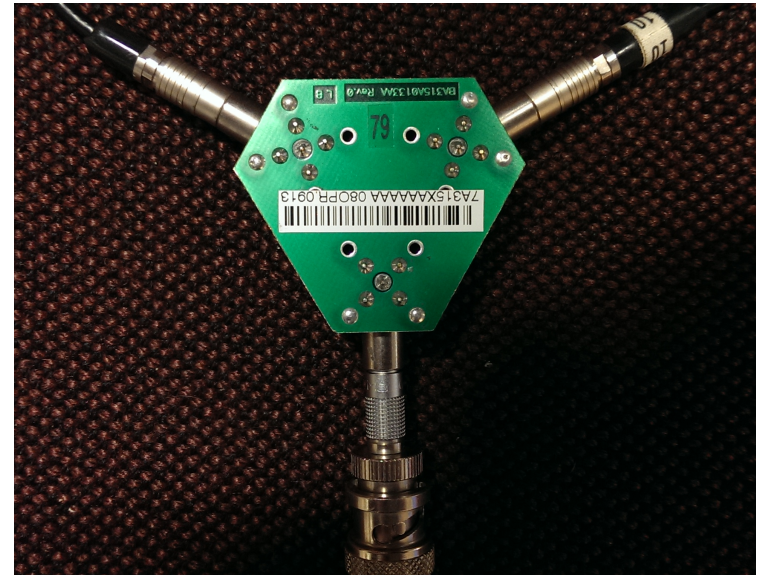
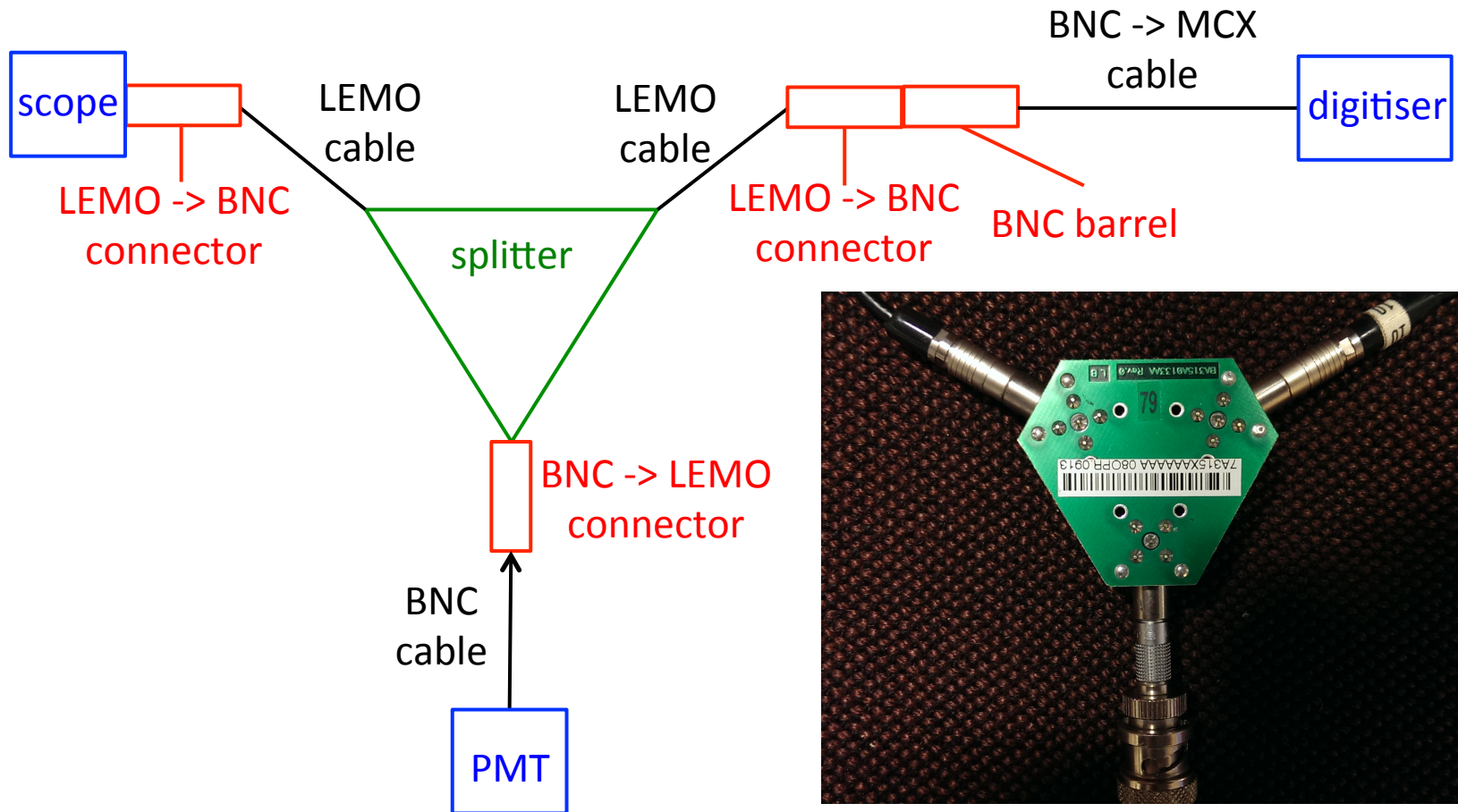
50 Ω Splitter Testing

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Introduction

- For future test beams we need to be able to fully control all of our equipment remotely:
 - Usually, we manually change the cable between the **digitiser** (used for **data taking**) and the **oscilloscope** (used for measuring the **peak current** (pulse amplitude and FWHM) and **rates**)
 - When the digitiser and the oscilloscope are both in the treatment room we are not easily able to do this!
 - Try using a splitter to split the signal between the digitiser and the oscilloscope
 - This could potentially introduce noise into the system and also reduce the signal too much with the new PMT parts which will already reduce the gain
 - Currently available we have a **50 Ω LEMO splitter**
 - Start tests with this at UCL!
 - Look at the ADC distributions and energy resolutions with and without using the splitter for the “usual” peak current and HV settings

The Splitter Setup

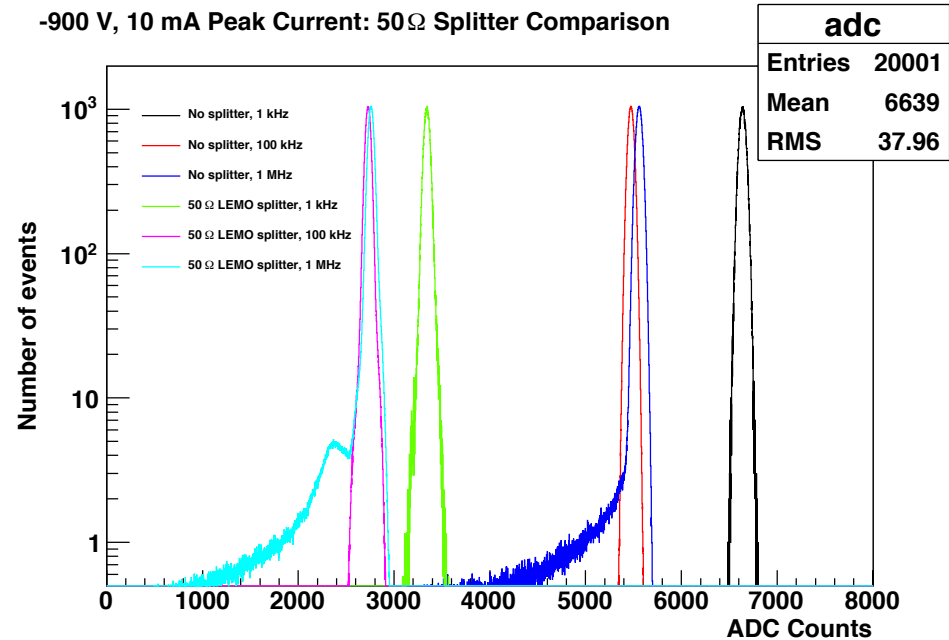
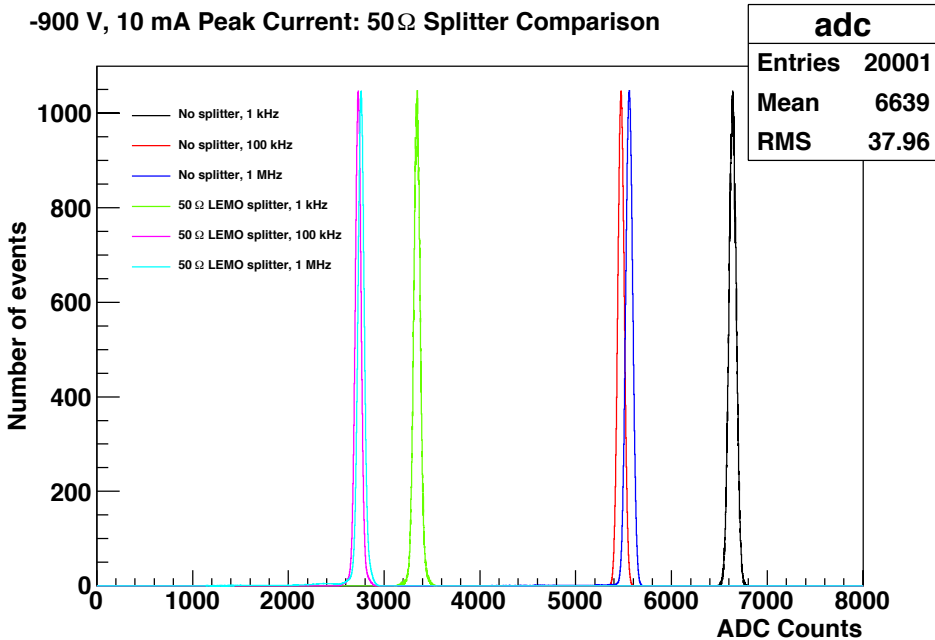


- We are introducing the following into the setup:
 - Four cables
 - Four barrels/connectors
 - A lot of potential for noise!

Measurement Setup:

- 2" Hamamatsu R13089-100-11 PMT with negative HV active divider base (made by Hamamatsu)
- 3 cm x 3 cm x 45 cm cuboid ENVINET standard scintillator
- Coupled with BC-630 Saint Gobain silicone optical gel (refractive index = 1.465)
<http://www.crystals.saint-gobain.com/uploadedFiles/SG-Crystals/Documents/Organic%20Product%20Accessories%20Data%20Sheet.pdf>
- With 50 Ω LEMO splitter
- Pulsed with an LED

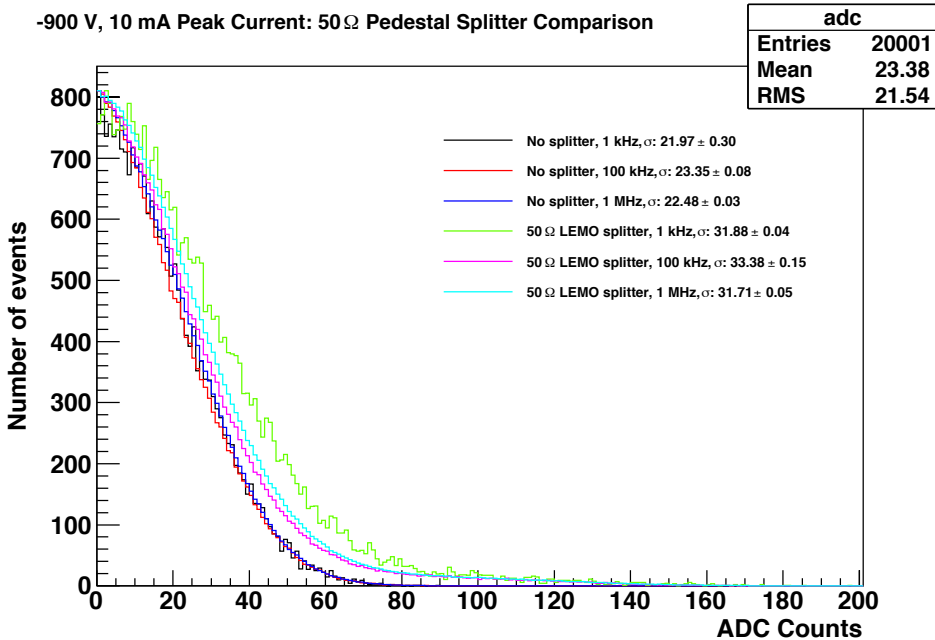
HV: -900 V, $I_{\text{peak}} = 10 \text{ mA}$



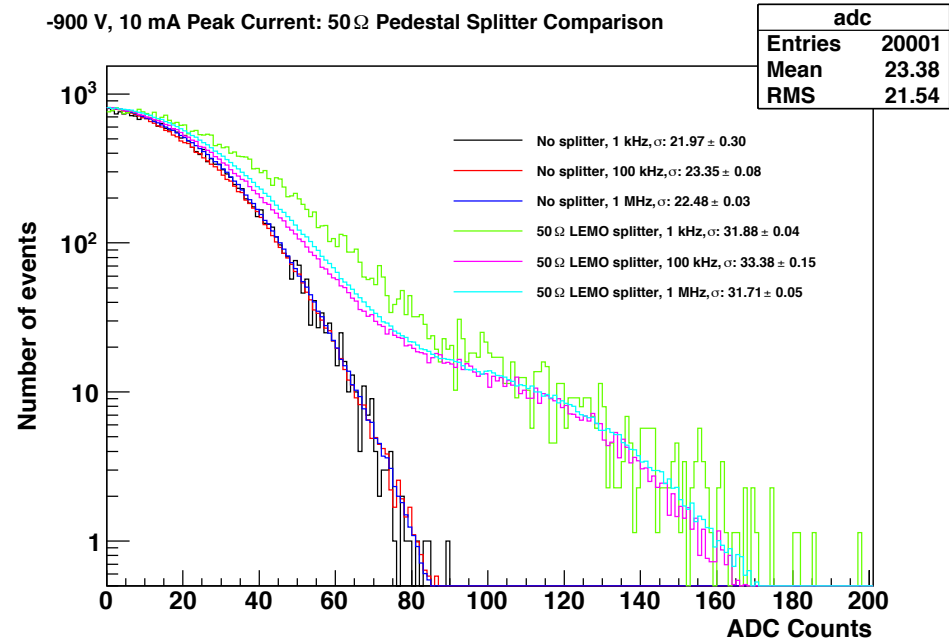
- The spectra become less Gaussian and more difficult to fit when using the splitter.

HV: -900 V, $I_{\text{peak}} = 10 \text{ mA}$: Pedestal

-900 V, 10 mA Peak Current: 50 Ω Pedestal Splitter Comparison



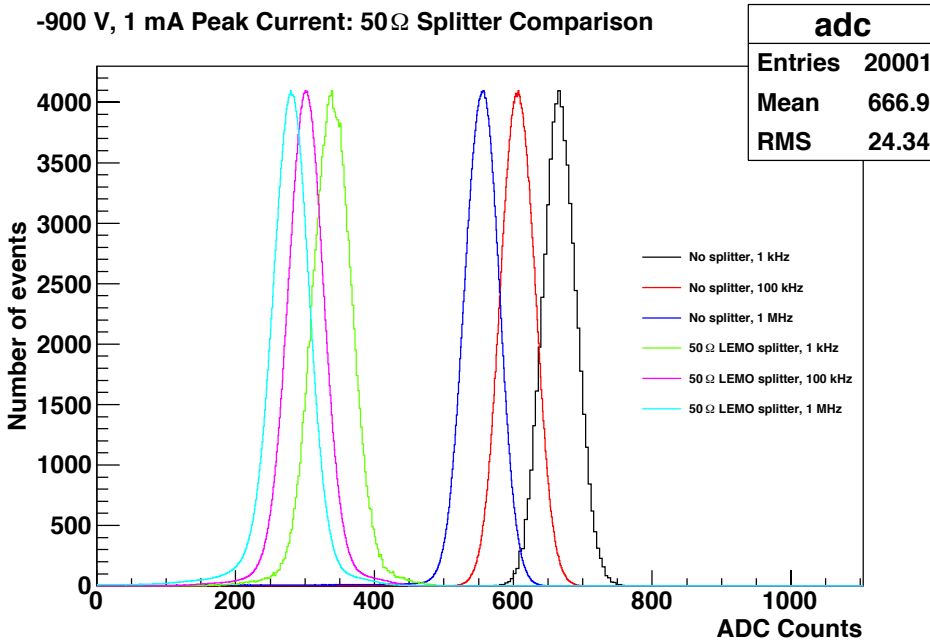
-900 V, 10 mA Peak Current: 50 Ω Pedestal Splitter Comparison



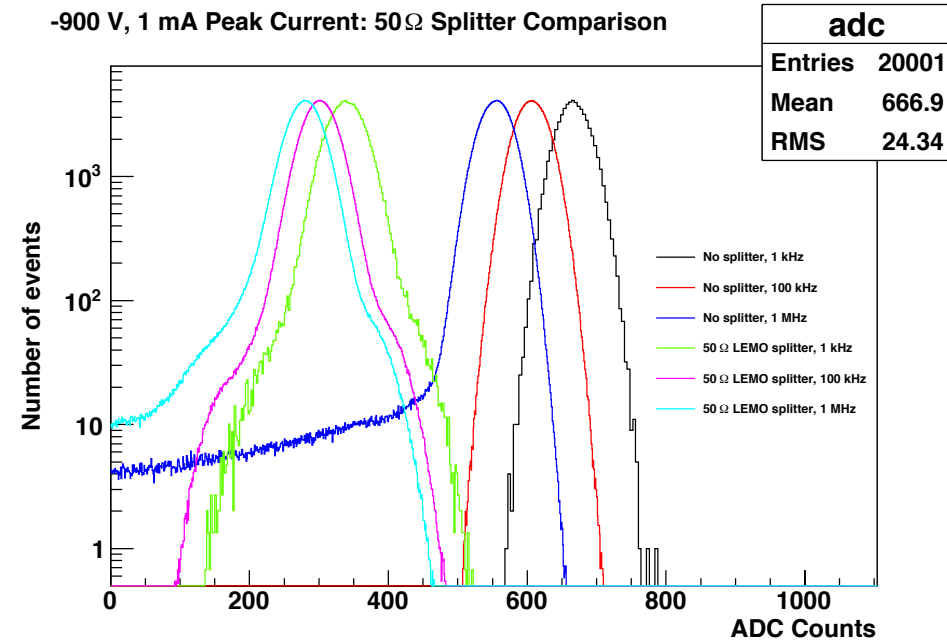
- The pedestal is significantly **less Gaussian** when using a splitter! It becomes difficult to fit.
 - Without splitter: $\sigma_{\text{pedestal}} \sim 22$ ADC counts, σ_{data} : 33 – 38 ADC counts
 - With splitter: $\sigma_{\text{pedestal}} \sim 32$ ADC counts, σ_{data} : 31 – 35 ADC counts
- Therefore, when using the splitter σ_{pedestal} and σ_{width} are very close to each other. In some cases, $\sigma_{\text{pedestal}} > \sigma_{\text{width}}$, therefore we **cannot** get a **reliable energy resolution measurement** when using the splitter!

HV: -900 V, $I_{\text{peak}} = 1 \text{ mA}$

-900 V, 1 mA Peak Current: 50 Ω Splitter Comparison



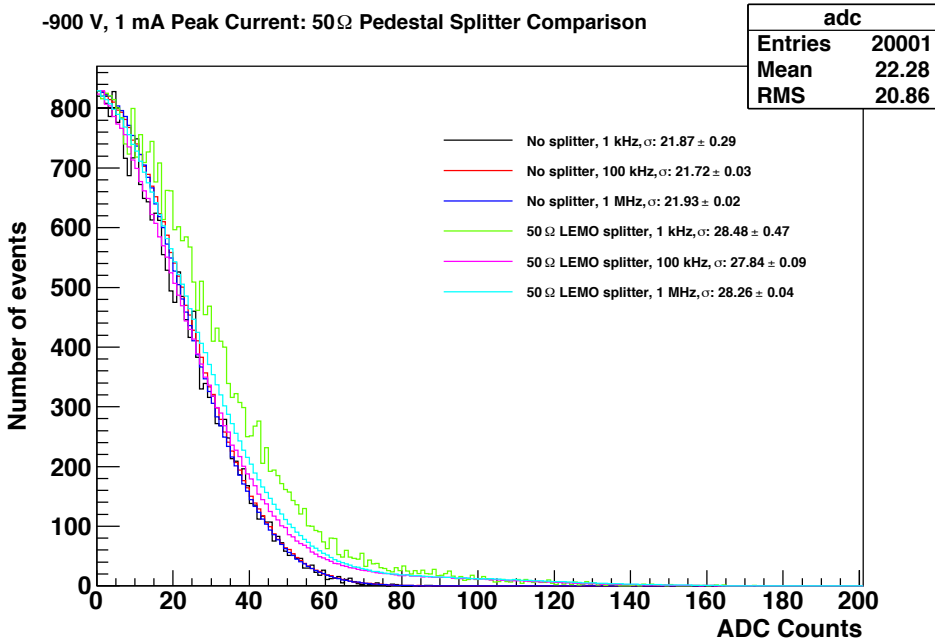
-900 V, 1 mA Peak Current: 50 Ω Splitter Comparison



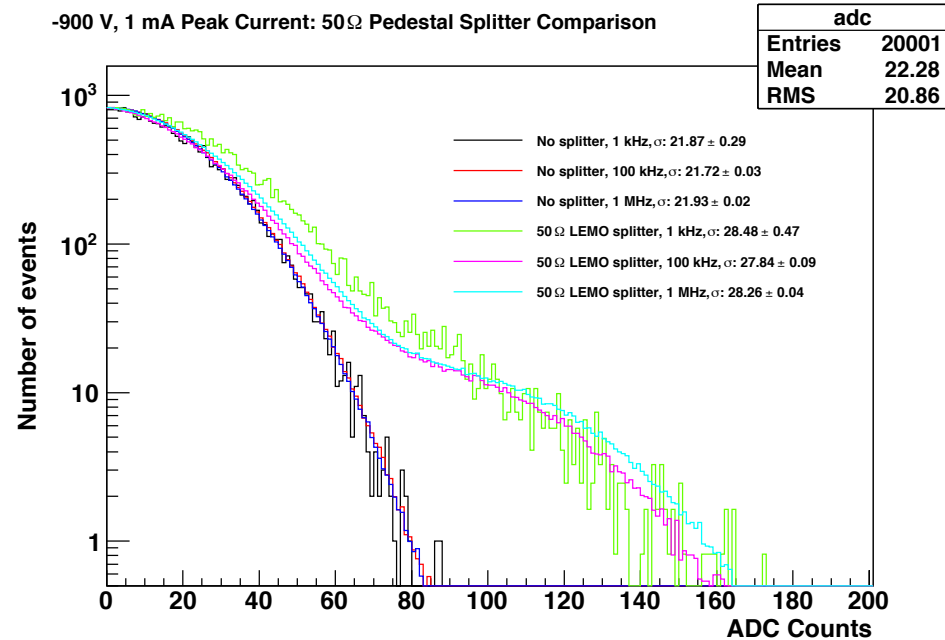
- The spectra become a lot less Gaussian and more difficult to fit when using the splitter.

HV: -900 V, $I_{\text{peak}} = 1 \text{ mA}$: Pedestal

-900 V, 1 mA Peak Current: 50 Ω Pedestal Splitter Comparison



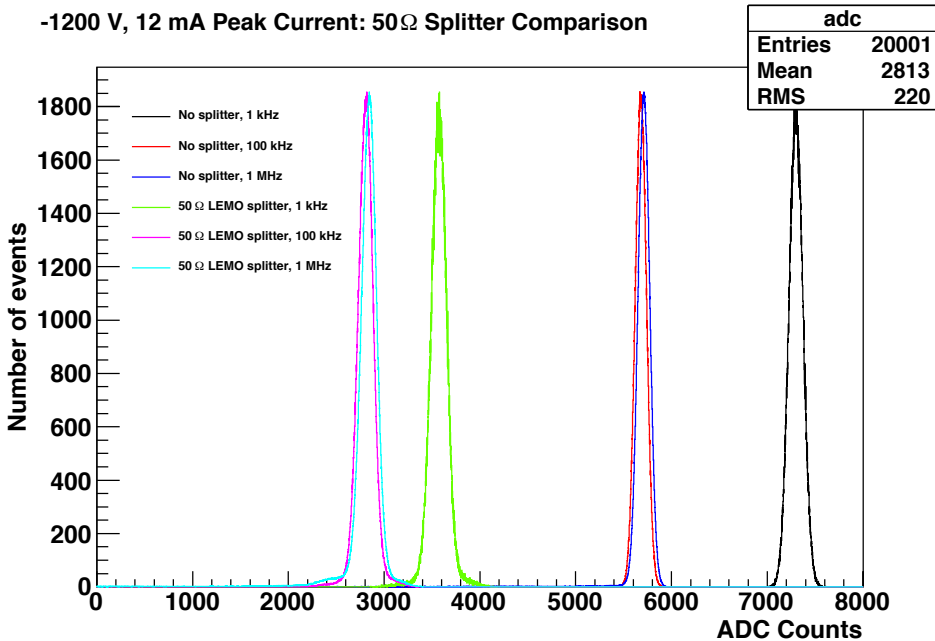
-900 V, 1 mA Peak Current: 50 Ω Pedestal Splitter Comparison



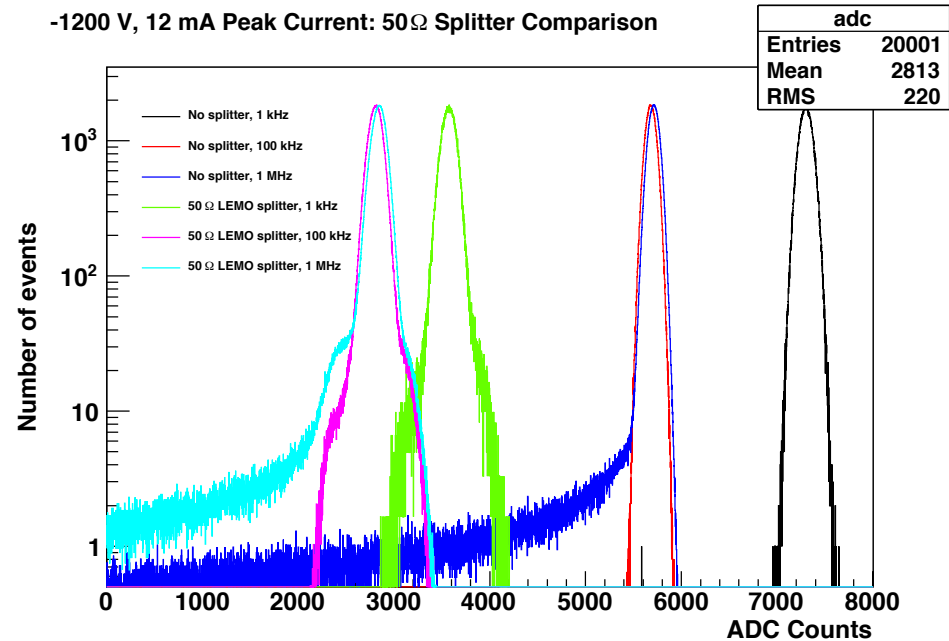
- The pedestal is significantly **less Gaussian** when using a splitter! It becomes difficult to fit.
 - Without splitter: $\sigma_{\text{pedestal}} \sim 22$ ADC counts, $\sigma_{\text{data}}: \sim 24$ ADC counts
 - With splitter: $\sigma_{\text{pedestal}} \sim 28$ ADC counts, $\sigma_{\text{data}}: 26 - 29$ ADC counts
- Again, when using the splitter σ_{pedestal} and σ_{width} are very close to each other. In some cases, $\sigma_{\text{pedestal}} > \sigma_{\text{width}}$, therefore we **cannot** get a **reliable energy resolution measurement** when using the splitter!
- The situation is worse at lower ADC values/lower peak current.

HV: -1200 V, $I_{\text{peak}} = 12 \text{ mA}$

-1200 V, 12 mA Peak Current: 50 Ω Splitter Comparison

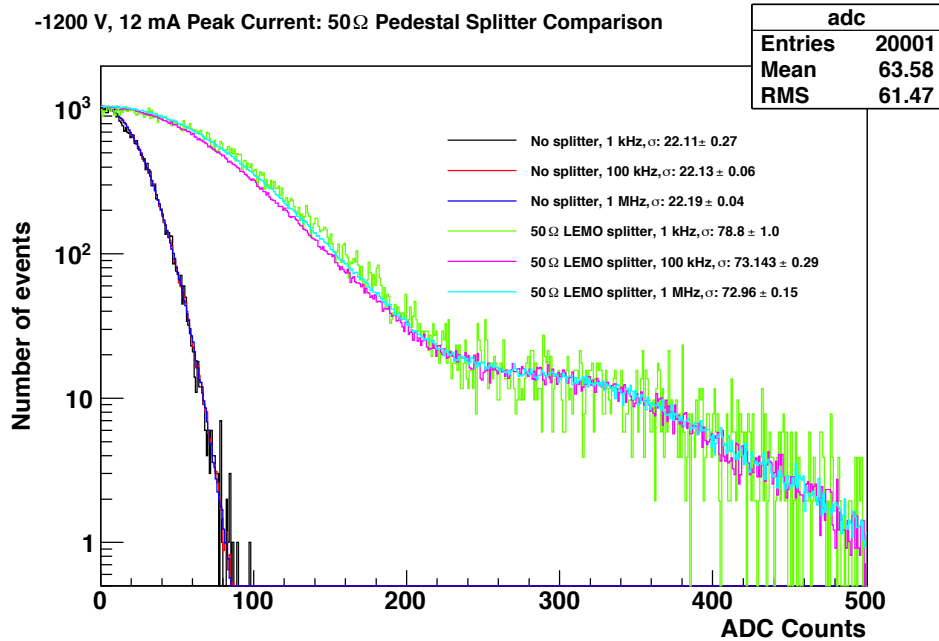
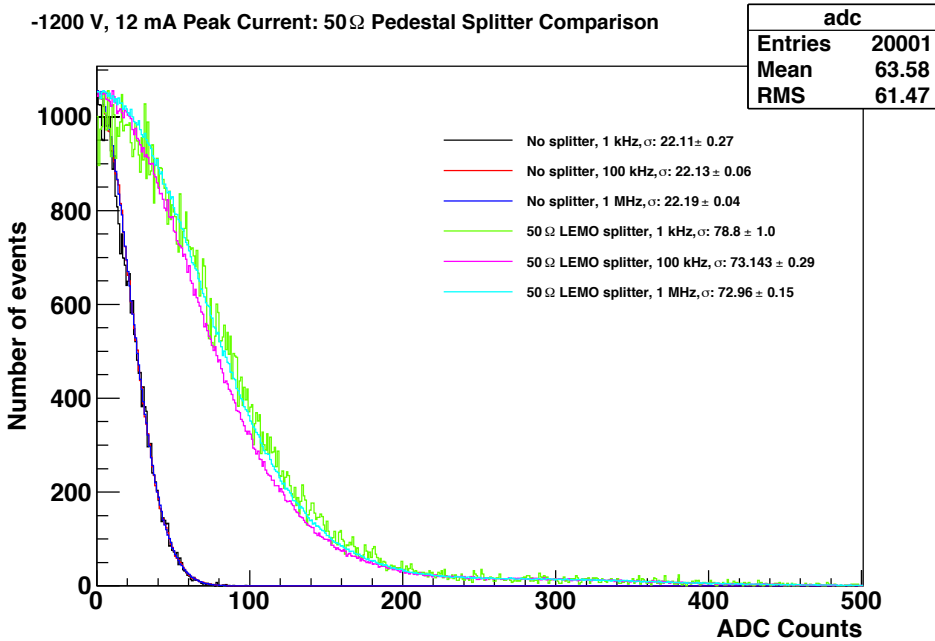


-1200 V, 12 mA Peak Current: 50 Ω Splitter Comparison



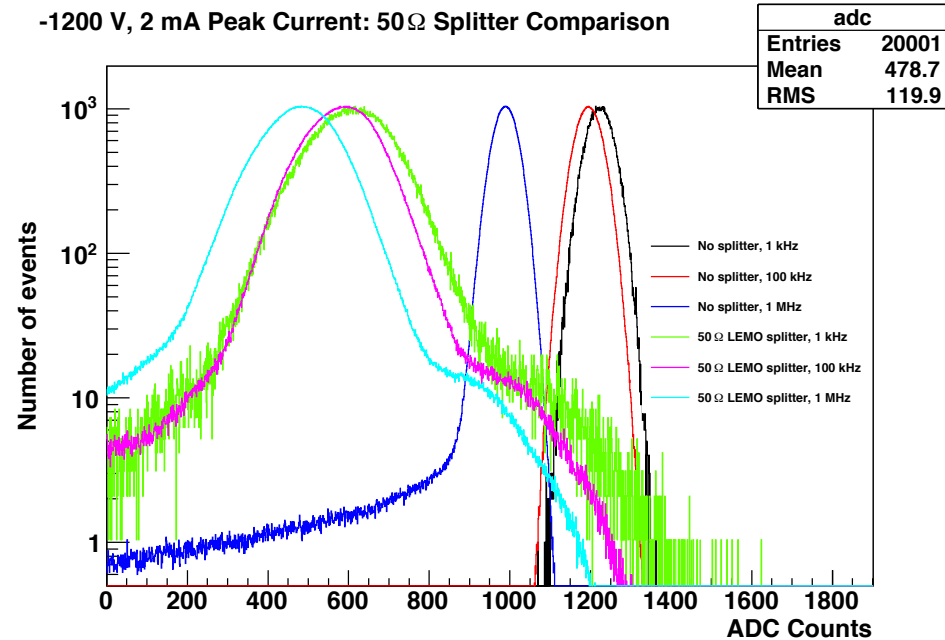
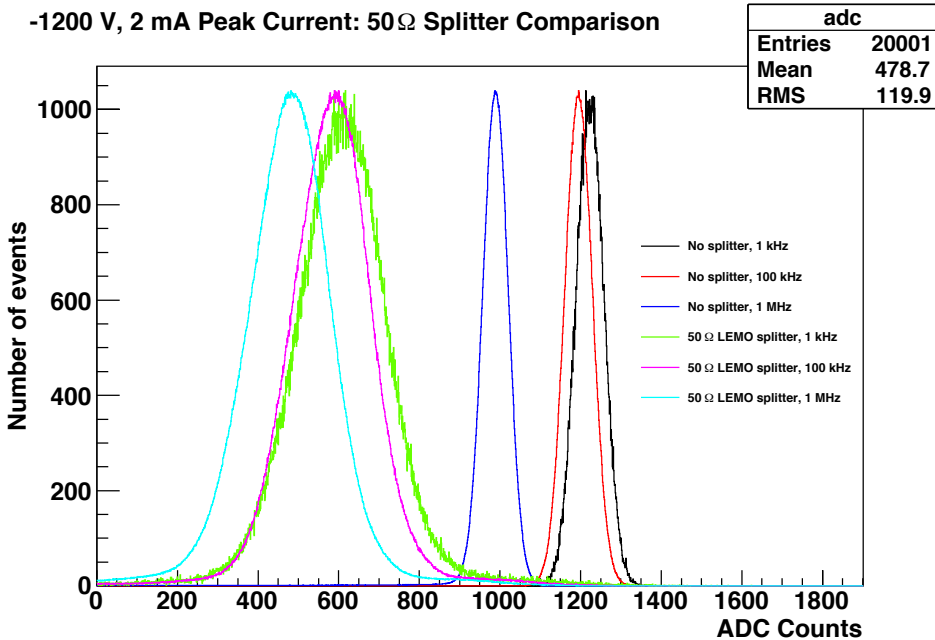
- The spectra become less Gaussian and more difficult to fit when using the splitter.

HV: -1200 V, $I_{\text{peak}} = 12 \text{ mA}$: Pedestal



- The pedestal is significantly **less Gaussian** and **MUCH larger** when using a splitter! It becomes difficult to fit.
 - Without splitter: $\sigma_{\text{pedestal}} \sim 22$ ADC counts, σ_{data} : 58 - 73 ADC counts
 - With splitter: $\sigma_{\text{pedestal}} \sim 75$ ADC counts, σ_{data} : 77 - 82 ADC counts
- Therefore, when using the splitter σ_{pedestal} and σ_{width} are very close to each other. In some cases, $\sigma_{\text{pedestal}} > \sigma_{\text{width}}$, therefore we **cannot** get a **reliable energy resolution measurement** when using the splitter!

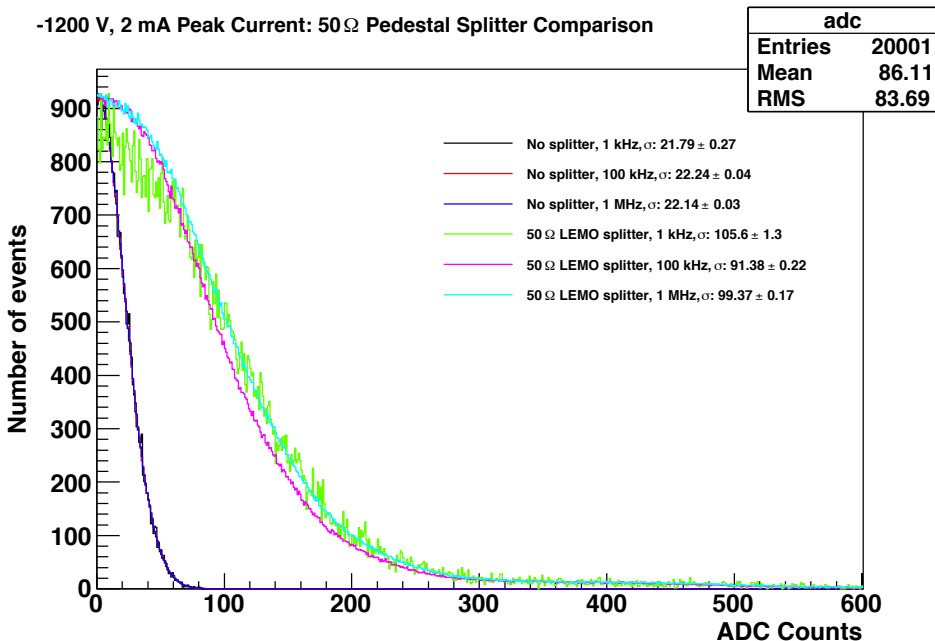
HV: -1200 V, $I_{\text{peak}} = 2 \text{ mA}$



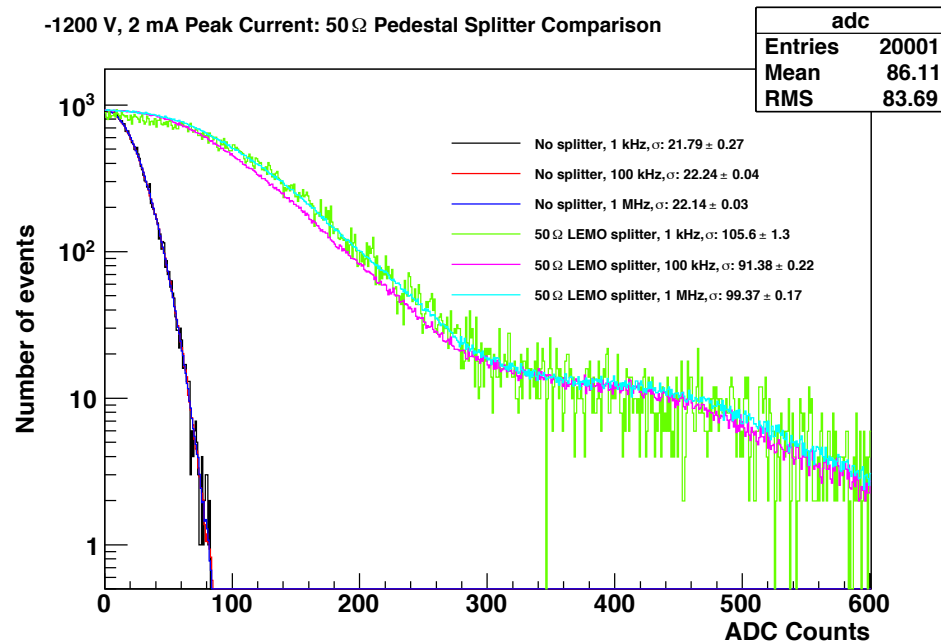
- The spectra become a lot less Gaussian and more difficult to fit when using the splitter.

HV: -1200 V, $I_{\text{peak}} = 2 \text{ mA}$: Pedestal

-1200 V, 2 mA Peak Current: 50 Ω Pedestal Splitter Comparison



-1200 V, 2 mA Peak Current: 50 Ω Pedestal Splitter Comparison



- The pedestal is significantly **less Gaussian** and **MUCH larger** when using a splitter! It becomes difficult to fit.
 - Without splitter: $\sigma_{\text{pedestal}} \sim 22$ ADC counts, $\sigma_{\text{data}}: \sim 32 - 34$ ADC counts
 - With splitter: $\sigma_{\text{pedestal}} \sim 100$ ADC counts, $\sigma_{\text{data}}: 90 - 100$ ADC counts
- Again, when using the splitter σ_{pedestal} and σ_{width} are very close to each other. In some cases, $\sigma_{\text{pedestal}} > \sigma_{\text{width}}$, therefore we **cannot** get a **reliable energy resolution measurement** when using the splitter!
- The situation is worse at lower ADC values/lower peak current.

Conclusions

- When using the **splitter** σ_{pedestal} and σ_{data} are always roughly **equal**! Does this tell us anything helpful?
- Using the current 50 Ω LEMO splitter will not work...
 - Could any of the cables and connectors be causing problems?
 - Too many to test and still unreliable...
- Possible solutions:
 - Make an active splitter to keep original signal size
 - Get a 50 Ω BNC splitter in order to reduce number of connectors and cables
 - Any other ideas?