News on the limits

Limits in the HIP/monopole search @ 8 TeV

https://cds.cern.ch/record/1704393/files/ATL-COM-PHYS-2014-538.pdf

DY Spin-½ HECO Mass [GeV]	95% CL upper limit on number of signal events			
	|z| = 10	|z| = 20	|z| = 40	|z| = 60
200	3	3	3	3
500	3	3	3	3
1000	3	3	3	3
1500	3	3	3	3
2000	3	3	3	3
2500	3	3	3	-

Obtained given the following conditions:

$$\delta\varepsilon = 13\%$$
$$N_{bkg}^{expected} = 0.4$$
$$\delta N_{bkg}^{expected}\,(stat.) = 60\%$$
$$\delta N_{bkg}^{expected}\,(syst.) = 40\%$$
$$N^{observed} = 0$$
$$\delta\mathcal{L} = 2.8\%$$

I asked them in https://cds.cern.ch/record/1704393/comments#C123040 why the upper limits equal three events in each and every case. Shouldn't they be [much] greater than that?

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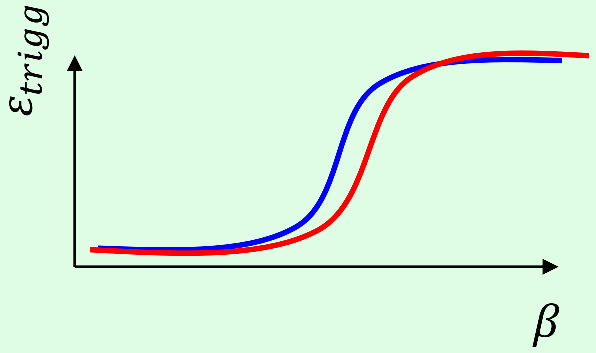
Their reply in https://cds.cern.ch/record/1704393/comments#C124608 :

--- I understand your concern. In the CLs procedure, when the pseudo data experiments are carried out, it is important to note that the nuisance parameter (of which the systematics is one), are actually *not randomized*. They are instead set to the cond. MLE wrt the mu that we test for and the *observed data*. In our case having 0 oberved events, it is very unlikely that the MLEs would deviate much from the nominal value 1, (at least to values corresponding to higher signal efficiency). When the test statistic is evaluated for (pseudo) data, the nuisance parameters are however left floating (as far as the constraint functions permit), but since the data is generated with the MLEs, it is quite unlikely that the best fit value would be something large for the signal efficiency. Thus, the test statistic distributions won't be affected that much, and thus the limits will not either. This all assumes that the fits are stable and find the global minima, which has been ensured by separate studies described in the note and maybe most importantly that we have upgraded to Minuit2. (KB)

RPC-trigger-efficiency correction

The idea

- The idea is to somehow compare the turn-on curves of the single-muon trigger as a function of β between data and MC;



- By applying some sort of correction to the MC curve we can make it match the data curve;

- How can we derive that correction if the single-muon trigger fires only because of the muons (at least in the data), but all muons have $\beta \approx 1$?

The model

- Instead of obtaining those turn-on curves directly from data (something we can't do) and MC (something we can't trust), we can parameterize these with

$$\varepsilon_{trigger}^{data/MC} = \frac{1}{2}\left(1 - erf\left(\frac{t - t_0 - \Delta_{data/MC}}{\sqrt{2}\sigma_{data/MC}}\right)\right)$$, where

$t = \frac{L}{\beta c}$ - time the signal particles take to reach the outermost RPC plane

$t_0 = \frac{L}{c}$ - time muons take to reach the outermost RPC plane

$\beta = \frac{\beta_{ID} + \beta_{MS}}{2}$ - effective β

$L = \frac{r}{\sin\theta}$ - distance between the IP and outermost RPC plane, $r = 10$ m $\rightarrow \eta$ dependence

Δ - peak position of the timing distribution of muons within the readout window

σ - width of that timing distribution

Where does the data/MC difference come from in the model?

- Δ and σ can be extracted from *muon* distributions in data and MC:

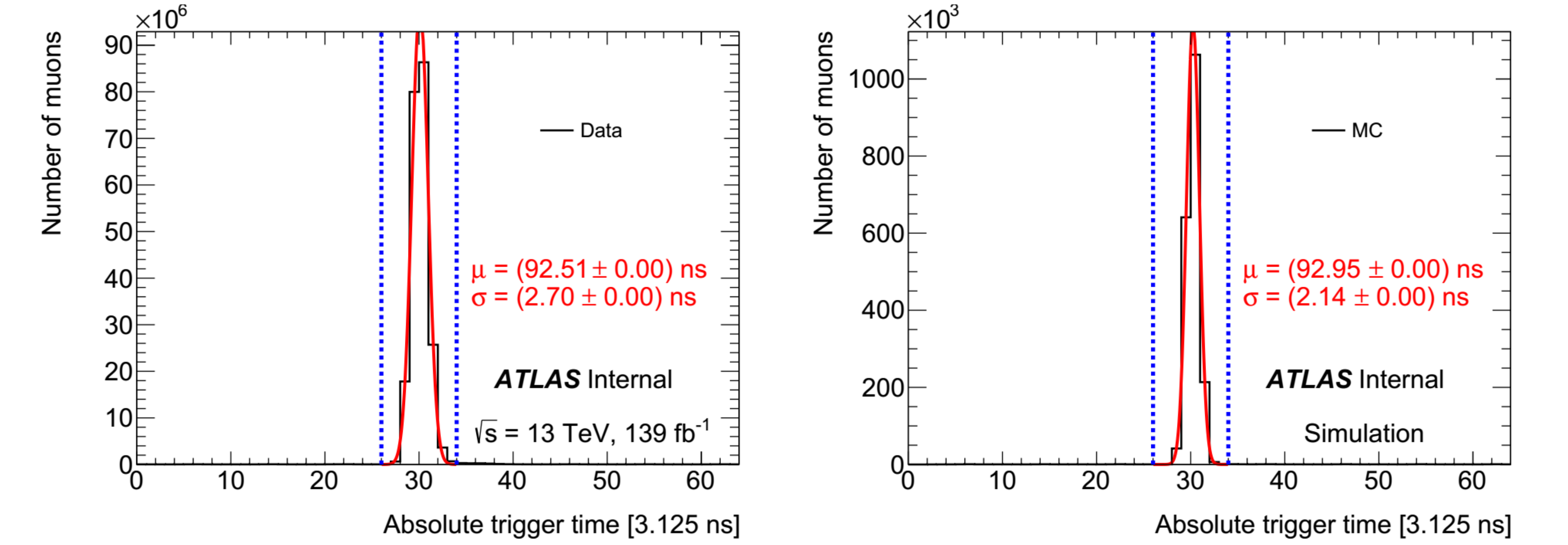


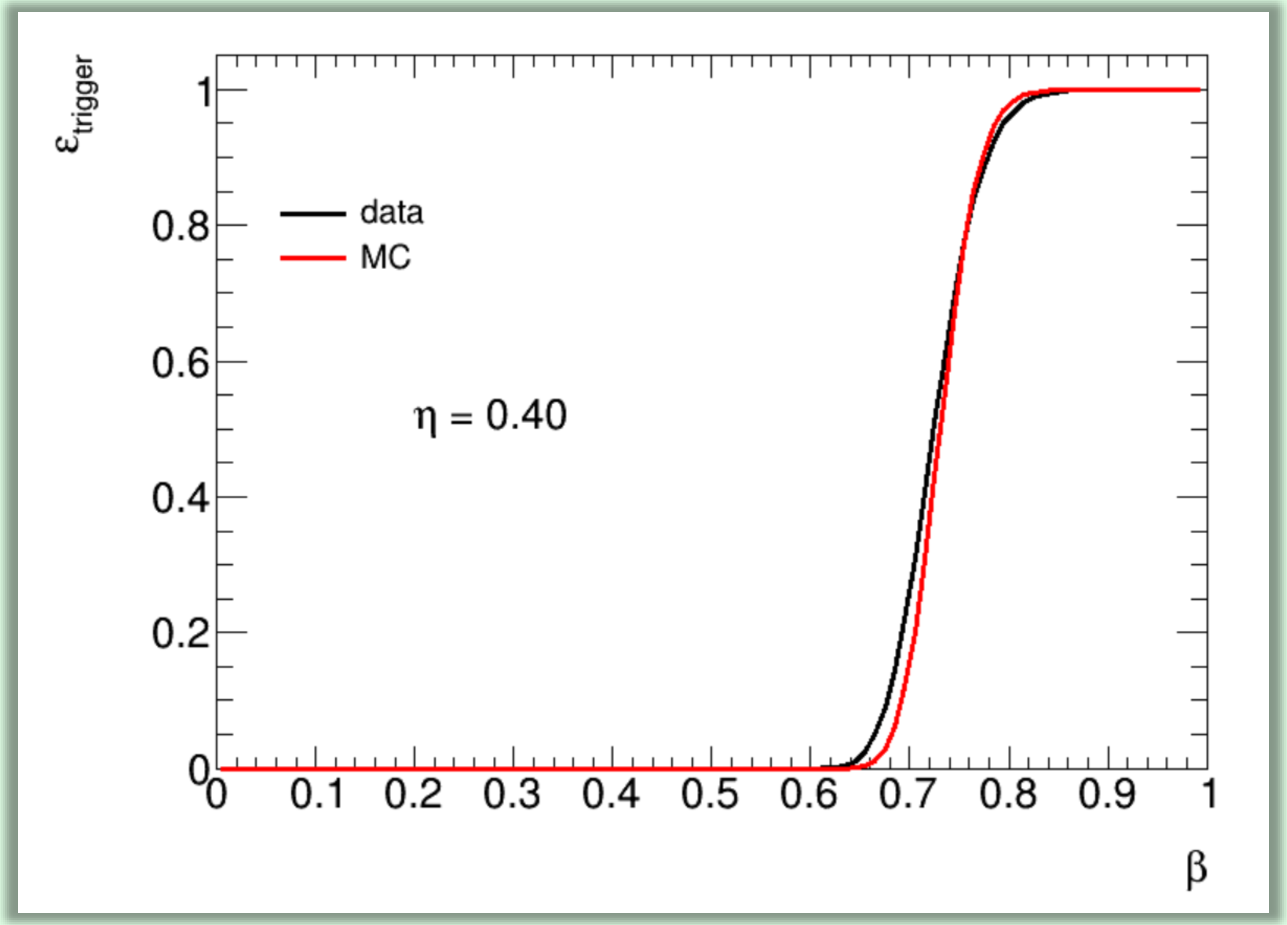
Figure 26: Hit arrival time of L1 RPC triggers in data **(left)** and Monte Carlo **(right)**. Gaussian fits and their parameters are shown in red. Vertical dashed blue lines denote the 25 ns-wide trigger timing windows.

$$\Delta = 34 \cdot 3.125 - \mu$$

- these two differences (one between Δ_{data} and Δ_{MC} and another one between σ_{data} and σ_{MC}) are the only parameters in the model responsible for any potential data/MC disagreement.

The final turn-on curves

- Now we plug everything into the $\varepsilon_{trigger}^{data/MC} = \frac{1}{2}\left(1 - erf\left(\frac{t - t_0 - \Delta_{data/MC}}{\sqrt{2}\sigma_{data/MC}}\right)\right)$ and plot it as a continuous function of β for a fixed value of η:



The correction

- The ratio of $$\frac{\varepsilon_{trigger}^{data}}{\varepsilon_{trigger}^{MC}} = \frac{1 - erf\left(\frac{t - t_0 - \Delta_{data}}{\sqrt{2}\sigma_{data}}\right)}{1 - erf\left(\frac{t - t_0 - \Delta_{MC}}{\sqrt{2}\sigma_{MC}}\right)} = \rho_{one\ candidate}$$ gives the correction we need to multiply the $\varepsilon_{trigger}^{MC}$ by;

- This only applies to MCPs, which made the RPC trigger fire. If a non-MCP object (e.g., a muon) also made the RPC trigger fire or any other trigger (e.g., the MET trigger) also fired in this event, the correction is set to 1;

- This only applies to events where exactly one MCP made the single-muon trigger fire. If both of them made it fire within the RPC pseudorapidity range ($|\eta| < 1.05$), the correction will look like

$$\rho_{two\ candidates} = \frac{1 - \left(1 - \varepsilon_{trigger\ 1}^{data}\right)\left(1 - \varepsilon_{trigger\ 2}^{data}\right)}{1 - \left(1 - \varepsilon_{trigger\ 1}^{MC}\right)\left(1 - \varepsilon_{trigger\ 2}^{MC}\right)}$$

(again, if neither of these two MCPs (or any other objects in the event) made any other trigger fire, including the same single-muon trigger within the TGC range)

Correction-related uncertainties

We vary $t = \frac{L}{\beta c} \rightarrow \frac{L}{\left(\beta \pm \frac{|\beta_{ID} - \beta_{MS}|}{2}\right) c}$ and $t = \frac{L}{\beta c} \rightarrow \frac{L}{\beta c} \pm \sigma_{data}$

For each signal sample the maximal difference between two variation directions of the first variation was added in quadrature with the maximal difference of the second variation. These uncertainties are negligible for all considered MCP samples, < 0.01%.

THANKS!