Towards CMS full simulation fits

Electrons and muons

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Challenges

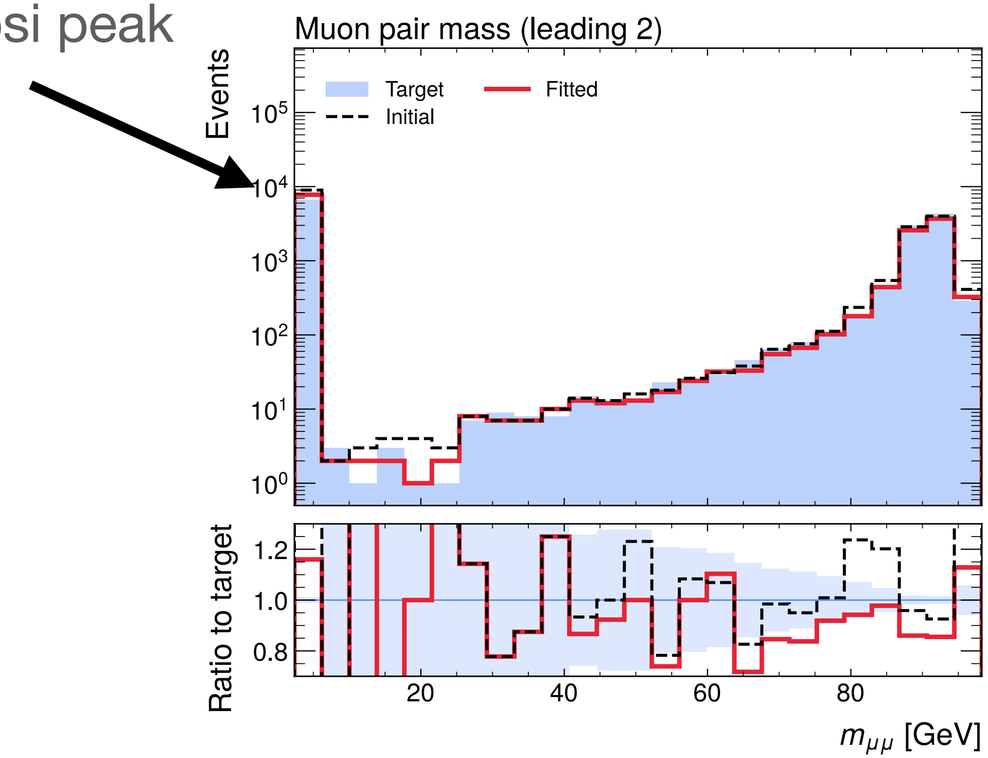
- Geant4 and CMS PF model physics which is not encoded in Delphes
- Different datasets highlight a range of universal detector effects
  -> we have to control a misspecified fit (best-fit parameters do not include CMS)

- Start from the simplest physics:
  - $Z \to \mu\mu, J/\psi \to \mu\mu$, flat in p_T
  - $Z \to ee, J/\psi \to ee$, flat in p_T
  - generated by Abdel with CMSSW
  - likelihood loss

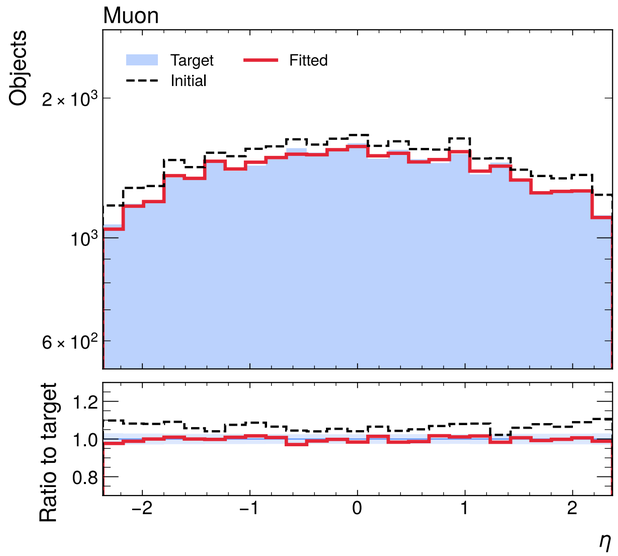
Muons

- Likelihood fit on the entire dataset:

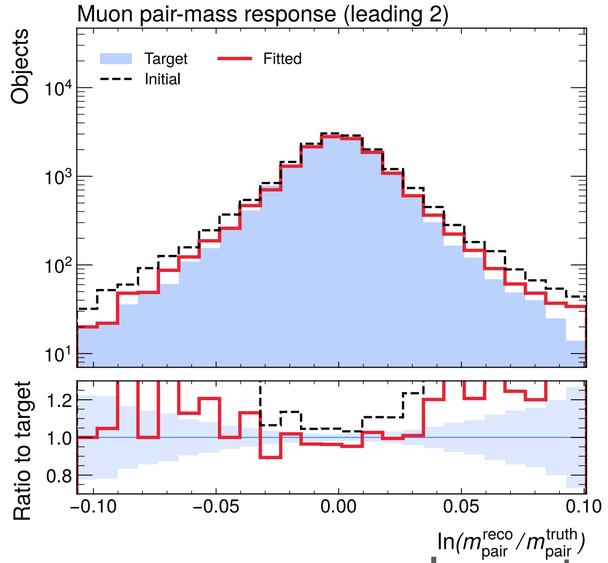
single-bin J/psi peak



But worse agreement at the Z-peak?



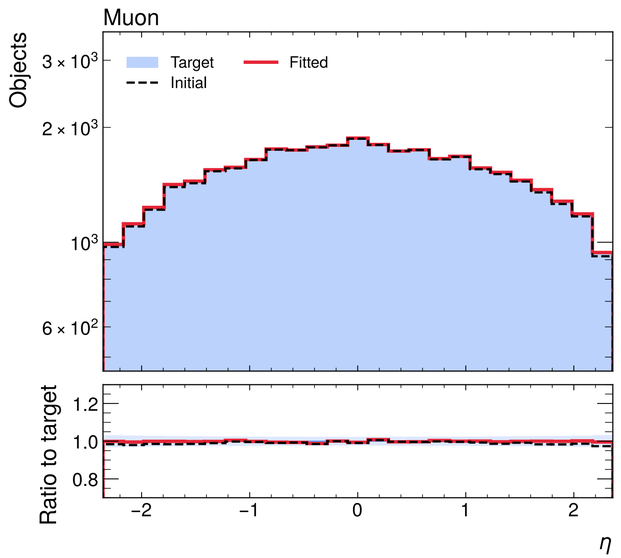
correct normalisation



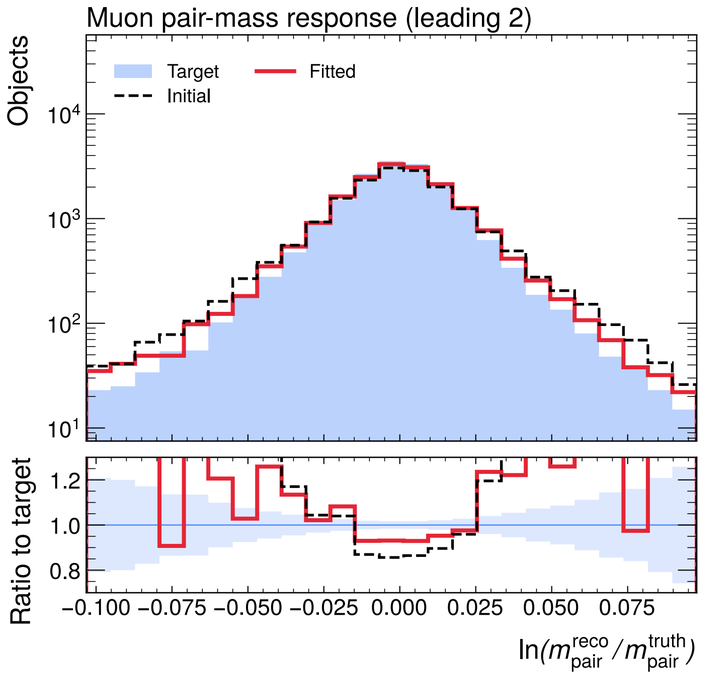
dimuon mass response closer to CMS

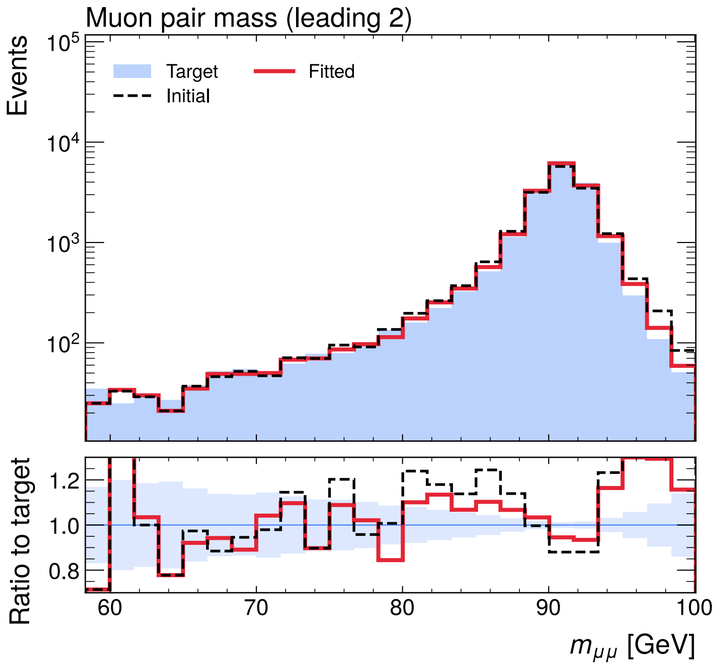
Muons

- Let's look at the $Z \to \mu\mu$ only:



normalization is already correct!



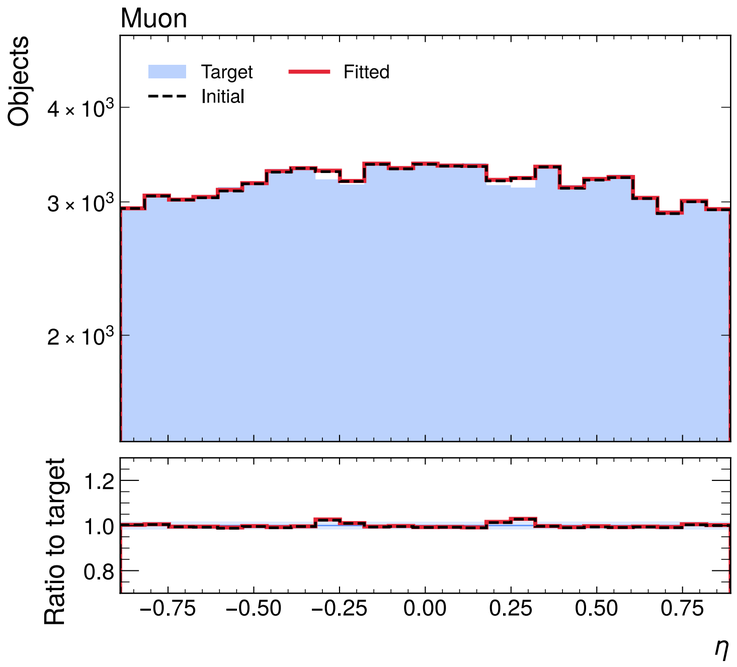


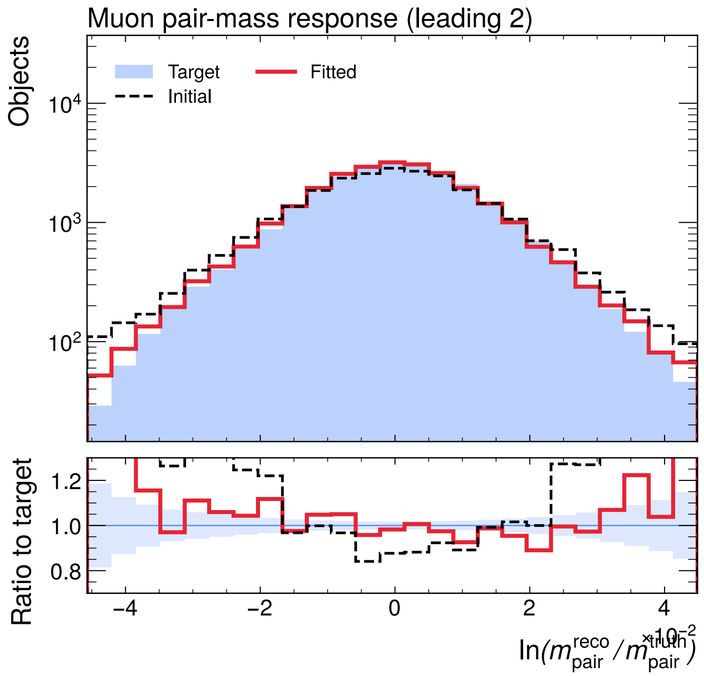
5-10% improvement in the dimuon mass spectrum/response

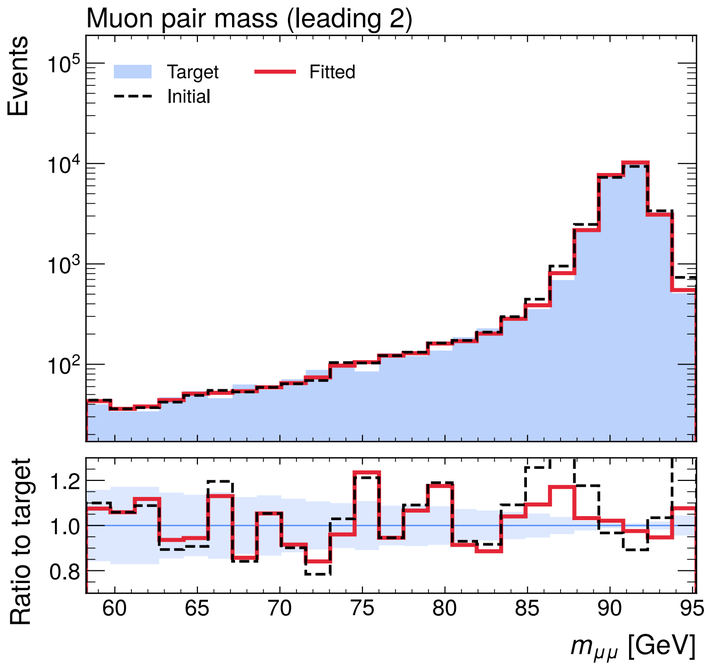
- The combined fit absorbs the low-energy effects from J/Psi in global efficiencies:
  - lost collinear and soft muons;
  - low-pT mis-reconstruction

Muons

- Let's look at the $Z \to \mu\mu$ and $|\eta| < 0.9$:



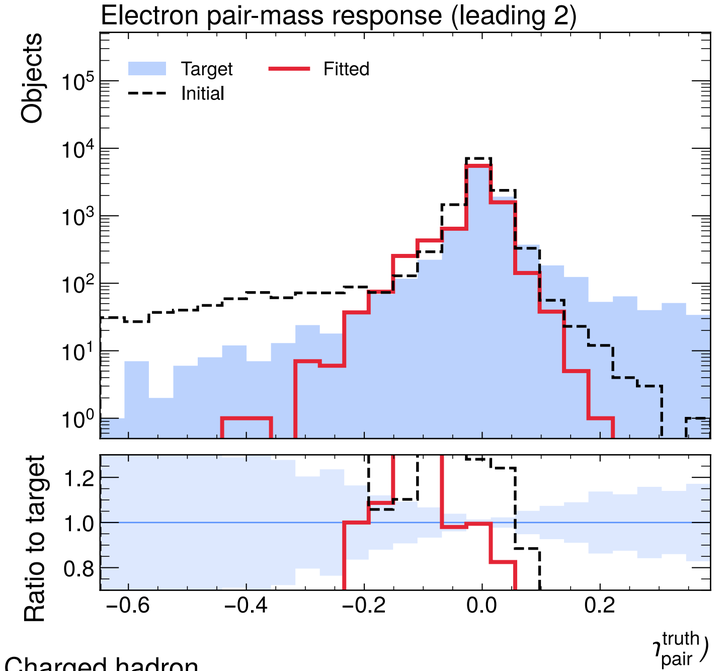


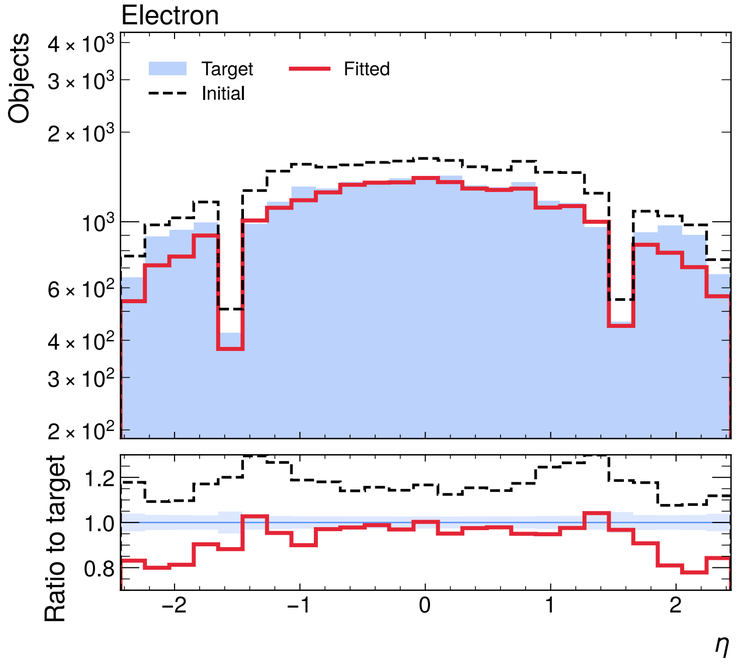


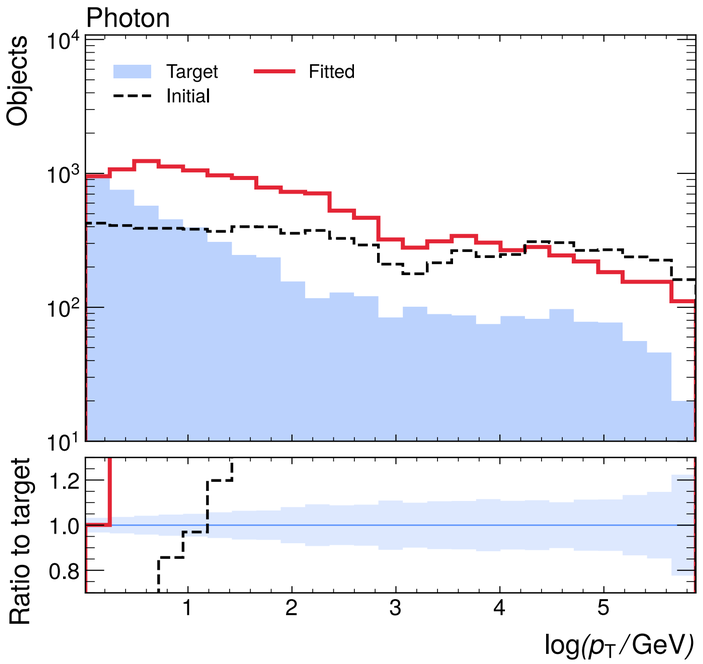
- Extract a usable detector card for muons in the barrel:
  - constant terms in momentum smearing are physical:
    - a_raw[0]: $1.0 \times 10^{-2} -> 0.95 \times 10^{-2}$
    - a_raw[1]: $1.5 \times 10^{-2} -> 1.15 \times 10^{-2}$

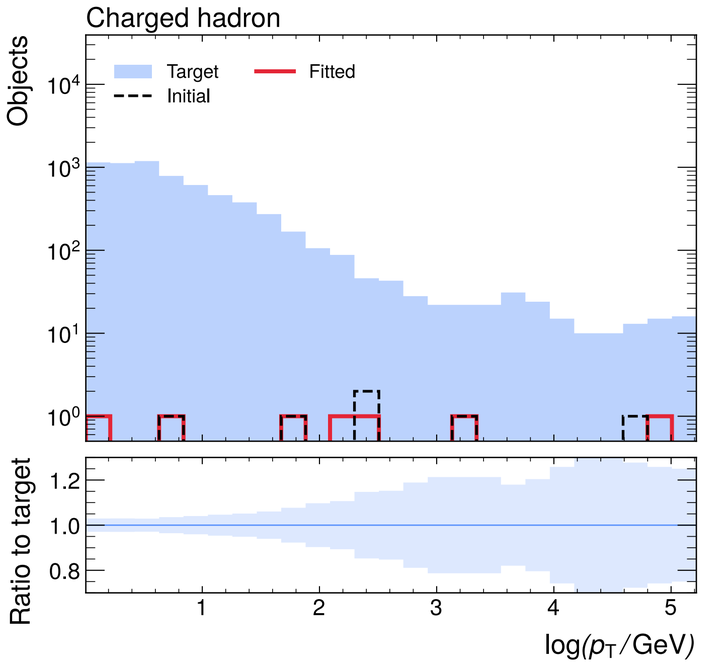
Electrons

- Same story for electrons:









- Right number of electrons and more faithful resolution at the Z peak
- Generate additional soft-photons and no charged hadrons

Message

- We have to be careful of fitting universal detector response effects
- We have to be careful of not fitting process-specific effects
- We should be as explicit as possible in the paper:

Example 1:
“We fit a card for muons produced from a Z in this (pT, eta) range”

Example 2:
“We include the modelling of this new *universal detector effect*, e.g. electron mis-identification in this (pT, eta) range, and fit a detector response for muons and electrons at the J/Psi and Z peak.”