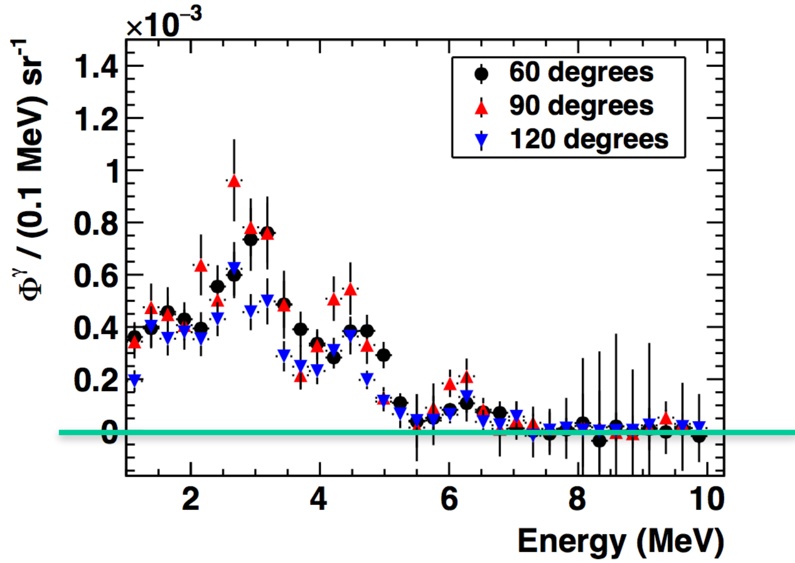
Update on neutral analysis

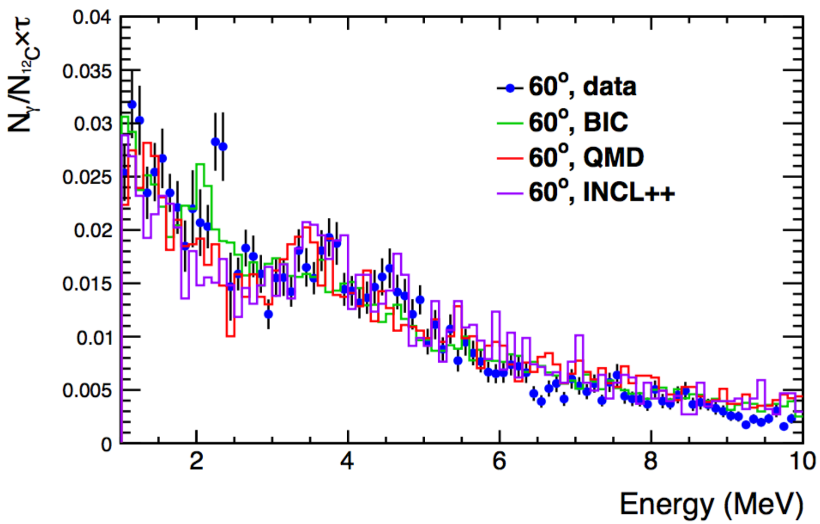
Paper content: remaining issues

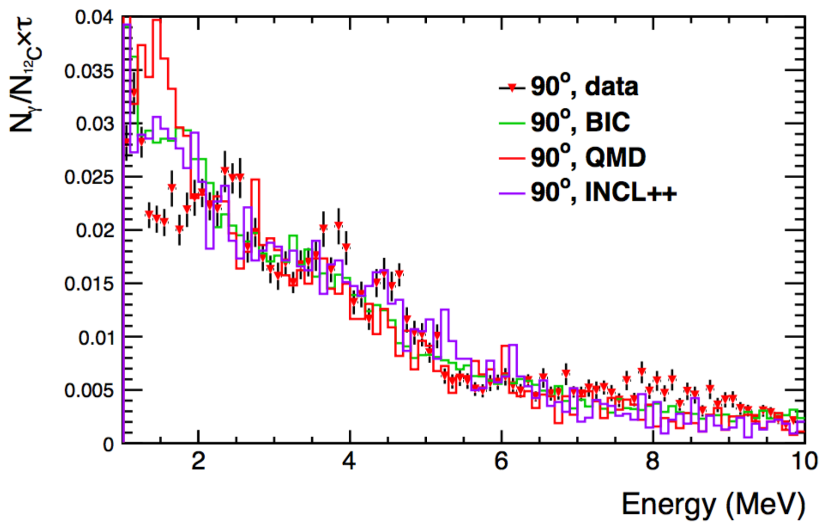
- Prompt Gammas (PG) spectra: BaF & LYSO
  - Here the main problem we have is the consistency among the BaF and LYSO spectra before and after any analysis/unfolding. The two detectors are seeing a different raw spectra [let's focus @ 90°] and after the unfolding the situation does not improve **the main remaining issue is the difference in the long tail > 7 MeV for BaF and LYSO**
- PG integrated flux (2-10 MeV) : BaF & LYSO
  - Here we have to: be consistent with other published data (either from us or from other exp.), be consistent with other experiments we made but are not yet published, check also against MC models what's going on.
- Discussion against MC models: BaF only
  - Very nice work done on BaF paper, no issues there.

Spectra

- Spectra endpoint:
  - 7 MeV: LYSO at GSI and other data from IBA (protected by undisclosure agreement, cannot add the plot here)
  - 10 MeV and above: BaF, MC Geant
- Now that the MC reproduce the data it would be nice to understand the origin of such large energy photons: are they de-excit. PG or they are due to "double counting" inside the BaF (since BaF has large acceptance there's a higher chance to have additional energy deposits together with the PG)

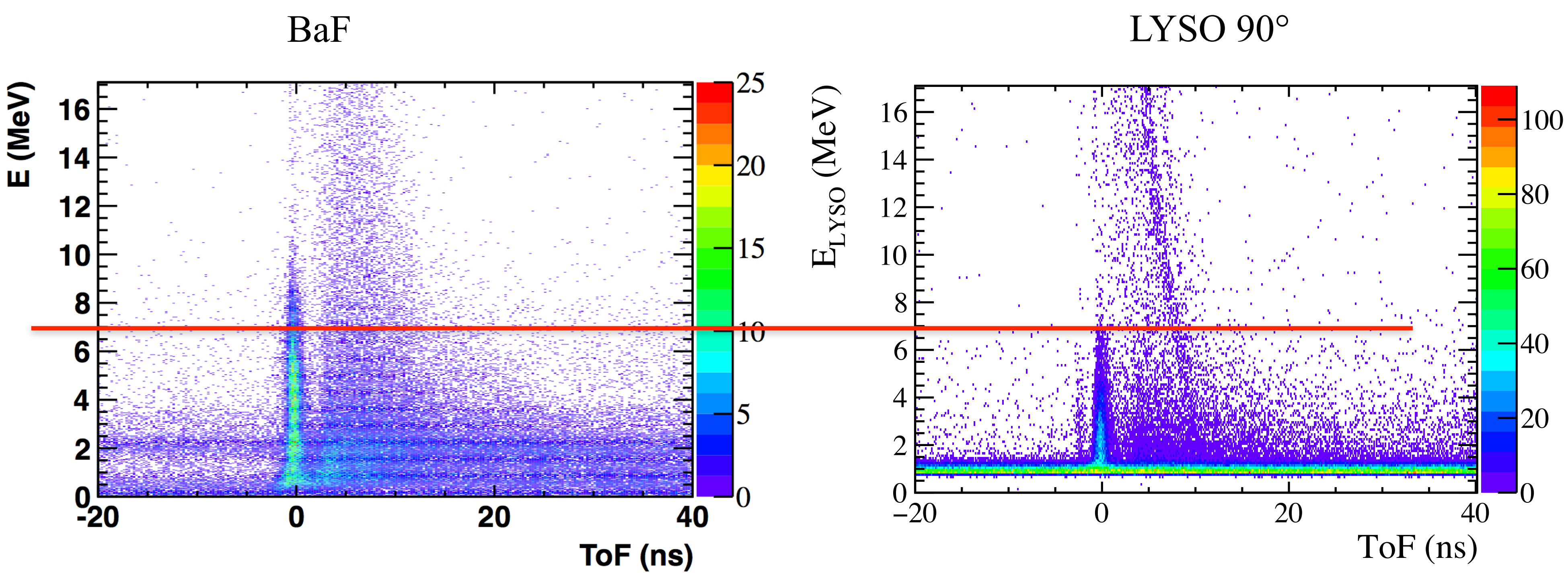






Spectra, raw

- Problem of the spectra endpoint **IS NOT RELATED** to analysis:
  - raw (calibrated) spectra already show the behavior



Integrated fluxes

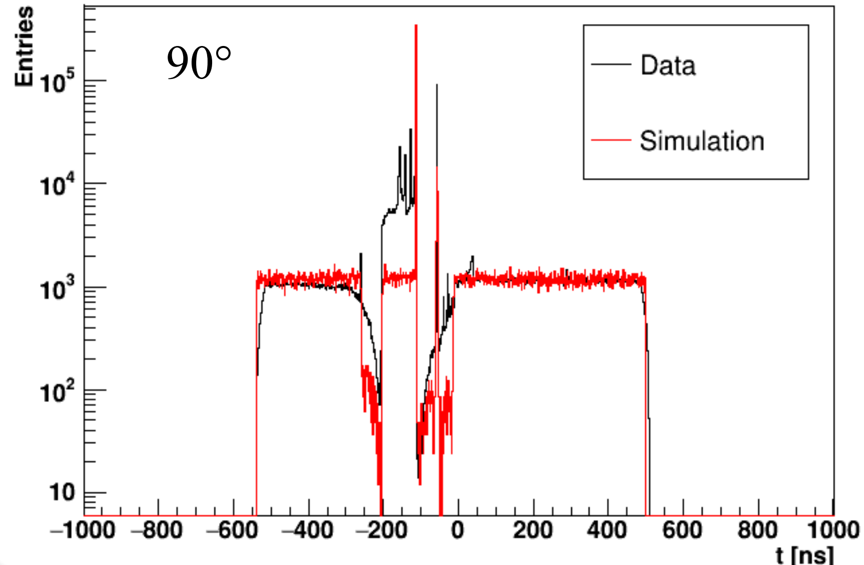
- While X-chking the analysis of the data acquired at HIT in 2014 @ 220 MeV/u we understood that we were missing a correction for the 80 ns discrimination time set on the SC signal.
- We have gone trough the exercise of computing the impact of the 80s discrimination time set on the SC signals on the counting of the incoming 12C.
  - For 80ns the scaler is "blind": how many carbon ions do we miss? Used a dedicated simulation to compute the number.
  - A scaling factor sc_fact is computed and a systematic uncertainty is assigned by varying the rate, accordingly to the measured spectra and redoing the calculation.

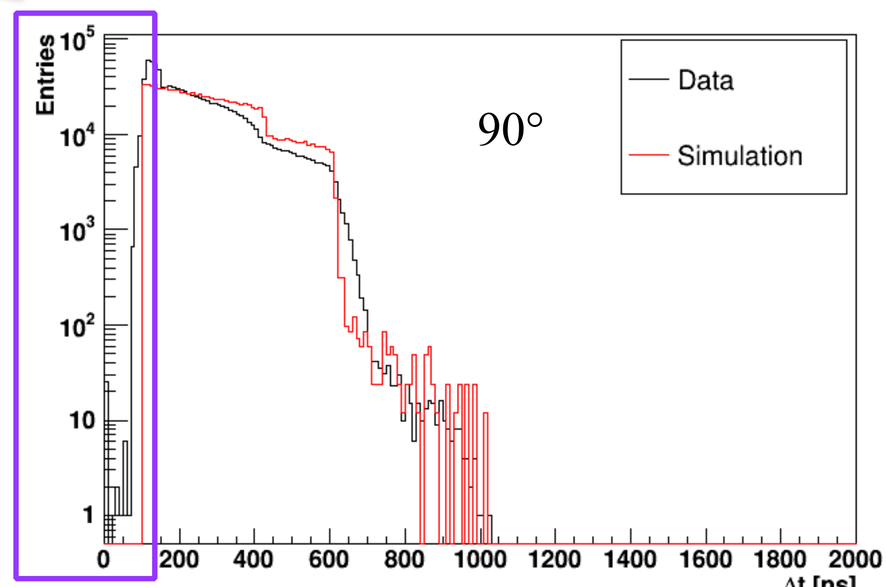
N ^{12}C Correction

- Simulated the beam structure for 90, 60 and 120° run
- Tried to evaluate the impact of the 80-100 ns discrimination cut

90°	**1.12 ± 0.07**
60°	**1.37 ± 0.19**
120°	**1.35 ± 0.15**

- the uncertainty comes from the folding of the sc_fact calculation with the measured rate spectra
- To apply the correction, just scale $N\ ^{12}C = N\ ^{12}C * sc\_fact$

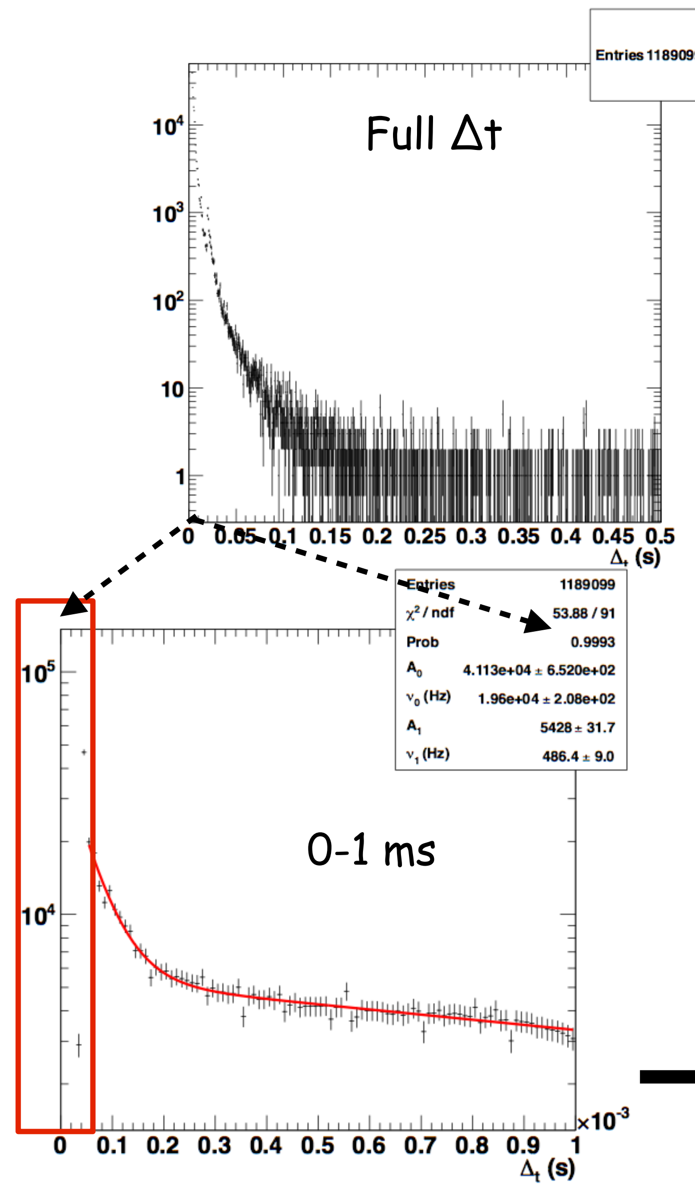




A bad news

- While struggling to understand how our numbers (both LYSO and BaF) compare to all the available measurements and MC predictions we have again had a look at the dead time measurement procedure.

- What we do now:
  - We take the full Δt distribution
  - We evaluate $\varepsilon_{\Delta t}$ as 1- Nlost/Nall where Nlost is computed integrating the fit function in the 0 - 50μs range and Nall is the sum of what is inside the 0 - 50 μs window + all the rest [from the histogram]
- Is this wrong?
  - YES (unfortunately). see next slide.



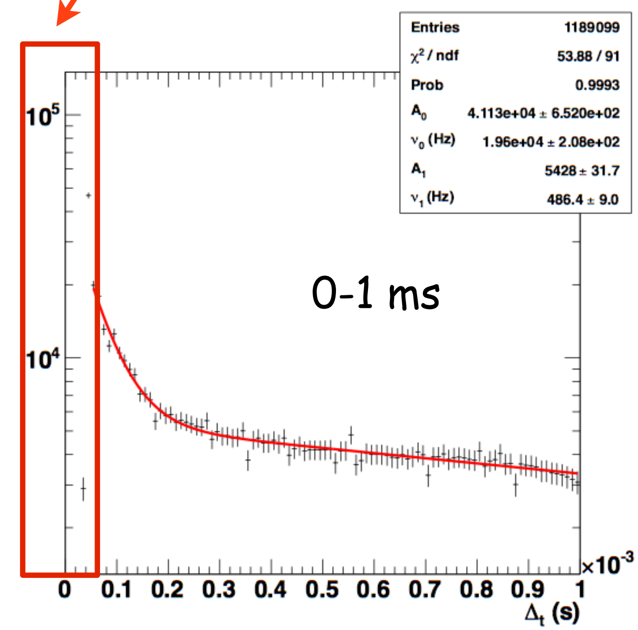
Our DAQ

- how the DAQ works?
  - VME driven
  - Takes 10 events (buffering the info)
  - On the last, the info buffered in the modules is read and written: this allowed a significant speedup of the DAQ since EACH VME instruction takes "ages" (~tens of μs)
- So the chain is:
  - Collect 10 consecutive triggers (to unlock the busy and check for a trigger we take, at least, 50 μs due to VME stufff)
  - Then on the last of the 10, we do our reading/writing.

The mistake

- We realized that by taking into account only the 0 - 50μs window we are actually considering only the impact of the SMALLEST dead time (the one connected to the unlock of the DAQ), while the real dead time is much longer and it is related to the events in which we actually write/read stuff from the boards (this DT actually fluctuates a lot, depending on how much busy where the events)!
- **This is leading to a clear underestimation of the DAQ DT.**
- Not easy to find a quick replacement for the DT procedure (~ everything we could use at GSI was actually broken/missing)
  - A reweighing of the HIT data could help us, we need few days to figure out how to do it

The area of what you loose btw 0 and 50μs wrt to the FULL area 0 - 0.5 s tells you the DeadTime [events lost because of DAQ DT]



N ^{12}C: do we still have a problem?

- After all fixes I have recomputed the fluxes with the best estimate given in our paper drafts. **DT problem not yet fixed!**
- I have focused on the integrated flux at 90°

$$\Phi_\gamma = \frac{N_\gamma}{N_C \times \tau \times \varepsilon_{det} \times \varepsilon_{geo} \times \Omega}$$

- Things to keep in mind when making comparisons:
  - Flux for BaF and LYSO are computed in different way ($N_\gamma/\varepsilon_{det}$ in LYSO analysis is taken from the unfolding procedure, while BaF applies a bin by bin correction to the Raw spectra). **We expect this difference to give a MINOR contribution**
  - If I have understood correctly: LYSO and BaF analyses computes ε_{geo} x Ω directly using MC in the same way (see how many PG cross the detector region in MC shooting PGs from PMMA)
  - When comparing with Ganil: our friends give a flux/mm (taking into account the dependence on the origin point/shape of the emission spectra) while we have an integrated number..
  - When comparing with HIT: comparing different target / same energy might reserve some surprises for us [preliminary study shows that PG on 20 cm TGT should be > than those produced by a 10 cm TGT]

N ^{12}C: do we still have a problem?

- **Since DT was underestimated on 220 MeV/u GSI data, consider that fluxes are expected to increase**

BaF definition

$$\Phi_\gamma = \frac{N_\gamma}{N_C \times \tau \times \varepsilon_{det} \times \varepsilon_{geo} \times \Omega}$$

	DATA		MC
LYSO 220MeV/u GSI	**0.66 10^{-2}**	**FLUKA**	**2.41 10^{-2}**
BaF 220 MeV/u GSI	**1.15 10^{-2}**	**GEANT BIC**	**1.83 10^{-2}**
BaF 310 MeV/u GSI	**0.98 10^{-2} (*)**	**GEANT QMD**	**1.88 10^{-2}**
LYSO 220 MeV/u HIT	**2-2.4 10^{-2} (**)**	**GEANT INCL**	**1.09 10^{-2}**

(*) This measurement done by Ganil friends has to be "integrated" in the range of our beam with some assumptions: **to get the final number I have assumed that the same flux holds for 310 and 220, and used the correct range for a ^{12}C ion beam of 220 MeV/u** (^{12}C Range is 12.4 cm @ 310 MeV/u and 8.57 cm at 220): **in principle this is a minimum value for the flux, since we know that the /mm PG emission drops with higher energies, and thus at 220 we expect an higher value…..**

(**) Preliminary result assuming good data/MC agreement and hyper-preliminary MC result

Some remarks

The fix from DT calculation will help increasing the fluxes and improving the agreement with other exp. and MC calculations

- Lyso and BaF differ: discrepancy is partially recovered if we blame the tail for the effect…
- **BaF result** matches with what projected from Ganil (using a BaF), from LNS [if you believe a x5 factor from MC going from 80 to 220 MeV/u] and with GEANT INCL MC. Disagreement is found with GEANT QMD (and this goes in the right directions since Fluka uses QMD and gets an higher flux)

	MC
FLUKA	**$2.41\ 10^{-2}$**
GEANT BIC	**$1.83\ 10^{-2}$**
GEANT QMD	**$1.88\ 10^{-2}$**
GEANT INCL	**$1.09\ 10^{-2}$**
	DATA
LYSO 220MeV/u GSI	**$0.66\ 10^{-2}$**
BaF 220 MeV/u GSI	**$1.15\ 10^{-2}$**
BaF 310 MeV/u GSI	**$0.98\ 10^{-2}$ (*)**
LYSO 220 MeV/u HIT	**2-2.4 10^{-2} (**)**

- **LYSO result** (GSI): disagrees with LYSO @ HIT, is too low to match any MC prediction and other published data

Conclusions

- Before going on with a publication we need to revise the eps_DT calculation to fix it and have reasonable results
  - Any change on ε_{DT} (called τ in the BaF paper) will affect BOTH results (BaF and LYSO): so we need to finalize the study ASAP
  - Impact on BaF for a larger dead time efficiency will be somehow not dramatic: BaF will remain in the good range predicted by QMD model.. however a better understanding of the tail is needed to understand if it is a real effect or if we are double counting something
- After that the LYSO is ~ ready [paper already improved collecting comments from Marie and Riccardo]
  - We will redo the unfolding with also roounfold (less critical) after having fixed a small mistake with energy smearing
  - implement the sc_factor correction in the macros (done by hand now)