Imperial College London


# VBF Higgs to Invisible - Update

AN-14-243

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# Introduction

- Summary of last week's work:
- Source of limit improvement study completed
- New QCD estimation finished
- AN updated and in iCMS

# Source of gain study

- Light trees have been made using prompt data ntuples and trigger weights
- Data cards have been made using the prompt light trees for both the prompt and parked cuts
  - I don't have the ggH samples or UES information in the prompt data ntuples,
  - ggH and UES are therefore neglected in all limits on next slide
- Results on next slide
- nb As we now drop $W\gamma$ the limits on the next slide should be compared to 46.29% not the 49% in the paper

# Limits

- $14 \pm 10$ used for parked cuts QCD estimate
- $31 \pm 23$ from paper used for prompt cuts QCD estimate
- Data driven top control region used for both prompt and parked cuts
- Prompt trigger weights ignore correlations in turn on part of parked cut region

| | Prompt trigger | parked trigger |
|---|---|---|
| Prompt cuts | 45.12% | 45.51% |
| Parked cuts | 47.07% | 39.65% |

## Interpretation

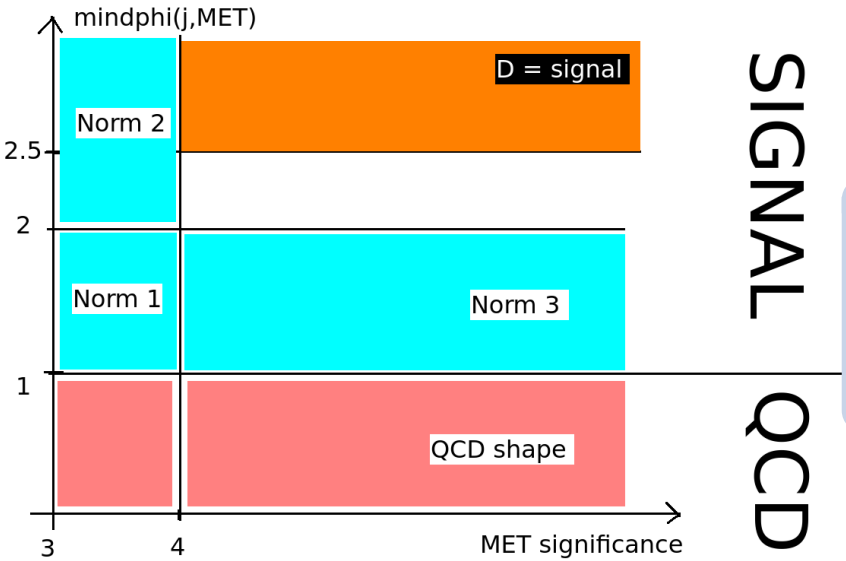
- Prompt cuts limits $\sim$ same as old card with both prompt and parked trigger
- The parked cuts give a worse limit with prompt trigger than with parked trigger
  - i.e. We can only use the parked cuts because of the parked trigger
- Also seen in parked cuts control region data yields, most higher with parked trigger
  - Where prompt trigger yield is larger prompt and parked yields are within stat. unc. of each other

# Limit improvement summary

- Prompt cuts numbers from light tree framework compatible with old cards for prompt and parked triggers
- Improvement to limit seen from using parked analysis cuts is only possible because of parked trigger
- Adding ggH and UES contribution back into parked trigger with parked cuts card gives limit of 37% as shown on Monday

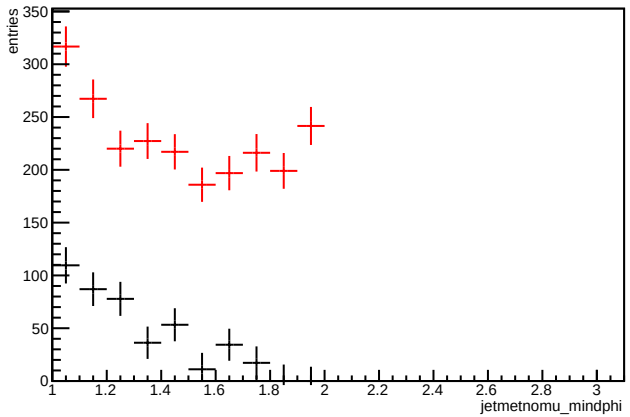
# QCD background estimation

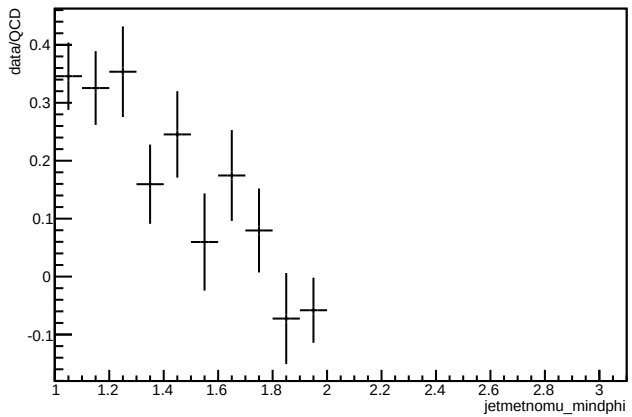
- Same method as for Higgs-EXO update talk used
- Cuts updated to new optimum values
- Cross-checks in "norm 2 and norm 3" regions repeated

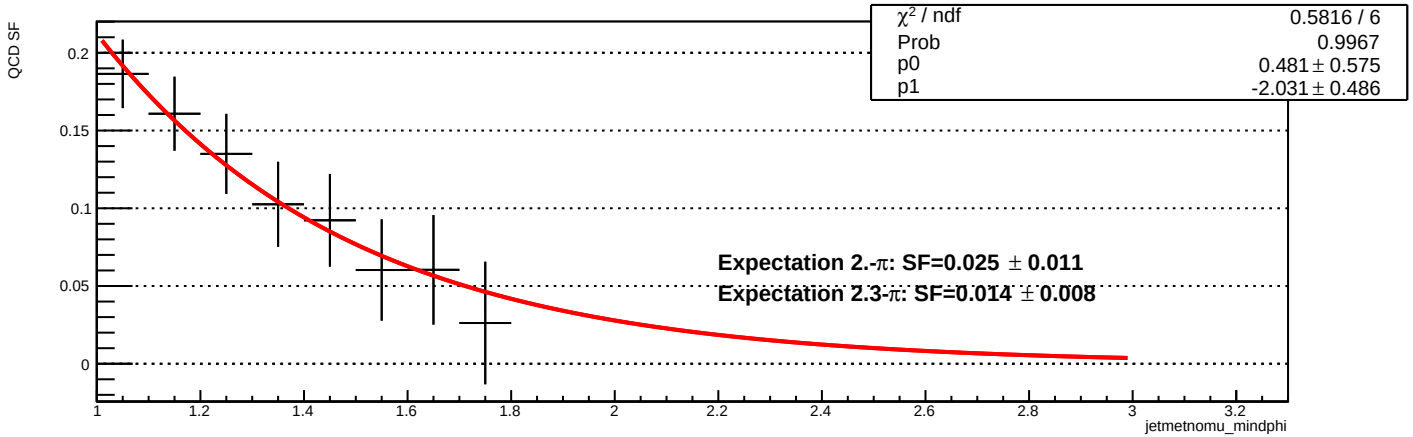



| Region | Signal | Bkg | Data | sig frac | QCD |
|---|---|---|---|---|---|
| Norm1 | 50±5 | 1188±29 | 1586 | 3% | 2290±55 |
| Norm2 | 51±4 | 297±14 | 411 | 12% | 1954±48 |
| Norm3 | 132±8 | 1300±34 | 1517 | 9% | 438±31 |
| Signal | 296±11 | 420±16 | XXX | - | 362±36 |

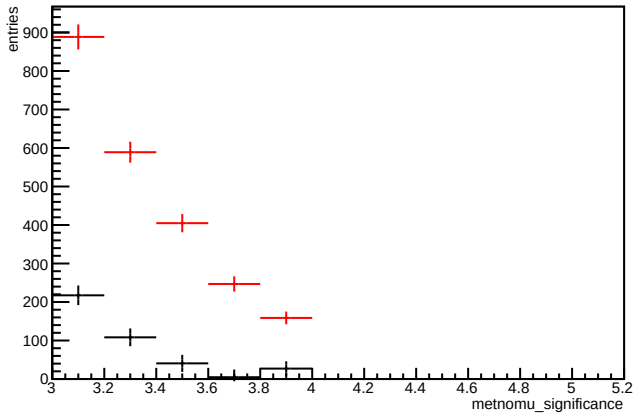
# Scale factor fits - Norm 1

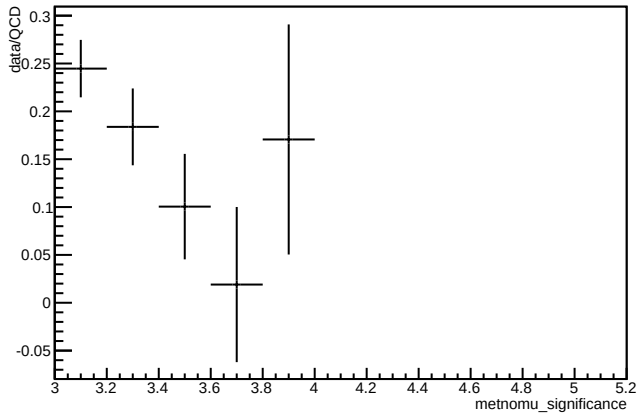


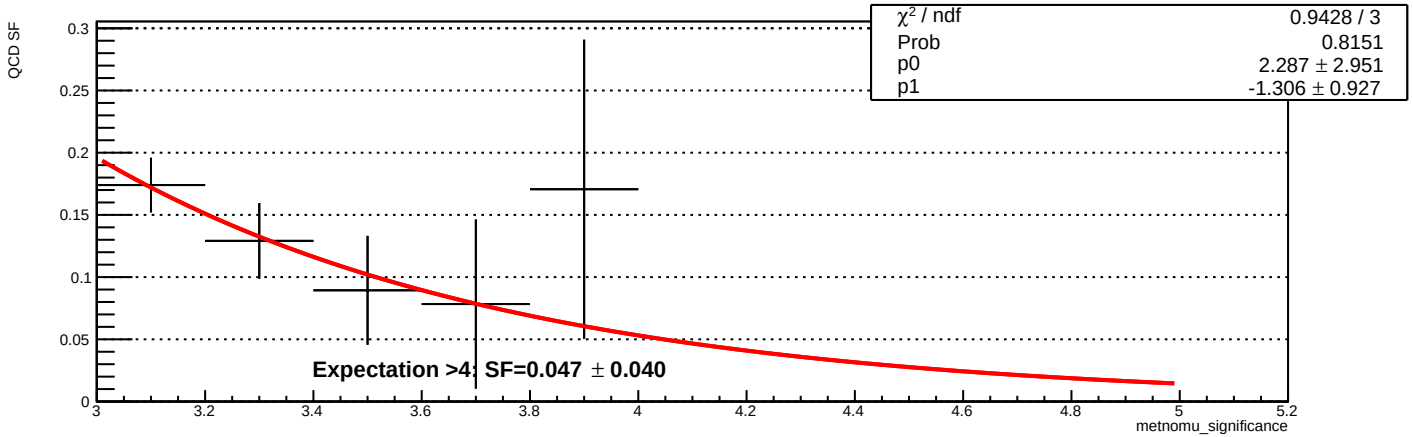



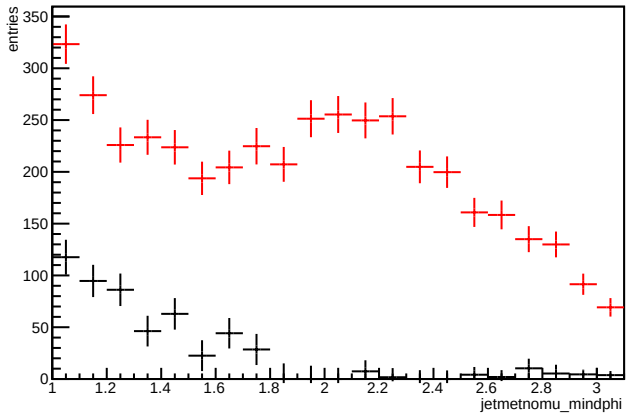
# Scale factor fits - Norm 1

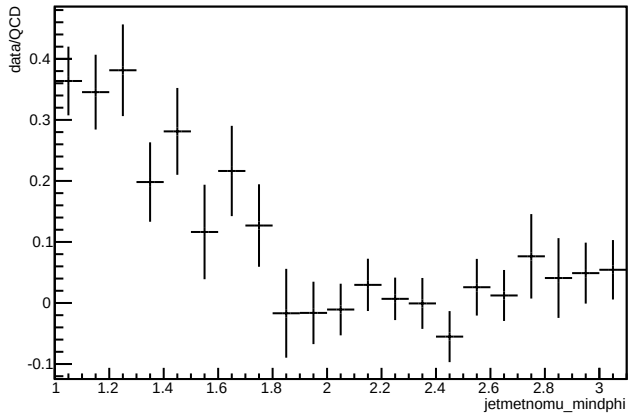


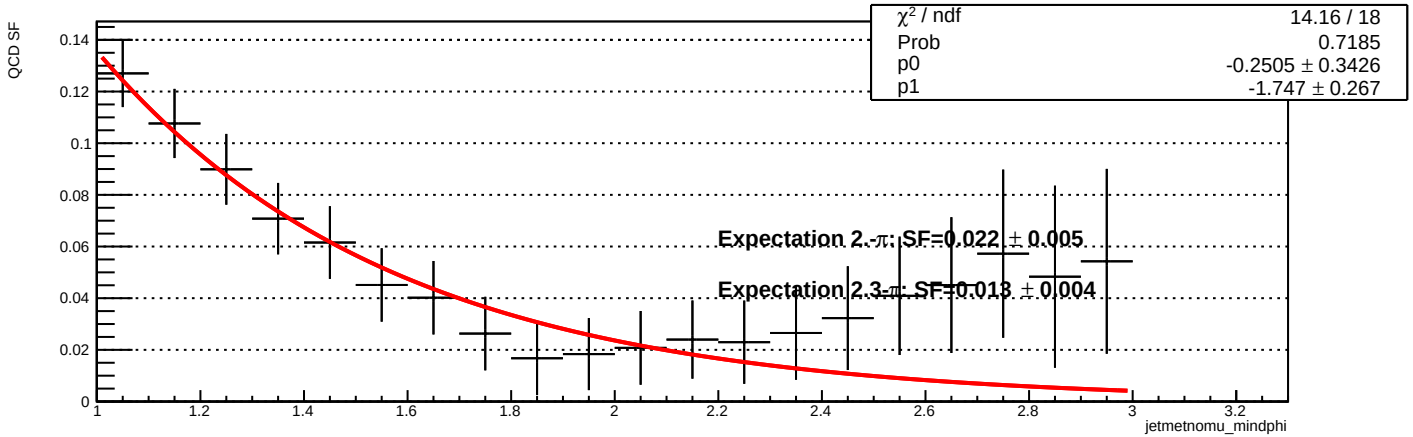



# Scale factor fits - Norm 12



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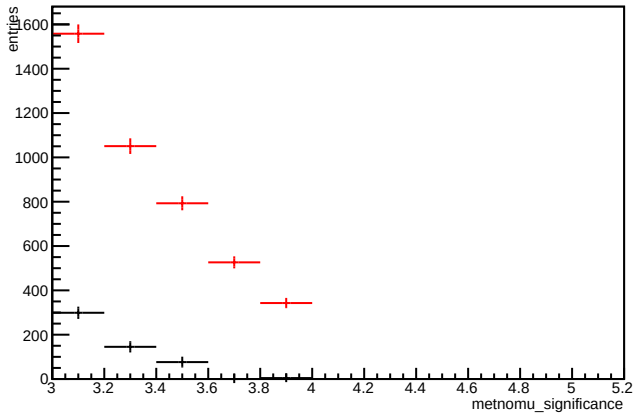
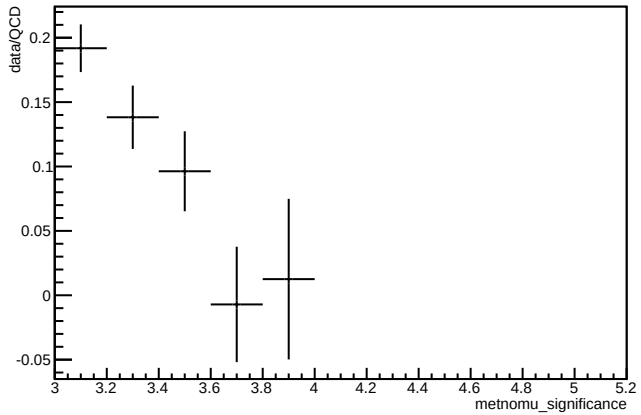
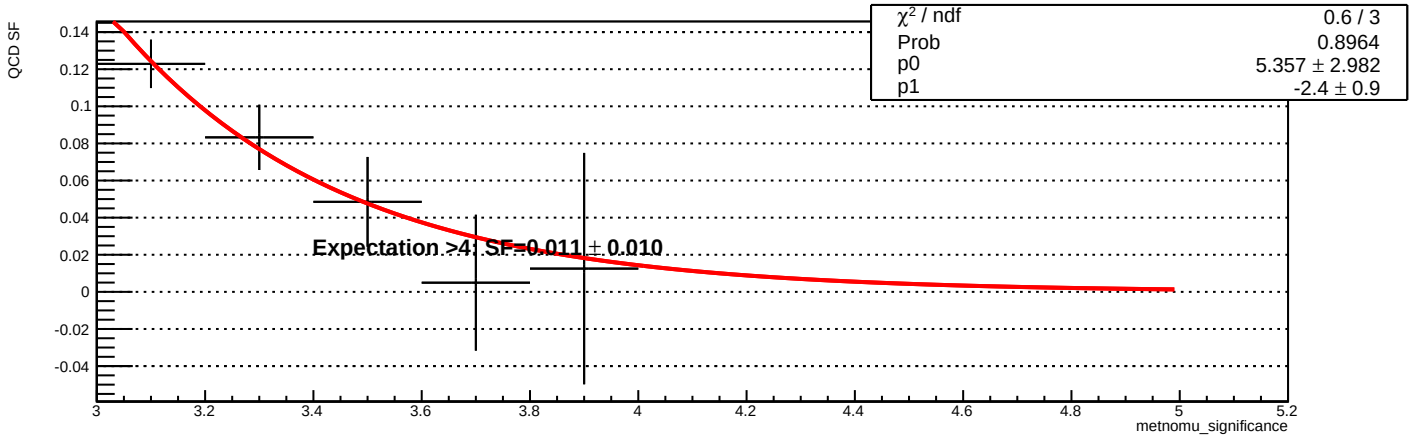
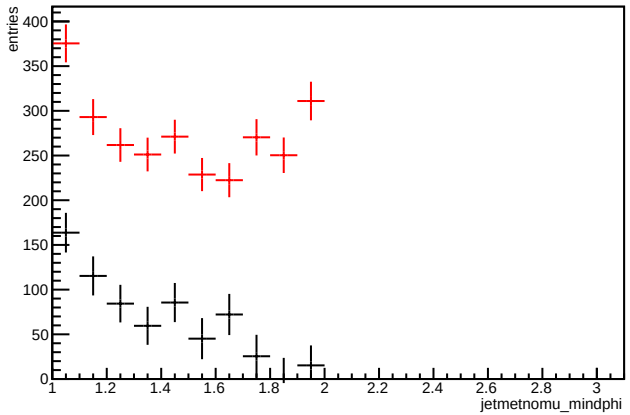
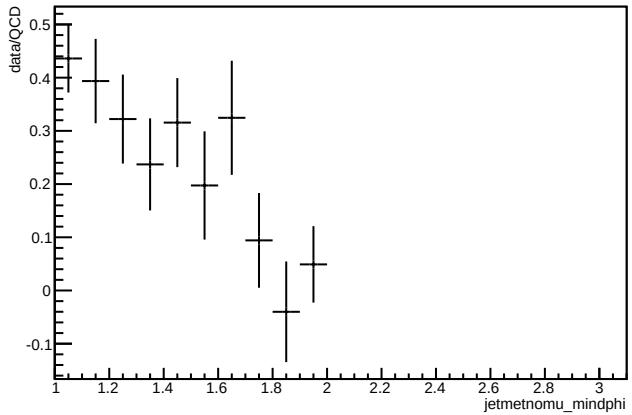


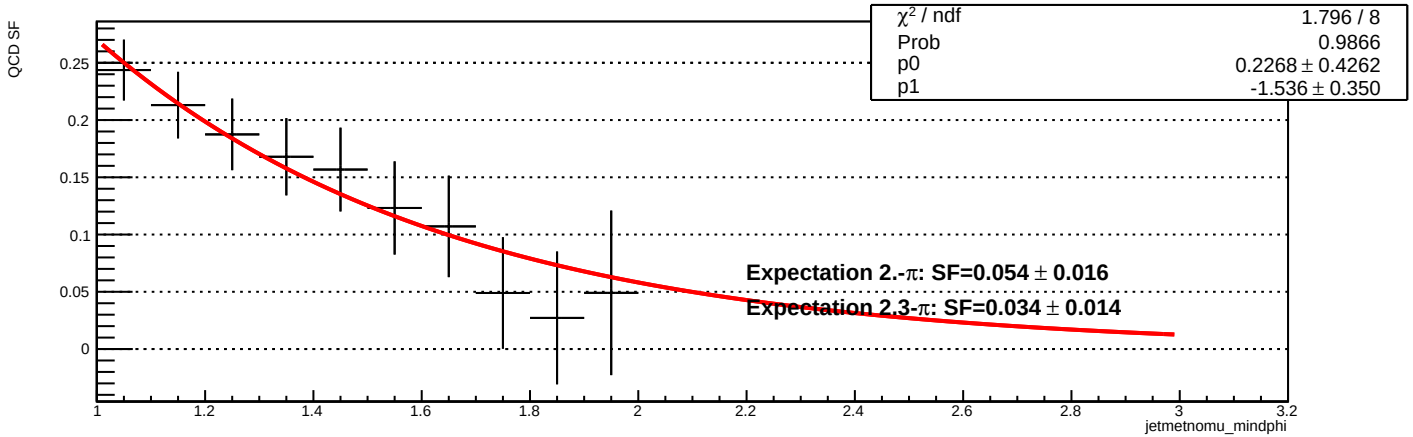



# Scale factor fits - Norm 13



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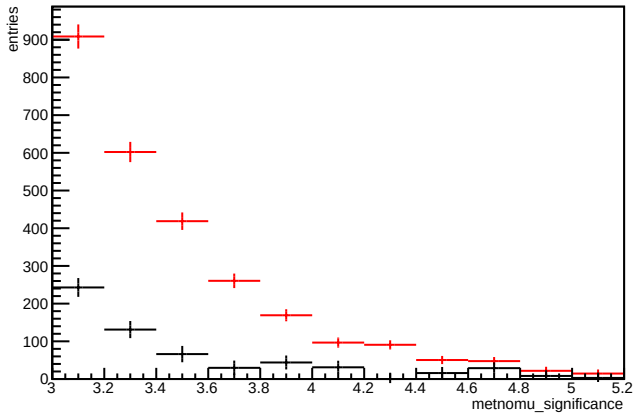


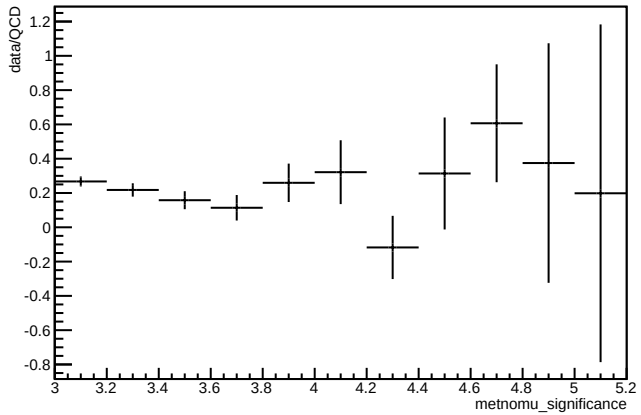


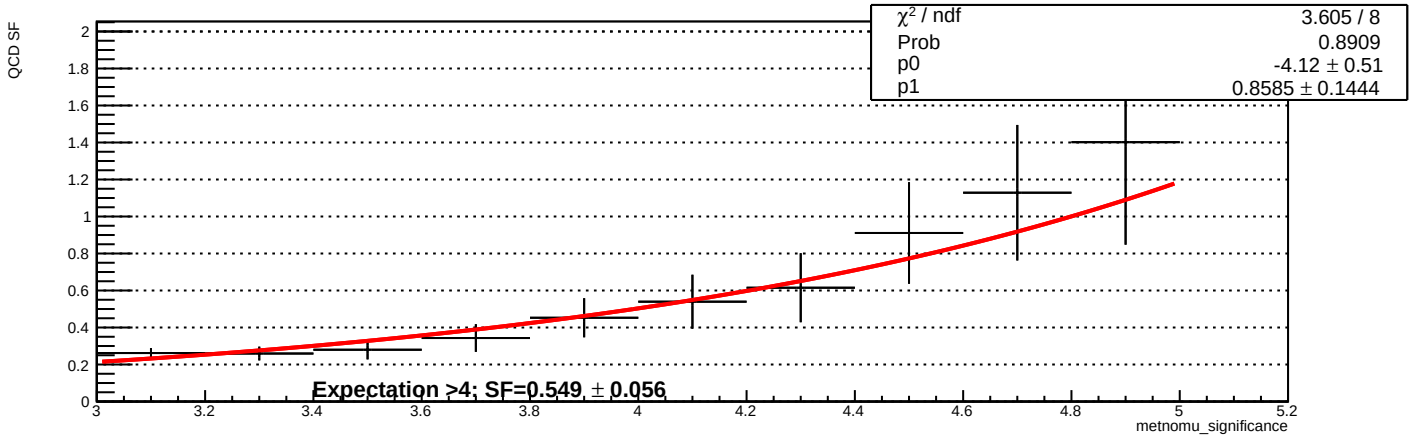

# QCD background result

| Region | Factor | Extrapolation mindphi$>$ 2.3 | Extrapolation metsig$>$ 4 |
|---|---|---|---|
| Norm 1 | 0.17 $\pm$ 0.02 | 0.014 $\pm$ 0.008 | 0.05 $\pm$ 0.04 |
| Norm 1+2 | 0.12$\pm$0.01 | 0.013 $\pm$ 0.004 | 0.01 $\pm$ 0.01 |
| Norm 1+3 | 0.24$\pm$0.03 | 0.03 $\pm$ 0.01 | 0.55 $\pm$ 0.06 |
| Norm 2 | 0.06$\pm$0.01 | - | 0.01 $\pm$ 0.02 |
| Norm 3 | 0.5$\pm$0.1 | 0.209 $\pm$ 0.114 | - |

- Behaviour consistent with what was seen before
- Still see strange behaviour in norm 3 where we require significant met with nothing opposite
- Use middle of "envelope" of norm 1 scale factors.
- Result is 17$\pm$14
- Limit stays at 37%

# Conclusion

- Improvement comes from use of new areas of phase space only accessible with parked trigger
- New QCD estimate is 17$\pm$14
- Expected limit is still 37%
- AN is updated in iCMS with new QCD
  - Trigger eff. fit plots need to be added
- To do:
  - Z$\rightarrow \nu\nu$ to Z/$\gamma^* \rightarrow \mu\mu$ extrapolation uncertainty study
  - PAS draft - AM working on it

# Backup