

# WIMP benchmark

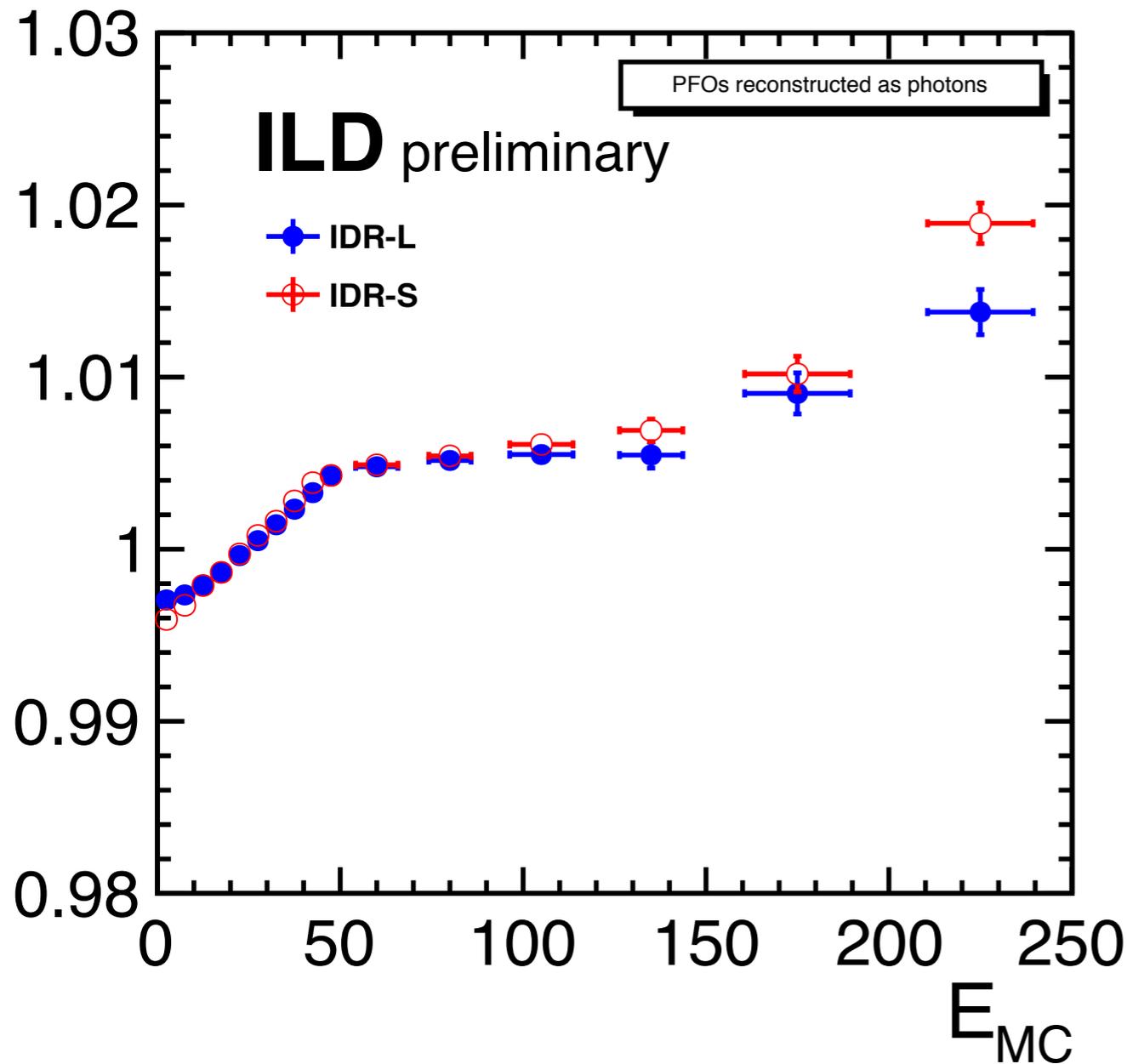
Ryo Yonamine



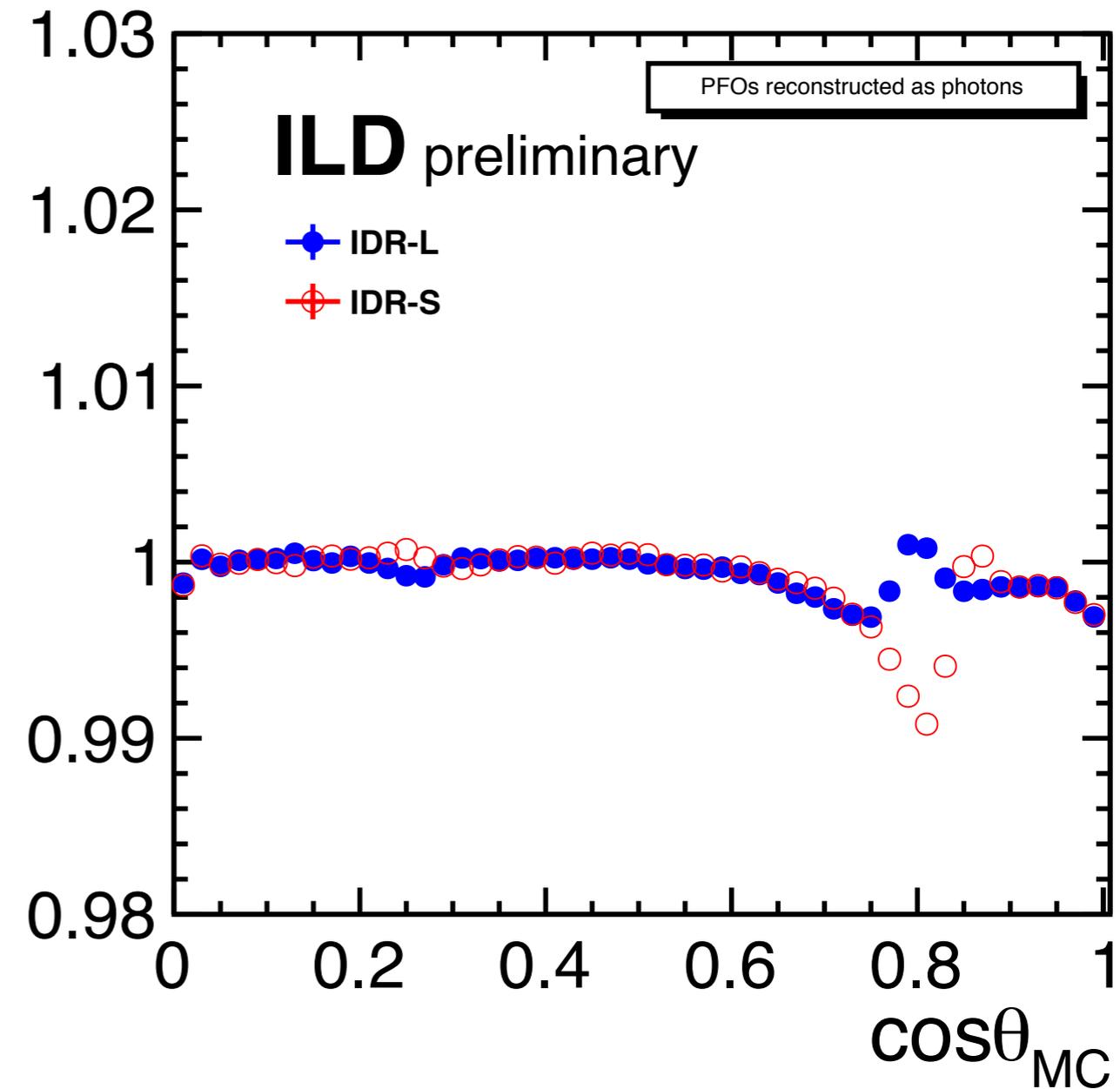
TOHOKU  
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# Photon reconstruction

$\langle N_{\text{rec}}/N_{\text{gen}} \rangle$

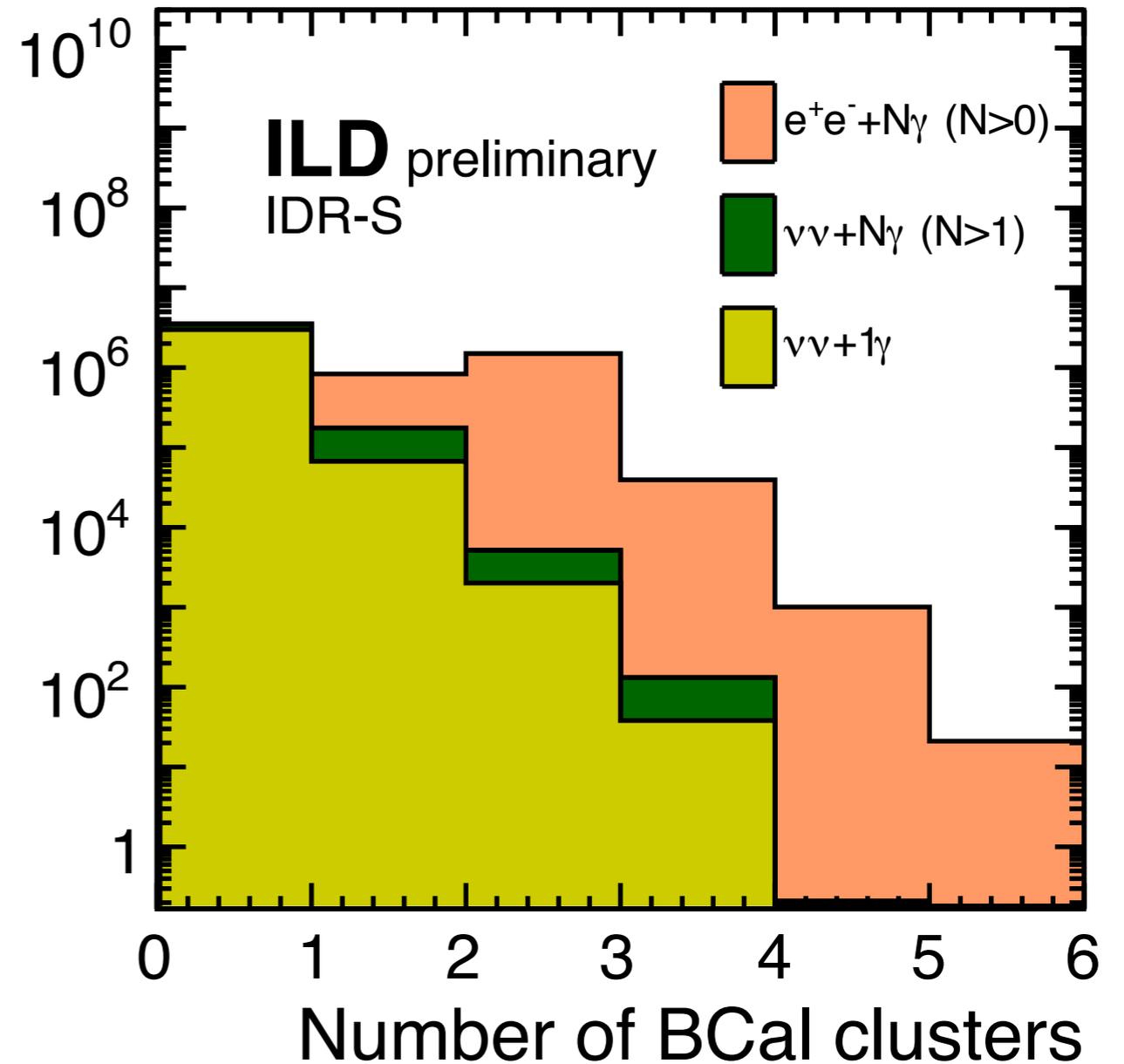
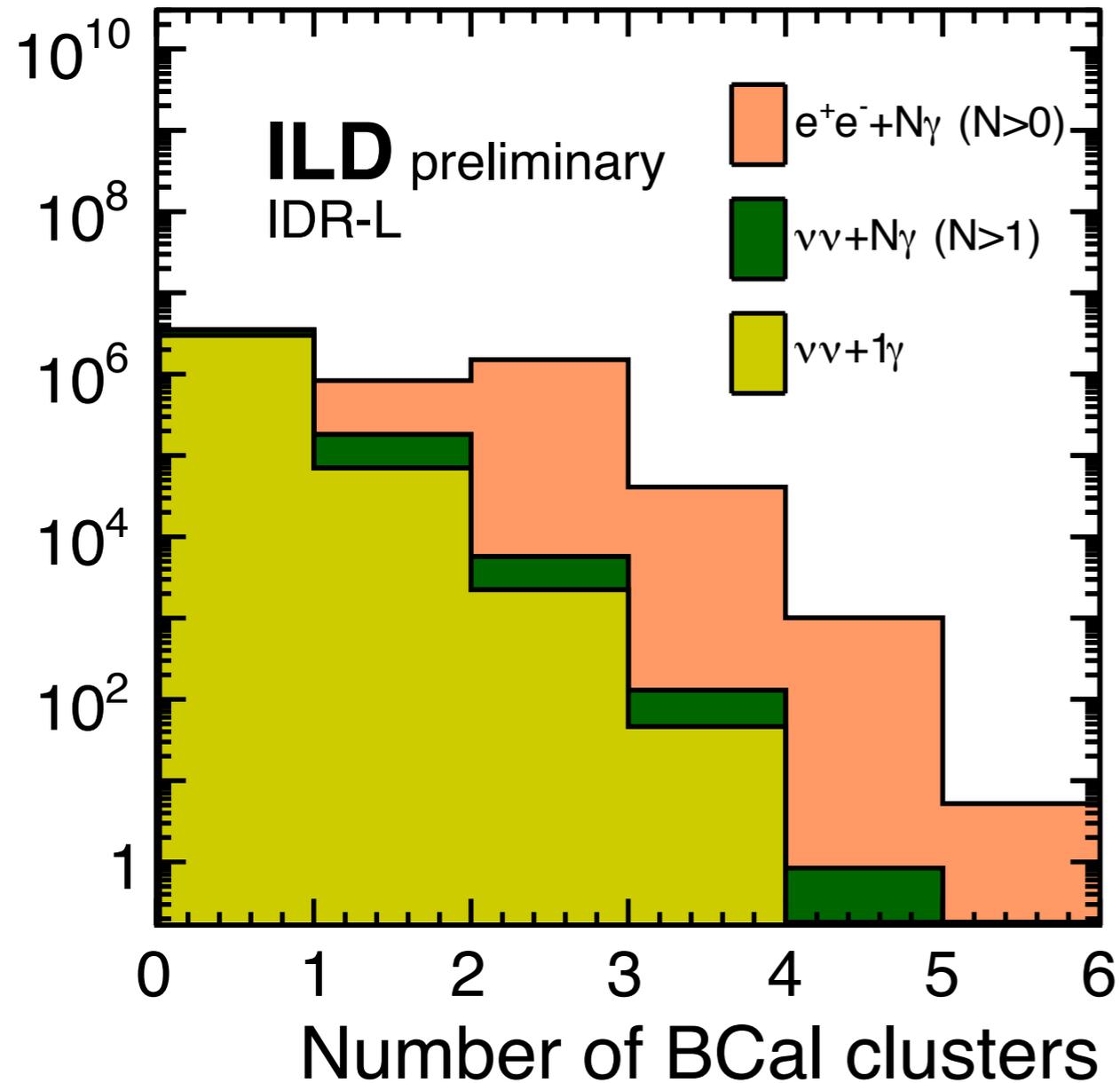


$\langle N_{\text{rec}}/N_{\text{gen}} \rangle$



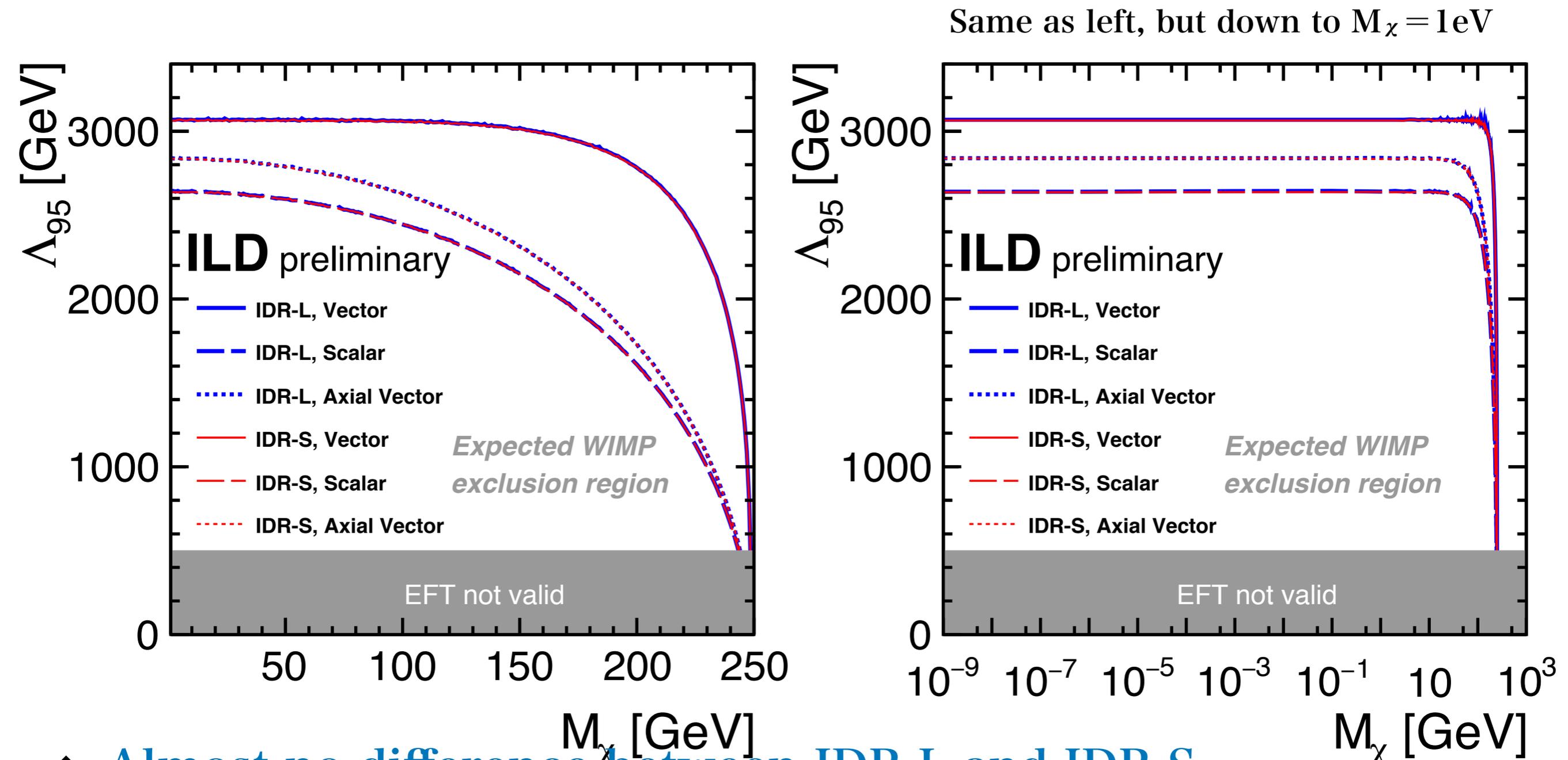
- ❖ Bin width has been broaden at large  $E_{\text{MC}}$  (left).
- ❖ A drop around  $\cos\theta = 0.8$  has been found to be caused by photon identification failure (Need further investigation in PandaPFA  $\rightarrow$  decided not to pursue further for IDR) (Right).

# # of BCal clusters



❖ Almost no difference between IDR-L and IDR-S.

# Exclusion limit



- ❖ Almost no difference between IDR-L and IDR-S.
- ❖ Now  $E_{\text{max}} < 220\text{GeV}$  requirement is removed. (Due to (probably) a technical reason, I still use  $E_{\text{max}} < 250\text{GeV}$ .)
- ❖ Extended lower mass region down to  $1\text{eV}$  (right).

# Summary

- ❖ **IDR plots are ready.**
  - ▶ BCal bkg map issue has been solved.
  - ▶ Eventually no difference is seen between IDR-L and IDR-S. (IDR-L becomes close to IDR-S.)
  - ▶ Git repository has been updated.

# To Do

- ❖ **Update supporting document**
  - ▶ Add more explanation (Filip has already given comments).

**Backup**

# WIMP Detection at ILC

- ❖ **Missing four-momentum could be signals from undetectable particles.**
  - ▶ We should ensure that it is not due to detector inefficiency etc..
  - ▶ We use ISR photons with some requirements to identify such events.
  - ▶ Target process is :  $e^+e^- \rightarrow \chi\chi\gamma_{\text{ISR}}$  Empty except for ISR photon!
- ❖ **Possible background**
  - ▶ Neutrino pairs +  $N\gamma_{\text{ISR}}$  (xsec.~10pb, irreducible)
  - ▶ Bhabha scattering +  $N\gamma_{\text{ISR}}$ (xsec.~100pb,  $e^+e^-$  in forward region)
- ❖ **Signal photon definition**
  - ▶ Polar angle  $> 7^\circ$  so that we can ensure it is not  $e^+/e^-$ .
  - ▶ Energy  $> 2\text{GeV}$  to avoid noises and  $< 220\text{GeV}$  to avoid contribution from Z return events.
  - ▶  $P_t > 5.71(1.97) \text{ GeV}$  for  $|\Phi| \leq 35^\circ$  ( $|\Phi| > 35^\circ$ ) to ensure Bhabha  $e^+/e^-$  to be detectable. ( $\Phi$  dependent cut in accordance with BCal inner rim structure.)
- ❖ **Key to reduce Bhabha events**
  - ▶ Require BCal has no clusters.

# Some remarks on this analysis

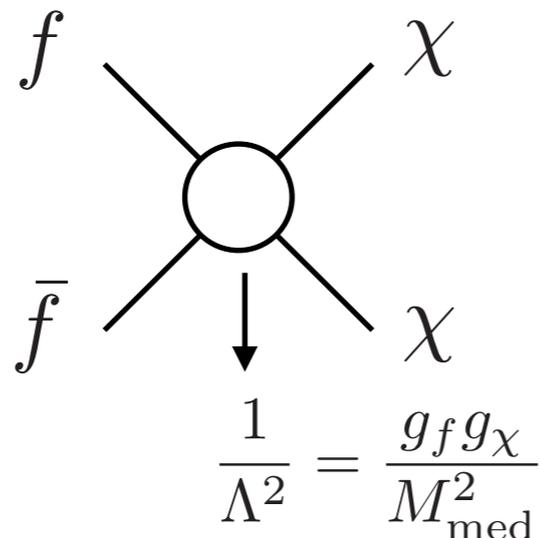
## ❖ **WIMP signals by re-weighting neutrino pair events.**

- ▶ Neutrino pair events are background but has same event signatures. Therefore we will use the half of the samples as WIMP signals by re-weighting according to theoretical models. We will try to keep neutrino pair events and try to reduce Bhabha events.

## ❖ **General approach with effective operators**

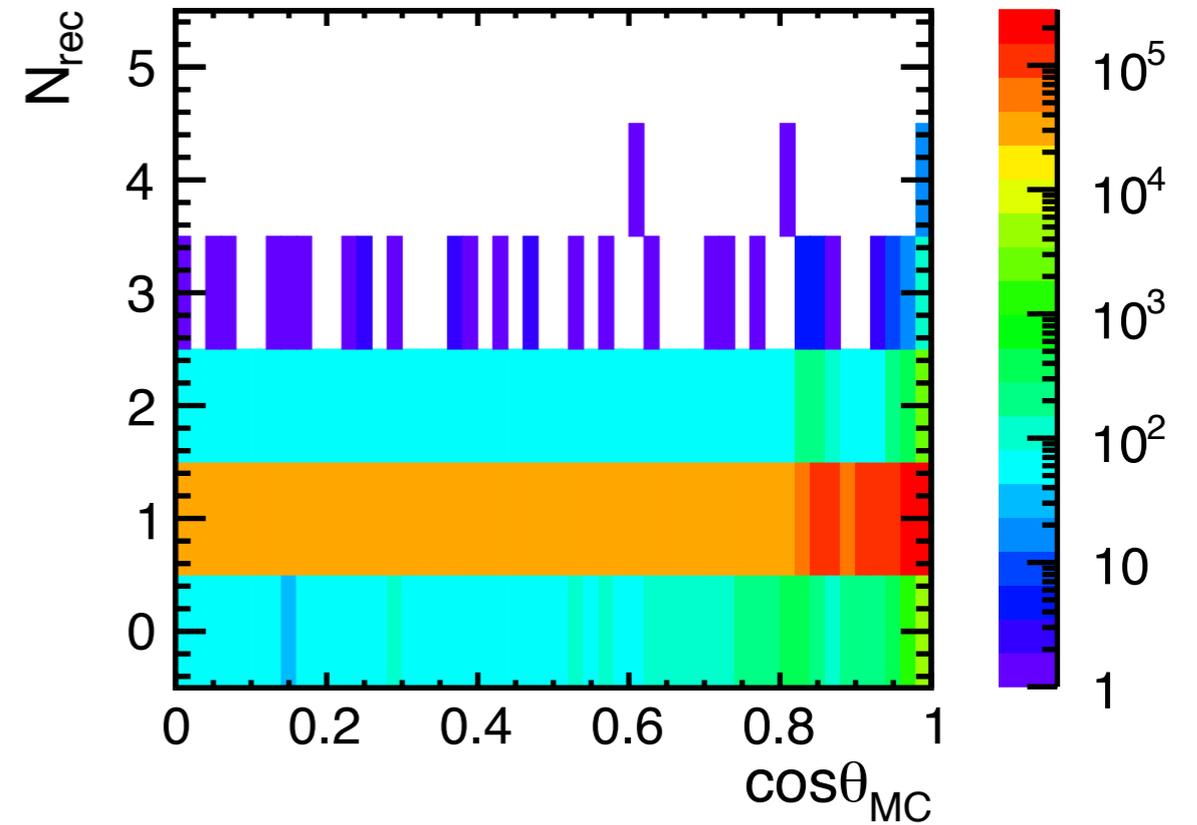
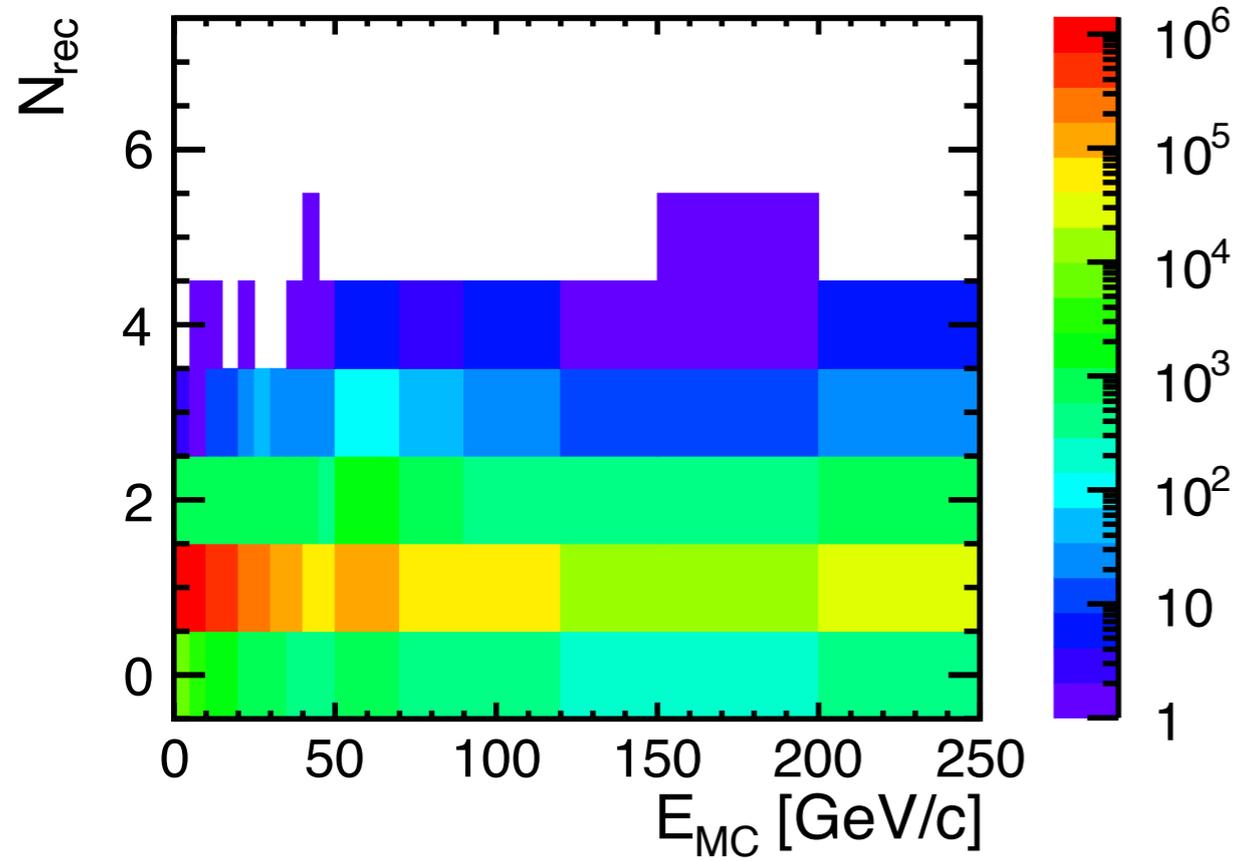
- ▶ Setup and cross-section formulas from Chae and Perelstein JHEP05(2013)138

$$\mathcal{L}^{\text{eff}} = \frac{1}{\Lambda^2} (\bar{f}\Gamma f) (\chi\Gamma\chi) \quad \Gamma = \begin{cases} 1 \\ \gamma^\mu \\ \gamma^5\gamma^\mu \end{cases}$$

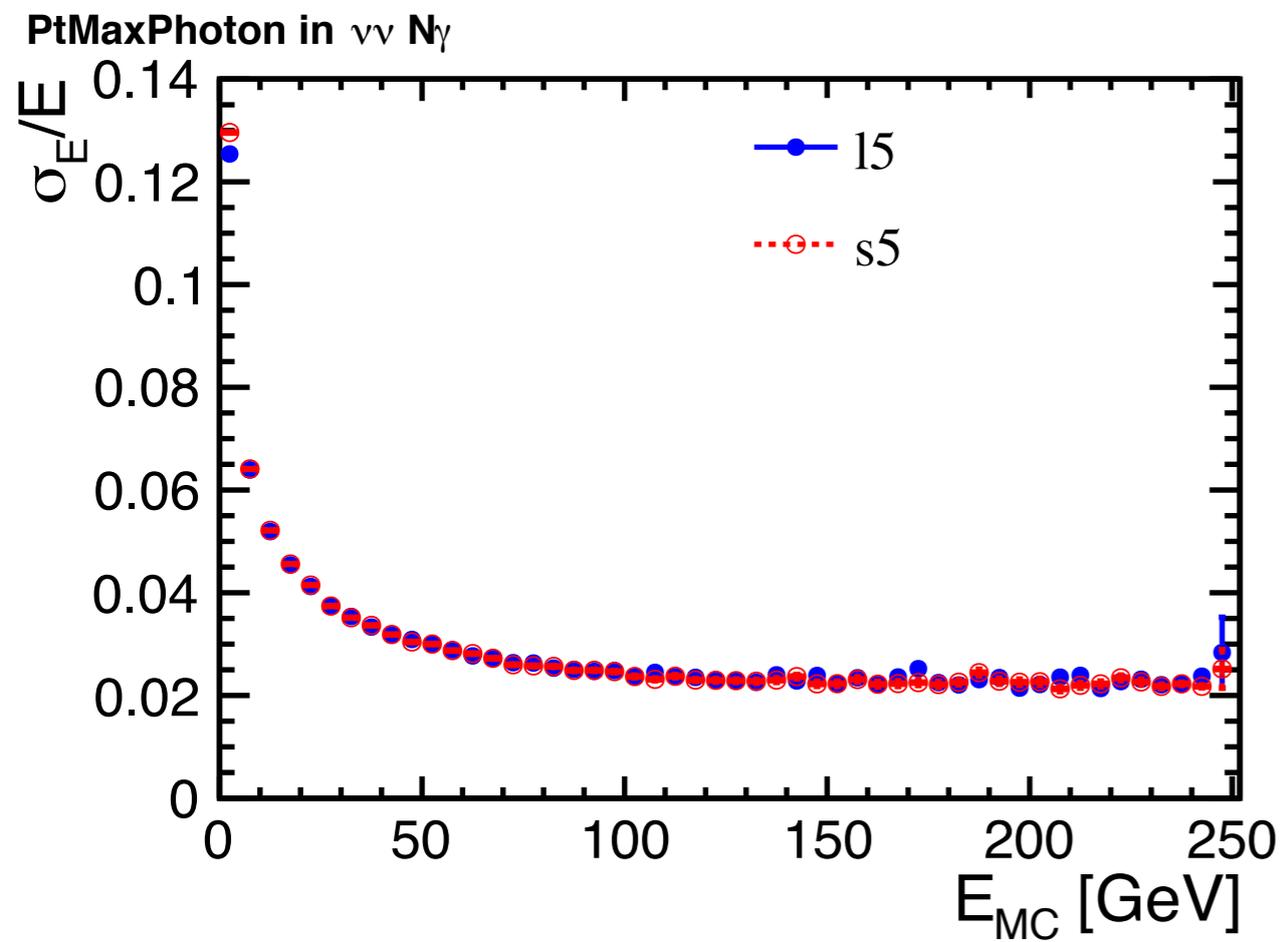


**Models are parameterized by  $\Lambda$  (energy scale of new physics).**

Mean and error are computed in each x-bin and plot each bin (—> page 2)



### Energy resolution



### Polar angle resolution

