Benchmark study on mono-photon search



The work is based on Moritz's achievements in his PhD thesis.

The 60th general meeting of the ILC physics working group @ KEK, 9th Feb. 2019

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 : $e^+e^- \rightarrow \chi \chi \gamma_{ISR}$ [Empty except for ISR photon!]

* Possible background

- Neutrino pairs + Nγ_{ISR} (xsec.~10pb, irreducible)
- Bhabha scattering + Nγ_{ISR}(xsec.~100pb, e⁺e⁻ in forward region)

Signal photon definition

- Polar angle > 7° so that we can ensure it is not e⁺/e⁻.
- Energy >2GeV to avoid noises and < 220GeV to avoid contribution from Z return events.
- Pt > 5.71(1.97) GeV for |Φ|≤35° (|Φ|>35°) to ensure Bhabha e+/e- to be detectable. (Φ 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 reweighting 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

Models are parameterized by Λ (energy scale of new physics).

Status summary

- * Thanks to Moritz's helps, we succeeded in reproducing several plots in his PhD thesis with the IDR samples.
 - In previous report, I only tested with a limited statics, but now with full statistics.
 - In previous report, I didn't apply normalization according to the beam polarization and luminosity, but now they are taken into account.
 - Exclusion limit plot is also available now.

* BCal reconstruction issue

- We found a signal efficiency drop at BCal veto comparing with Moritz's results (70% —> 50%), and also a discrepancy in BCal cluster energy distribution.
- It turned out that an energy threshold at BCal cluster reconstruction has been wrongly set and we believe this is the cause (but not yet confirmed).
- We decided to put a countermeasure at analysis stage for now, and we found the signal efficiency can be recovered.

Extra info regarding BCal issue

15

Pt [GeV]



Too high BCal energies (15)



This is under investigation.

(Maybe due to the wrong threshold at Bcal reco. step.)

Cut summary



BCal veto is working well.

of Reco. Photon per # of MC photon

BCal Veto

BCal veto plays an important role.

Exclusion limit (Vector operator, L=500fb⁻¹)

Photon energy reconstruction

Takahiro reported that the reconstructed photon (PFO) tends to be shifted to higher energies (https://agenda.linearcollider.org/event/8148/).

Expected: 241.7 GeV

Conclusion

* We have succeeded in producing comparable results to Moritz's PhD thesis using the IDR samples (I5 and s5).

IDR note

- Just started with OverLeaf, which helps to share the draft between analyst and reviewers.
- Lesson learned: When I created a project on OverLeaf, it allows me to share one additional person, and if I want to share more persons, it requires payment. On the other hand, when Filip did same, it allows him to share up to 5 persons! He gave me a guess that it may be related to registration with CERN email account. If you have same problem, try to catch your coauthor who has CERN email account.