# The Strange Quark as a probe for new Physics in the Higgs Sector


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# News

- Paper sent to ILD for review, 2 referees (Ulrich Einhaus & Alberto Ruiz) assigned
  - Received comments last week
  - Mostly implemented
  - To discuss with Uli today

- Snowmass deadline on March 15th
  - For Ftag and H->cs decided during last week meeting to mention it in the next steps and later on update the arxiv paper

  - First draft of ILC paper available for review:
    - https://agenda.linearcollider.org/event/9135/
    - At the moment, it only includes our final theory plot and a link to our work, but no real analysis summary nor detector description (even though it contains a section on detectors)
      - Will get in touch with the editors to see if we can add it

# Reviewer's comments

Question

I am not sure I fully understand your approach with the polarisation.

You take 2 ab-1 of (-80,+30) and extract the fraction (~60%) of events that are actually LR. Yes?

If so, this is not accurate in two ways: the 2 ab-1 comprise of a mixture of polarisation combinations. The H20 scenario [https://arxiv.org/abs/1506.07830, table 2] is the most commonly used one in analyses and the luminosity at 250 GeV is split into 67.5% (-,+), 22.5% (*,-), and 5% of each (-,-) and (+,+). In addition, the data gathered with (-80,+30) consists of LR, RL, LL and RR events, which provide signal but also background that can not a priori be separated from the event sample you select.

Is it possible to include the missing data? It would not change the analysis per se, but require a re-run with the corresponding files and event weights.

Uli says in the meeting that this is not 67.5% (-,+) but actually 45% (-,+)

All MC samples are generated using 100% left-handed- (LH-) polarised electron beams and 100% right-handed- (RH-) polarised positron beams. As we consider the ILC running scenario at $\sqrt{s} = 250\,\text{GeV}$ using 80% LH-polarised electron beams (i.e., $P_L[e^-] = -80\%$) and 30% RH-polarised positron beams (i.e., $P_R[e^+] = +30\%$), the polarisation-inclusive cross section $\sigma_{\text{inc}}$ must be corrected. In particular, the 100% LH electron and 100% RH positron cross section $\sigma_{LR}$ is given by:

**Not sure this is correctly written...**

$$\begin{aligned}\sigma_{LR} &= P_L P_R \sigma_{\text{inc}} \\ &= \frac{1 - P_L[e^-]}{2}\frac{1 + P_R[e^+]}{2}\sigma_{\text{inc}} \\ &= 0.585\sigma_{\text{inc}}\,. \end{aligned} \tag{1}$$

For this particular running scenario, an integrated luminosity $\mathcal{L}$ of $2\,\text{ab}^{-1}$ is expected, as per the ILC physics programme [53]. Using the corrected cross sections and the expected luminosity, each sample is normalised prior to applying any analysis cuts, where the event weights are modified as:

$$w_i' = \frac{\mathcal{L}\sigma_{LR}}{\sum_j w_j} w_i \,\forall\, i\,, \tag{2}$$

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Answer

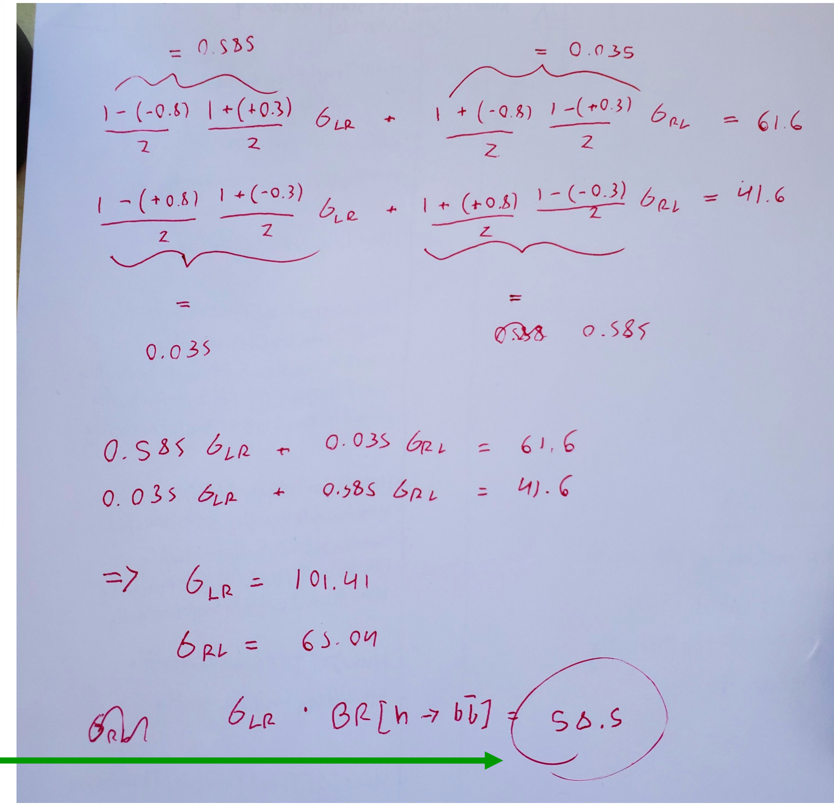
We should include an additional factor of 0.675 to use the fraction of the 2 iab luminosity which is sgn(PL,PR) = (-,+). However, not sure if there is a good way to handle the LR, RL, LL, and RR events contained within that luminosity slice. The only samples we have are LR (for all signal and background.
We would say requesting all of the needed samples with full statistics is impossible on the Snowmass timescale and likely won't change the overall picture dramatically. So, we are left with two options:

- to assume the (-,+) is an idealistic 100-100% polarization scenario
- to assume the LR collisions can be perfectly extracted

In either case, the analysis will be "representative" of the limits and techniques that could be used.

| | $\sqrt{s}$=250 GeV operation polarization Cross-section (fb) | | fully polarization MC sample | | | |
|---|---|---|---|---|---|---|
| $P(e^-, e^+)$ | $(-80\%, +30\%)$ | $(+80\%, -30\%)$ | $P^L_{e^-}P^R_{e^+}$ | $P^R_{e^-}P^L_{e^+}$ | $P^L_{e^-}P^L_{e^+}$ | $P^R_{e^-}P^R_{e^+}$ |
| $eeH$(s) | 10.7 | 7.14 | $4.00 \cdot 10^4$ | $1.00 \cdot 10^4$ | 0 | 0 |
| $eeH$(t) | 0.71 | 0.52 | $1.00 \cdot 10^4$ | $1.00 \cdot 10^4$ | 3992 | 3992 |
| $\mu\mu H$ | 10.4 | 7.03 | $4.00 \cdot 10^4$ | $1.00 \cdot 10^4$ | 0 | 0 |
| $qqH$ | 210.2 | 141.9 | $5.45 \cdot 10^5$ | $2.94 \cdot 10^5$ | 0 | 0 |
| $\nu\nu H$ (s) | 61.6 | 41.6 | $12.8 \cdot 10^4$ | $6.50 \cdot 10^4$ | 0 | 0 |
| $\nu\nu H$ (t) | 15.4 | 0.93 | $12.8 \cdot 10^4$ | $6.50 \cdot 10^4$ | 0 | 0 |
| $2f\_l$ | $3.82 \cdot 10^4$ | $3.49 \cdot 10^4$ | $2.63 \cdot 10^6$ | $2.13 \cdot 10^6$ | $5.03 \cdot 10^5$ | $5.03 \cdot 10^5$ |
| $2f\_h$ | $7.80 \cdot 10^4$ | $4.62 \cdot 10^4$ | $1.75 \cdot 10^6$ | $1.43 \cdot 10^6$ | 0 | 0 |
| $4f\_l$ | $6.03 \cdot 10^3$ | $1.47 \cdot 10^3$ | $2.25 \cdot 10^6$ | $9.80 \cdot 10^4$ | $2.73 \cdot 10^5$ | $2.73 \cdot 10^5$ |
| $4f\_sl$ | $1.84 \cdot 10^4$ | $2.06 \cdot 10^3$ | $4.04 \cdot 10^6$ | $3.56 \cdot 10^5$ | $9.78 \cdot 10^4$ | $9.78 \cdot 10^4$ |
| $4f\_h$ | $1.68 \cdot 10^4$ | $1.57 \cdot 10^3$ | $2.38 \cdot 10^6$ | $2.42 \cdot 10^5$ | 0 | 0 |

^ Taken from Ogawa's thesis




We have 58.1 fb (including h->bb BR) decorated onto our eLpR miniDSTs, so **consistent**

<u>Raises question about what to do with sample normalization</u>:

- Acquire the other most important polarization slice for the (-80%,+30%) polarization scenario, eLpL (**impossible on 2 week time scale**)
- Assume the 2 ab$^{-1}$ scenario uses (-100%,+100%) (**pick up factor 1**)
- Assume the 0.675*(2 ab$^{-1}$) scenario uses (-100%,+100%) (**pick up factor 0.675**)
- Only look at the LR slice of the 0.675*(2 ab$^{-1}$) scenario (**pick up factor of 0.675*0.585**)

# Thanks for your attention!


Valentina Cairo