First look at pysics analysis at HALFH

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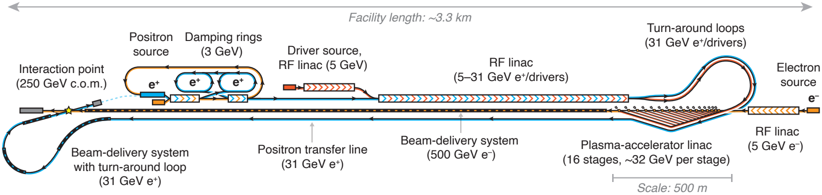
Hybrid Asymmetric Linear Higgs Factory (HALHF)



- So we have
  - E(e^-) = 500 GeV, E(e^+) = 31 GeV $\Rightarrow E_{cm} = 2\sqrt{500 \cdot 31} = 249$ GeV.

Experimental conditions at HALHF

First look at the experimental implications of the HALHF.

- Generate with Whizard. Settings:
  - E(e^-) = 500 GeV, E(e^+) = 31 GeV $\Rightarrow E_{cm} = 2\sqrt{500 \cdot 31} = 249$ GeV.
  - No beam-spectrum (not yet available), no crossing angle, no polarisation.
  - But ISR - the worst spoiler of the recoil mass - is included.
  - Simulate ILD or ILD$'$ with SGV.
- Look at
  - Golden process: $e^+e^- \to ZH, Z \to \mu\mu$.
  - $e^+e^- \to \mu\mu$.
  - Track momentum resolution.

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Higgs recoil at HALHF

- Look at $\mathrm{e}^+\mathrm{e}^- \rightarrow ZH, Z \rightarrow \mu\mu$.
- Red-dash: HALHF, black-solid: same conditions, but E(e$^-$) = E(e$^+$) = 124.5
  - $\cos\theta$ of the muons ...
  - M_Z ...
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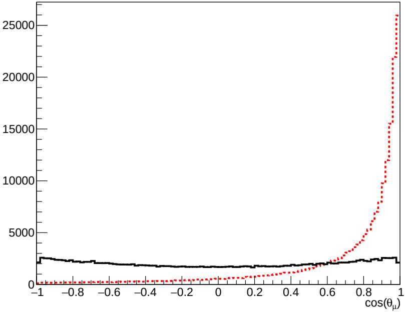

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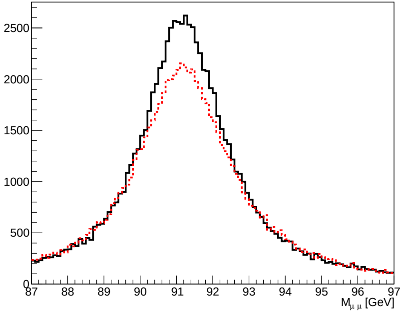

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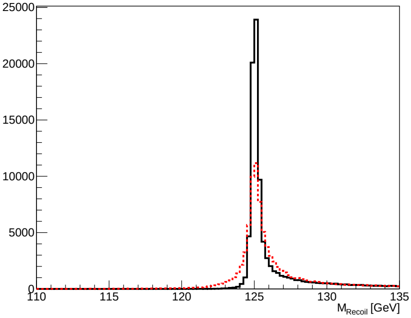

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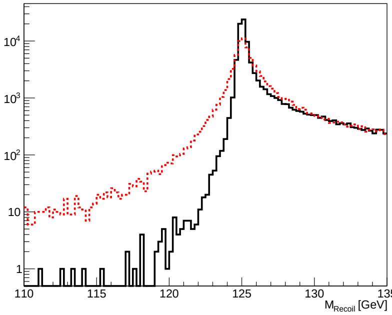

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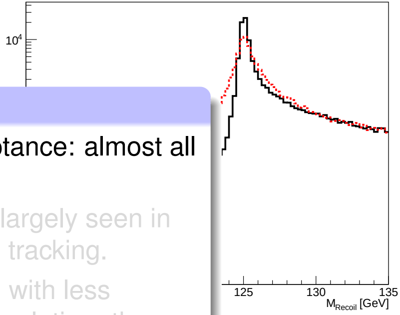

Preliminary uptake

- The problem is not acceptance: almost all μ:s are seen.
- Rather, it is that they are largely seen in the much weaker forward tracking.
- This can't be ameliorated with less material or better point-resolution: the problem is the lever-arm!
- So, either the forward region needs to be made longer, or the B-field must be modified ...

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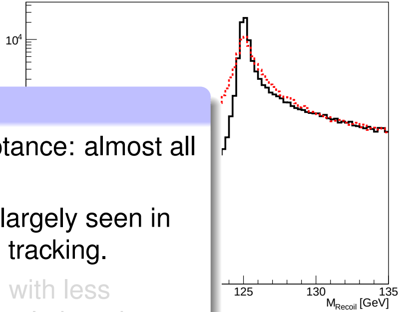

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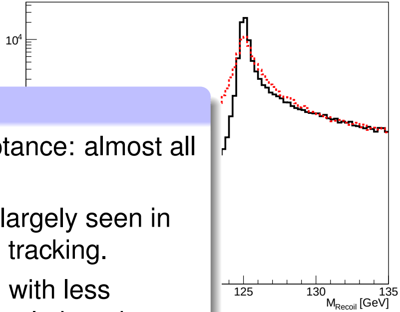

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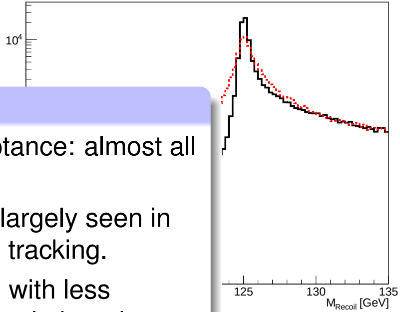

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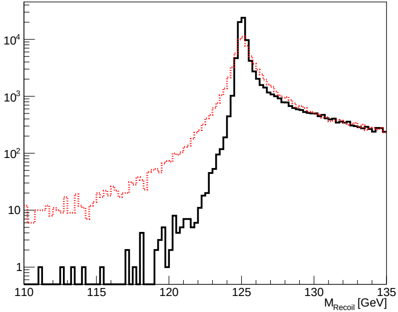
Higgs recoil at HALHF: modified ILD

Modify detector length (Easy to do with SGV)

- ILD at ILC and ILD at HALHF
- and ILD made twice longer in the forward at HALHF
- and ILD made twice longer in the forward, but reduce TPC radius from 1.8 m to 1.55 m ⇒ about the same size (Solenoid volume, area of detectors).
- Long-ILD would give a recoil-mass peak about 80% lower ⇒ very roughly S/B 20% worse ⇒ ∼ 60% more integrated luminosity needed.



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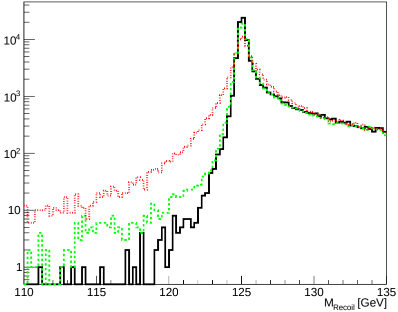

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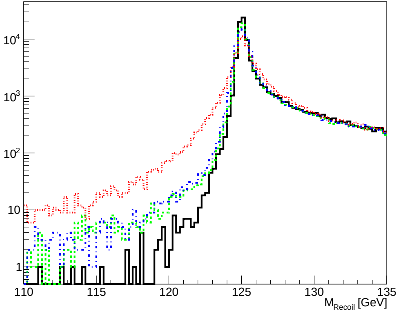

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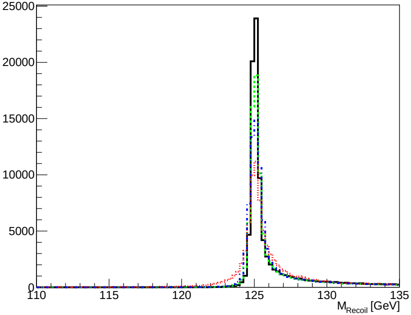

Muon pairs at HALHF

What about fermion pairs, and things like A_{FB} ?

- Generate $\mathrm{e}^+\mathrm{e}^- \rightarrow \mu^+\mu^-$, and look at Pseudorapidity of μ^+(dashed) and μ^- (solid), separately. Black is ILD@ILC, Red is longer, R-reduced ILD at HALHF.
- In the lab-frame ...
- ... or the CM frame.
- $\Rightarrow$ The symmetry is broken - loss in the forward, but gain in the backward - Maybe that partly compensates ? Also slightly wider ...

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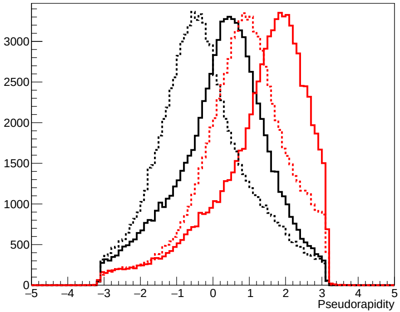

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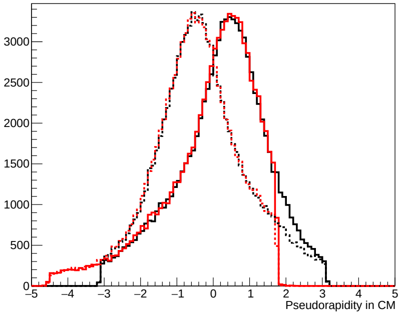

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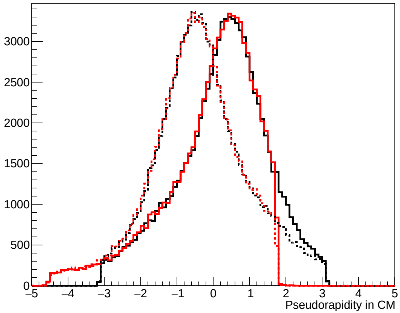

Experimental conditions at HALHF: Track momentum resolution

- Standard ILD-at-ILC: $\sigma(1/p_T)$ vs. p
- To compare apples with apples with boosted system: look at $\sigma(p)$ vs. p
  - Not $\propto p^2$, rather to P^1.
  - ... because M.S. dominates all over.
- Now, in HALHF, but look at $\sigma(p)$ vs. p *in the CM system*: Apples with apples:
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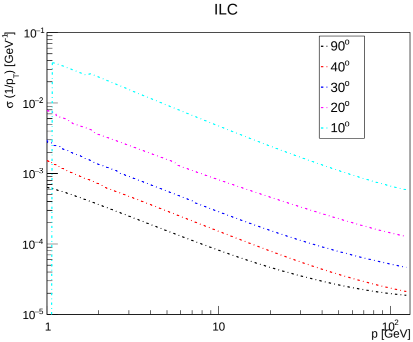

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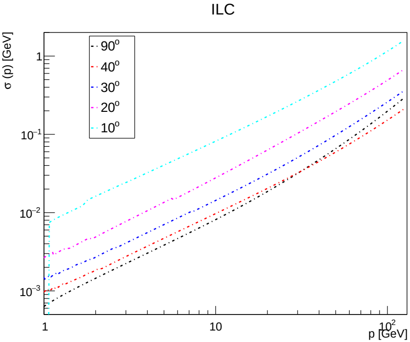

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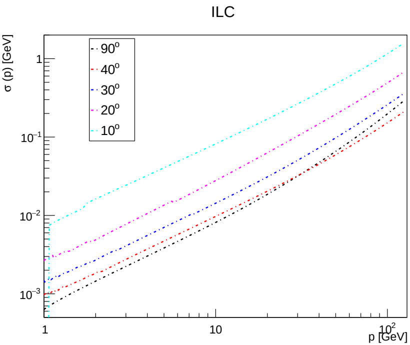

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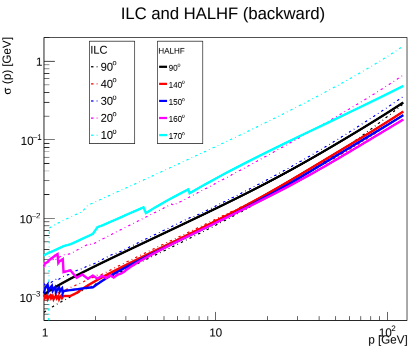

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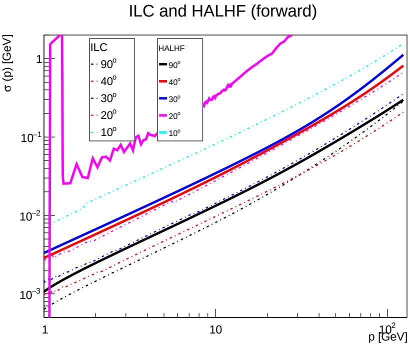

Bhabha at HALHF

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- Luminousity is a source of systematic errors everywhere.
- $\Rightarrow$ need per mil level control.
- Need back-to-back coincidence at as low angles as possible.
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Outlook - No conclusions ...

More work needed:

- Beam-spectrum ?
- Pairs-background - is it better/worse/similar to ILC ?
  - ... and adapt lowest angle detectors to this
- Luminosity measurement: How to do that when bhabha's are not back-to-back ?
- Modify B-field in the forward (toroidal, di-pole, ...). And what would that do the pairs ...
- More physics implications: Flavour tag, searches, ...
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