### 1- Motivation

<table>
<thead>
<tr>
<th>$N_{\text{SID}}$</th>
<th>0</th>
<th>1</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>$N^\text{D}_{\text{SID}}$</td>
<td>34%</td>
<td>24%</td>
<td>4%</td>
</tr>
<tr>
<td>$N^\text{ID}_{\text{SID}}$</td>
<td>18%</td>
<td>12%</td>
<td>2%</td>
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<tr>
<td>$N^\text{ID}_{\text{SID}}$</td>
<td>3%</td>
<td>2%</td>
<td>0%</td>
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3.2% of $H \to bb/\gamma\gamma$ events have at least one semi-leptonic $b$- or $c$-decay $\Rightarrow$ degrade the invariant di-jet mass (important to separate $ZH/ZZ$ and $ZH/ZZH$) [1]

- avoid by:  
  - a better neutrino correction
  - a better parametrisation of the jet uncertainties

### 2- $\nu$-correction

1. identify $b$- or $c$-jets $\to$ flavour tagging
2. find the semi-leptonic decay(s) in the jet $\to$ find and tag leptons in jets
3. estimate neutrino momentum from kinematic of the semi-leptonic decay

$$ E_\nu = E_X - E_{\text{vis}} = \frac{E_{\text{vis}}}{m_X} \bar{p}_{\text{vis}} \parallel \left( m_X^2 - E_{\text{vis}}^2 \right)^{1/2} - \bar{p}_{\text{vis}}^\perp $$

Use kinematic fit to decide!

As proof of principle: cheat input to $\nu$-correction

### 3- Kinematic fitting

Mathematical tool that adjusts measured quantities within their uncertainties to fulfill certain constraints [2] [3]

- $E$ & $p\bar{p}$ conservation: clean collision environment at lepton colliders
- Invariant mass of known particles (e.g. $m_{\mu\mu}$) as soft constraint
- Minimize $\chi^2$:
  $$ \chi^2 (a, \xi, f) = (\eta - a)^T V^{-1} (\eta - a) - 2 \lambda^T f (a, \xi) $$

  - $\eta$: vector of measured kinematic variables
  - $V$: covariance matrix
  - $a$: vector of fitted quantities
  - $\lambda$: Lagrange multipliers
  - $\xi$: vector of unmeasured kinematic variables
  - $f (a, \xi)$: vector of constraints

### 4- PFA paradigm and jet error parametrization

**ErrorFlow** [4]

1. $\sigma_\text{det}$: detector resolution
2. $\sigma_\text{conf}$: effects of confusion in the PFA
3. $\sigma_\text{clus}$: mistakes in the jet clustering
4. $\sigma_\text{overlay}$: uncertainties of $\gamma\gamma \to \ell\mu\nu \ell\mu\nu$ hadron overlay removal
5. $\sigma_\text{\nu}$: uncertainties of $\nu$-correction for semi-leptonic $b$- and $c$-decays

### 5- Fit performance

- Flatmost fit probability ever seen!
- Drastically improved pull distributions

### 6- Higgs mass reconstruction

- ISR and Beamstrahlung included
- Fully cheated $\nu$-correction
- ErrorFlow: jet error estimation

<table>
<thead>
<tr>
<th>$m_H$: \ $\nu$ correction + Kinfit $\Rightarrow$ together</th>
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<tbody>
<tr>
<td>DRAstically improved reco.</td>
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<tr>
<td>$m_H$:</td>
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Add backgrounds:

- $e^+e^- \to ZZ \to \mu\mu$
- $\gamma\gamma \to low p_T$ hadron overlay
- $Z \to bb$ and $H \to bb$ well separated: background not pulled towards signal
- Potentially large improvement eg for Higgs self-coupling prospects

ongoing: perform $\nu$-correction based on reconstructed information only