Matrix Element Method for ILC Physics Analysis

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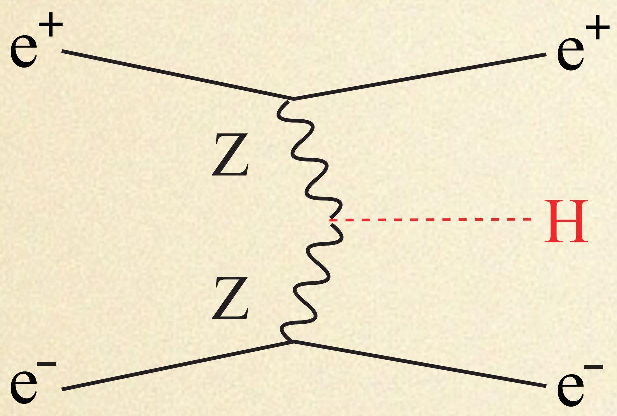
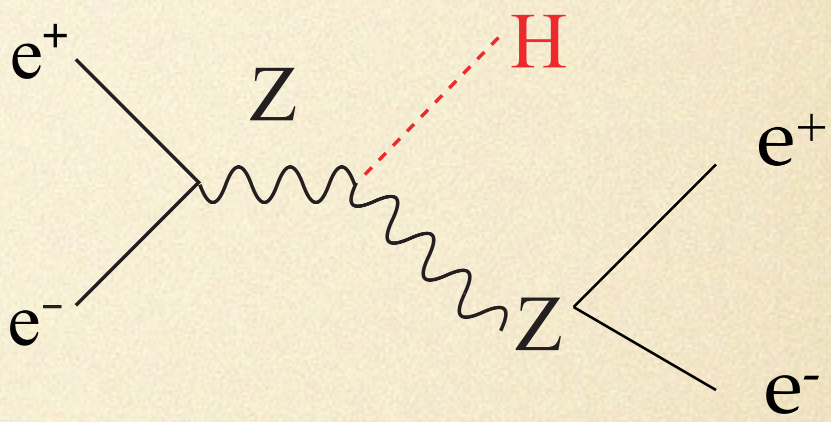
status: ongoing analysis of e+e- —> e+e-H

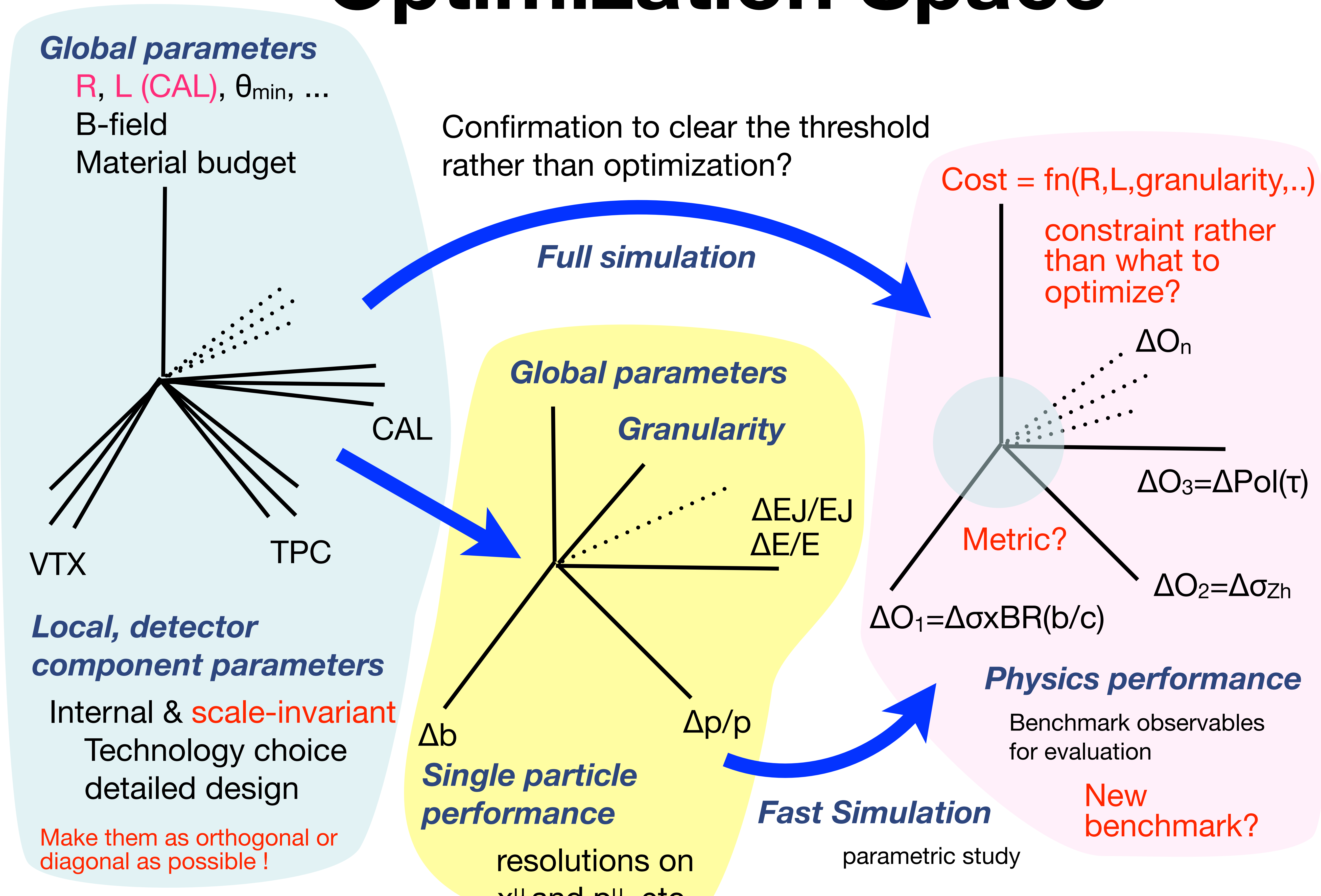




σ_S=0.7/7.5/22.8 fb @ 250/500/1000 GeV

- analysis ongoing: optimizing forward electron selection and overlay removal for this fusion process.
- today: detector optimization & analytic calculation of recoil mass resolution.

Optimization Space



K.Fujii ILD Meeting, Krakow, 24 Sep. 2013

How exactly to do?
example: Higgs total width

$$Y_1 = \sigma_{ZH}$$
$$Y_2 = \sigma_{\nu\bar{\nu}H} \cdot \mathrm{Br}(H \to b\bar{b})$$
$$Y_3 = \sigma_{ZH} \cdot \mathrm{Br}(H \to b\bar{b})$$
$$Y_4 = \sigma_{\nu\bar{\nu}H} \cdot \mathrm{Br}(H \to WW^*)$$

Global Fit

$$\Delta\Gamma_H \sim 2\Delta Y_1 \oplus 2\Delta Y_2 \oplus 2\Delta Y_3 \oplus \Delta Y_4$$

$$\Gamma_H \propto \frac{g^4_{HWW}}{Y_4} \propto \frac{Y_1^2 Y_2^2}{Y_3^2 Y_4}$$

physics analysis (signal and background)

$$\Delta Y_1 \sim c_{11}\frac{\Delta P}{P} \oplus c_{12}\frac{\Delta E_B}{E_B} \oplus c_{13}\frac{1}{\Omega}$$

$$\Delta Y_2 \sim c_{21}\frac{\Delta E_j}{E_j} \oplus c_{22}\Delta Btag$$

$$\Delta Y_3 \sim c_{31}\frac{\Delta P}{P} \oplus c_{32}\frac{\Delta E_j}{E_j} \oplus c_{33}\Delta Btag \oplus c_{34}\Delta Jconfusion$$

interesting in many aspects to see those coefficients!

$\frac{\Delta P}{P}$ $\frac{\Delta E_j}{E_j}$ $\Delta Btag$ Ω

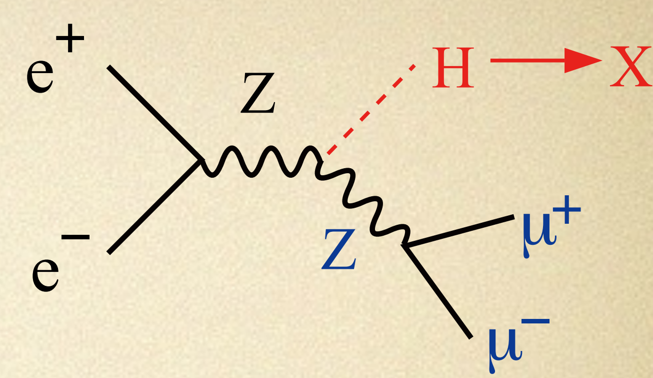
tracking, PFA, flavor tagging…

Detector Optimization

$\Delta\Gamma_H/\Gamma_H$	250 GeV	+ 500
Baseline	11%	5%
LumiUP	5.4%	2.5%

$$\frac{\Delta M_H}{M_H}$$

resolution of recoil mass



$$M_H^2 = (E_{cm} - E_1 - E_2)^2 - |\vec{p_1} + \vec{p_2}|$$
$$= E_{cm}^2 - 2E_{cm}(E_1 + E_2) - M_Z^2$$

i) pure beam effect: $\Delta P = 0$

$$\frac{\Delta M_H}{M_H} = F_B \frac{\Delta E_{cm}}{E_{cm}} \qquad F_B = \frac{E_{cm}^2}{2M_H^2}\left(1 + \frac{M_H^2 - M_Z^2}{E_{cm}^2}\right)$$

ii) pure detector effect: $\Delta E_{cm} = 0$ $\sim \Delta\theta_{12} = 0$

$$\frac{\Delta M_H}{M_H} = F_D(P_1)\frac{\Delta P_1}{P_1} \oplus F_D(P_2)\frac{\Delta P_2}{P_2} \qquad F_D(P) = \frac{E_{cm}P + M_Z^2/2}{M_H^2}$$

$$E_1 = P_1$$
$$E_2 = P_2$$
$$\Delta\theta_{12} = 0$$
$$\frac{\Delta M_Z}{M_Z} = \frac{\Delta P_1}{2P_1} \oplus \frac{\Delta P_2}{2P_2}$$

iii) overall:

$$\frac{\Delta M_H}{M_H} = F_B \frac{\Delta E_{cm}}{E_{cm}} \oplus F_D(P_1)\frac{\Delta P_1}{P_1} \oplus F_D(P_2)\frac{\Delta P_2}{P_2}$$

Ecm / GeV	F	F	F	ΔEcm/Ecm	ΔM/M (B)	ΔM/M (D)	ΔM/M
250	2.2	1.4	0.9	0.17%	0.38%	0.21%	0.43%
350	4.2	2.7	1.4	0.13%	0.54%	0.62%	0.82%
500	8.2	5.4	2.8	0.10%	0.80%	1.8%	2.0%