EF04: EW Precision Physics and constraining new physics

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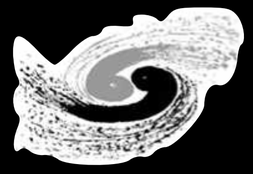

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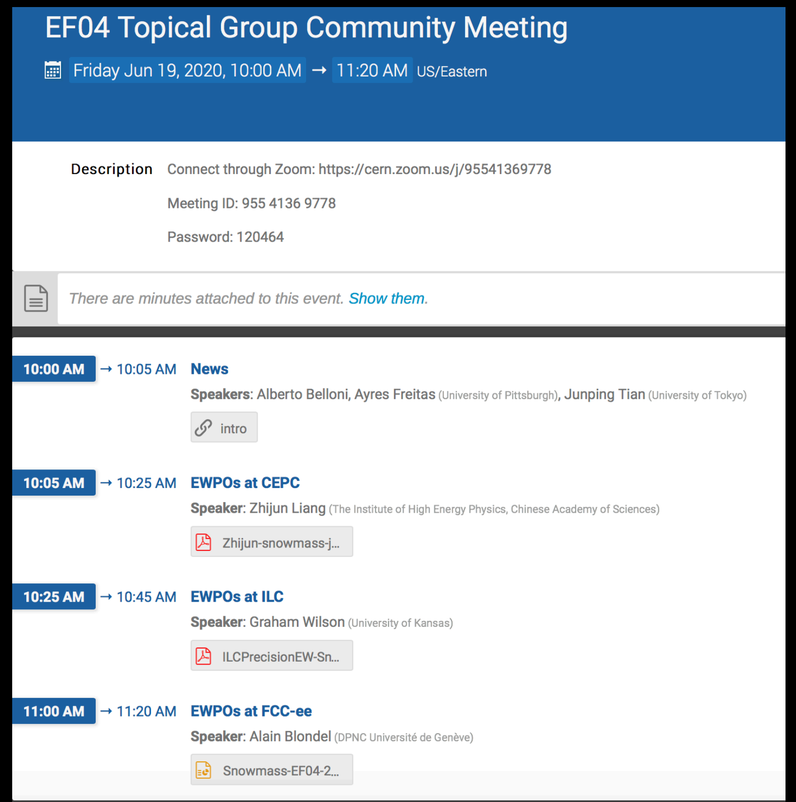
EF04: status and meeting

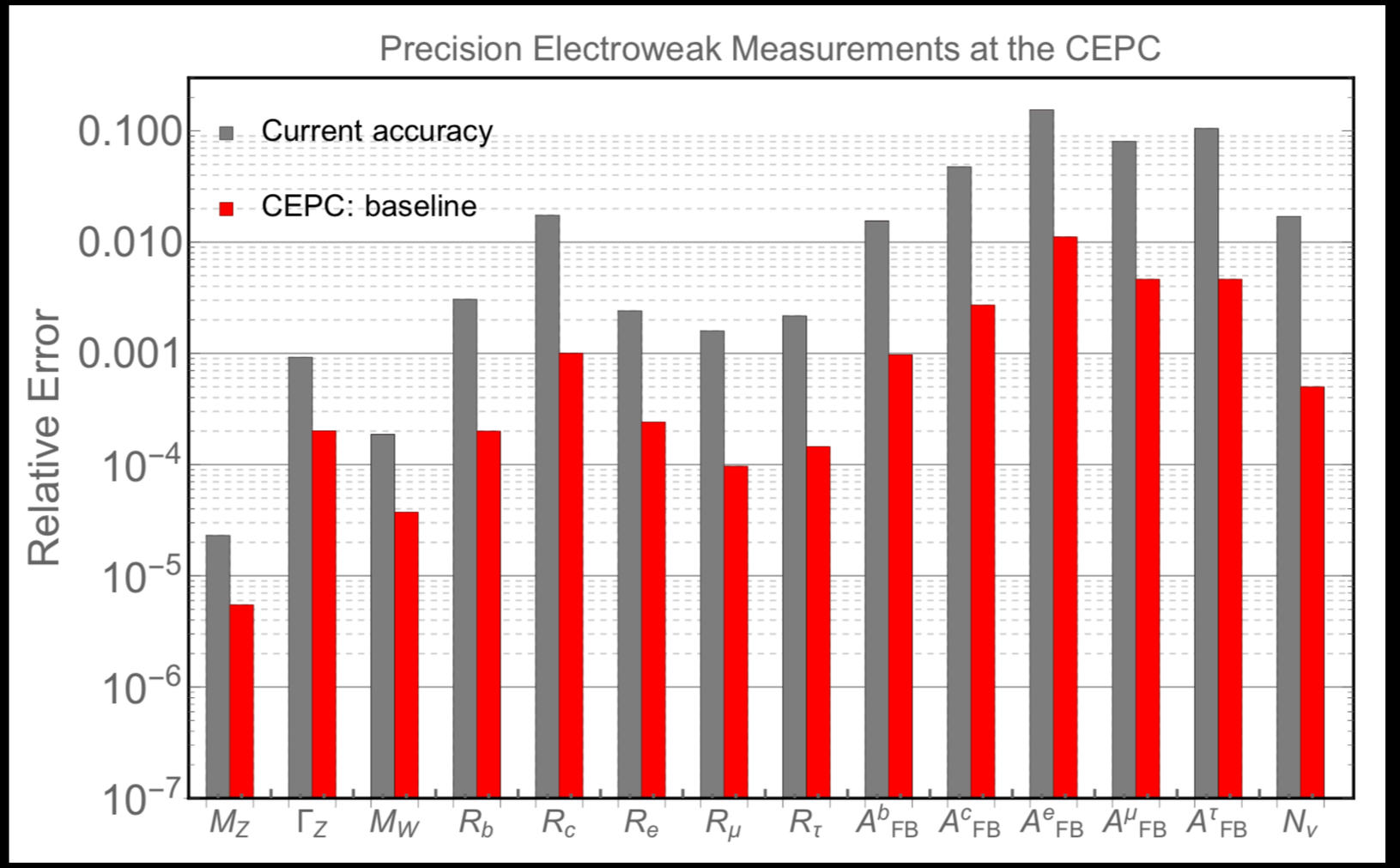
- Conveners: Alberto Belloni, Ayres Freitas, Junping Tian
  - Meeting every two weeks, Friday 10:00am US/Eastern time
- CEPC contact: Zhijun Liang
  - First CEPC talk in EF04: June 19th

- **https://indico.fnal.gov/category/1138/**



Overview of CEPC electroweak physics

- expected precision of electroweak measurements in CEPC CDR
- Estimated by extrapolation from LEP experiments



observables
m_Z
Γ_Z
$\sigma_{\rm had}$
R_e
R_μ
R_τ
R_b
R_c
$A_{\rm FB}^{0,e}$
$A_{\rm FB}^{0,\mu}$
$A_{\rm FB}^{0,\tau}$
$A_{\rm FB}^{0,b}$
$A_{\rm FB}^{0,c}$
A_e (τ pol)
A_τ (τ pol)
BR($Z \to$ inv)
m_W
m_W
Γ_W
$\sigma^{\rm tot}_{240\rm GeV}(WW)$
BR($W \to e\nu$)
BR($W \to \mu\nu$)
BR($W \to \tau\nu$)
BR($W \to jj$)★
derived quantiti
$\sin^2\theta_W^{\rm eff}$
N_ν
N_ν

Example 1: Branching ratio (R^b)

$$\frac{\Gamma(Z \to b\bar{b})}{\Gamma(Z \to had)}$$

- At LEP measurement 0.21594 ±0.00066
- CEPC aim to improve the precision by a factor ~20
- R^b measurement is sensitive to New physics models (SUSY)
  - SUSY predicts corrections to Z→ bb vertex
  - Through gluino and chargino loop …

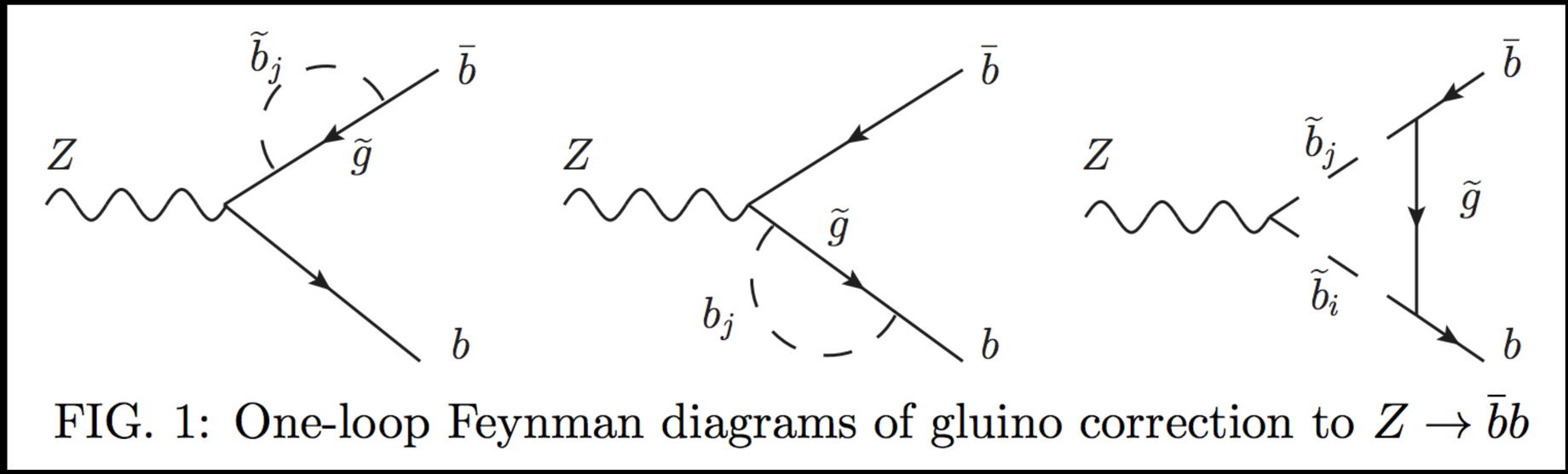


FIG. 1: One-loop Feynman diagrams of gluino correction to $Z \to \bar{b}b$

Arxiv:1601.07758v2

R^b: b tagging hemisphere correlations

- Hemisphere is taken to be tagged
  - if it is tagged by either one or both of the secondary vertex and lepton tags.
- Major systematics: hemisphere correlations
  - The tagging efficiency correlation between the two hemispheres in one event:
    - Angular effects : due to inefficient regions of detector
    - QCD effects (g->bb)
    - Vertex effects : due to vertex fitting

$$C_b = \frac{\varepsilon_{2jet-tagged}}{(\varepsilon_{1jet-tagged})^2}$$

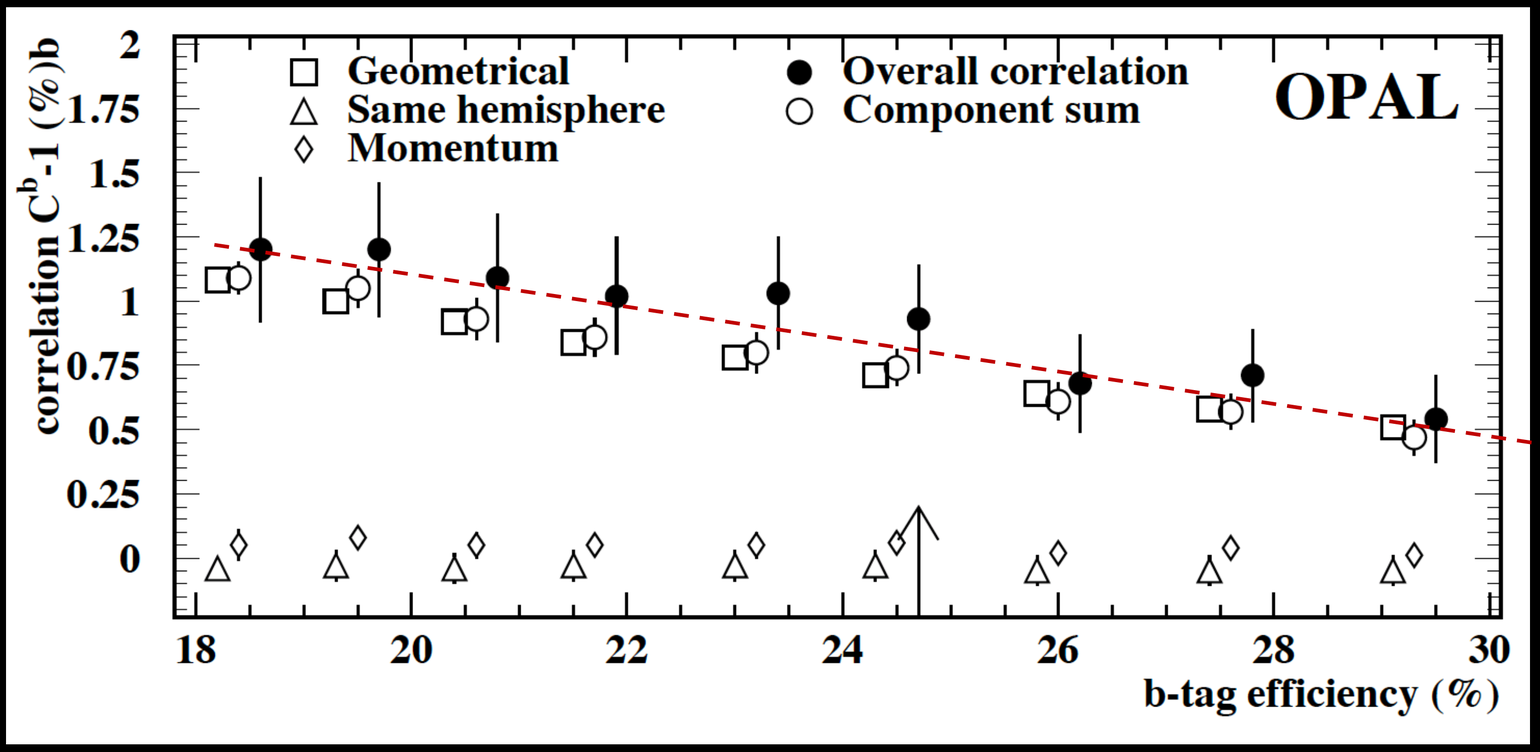
Single (N_t) and double tagged events (N_{tt})

- $$\begin{aligned} N_{\mathrm{t}} &= 2N_{\mathrm{had}}\{\epsilon^{\mathrm{b}}\ R_{\mathrm{b}} + \epsilon^{\mathrm{c}}\ R_{\mathrm{c}} + \epsilon^{\mathrm{uds}}\ (1 - R_{\mathrm{b}} - R_{\mathrm{c}})\}, \\ N_{\mathrm{tt}} &= N_{\mathrm{had}}\{C^{\mathrm{b}}\ (\epsilon^{\mathrm{b}})^2\ R_{\mathrm{b}} + C^{\mathrm{c}}(\epsilon^{\mathrm{c}})^2\ R_{\mathrm{c}} + C^{\mathrm{uds}}(\epsilon^{\mathrm{uds}})^2\ (1 - R_{\mathrm{b}} - R_{\mathrm{c}})\}, \end{aligned}$$

R^b: b tagging hemisphere correlations

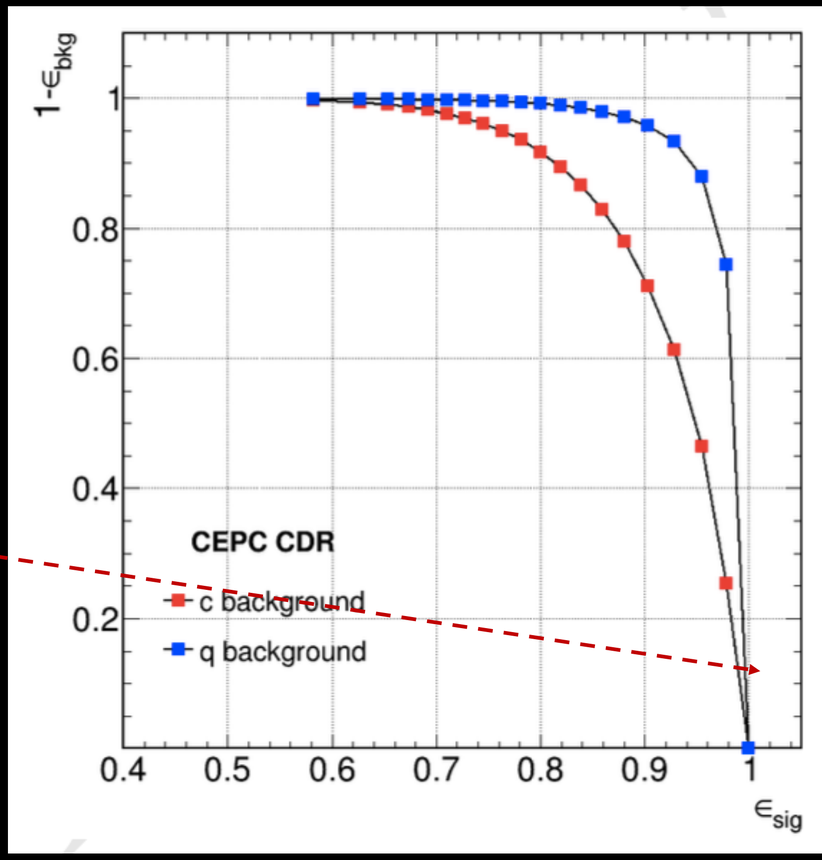
- hemisphere correlations depends on b tagging efficiency
  - with 95% purity working points efficiency> 70%
  - This systematics will not be dominated

$$C_b = \frac{\varepsilon_{2jet-tagged}}{(\varepsilon_{1jet-tagged})^2}$$



OPAL collaboration, Eur.Phys.J.C8:217-239,1999

CEPC b tagging ROC curve



Plan for Snowmass EF04 LOIs contribution

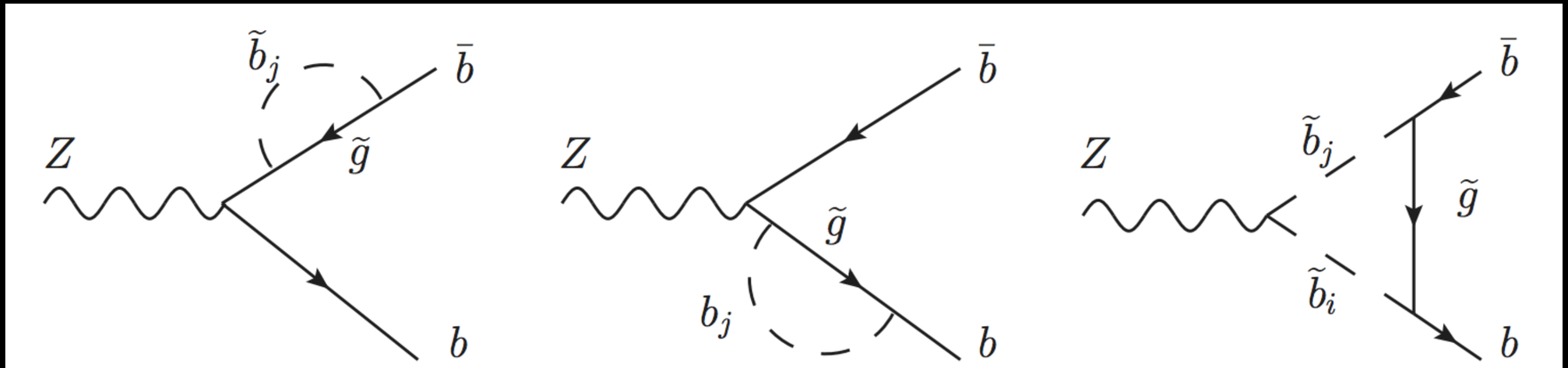
- More detailed study of 2~3 benchmark electroweak observables
  - Eg: weak mixing angle from Z->bb backward-forward asymmetry
  - More study with more realistic simulations
  - More detailed study on experimental and theory systematics
- High order EWK calculation (NNLO EWK corrections)
  - Already setup connection between Zhao Li and EF04 conveners
- EFT fit from EWPOs
- aTGCs/QGCs in WW events
- Please consider to join us and write down your topics in QQ docs

https://docs.qq.com/sheet/DR1NXTXp6V2JkR1NH?tab=m0d77k

EF04	EW Precision Physics and constraining new physics	
EF04.1	WW process	Junmou Chen
EF04.2	TGC (remark: Jet can be measured to energy resolution of 4%, direction resolution of 1%)	
EF04.3	Afb(b) – sin^2(theta_W) (remark: Jet Charge Measurement)	
EF04.4	NNLO EW correction to HZ production	Zhao Li

Feedback from Snowmass EF04

- R^b measurement is sensitive to New physics models (SUSY)
  - Very interesting about physics implication from Z->bb measurements
  - Ayres Freitas would like to follow up on that
- Systematics: b tagging efficiency hemisphere correlationshigh
  - Feedback: Need input from QCD experts
  - Feedback: better to avoid extrapolation from LEP, try standalone estimation from CEPC simulation.
- Feedback about the our plan:
  - Conveners would like to talk with Zhao Li to coordinate NNLO EWK correction calculation



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EF04: News EU strategy (from Alain Blondel)

- Alain Blondel presented the news of Fcc-ee and news in EU strategy
- He mentioned to prepare Fcc-ee TDR and financial documents by ~2025

EF04 news: beam polarization (from Alain Blondel)

- Fcc-ee seems to conclude that longitudinal polarization is not preferred
- Only keep transverse polarization for beam energy measurement.

Beam Polarization can provide two main ingredients to Physics Measurements

2. Longitudinal beam polarization provides chiral e+e- system

-- High level of polarization is required (>40%)

-- Must compare with natural e+e- polarization due to chiral couplings of electrons (15%) or with final state polarization analysis for CC weak decays (100% polarized ... and top)

-- **Physics case** for Z peak is very well studied and motivated:

$A_{LR} = A_e$, $A_{FB}^{Pol}(f)$ etc... (CERN Y.R. 88-06)

figure of merit is $L.P^2$ --> must not lose more than a fact...

self calibrating polarization measurement requires c... and e- polarization

at high statistics $A_{FB}^{Pol} = A_e$ *plays the role of A...*

-- enhance Higgs cross section (by up to ~3...

top quark couplings? final st... ...es as well (Janot **arXiv:1503.01325)**

enhance signal, subtract... ...ckgrounds, for ee→WW , ee →H

-- requires High polarizatio... ...en both e- and e+ polarization

➔ **not interesting if... ...nosity is too high**

-- Obtaining high... ...ization in high luminosity collisions is delicate in top-up mode

DECIDED... ...N TRANSERSE POLARIZATION FOR ENERGY CALIBRATION

As far as we could check, there is no physics that can be done with longitudinal polarization that cannot be done without, given enough luminosity

EF04: New: EF MC task force (from conveners)

- We should fill in the survey prepared by the EF MC Task Force members
- Make our CEPC MC sample as official sample for snowmass study
  - https://docs.google.com/forms/d/e/1FAIpQLSfBDI8fy08uli35gLPFYAL2vGRF9YtkApm5i27Z6MCS9FDNXg/viewform?pli=1
  - Discuss your plans / interests with conveners
- The input will be used to determine if centralized effort to produce additional MC samples is needed
  - Details in email sent to EF mailing list by J. Stupak (EF MC Task Force) on June 1
- All the information provided to the EF MC Task Force is collected here:
  - https://docs.google.com/document/d/1evkV0F7RA2GS8kFjr4A6YsryxY6D9KVlqTEbVADeIRE/
  - https://docs.google.com/spreadsheets/d/19KWScsrEgmHRBtqq3tKxHiREEbT0e_IC3DIPcTdEixc/

EF04: plan

- Internal CEPC discussion every two weeks.
- Prepare for LOIs in this summers
- Next snowmass EF04 meeting in July 2nd
  - Next topic: Input from Diboson measurements.
- Snowmass joint EF workshop July 22nd (time to be confirmed)

Backup: EF04 wechat group

SnowMass EF04: EWK precision

该二维码7天内(7月5日前)有效，重新进入将更新