# Status and plans for WG1 - Physics and Simulation

Meeting RD_FA - 4/7/2017 Bologna

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# Overview of activities last year - Physics

- @FCC-hh:
  - HH->VVbb decay channel at FCC-hh (B. Di Micco, S. Braibant, N. De Filippis, M. Testa, M. Verducci)

- @FCC-ee:
  - W mass and width from threshold (P. Azzurri)
  - Top FCNC (P. Azzi w/ IPN group)
  - BSM interpretation of EWK top couplings precision (S. De Curtis, S. Moretti w/ P. Janot)
  - Top reconstruction with PAPAS (N. Foppiani)

# Overview of activities last year - Simulation

- Different activities:
  - Generation of signal and background samples with Delphes for the HH analysis at FCC-hh
    - non trivial with 500PU
    - *See Talk by Michele Selvaggi*
  - Generation and simulation of signal and background with PAPAS/Delphes for top physics at FCC-ee (Foppiani)
    - used for PAPAS debugging/validation
    - test of HEPPY analysis framework in FCCSW
  - Full simulation of different detectors for ee (Wire chamber, DR calorimeter) in their « standalone » version
    - See talk by Francesco Tassielli

# the *now* - Current Deadlines

- CEPC CDR:
  - deadline ~Fall 2017
- FCC-ee CDR:
  - September: write-up of the Berlin presentations (CDR draft0)
    - use new collaborative editing platform Overleaf
  - CDR review in April 2018
  - Ready by October 2018
- no need to explain that time is quite tight
  - community also busy with HL-LHC TDRs and other documents needed by the European Strategy in 2020 with the same timescale

# Plans for next 12 months - Simulation

- high priority to integration of the full simulation of the detector components of IDEA into the software of the experiments
  - G. Tassielli(LE) responsible for the overall program of integration of the detectors into the full simulation of the experiments
  - need help/collaboration with experts from experiments
    - from CEPC expert coming for few months in Pavia
    - from FCC experts here at this meeting (Nilou Tehrani)
    - F. Grancagnolo(LE) new convener of the FCCee detector working group with M. Dam (replaces G. Rolandi)
- need to setup a team of validators to test the performance of the whole detector with single particles, simple jets, simple events.
  - this is where newcomers should be directed. To optimize learning curve:
    - for CEPC, no documentation available, (Pat) collecting instructions for running using the baseline detector
    - our original contribution should be with the IDEA concept in Mokka
    - for FCCee, learn how to generate and make studies with CLIC-inspired detector
    - move on to IDEA simulation/digi/reco (DCH first) as soon as available

# Plans for the next 12 months - Simulation

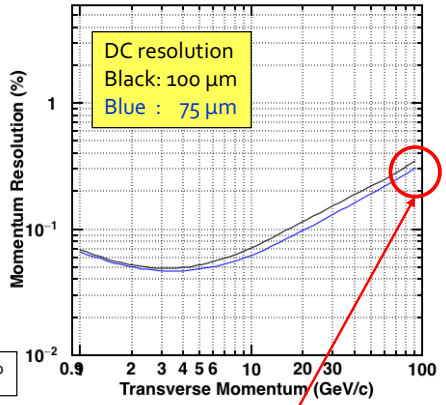
- small groups of expert of specific detector simulation already working well for the DCH(Lecce) and the DRCalo (Pavia, Como)
  - need to continue and finalize description of detector response and optimizations
  - validation with test beam data when possible
    - seen presentation this morning
- need to start performance studies looking at response of single particles, or simple jets in standalone configuration.
  - in particular focus on digitization and local reconstruction to study/push performance potential

# Studies with detector

- Some studies already starting (M. Dam, G. Tassielli)
- Need to coordinate and find a critical mass in INFN

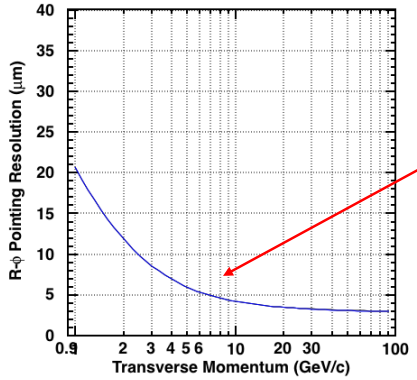
## IDEA Tracking System Performance – First Results

- Beam pipe: r = 1.56 cm; 0.48% of $X_0$
- Five VTX layers (5 μm resolution)
  - r = 1.7, 2.3, 3.1 cm; 0.3% of $X_0$ per layer
  - r = 15, 25 cm; 1% of $X_0$ per layer
- Drift chamber (112 layers of 100 (75) μm resolution)
  - r = 35-200 cm
- One precise Si strip measurement (10 μm resolution)
  - r = 201 cm
- Very light: Total of ~5% of $X_0$ before pre-shower




Performance at θ = 65°

Reaching 0.3% at 100 GeV




Impact parameter resolution

$$\sigma_{d_0} = a \oplus \frac{b}{p \sin^{3/2}\theta}$$

$a \simeq$ 3 μm $b \simeq$ 18 μm GeV

Results by ALICE tracking system optimization tool kindly provided by R. Shahoyan

Very fresh results. Optimization to be done!

Mogens Dam / NBI Copenhagen FCC-ee Detector Design 19 June 2017 5

M. Dam - FastSim from Alice

# Requirements from Physics

- Need to attache names to each specific study to make sure it gets done :-):
  - systematic studies with single particles
  - studies of particle ID
  - studies of particle separation using (simple) jets
  - studies/performance from physics channels:
    - Z, W, top, Higgs
  - Studies/performance using BSM cases.
    - FCNC for btagging, charm tagging
    - Composite Higgs (mass resolution)

# Effects of Fast Sim Studies

- Even if the Fast Simulation offer a simplistic view of the detector, they are very useful in the early stages to quickly evaluate big effects on the physics measurements.

- In the case of ee colliders it is true that the FullSim is very quick and « inexpensive » from the CPU and event size point of view. However in the case of hadron colliders there is no choice (especially with O(100) PU events)

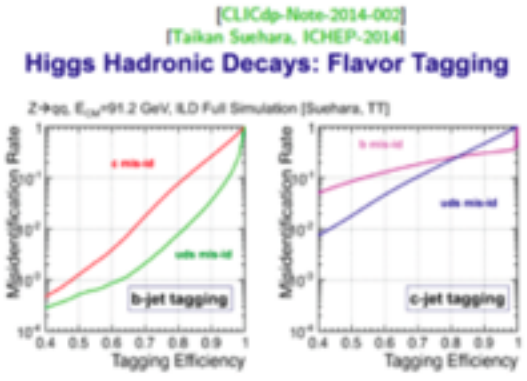
- Some studies already performed to give an idea of the effect of changing the parameters

# b-tag effect on analysis case: Top FCNC

FCNC in single top production at ee: ee->tc, Delphes simulation

- in the first iteration of the FCNC l+jets analysis there was a check of the effect of using different b-tagging working points.
- Used two working points: eff(b)=60(80)% and rej(c)=250(10) and rej(light)=1000(100). Number from ILC
- large effect on efficiency and rejection —> limits
- Analysis being redone with latest simulation card and working points variation

[CLICdp-Note-2014-002]
[Taikan Suehara, ICHEP-2014]




ILC detectors allow high performance b/c/g tagging
Precise measurement of BR(H→bb, cc, gg)

## Example from old study

| | $\epsilon_b = 60\%$ | $\epsilon_b = 80\%$ |
|---|---|---|
| $tcA$ | $426.17\|\lambda_{qt}\|^2$ | $479.28\|\lambda_{qt}\|^2$ |
| $tcZ, \gamma_\mu$ | $178.82\|\mathcal{X}_{qt}\|^2$ | $199.22\|\mathcal{X}_{qt}\|^2$ |
| $tcZ, \sigma_{\mu\nu}$ | $281.32\|\kappa_{qt}\|^2$ | $316.92\|\kappa_{qt}\|^2$ |
| $Wjj$ | 2.40 | 34.35 |

Table: Cross section normalisation factors (in fb) after complete cut flow

M. Najafabadi et al.

# Impact of detector parameters

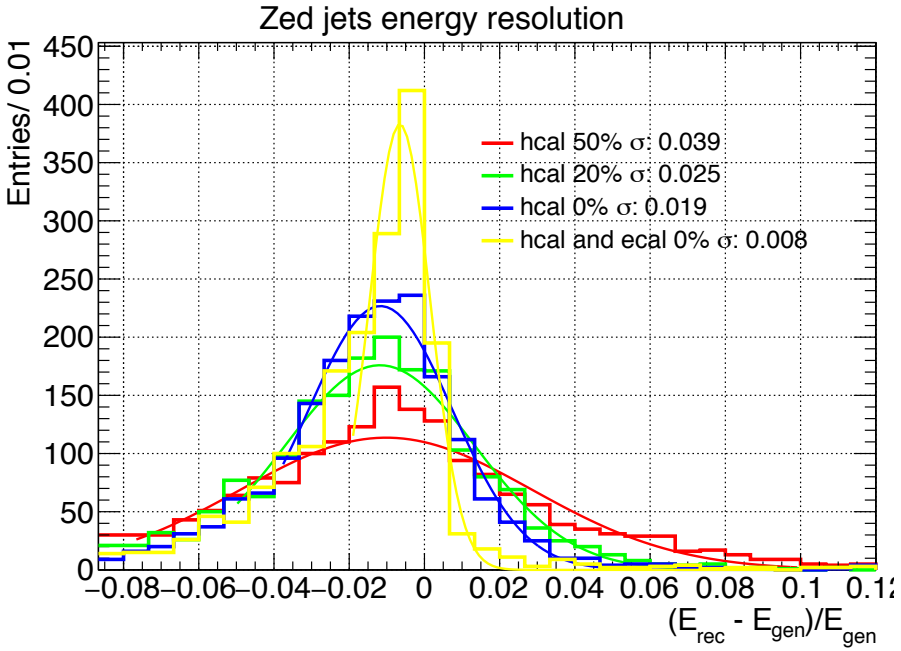
Janik von Ahnen Krisztian Peters, Katharina Behr

- Study in the context of FCC-ee Higgs group done with Papas simulating CMS performance

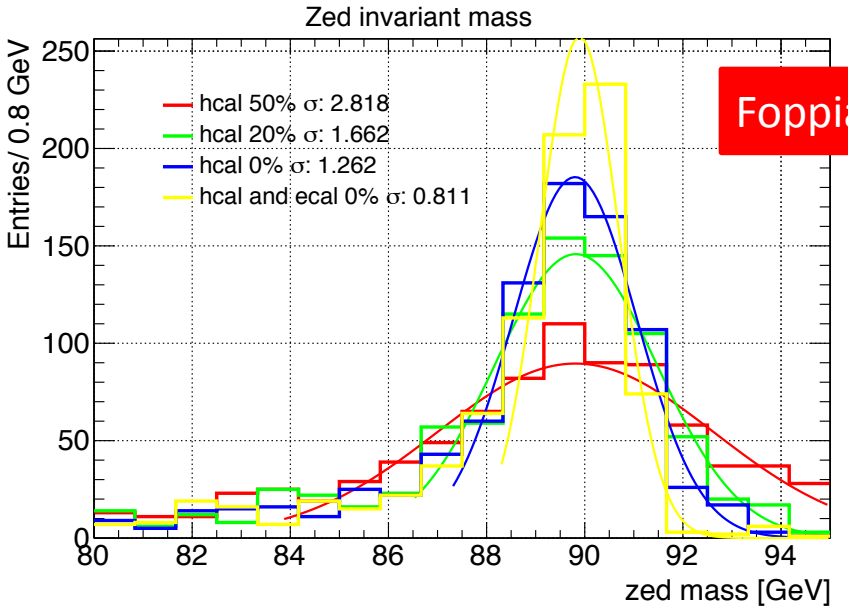
  - 100k HS events with $H \to b\bar{b}$, $Z \to \nu\bar{\nu}$ are studied
  - Estimate improvement with the width of the signal

| Detector parameter | Factor | Width improvement [%] |
|---|---|---|
| Magnetic field | 5/3.8 | 2.26 |
| **Tracker radius** | 1.8/1.29 | **3.89** |
| **Tracker efficiency** | 100%, $p_T \geq 0.2$ | **20.99** |
| ECAL cluster size | 0.5 | 3.89 |
| ECAL energy resolution | 0.5 | 0.8 |
| HCAL cluster size | 0.5 | 0.86 |
| **HCAL energy resolution** | 0.5 | **21.49** |
| $p_T$ resolution | 0.5 | 0.1 |

# Effect of HCAL resolution: Z->qq




- Study with Papas in the ILD configuration
- Part of validation process: this is quite new still…



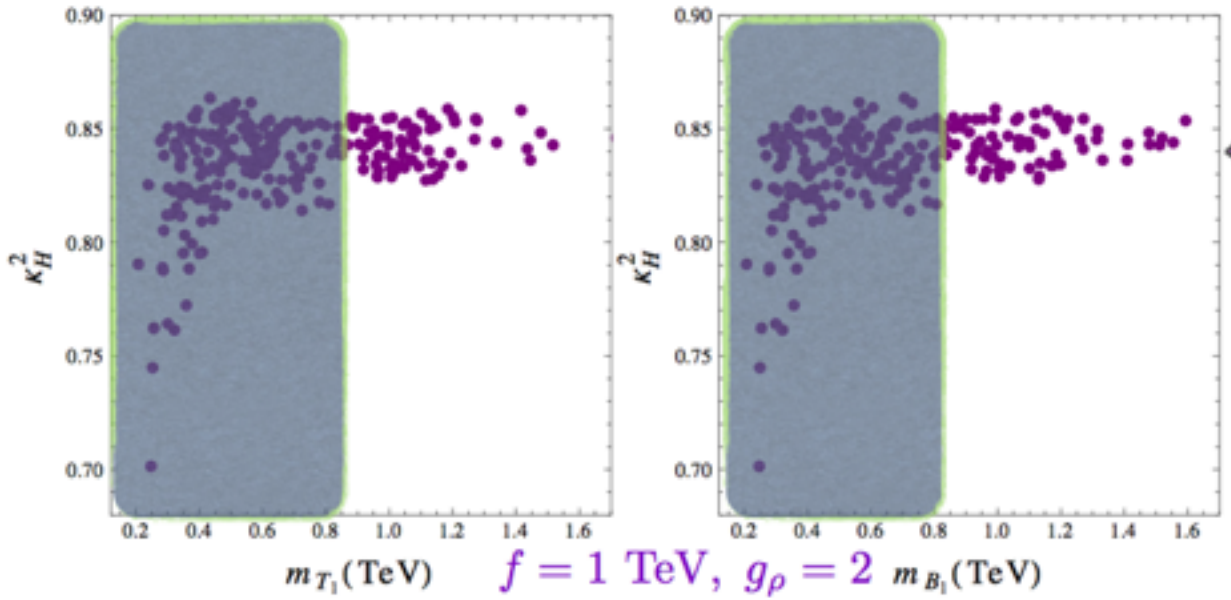
# Requirements from CH

## Higgs width

$\kappa_H$ smaller: $b - b'$ mixing, all Higgs rates rise

- ~15-20% reduction in the 4DCHM **mainly due to the modification of the Hbb coupling** but also **loop effects** especially for low extra-fermion masses

direct searches exclusion: $M_{T_1}, M_{B_1} > 800$ GeV




$f = 1$ TeV, $g_\rho = 2$

in agreement with $c^2 = \dfrac{(1-2\xi)^2}{1-\xi}$

$\xi = \dfrac{v^2}{f^2}$

# Conclusions? Planning for next year

- For Physics studies:
  - finish and write up contributions to EWK andTop physics chapter of CDR for ee.
  - HH in the FCC-hh CDR.
- In general: shift focus from Physics Signatures to Detector studies:
  - clear planning shown both by DCH and DR calorimeter groups
  - G. Tassielli new responsible for the simulation integration
  - Good moment to include other colleagues usually more connected to physics
- Of course, we are always open to find new interest for Physics studies:
  - contact us!