

FCC-hh: plans for ESPPU submission

Editors: M.L. Mangano, M. Selvaggi, B. Stapf, A.Taliercio, S. Williams

- **Context:**
 - 10 page doc's, to be submitted by March 31
 - Will be reviewed by the WGs of the Strategy Preparatory Group, to prepare
 - presentations at the Open Symposium (Venice)
 - briefing book of the ESPP, to be used during the strategy-setting mtg of the Strategy Group
 - for details, see: <https://europeanstrategyupdate.web.cern.ch/process-0>
- **FCC PED submissions**, as agreed with the ESPPU leadership (main editors):
 - 1. **Physics-Experiments-Detectors Overview** (C.Grojean, P.Janot, G. Wilkinson)
 - 2. **QCD** physics (D. d'Enterria, P. Monni)
 - 3. **Higgs/EW/Top** physics (P. Azzi, J. Bendavid, J. de Blas, G. Durieux, J. Eysermans, A.Freitas, E. Perez, M. Selvaggi)
 - 4. **Flavour** physics (J. F. Kamenik, S. Monteil, G. Wilkinson)
 - 5. **BSM** searches (T. You, R. Gonzalez Suarez, M. McCullough, P. Azzi)
 - 6. **FCC-hh specificities** (M. Mangano, M. Selvaggi, B. Stapf , A. Taliercio, S. Williams)
- **Benchmarks for the 10-page docs**, proposed by the Preparatory Group: see **attachment** to this indico agenda item

H/EW/top (items of relevance to hh)

- **Higgs:**
 - Single Higgs couplings, in view of BSM sensitivity via EFT fits (various fit scenarios requested, see doc for details)
 - Higgs self-coupling from HH (exclusive and inclusive determination of κ_λ)
 - **Status:** updates on most CDR projections
 - $\mu\mu$, $Z\gamma$, $\gamma\gamma$ over 4leptons , HH => Birgit Angela Sarah Michele... — see today report
 - ttH/ttZ => Elena Stefano — see today report
 - **New results:**
 - HWW in VBF => Eliot — see today report
 - HWW, Hbb and H $\tau\tau$ ratios from VH — 2019 MLM study, attached to agenda => to be updated?
- **EW:**
 - probes of Electroweak symmetry breaking/Multi-Boson processes
 - E.g. Longitudinal Vector Boson Scattering(VBS): Same-sign VBS@Hadron colliders
 - **Status:**
 - $W_L W_L$ BNL study => Chilufya, Marc-Andre', ... — see today's report
- **Top:**
 - top properties from SMEFT fits:
 - top yukawa, 4-fermion int's, top-dipole op's
 - include projected uncertainties of the observables provided for the EFT interpretation
 - **Status:**
 - see old *Pinning down top dipole moments with ultra-boosted tops* (MLM & Aguilar Saavedra)
 - not aware of new ongoing work — can generate SM distributions (m_{tt} , $p_{T,top}$) for use in EFT fits?
 - refer to Yellow Report/CDR projections for top FCNC ?

QCD (items of relevance to hh)

- **pp:**
 - α_s and PDFs =>
 - discuss **Forward Physics Facility for PDFs**
- **Hot and dense QCD:**
 - Wiedemann and Dainese to provide **1-page summary of findings** from FCC Yellow Report and CDR

Flavour (items of relevance to hh)

- **Focus on b, c and τ physics** (CKM, FCNC, rare/forbidden decays, ...):
 - No dedicated study available, include a couple of paragraphs to highlight the proven potential of a pp collider to do flavour physics, form the example of LHC (to be provided by Guy Wilkinson)
- **Flavour at high pt** (high-Q manifestations of flavour anomalies) => **see BSM section**

BSM (items of relevance to hh)

- New gauge forces ($Z', W' \dots$): U(1)-Y-universal, U(1)B-L (universal and 3rd gen), HVT SU(2)L custodial, HVT Right-handed
 - plan: recycle old CDR studies + include new on HVT (Torre et al)
- Compositeness (indirectly from EFT fits): Scenario discussed in 1905.03764 + 4q, 2q-2l
 - plan: recycle Y,W YR studies ... provide jet high-pt rates for 4q ops' limits?
- Extension of the minimal real scalar sector giving 1st order EW phase transition and possibly stability: scenario discussed in e.g. 2303.03612
 - plan: these are single-scalar SM extensions, with $S \rightarrow HH$, s discussed in CDR studies. Authors of proposed paper in contact with Angela et al for update
- Minimal dark matter (WIMP) global: see e.g. 2107.09688
 - plan: CDR displaced-track analysis updated to 80 TeV; plus update from Barducci et al
- Flavor (together with flavor group): scalar and vector leptoquarks with third generation specificities
 - plan: Cornella et al looking at $pp \rightarrow \tau\tau$ (t-channel LQ exchange, b- τ -LQ vertex)
- SUSY (direct only collider, global on with specific assumptions): see Briefing Book 2020
 - nothing new, reiterate CDR/YR limits
- Portals (dark photon, dark higgs, HNLs, axions, ALPs): see Briefing Book 2020
 - reiterate CDR/YR studies
 - **New:** David d'Enterria and Patricia Rebello, ALP searches in $\gamma\gamma$ ultraperipheral HI collisions

Neutrinos, DM and dark sectors

what is produced of relevance in the context of the BSM benchmarks will be fed to the Neutrino and DM WGs by the BSM group

Structure of FCC-hh specificities documents:

- **Introduction:**
 - general references to 2016 Yellow Report and CDR, baseline detector YR
 - discussion of energy-luminosity scenarios, since CDR
- Results of relevance to the combined FCC-ee and FCC-hh performance (eg Higgs couplings, EWSB parameters, etc):
 - include the baseline **results** (84 or 100 TeV) in the H/EW/top document
 - just the **results...** details on analysis, detector syst assumptions, etc, in the FCC-hh doc or in back-up document or in CDS/arXiv notes
- EFT inputs from high-Q² physics (eg tt, W,Y params, etc): depends on the format
 - eg high-Q distributions can be tabulated in separate notes, made available to Prep Group for their fits
 - individual numbers (eg direct limits from existing studies, like W,Y constraints): go to H/EW/top document
- Results specific to FCC-hh (eg HI's, PDFs, high-mass BSM searches, ...): in the FCC-hh doc
- BSM studies of joint interest for FCC-ee (eg ALPs, DM, ...): will discuss once the BSM document draft is available
- In general, will apply common sense, to optimize presentation of physics case
- **As always, please share your suggestions/proposals with the WG coordinators:**
 - fcc-ped-hh-espp25-admin@cern.ch (general)
 - fcc-ped-hh-physicsperformance-espp25-admin@cern.ch (physics performance)