

Special FCC P&P Software Meeting, 10 Feb 2021

Present: None; Vidyo only meeting following CERN coronavirus restrictions
Remote: E Perez, P Azzi, G Ganis, C Helsens, V Volkl, A Salzburger, F Bedeschi, A Akhundov, Ang Li, Aridam Das, F Briec, D Contardo, Hwidong Yoo, I Korzhavina, J Alcaraz, L Gouskos, L Poggioli, M Boscolo, M Chrzaszcz, P Gesinger-Befurt, P Fernandez, R Sengupta, R Aleksan, S Heinmeyer, W Hulsbergen, Ziad El Bitar, M Selvaggi, F Grancagnolo, D Hill, B Schlag, A Blondel, G Wilkinson, M Dam, S Monteil, BFL Ward, E Gorini, J Smiesko, G Tassielli, P Azzurri, V Diolaiti, Sanghyun Ko, J Andrea, K Gautam, A Sailer
Agenda: <https://indico.cern.ch/event/1003610/>

The following are some notes taken during the discussions which followed each talk. Please refer to the slides for the content of the talks themselves.

Physics motivations (R Aleksan)

Slides

- Precision physics depends on the quality of tracking and vertexing
- Presented numbers are for FCC-ee (not LHCb ...)
- Tagging requires precise vertexing
- FB: nice review of vertexing needs
 - There are also long lived particles (Ks, Lambda, ...) that come to play, with less pushed requirements, but should be included in the overall evaluation of the detector designs we are studying (gaseous detector vs silicon trackers)
- AB: Orthogonal set of processes: very good. Other requirements and synergies for WW physics, especially due to the large number of B (tools and physics interconnection). Also for Vub.
- SM: stress the previous. Comment that, while the Bc decay constant should be known quite precisely from lattice QCD by the time of FCC, large uncertainties would remain on the Bc hadronisation fraction, which will entach the determination of Vcb via Bc to tau nu. Hence Vcb from WW is indeed crucial.

ACTS (A Salzburger, B Schlag)

AS slides, BS slides

- ACTS means to be flexible.
- Focus of performance

- Propagator engine is at the core
 - Can be extended at compile time with ad hoc actions
- Several Geometry interfaces
 - TGeo, DD4hep, text
- FB: do you handle stereo layers? Yes, all types, (describes ATLAS complicated situations ...)
- Gaudi type configuration
- Fire Brigade model: you call us and we take care
- CH: not only for vertexing, also for tracking (in complex environments)
- AB: where ACTS is set? Started from ATLAS, carried on by LHC and not LHC interested people; group of friends; open to contributions
- Vertexing:
 - All ATLAS (primary) vertexing algorithms imported
 - Fully integrated in ATHENA; fully validated and tested
 - Good CPU (GPU?) performance (2x faster in average)
 - Multi-threaded version validated
 - ATLAS will use in run3
 - Time information is included
 - Seed finder up to 40x faster than current ATLAS one
 - Excellent physics and CPU performance
 - PAzzi: Timing resolution has been tried? No, we are prepared for that
 - FB: my impression is that for FCC-ee will not be relevant (it is for FCC-hh)
 - PAzzi: may be relevant to some specific cases ...
 - AS: Constrained fitting not addressed yet

A stand-alone vertex-fitting algorithm (F Bedeschi)

Slides

- Provide simple code easy to run waiting for more complex implementations to be available in the FCC software framework
- Input: 5 par + cov ; perfect helix
- Output: 3D vertex + cov
- Chi2 minimization
 - The formulation is done with 3D matrices, with better numerical control
 - Thanks to the use of Lagrange multipliers
- Very good performance with 3 and 2 tracks
- Very fast!
- LG: why tertiary is complicated? Because of the many levels of fitting

First example resolutions of displaced vertices in exclusive processes (using FB's algo)(E Perez)

Slides

- AB: Gaussian fits should be taken with a grain of salt, because there are tails
 - FB: this is because the full cov matrix cannot be used by now (only the diagonal matrix)
 - CH: the problem is that Delphes does not allow yet to extract the missing terms
 - MS: not all the terms are written to output. It is trivial to fix and will be done
- RA: results are surprisingly good, similar resolution in Ds K and in J/Psi Phi with 4 tracks! Is this understood? Not completely - the K in DsK is very energetic and the angular separation between the Ds and the K is large, but still investigating.
- RA: is it thinkable to have the code embedded for secondary and tertiary vertex available? A general code? The idea is to make available publicly (in GitHub), not sure it is fully general, but should be flexible enough
- CH (on Bc to tau): many things are very fresh, we need to digest and understand ...
- DH: comparing the tertiary vertices made with 3 tracks, in Bc -> tau -> 3pi and in Ds (from Bs) -> 3 tracks : for Bc -> 3pi the resolution is 20 um larger than in Bs -> Ds K; probably because pions are softer than in the other cases
 - MD: the 3pi from tau have more boost and therefore larger error on the vertex, due to the smaller angular separation

The DecayTreeFitter algorithm (W Hulsbergen)

Slides

- CH: did not know about this code. DTF should be used at the very end, because expensive? Yes, not at selection step.
- GG: Is it implemented as Gaudi algorithm? It is standalone C++ glued in Gaudi. It uses the LHCb event model (main difference with BaBar). Belle2 re-implementation uses libeigen, but performance numbers are a bit disappointing.
- Suggest to start from the LHCb implementation, and not from the Babar implementation, because it has important improvements e.g. in the KF; Wouter could help port what is needed from the Babar implementation (e.g. the solenoidal field in the model).
- SM: DTF would be an asset for FCC-ee, although many things can be done without. Decay chains with neutrinos can be improved. Worth to be tried.
 - WH: sometimes one can "loose" in DTF, compared to quasi-analytical formulae, because DTF has only one parametrisation (px,py,pz for the neutrino, while p_parallel, p_perp may offer more stability in the fits)
- MD: LHC-ee was called LEP in the past ...

- CH: Can constrained fits be used to “measure” bad-measured neutrals ? Might be useful in some cases, but difficult in general; very good calorimetry is a must. Is energy resolution more important than position resolution? To be studied ...

Implementation of the LCFI+ algorithm into key4hep (P Fernandez)

Slides

- CH: The immediate goal is to use LCFI+, good to have to compare with other algorithms and technologies.
- AS: if we want the output in EDM4hep we need also the conversion back (next step).
- EP: what is the overhead? Not yet measured; will do.

LCHb algorithms in key4hep (M Chrzaszcz)

No slides

Re-implementing what is done in LCHB for primary vertex fitting, e.g finding seeds and then determining the position of PV. It will be implemented as Gaudi algorithm, and should facilitate access to PV. Will have something soon.