

OpenLoops: Status and Outlook

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For NLO QCD Sherpa+OpenLoops is in a very good shape. Practically no support requests concerning the interplay between Sherpa and OpenLoops.

- Simplified installation / updates.
- Improved platform compatibility (FreeBSD, OS X, Linux on AArch64, ...).
- Not everybody is happy with the “download and compile in your home directory” approach.
- Request: system wide installation and per user process installation. (some people submit a complete OpenLoops with the needed processes to a cluster instead of installing everything globally and use that as intended by us.)
- Versioning of generic code and processes:
keep your OpenLoops installation up to date!
Process code usually doesn't change.
Numbers do not change between different versions and we check that with every release.

Loosening technical restrictions

- Support for processes with more than 6 external particles.
- Support for tensor rank greater than 5.
- e.g. $tt+3j$, $V+4j$, $H+3j$ (HEFT *and* loop induced), ...

For NLO: public OpenLoops with CutTools works smoothly (but for low multiplicities Collier is faster).

Loop-induced processes can only be calculated efficiently with tensor integral reduction, i.e. Collier.

Process library extended to include virtually all loop induced SM processes which are interesting: one or two bosons (H, γ, W, Z) with jets up to $2 \rightarrow 3$ and leptonic decays on top (need integrators!).

Status of Collier

Semi-public beta version available

- We just got permission to distribute the source code to the ATLAS and CMS (previously only binaries).
- Meant as a step towards a public release. Development seems to converge (all important features available; lots of testing, debugging and tuning done in the last few months).
- Limitations in particle multiplicities and tensor rank removed
→ loop induced hexagons work now (e.g. $gg \rightarrow Hggg$ via top loops).
- Also Sherpa members should switch to the new version (I'll send an e-mail with instructions) and report problems to us.

Every year: decays (afterburner)

Decay afterburner

Is there a way to implement multiple decays with intermediate offshell particles? → Need to think about onshell mappings of intermediate vector bosons “one onshell, one offshell”.

(Usual problems with hadronic decays;
lots of EW offshell stuff in VBF $H \rightarrow 4l$.)

Btw. $H \rightarrow b\bar{b}$ needs massive b quarks which is inconsistent with 5 flavour PDFs. If one sets $m_b > 0$ by brute force, the number of running quarks must be set to 5 manually in OpenLoops.

A propos: has anybody thought about communicating information about the α_s running to the matrix element generator (do b and t contribute to the running above threshold)?

Every year: decays (resonant diagrams)

Decays in the matrix elements

(i.e. selecting of resonant diagrams)

New development: gauge invariant approach by Dittmaier et al.;
invalidates previous arguments against this approach.

Planned to implement in OpenLoops.

→ NLO decays; recipe to treat real radiation;
need mapped phase space points.

Physics models

QCD+EW Standard model, EW → talk by Jonas.

- Yukawas and naive coupling scaling (also negative).
- Higgs effective theory implemented (H+3jets available).
- very recently: HEFT with two Higgs bosons.
- 2HDM Type 1 & 2 with QCD corrections, partly checked against Silvan's UFO 2HDM at tree level.

Currently implementing new physics models is quite painful for us, especially if the ingredients (Lorentz structures, R_2 Feynman rules) are not implemented yet (or unknown in the case of R_2).

One thing to come: HEFT for pseudoscalar Higgs.

→ Bridge the time gap until we are able to import UFO models.

Ongoing developments

- Writing something that deserved the name “documentation”.
- High multiplicity processes: explore ideas to further improve performance and numerical stability.

Reimplementation of the OpenLoops generator

- Announced at the 2015 Sherpa meeting.
- Going slowly, but after some tests and abandoning inconvenient approaches from the original plan we know now where we are going.
- Make the process generator public.
- Import UFO models (consistent with Silvan’s code).
- Expect first working code until the next Sherpa Meeting.