



Precision Working Group Update

GAMBIT XV

Peter Athron & Eliel Camargo-Molina

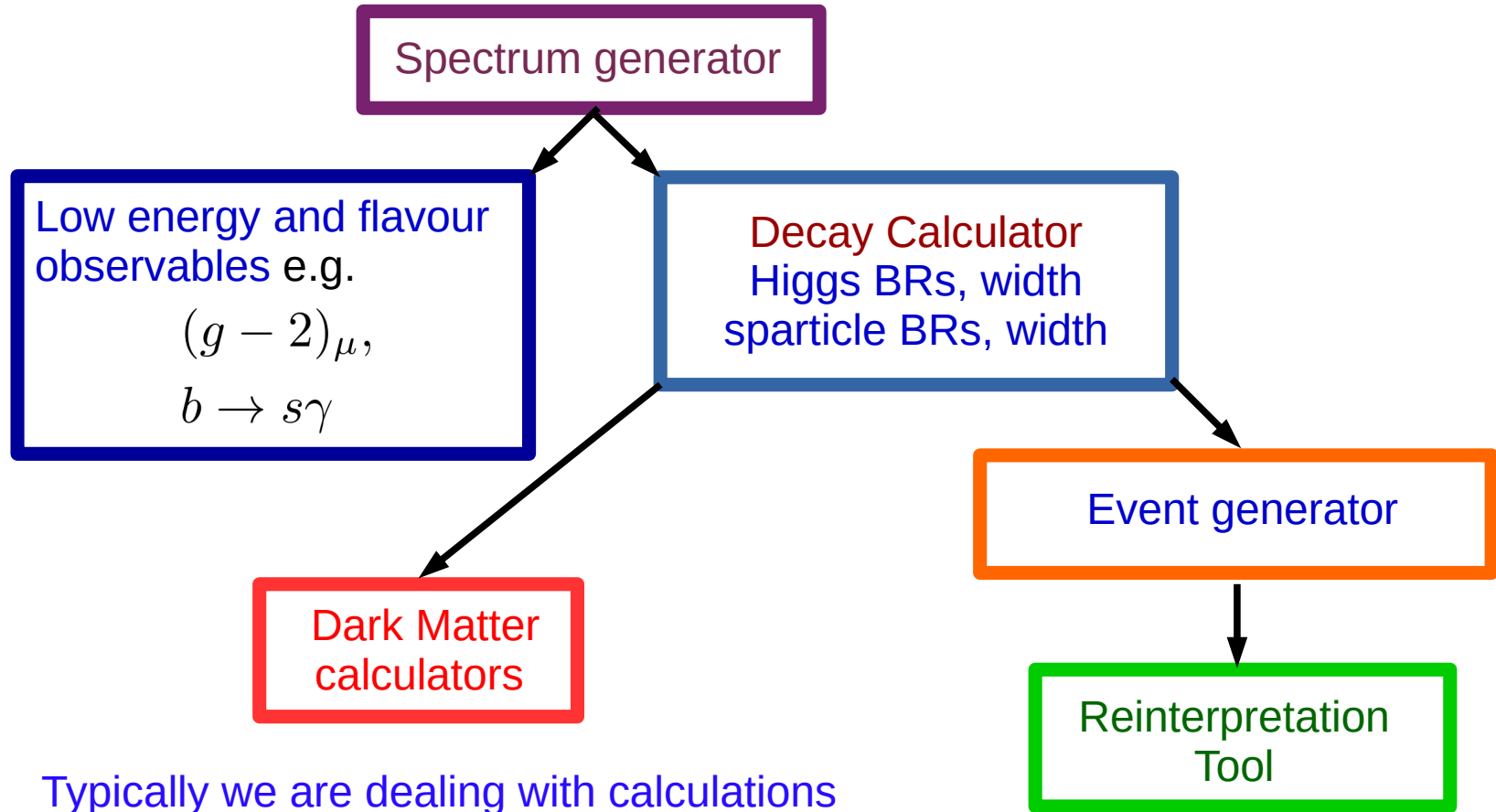
What is the Precision WG?

Handles (precision) theory calculations not directly related to flavour, collider or dark matter.

We are responsible for the following “Bits” of GAMBIT.

- SpecBit – Provides the mass spectrum and couplings, spectrum generator backends, vacuum stability calculations
- DecayBit – Provides decay tables, backends decay calculators
- PrecisionBit – precision calculations and likelihoods (e.g. muon $g-2$, EWPO, W-mass..)

Typical Tool Chain



Typically we are dealing with calculations at the top of the tool chain.

Members

Peter Athron
Eliel Camargo
Tomas Gonzalo
Anders Kvellestad

Roberto Ruiz
Cristian Sierra
Wei Su
Martin White
Yongcheng Wu
Pengxuan Zhu

Historically very few active
members at any given time

Currently we have expressions of
interest from a number of people...

but translating that into activity
remains a challenge.

Past members

Pat Scott
Ben Farmer
James McKay
Csaba Balazs
Douglas Jacob

Did I miss anyone out?

Anyone who wants to be more involved in this group is welcome,
Please do get in touch and let us know

People interested in convening now
or in the future are also very welcome!

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 - ▶ Got partly held up while BOSSing FlexibleSUSY was worked on
 - ▶ Much of the structure was developed but there were many issues still to be looked at
 - ▶ Plan is Tomas and I push on this in October/November/December and this finally gets finished

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At this stage what needs doing is very elementary and it is next on my todo list.

I still worry testing will reveal big headaches and problems, but lets see.

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- Also want to add 2HDM for GM2Calc and new calculations from FlexibleSUSY (muon g-2, MW)
 - ▶ Douglas Jacob had begun the adding 2HDM for GM2Calc, but unfortunately left physics before this is was ready or close to mature

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- Plenty of discussion of backending code EW global fits (HEP-Fit, Gfitter)
 - ▶ **Yongcheng investigated Gfitter and Anders looked into HEP-Fit, the latter looking more promising for use as a library as we recall...**

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- Plenty of discussion of backending code EW global fits (HEP-Fit, Gfitter)
- S, T and U parameters needed if not a wider set of EWPO.
 - ▶ S,T & U can be done fairly easily as an extension to a spectrum generator (it uses self energies and their derivatives) but just needs the time.
 - ▶ There was some proposal for that this could be done easily outside of this, and a plan to discuss this here...

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- S, T and U parameters needed if not a wider set of EWPO.
- Soon we will want to add codes for PhaseTransitions / GWs
- Other codes needed?

Organisation

- We have been trying to have monthly meetings though many got cancelled / moved so much more irregular than every month
- I think this helped initially to get some momentum but too rigid recently.
- Proposal after discussing with Anders is:
 - ▶ they will go back irregular meeting as and when needed. People can email me requesting this when there is progress or issues to discuss.
 - ▶ Next one will be likely after progress on FeynHiggs backending, Tomas and I may meet alone for SpecBit redesign
 - ▶ We will also have project focussed meetings for MW MSSM, etc though again for that one I prefer to call them based on progress for now.

Discussion points and related physics projects

- S,T & U
- EW Global fits
- MSSM MW targetting global
- SMEFT project
- Phase Transitions, Graviational Waves and EWBG
(also related to cosmoWG)

The END

Physics Proposals

- Phase Transitions / GravitationalWaves / EWBG/ EDMs:
 - ▶ A lot of discussion in PrecisionBit about projects to motivate work
 - ▶ Many discussions / ideas were on Phase Transition related ideas as many have interest there (e.g. both convenors).
- Some ideas like:
 - Straight FOPT study NMSSM, with a GW motivation
 - EDM constraints in specific models
 - Simple Higgs extensions with muon $g-2$, FOPT, Higgs limits.
 - All with the goal to progressively build the capabilities to tackle a larger EW baryogenesis fit

Code Updates

This is where progress has been slow.

Meetings so far mostly interesting discussion / planning, but not yet progressed to actionable points.

- FeynHiggs update:
 - ▶ Update to latest version 2.18.1
 - ▶ This is happening now, actually pushed forward by Martin some significant progress,
 - ▶ We will remove the module function `FeynHiggs_MSSMMasses` and capability: `MSSMMasses`. The signature changed. This was never used, its existence led to misunderstandings, I do not believe this is intended to give the user predictions for MSSM pole masses, but others thought it was.
 - ▶ There is unfortunately a lot of careful testing required, many concerns were uncovered in project with Alyshah.
 - ▶ This will be useful for MSSM MW project, maybe one of the gravitino projects. And for long term projects of the impact of Higgs mass calcs and uncertainty on global fits

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- [GM2Calc_THDM](#) – Douglas Jacob, Work In Progress
- [SpecBit Redesign \(SpecBit_redesign_dev_rebase\)](#)
 - ▶ Only being reactivated now
 - ▶ At least BOSS now should work for FS, so this can be done
 - ▶ its just a matter of finding time (which is pretty hard)
- [SUSYPOPE](#) – We are removing this interface to a non-public code. There is now a FeynHiggs routine FHEWPO though this is just giving MW, $\sin\theta_W$, and the loop corrections that enter them, Deltar, Deltarho,

- **VEVAcious**

Vevacious finds “dangerous” minima of the scalar potential, calculates loop and thermal corrections and the decay width of the EW minimum. Model file from SARAH thus part of GUM.

- Often slower part of Specbit.
- In large part because of path deformation and overshoot/undershoot method.
- Straight path estimation might be a way to go to speed it up if necessary (for some models).
- Same goes for loop corrections. Calculating tunnelling with the 1-loop effective potential is not always the most consistent thing anyway (though no much better automatable option exists for generic models where the EW minimum only exists at > 1 Loop).
- Tree-level might be enough in some models though.
- *(Elie) I need to bite the bullet and start working on this.*
- For MSSM, where we have run Vevacious extensively, a ML-powered fit might help in making things faster.

Personal Comment

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