

ColliderBit update

GAMBIT XIV

WG Convenors: Anders Kvellestad, Are Raklev

What does ColliderBit do?

- Likelihoods for LHC searches
 - Code to replicate ATLAS and CMS analysis run on MC data
 - Major part of `ColliderBit` work is to update analysis as LHC data increases
- Likelihoods for (some) LEP searches (by interpolation of cross sections)
- Likelihoods for the Higgs sector
 - Using `HiggsBounds` and `HiggsSignals` as backends

Members (from email list)

- Anders Kvellestad (convenor)
- Are Raklev (convenor)
- Andy Buckley
- Ankit Beniwal
- Christopher Chang
- Christopher Rogan
- Csaba Balazs
- Holly Pacey
- Jonathan Cornell
- Felix Kahlhoefer
- Kelton Whiteaker
- Lasse Braseth
- Nazila Mahmoudi
- Martin White
- Matthias Danninger
- Marcin Chrzaszcz
- Nicola Serra
- Pat Scott
- Peter Athron
- Philip Grace
- Tomas Gonzalo
- Tomasz Procter
- Patrick Tunney
- Victor Ananiev
- Yang Zhang

Work in progress from GAMBIT XIII

- CBS
- ATLAS “full likelihoods”
- System for InterpolatedYields analyses
- H/A → tau tau likelihoods from `HiggsBounds 5`: stability issues and code merging
- Event class extension for long-lived particle searches
- Pacer project: Speeding up event generation
- Simplify LEP cross-section capability structure
- Switch to using subcapability system for adding list of searches to include in likelihood
- `xsec` backend: cmake system and some testing
- `simplexs`
- Finalise `Prospino` backend (stability)
- Implement alternative to capped likelihood?
- `SModels` backend(?)
- `salami` (?)
- Backend `MadGraph`

Done since last meeting (in no particular order)

- ATLAS Full-Likes (Chris)
- Further improvements to the Contur + Rivet interface (Tomek)
- Improvements to InterpolatedYields system (Chris, will be part of code merge for Simplified DM project)
- Pythia 8.3 aalmost... (Are/Anders)
 - The Pythia `_nohepmc` build will be removed in near future
 - Pythia is moving in the direction of parallel event generation w/OpenMP – still experimental, may be too early for us to switch?
- HepMC upgrade from 3.1.1 to 3.2.5 (Pat)
- Simplex (Chris)
- New heputils functionality allows events to contain multiple jet-collections (Andy)
 - But not propagated to use in analysis yet (work ongoing with Holly and Martin for leptoquark paper)
 - Warning: run time is ~ proportional to number of jet collections (fastjet calls dominate run time)
- Fix for signal uncertainty bug (Martin/Anders)
- Issue with likelihood profiling accuracy (Anders)
- Some further work on CBS paper (Yang)
- Early investigations into prospects for using MadGraph for event generation (Chris)

Work in progress

- CBS
- Make InterpolatedYields system more general (less model-specific)
- H/A → tau tau likelihoods from HiggsBounds 5 stability issues and code merging
- Event class extension for long-lived particle searches
- Pacer project: Speeding up event generation
- Simplify LEP cross-section capability structure
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- `xsec` backend: cmake system and some testing
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New stuff:

- Complete the Pythia 8.3 move
- Fix how we get the initial cross section maximum estimates from Pythia
- Beam dump constraints (MadDump as a backend?)
- Generalize and streamline efficiencies used in BuckFast
- Make cutflows threadsafe and automate testing

ML/stats challenges

- What are the computationally slowest parts of ColliderBit?
 - Event generation and cross-section computation
 - Jet clustering – fastjet
 - Possibly PDF lookup
 - For GUM generated $2 \rightarrow n$ ($n > 2$) processes the phase space sampling is problematic
 - Likelihood computation
 - Profiling (or marginalising) over correlated background uncertainties
- Could/should this be improved with e.g. ML-based approximations (i.e. is it worth the effort to try?)
 - Possibly, but not at the event generation level
- Is there ongoing/planned work in this direction?
 - Plans for continual learning of signal predictions / analysis likelihoods / scan likelihood (Anders)
 - Postdoc in Oslo announced in fall (2 years)
 - Need to finalize backend to xsec, continue xsec work (Anders, Are, Lasse)
- Is any new GAMBIT code infrastructure / Core functionality needed for this, or is it mostly a matter of connecting new backends?
 - Yes, for cont. learning. To be discussed in that session.

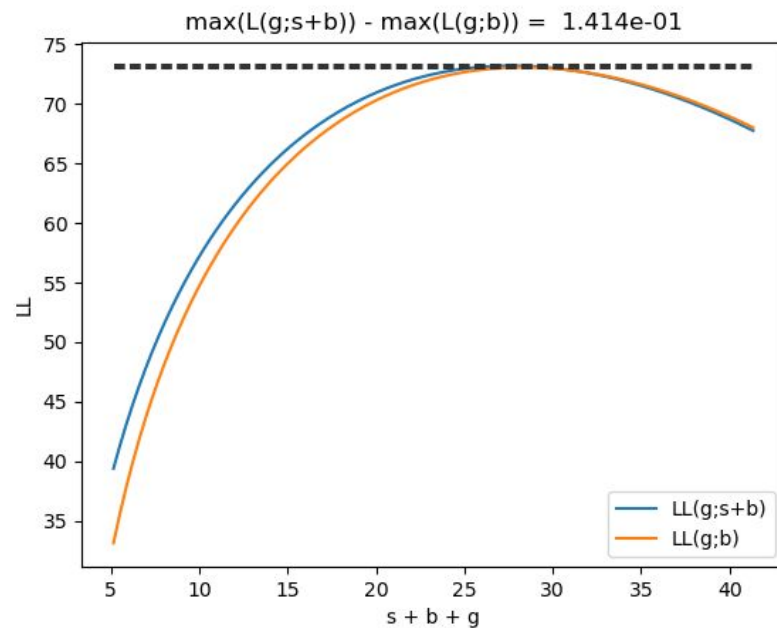
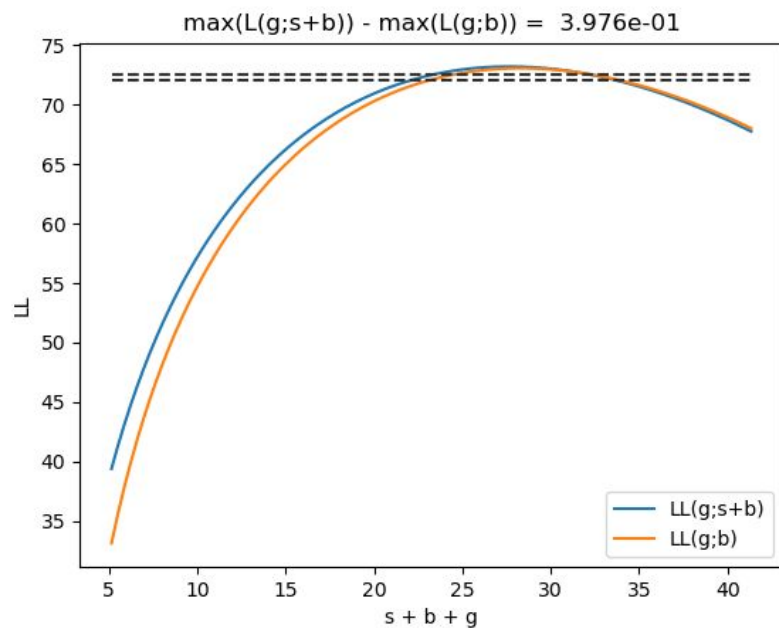
Convenorship

- Current WG convenors: Anders and Are
- Community policies says Head / Deputy Head should preferably not lead any of the Working Groups
- Chris has volunteered to step in as convenor replacing Anders
- Are would be happy to step down now if anyone else is interested (don't listen to Pat!)
 - After next all-collab other work commitments will make it difficult to continue

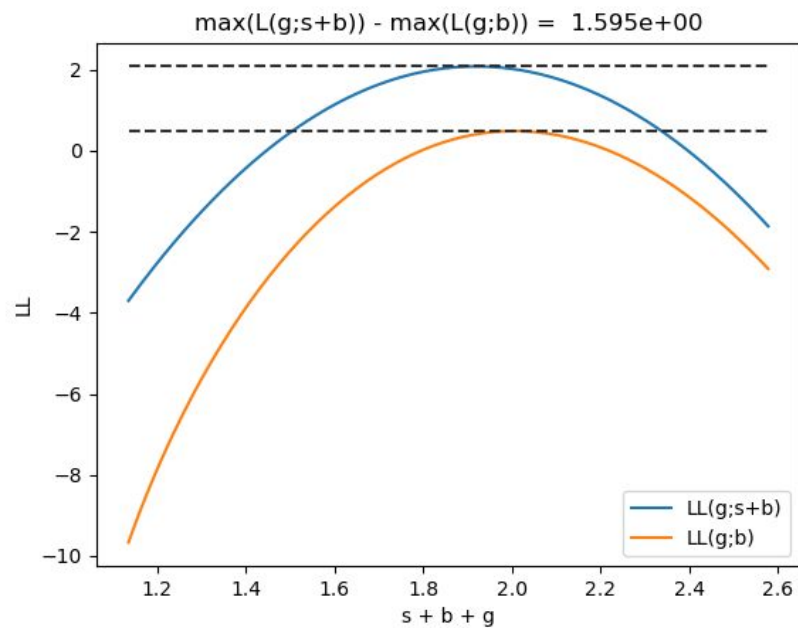
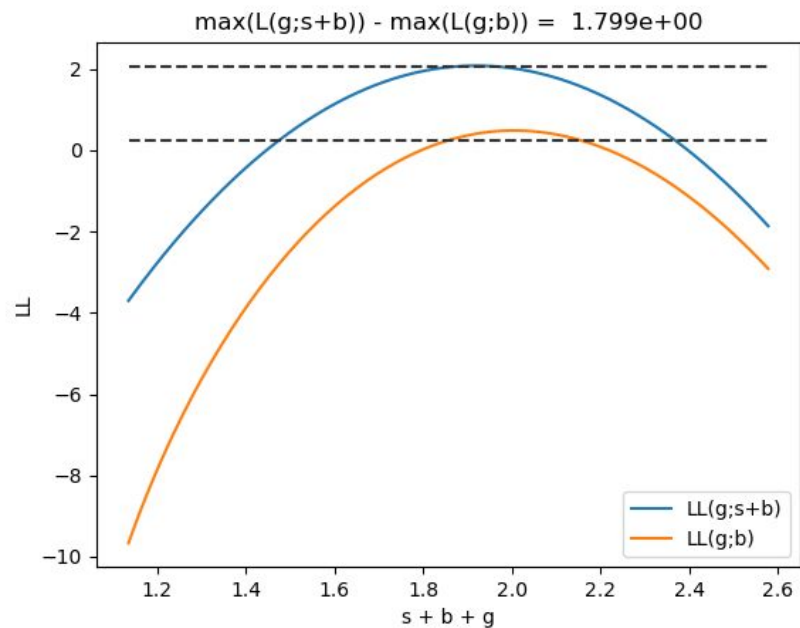
Anything else?

Backup slides

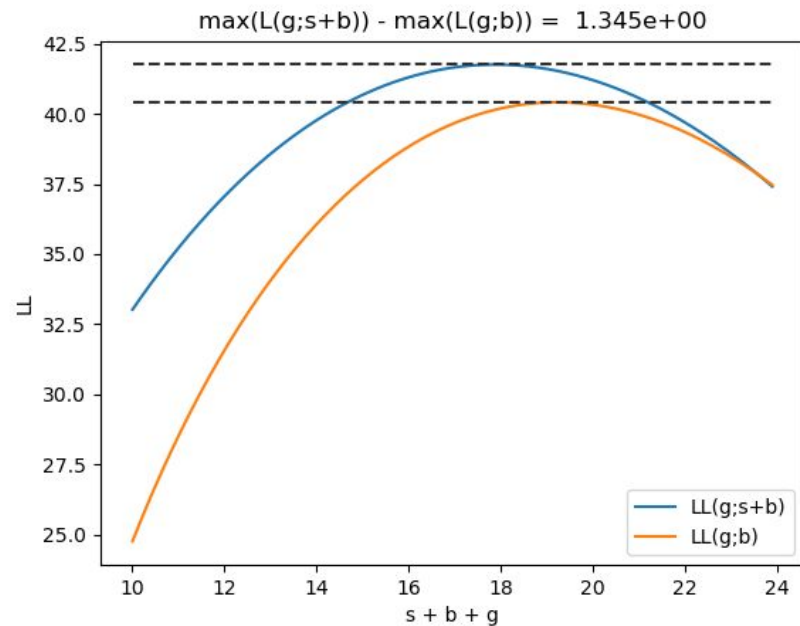
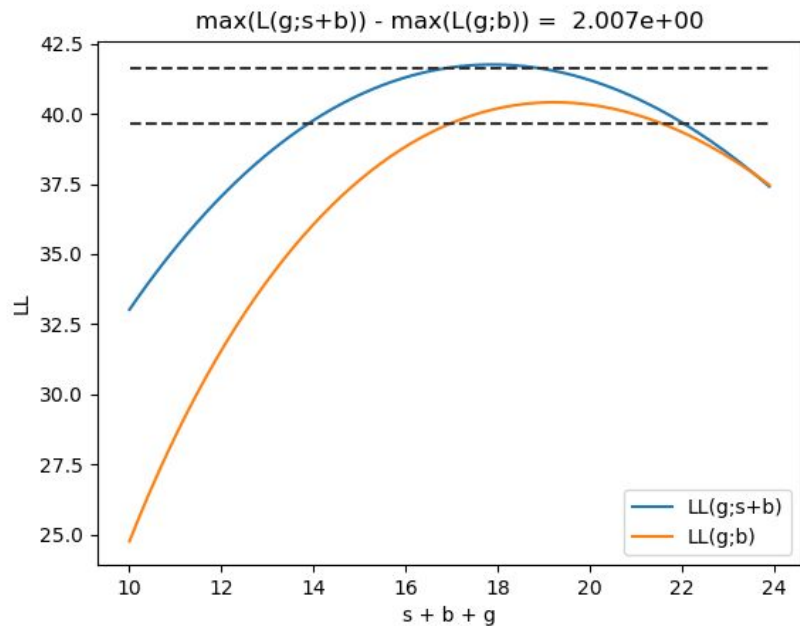
Problem with profiling of likelihood nuisance parameter



$$\mathcal{L}_{\text{search}}(s, \gamma) = \prod_{i=1}^{n_{\text{SR}}} \left[\frac{(s_i + b_i + \gamma_i)^{n_i} e^{-(s_i + b_i + \gamma_i)}}{n_i!} \right] \times \frac{1}{\sqrt{\det 2\pi \Sigma}} e^{-\frac{1}{2} \gamma^T \Sigma^{-1} \gamma},$$



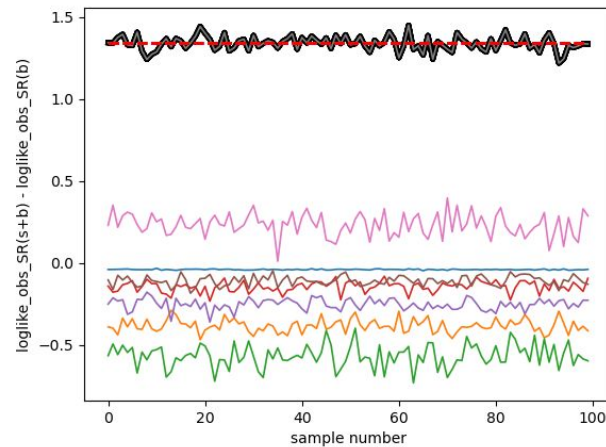
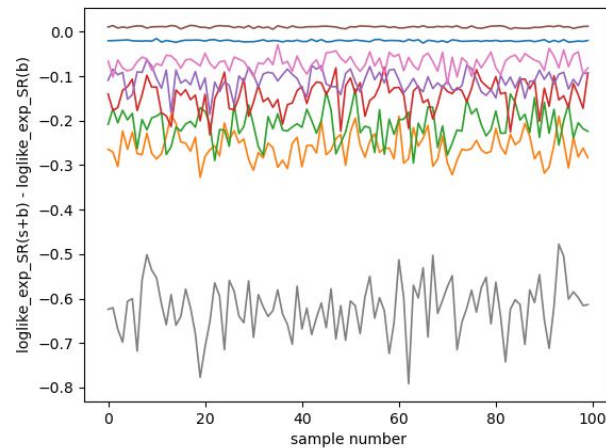
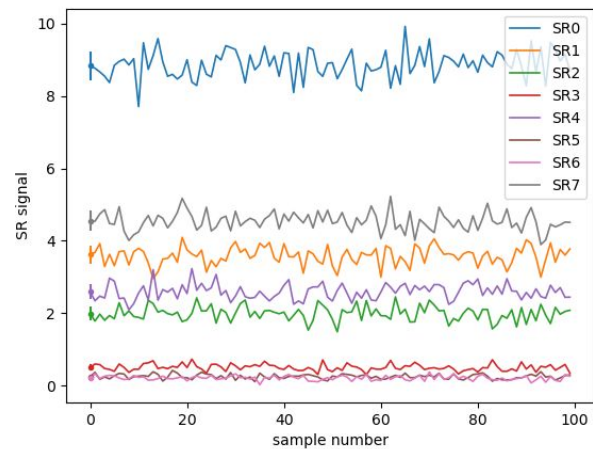
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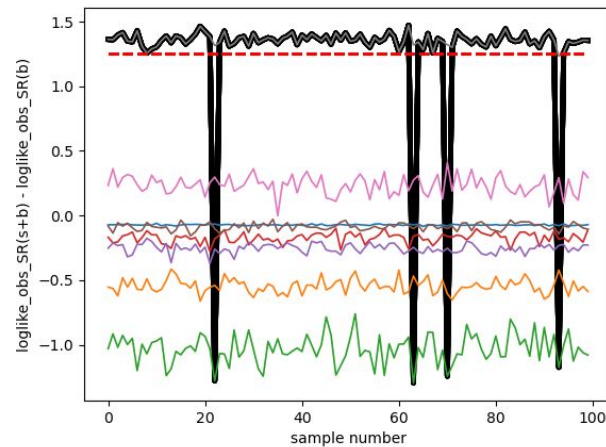
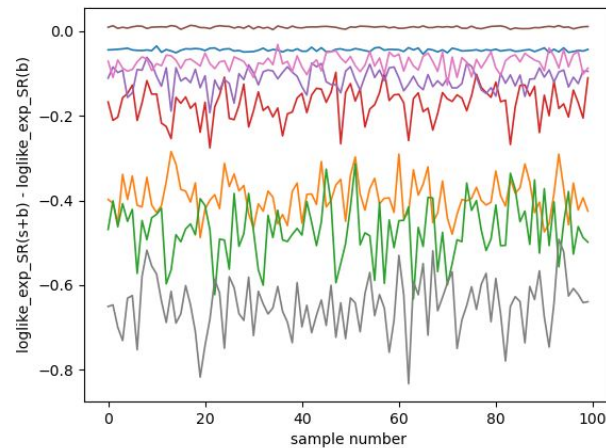
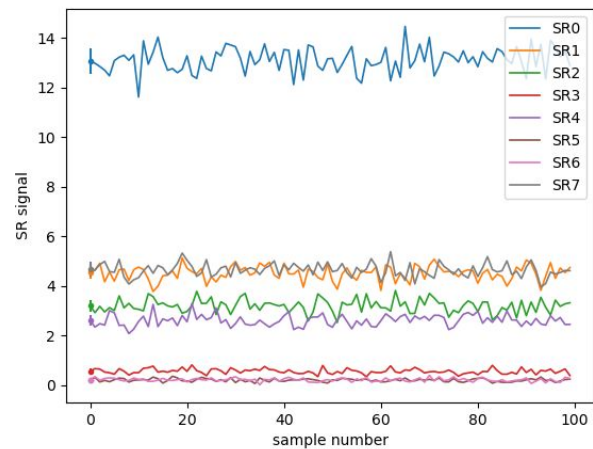
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Likelihood flip-flop examples

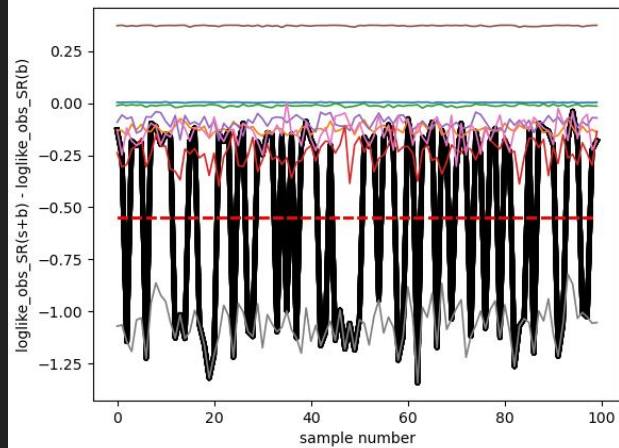
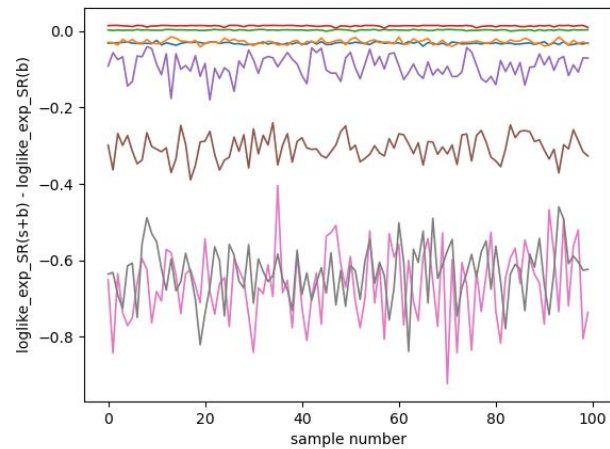
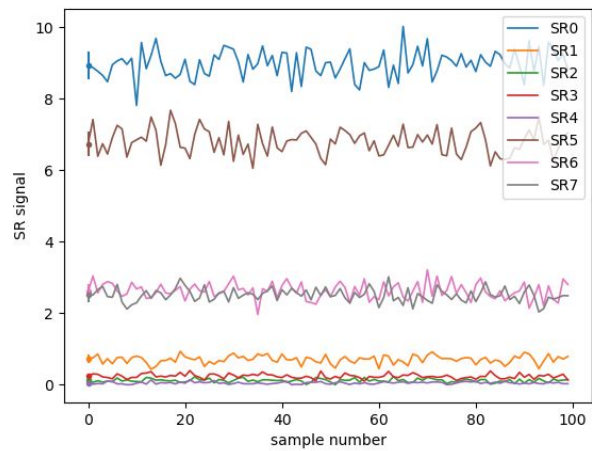
ATLAS_4LEP, point 0



ATLAS_4LEP, point 4



CMS_4LEP, point 0



CMS_4LEP, point 4

