JOHANNES GUTENBERG UNIVERSITÄT MAINZ

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Area 3 targets

Experimental Measurements and Observables

Anke Biekötter for Area 3

5th General Meeting of the LHC EFT Working Group
2nd December 2022

Area 3 initial targets

Area 3 note

3. Experimental measurements and observables

How observables relate to operators, which measurements are important for a given operator or set of operators, differential/fiducial measurements vs. dedicated ones, identification of optimal observables, machine learning, re-interpretation vs. static, presentation of results: covariance, multi-D likelihood, etc., compatibility with global fits (i.e. assumptions used in deriving measurement and reporting results).

- Study observable, channel, process sensitivities and complementarities (***)
  - Experimental targets: survey of the sensitive channels and corresponding operators
  - Differential distributions, optimal observables, including machine learning, and dedicated EFT measurements, spin density matrices, EFT-optimized fiducial regions, amplitude analyses, angular distributions (e.g. for CP), pseudo observables, etc.
  - Agreement across experiments (for fiducial regions in particular)
  - What observables are most sensitive to new physics? Exploit energy growing effects, non-interferences, and other TH knowledge
  - Expected uncertainties: sys. or stat. dominated
- Analysis strategies & experimental outputs, also with a view at legacy measurements and their possible reinterpretation (***)
  - Dedicated EFT extractions by collaborations
  - Differential measurements and the best choice of observables for re-interpretation.
  - Presentation of measurements: cross sections, correlations/covariance, multi-D likelihood, etc…
  - Experimental systematics related to EFT (e.g. accounting for detector effects)
  - Detector effects: unfolding, forward folding, efficiency maps, recasting through reweighting, etc.
  - EFT in backgrounds: final-state driven instead of sig-bgd, statistical model (***)

Area 3 initial targets

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Future targets?

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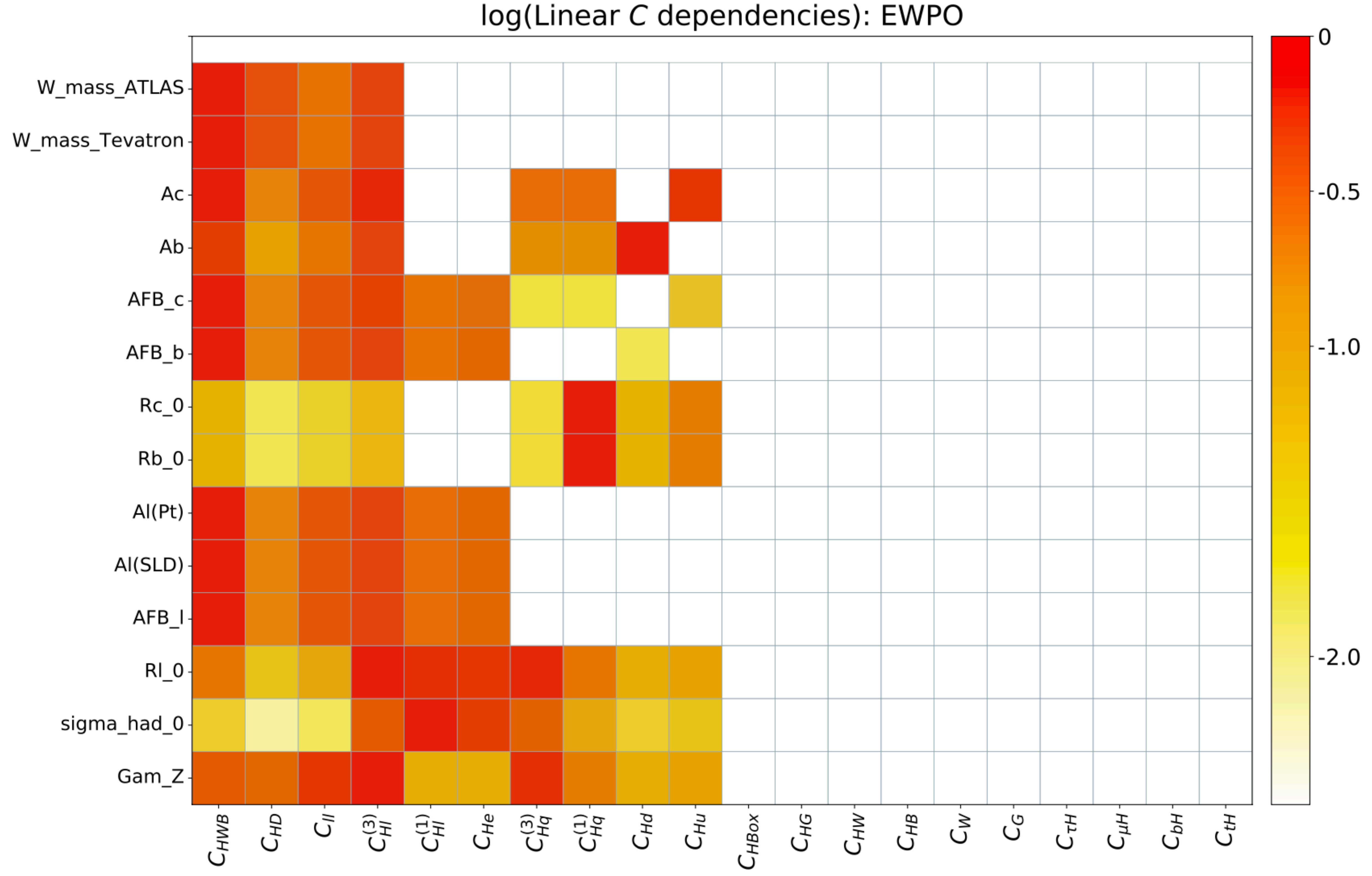
Area 3 targets - physics cases

- Build upon previous WG work identifying powerful observables
- Concrete physics cases to study which observables could improve global fits
  - e.g. by resolving blind directions



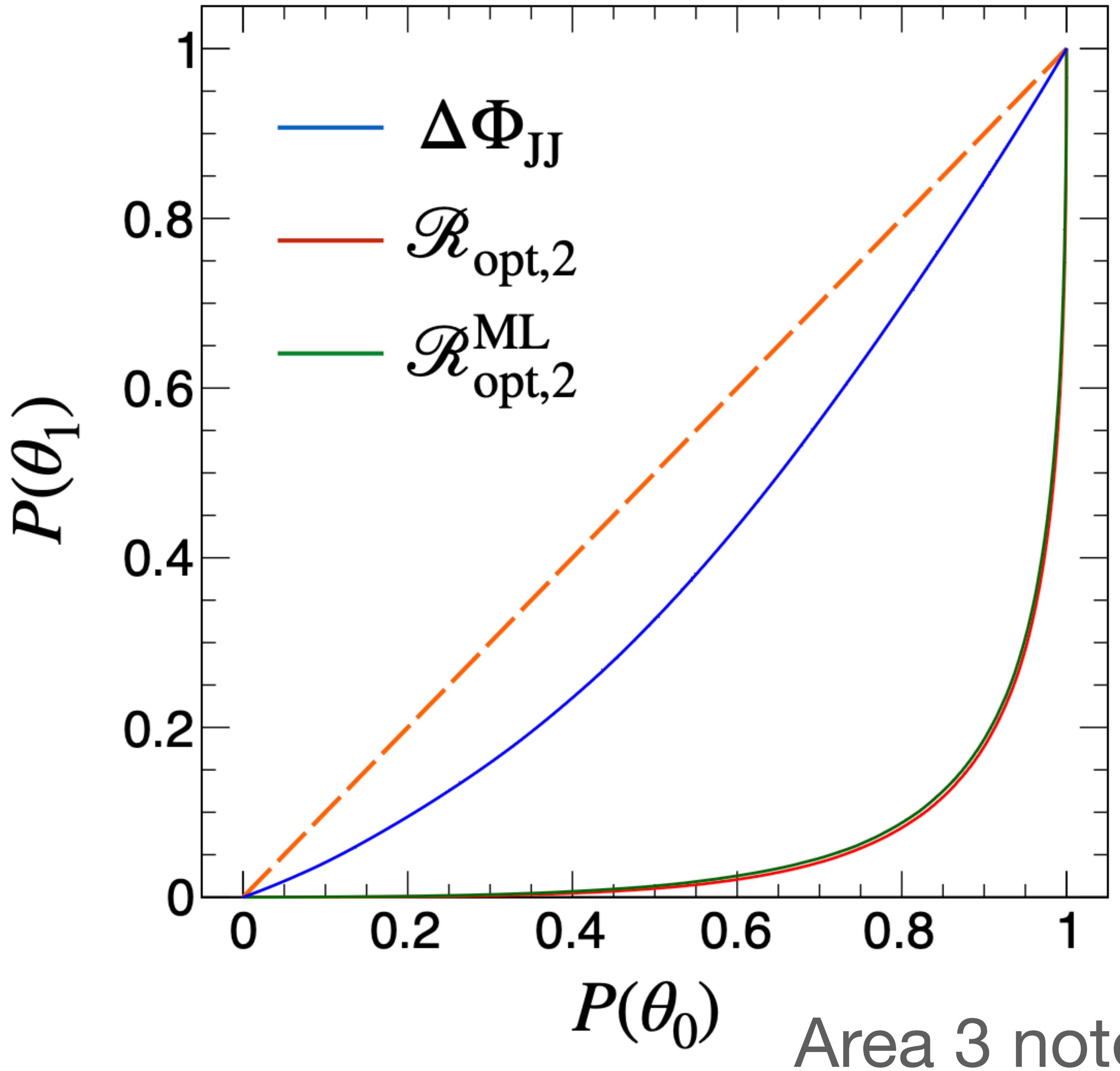
Area 3 note

Area 3 targets - ML-optimised observables

- Concrete examples for how to use and combine ML-optimised observables in practise
    - e.g. pre-train ML models that could be handed to ATLAS/CMS
    - CP-odd sector might be interesting test case

      (small subset of operators)

[Area 4]



Area 3 note

POSSIBLE ACTION ITEMS / CONCLUSION

A. Suggest comparative study of all approaches (& aware of STXS parametrisation)

	Sample based	**Event based (per hel.)**	**Event based (summed hel.)**
Persistency	1 sample per term	1 number per event & term	1 number per event & term
Madgraph reweighting	None	$W_{new} = \frac{\lvert M^h_{new}\rvert^2}{\lvert M^h_{orig}\rvert^2} W_{orig}$	$W_{new} = \frac{\lvert M_{new}\rvert^2}{\lvert M_{orig}\rvert^2} W_{orig}$
Phase space mismatches?	No problem	May require c≠0	May require c≠0 (fewer cases)
Can be staged?	Yes, including hel.	No new hel.	Yes, including hel.
ML sample efficient?	Less so	Yes	Yes

B. Analysis persistency for later reinterpretation – tools, practises, shortcomings

- Are we ready for an excess?

[Robert's talk]

C. Best practices for publication of ML results

- proposal [Publishing statistical models: Getting the most out of particle physics experiments, 2109.0491]

More area 3 targets

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- Observables database matching area 2 proposal (observables, overlaps) [Area 2]
- Energy-dependent operators
- NLO electroweak predictions (differential) - push for automatisation

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More to add?