Linearizing the diagonal spin correlations

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Thanks to Jacob Linacre for useful feedback and scrutiny

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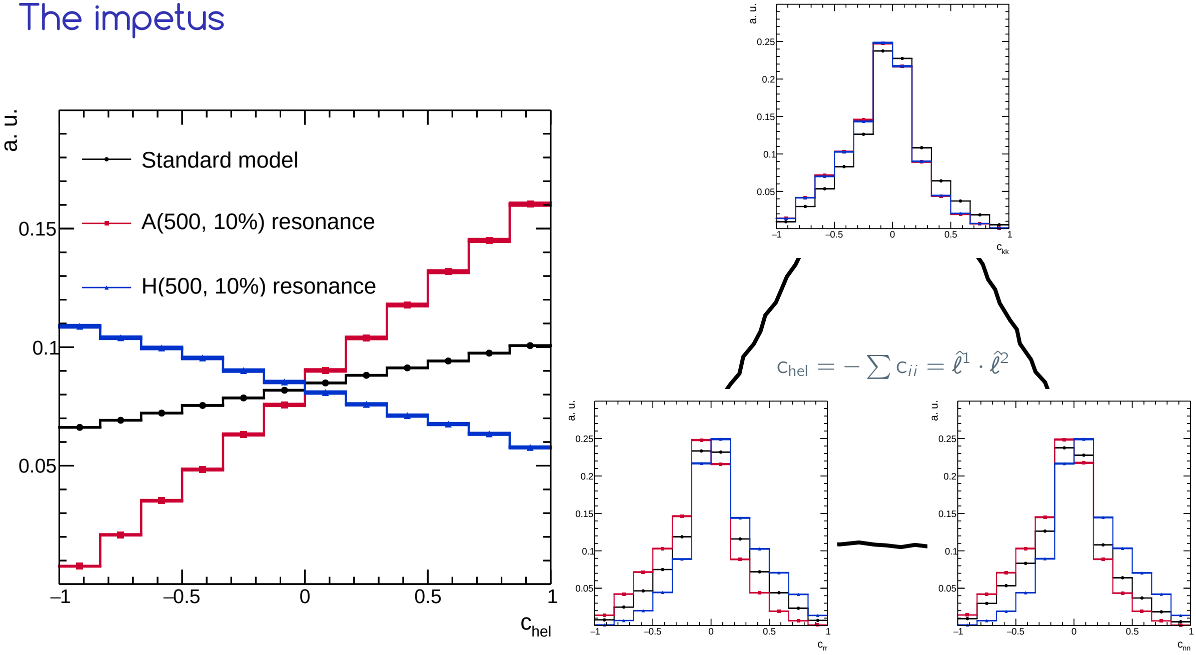
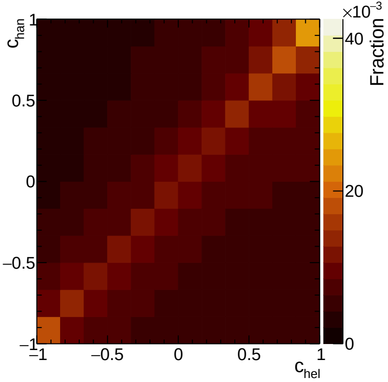
The impetus

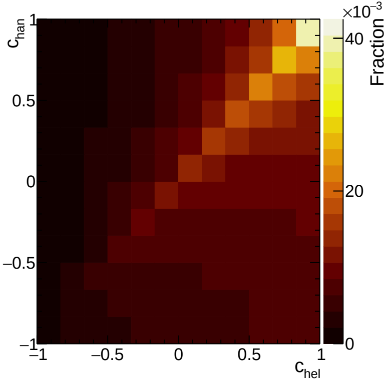


a. u.
Standard model
A(500, 10%) resonance
H(500, 10%) resonance
c_{hel}
c_{kk}
c_{rr}
c_{nn}
$c_{hel} = -\sum c_{ii} = \hat{\ell}^1 \cdot \hat{\ell}^2$

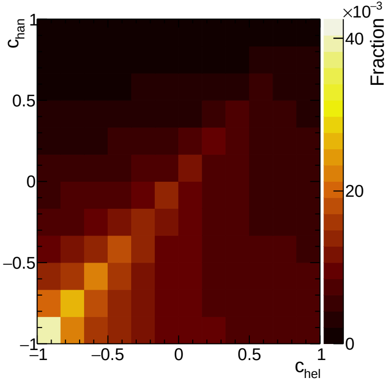
The impetus



SM $t\bar{t}$



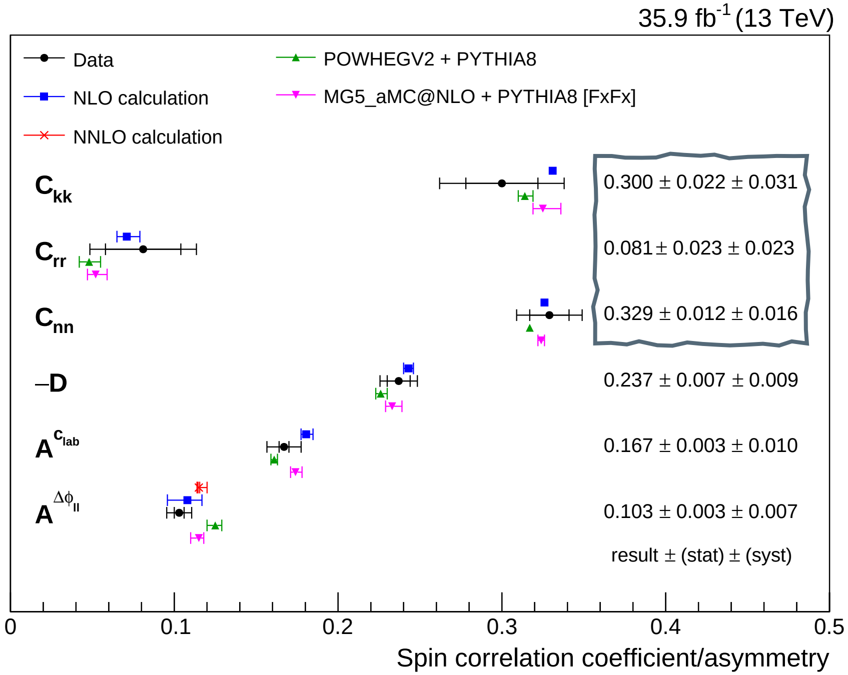
$A \to t\bar{t}$



$H \to t\bar{t}$

How else can we use them?

Unfolding!

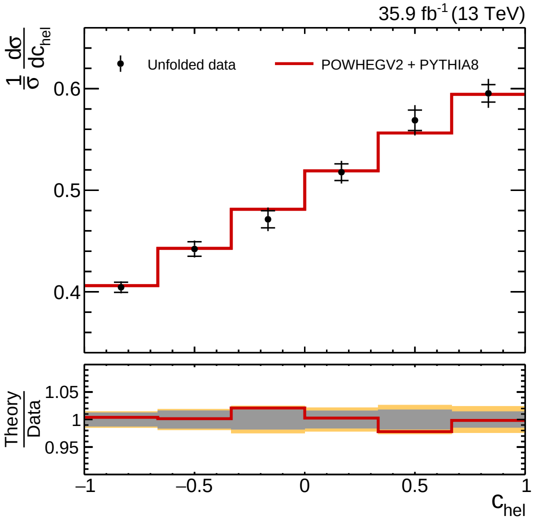


Exploit linear shape

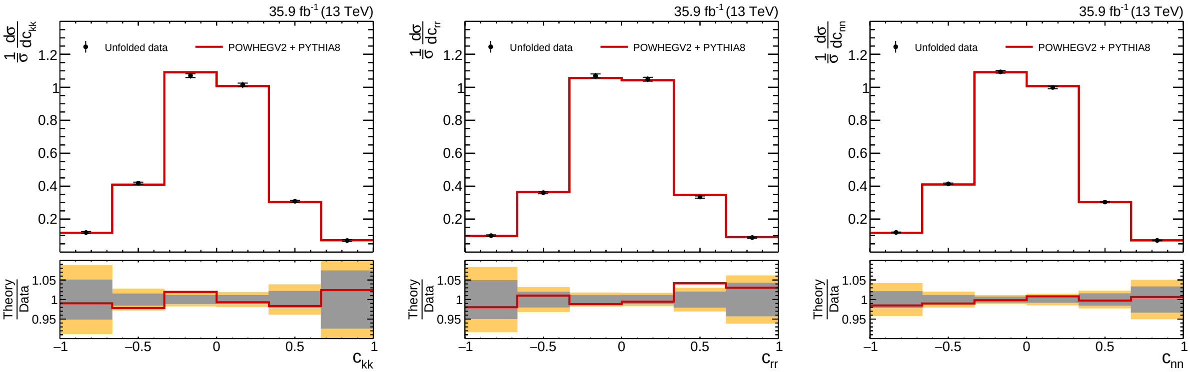
to improve uncertainties

The works

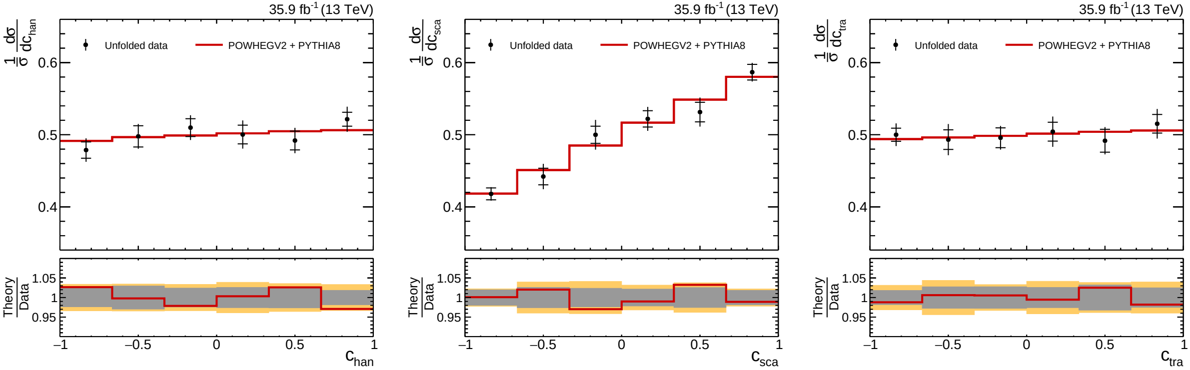
- Unfold the distributions of c_{han}, c_{sca} and c_{tra}
  - …which are c_{hel} with one spin vector flipped about the k, r and n axes respectively
- Unfolding setup more or less exactly as in TOP-18-006
  - Although some systematics e.g. PDF are dropped due to limits in resources
- Unfolded also the corresponding distributions along the x, y and z axes
  - Angles will be called c_{xx} and c_{xxx} etc
  - As a cross check if the knowledge of the direction makes a difference
  - Also interesting by themselves, they're also SM predictions e.g. $C_{xx} = C_{yy}$, but we won't be looking explicitly at this in this talk



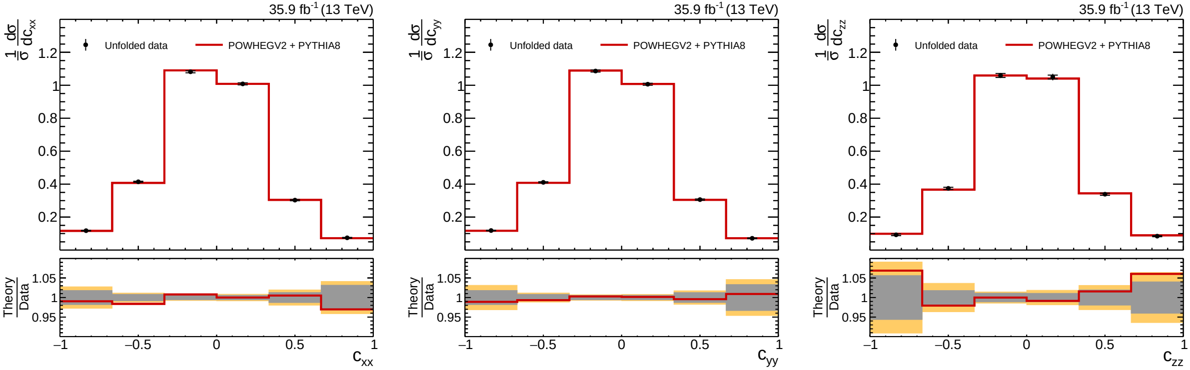
Unfolded distributions



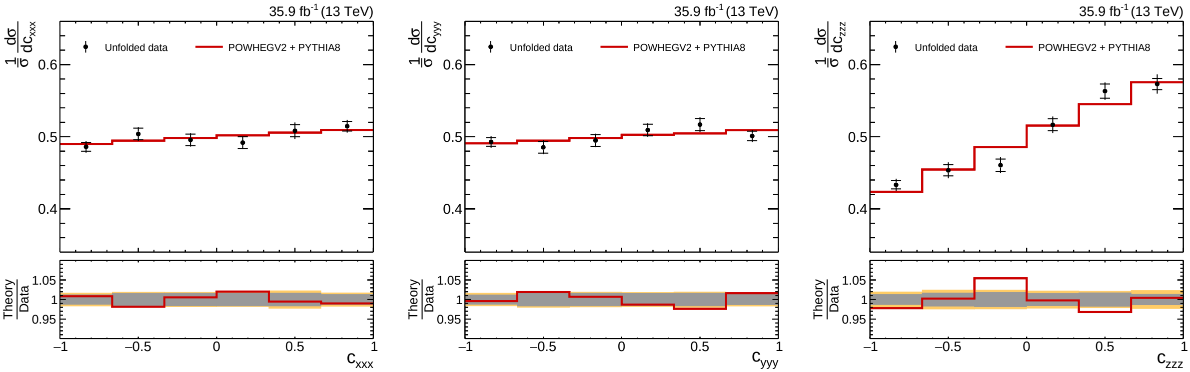
Unfolded distributions



Unfolded distributions



Unfolded distributions



Direct coefficients

Coefficient	Value	Total	Stat
C_{kk}	0.299	0.036	0.023
C_{rr}	0.080	0.031	0.023
C_{nn}	0.327	0.019	0.012
$-D$	0.236	0.010	0.007
$-D_k$	0.032	0.020	0.010
$-D_r$	0.196	0.013	0.010
$-D_n$	0.013	0.022	0.012
C_{xx}	0.306	0.018	0.011
C_{yy}	0.311	0.016	0.011
C_{zz}	0.092	0.049	0.024
$-D_x$	0.026	0.012	0.007
$-D_y$	0.023	0.012	0.007
$-D_z$	0.184	0.015	0.007

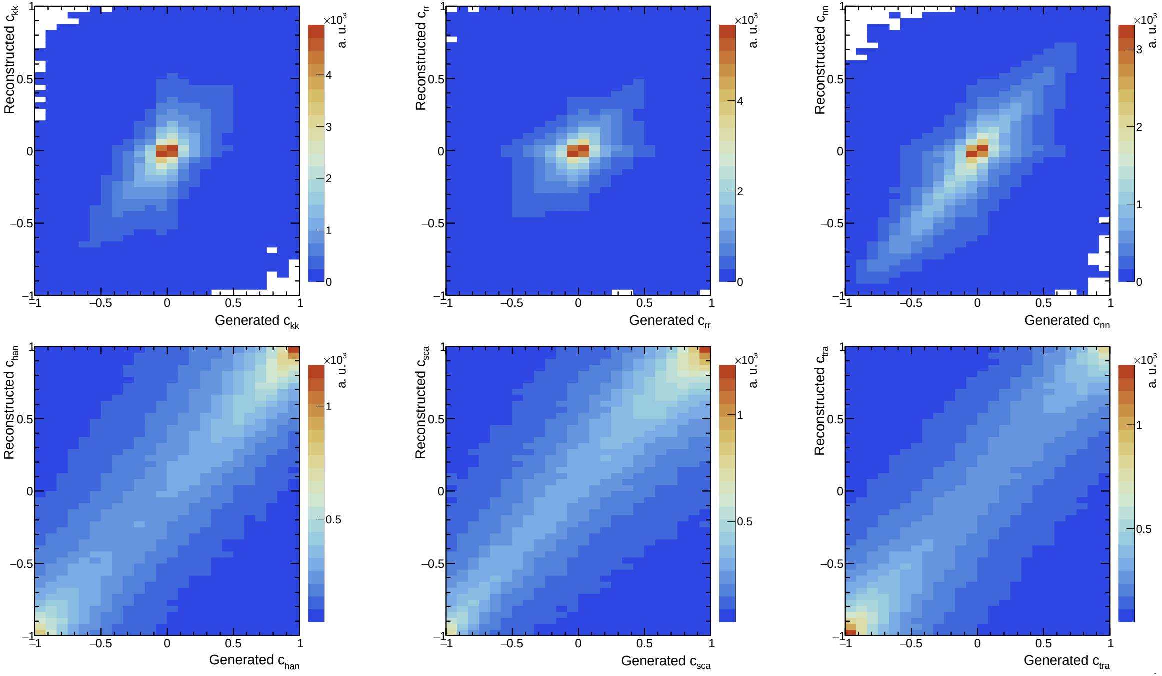
Indirect coefficients I

Indirect coefficient obtained by $C_{ii} = 1.5(D_i - D)$, taking correlations into account

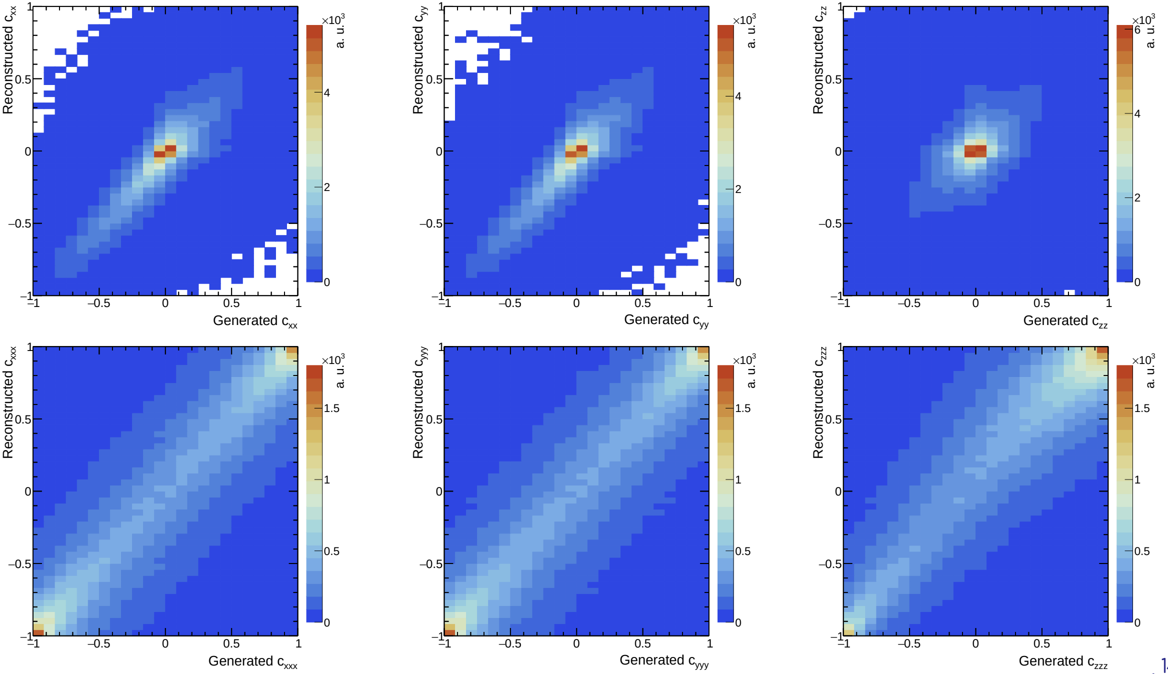
Coefficient	Value	Total	Stat
C_{kk}	0.306	0.034	0.016
C_{rr}	0.060	0.018	0.013
C_{nn}	0.334	0.033	0.019
C_{xx}	0.315	0.021	0.013
C_{yy}	0.319	0.019	0.013
C_{zz}	0.077	0.026	0.011

Blue coefficients improve when extracted indirectly, red deteriorate

Smearing matrices



Smearing matrices



Indirect coefficients II

Indirect coefficient obtained by $C_{aa} = -1.5(D_b + D_c)$, taking correlations into account

Coefficient	Value	Total	Stat
C_{kk}	0.314	0.037	0.019
C_{rr}	0.068	0.022	0.017
C_{nn}	0.342	0.034	0.020
C_{xx}	0.311	0.022	0.013
C_{yy}	0.316	0.018	0.014
C_{zz}	0.074	0.026	0.012

Results are consistent with, but generally worse than $C_{aa} = 1.5(D_a - D)$

Same as when using $C_{aa} = -3D - C_{bb} - C_{cc}$

Afterword

- Distributions of c_{han} etc allow for a more precise extraction of C_{ii}
  - Exploiting the fact that their linear shapes (usually) lead to better smearing matrices
- Planning to propose these distributions to be measured in full Run 2
  - One remaining test: correlation between direct and indirect C_{ii}
- Expect that these are even better in pure reco analyses e.g. A/H, but plots will tell…

Backup