

# $B_s^0 \rightarrow K_S^0 \pi^+ \pi^-$ Amplitude Analysis with Run 1+2 data

Update: Fit stability (local) and fluctuations of combinatoric bkg. model

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Internal Meeting @ LPCA



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**ÉCOLE DOCTORALE  
DES SCIENCES FONDAMENTALES**  
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# Context

Currently studying an optimal working point for the topological MVA score. Points under consideration:

- **Fit stability:** Ability of the fit to converge back to the truth solution.
  - Studied with pseudo-experiments fits by varying the number of events for each sub-sample according to the output of the invariant-mass fit for a given set of topo cuts.
  - It also allows to determine the *statistical uncertainty* ( $\sigma_{stat}(X_i)$ ) of the Isobar Parameters (IP) and do a sanity check  $\Rightarrow \sigma_{stat}(X_i) \approx \sigma_{fit}(X_i)$ .
- **Fluctuations of combinatoric model:** Response of the IP ( $\sigma_{comb}(X_i)$ ) of different contributions due to the statistical fluctuations of the combinatoric background model (maps).
  - Assessed by fits on data, with combinatoric models fluctuated from the baseline according to Poisson-Gamma statistics.
  - Special interest in the impact on the NR component, for which a "competition" with combinatorics is expected.

# Fit stability

## Local closure

Procedure for each topo MVA cut:

- Fit data many times from different starting points.
- Perform the best solution study.
- Generate toys from that solution.
- Refit the toys, *starting at the generation point* (local).

Study whether the fitter comes back and how that depends on the MVA cut. Also would help to assess:

- Does tightening the cut reduce secondary solutions? Does it reduce bias? Does it improve convergence without increasing uncertainties too much?
- Uncertainties  $\Rightarrow \sigma_{stat}(X_i)$

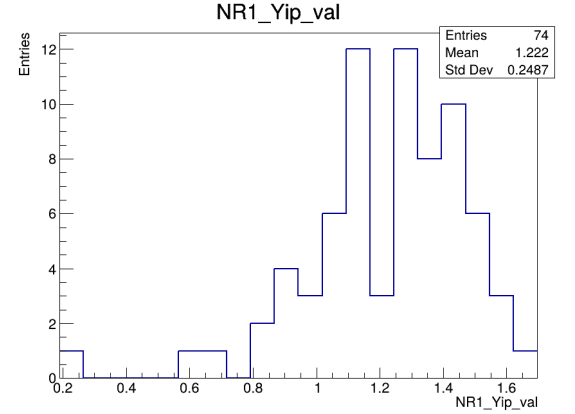
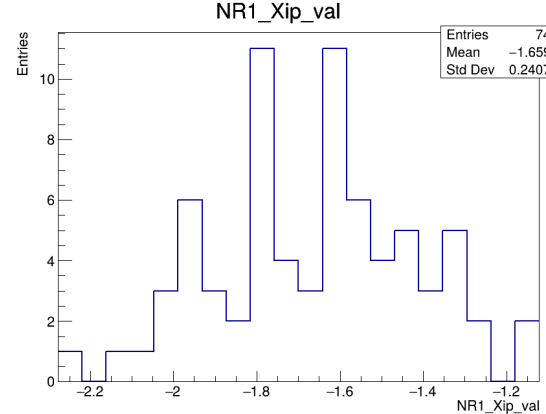
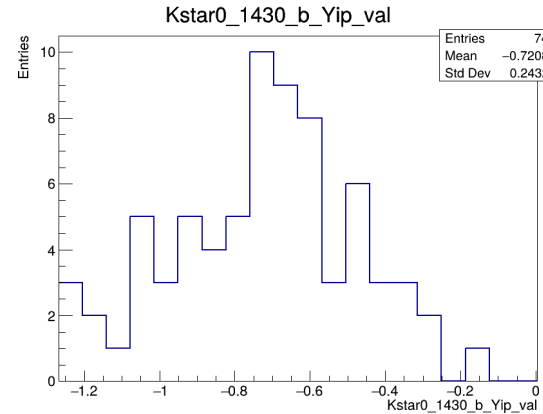
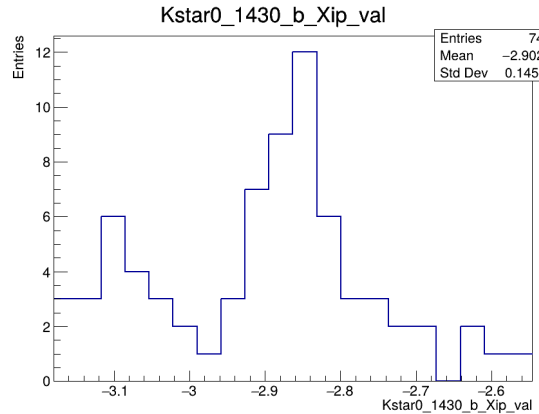
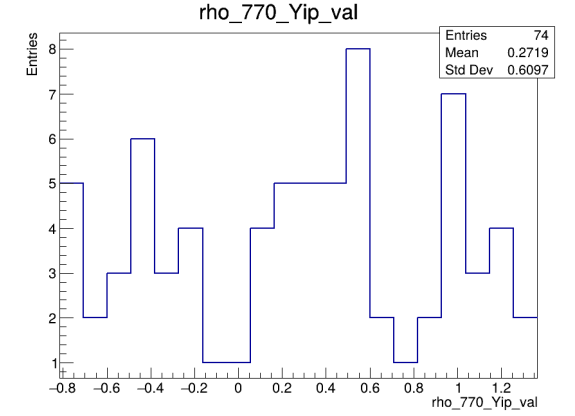
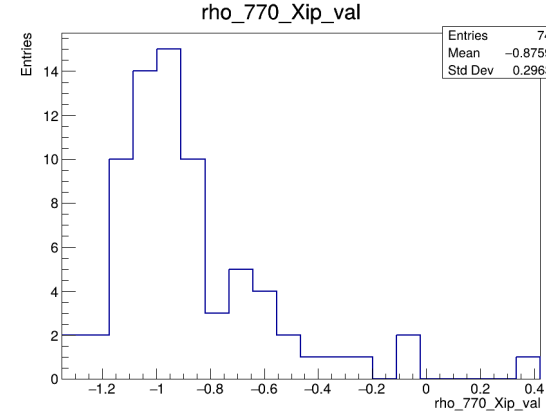
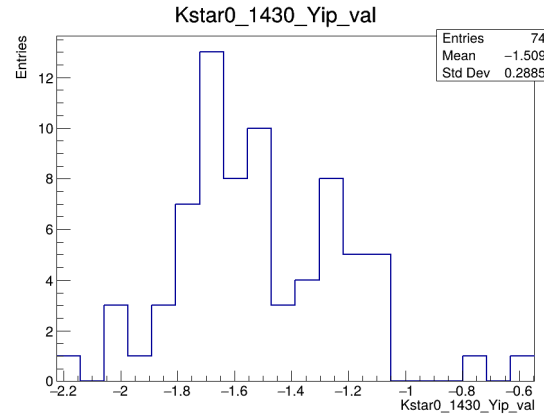
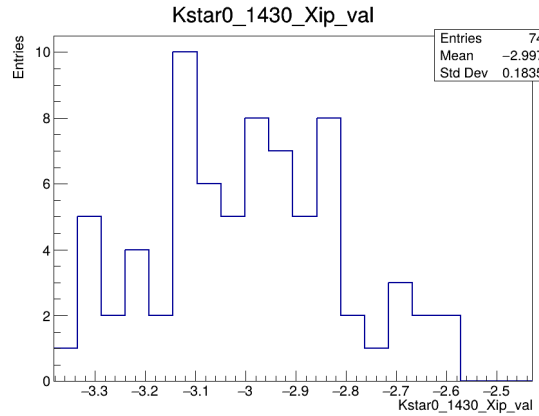
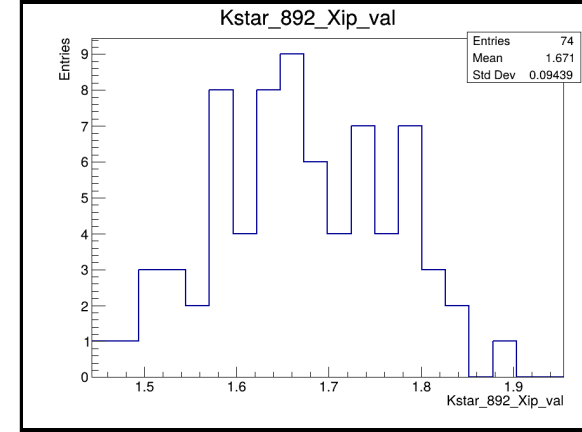
In this context, a "good" cut is often the one that gives the best effective fit stability, not simply the lowest background. However, "more stable" does not mean "more reliable physics"  $\Rightarrow$  always keep an eye on observables

## Best solution pars

par	final	err
Kstar0_1430_Xip	-3.02520502932108	0.264196694543859
Kstar0_1430_Yip	-1.46772198898368	0.338214517779853
Kstar0_1430_b_Xip	-2.90993865013091	0.235387388223321
Kstar0_1430_b_Yip	-0.7159680894808	0.335324258768869
Kstar_892_Xip	1.67385843334312	0.148916861637277
NR1_Xip	-1.63276731703442	0.266238789256066
NR1_Yip	1.275853584072	0.269220436762829
rho_770_Xip	-1.12622985029683	0.116115697231217
rho_770_Yip	0.118191636819219	0.766497071315891

# Results

Local closure  
BF working point



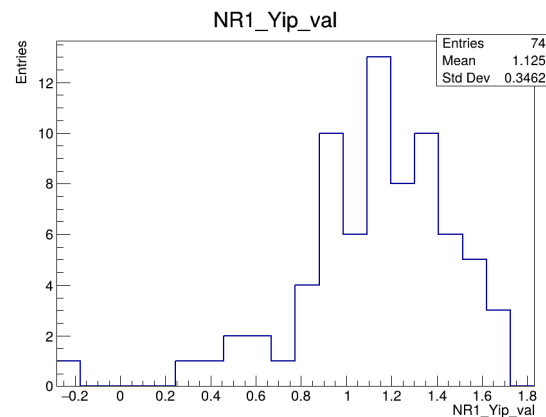
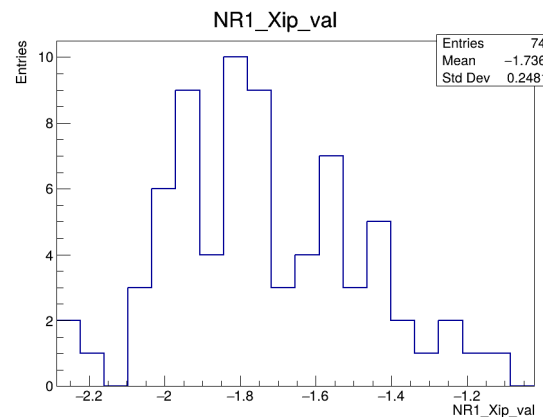
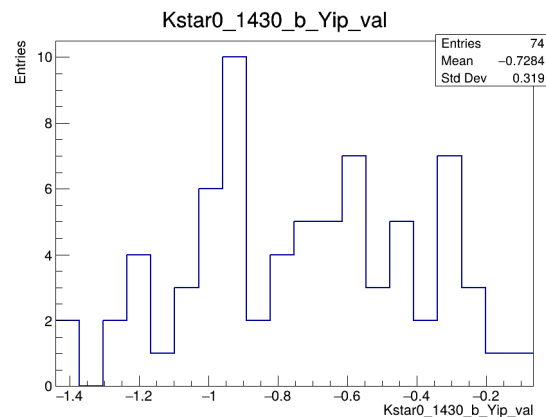
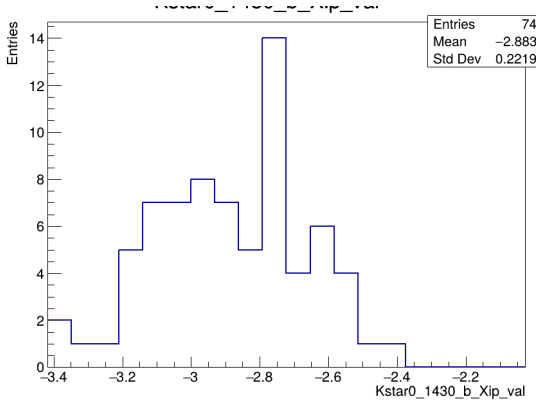
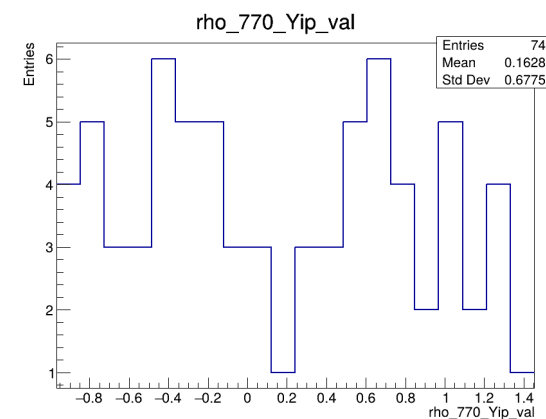
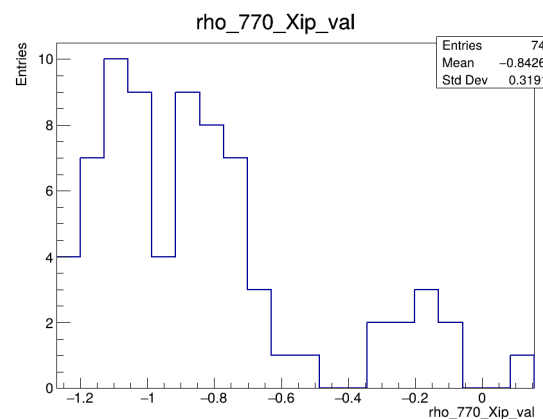
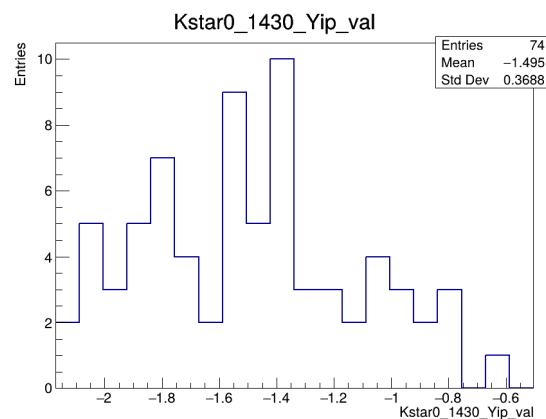
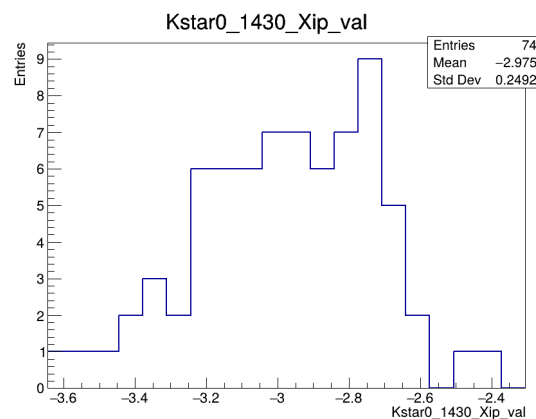
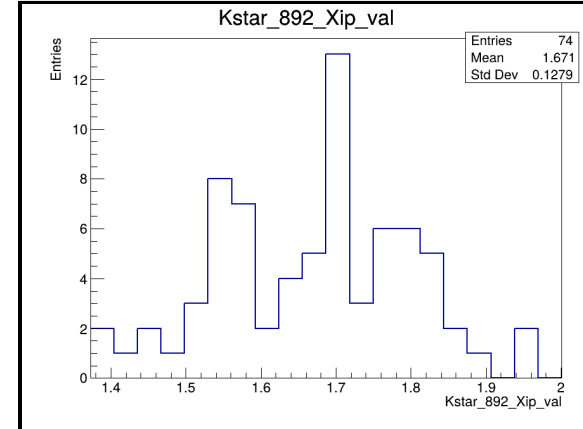
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.99647277355465	0.262362763049918
Kstar0_1430_Yip	-1.47386059013416	0.336381355376998
Kstar0_1430_b_Xip	-2.8753262484281	0.234972320100537
Kstar0_1430_b_Yip	-0.757196628301063	0.327663649576913
Kstar_892_Xip	1.67031727628018	0.14841053140165
NR1_Xip	-1.72331695044889	0.245122128269253
NR1_Yip	1.21593146978505	0.279039169275597
rho_770_Xip	-1.11964795463084	0.115261090053512
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# Results

Local closure

Tight working point



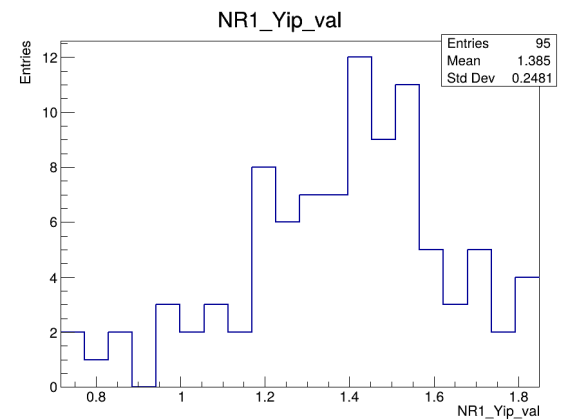
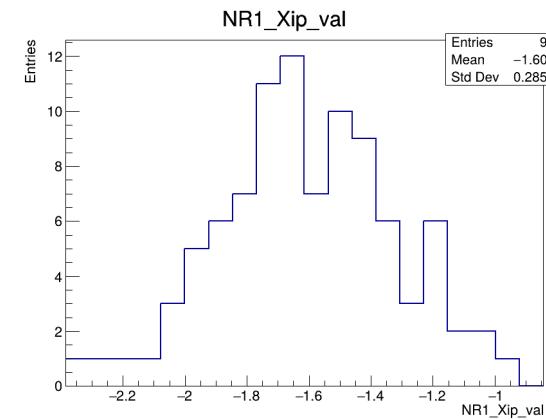
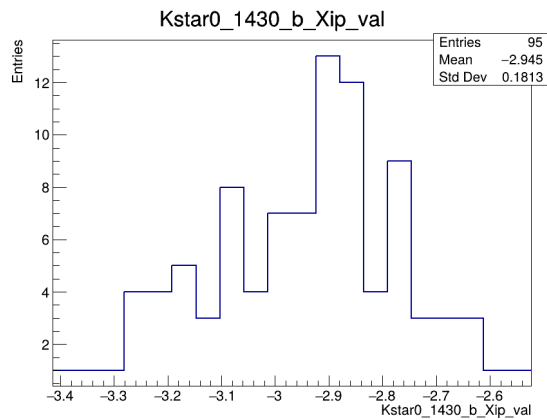
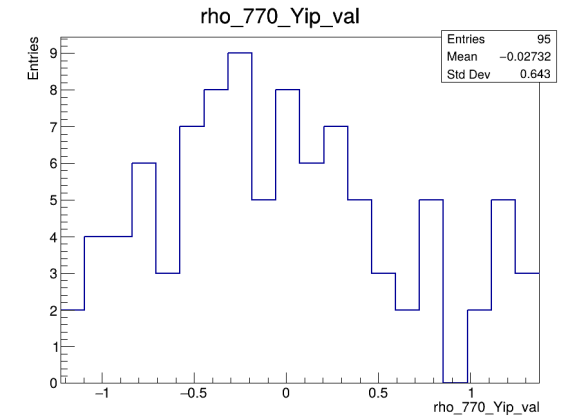
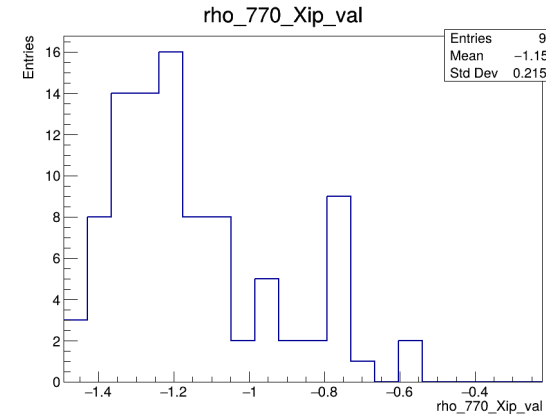
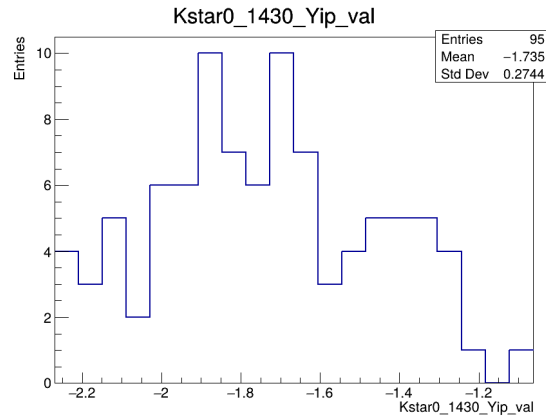
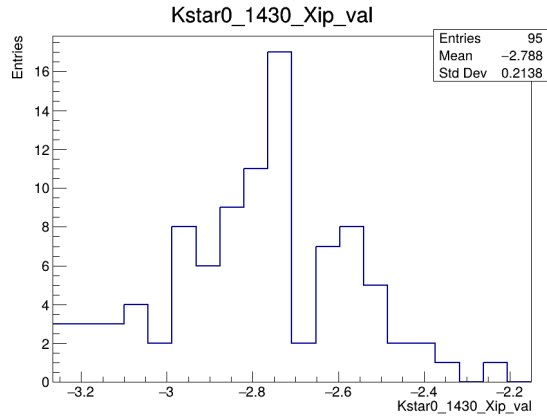
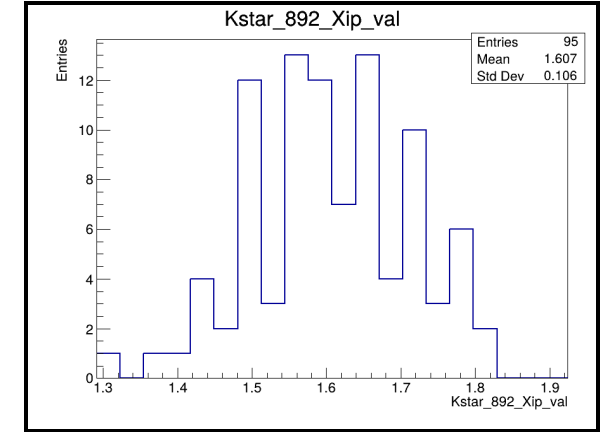
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.91001700127163	0.206902406993448
Kstar0_1430_Yip	-1.54687166892531	0.270876256599909
Kstar0_1430_b_Xip	-3.01762193036827	0.175387918647077
Kstar0_1430_b_Yip	-0.511897612954002	0.293422170793525
Kstar_892_Xip	1.60463376790922	0.111166990805666
NR1_Xip	-1.20012766541357	0.251532156291024
NR1_Yip	1.40451164441031	0.165694995154965
rho_770_Xip	-1.32967337069092	0.163566295174407
rho_770_Yip	-0.156483328442786	0.679622743247309

# Results

Local closure

Topo scan 1



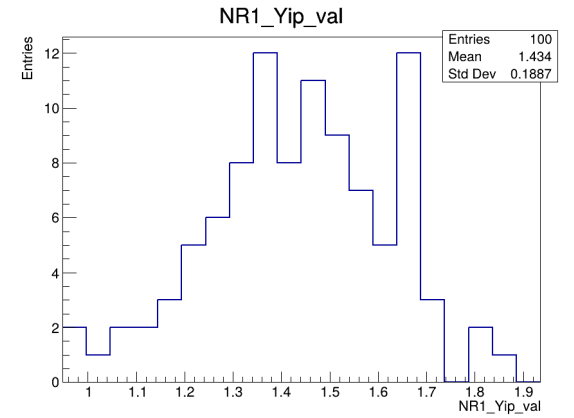
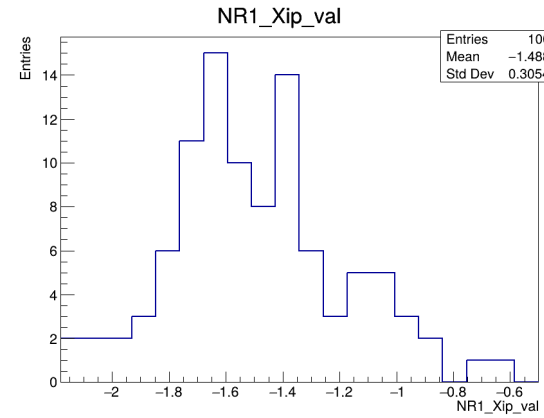
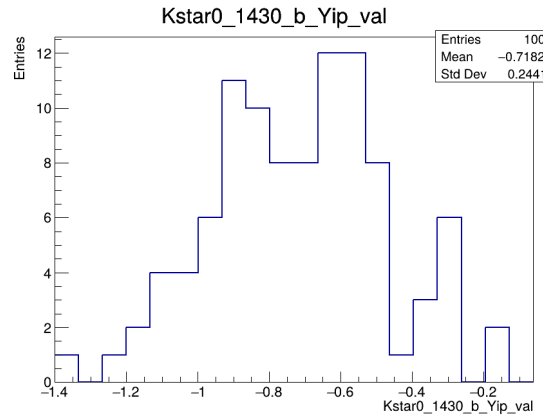
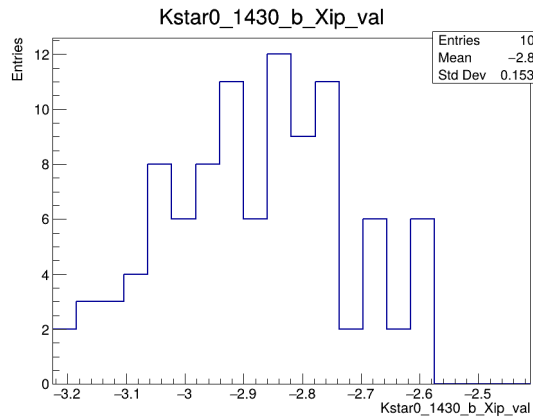
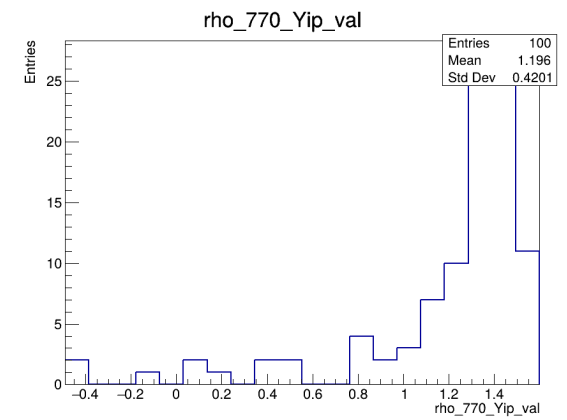
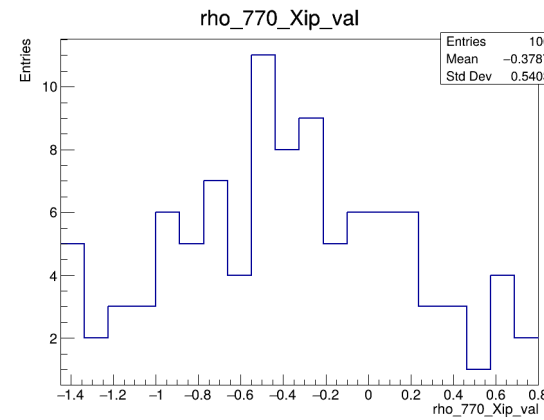
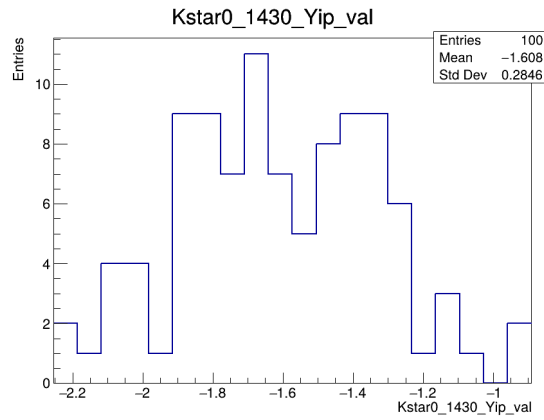
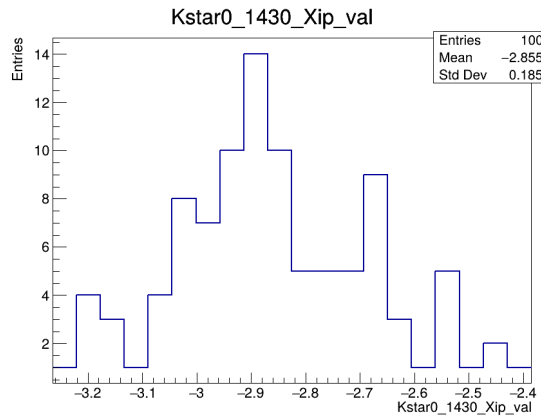
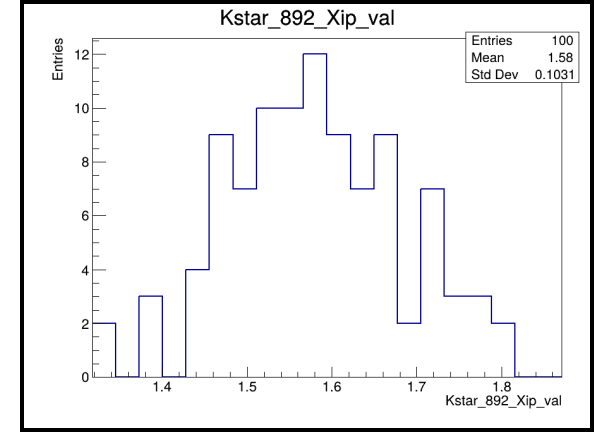
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.96913299564514	0.201947232917815
Kstar0_1430_Yip	-1.41031944280172	0.284957656891285
Kstar0_1430_b_Xip	-2.94134100751643	0.174059668037344
Kstar0_1430_b_Yip	-0.54489083429463	0.281659094306928
Kstar_892_Xip	1.57838789662115	0.111270679814721
NR1_Xip	-1.11715805166114	0.262813642923192
NR1_Yip	1.43249902879569	0.163796975707884
rho_770_Xip	-0.159457281918524	0.554746377726659
rho_770_Yip	1.46893765582474	0.115926940017102

# Results

Local closure

Topo scan 5



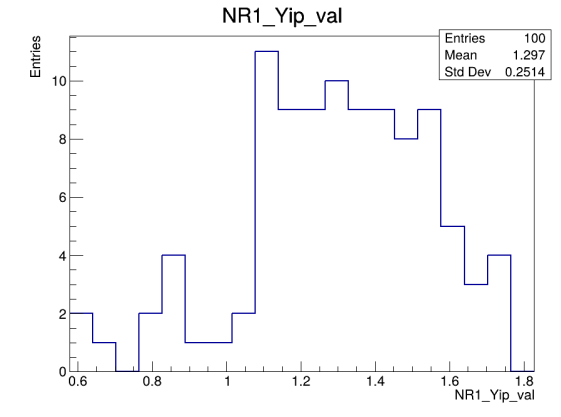
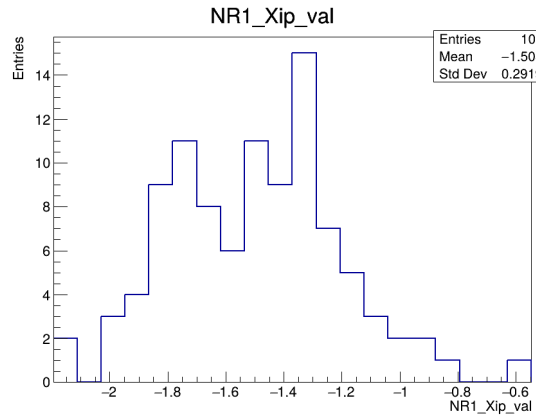
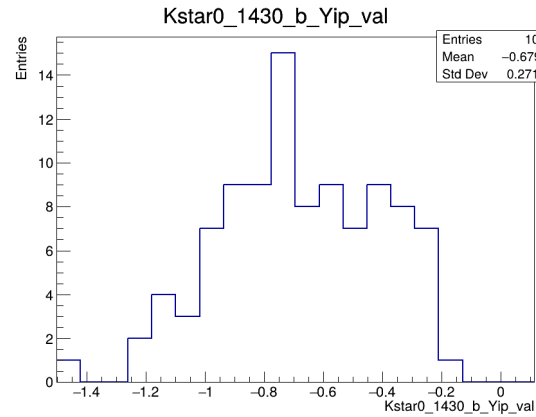
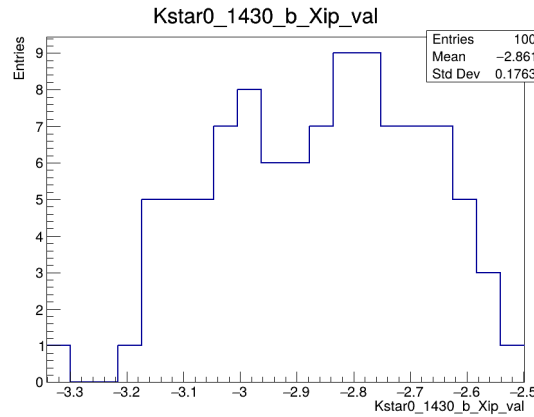
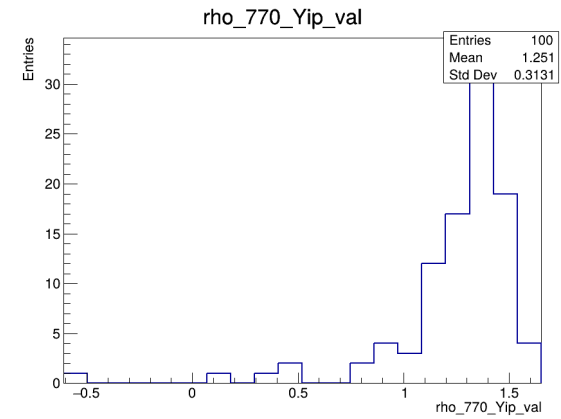
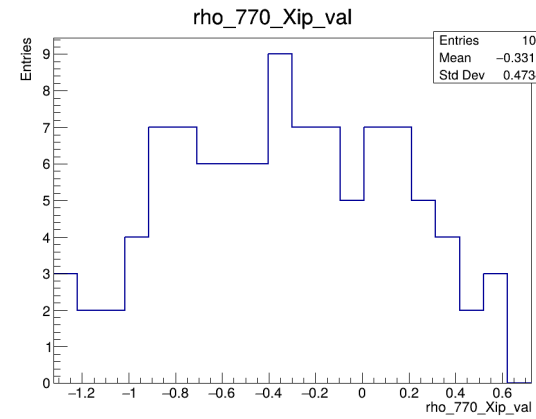
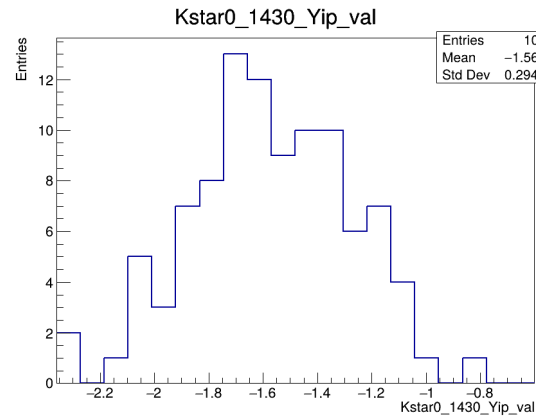
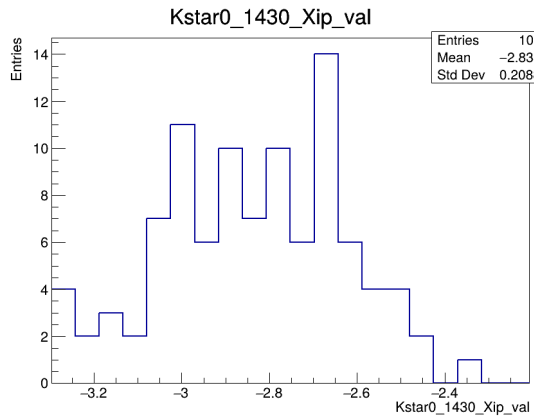
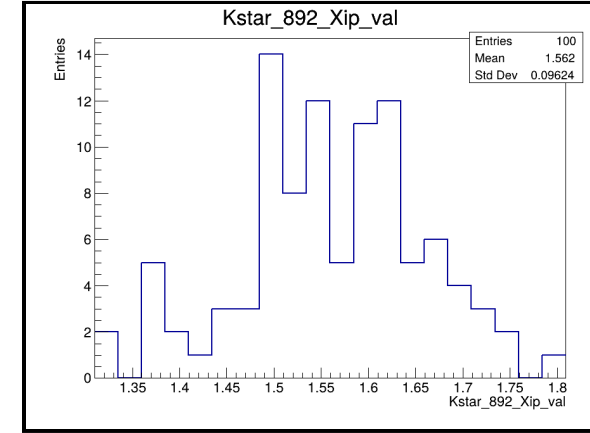
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.93931900688001	0.20812290409067
Kstar0_1430_Yip	-1.39363548892207	0.295786105270246
Kstar0_1430_b_Xip	-2.92931280121541	0.176703700183934
Kstar0_1430_b_Yip	-0.52270648585208	0.290611569699946
Kstar_892_Xip	1.56959903651927	0.11439266717921
NR1_Xip	-1.12757677670103	0.24950849996331
NR1_Yip	1.32286827413095	0.171979072654285
rho_770_Xip	-0.14568266344623	0.59643631938456
rho_770_Yip	1.45650437724249	0.11801674503011

# Results

Local closure

Topo scan 10



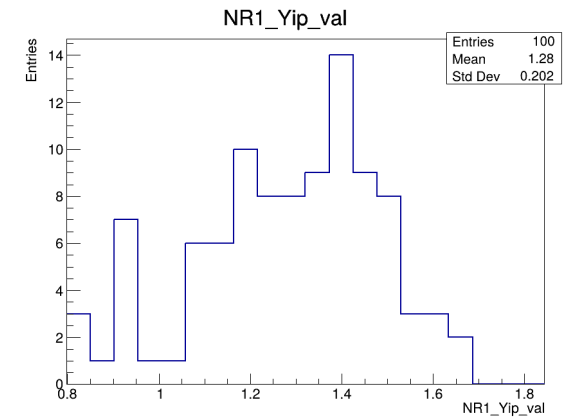
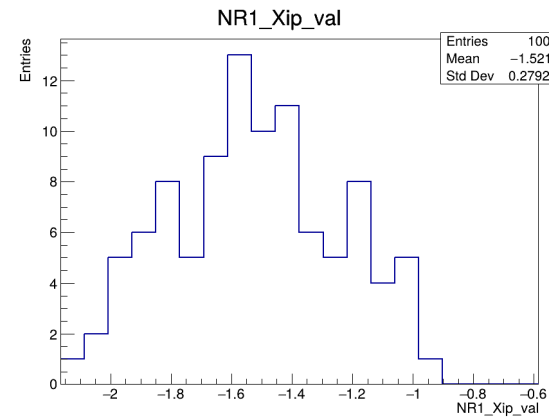
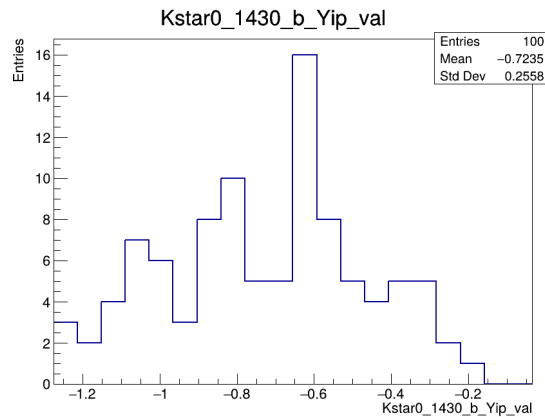
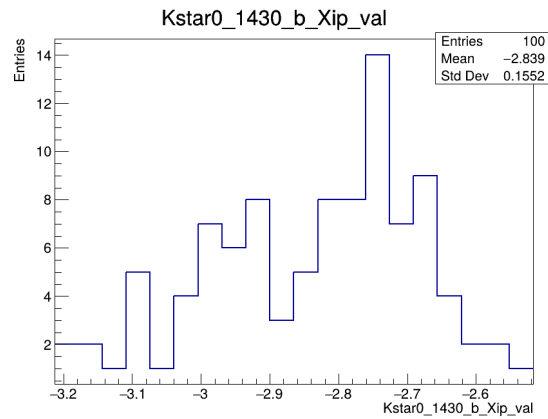
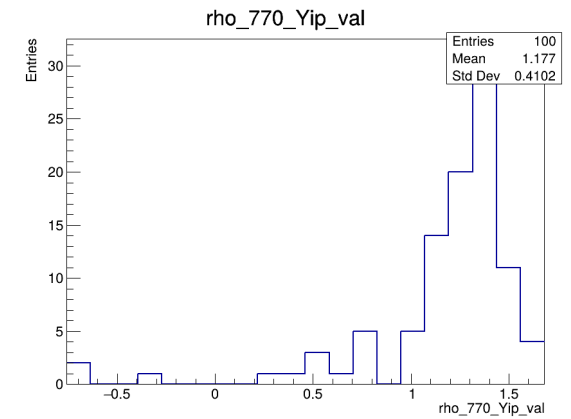
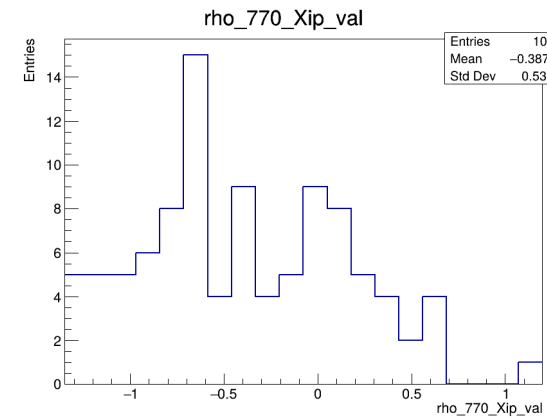
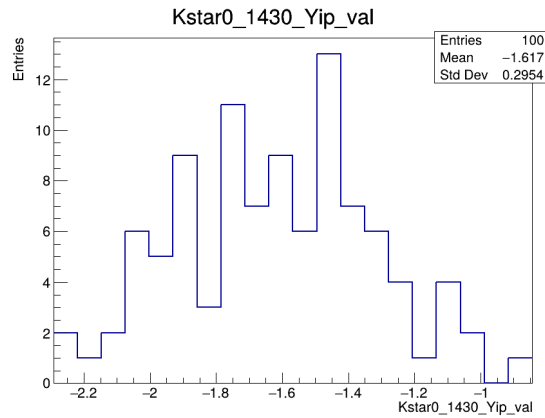
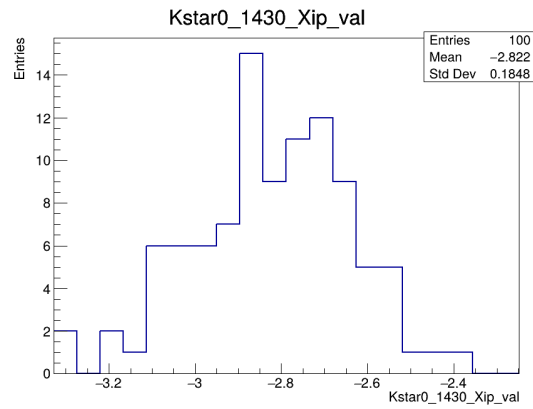
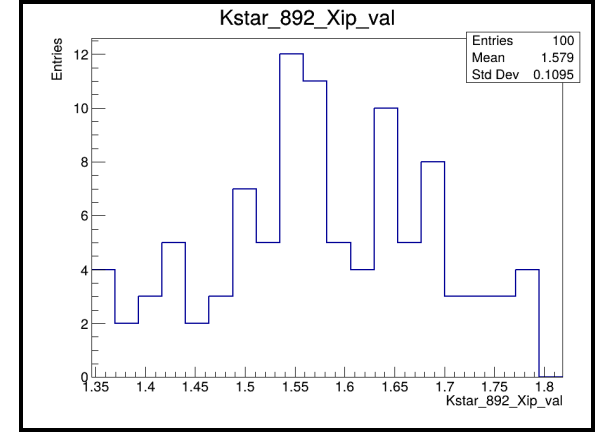
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.91627749225287	0.212490452276338
Kstar0_1430_Yip	-1.47027585106652	0.290215355668272
Kstar0_1430_b_Xip	-2.89680381418533	0.179029963834001
Kstar0_1430_b_Yip	-0.6086661620268	0.285765007251321
Kstar_892_Xip	1.57790758802846	0.116284070654457
NR1_Xip	-1.25037736125138	0.245922254022736
NR1_Yip	1.31675432140141	0.18111628087313
rho_770_Xip	-0.28454627445895	0.626796327137869
rho_770_Yip	1.43523794962413	0.170253276459489

# Results

Local closure

Topo scan 15



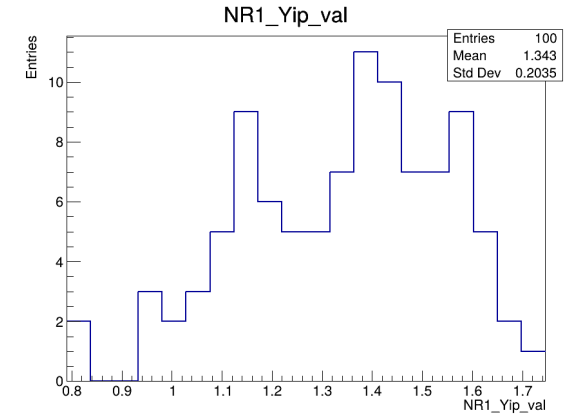
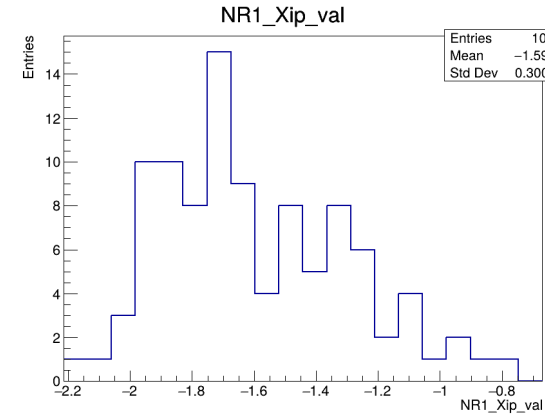
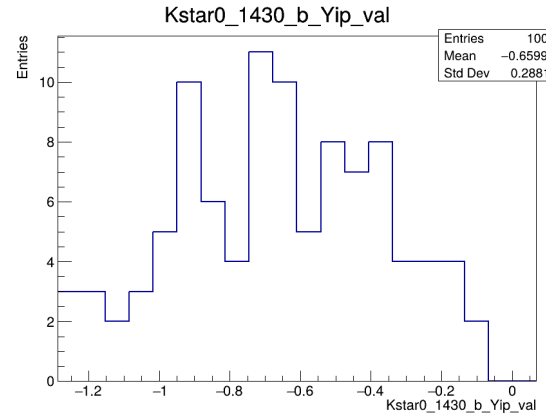
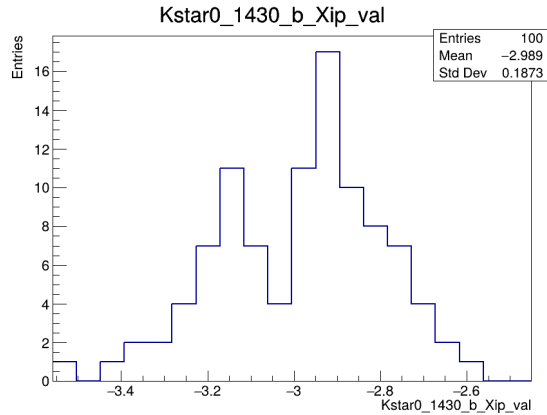
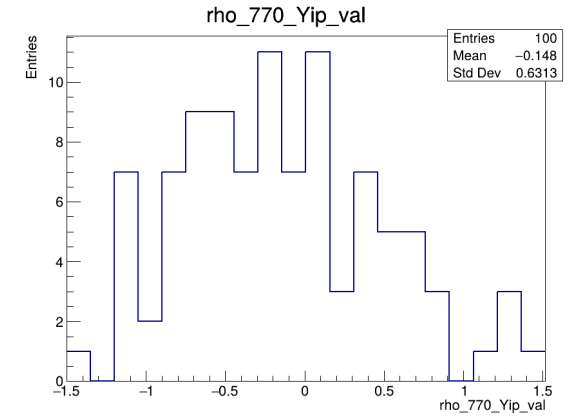
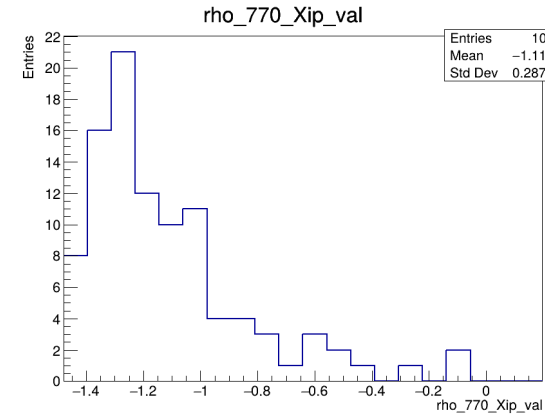
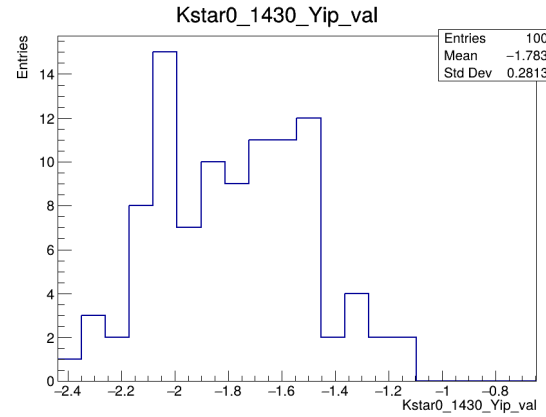
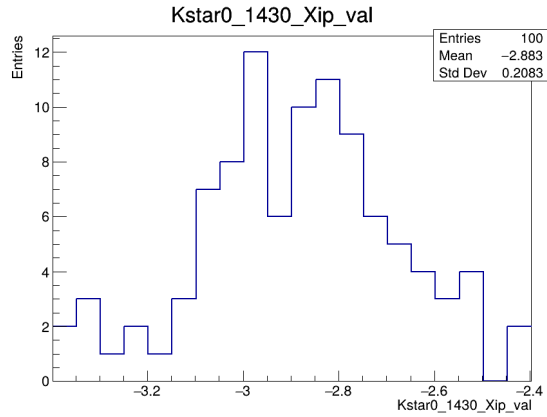
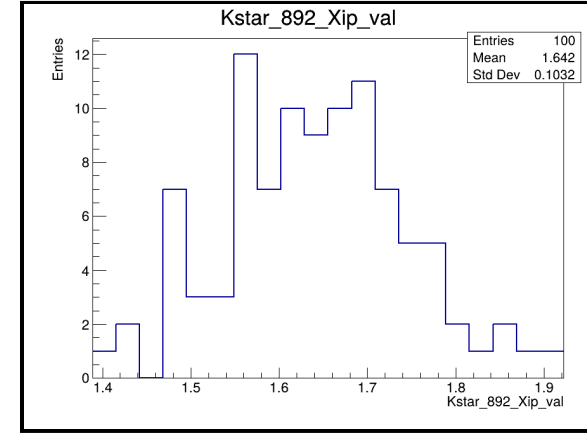
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.95978157665814	0.230097198549323
Kstar0_1430_Yip	-1.64838381888258	0.281279735040892
Kstar0_1430_b_Xip	-3.02557780786971	0.195896616431517
Kstar0_1430_b_Yip	-0.57506305088442	0.31614549376294
Kstar_892_Xip	1.6423421575746	0.122193357915295
NR1_Xip	-1.39642443931866	0.276751518634761
NR1_Yip	1.36449044858984	0.206105814830622
rho_770_Xip	-1.3260912983536	0.173739593092568
rho_770_Yip	-0.169397447225425	0.660329594931945

# Results

Local closure

Topo scan 20



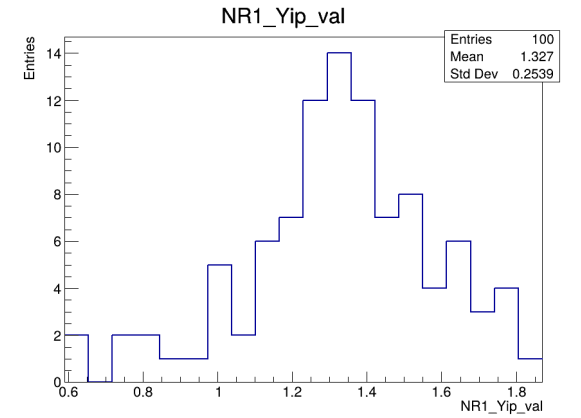
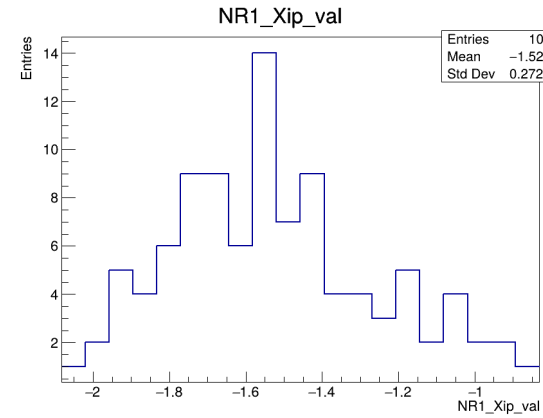
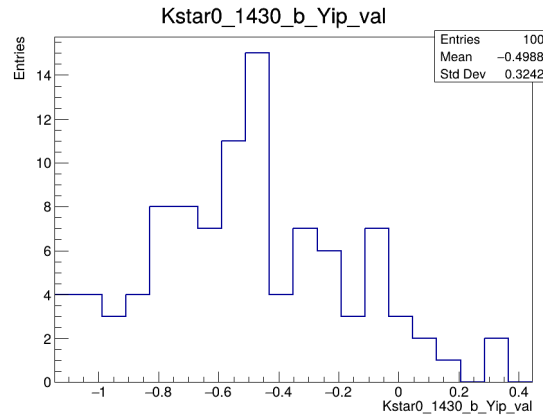
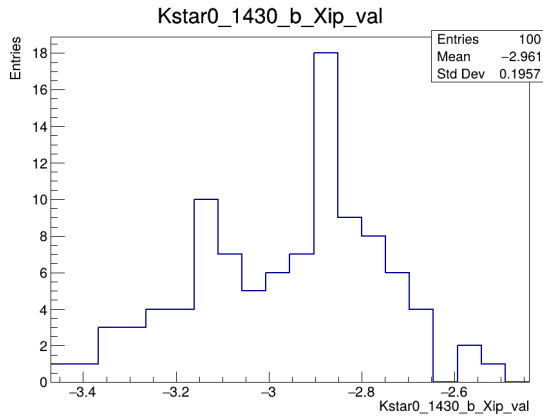
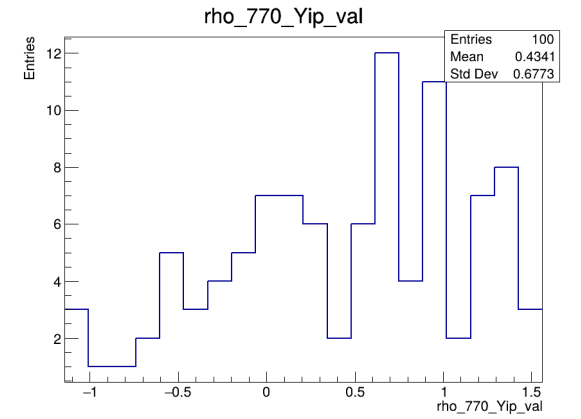
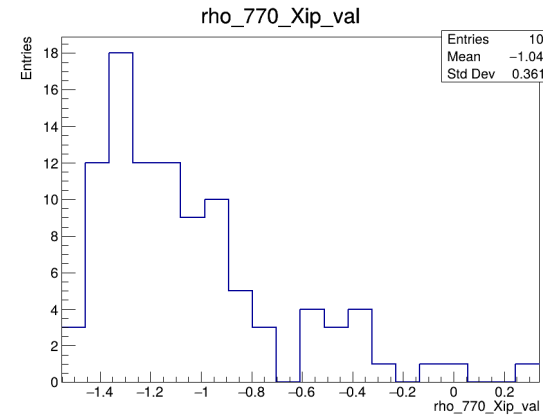
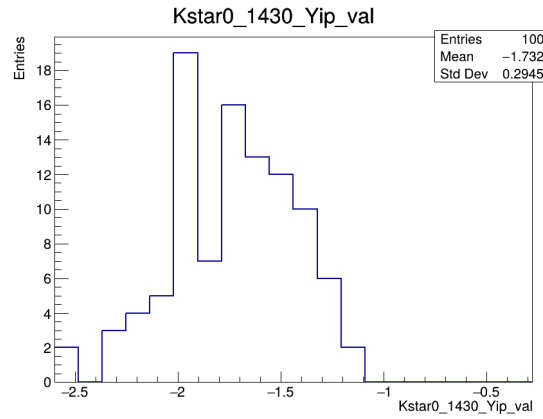
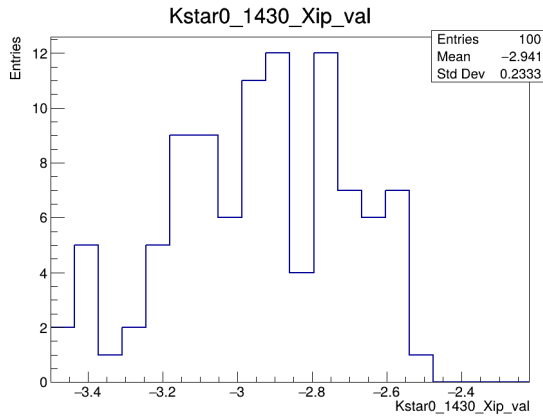
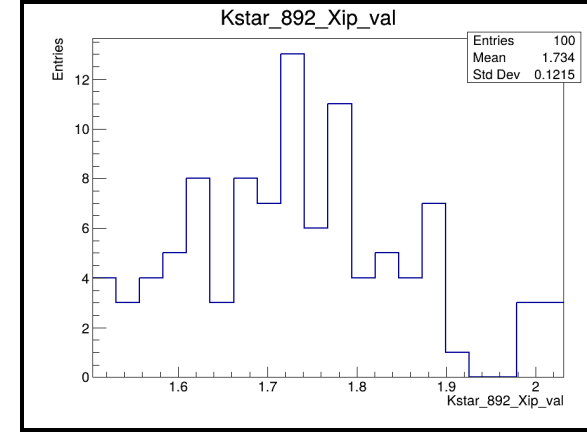
## Best solution pars

par	final	err
Kstar0_1430_Xip	-3.01117980925154	0.242819621436249
Kstar0_1430_Yip	-1.6186821659877	0.302357324197308
Kstar0_1430_b_Xip	-3.00038337721891	0.197264678627603
Kstar0_1430_b_Yip	-0.414486235995149	0.328837483576864
Kstar_892_Xip	1.73410877752692	0.13122262239043
NR1_Xip	-1.32213784333967	0.307793265907902
NR1_Yip	1.36524471656438	0.212777751379649
rho_770_Xip	-1.29538475763441	0.291334306652963
rho_770_Yip	0.48254318908247	0.989497189323522

# Results

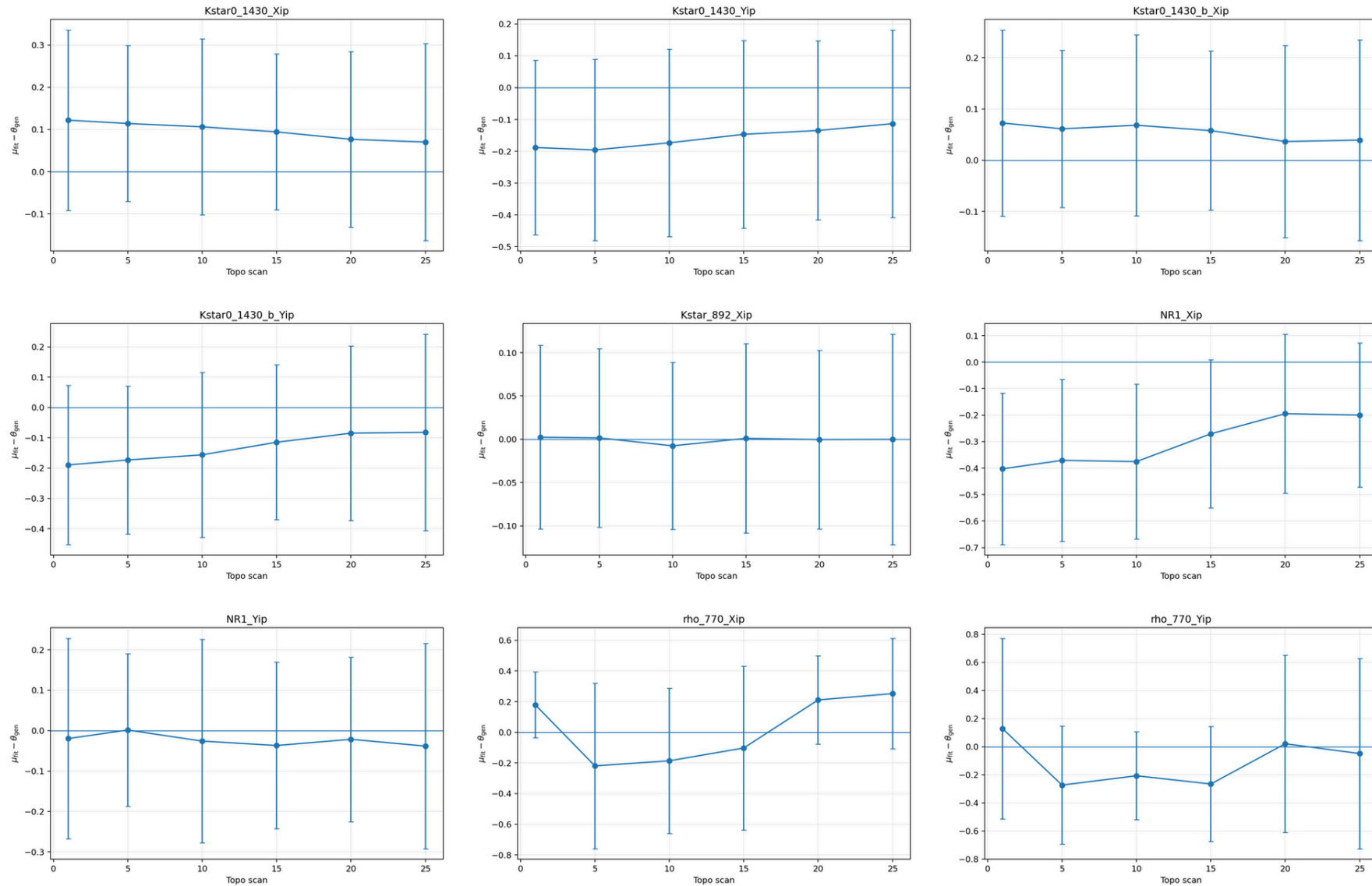
Local closure

Topo scan 25

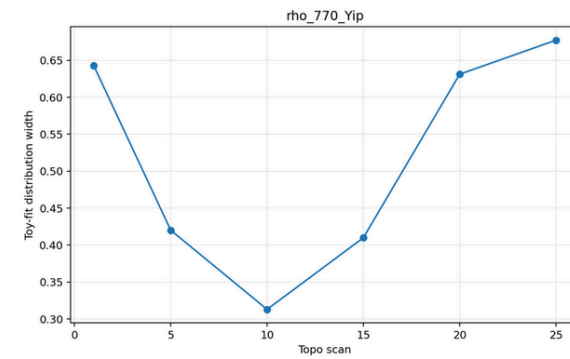
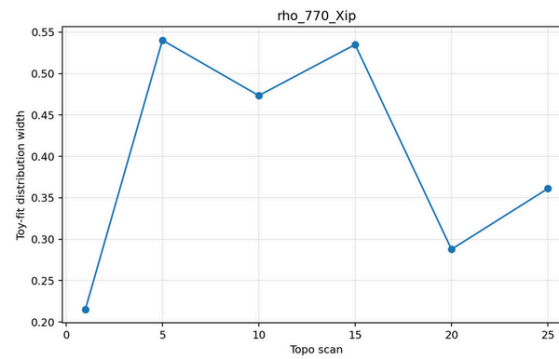
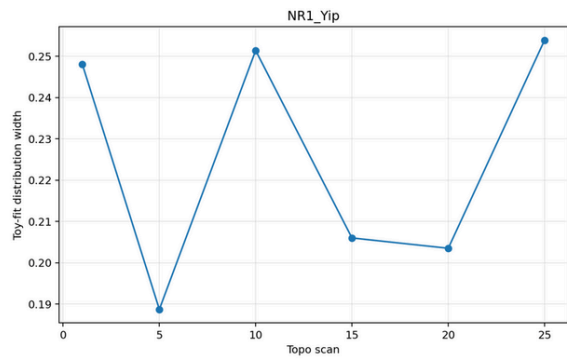
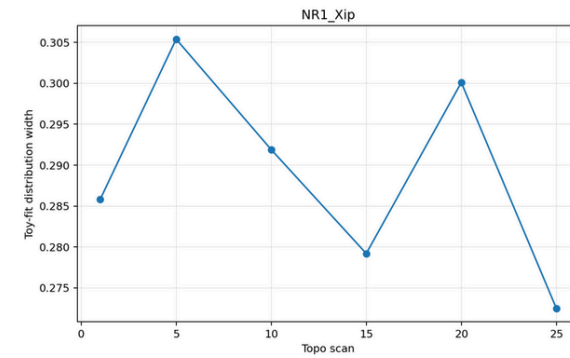
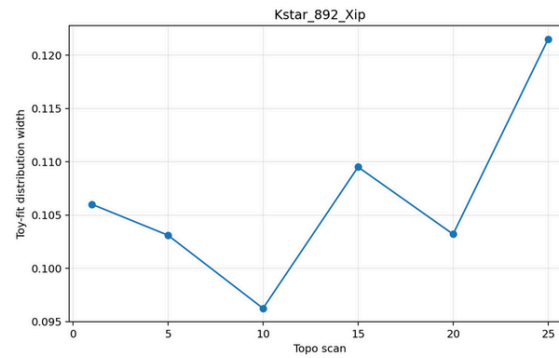
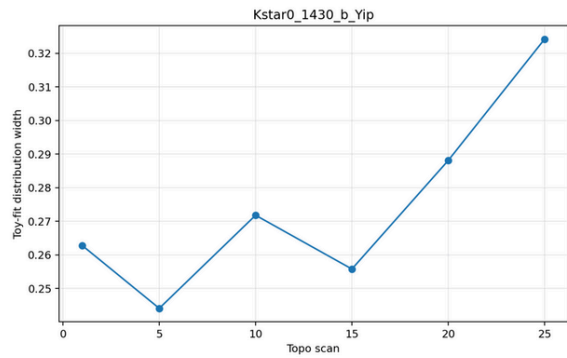
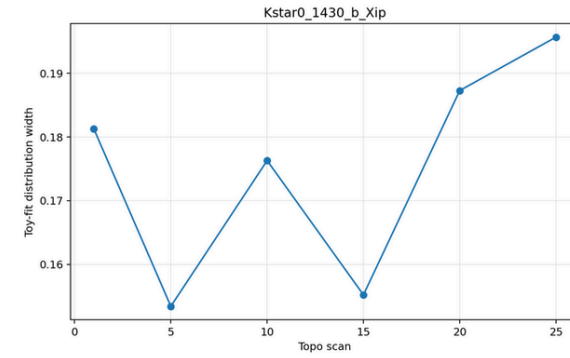
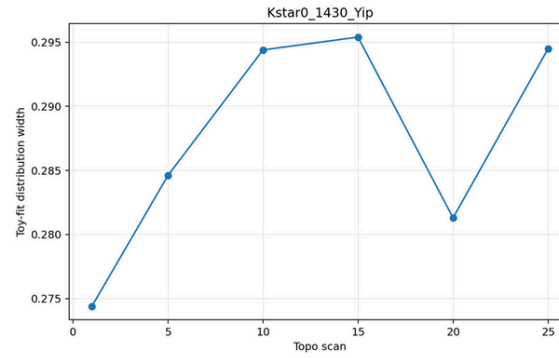
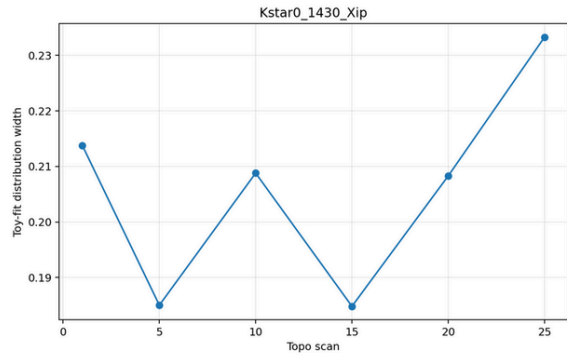


# Summary: residuals

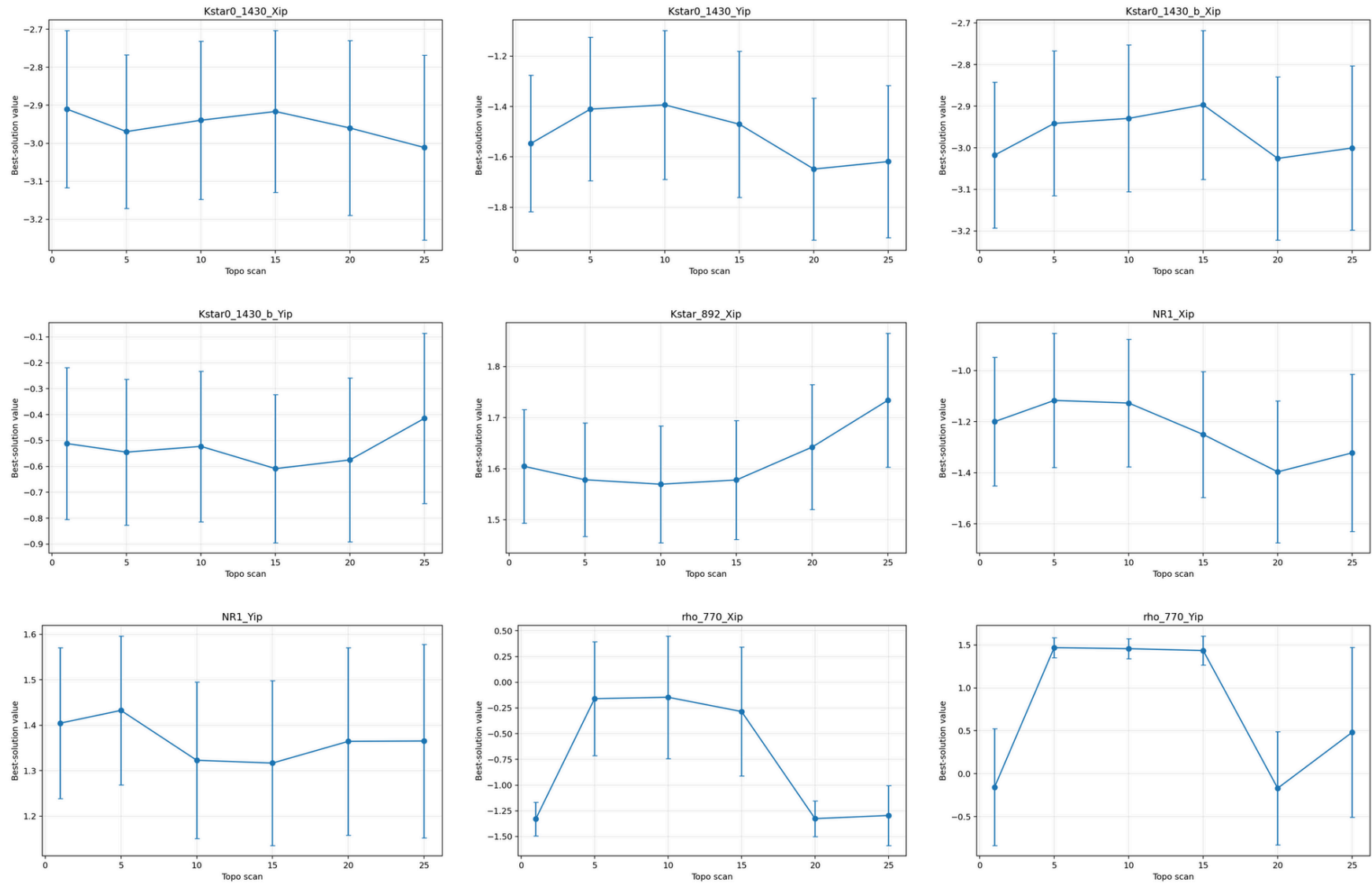
Here uncertainties  
are:  $\sigma_{stat}$



# Summary: $\sigma_{stat}$ vs topo cut



# Summary: best solution vs topo cut



Here uncertainties  
are:  $\sigma_{fit}$

# Fluctuations of combinatoric model

Local stability is just part of the story... Combinatorial background model fluctuations are crucial as well.

- Combinatorics is modeled from upper side-band events and it is statistically limited, depending on the topo MVA selection.
  - How much the stability and the IP depend on the background knowledge?

Procedure, temporarily for two topo cuts (BF and tight):

- Preliminary: Fits to data (fixed) with fluctuated combinatorial maps  $\Rightarrow \sigma_{comb}(X_i)$
- Fit to toys from best solution with fluctuated combinatorial maps  $\Rightarrow \sigma_{tot}^2(X_i) = \sigma_{comb}^2(X_i) + \sigma_{stat}^2(X_i)$

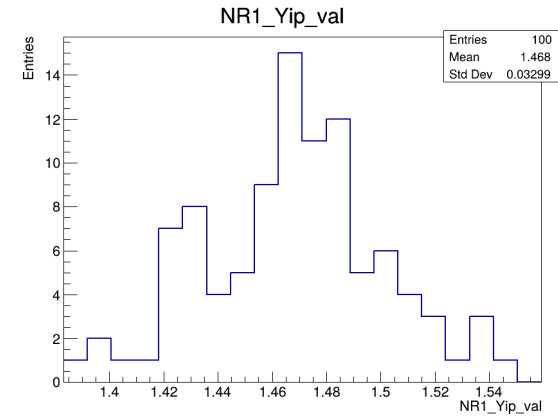
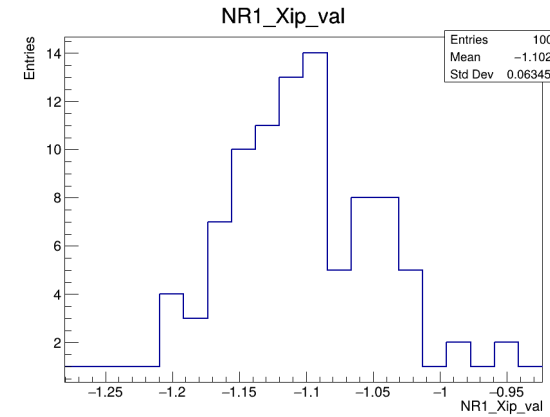
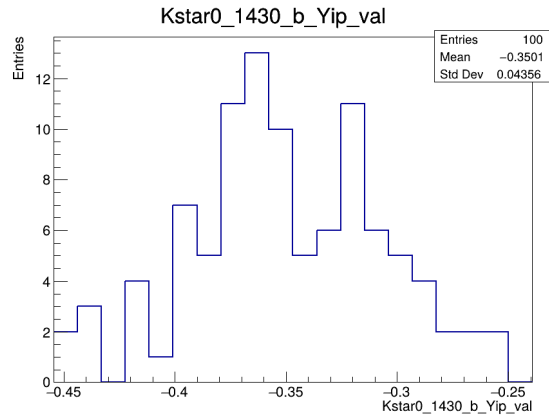
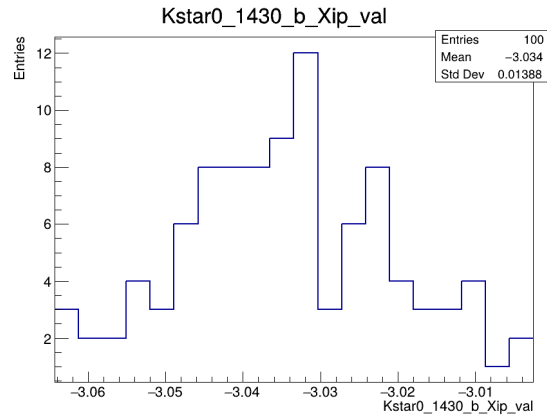
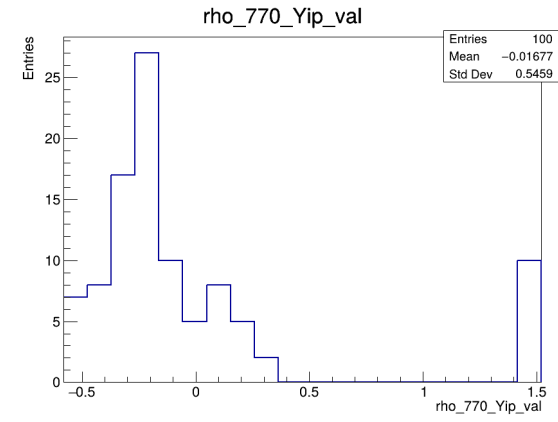
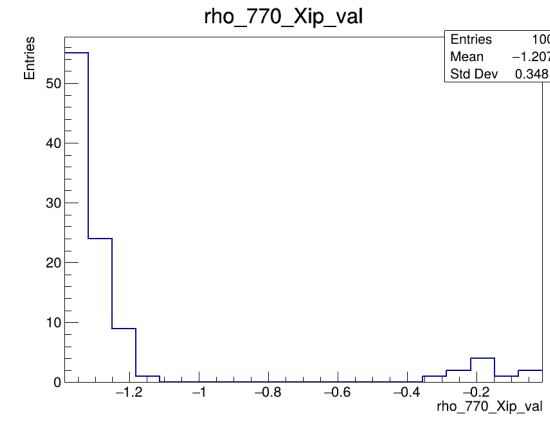
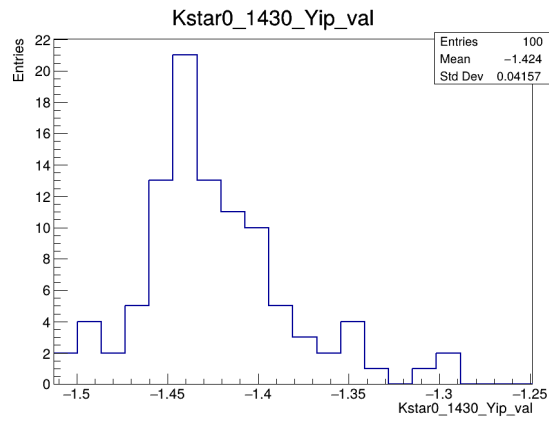
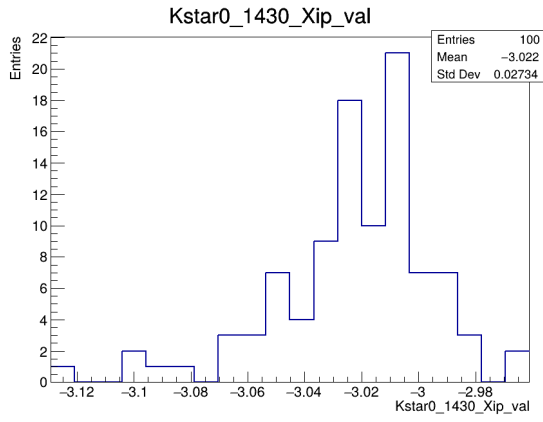
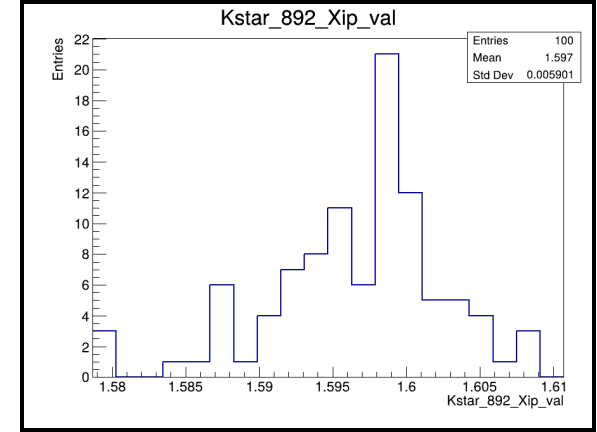
## Best solution pars

par	final	err
Kstar0_1430_Xip	-3.02520502932108	0.264196694543859
Kstar0_1430_Yip	-1.46772198898368	0.338214517779853
Kstar0_1430_b_Xip	-2.90993865013091	0.235387388223321
Kstar0_1430_b_Yip	-0.7159680894808	0.335324258768869
Kstar_892_Xip	1.67385843334312	0.148916861637277
NR1_Xip	-1.63276731703442	0.266238789256066
NR1_Yip	1.275853584072	0.269220436762829
rho_770_Xip	-1.12622985029683	0.116115697231217
rho_770_Yip	0.118191636819219	0.766497071315891

# Results

Comb. fluctuations on data fits

BF working point



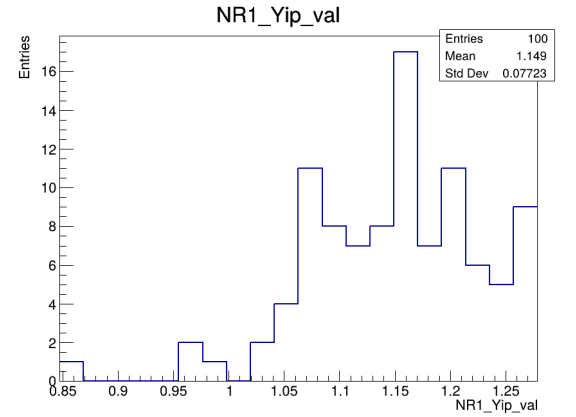
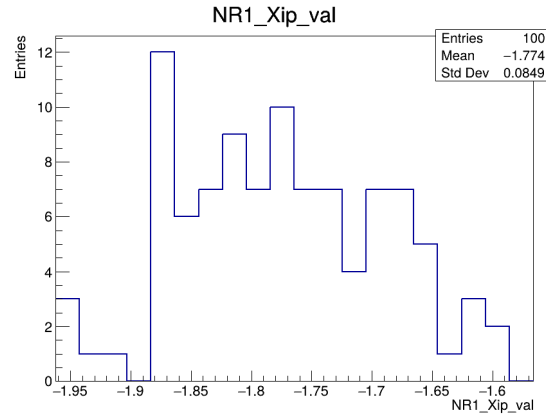
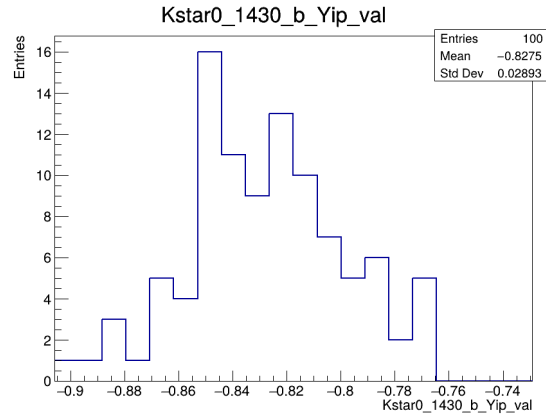
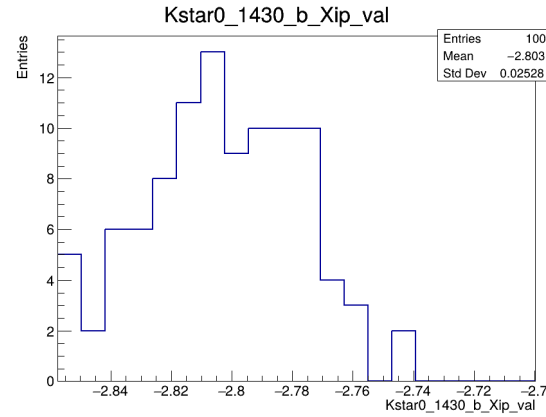
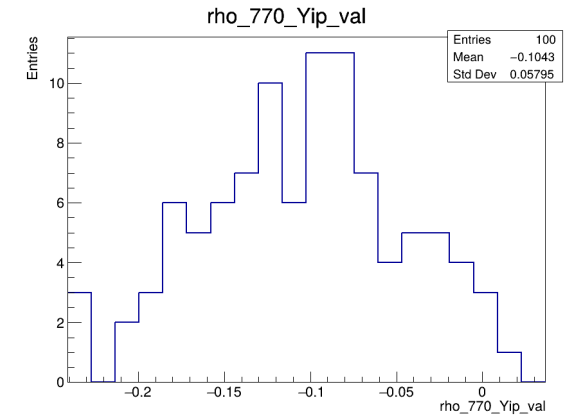
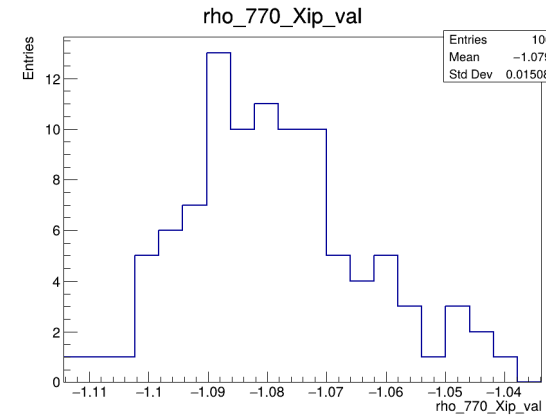
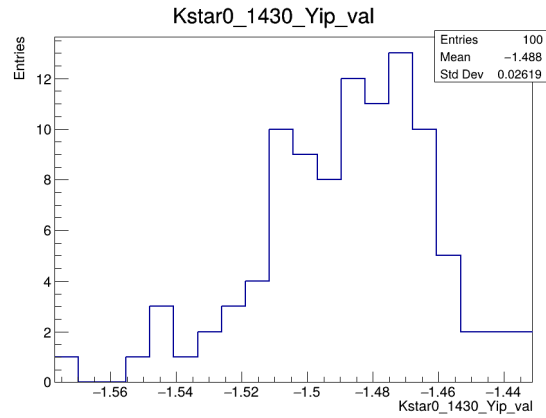
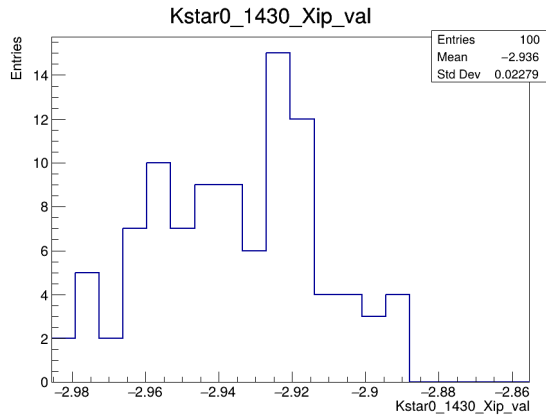
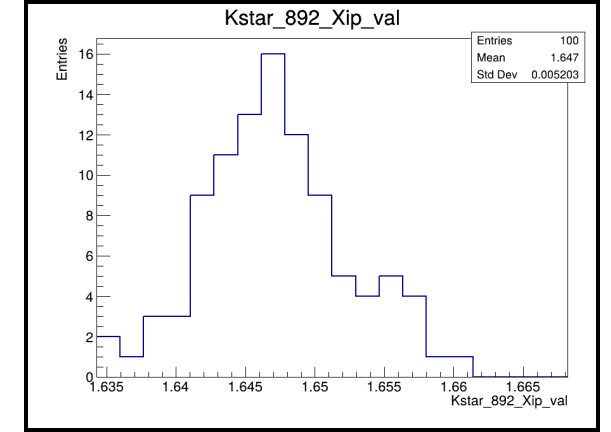
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.99647277355465	0.262362763049918
Kstar0_1430_Yip	-1.47386059013416	0.336381355376998
Kstar0_1430_b_Xip	-2.8753262484281	0.234972320100537
Kstar0_1430_b_Yip	-0.757196628301063	0.327663649576913
Kstar_892_Xip	1.67031727628018	0.14841053140165
NR1_Xip	-1.72331695044889	0.245122128269253
NR1_Yip	1.21593146978505	0.279039169275597
rho_770_Xip	-1.11964795463084	0.115261090053512
rho_770_Yip	0.0810104635136781	0.731032570515417

# Results

Comb. fluctuations on data fits

Tight working point



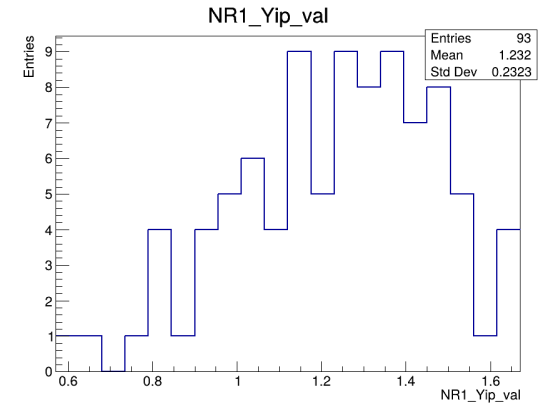
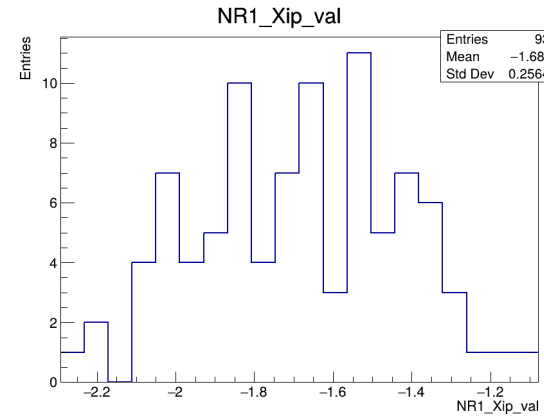
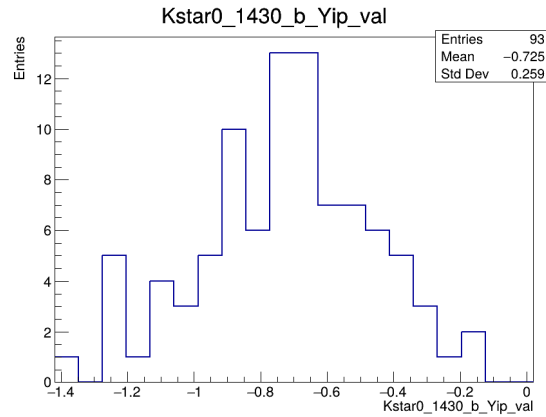
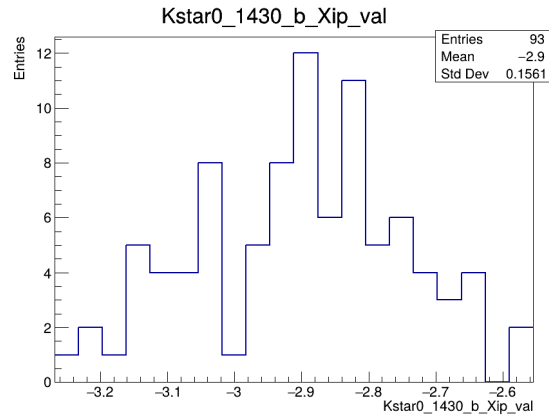
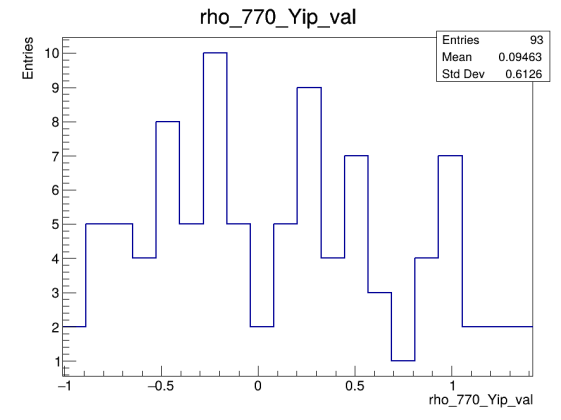
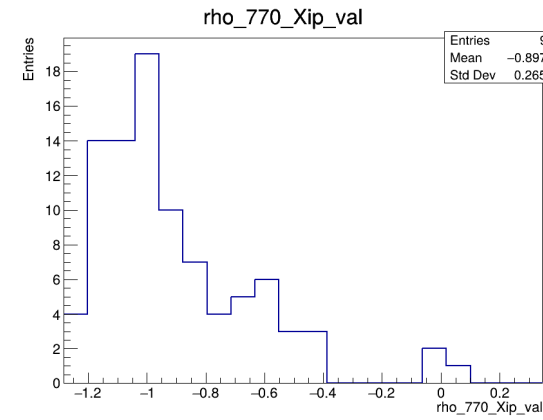
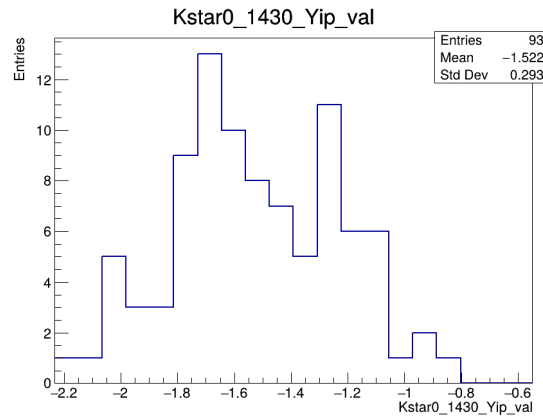
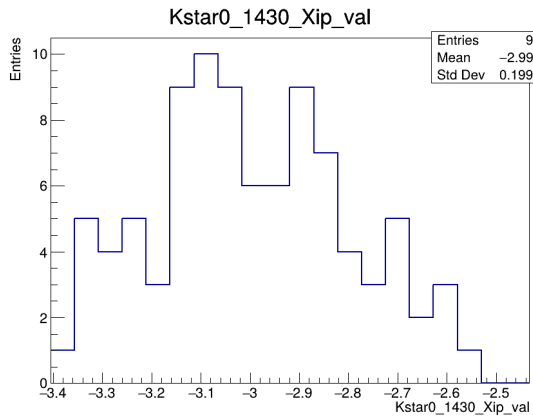
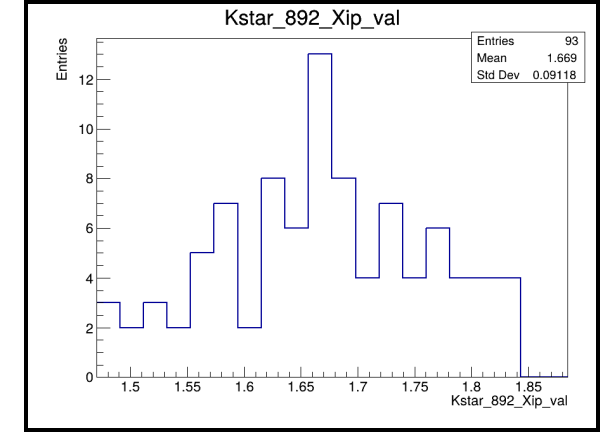
## Best solution pars

par	final	err
Kstar0_1430_Xip	-3.02520502932108	0.264196694543859
Kstar0_1430_Yip	-1.46772198898368	0.338214517779853
Kstar0_1430_b_Xip	-2.90993865013091	0.235387388223321
Kstar0_1430_b_Yip	-0.7159680894808	0.335324258768869
Kstar_892_Xip	1.67385843334312	0.148916861637277
NR1_Xip	-1.63276731703442	0.266238789256066
NR1_Yip	1.275853584072	0.269220436762829
rho_770_Xip	-1.12622985029683	0.116115697231217
rho_770_Yip	0.118191636819219	0.766497071315891

# Results

Comb. fluctuations on toy fits

BF working point



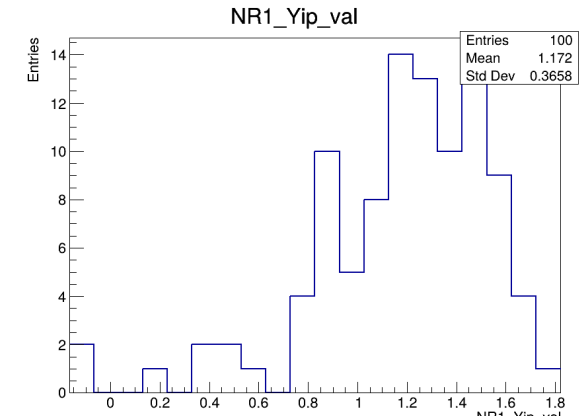
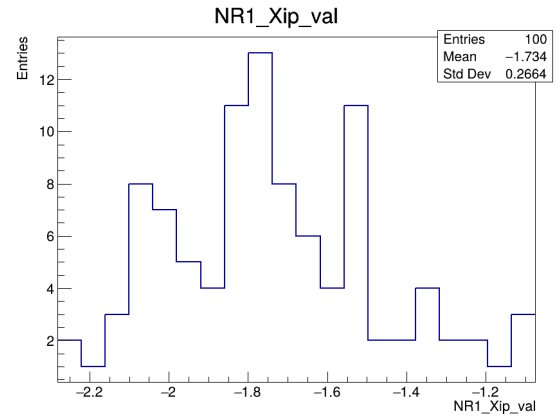
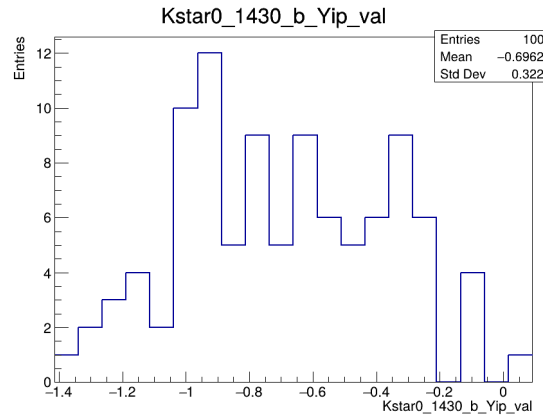
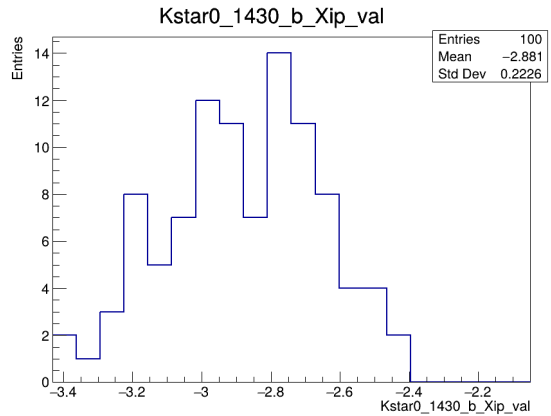
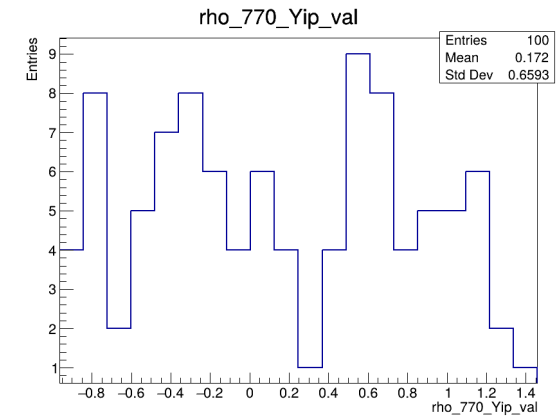
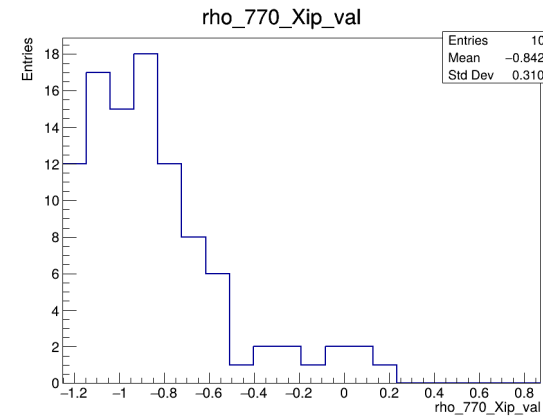
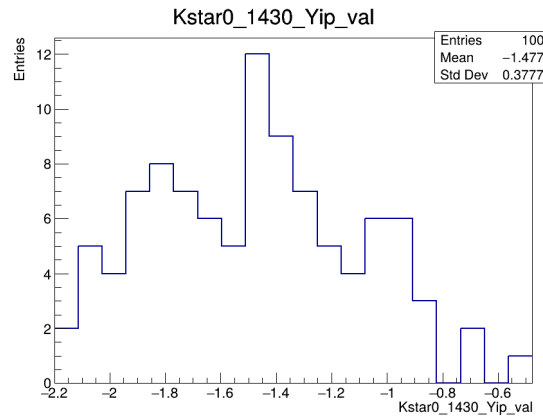
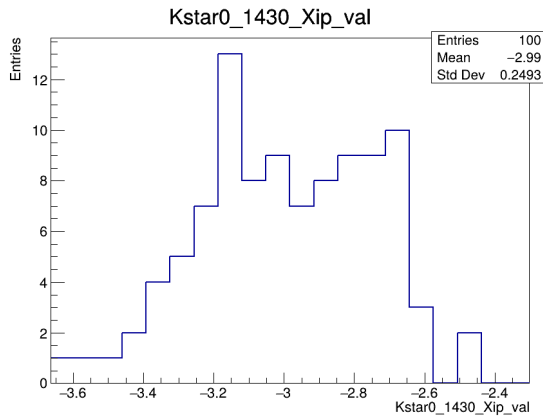
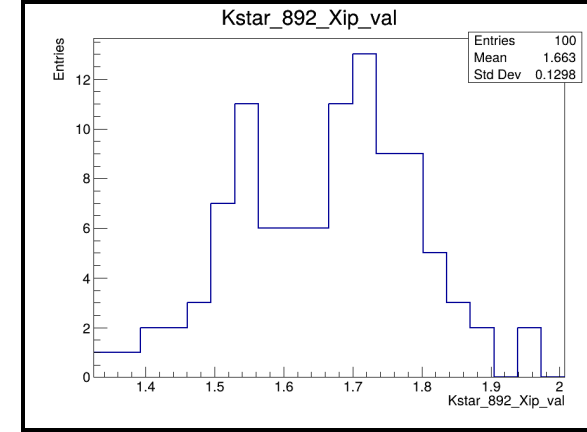
## Best solution pars

par	final	err
Kstar0_1430_Xip	-2.99647277355465	0.262362763049918
Kstar0_1430_Yip	-1.47386059013416	0.336381355376998
Kstar0_1430_b_Xip	-2.8753262484281	0.234972320100537
Kstar0_1430_b_Yip	-0.757196628301063	0.327663649576913
Kstar_892_Xip	1.67031727628018	0.14841053140165
NR1_Xip	-1.72331695044889	0.245122128269253
NR1_Yip	1.21593146978505	0.279039169275597
rho_770_Xip	-1.11964795463084	0.115261090053512
rho_770_Yip	0.0810104635136781	0.731032570515417

# Results

Comb. fluctuations on toy fits

Tight working point



**Thank you**

# Backup

# Fit stability

## Fractions in the signal window

### BF baseline

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	$(69.44 \pm 7.47)\%$	$(81.26 \pm 7.06)\%$	$(76.39 \pm 4.20)\%$	$(71.95 \pm 6.55)\%$	$(67.91 \pm 2.75)\%$	$(63.62 \pm 3.21)\%$	$(65.28 \pm 3.13)\%$
$B_d^0$	$(7.62 \pm 1.36)\%$	$(4.37 \pm 1.23)\%$	$(6.15 \pm 0.95)\%$	$(7.01 \pm 1.37)\%$	$(9.32 \pm 0.86)\%$	$(11.07 \pm 0.98)\%$	$(7.25 \pm 0.58)\%$
Combinatorial	$(22.94 \pm 6.98)\%$	$(14.37 \pm 6.23)\%$	$(17.46 \pm 3.83)\%$	$(21.04 \pm 5.58)\%$	$(22.77 \pm 2.22)\%$	$(25.31 \pm 2.73)\%$	$(27.47 \pm 2.80)\%$
$K_S^0$ (DD)							
$B_s^0$	$(83.52 \pm 3.35)\%$	$(54.44 \pm 8.26)\%$	$(69.77 \pm 3.50)\%$	$(74.06 \pm 4.73)\%$	$(61.91 \pm 2.44)\%$	$(66.27 \pm 2.22)\%$	$(68.53 \pm 1.92)\%$
$B_d^0$	$(4.52 \pm 0.72)\%$	$(6.41 \pm 1.38)\%$	$(5.54 \pm 0.66)\%$	$(7.34 \pm 1.26)\%$	$(6.04 \pm 0.38)\%$	$(7.92 \pm 0.52)\%$	$(6.63 \pm 0.37)\%$
Combinatorial	$(11.96 \pm 2.76)\%$	$(39.15 \pm 7.10)\%$	$(24.69 \pm 3.39)\%$	$(18.60 \pm 4.09)\%$	$(32.05 \pm 2.11)\%$	$(25.82 \pm 1.77)\%$	$(24.84 \pm 1.64)\%$

### Tight topo

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	$(79.71 \pm 6.45)\%$	$(79.73 \pm 7.75)\%$	$(88.03 \pm 2.77)\%$	$(81.60 \pm 5.45)\%$	$(84.51 \pm 2.06)\%$	$(79.14 \pm 2.99)\%$	$(85.62 \pm 2.01)\%$
$B_d^0$	$(9.11 \pm 2.49)\%$	$(3.55 \pm 1.03)\%$	$(6.18 \pm 1.34)\%$	$(8.38 \pm 2.09)\%$	$(9.70 \pm 1.10)\%$	$(13.96 \pm 1.49)\%$	$(8.69 \pm 0.97)\%$
Combinatorial	$(11.18 \pm 4.29)\%$	$(16.72 \pm 7.18)\%$	$(5.79 \pm 2.38)\%$	$(10.02 \pm 4.34)\%$	$(5.79 \pm 1.37)\%$	$(6.89 \pm 1.82)\%$	$(5.68 \pm 1.38)\%$
$K_S^0$ (DD)							
$B_s^0$	$(87.39 \pm 2.72)\%$	$(85.95 \pm 4.63)\%$	$(87.69 \pm 2.56)\%$	$(79.04 \pm 7.27)\%$	$(84.67 \pm 2.11)\%$	$(83.06 \pm 1.74)\%$	$(82.05 \pm 1.79)\%$
$B_d^0$	$(4.68 \pm 0.83)\%$	$(6.46 \pm 1.45)\%$	$(6.84 \pm 1.28)\%$	$(8.97 \pm 2.38)\%$	$(8.66 \pm 0.85)\%$	$(9.22 \pm 0.82)\%$	$(8.57 \pm 0.81)\%$
Combinatorial	$(7.93 \pm 2.74)\%$	$(7.59 \pm 4.17)\%$	$(5.47 \pm 2.01)\%$	$(11.99 \pm 5.46)\%$	$(6.67 \pm 1.57)\%$	$(7.72 \pm 1.36)\%$	$(9.38 \pm 1.30)\%$

# Fit stability

## Fractions in the signal window

### Topo 1

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(44.11 ± 0.00)%	(71.50 ± 0.00)%	(70.03 ± 0.00)%	(71.41 ± 0.00)%	(70.37 ± 0.00)%	(67.17 ± 0.00)%	(65.43 ± 0.00)%
$B_d^0$	(11.95 ± 0.00)%	(4.00 ± 0.00)%	(6.36 ± 0.00)%	(6.47 ± 0.00)%	(7.53 ± 0.00)%	(11.13 ± 0.00)%	(5.98 ± 0.00)%
Combinatorial	(43.94 ± 0.00)%	(24.50 ± 0.00)%	(23.61 ± 0.00)%	(22.12 ± 0.00)%	(22.10 ± 0.00)%	(21.70 ± 0.00)%	(28.59 ± 0.00)%
$K_S^0$ (DD)							
$B_s^0$	(66.82 ± 0.00)%	(58.08 ± 0.00)%	(52.77 ± 0.00)%	(49.17 ± 0.00)%	(64.69 ± 0.00)%	(59.81 ± 0.00)%	(61.59 ± 0.00)%
$B_d^0$	(3.26 ± 0.00)%	(5.87 ± 0.00)%	(5.72 ± 0.00)%	(7.58 ± 0.00)%	(5.93 ± 0.00)%	(6.48 ± 0.00)%	(6.75 ± 0.00)%
Combinatorial	(29.92 ± 0.00)%	(36.05 ± 0.00)%	(41.51 ± 0.00)%	(43.25 ± 0.00)%	(29.38 ± 0.00)%	(33.71 ± 0.00)%	(31.66 ± 0.00)%

### Topo 5

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(74.97 ± 0.00)%	(36.85 ± 0.00)%	(71.22 ± 0.00)%	(54.42 ± 0.00)%	(67.34 ± 0.00)%	(70.01 ± 0.00)%	(61.89 ± 0.00)%
$B_d^0$	(6.85 ± 0.00)%	(6.55 ± 0.00)%	(5.02 ± 0.00)%	(8.78 ± 0.00)%	(9.21 ± 0.00)%	(11.40 ± 0.00)%	(6.83 ± 0.00)%
Combinatorial	(18.18 ± 0.00)%	(56.60 ± 0.00)%	(23.77 ± 0.00)%	(36.80 ± 0.00)%	(23.45 ± 0.00)%	(18.60 ± 0.00)%	(31.28 ± 0.00)%
$K_S^0$ (DD)							
$B_s^0$	(68.45 ± 0.00)%	(65.40 ± 0.00)%	(61.52 ± 0.00)%	(62.25 ± 0.00)%	(67.32 ± 0.00)%	(63.51 ± 0.00)%	(65.23 ± 0.00)%
$B_d^0$	(3.28 ± 0.00)%	(5.99 ± 0.00)%	(4.27 ± 0.00)%	(6.62 ± 0.00)%	(5.95 ± 0.00)%	(7.68 ± 0.00)%	(7.05 ± 0.00)%
Combinatorial	(28.27 ± 0.00)%	(28.61 ± 0.00)%	(34.20 ± 0.00)%	(31.13 ± 0.00)%	(26.74 ± 0.00)%	(28.80 ± 0.00)%	(27.72 ± 0.00)%

# Fit stability

## Fractions in the signal window

### Topo 10

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(70.35 ± 0.00)%	(64.80 ± 0.00)%	(69.49 ± 0.00)%	(74.27 ± 0.00)%	(71.23 ± 0.00)%	(75.63 ± 0.00)%	(59.92 ± 0.00)%
$B_d^0$	(8.74 ± 0.00)%	(3.64 ± 0.00)%	(5.98 ± 0.00)%	(7.04 ± 0.00)%	(9.85 ± 0.00)%	(12.87 ± 0.00)%	(8.17 ± 0.00)%
Combinatorial	(20.90 ± 0.00)%	(31.56 ± 0.00)%	(24.52 ± 0.00)%	(18.69 ± 0.00)%	(18.92 ± 0.00)%	(11.49 ± 0.00)%	(31.91 ± 0.00)%
$K_S^0$ (DD)							
$B_s^0$	(74.64 ± 0.00)%	(63.18 ± 0.00)%	(57.57 ± 0.00)%	(62.07 ± 0.00)%	(65.20 ± 0.00)%	(59.47 ± 0.00)%	(72.19 ± 0.00)%
$B_d^0$	(4.03 ± 0.00)%	(6.74 ± 0.00)%	(5.86 ± 0.00)%	(5.48 ± 0.00)%	(7.17 ± 0.00)%	(8.56 ± 0.00)%	(6.24 ± 0.00)%
Combinatorial	(21.33 ± 0.00)%	(30.08 ± 0.00)%	(36.57 ± 0.00)%	(32.45 ± 0.00)%	(27.63 ± 0.00)%	(31.97 ± 0.00)%	(21.58 ± 0.00)%

### Topo 15

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(69.14 ± 0.00)%	(54.71 ± 0.00)%	(71.68 ± 0.00)%	(77.32 ± 0.00)%	(71.02 ± 0.00)%	(70.55 ± 0.00)%	(67.75 ± 0.00)%
$B_d^0$	(10.37 ± 0.00)%	(5.75 ± 0.00)%	(7.16 ± 0.00)%	(6.89 ± 0.00)%	(9.73 ± 0.00)%	(16.30 ± 0.00)%	(7.42 ± 0.00)%
Combinatorial	(20.48 ± 0.00)%	(39.55 ± 0.00)%	(21.15 ± 0.00)%	(15.80 ± 0.00)%	(19.24 ± 0.00)%	(13.14 ± 0.00)%	(24.83 ± 0.00)%
$K_S^0$ (DD)							
$B_s^0$	(80.15 ± 0.00)%	(61.74 ± 0.00)%	(60.50 ± 0.00)%	(72.84 ± 0.00)%	(70.49 ± 0.00)%	(71.42 ± 0.00)%	(71.27 ± 0.00)%
$B_d^0$	(3.89 ± 0.00)%	(7.69 ± 0.00)%	(5.85 ± 0.00)%	(4.52 ± 0.00)%	(7.19 ± 0.00)%	(7.46 ± 0.00)%	(7.09 ± 0.00)%
Combinatorial	(15.96 ± 0.00)%	(30.57 ± 0.00)%	(33.65 ± 0.00)%	(22.64 ± 0.00)%	(22.31 ± 0.00)%	(21.12 ± 0.00)%	(21.64 ± 0.00)%

# Fit stability

## Fractions in the signal window

### Topo 20

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(77.20±0.00)%	(71.64±0.00)%	(76.87±0.00)%	(70.83±0.00)%	(73.36±0.00)%	(78.91±0.00)%	(72.18±0.00)%
$B_d^0$	(8.73±0.00)%	(3.74±0.00)%	(5.83±0.00)%	(7.49±0.00)%	(9.14±0.00)%	(14.13±0.00)%	(6.79±0.00)%
Combinatorial	(14.07±0.00)%	(24.63±0.00)%	(17.31±0.00)%	(21.68±0.00)%	(17.49±0.00)%	(6.97±0.00)%	(21.03±0.00)%
$K_S^0$ (DD)							
$B_s^0$	(78.25±0.00)%	(70.83±0.00)%	(59.29±0.00)%	(68.79±0.00)%	(75.00±0.00)%	(75.65±0.00)%	(77.73±0.00)%
$B_d^0$	(3.70±0.00)%	(5.89±0.00)%	(5.26±0.00)%	(5.11±0.00)%	(6.91±0.00)%	(7.32±0.00)%	(6.73±0.00)%
Combinatorial	(18.05±0.00)%	(23.28±0.00)%	(35.45±0.00)%	(26.10±0.00)%	(18.09±0.00)%	(17.03±0.00)%	(15.54±0.00)%

### Topo 25

Component	2011	2012a	2012b	2015	2016	2017	2018
$K_S^0$ (LL)							
$B_s^0$	(77.18±0.00)%	(80.04±0.00)%	(80.10±0.00)%	(74.67±0.00)%	(75.86±0.00)%	(78.16±0.00)%	(72.63±0.00)%
$B_d^0$	(8.27±0.00)%	(3.01±0.00)%	(5.19±0.00)%	(7.17±0.00)%	(8.76±0.00)%	(15.64±0.00)%	(8.54±0.00)%
Combinatorial	(14.55±0.00)%	(16.95±0.00)%	(14.71±0.00)%	(18.16±0.00)%	(15.38±0.00)%	(6.20±0.00)%	(18.83±0.00)%
$K_S^0$ (DD)							
$B_s^0$	(80.22±0.00)%	(81.25±0.00)%	(66.86±0.00)%	(58.22±0.00)%	(71.50±0.00)%	(73.82±0.00)%	(78.07±0.00)%
$B_d^0$	(5.20±0.00)%	(6.71±0.00)%	(8.01±0.00)%	(8.19±0.00)%	(9.61±0.00)%	(8.53±0.00)%	(7.54±0.00)%
Combinatorial	(14.57±0.00)%	(12.04±0.00)%	(25.13±0.00)%	(33.59±0.00)%	(18.88±0.00)%	(17.65±0.00)%	(14.39±0.00)%