

# Topological implementations: detailed comparisons

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# Project

- Systematically determine the differences between the November and February implementations of the topological trigger,
- Examine their effects on modes that interest me:
  - 1412 offline-selected secondary  $D^{*+} \rightarrow \pi_s^+ D^0(hh')$ ,
  - 1163 offline-selected prompt  $D^{*+} \rightarrow \pi_s^+ D^0(hh')$ ,
  - $50 \times 10^3$  L0-stripped minimum bias.
- Results here for the Online/Hlt2/TGA part of the topological trigger,
  - Still compiling number for the Offline/Hlt3/TGB,
  - Completed study to be presented at a later T-Rec.
- Carried out in DaVinci v21r0.

# Topological implementations

General differences between the November and February:

## November

Implemented in GaudiPython

Pion mass assumed for all final state candidates

Single mass window around  $B$  mass

Hlt3/TGB stage implemented on offline objects using offline calculators and tools

## February

Implemented in DaVinci/Hlt sequences and CombineParticles

Signatures with mixtures of pion and kaon mass

Two disjoint mass windows, the original  $B$  mass window and a second around the  $D$  mass

Hlt3/TGB stage implemented in HLT context with refit Hlt2 tracks, Hlt PVs, and a mixture of online and offline calculators and tools

# Method and summary

## Method:

- Create an implementation in CombineParticles/sequences that exactly reproduces the combinations of the November GaudiPython implementation,
- Identify all of the differences between the two CombineParticles implementations,
- Examine the effect of each difference independently based on the November-consistent implementation.

## Hlt2/TGA stage end-point comparison:

Sample	$N_{\text{HLT1}}$	Imp	2-body		3-body		4-body		Total	
			Ev	Cand	Ev	Cand	Ev	Cand	Ev	Cand
prompt $D^*$	141	Nov	1	1	47	127	74	1255	78	1383
		Feb	122	149	83	409	88	4317	130	4875
Secondary $D^*$	500	Nov	13	19	296	1598	393	12378	399	13995
		Feb	319	563	399	5993	436	46304	464	52860
Min bias	1921	Nov	10	11	227	1013	438	12289	457	13313
		Feb	159	261	638	10180	619	96739	766	107180

# Specific differences in Hlt2/TGA stage, I

- 1 Mass window variable
  - November: Measured mass
  - February: Combination mass, AM in CombinationCut
- 2 Best PV relator method
  - November: smallest IP
  - February: smallest IP  $\chi^2$ , the HLT context default for CombineParticles
- 3 CombineParticles BPV bug ([Savannah # 45964](#))
  - November: No bug, GaudiPython implementation not subject
  - February: Bug present. Fixed in most recent DaVinci version.
- 4 Mass windows
  - November:  $4 \text{ MeV} < M < 6 \text{ MeV}$
  - February:  $4 \text{ MeV} < M < 6 \text{ MeV}$  or  $1.7 \text{ MeV} < M < 2.1 \text{ MeV}$

# Specific differences in Hlt2/TGA stage, II

## 5 Decay signatures/descriptors for combinatorics

- 2-body

- November:  $\{\pi^+\pi^-, \pi^+\pi^+, \pi^-\pi^-\}$
- February:  $\{K^+\pi^-, K^+\pi^+, K^-\pi^-\}$

- 3-body

- November:  $\{\pi^+\pi^+\pi^+, \pi^+\pi^+\pi^-, \pi^+\pi^-\pi^-, \pi^-\pi^-\pi^-\}$
- February:  $\{K^+K^+\pi^+, K^+\pi^+K^-, \pi^+K^-K^-, K^-K^-\pi^-\}$

- 4-body

- November:  $\{4\pi^+, 3\pi^+\pi^-, 2\pi^+2\pi^-, \pi^+3\pi^-, 4\pi^-\}$
- February:  $\{K^+K^+\pi^+\pi^-, K^+\pi^+K^-\pi^-, K^+K^-\pi^-\pi^-\}$

Effect on Prompt  $D^*$ : Candidates

## Candidate-level differences

Implementation	2-body	3-body	4-body	Total
November-consistent	1	127	1255	1383
Nov + mass window variable AM	1	127	1255	1383
Nov + default PV relator	1	115	963	1079
Nov + BPV bug	1	131	1000	1132
Nov + $D$ mass window	101	320	1349	1770
Nov + signature change	2	290	5638	5930
Nov + $D$ mass win + sig change	151	427	5729	6307
February	149	409	4317	4875

Effect on Prompt  $D^*$ : Events

## Event-level differences

Implementation	2-body	3-body	4-body	Total
Passing HLT1				141
November-consistent	1	47	74	78
Nov + mass window variable AM	1	47	74	78
Nov + default PV relator	1	46	70	74
Nov + BPV bug	1	48	71	76
Nov + $D$ mass window	90	105	79	126
Nov + signature change	1	66	89	95
Nov + $D$ mass win + sig change	123	84	89	130
February	122	83	88	130



Effect on Secondary  $D^*$ : Candidates

## Candidate-level differences

Implementation	2-body	3-body	4-body	Total
November-consistent	19	1598	12378	13995
Nov + mass window variable AM	19	1598	12379	13996
Nov + default PV relator	18	1416	10415	11849
Nov + BPV bug	18	1472	11629	13119
Nov + $D$ mass window	311	2743	15018	18072
Nov + signature change	37	3712	45213	48962
Nov + $D$ mass win + sig change	569	6337	51671	58577
February	563	5993	46304	52860

Effect on Secondary  $D^*$ : Events

## Event-level differences

Implementation	2-body	3-body	4-body	Total
Passing HLT1				500
November-consistent	13	296	393	399
Nov + mass window variable AM	13	296	393	399
Nov + default PV relator	12	284	386	392
Nov + BPV bug	12	285	387	394
Nov + $D$ mass window	233	419	417	459
Nov + signature change	19	342	429	438
Nov + $D$ mass win + sig change	324	406	439	465
February	319	399	436	464

# Effect on Minimum bias: Candidates

## Candidate-level differences

Implementation	2-body	3-body	4-body	Total
November-consistent	11	1013	12289	13313
Nov + mass window variable AM	11	1013	12281	13305
Nov + default PV relator	8	825	9800	10633
Nov + BPV bug	8	930	12437	13375
Nov + $D$ mass window	99	2276	19743	22118
Nov + signature change	25	2713	44075	46813
February	261	10180	96739	107180

# Effect on Minimum bias: Events

## Event-level differences

Implementation	2-body	3-body	4-body	Total
Passing HLT1				1921
November-consistent	10	227	438	457
Nov + mass window variable AM	10	227	438	457
Nov + default PV relator	7	180	355	370
Nov + BPV bug	7	193	371	390
Nov + $D$ mass window	86	482	588	686
Nov + signature change	16	308	530	559
February	159	638	619	766

# Intermediate comments

- For the Online/Hlt2/TGA stage, the main differences come from manipulations of the windows and signatures
  - For  $D^*$  selections, this is a clear benefit for efficiency
- Work at this detail. . .
  - Reveals bugs: [#45964](#), [#47362](#) (which should have been found before i stumbled onto them),
  - Gives a more complete understanding of contextual defaults and relations among parts.
- Not the final word; the topological trigger is still in development,
- The differences in the Offline/Hlt3/TGB stage will be tabulated soon.