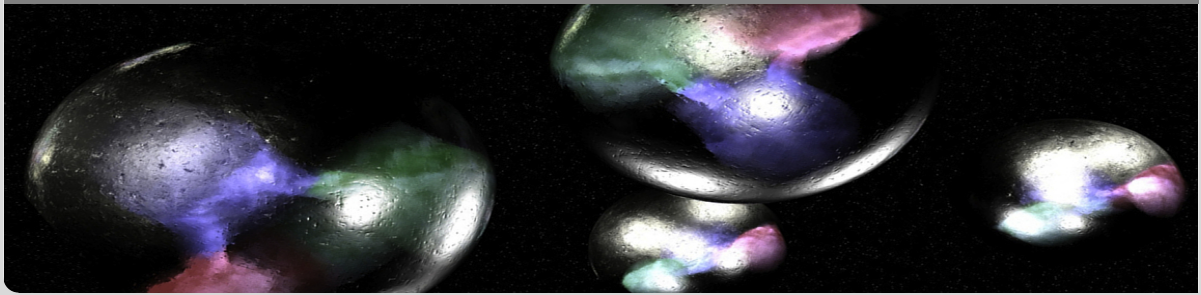
Some More Quality Estimator Studies

Tracking Meeting

Felix Metzner | 3rd August 2018

INSTITUT FÜR EXPERIMENTELLE TEILCHENPHYSIK (ETP)



Bug Fix in Triplet Fit Quality Estimator

Sebastian discovered a **bug** in the **Triplet Fit** code.
The respective code calculates the material budget of the sensors considered in the fit.
For this calculation an estimate of the entrance angle of the particle trajectory is used.
This was done incorrectly in the past. (And still is. . .)

Before a fix of the bug is pushed, several points have to be considered:

- Retuning the hyper parameters of the **Triplet Fit**
- Evaluate performance of fixed **Triplet Fit Quality Estimator**
- Evaluate performance of **MVA QE** after retraining with fix.

Bonus: Study of **MVA QE** trained on **new target**.

Setup

Working on Master from 11th of July
Commit hash: ab1cb0c0c969ad0c25bb524f03d7253e557acb1c

For the evaluation 10 k $\Upsilon(4S)$ events with background overlay have been used.

Fresh MVA QE trainings were done with an independent sample of 20 k events.

Triplet Fit QE Performance after Fix

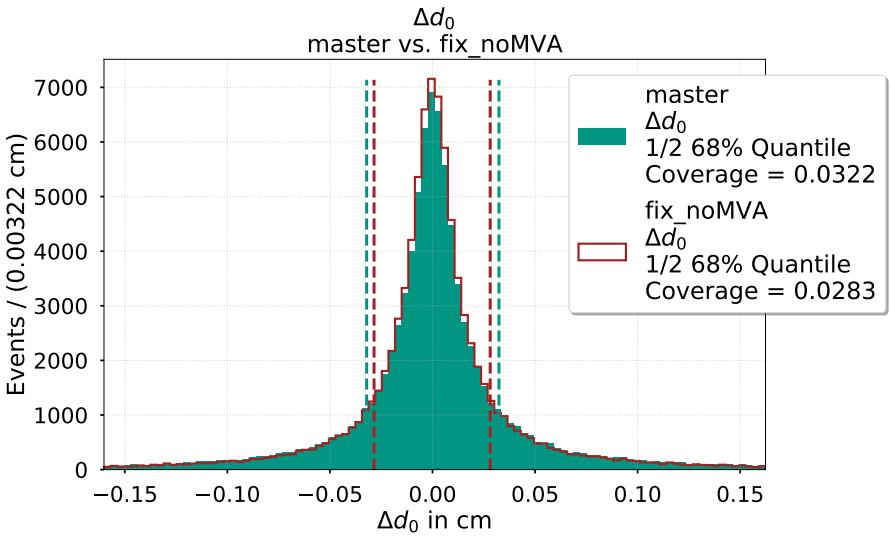
Figures of Merit

Values in %	Master	Master w/o MVA	Fixed w/o MVA
Finding Eff. (Prim)	96.64	95.76	96.25
Finding Eff.	93.94	93.00	93.49
Fake Rate	5.62	6.02	5.65
Clone Rate	2.13	2.10	2.06
Hit Eff. (Prim)	88.53	94.96	95.74
Hit Eff.	87.81	94.27	95.06
Hit Purity (Prim)	99.24	98.71	98.97
Hit Purity	99.03	98.54	98.81

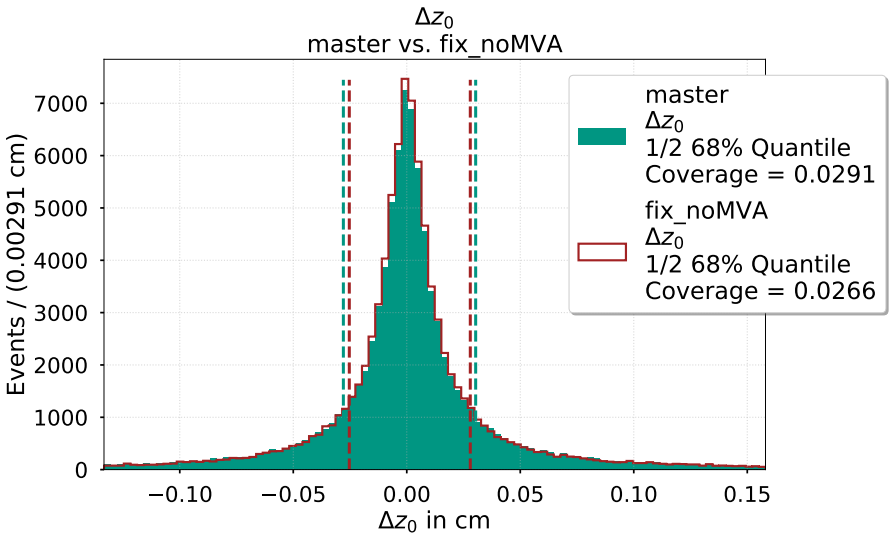
Helix Parameter Resolution

	Master	Master w/o MVA	Fixed w/o MVA
Δd_0 (μm)	322.5	285.7	283.1
Δz_0 (μm)	291.4	269.1	266.5
$\Delta\omega$ (1/cm) $\cdot 10^3$	1.13	1.08	1.08
$\Delta \tan(\lambda) \cdot 10^3$	9.74	9.49	9.47
$\Delta\phi_0 \cdot 10^3$	11.2	10.6	10.5
Δp_t (MeV)	27.7	26.5	26.2

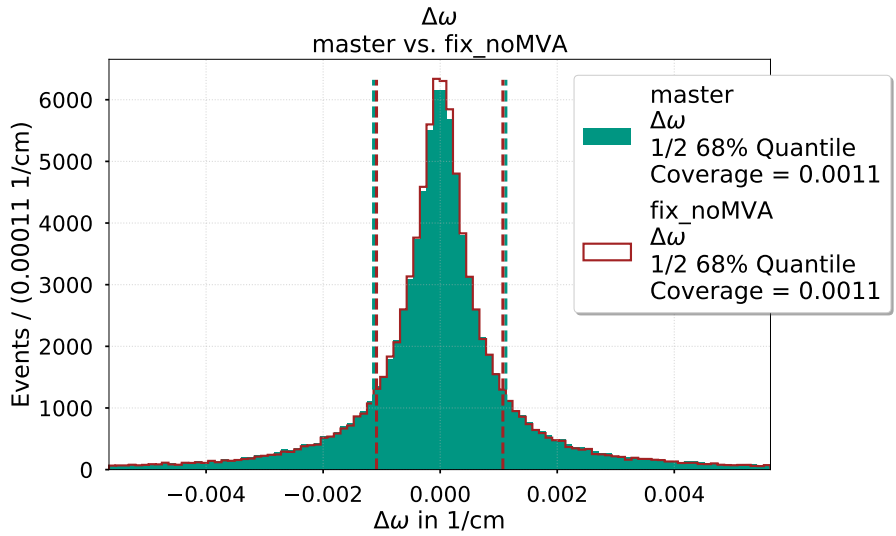
Triplet Fit QE Performance after Fix



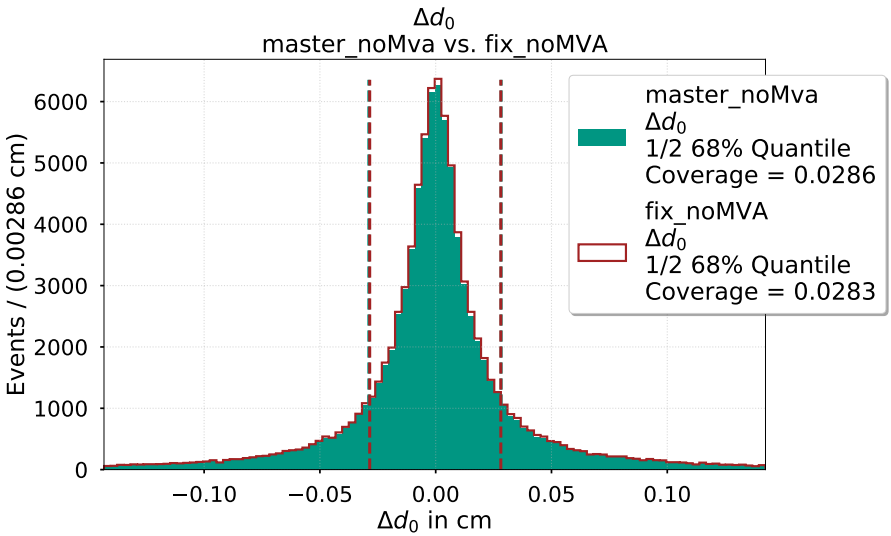
Triplet Fit QE Performance after Fix



Triplet Fit QE Performance after Fix



Triplet Fit QE Performance after Fix



MVA QE Performance after Fix

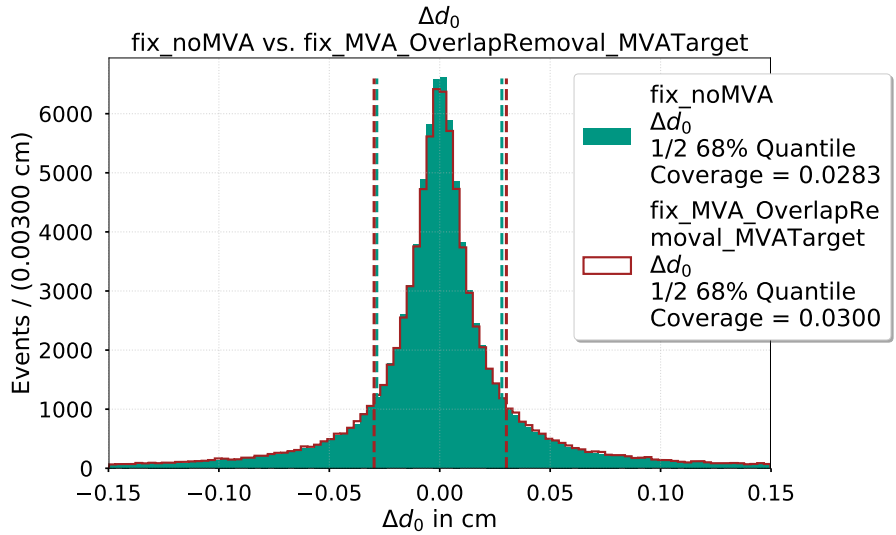
Figures of Merit

Values in %	Master w/ MVA	Fixed w/ MVA	Fixed w/o MVA
Finding Eff. (Prim)	96.64	96.82	96.25
Finding Eff.	93.94	94.13	93.49
Fake Rate	5.62	5.51	5.65
Clone Rate	2.13	2.13	2.06
Hit Eff. (Prim)	88.53	86.94	95.74
Hit Eff.	87.81	86.23	95.06
Hit Purity (Prim)	99.24	99.26	98.97
Hit Purity	99.03	99.04	98.81

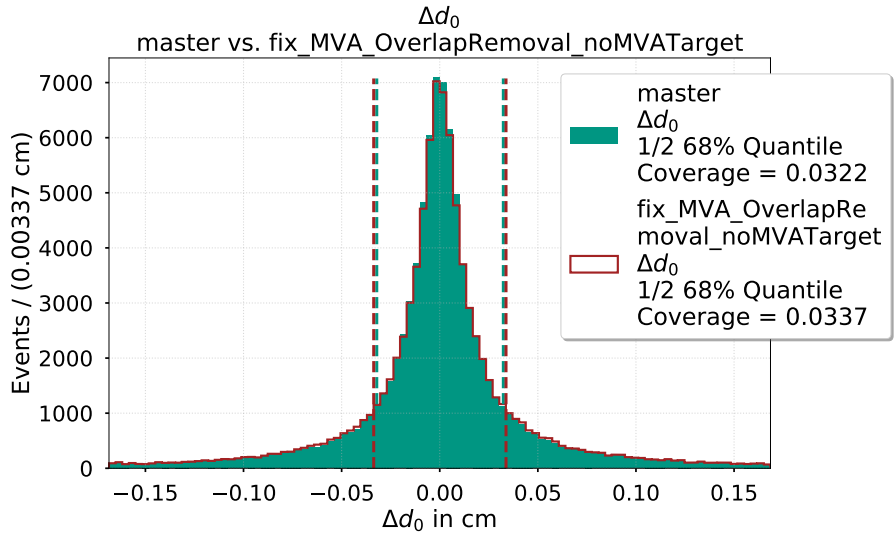
Helix Parameter Resolution

	Master w/ MVA	Fixed w/ MVA	Fixed w/o MVA
Δd_0 (μm)	322.5	337.1	283.1
Δz_0 (μm)	291.4	300.8	266.5
$\Delta\omega$ (1/cm) $\cdot 10^3$	1.13	1.15	1.08
$\Delta \tan(\lambda) \cdot 10^3$	9.74	9.82	9.47
$\Delta\phi_0 \cdot 10^3$	11.2	11.4	10.5
Δp_t (MeV)	27.7	28.2	26.2

MVA QE Performance after Fix



MVA QE Performance after Fix



New MVA QE Training Target

The MVA Quality Estimator with the fixed Triplet Fit was also trained using a new target:

Old Target

A pattern recognition (PR) Track for which all picked up hits are matched to an MC Track has a truth target value of 1.
If it contains hits, which are not matched to a MC Track it has a truth target value of 0.
But: A PR Track does not need to have all hits of the matched MC Track to get the truth target value of 1!

New Target

A PR Track must have **all hits** of the matched MC Track to receive a truth target value of 1.
It is 0 otherwise. $\Rightarrow$ High Hit Purity **and** high Hit Efficiency!

MVA QE Performance with New Training Target

Figures of Merit

Values in %	Fixed old MVA	Fixed new MVA	Fixed w/o MVA
Finding Eff. (Prim)	96.82	95.76	96.25
Finding Eff.	94.13	93.00	93.49
Fake Rate	5.51	6.02	5.65
Clone Rate	2.13	2.10	2.06
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Helix Parameter Resolution

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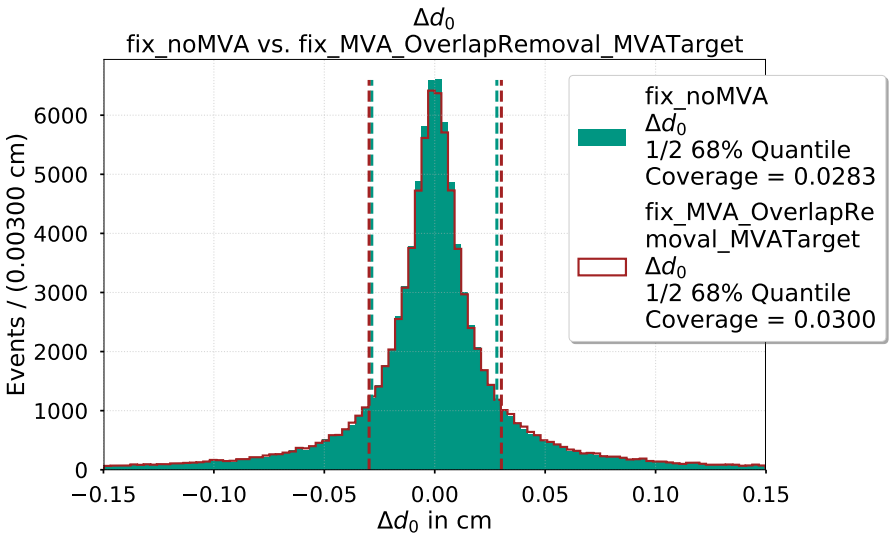
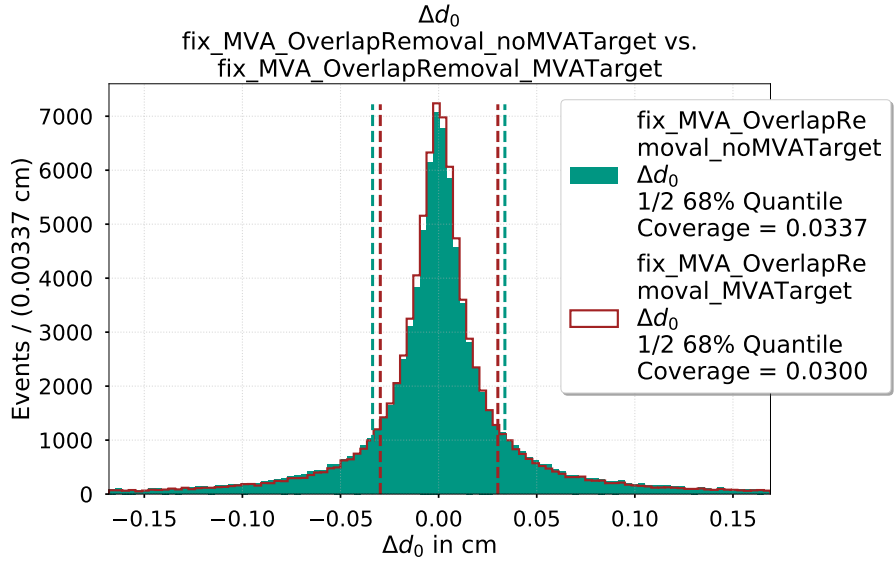
$\Delta\omega$ (1/cm) $\cdot 10^3$	1.15	1.12	1.08
$\Delta \tan(\lambda) \cdot 10^3$	9.82	9.58	9.47
$\Delta\phi_0 \cdot 10^3$	11.4	10.9	10.5
Δp_t (MeV)	28.2	27.0	26.2

MVA QE Performance with New Training Target



MVA QE Performance with New Training Target



Summary

- Fixed Triplet Fit Quality Estimator produces better results.
- MVA QE still yields best FoMs, but worse resolution.
- MVA QE trained with new target promises to produce higher Hit Efficiency but also shows slightly worse Finding Efficiency $\Rightarrow$ still a trade-off...
- Fixed Triplet Fit QE produces best resolution.

- I would suggest to use fixed Triplet Fit QE for now.
- New weight files should still be available in basf2.
- Some more improvements (using tuned Hopfield Network, tune FastBDT hyper parameters, study best training sample...) could give us the desired MVA QE that would overcome its current faults...