ARCADIA FNAL meeting

17-10-24

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TB analysis: status

What's new

Efficiency

- Implementation on spatial check for efficiency calculation
- Study of efficiency as function of time window used for coincidences
- Study of efficiency as function of fiducial distance of hit on det1 respect to expected hit
- Study of efficiency vs VCASN

Efficiency

**after alignment some row or col values are shifted outside the sensor area*

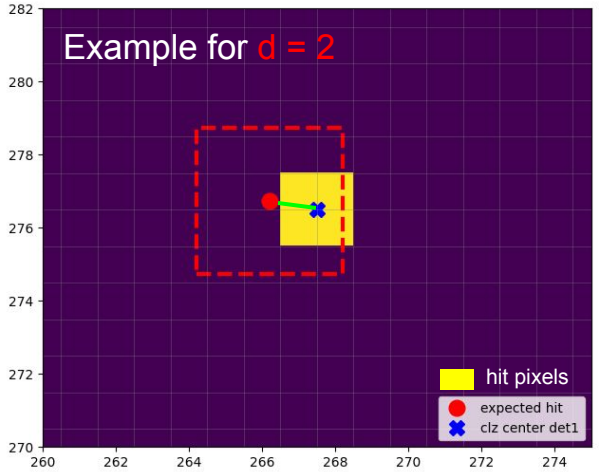
New algorithm

1. With tracks from previous tracking algorithm (one cluster on all planes), perform alignment and tilt correction
2. Cut events out of sensor area [0,512] *
3. Select events in time coincidence with time window (tw) between external planes 0,2
4. Look for clusters on plane 1 in same time window (tw) applying spatial cut:

abs (cluster center - expected hit) < **d [pixel]**

(squared fiducial area around the expected hit on det1)

NOTE: If there is more than one cluster on plane 1,
select the closest to the expected hit.



5. Compute efficiency as

$$efficiency = \frac{\#\ complete\ coincidences\ 0,1,2}{\#\ complete\ coincidences\ 0,1,2 + \#\ incomplete\ coincidences\ 0,2}$$

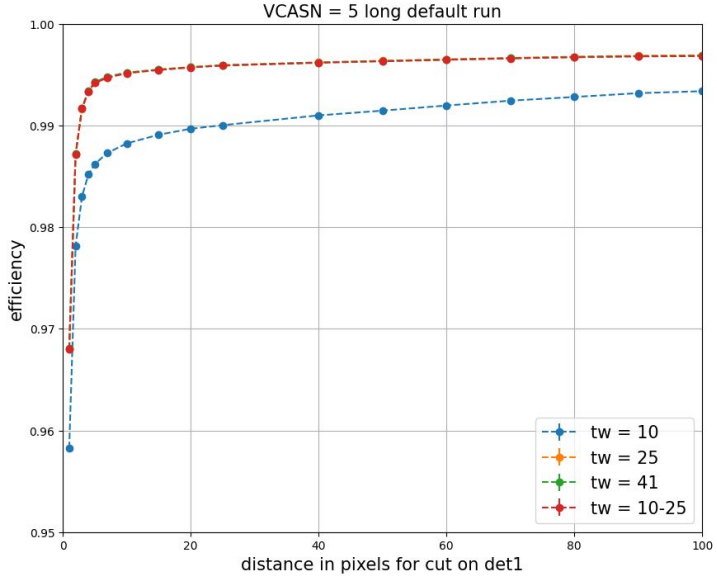
Part 1 of the analysis:

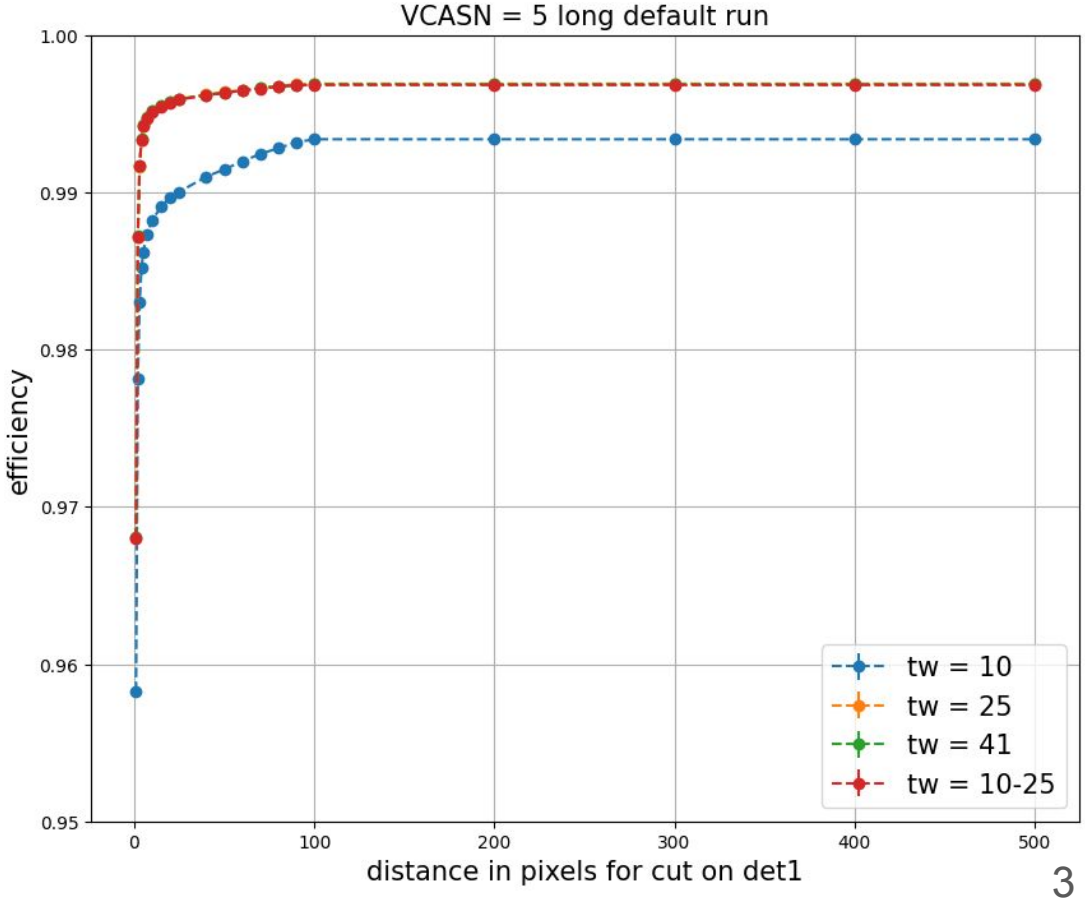
Find the right time window to make coincidences

Study of efficiency as function of different tw and spatial thresholds on det1 hits

Efficiency: study of efficiency as function of spatial threshold on det1 hit and coincidences tw

tracking with different tw, varying pixel distance for cut on DUT



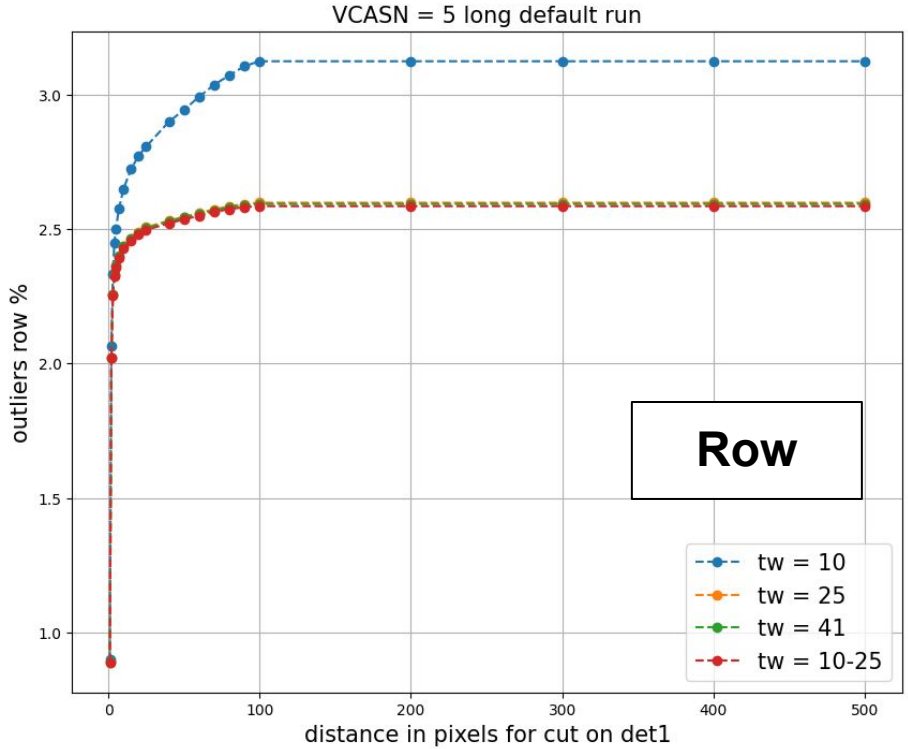


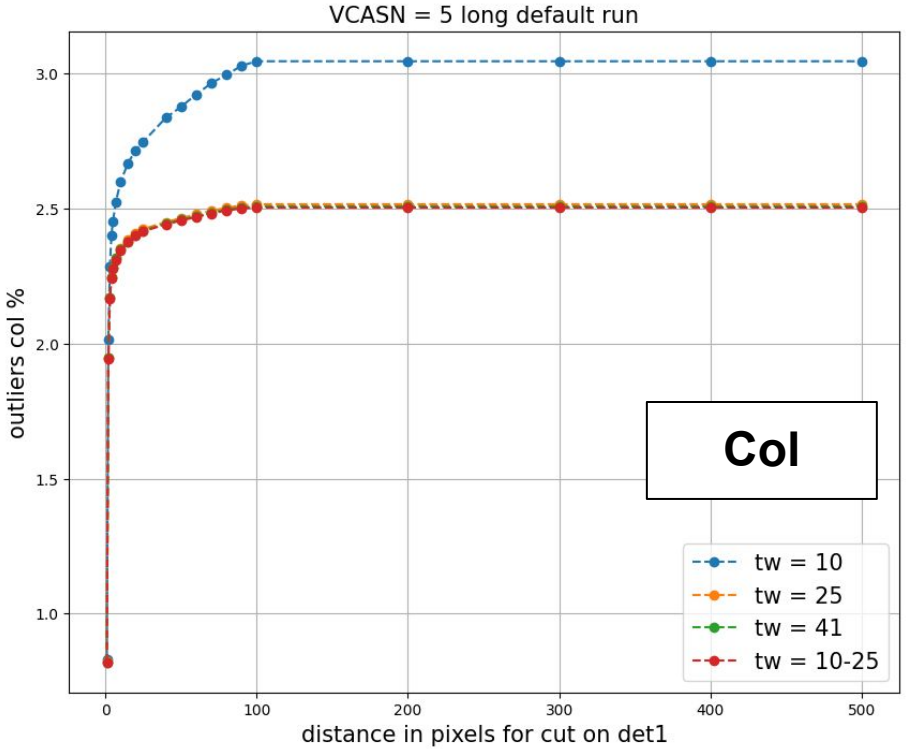
Efficiency calculated for different tw used to make coincidences (expressed in timestamps)

- tw = 10 ts → [-2 ; 2] us
- tw = 25 ts → [-5 ; 5] us
- tw = 41 ts → [-8.2 ; 8.2] us
- tw = -10/+25 ts → [-2 ; 5] us

Efficiency: study of efficiency as function of spatial threshold on det1 hit and coincidences tw

Outliers on row and col for different tw and spatial threshold



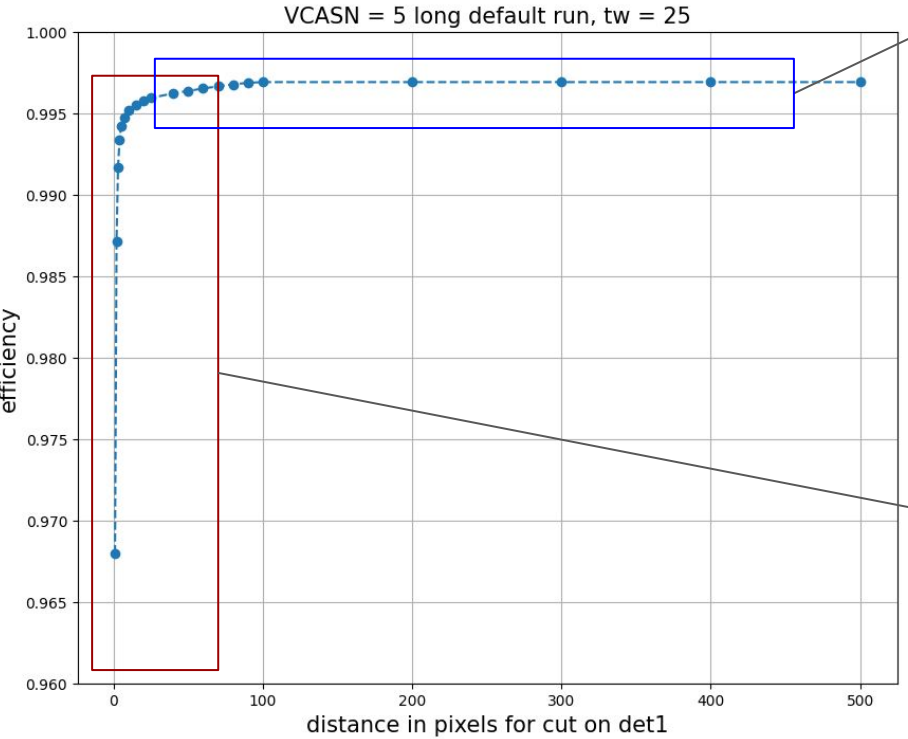


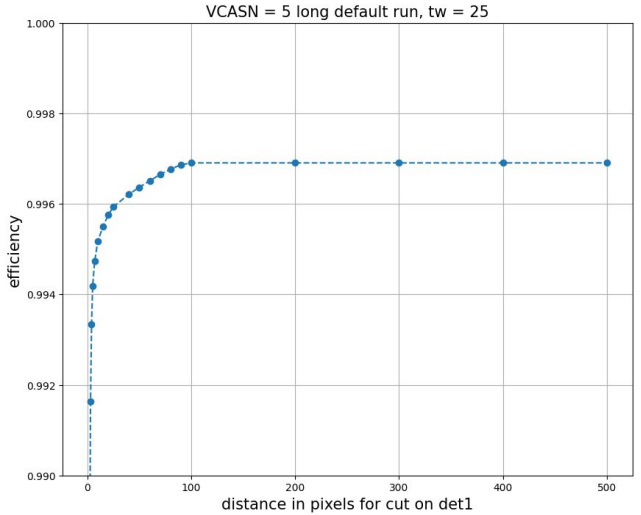
- Outliers grows with spatial threshold → if spatial thr. increases we include events with big residuals and so residual histos tails grow.
- Outliers grows as tw decreases → if the tw is too short coincidences could be split

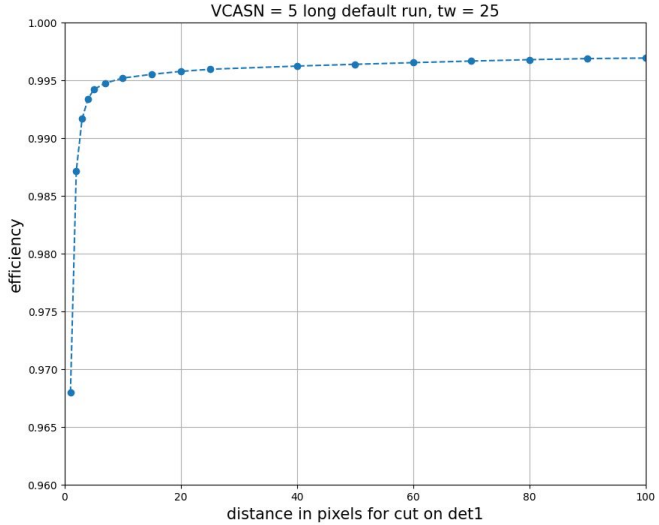
Efficiency: spatial cut study VCASN = 5

tracking with tw = 25 ts (symmetric window)
varying pixel distance for cut on DUT

with cut = 3 pixels, efficiency = 0.99164
with cut = 5 pixels, efficiency = 0.99418
with cut = 50 pixels, efficiency = 0.99637







From analysis of part 1:

TW = 25, TW = 41 and TW = -10/+25 are very similar in terms of efficiency and outliers%, much better than TW = 10.

<u>For now we use TW = 25 (~ 5 us)</u>

↓

Part 2 of the analysis:

Find the right spatial threshold using coincidences with tw = 25

↓

Study of efficiency as function of spatial threshold of det1 hit looking at:

- Outliers
- Resolutions

TW = 25

Efficiency: Study of spatial threshold on det1 hit @ TW = 25

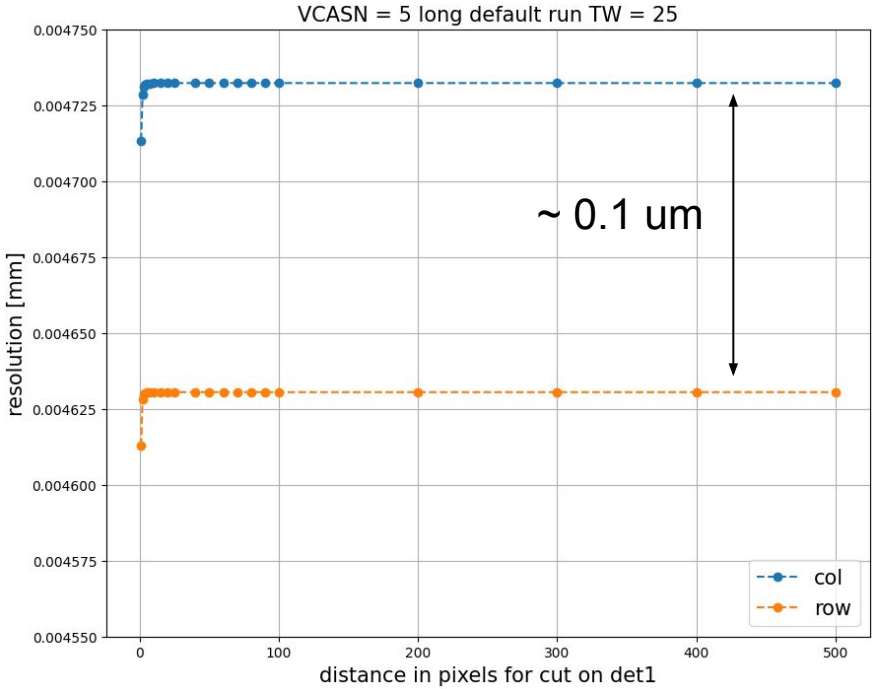
resolution vs spatial cut

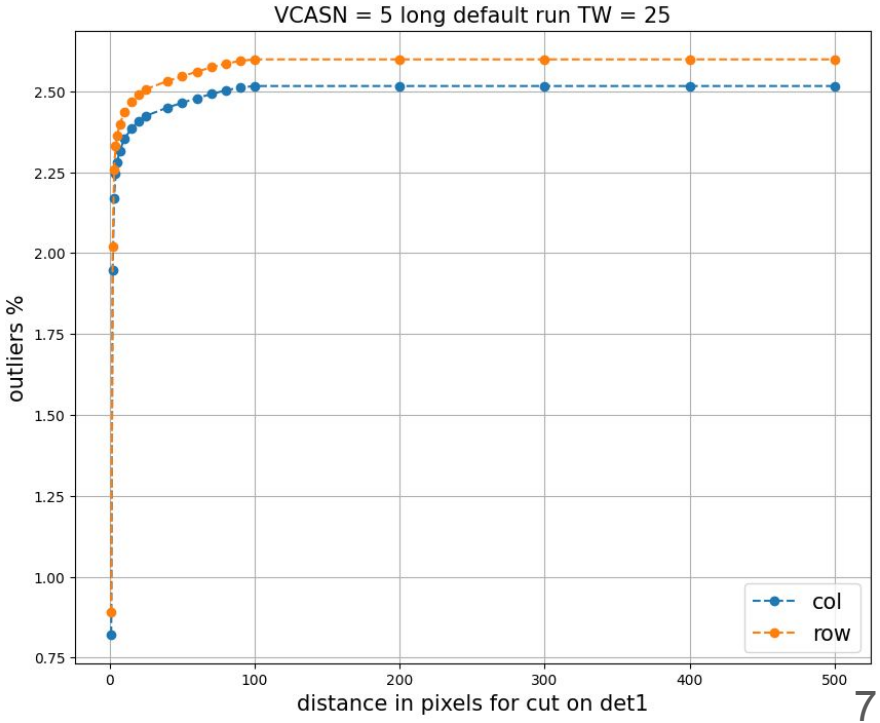
outliers vs spatial cut

spatial threshold analysed
d = 1, 2, 3, 4, 5, 7, 10, 15, 20, 25, 40, 50, 60, 70, 80, 90 100, 200, 300, 400, 500

with cut = 3 pixels → eff = 99,16% → outliers = 2.26% row - 2.17% col

→ resolution = 4.630 um row - 4.731 um col





Efficiency: Study of spatial threshold on det1 hit @ TW = 25

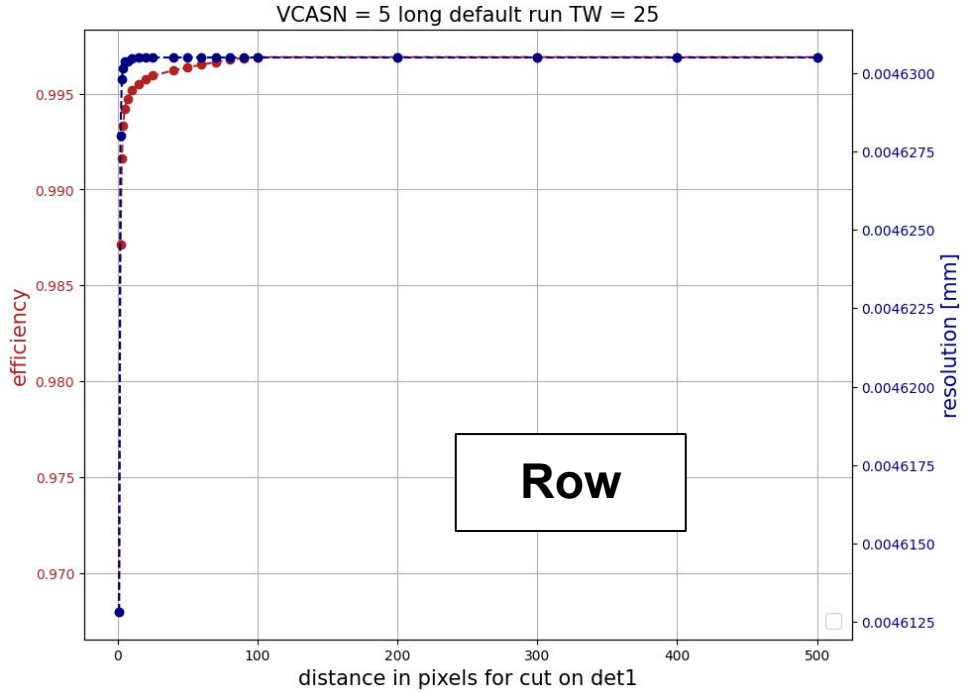
efficiency + resolution Row vs spatial cut

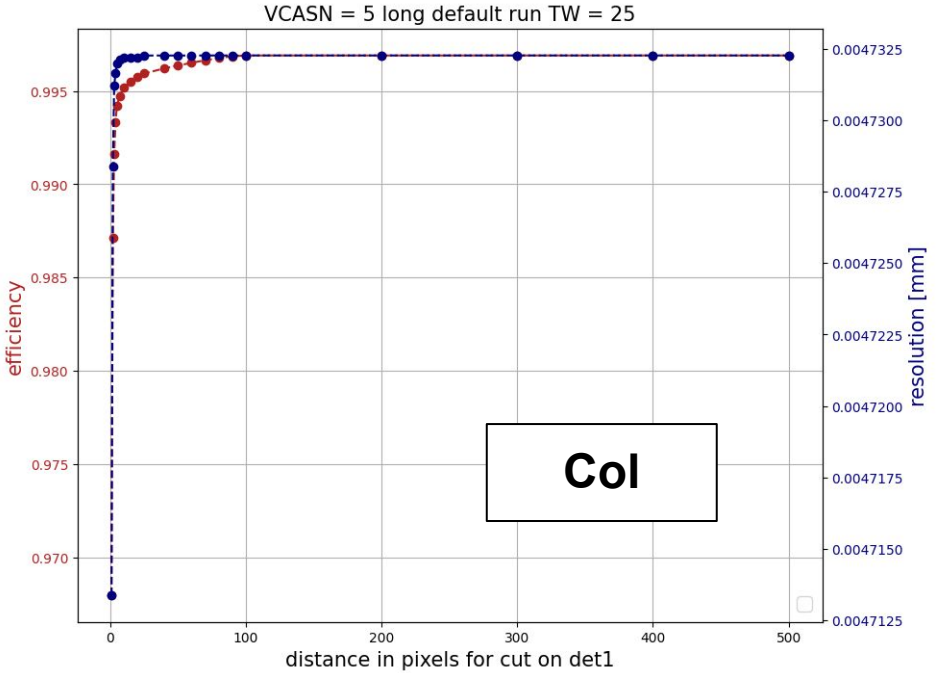
efficiency + resolution Col vs spatial cut

spatial threshold analysed
d = 1, 2, 3, 4, 5, 7, 10, 15, 20, 25, 40, 50, 60, 70, 80, 90 100, 200, 300, 400, 500

with cut = 3 pixels → eff = 99,16% → outliers = 2.26% row - 2.17% col

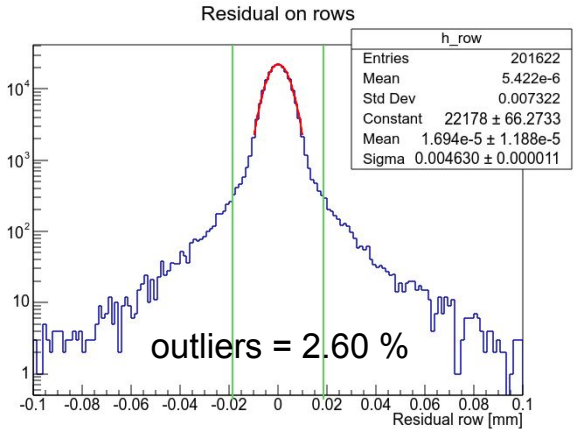
→ resolution = 4.630 um row - 4.731 um col

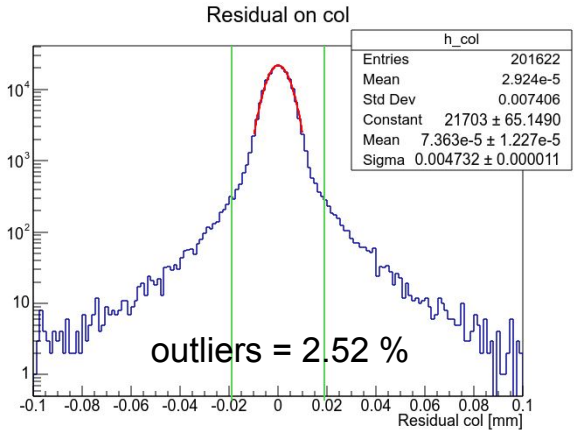




Residual comparison: with and without spatial cut

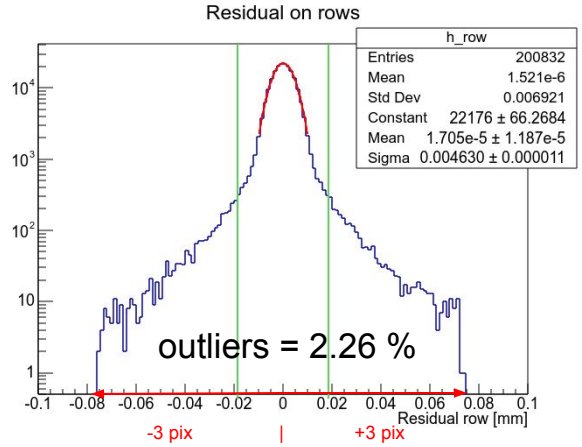
TW = 25, **no spatial cut**

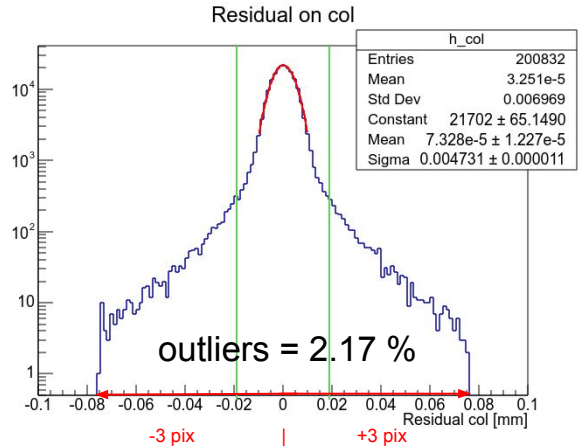




% of outliers decreases

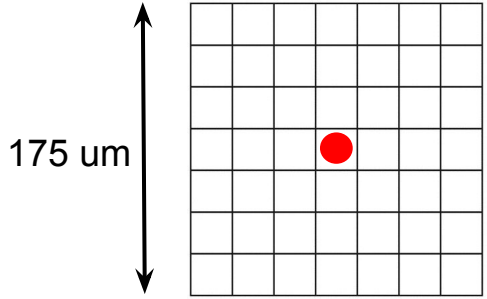
TW = 25, **spatial cut d = 3**





Study on efficiency parameters: tw - spatial cut
Recap

d = 3 means considering a matrix 7x7 around expected hit

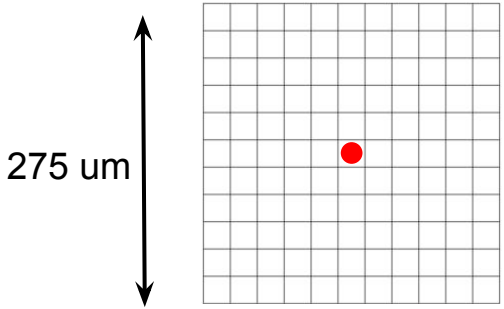


	TW = 10 , d = 3	**TW = 25** , d = 3	TW = 41, d = 3	TW = -10/+25, d = 3
efficiency	98.30%	99.16%	99.17%	99.17%
outliers row	2.33%	2.26%	2.26%	2.25%
outliers col	2.28%	2.17%	2.17%	2.17%
sigma row (resolution) [um]	4.625	4.630	4.630	4.630
sigma col (resolution) [um]	4.707	4.731	4.732	4.731

TW = time window in which look for coincidences (timestamps)
d = spatial cut on det1 hits (pixel)

Study on efficiency parameters: tw - spatial cut
Recap

d = 5 means considering a matrix 11x11 around expected hit



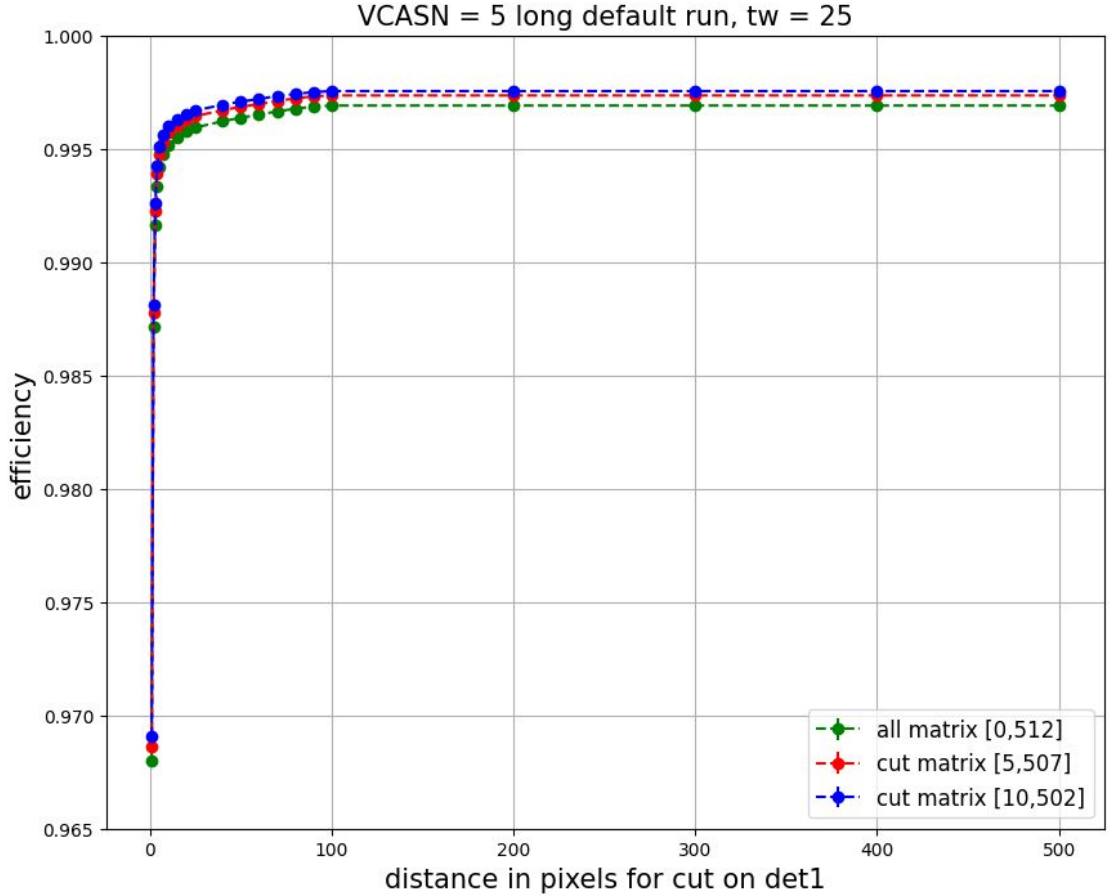
	TW = 10 , d = 5	**TW = 25** , d = 5	TW = 41, d = 5	TW = -10/+25, d = 5
efficiency	98.62%	99.42%	99.43%	99.42%
outliers row	2.50%	2.36%	2.36%	2.36%
outliers col	2.45%	2.28%	2.28%	2.28%
sigma row (resolution) [um]	4.626	4.630	4.631	4.630
sigma col (resolution) [um]	4.707	4.732	4.733	4.732

TW = time window in which look for coincidences (timestamps)
d = spatial cut on det1 hits (pixel)

Efficiency: Study of spatial threshold on det1 hit @ TW = 25

Efficiency with and without borders hits

spatial threshold analysed
d = 1, 2, 3, 4, 5, 7, 10, 15, 20, 25, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500



d = 3

no cut → efficiency = 0.9916

cut [5,507] → efficiency = 0.9922

cut [10,502] → efficiency = 0.9926

d = 5

no cut → efficiency = 0.9942

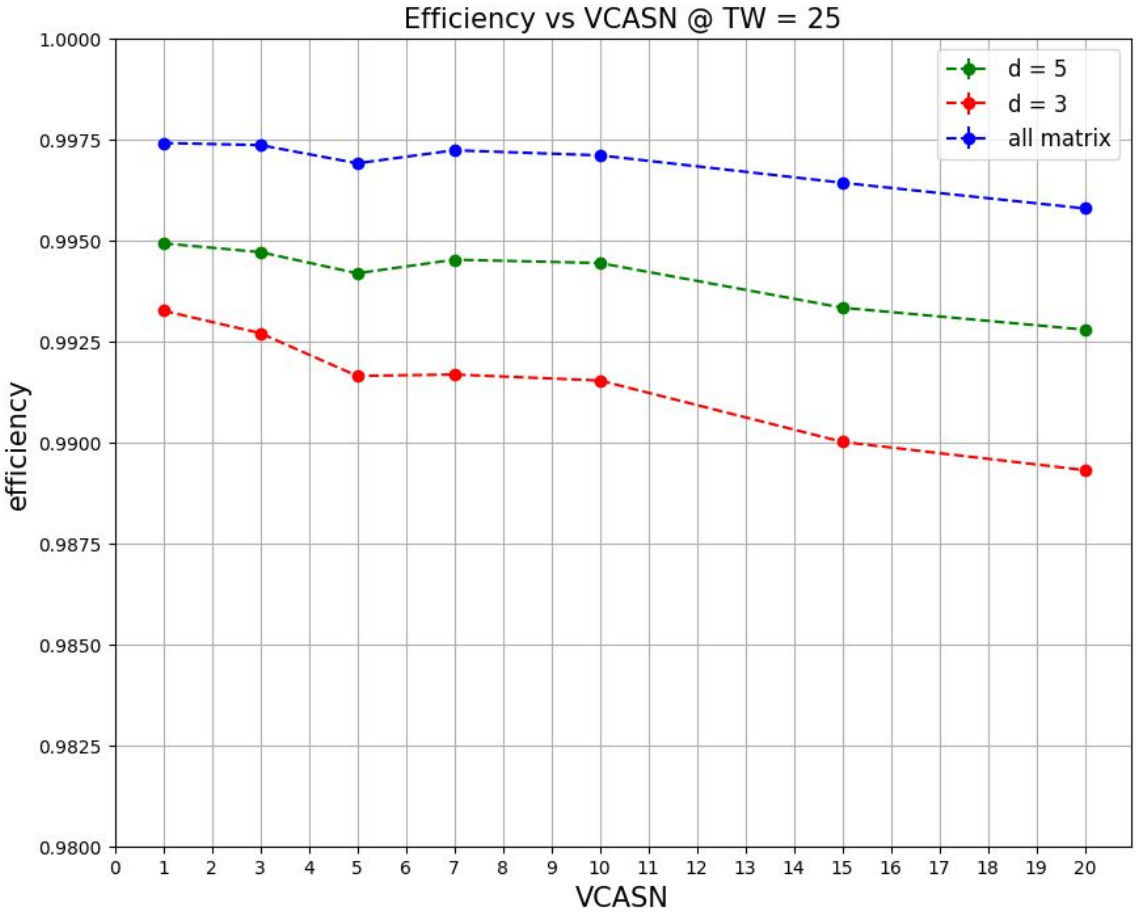
cut [5,507] → efficiency = 0.9947

cut [10,502] → efficiency = 0.9951

From analysis of part 1:
TW = 25, TW = 41 and TW = -10/+25 are very similar in terms of efficiency and outliers%, much better than TW = 10.
For now we use TW = 25 (~ 5 us)

From analysis of part 2:
Still considering d = 3 or d = 5 as best cut

Efficiency vs threshold (VCASN) scan on det1 @ TW = 25 + d = 5



d = spatial cut on det1 hits (pixel)

d = 5 → 11x11 matrix
d = 3 → 7x7 matrix

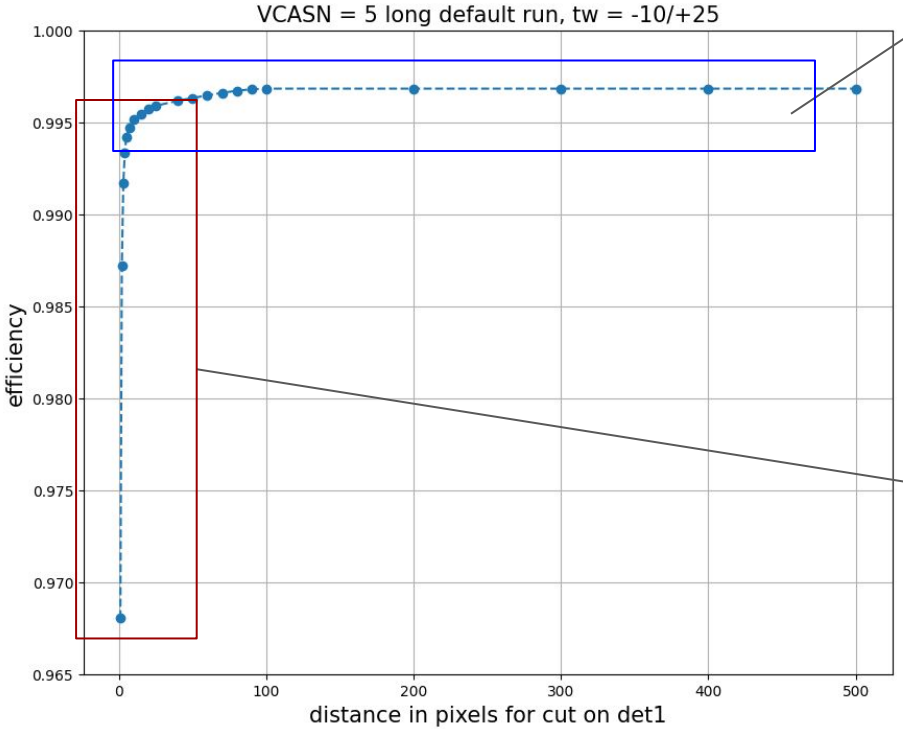
Still investigating on efficiency vs VCASN trend

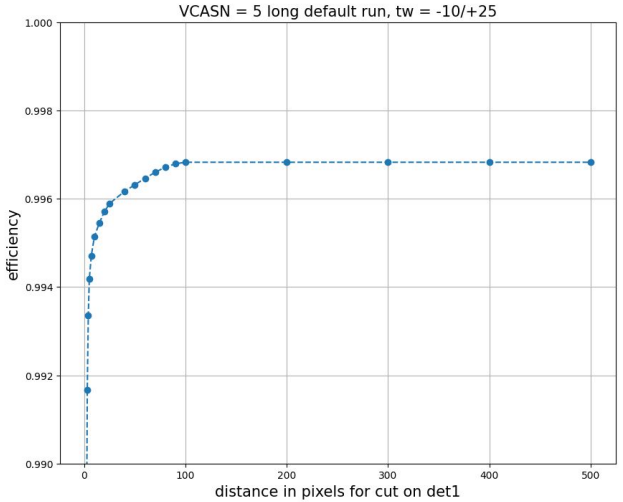
BACKUP

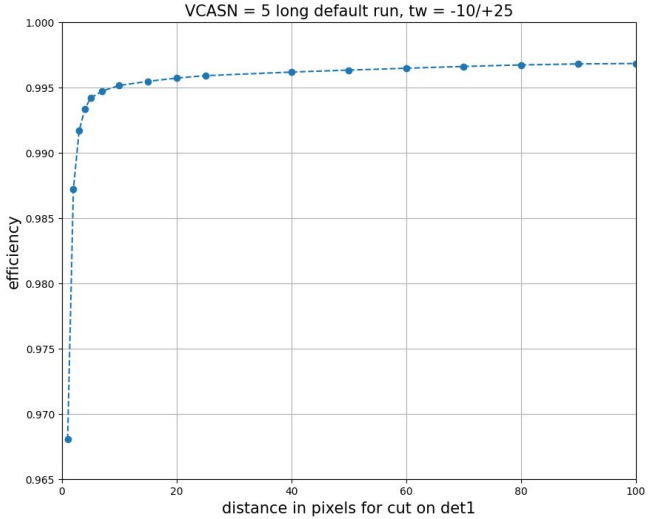
Efficiency: spatial cut study VCASN = 5

tracking with tw = [-10, 25] ts (asymmetric window)
varying pixel distance for cut on DUT

with cut = 3 pixels, efficiency = 0.99166
with cut = 5 pixels, efficiency = 0.99418
with cut = 50 pixels, efficiency = 0.99632



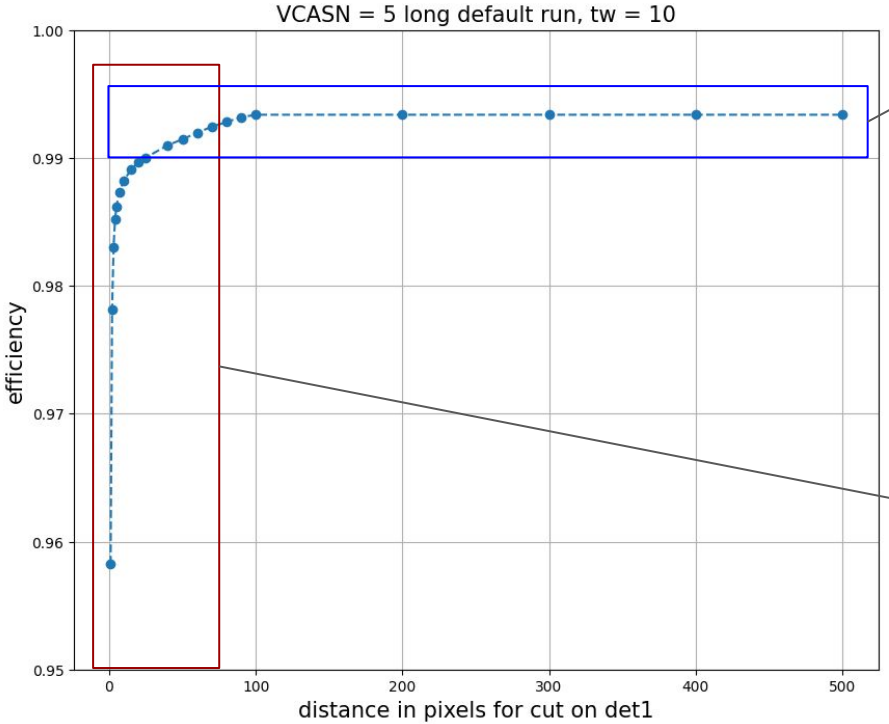


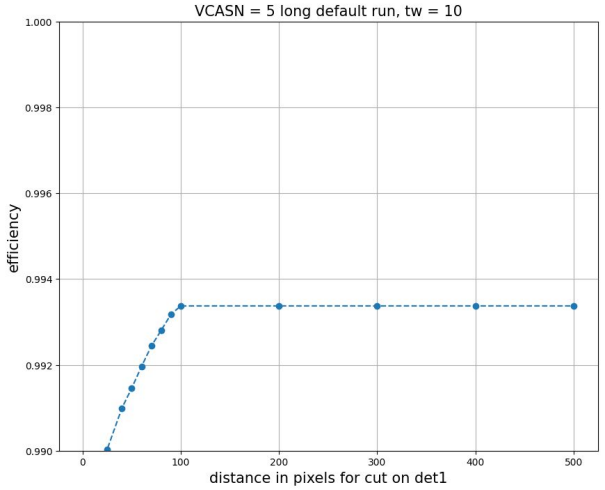


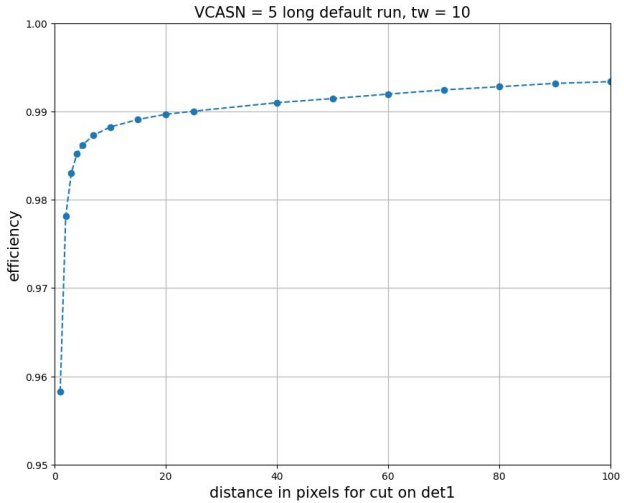
Efficiency: spatial cut study VCASN = 5

tracking with tw = 10 ts (symmetric window)
varying pixel distance for cut on DUT

with cut = 3 pixels, efficiency = 0.9830
with cut = 5 pixels, efficiency = 0.9862
with cut = 50 pixels, efficiency = 0.9915



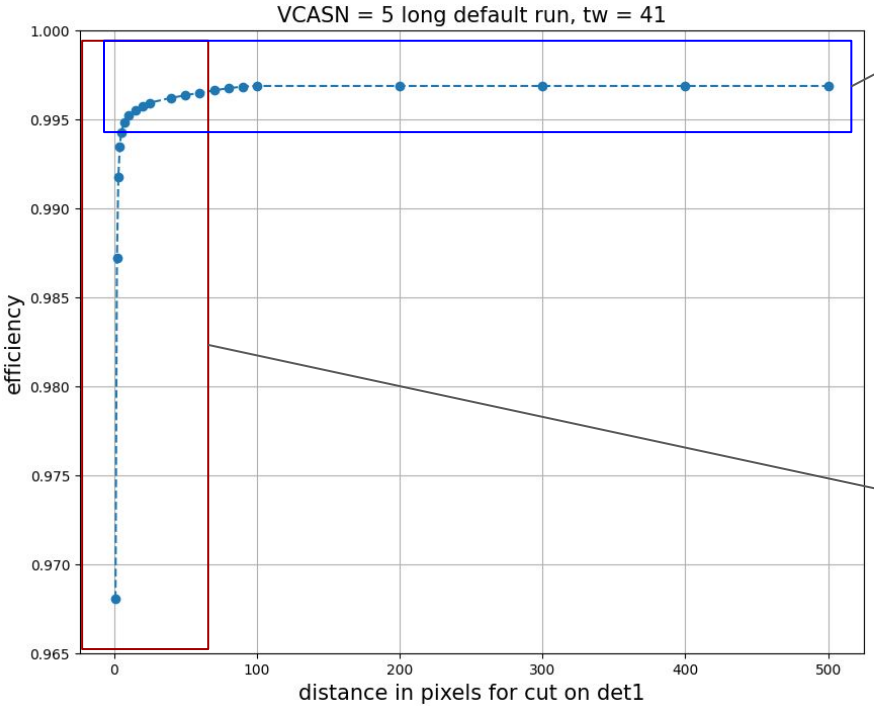


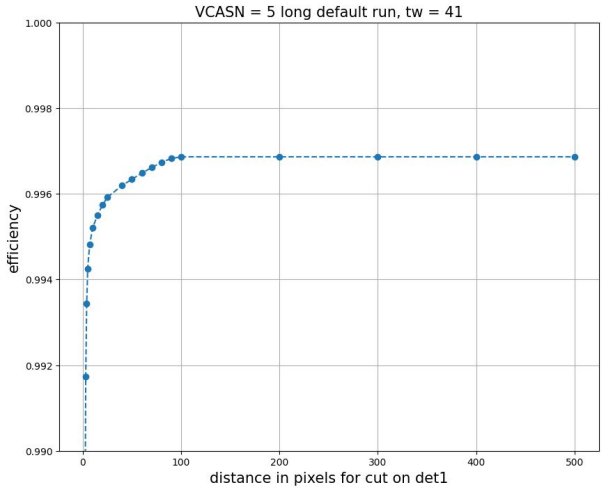


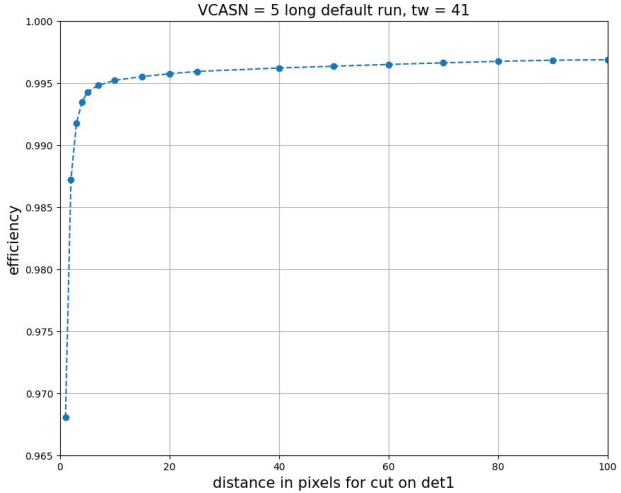
Efficiency: spatial cut study VCASN = 5

tracking with tw = 41 ts (symmetric window)
varying pixel distance for cut on DUT

with cut = 3 pixels, efficiency = 0.9917
with cut = 5 pixels, efficiency = 0.9943
with cut = 50 pixels, efficiency = 0.9963







Cut coincidences with expected position on det1 outside confidential area

→ **step 0**: align det2 using results from correlation plot (showed in previous presentation)
→ **step 1**: 3D line using position on external planes
→ **step 2**: make residuals and use mean of gaussian fit to align det1 (*1st time*)
→ **step 3**: plot resRow vs Col and resCol vs Ros to extract tilt angle
→ **step 4**: correct for tilting angle
→ **step 5**: make residuals and use mean of gaussian fit to align det1 (*2nd time*)
→ **step 6**: cut events out of sensor area [0,512] *
→ **step 7**: find coincidences within spatial cut on det1
→ **step 8**: calculate efficiency

**after alignment some rowCenterAlign or colCenterAlign values are shifted outside the sensor area*

Study on efficiency parameters: tw - spatial cut Recap

Long default run VCASN = 5

pixel distance	tw = 10	tw = 25	tw = 41	tw = -10/+25
d = 3	eff = 0.9830 outliers row = 2.33% outliers col = 2.28%	eff = 0.9916 outliers row = 2.26% outliers col = 2.17%	eff = 0.9917 outliers row = 2.26% outliers col = 2.17%	eff = 0.9917 outliers row = 2.25% outliers col = 2.17%
d = 5	eff = 0.9862 outliers row = 2.50% outliers col = 2.45%	eff = 0.9942 outliers row = 2.36% outliers col = 2.28%	eff = 0.9943 outliers row = 2.36% outliers col = 2.28%	eff = 0.9942 outliers row = 2.36% outliers col = 2.28%
d = 20	eff = 0.9897 outliers row = 2.77% outliers col = 2.72%	eff = 0.9958 outliers row = 2.49% outliers col = 2.41%	eff = 0.9957 outliers row = 2.49% outliers col = 2.40%	eff = 0.9957 outliers row = 2.48% outliers col = 2.40%
d = 50	eff = 0.9915 outliers row = 2.94% outliers col = 2.88%	eff = 0.9964 outliers row = 2.55% outliers col = 2.46%	eff = 0.9963 outliers row = 2.54% outliers col = 2.46%	eff = 0.9963 outliers row = 2.54% outliers col = 2.46%
d = 100	eff = 0.9934 outliers row = 3.12% outliers col = 3.05%	eff = 0.9969 outliers row = 2.60% outliers col = 2.52%	eff = 0.9969 outliers row = 2.59% outliers col = 2.51%	eff = 0.9968 outliers row = 2.59% outliers col = 2.50%