HLT based ROIs Tests

Simulation of the PXD Data Reduction Chain

Giulia Casarosa

INFN - Sezione di Pisa

Face2Face Tracking Meeting

Pisa, 29th ~ 30th September 2014

Simulation of the PXD Data Reduction Chain

```
# Add modules to paths
main.add_module(eventinfosetter)
main.add_module(eventinfoprinter)
main.add_module(evtgeninput)
add_simulation(main)
#main.add_module(track_finder_mc_truth)
main.add_module(vxd_trackfinder_pre)
#main.add_module(matcher)
main.add_module(pxdDataRed)
#main.add_module(pxdDataRedAnalysis)
main.add_module(pxd_digifilter)
main.add_module(pxd_clusterizer_post)
main.add_module(vxd_trackfinder_post)
```

```
# VXD TF (SVD) before PXD Data Reduction (pre ROI)
vxd_trackfinder_pre = register_module('VXDTF')
vxd_trackfinder_pre.param('GFTrackCandidatesColName', 'vxdtftracks_pre')
vxd_trackfinder_pre.param('TESTERexpandedTestingRoutines',False)
# settings from VXDTFModuleDemo.py (check)
vxd_trackfinder_pre.param('sectorSetup', ['secMapEvtGenOnR10933June2014SVDStd-moreThan500MeV_SVD',
                                          'secMapEvtGenOnR10933June2014SVDStd-125to500MeV_SVD',
                                          'secMapEvtGenOnR10933June2014SVDStd-30to125MeV_SVD'])
vxd_trackfinder_pre.param('tuneCutoffs', 0.06)
```

```
# PXD Data Reduction (ROI production)
pxdDataRed = register_module('PXDDataReduction')
param_pxdDataRed = {
    'trackCandCollName': trackCandName_pre,
    'PXDInterceptListName': 'PXDIntercepts',
    'ROIListName': 'ROIs',
    'sigmaSystU': 0.02,
    'sigmaSystV': 0.02,
    'numSigmaTotU': 10,
    'numSigmaTotV': 10,
    'maxWidthU': 0.5,
    'maxWidthV': 0.5,
    }
pxdDataRed.param(param_pxdDataRed)
```

```
#Filtering of PXDDigits
pxd_digifilter = register_module('PXDdigiFilter')
pxd_digifilter.param('ROIidsName','ROIs')
pxd_digifilter.param('PXDDigitsInsideROIName', "PXDDigitsIN");
pxd_digifilter.param('PXDDigitsOutsideROIName', "PXDDigitsOUT");
```

```
# post filtering PXDDigits clusterization
pxd_clusterizer_post = register_module('PXDClusterizer')
pxd_clusterizer_post.param('Digits','PXDDigitsIN')
pxd_clusterizer_post.param('Clusters','PXDFilteredClustersName')
```

```
# VXD TF (SVD+PXD) after PXD Data Reduction (post ROI)
vxd_trackfinder_post = register_module('VXDTF')
vxd_trackfinder_post.param('GFTrackCandidatesColName', 'vxdtftracks_post')
vxd_trackfinder_post.param('TESTERexpandedTestingRoutines',False)
vxd_trackfinder_post.param('pxdClustersName','PXDFilteredClustersName')
#settings from VXDTFModuleDemo.py (check)
vxd_trackfinder_post.param('sectorSetup', ['secMapEvtGenOnR10933June2014VXDStd-moreThan500MeV_PXDSVD',
                                           'secMapEvtGenOnR10933June2014VXDStd-125to500MeV_PXDSVD',
                                           'secMapEvtGenOnR10933June2014VXDStd-30to125MeV_PXDSVD'])
vxd_trackfinder_post.param('tuneCutoffs', 0.22)
```

Execution Time

Name	Calls	Memory(MB)	Time(s)	Time(ms)/Call
EventInfoSetter	10001	0	0.18	0.02 +- 0.00
EventInfoPrinter	10000	0	0.48	0.05 +- 0.01
EvtGenInput	10000	-481	16.69	1.67 +- 12.23
Gearbox	10000	0	0.14	0.01 +- 0.00
Geometry	10000	0	0.12	0.01 +- 0.00
FullSim	10000	-997	14165.42	1416.54 +- 397.46
PXDDigitizer	10000	0	108.95	10.89 +- 10.49
PXDClusterizer	10000	0	3.34	0.33 +- 0.05
SVDDigitizer	10000	-120	157.46	15.75 +- 4.31
SVDClusterizer	10000	0	65.26	6.53 +- 1.20
CDCDigitizer	10000	0	69.74	6.97 +- 2.99
TOPDigitizer	10000	0	11.79	1.18 +- 0.56
ARICHDigitizer	10000	0	0.53	0.05 +- 0.03
ECLDigitizer	10000	2	25.76	2.58 +- 0.57
BKLMDigitizer	10000	0	615.85	61.58 +- 36.51
EKLMDigitizer	10000	0	274.72	27.47 +- 36.39
TrackFinderMCTruth	10000	0	4.36	0.44 +- 0.10
VXDTF	10000	9	97.09	9.71 +- 86.97
MCTrackMatcher	10000	0	3.68	0.37 +- 0.09
PXDDataReduction	10000	1799	16890.74	1689.07 +-3551.01
PXDDataRedAnalysis	10000	0	15.14	1.51 +- 0.72
PXDdigiFilter	10000	0	34.32	3.43 +- 0.47
PXDClusterizer	10000	0	2.03	0.20 +- 0.04
VXDTF	10000	19	99.44	9.94 +- 88.55
RootOutput	10000	22	20.45	2.04 +- 34.58
Total	10001	253	32694.48	3269.12 +-3599.31

≃

- executed @ KEK
- no parallelisation
- compiled in *opt* mode

~ 76 MCParticles per event
~ 8.9 TrackCand per event

Execution Time With Background

Name	Calls	Memory(MB)	Time(s)	Time(ms)/Call
EventInfoSetter	10001	0	0.18	0.02 +- 0.01
EventInfoPrinter	10000	0	0.75	0.08 +- 0.38
EvtGenInput	10000	0	16.13	1.61 +- 9.69
Gearbox	10000	0	0.14	0.01 +- 0.00
Geometry	10000	0	0.12	0.01 +- 0.00
FullSim	10000	-45	14358.99	1435.90 +- 388.75
BeamBkgMixer	10000	-609	2478.12	247.81 +- 111.88
PXDDigitizer **X45**	10000	-58	4961.45	496.15 +- 62.86
PXDClusterizer	10000	0	42.53	4.25 +- 0.46
SVDDigitizer **X15**	10000	-14	2317.87	231.79 +- 27.48
SVDClusterizer	10000	1	121.51	12.15 +- 1.66
CDCDigitizer **X9**	10000	2	604.39	7+- 6.52
TOPDigitizer	10000	-64	30.05	3.00 +- 0.65
ARICHDigitizer	10000	0	0.85	0.09 +- 0.03
ECLDigitizer	10000	4	690.37	69.04 +- 3.86
BKLMDigitizer	10000	1	1247.49	124.75 +- 41.61
EKLMDigitizer	10000	0	876.91	87.69 +- 41.93
TrackFinderMCTruth	10000	0	5.13	0.51 +- 0.11
VXDTF **X3.5**	10000	10	364.76	36.48 +- 250.32
MCTrackMatcher	10000	0	5.67	0.57 +- 0.10
PXDDataReduction **+15%**	10000	1268	19454.87	1945.49 +-3450.45
PXDDataRedAnalysis	10000	0	15.79	1.58 +- 0.71
PXDdigiFilter	10000	0	1704.28	170.43 +- 44.93
PXDClusterizer	10000	0	3.04	0.30 +- 0.08
VXDTF	10000	0	341.27	34.13 +- 219.30
RootOutput	10000	35	57.52	5.75 +- 61.74
Total	10001	532	49721.60	4971.66 +-3533.36

≃

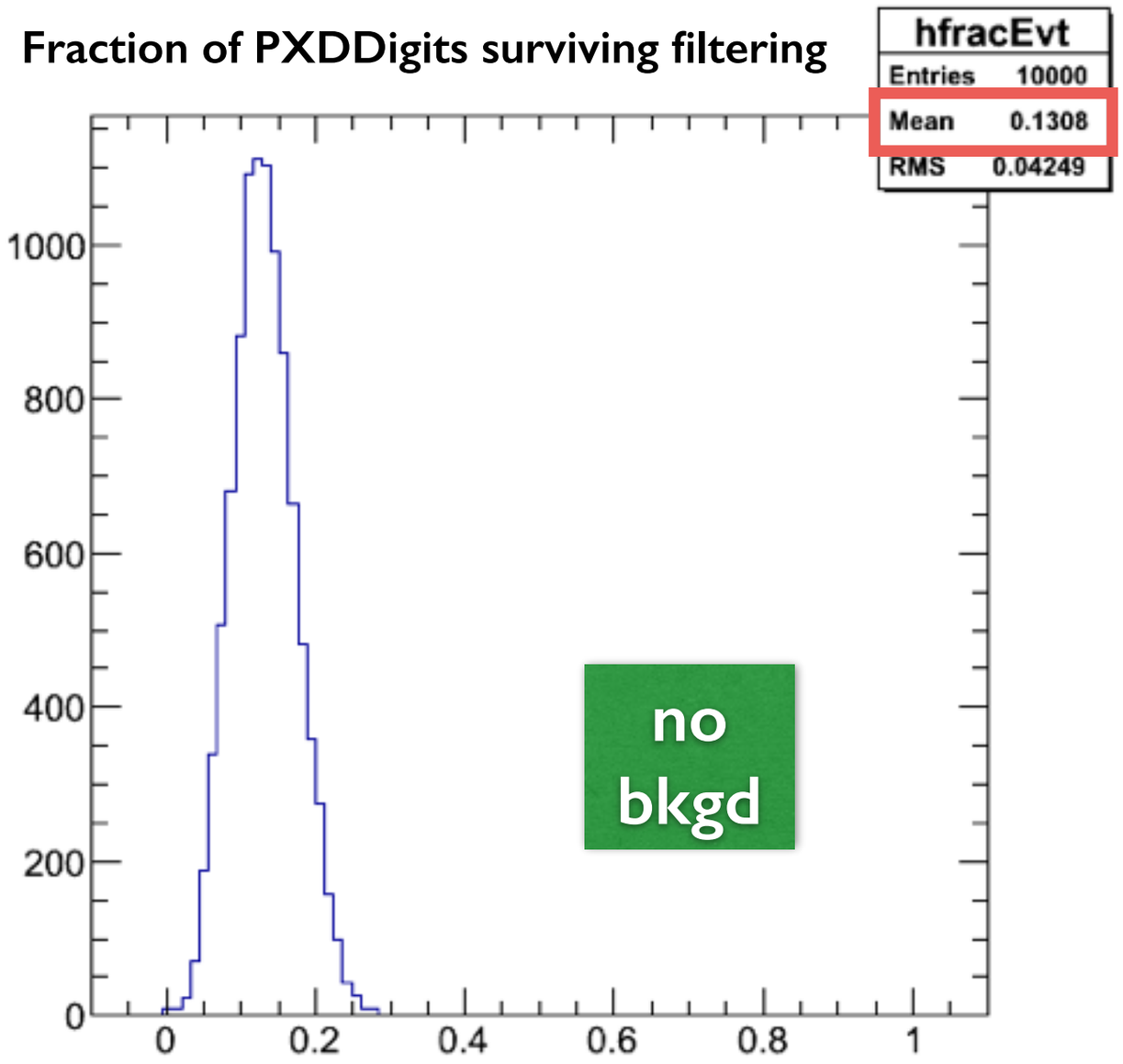
- executed @ KEK
- no parallelisation
- compiled in *opt* mode

~ 76 MCParticles per event
~ 9.4 TrackCand per event

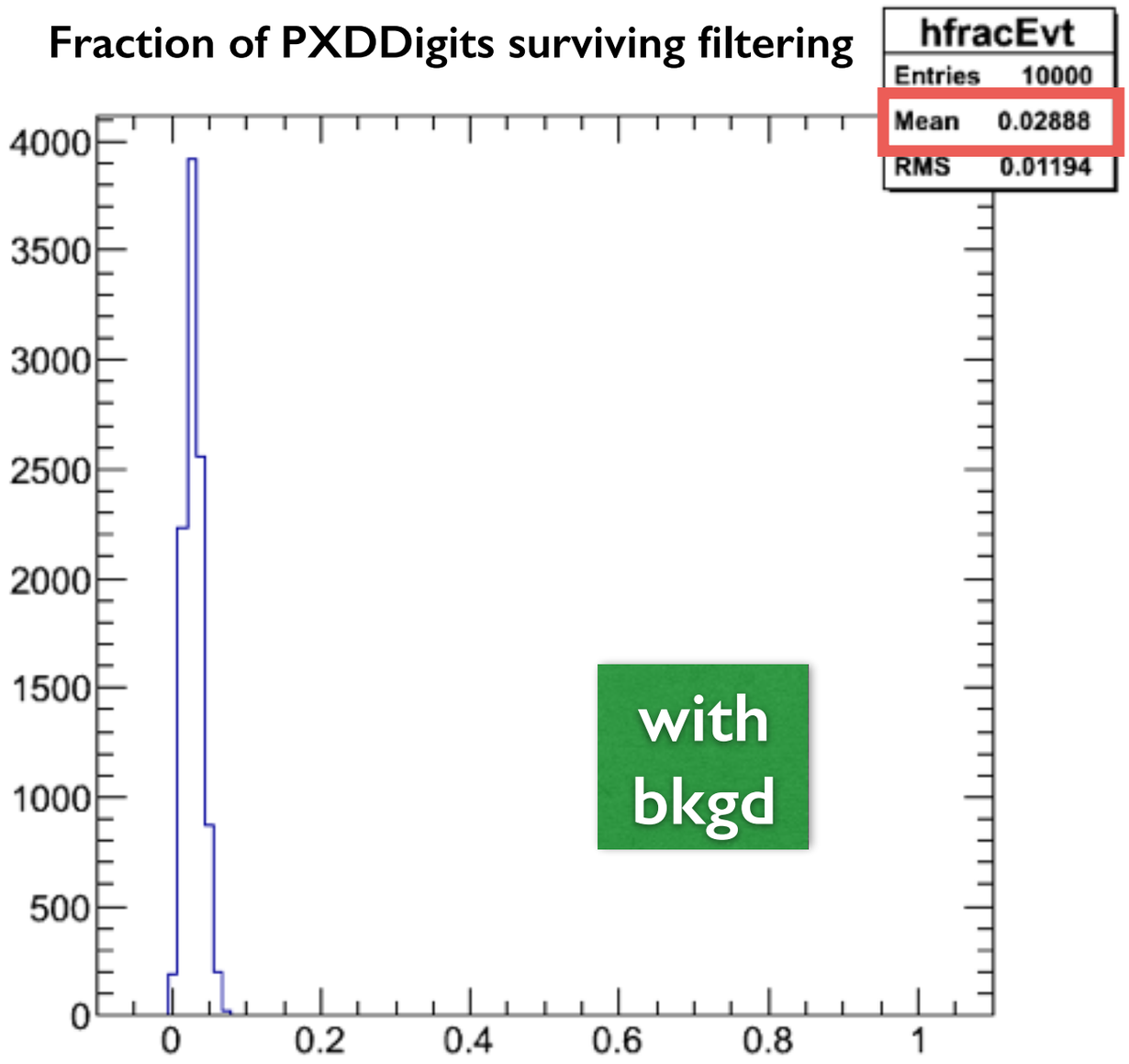
```
bkgdir = '/sw/belle2/bkg.new/'
bkgFiles = [
    bkgdir + 'twoPhoton_200us.root',
    bkgdir + 'Coulomb_HER_100us.root',
    bkgdir + 'Coulomb_LER_100us.root',
    bkgdir + 'RBB_HER_100us.root',
    bkgdir + 'RBB_LER_100us.root',
    bkgdir + 'Touschek_HER_100us.root',
    bkgdir + 'Touschek_LER_100us.root']
```

PXDDigit Filtering

Fraction of PXDDigits surviving filtering



Fraction of PXDDigits surviving filtering



- no bkgd: an average of 13% of PXDDigits survives the filtering
- with bkgd: an average of 3% of PXDDigits survives the filtering

ROI Finding Efficiency

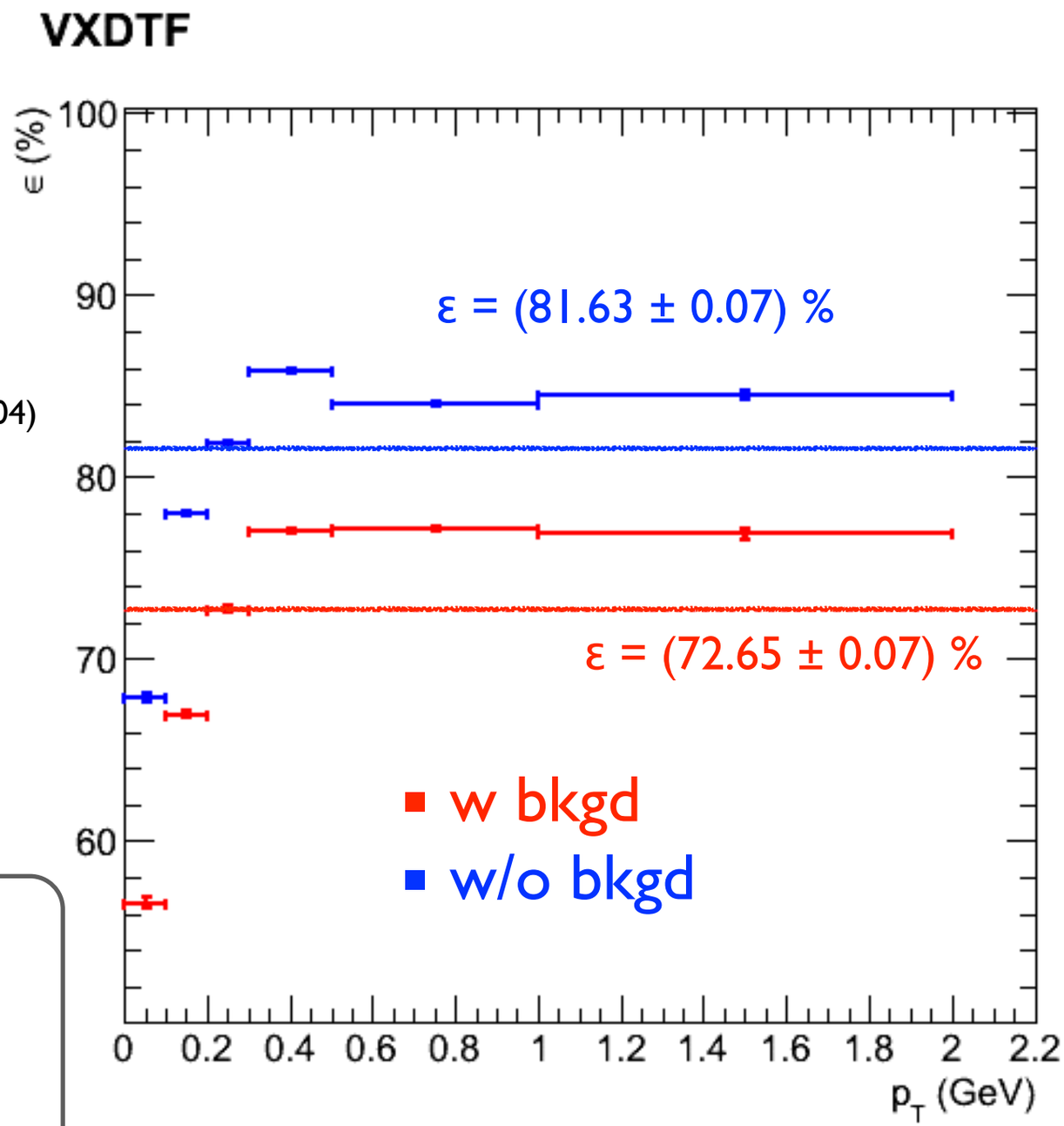
ROI finding efficiency evaluated on 10k generic B decays:

- Efficiency w/o bkg = (81.63±0.07)%
  - increased by ~6.5% w.r.t. previous studies (9th june 2104)
- Efficiency w bkg = (72.65±0.07)%
- In both cases inefficiency mostly due to failures in fitting the track and finding an intercept with the sensor planes (as always)

$$\varepsilon = \frac{\#\ \text{PXDDigits inside a ROI}}{\text{total \# PXDDigits of TrackCand}}$$

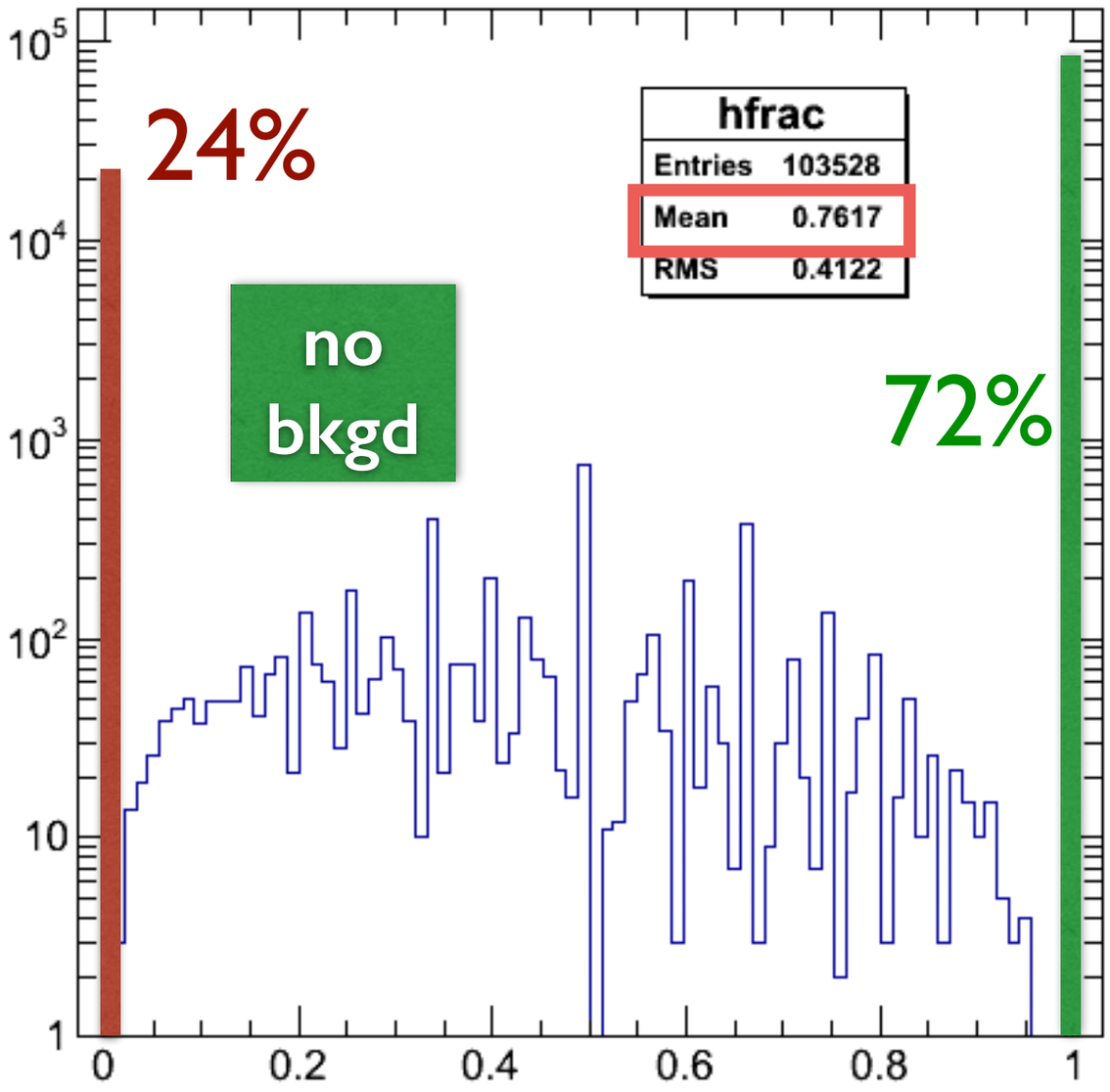
inefficiencies of the pattern recognition are factorized,

but the TrackCand quality is not!

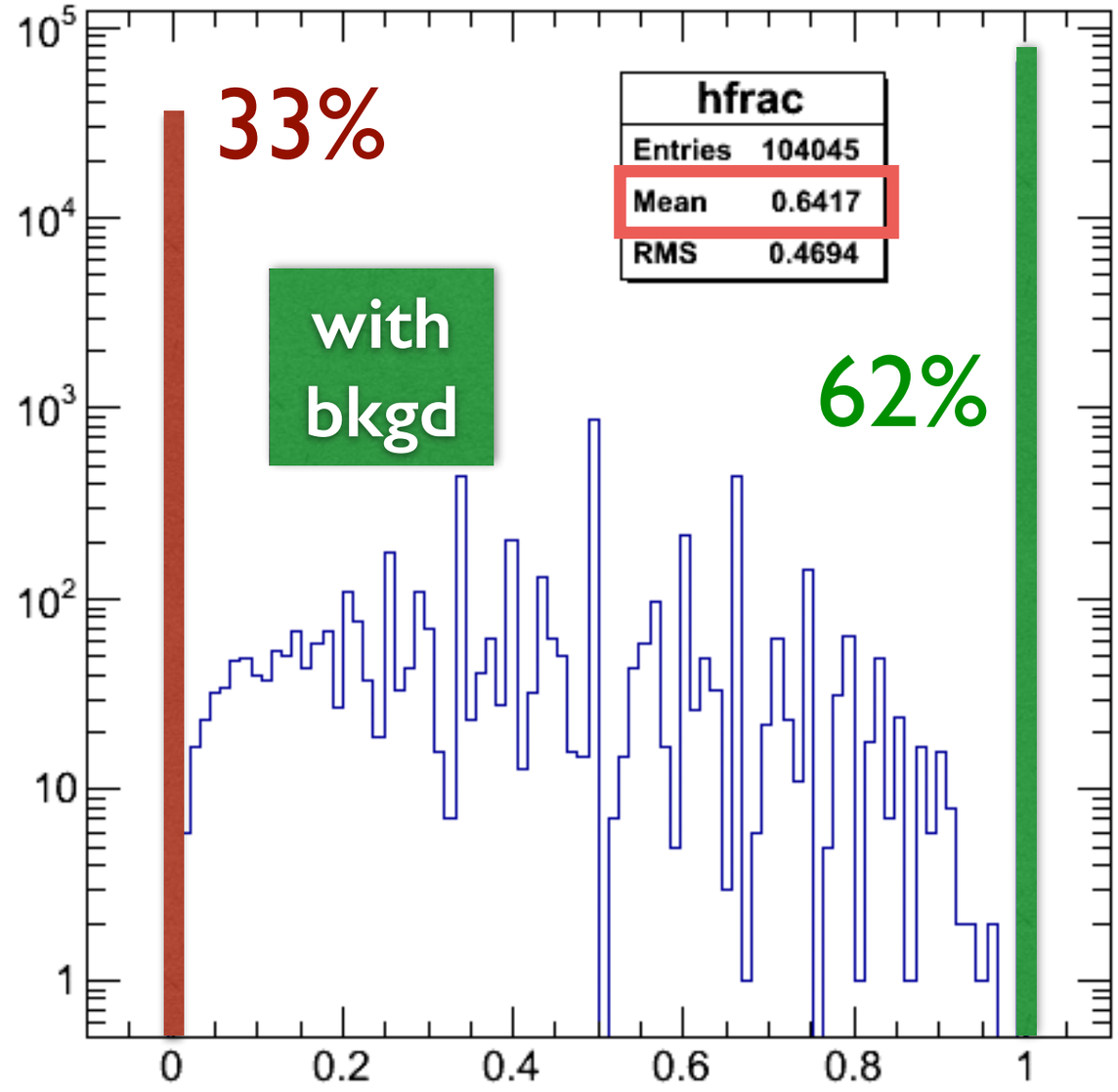


PXDDigits related to MCParticles

Fraction of PXDDigits in ROI per MCParticle



Fraction of PXDDigits in ROI per MCParticle

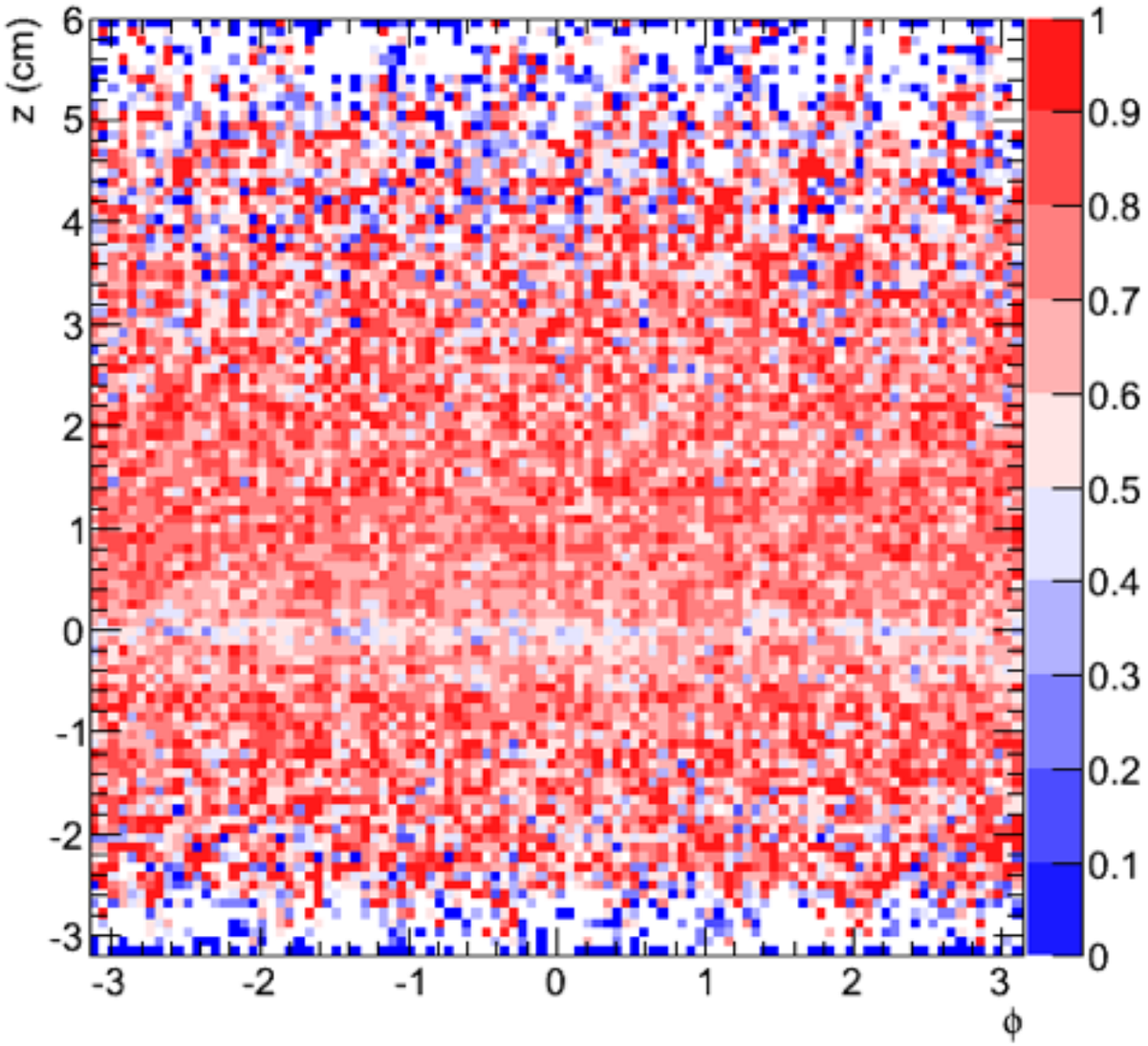


- when we (do not) find one PXDDigit, we highly probably (do not) find also all the others related to the same MCParticle (only in 4-5% of the cases a fraction of PXDDigts is found)
- first measurement of the *physics efficiency* (relative to MCParticle and not to TrackCand) gives:
  - $\varepsilon \simeq 76\%$ without bkgd
  - $\varepsilon \simeq 64\%$ with bkgd

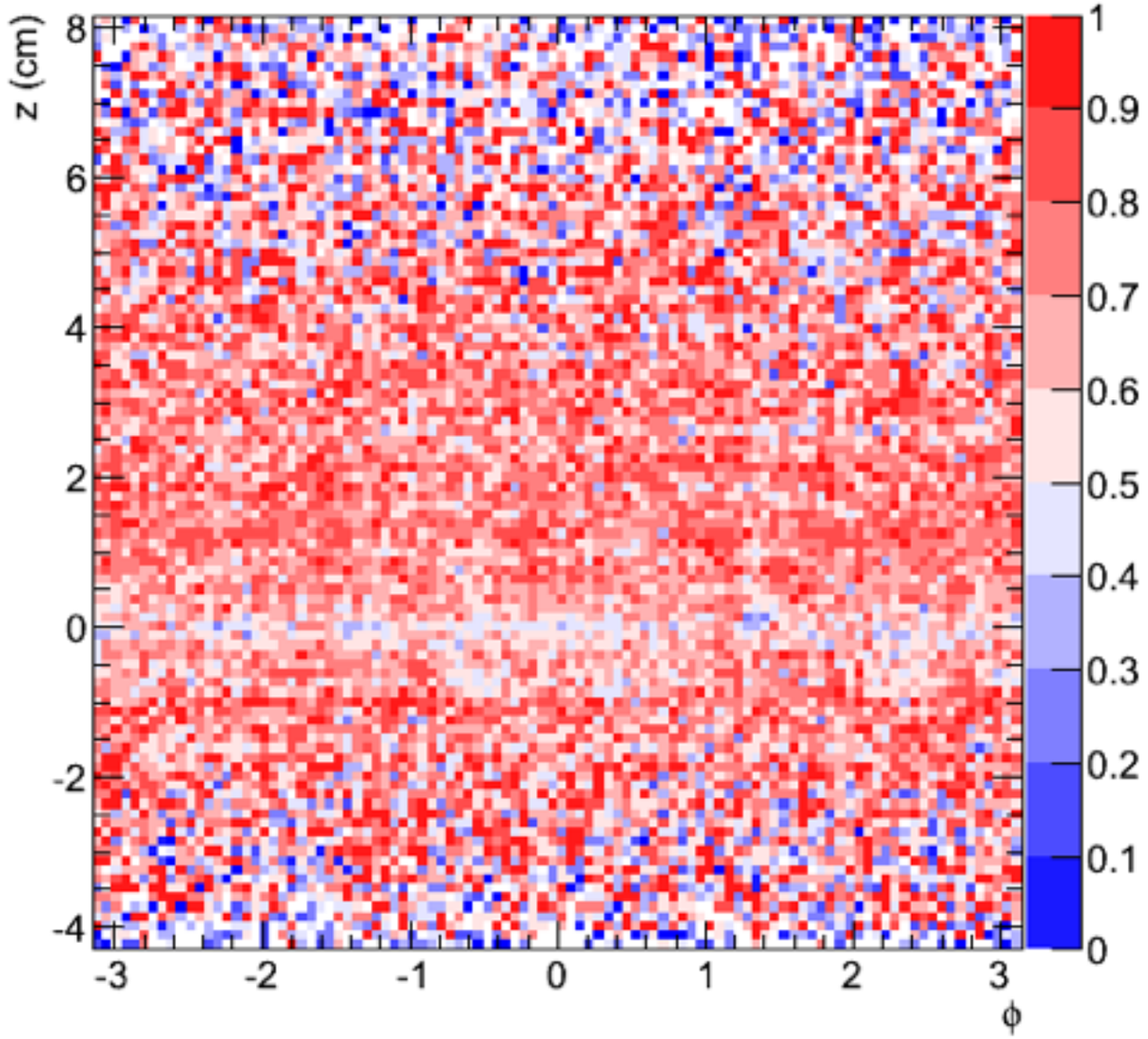
Physics (VXDTF+ROI) Efficiency

no bkgd

efficiency for global position of PXDDigit in L1



efficiency for global position of PXDDigit in L2

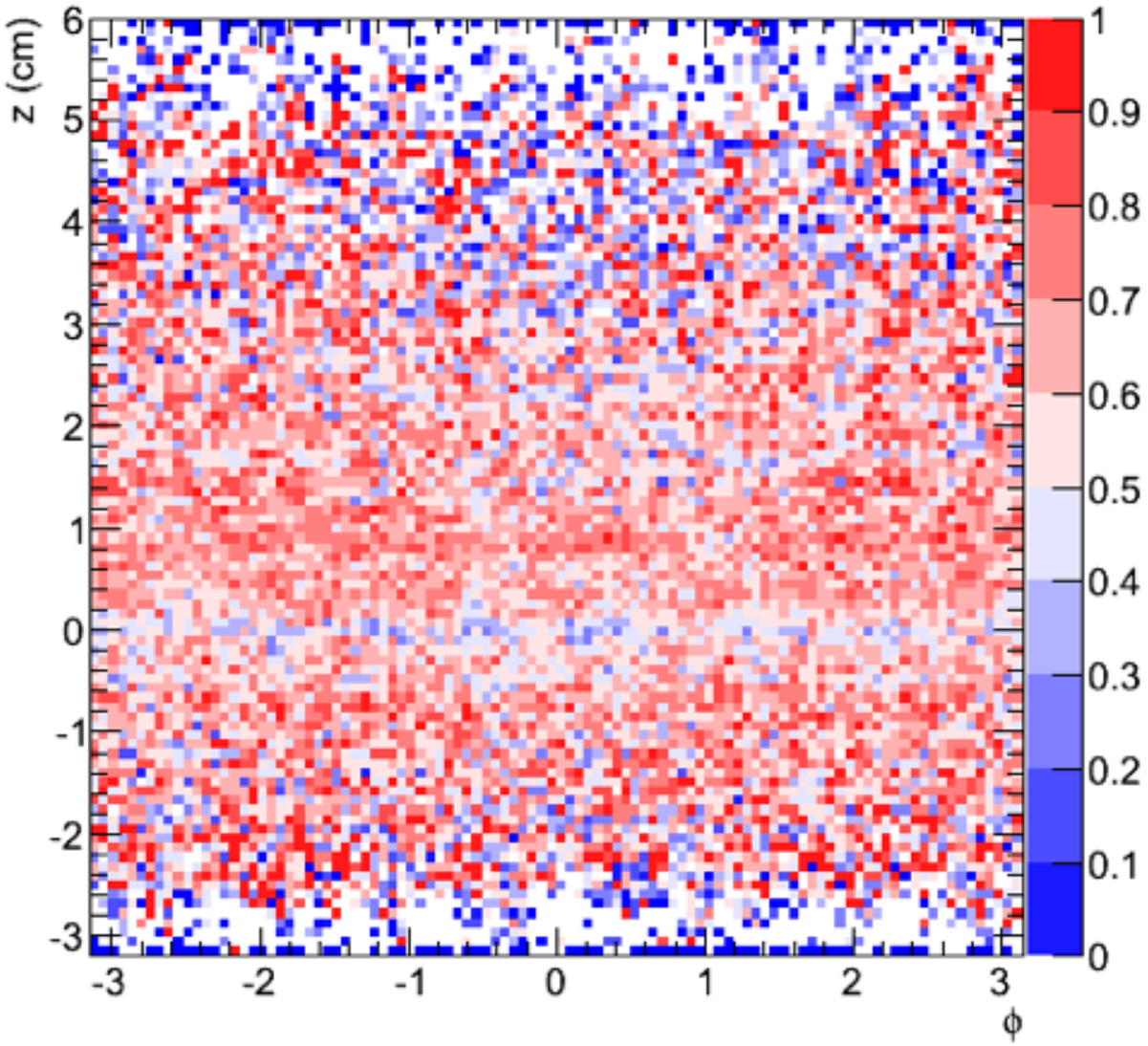


- Drop in efficiency on the transverse plane (z=0) and in the forward and backward direction, already seen

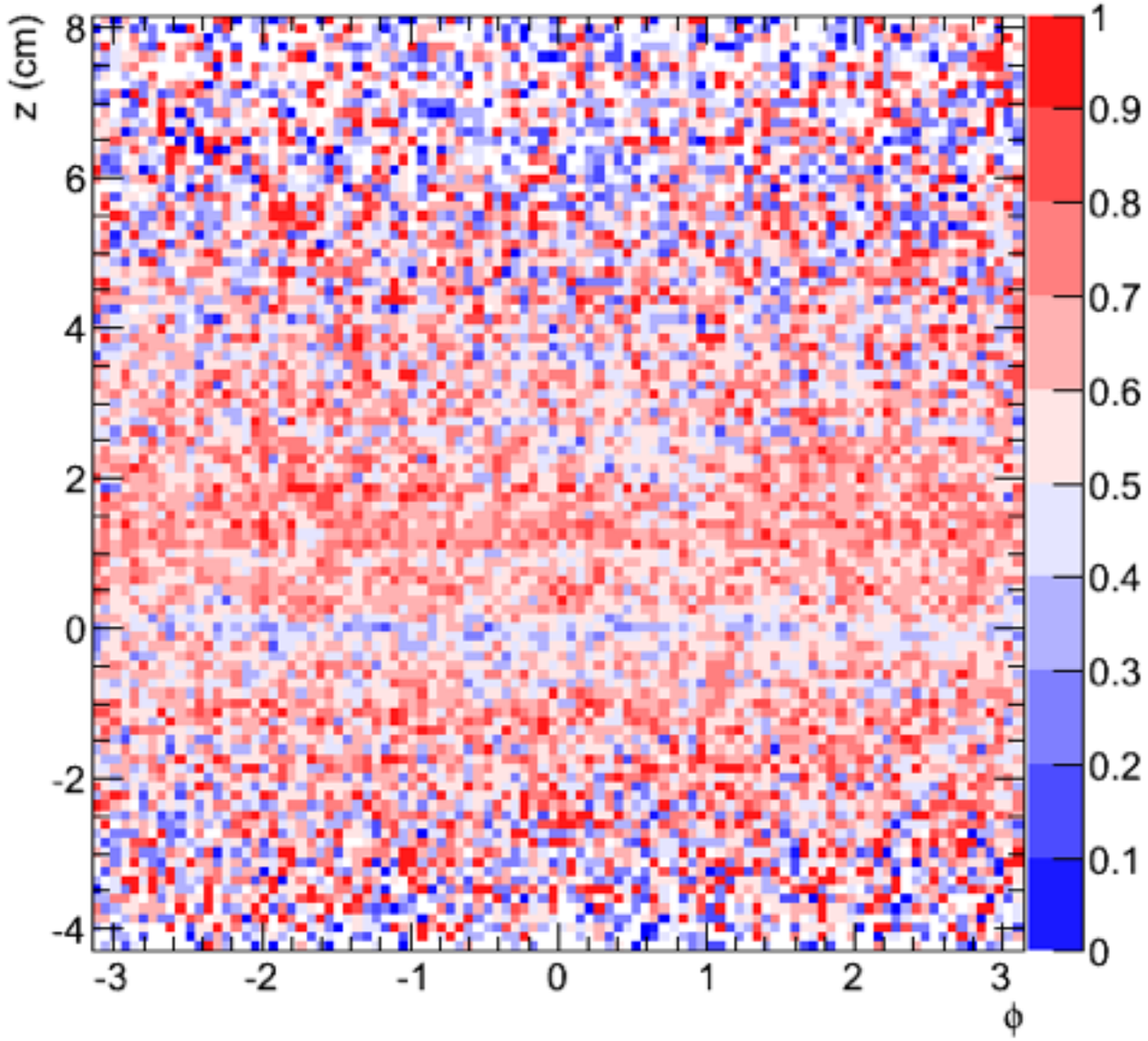
Physics (VXDTF+ROI) Efficiency

with bkgd

efficiency for global position of PXDDigit in L1

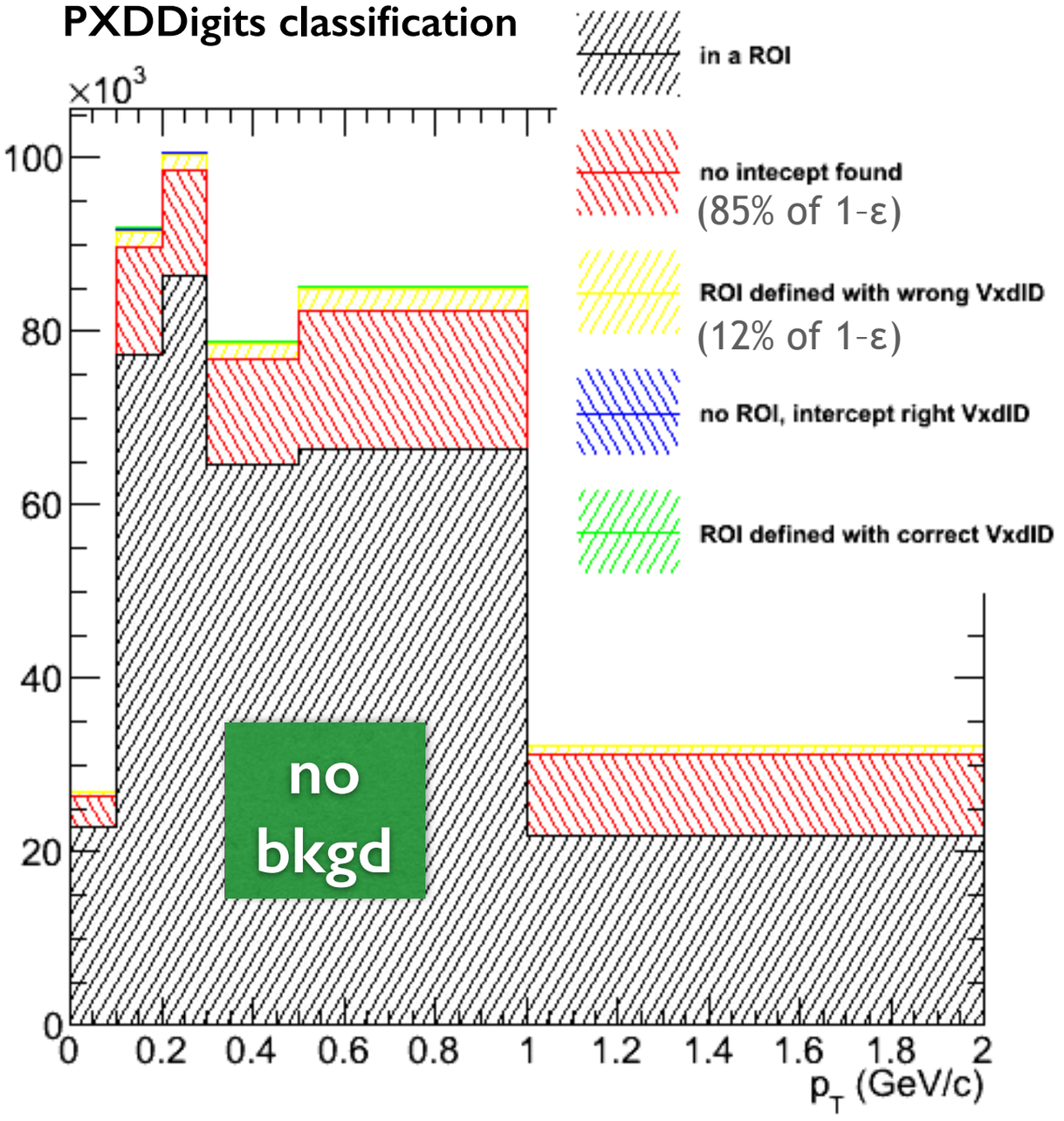


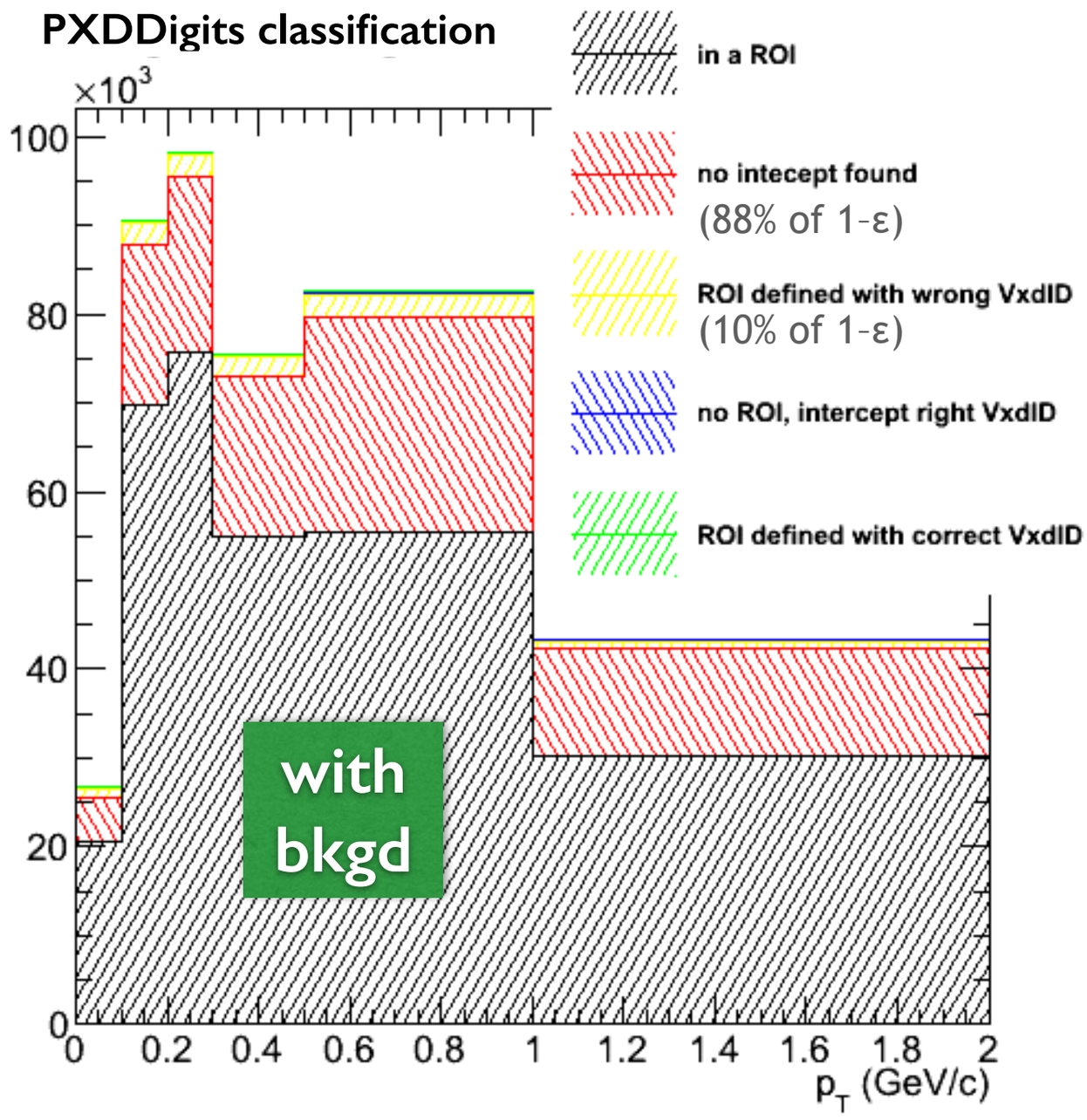
efficiency for global position of PXDDigit in L2



- Drop in efficiency on the transverse plane (z=0) and in the forward and backward direction is still there

ROI Finding *in*efficiency vs p_T

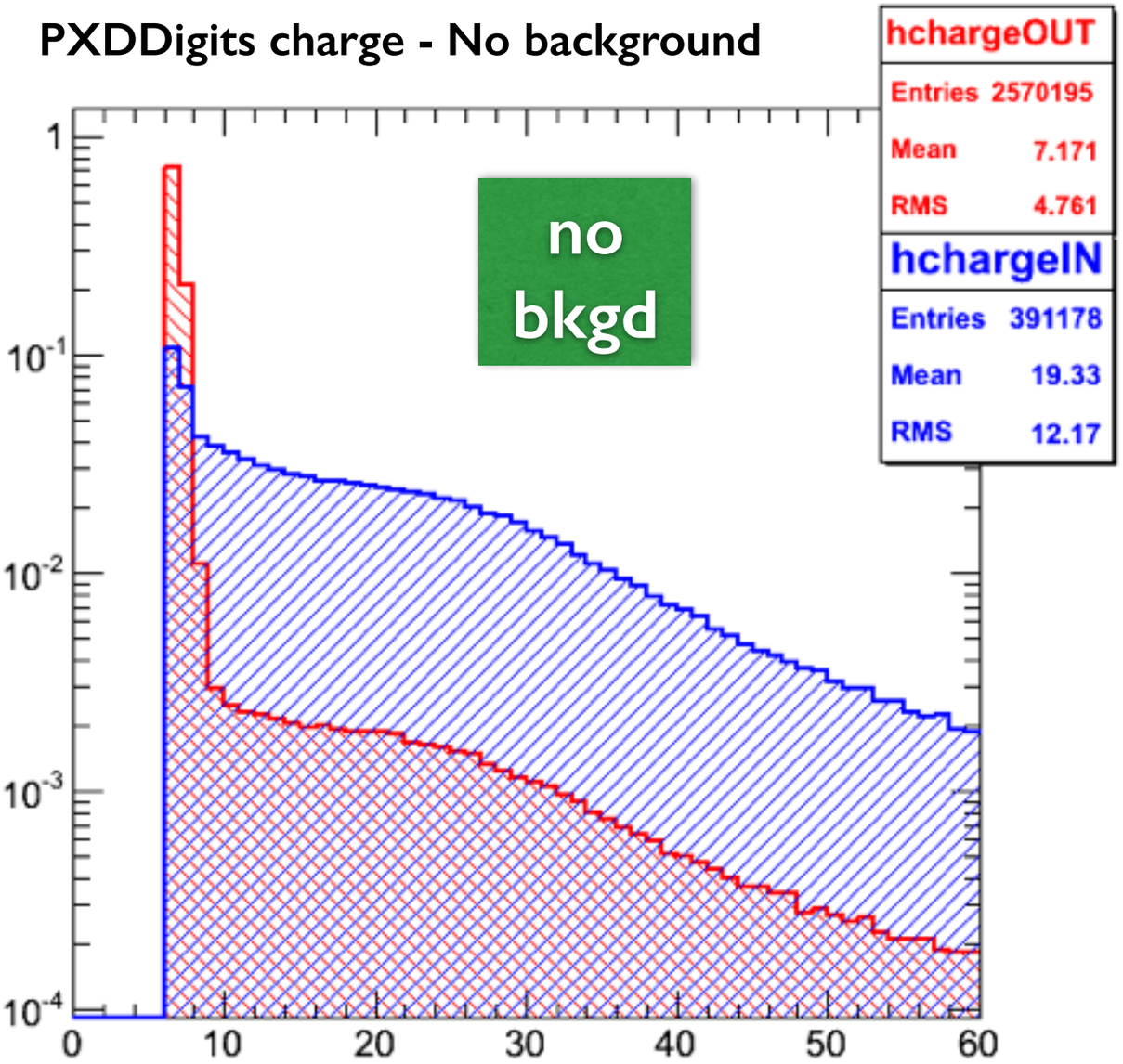




- no news in the inefficiencies, mostly related to bad fits to the TrackCand

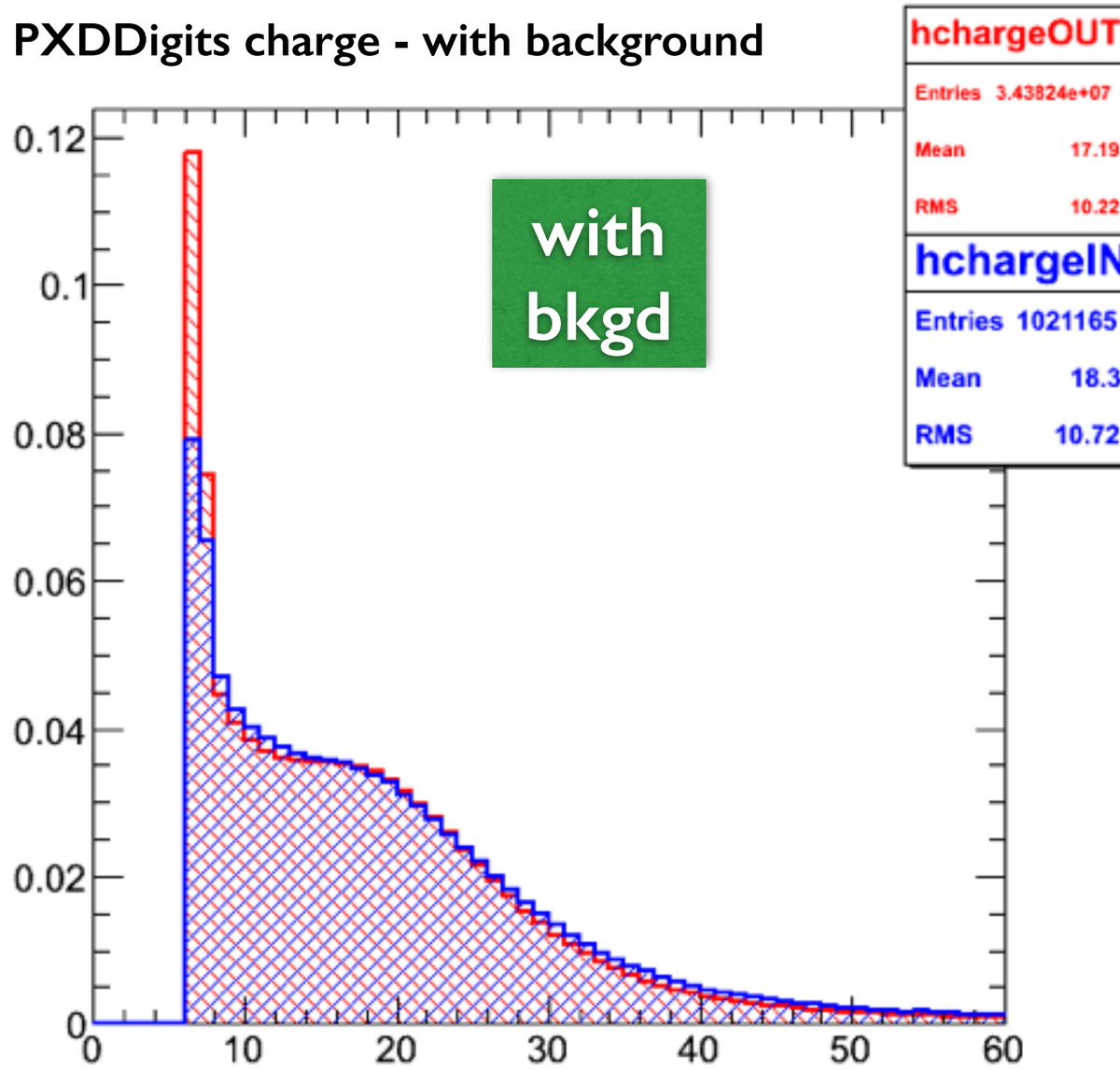
PXDDigit Charge: IN- vs OUT-side ROIs

PXDDigits charge - No background



- PXDDigits outside ROI have a lower value of the charge → noise related to electronics…

PXDDigits charge - with background

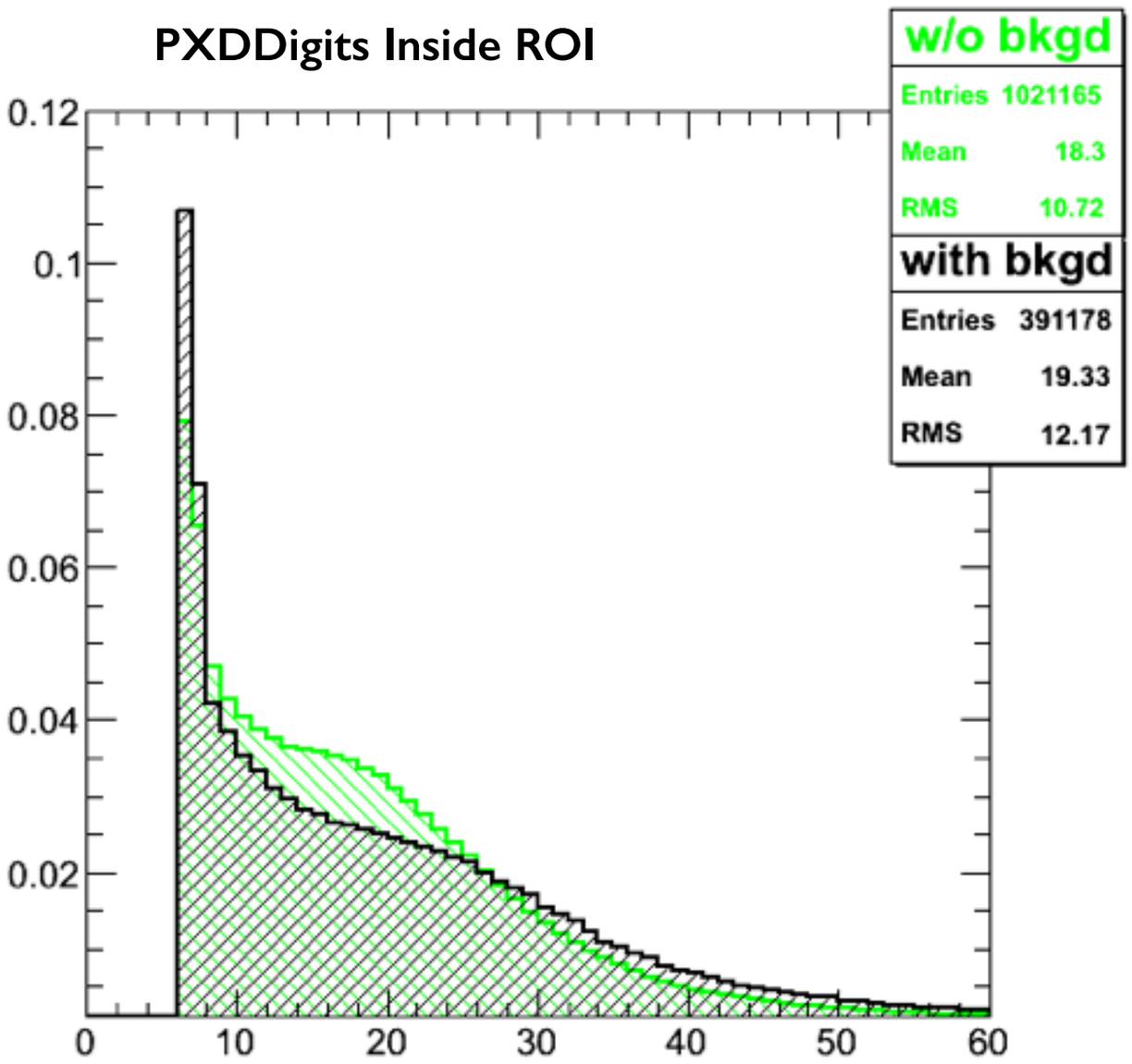


- PXDDigits hit by real (but not interesting) particles are rejected

note: all distributions are normalised to 1 over the full range (not displayed)

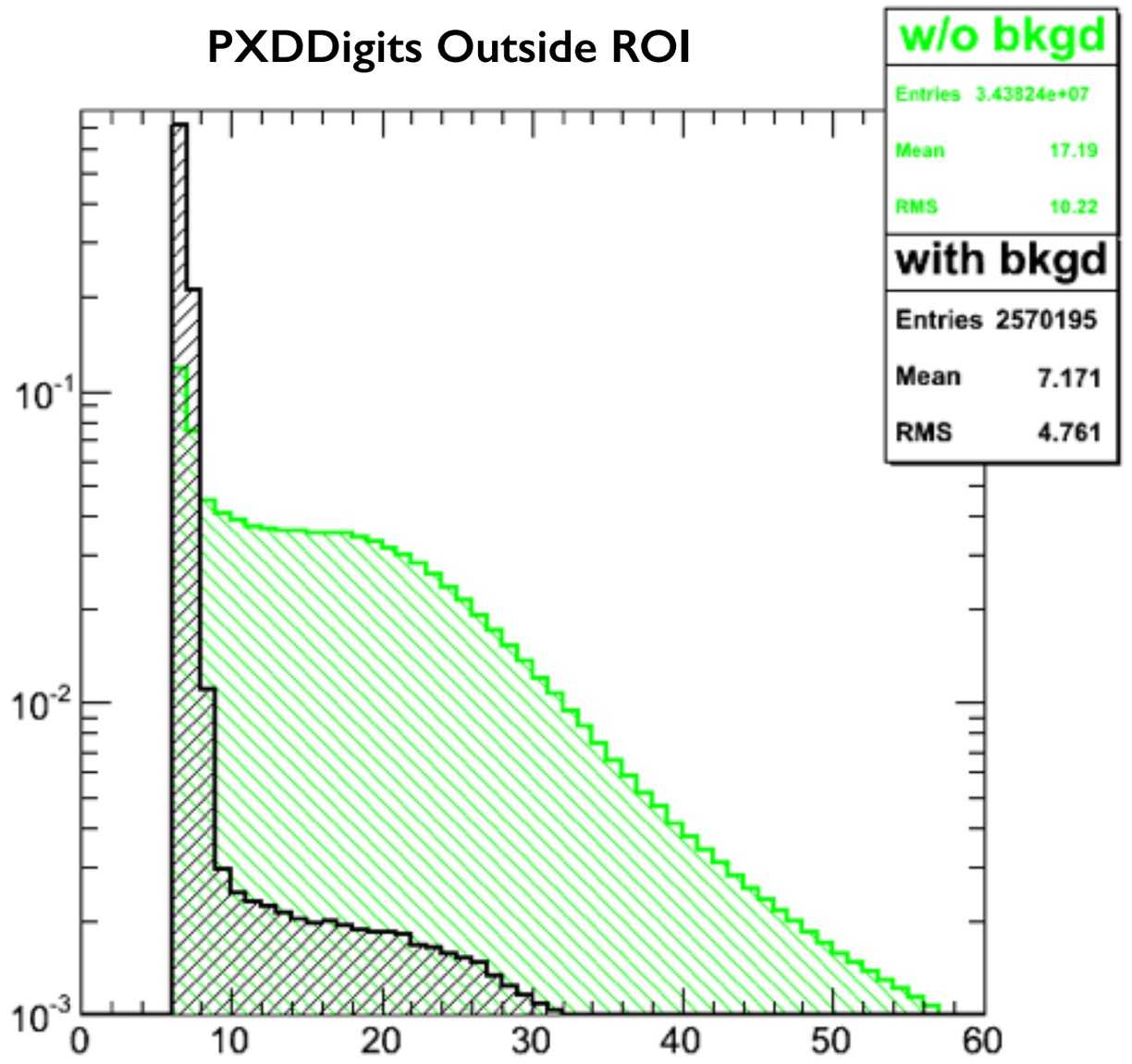
PXDDigit Charge: with vs w/o bkgd

PXDDigits Inside ROI



- some of the PXDDigits inside ROI in the simulation with bkgd are not "interesting" pixels

PXDDigits Outside ROI



- PXDDigits outside ROI have a different origin (real particles vs noise)

note: all distributions are normalised to 1 over the full range (not displayed)

Conclusions & Future Plans

- ➡ HLT—based PXD Data Reduction can now be simulated
- ➡ First tests with beam background are encouraging
- ➡ PXDDataReduction Module needs to be re-implemented in order to:
  - improve in speed
  - improve in efficiency
- ➡ Ideas: use a simple helix representation of the track

Thank You!

backup slides

ROI Finding Efficiency

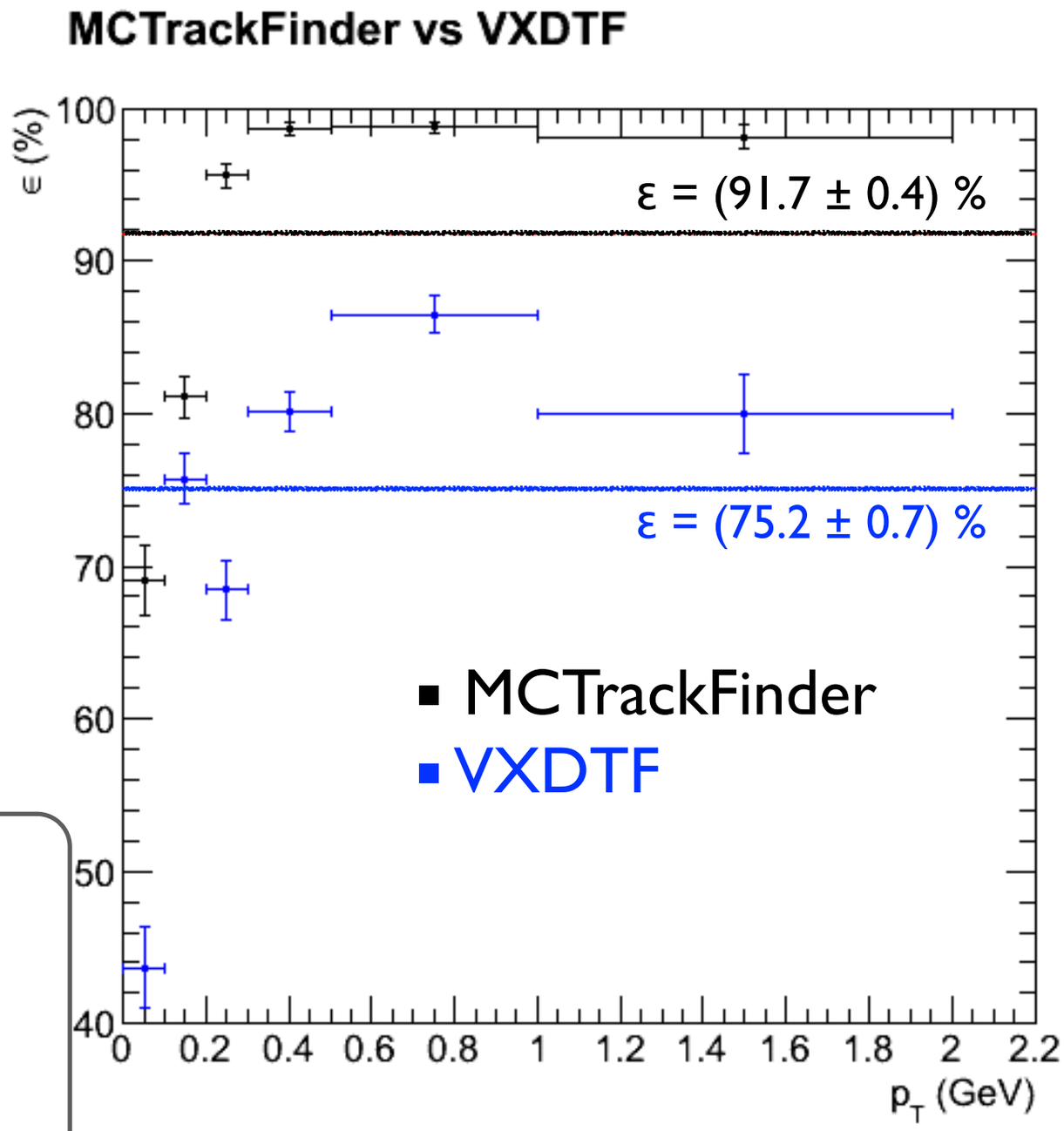
9th June 2014

- We compare the efficiency obtained using the VXDTF with the MCTrackFinder:
  - VXDTF: official track finder
  - MCTrackFinder: uses the *true* hits
- Efficiency with VXDTF = (75.2±0.7)%
- Efficiency with the MCTF = (91.7 ± 0.4) %
- In both cases inefficiency mostly due to failures in fitting the track and finding an intercept with the sensor planes (see next slide)

$$\varepsilon = \frac{\text{\# PXDDigits inside a ROI}}{\text{total \# PXDDigits of TrackCand}}$$

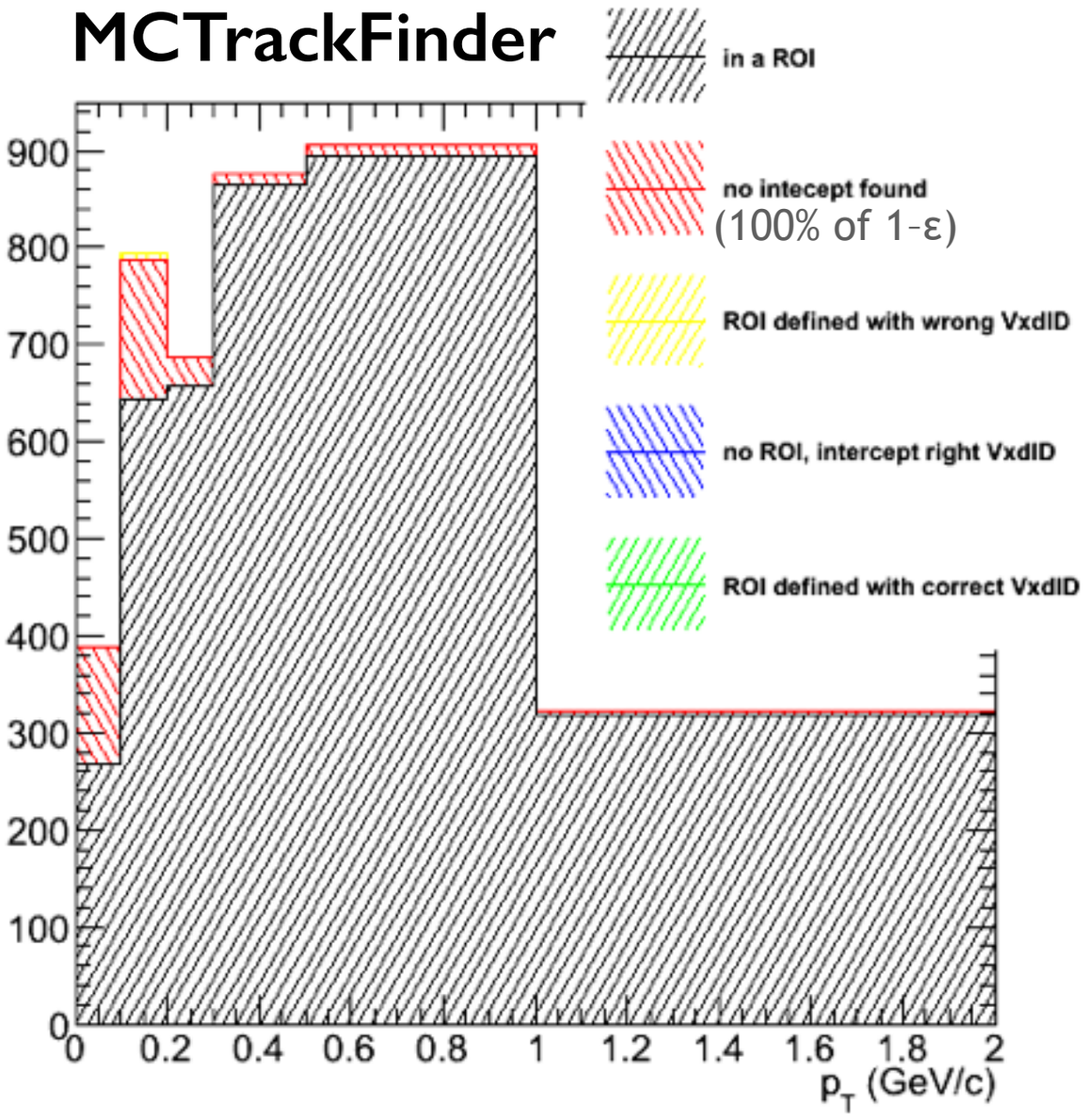
inefficiencies of the pattern recognition are factorized,

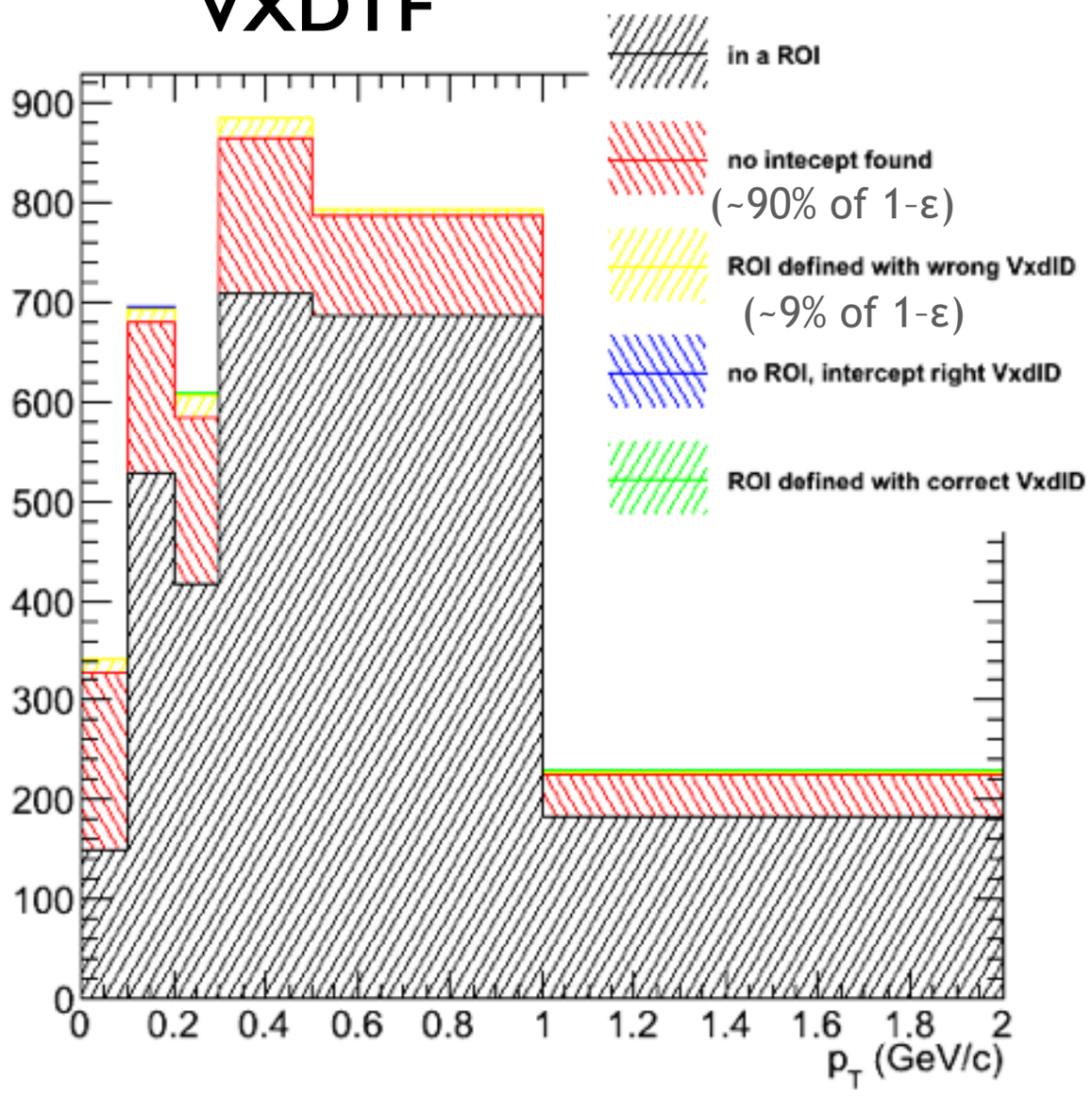
but the TrackCand quality is not!



PXDDigits classification

9th June 2014





Definition of the Figures of Merit

➡ Definition of efficiency for PXD Data Reduction:

$$\varepsilon = \frac{\text{\# PXDDigits inside a ROI}}{\text{total \# PXDDigits of TrackCand}}$$

inefficiencies of the pattern recognition are factorized!!

➡ Definition of data reduction factor:

$$r = \frac{\text{< \# pixels in ROI/event >}}{\text{250*768 pixels/module * 40 modules}}$$

➡ execution time: we run on the HLT, we need to be fast: benchmark = 1ms/track