

# Hit Efficiency of the Pixel Detector

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# Definition of efficiency, valid hit condition

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- RecHit Efficiency Definition:
  - $\text{Eff} = N_{\text{valid hits}} / (N_{\text{valid hits}} + N_{\text{missing hits}})$   
where both valid and missing hits come from track reconstruction
  - Layer 1 definition:  
 $\text{Eff} = N_{\text{valid propagated hits}} / (N_{\text{valid propagated hits}} + N_{\text{missing propagated hits}})$   
where hits are propagated from valid Layer 2 hits onto Layer 1
- Additionally, hits are required on the „other” layers or disks:
  - for Layer 1 : on Layer 2+3, Layer 2 + Disk 1, Disk 1 +2
  - Layer 2: Layer 1+3, Layer 1 + Disk 1
  - Layer 3: Layer 1+2
  - Disk 1 : Layer 1 +Disk 2, Layer 2 + Disk 2, will add *Layer 3 + Disk 2*
  - Disk 2: Layer 1 + Disk 1

# Run info

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- Runs:
  - 142928, 142933, 143007, 143323, 143833, 144011
  - 146436
  - 135537 for comparison with approved results
- Datasets
  - /MinimumBias/Run2010A-Sep17ReReco\_v2/RECO
  - /MinimumBias/Run2010B-PromptReco-v2/RECO
- Software version: CMMSW\_3\_8\_3
- Global tag: GR\_R\_38X\_V13A::All
- Lumi selections:
  - Checked Run registry for good lumisections requiring all detector subsystems with Good DQM status

# Overview

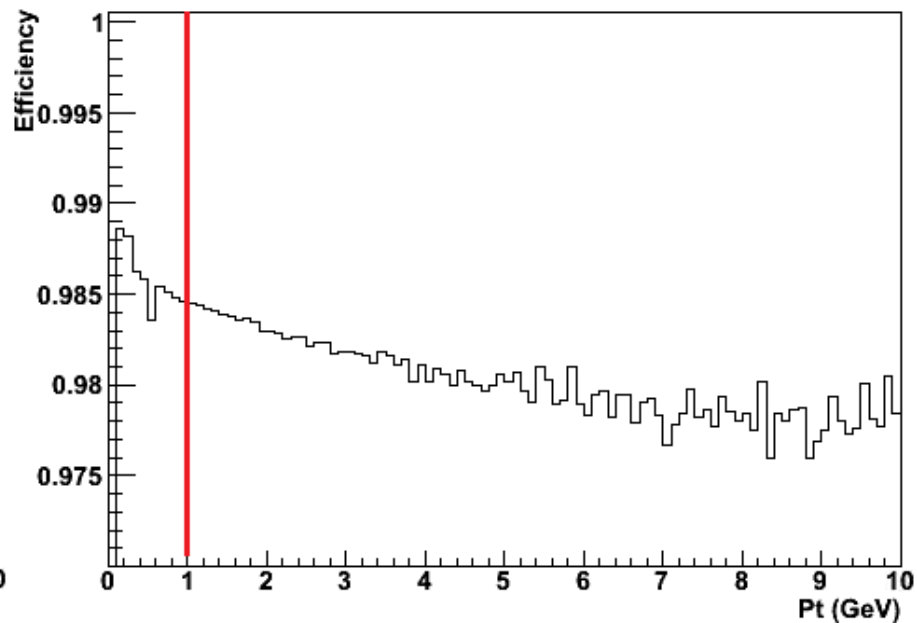
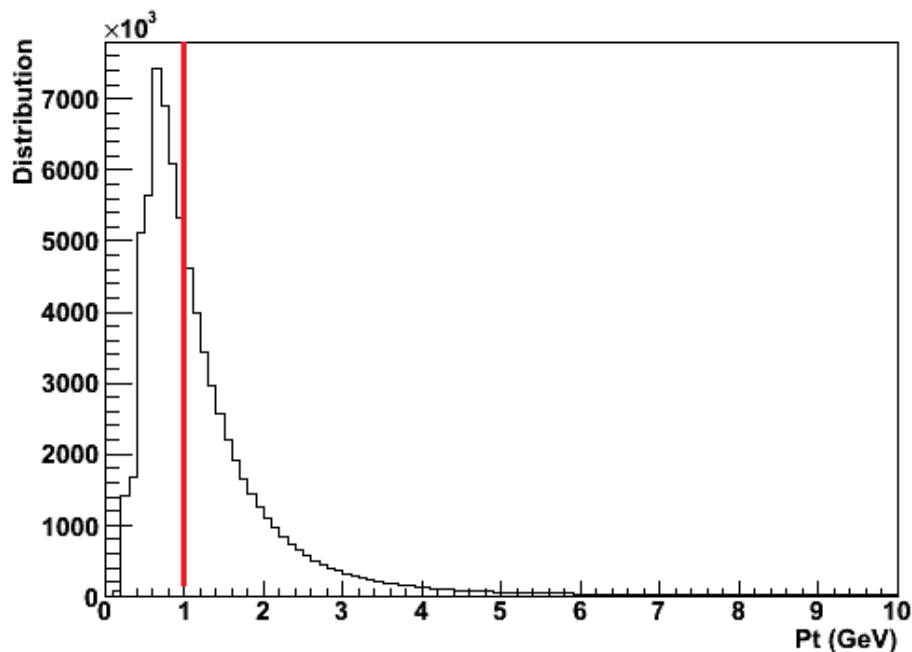
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- Event Selection (vertex)
  - Number of vertices  $\geq 1$ , where  $|z| \leq 15\text{cm}$ ,  $N_{dof} > 4$ ,  $|\rho| < 2.0$
- Track Selection for „generalTracks” – different for BPix and FPix
  - Min.  $p_T$  selection
  - Track consistent with primary vertex (cut on vertex corrected  $dz$ ,  $do$ )
  - Min. number of strip hit requirement
  - Valid hit conditions (listed earlier)
- Fiducial region selection (varies by module type)
  - Avoid module overlaps and edges
  - Ensure that propagated track falls on the right module in Layer 1
- Plot module and ROC efficiencies

# Pt selection - BPix

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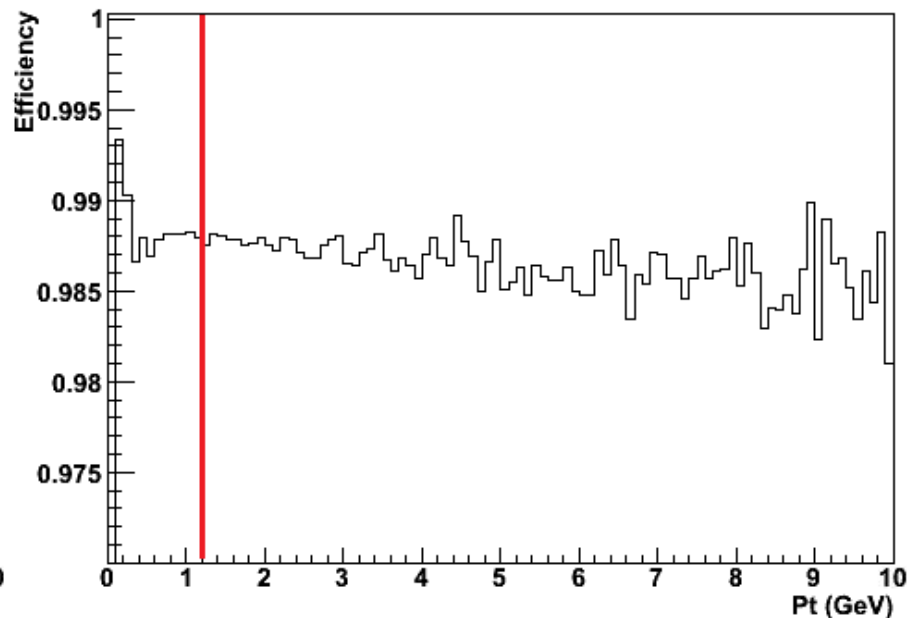
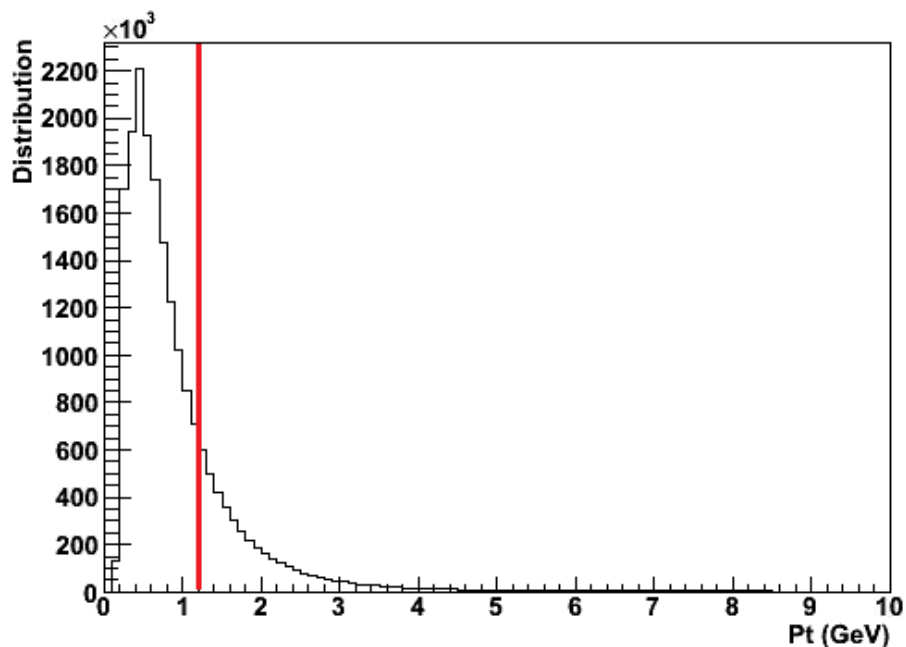
- BPix:  $p_T > 1.0$  GeV
- Shows  $p_T$  dependence with all cuts excluding one on  $p_T$  (N-1 plot)  
→ Thresholds were chosen before applying any other selections



# Pt selection - FPix

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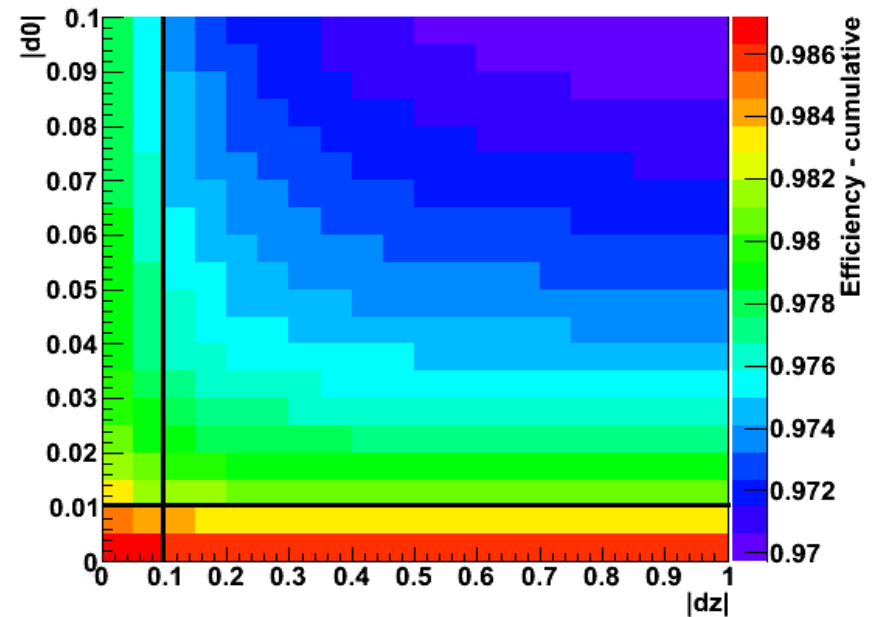
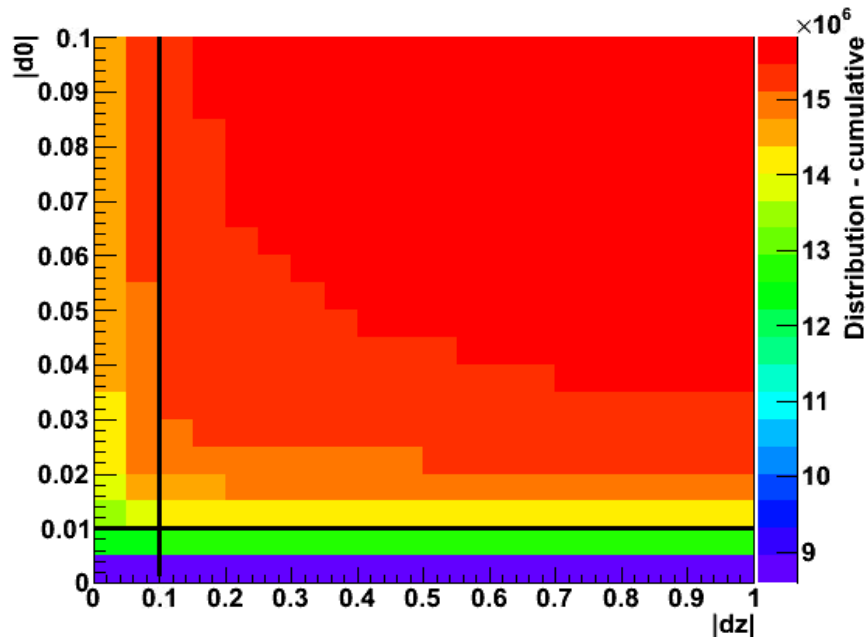
- FPix:  $p_T > 1.2$  GeV
- Note: cutting on  $p_T$  also excludes tracks produced by higher iterations (iter>1) of the track reconstruction algorithm



# Impact parameter cut

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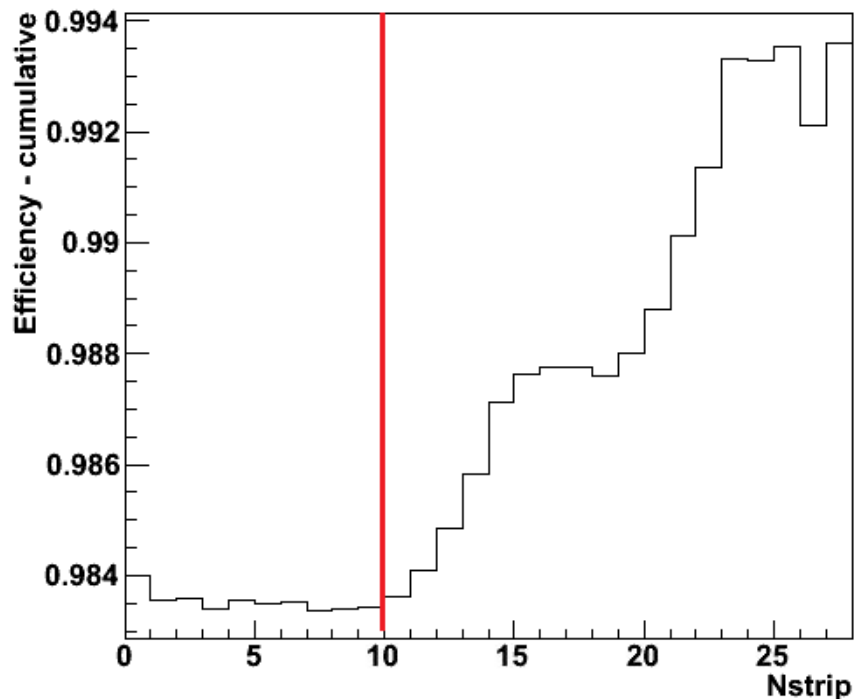
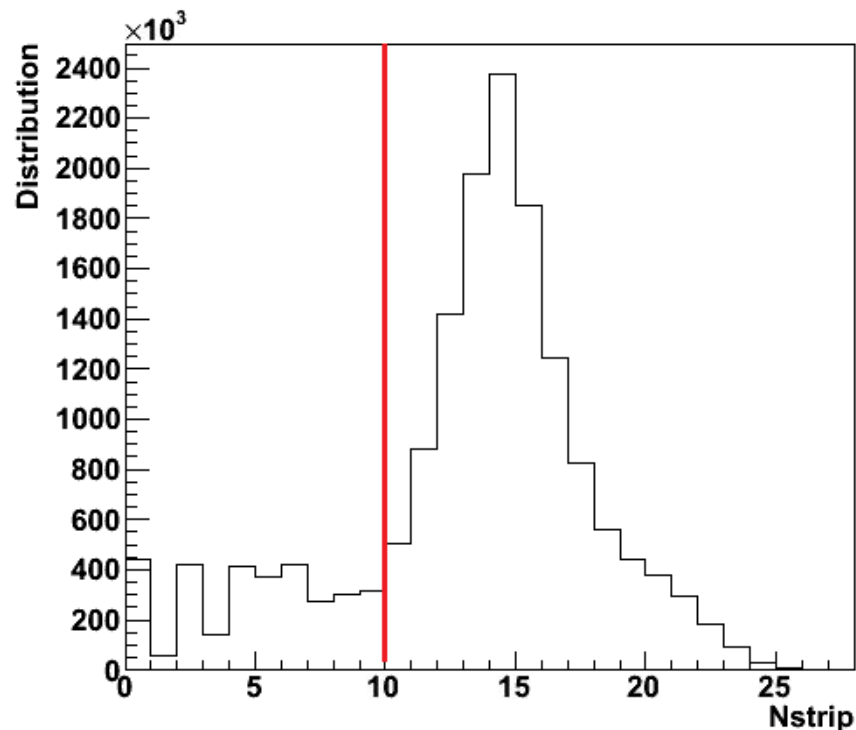
- More strict track – vertex association
- $|dz| < 0.1$  (BPix), 0.5 FPix
- $|d_0| < 0.01$  (Layer 1), 0.02 (Layer 2 and 3), 0.05 (FPix)
- $> 1.4\%$  improvement on Layer 1:



# Strip hit cut - BPix

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- BPix:  $N_{\text{strip}} > 10$  for all Layers
- Will also check  $\chi^2$  dependence

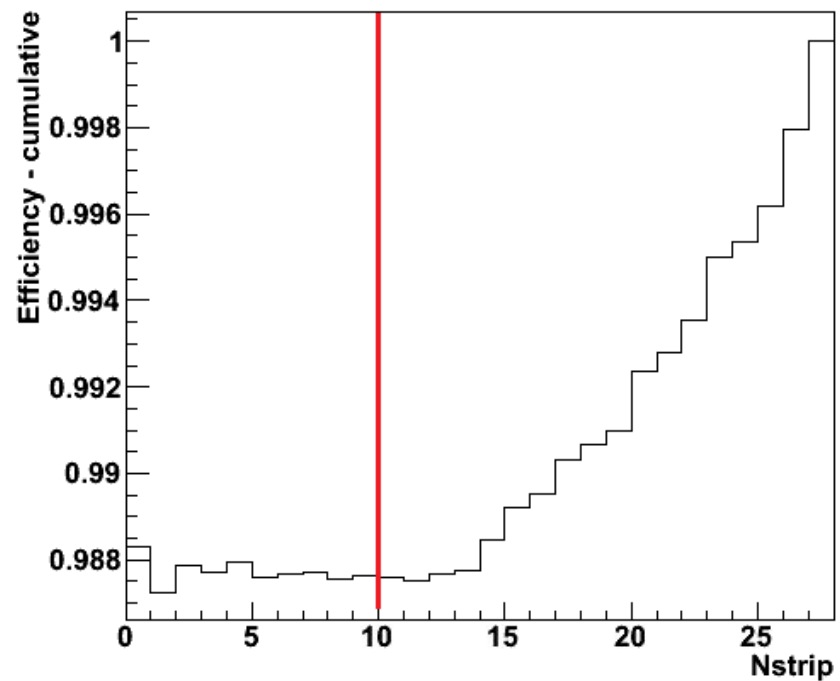
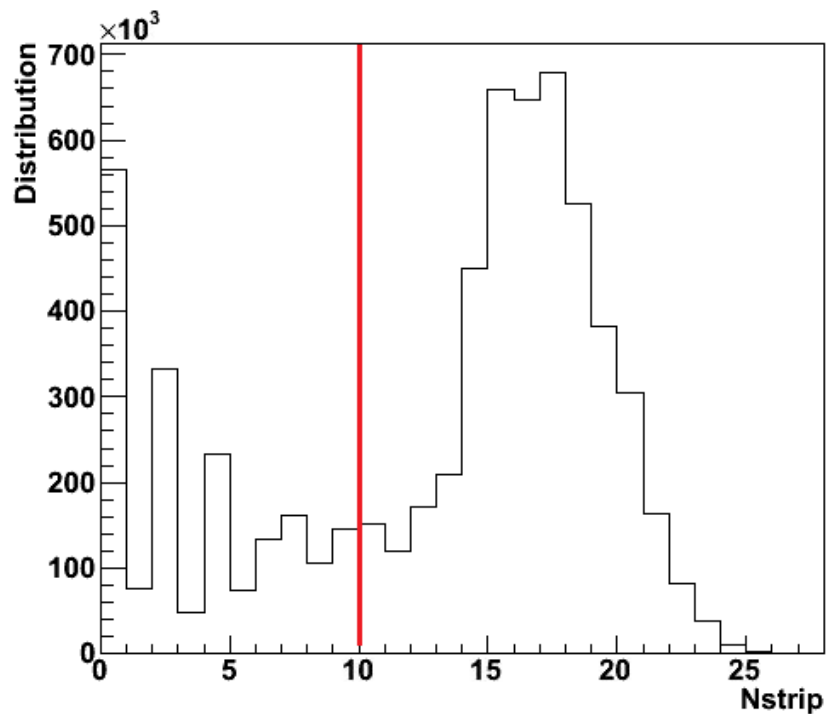




# Strip hit cut - FPix

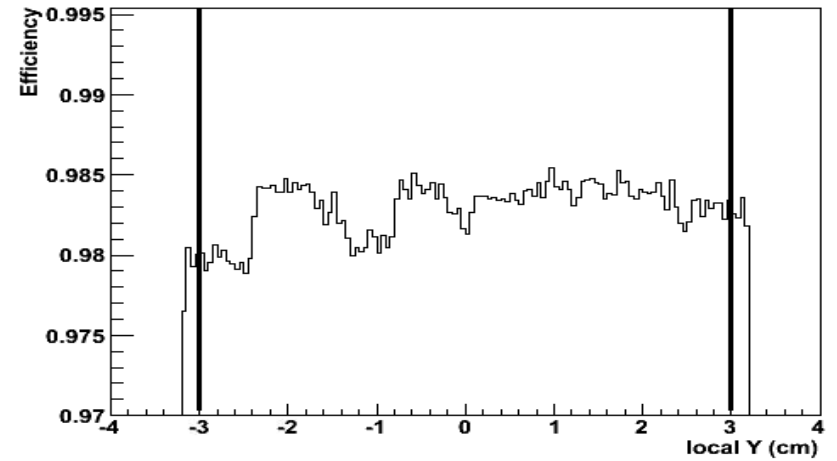
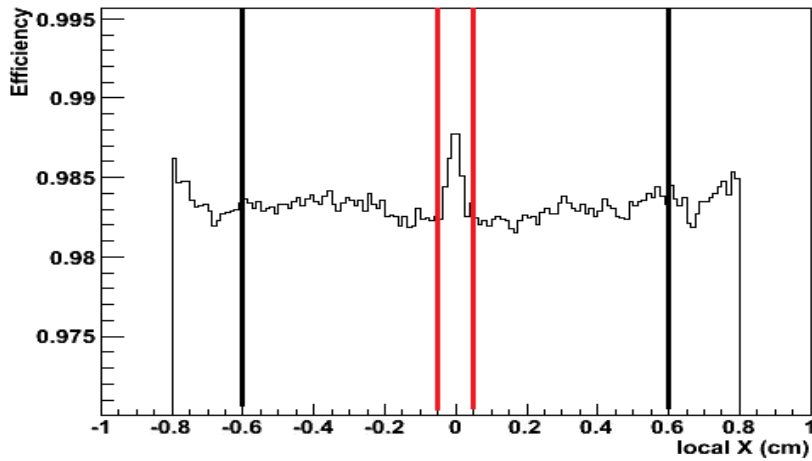
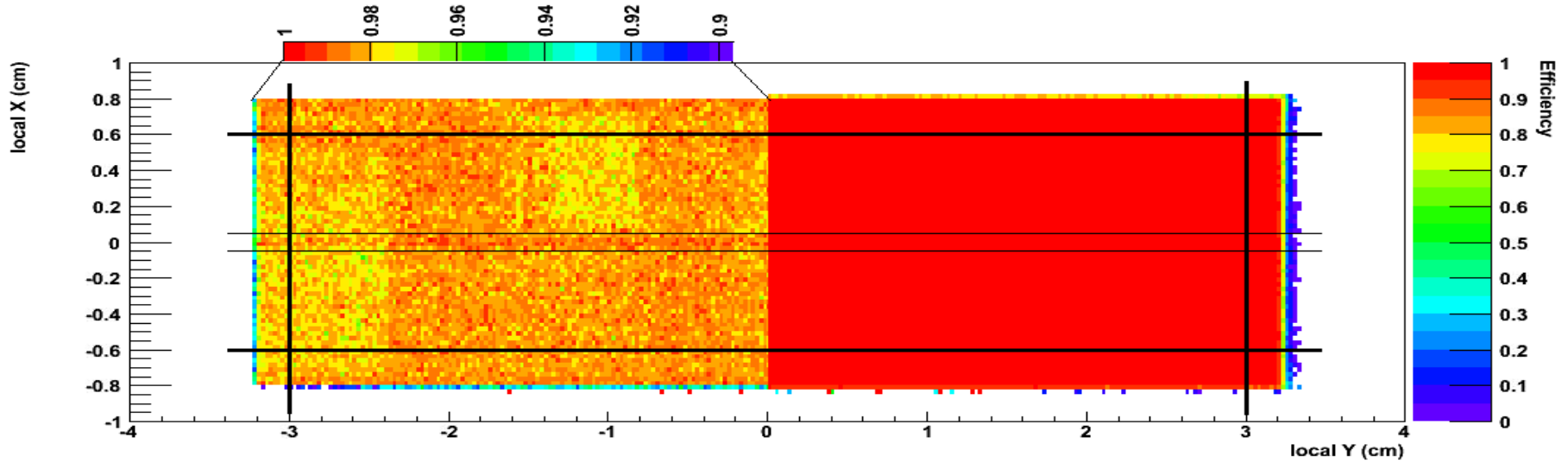
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- FPix: Nstrip  $> 10$



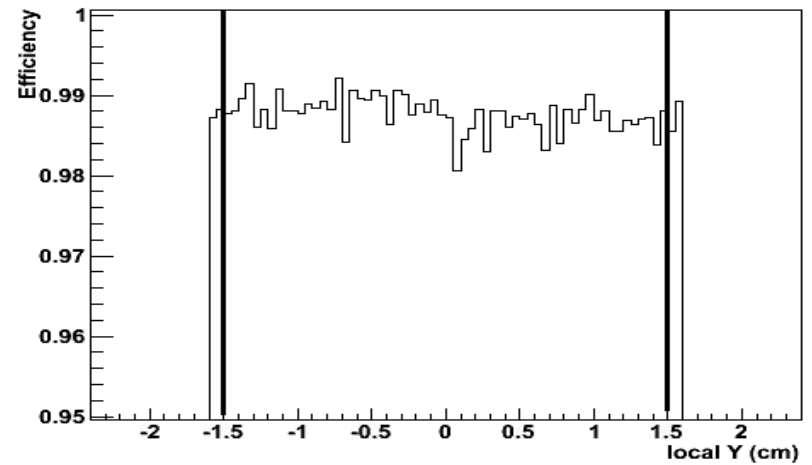
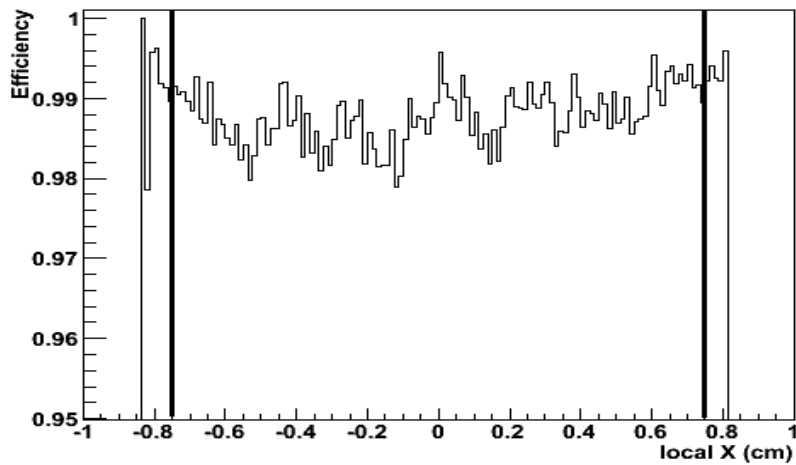
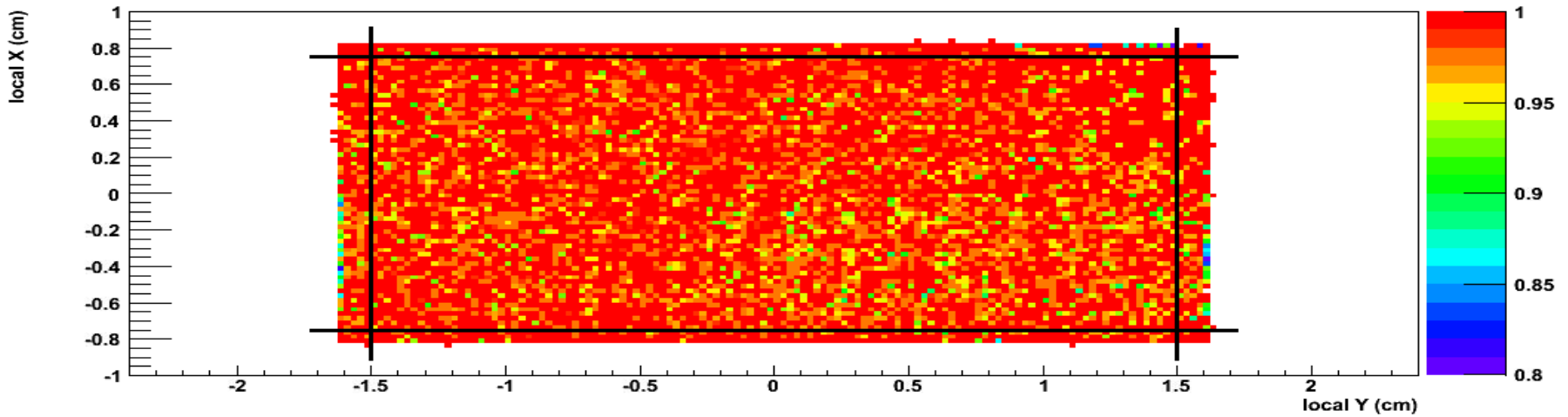
# Fiducial Region selection – Layer 2, Full Module

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# Fiducial region – Disk-2, Panel 1, Module 3

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# Fiducial Region Selection

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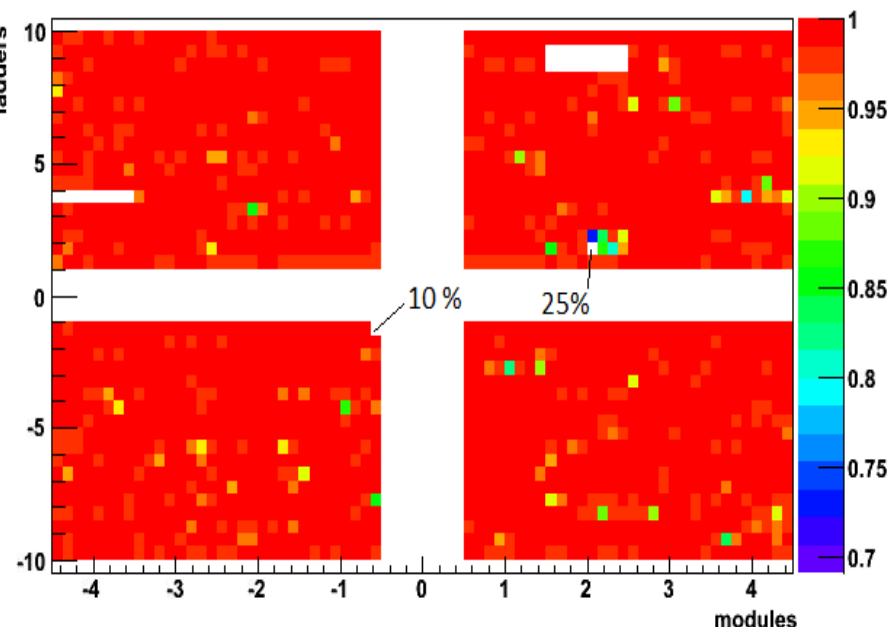
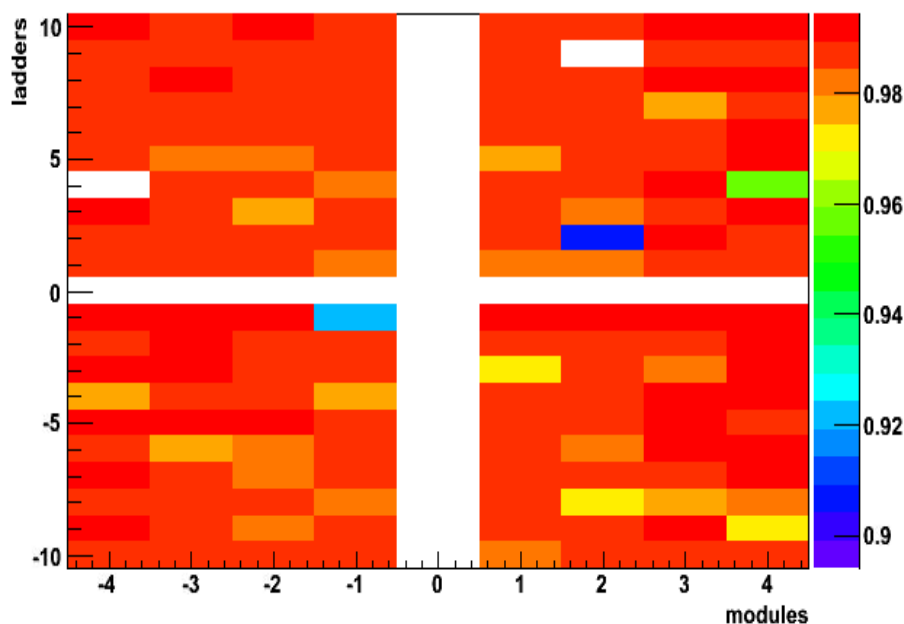
<b>BPix</b>	<b>Full Modules</b>		<b>Half Modules</b>	
<b>Layer 1</b>	$0.05 <  lx  < 0.6$	$ ly  < 3.0$	$-0.38 < lx < 0.3$	$ ly  < 3.0$
<b>Layer 2,3</b>	$0.05 <  lx  < 0.6$	$ ly  < 3.0$	$-0.38 < lx < 0.36$	$ ly  < 3.0$

<b>FPix</b>	<b>Module</b>	<b>Disk -2,+1,+2</b>		<b>Disk -1</b>	
<b>Panel 1</b>	1	$ lx  < 0.38$	$ ly  < 0.7$	$-0.15 < lx < 0.38$	$-0.7 < ly < 0.35$
	2	$ lx  < 0.75$	$ ly  < 1.1$	$-0.55 < lx < 0.6$	$ ly  < 1.0$ & $ly < 0.75$ for $-lx$
	3	$ lx  < 0.75$	$ ly  < 1.5$	$-0.5 < lx < 0.6$	$ ly  < 1.4$ & $ly < 1.1$ for $-lx$
	4	$ lx  < 0.38$	$ ly  < 1.9$	$-0.38 < lx < 0.2$	$ ly  < 1.9$
<b>Panel 2</b>	1	$ lx  < 0.75$	$ ly  < 1.1$	$ lx  < 0.75$	$ ly  < 1.1$
	2	$ lx  < 0.75$	$ ly  < 1.1$	$ lx  < 0.75$	$ ly  < 1.1$
	3	$ lx  < 0.75$	$ ly  < 1.5$	$ lx  < 0.75$	$ ly  < 1.5$

# BPix Layer 1 ROC Efficiency

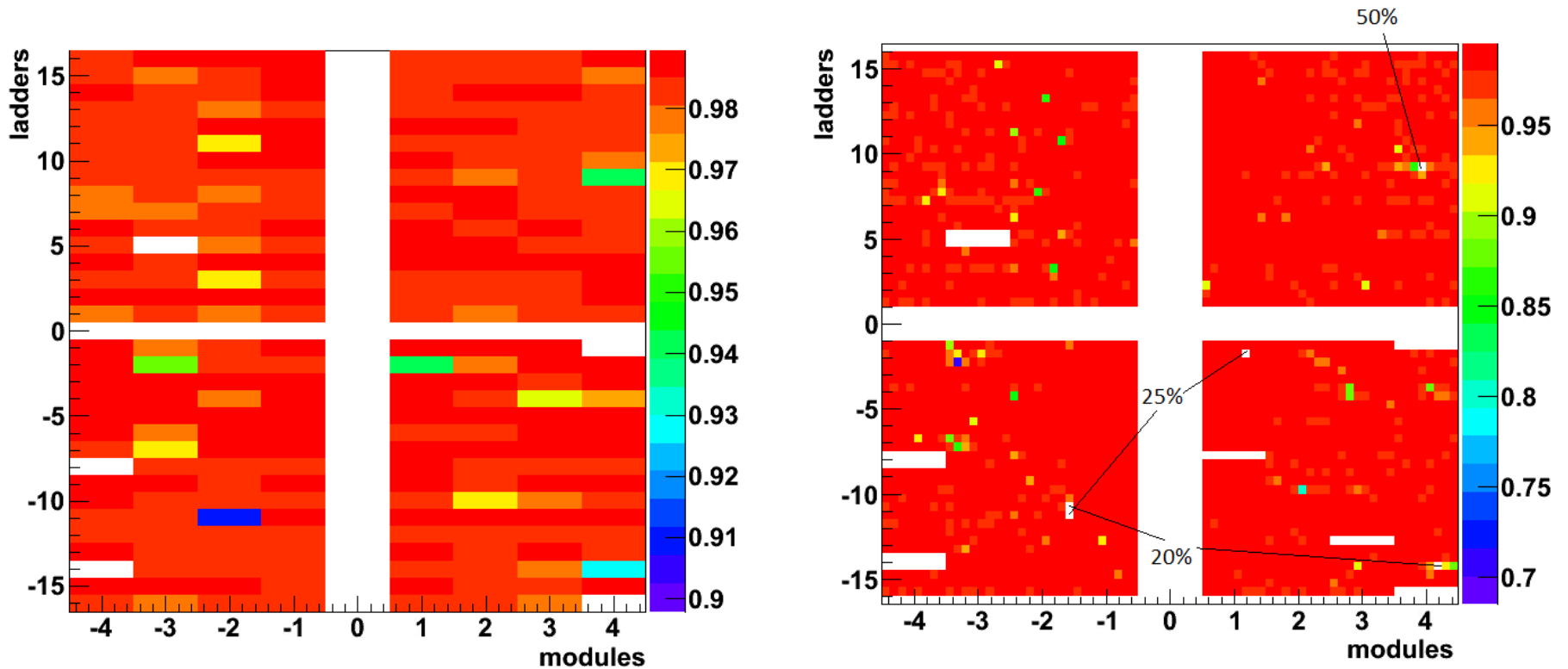
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- ROC indices were computed based on local coordinates (lx, ly)
- Plots follow the geometrical structure of the detector
- Certain ROCs have significantly lower efficiency causing the previously seen lower module efficiencies



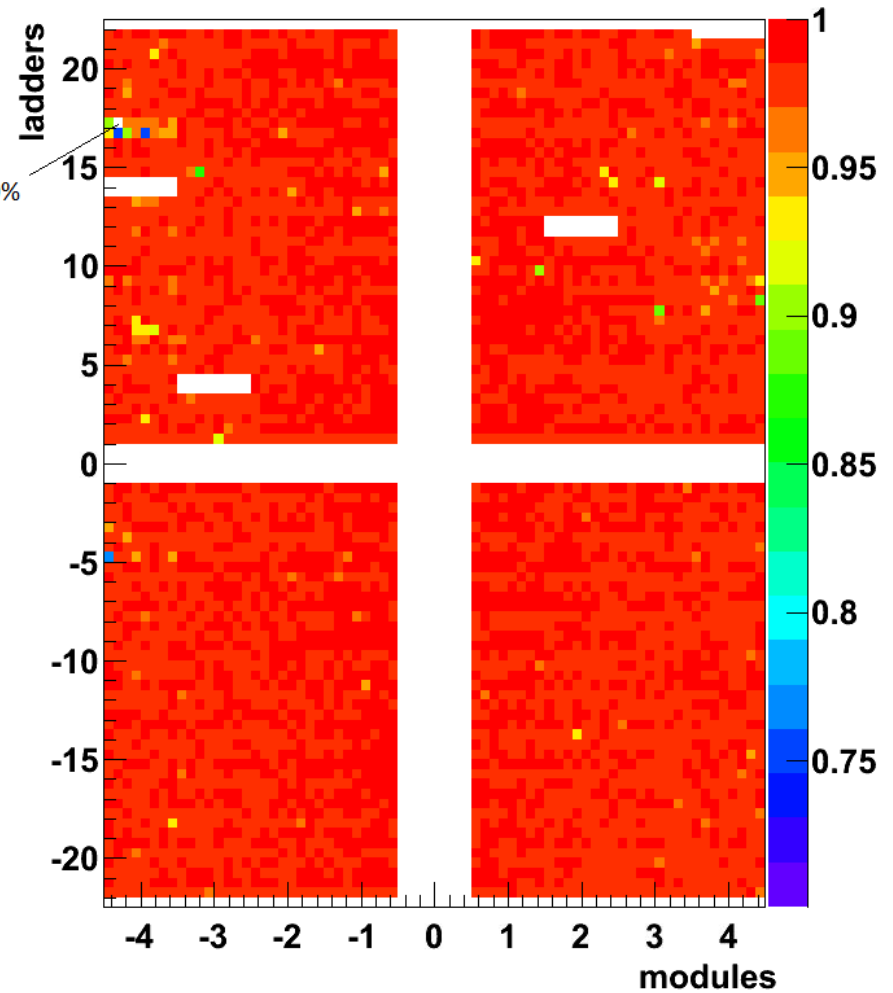
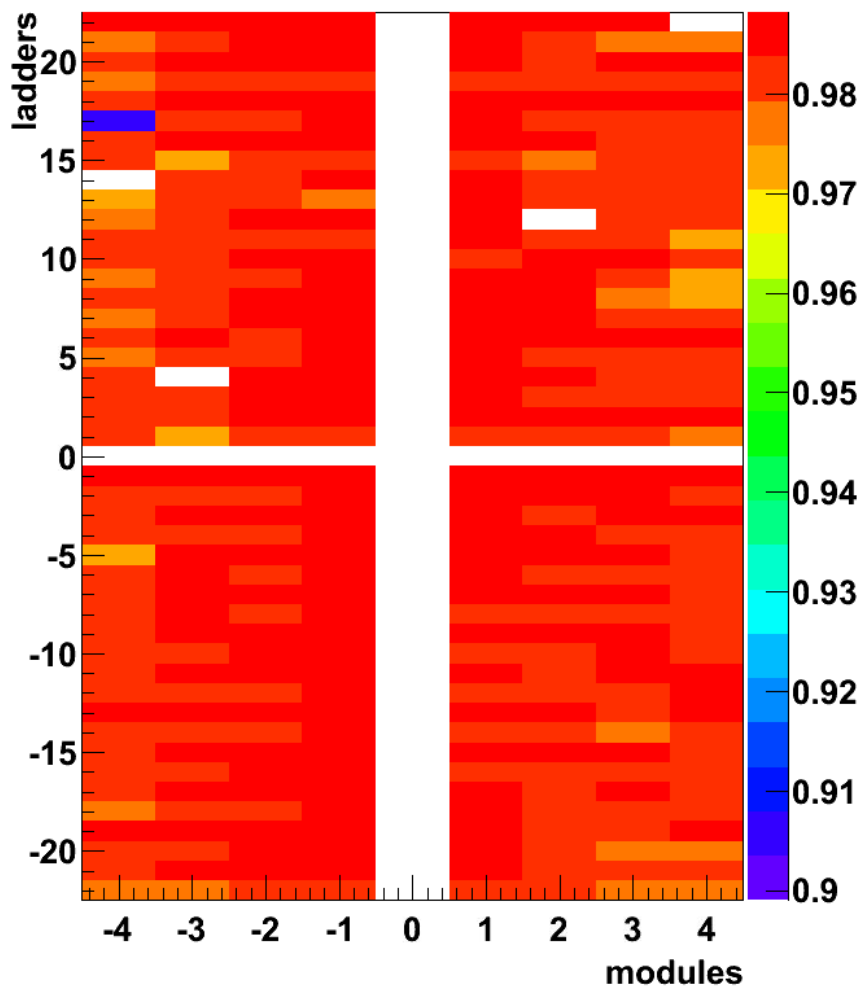
# BPix Layer 2 ROC Efficiency

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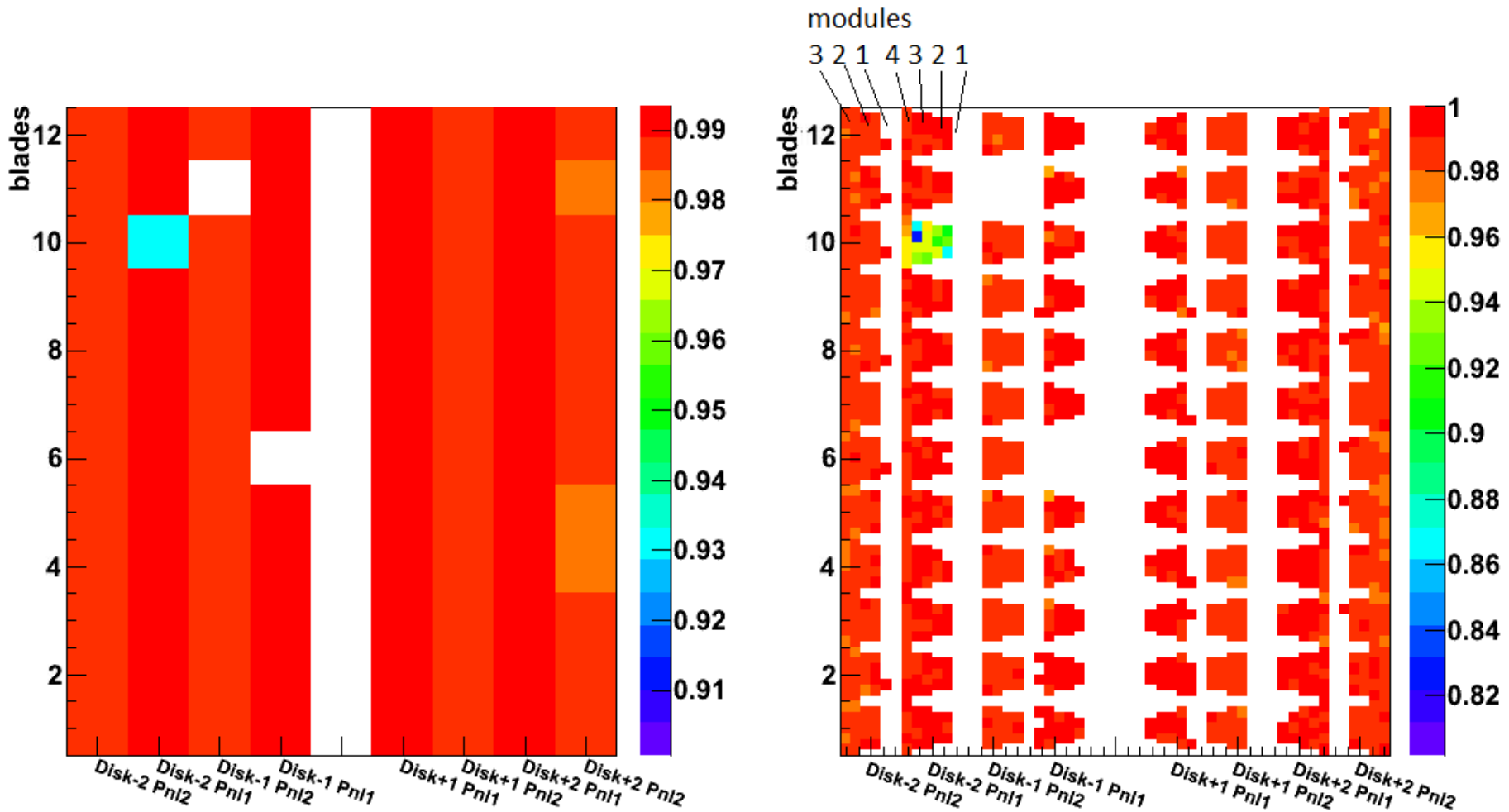
# BPix Layer 3 Efficiency

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# Fpix – BmI, BpI

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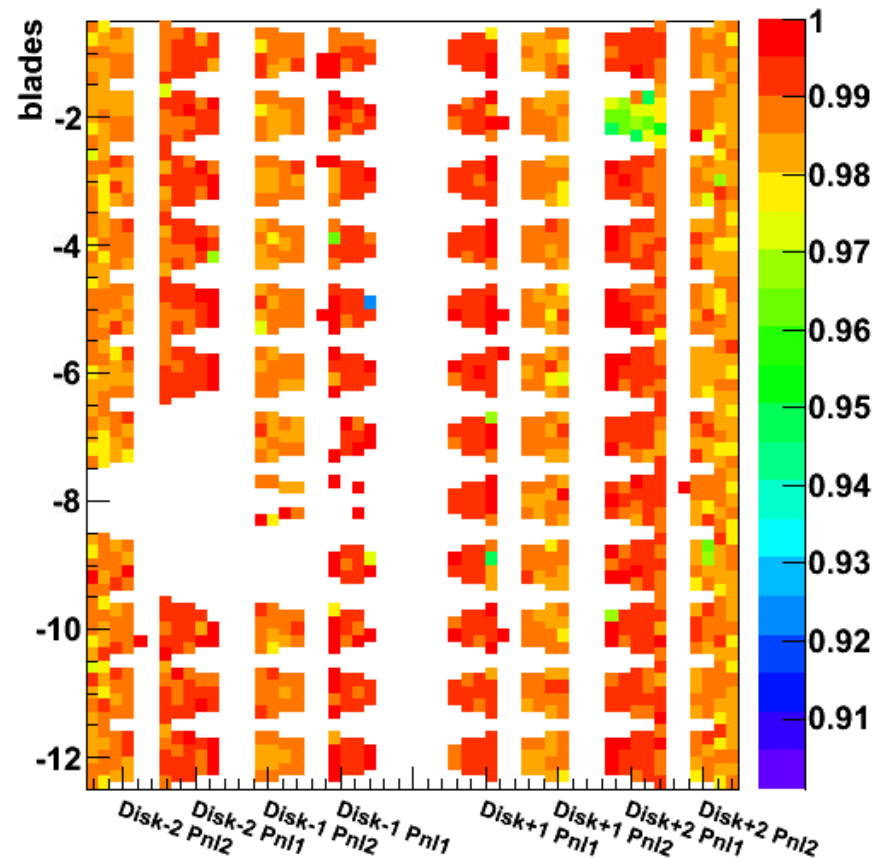
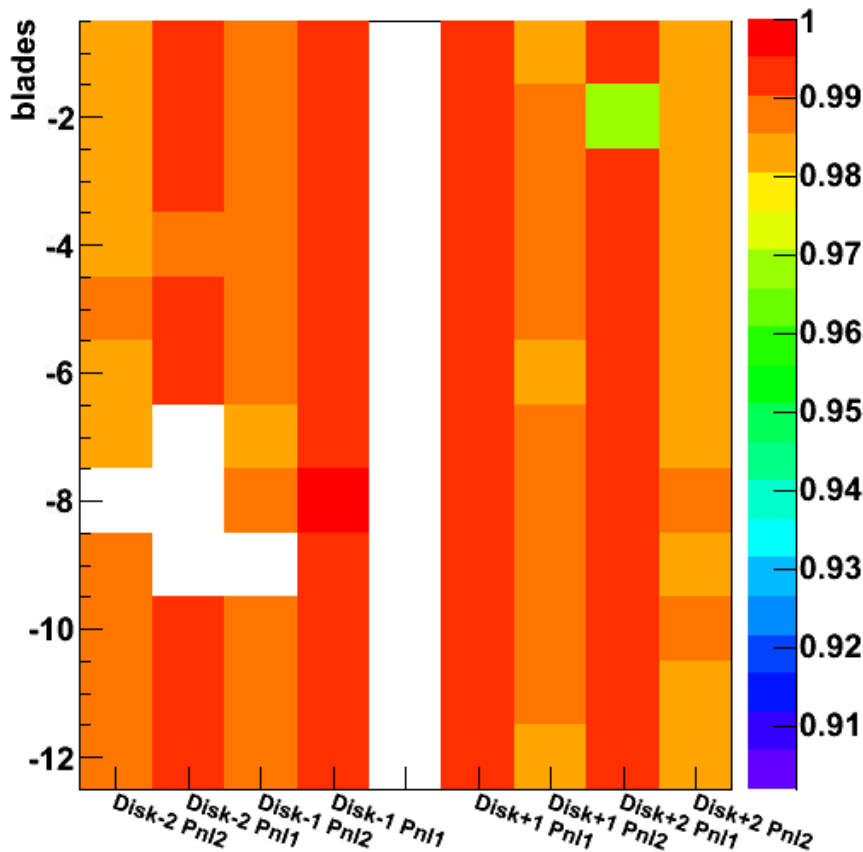




# Fpix – BmO, BpO

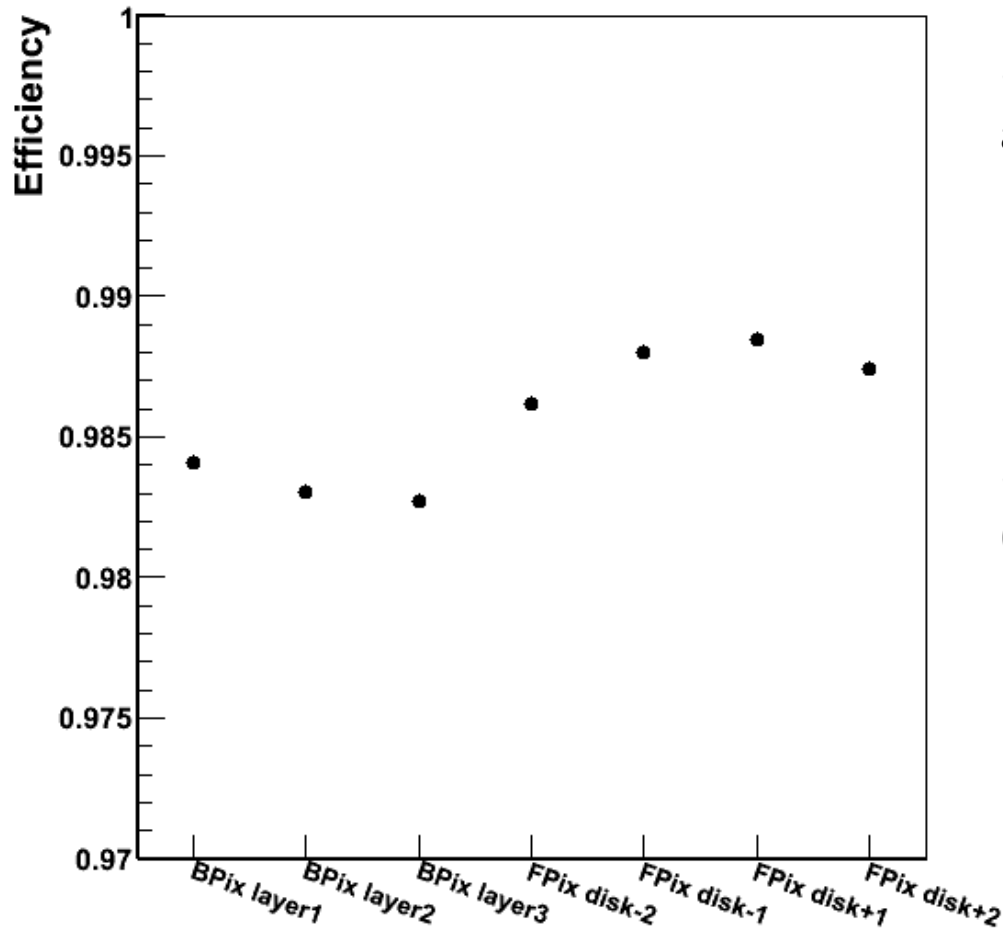
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- The valid hit requirements on the „other” disks/layers excludes certain areas (that are not tested by the tracking)



# Efficiency of layers/Disks for Sep17ReReco runs

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- Note: in FPix not all plaquettes are tested. Missing:

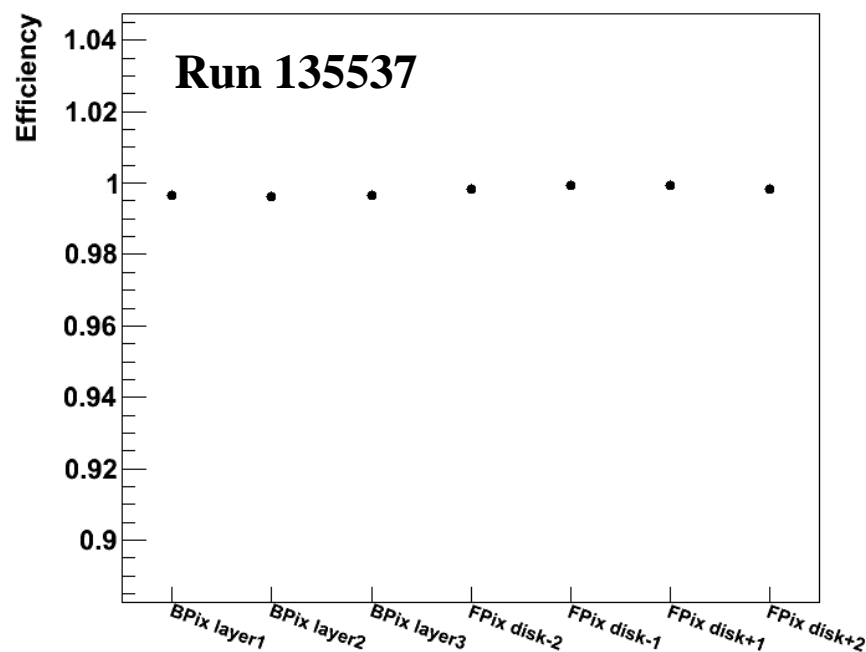
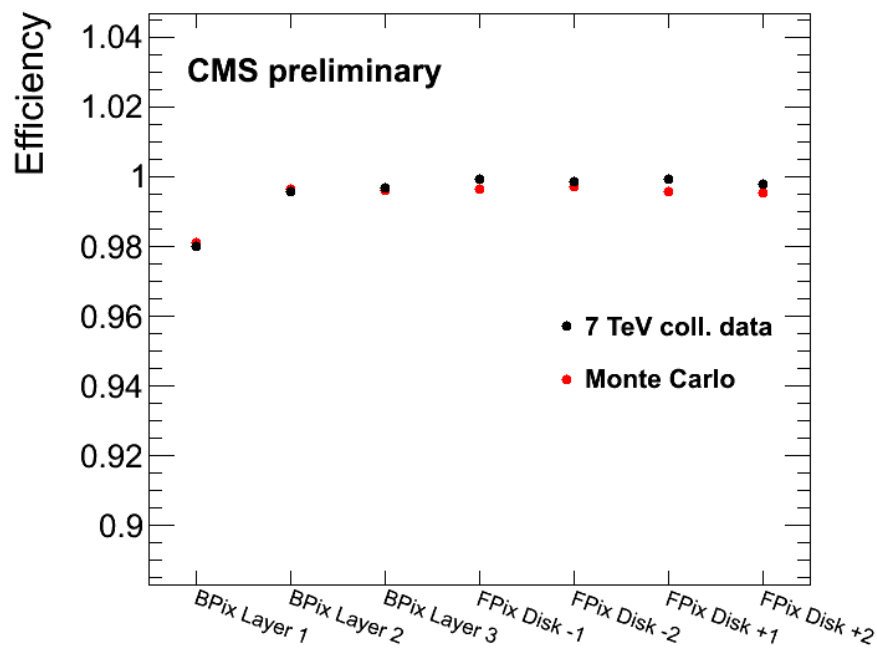
- Disk 2, Module 1
- Disk 1, Panel 1, Module 4
- Disk 1, Panel 2, Module 3 (counted radially outward)

- Efficiency is lower than expected (see comparison on next slide)

# Comparison with earlier results

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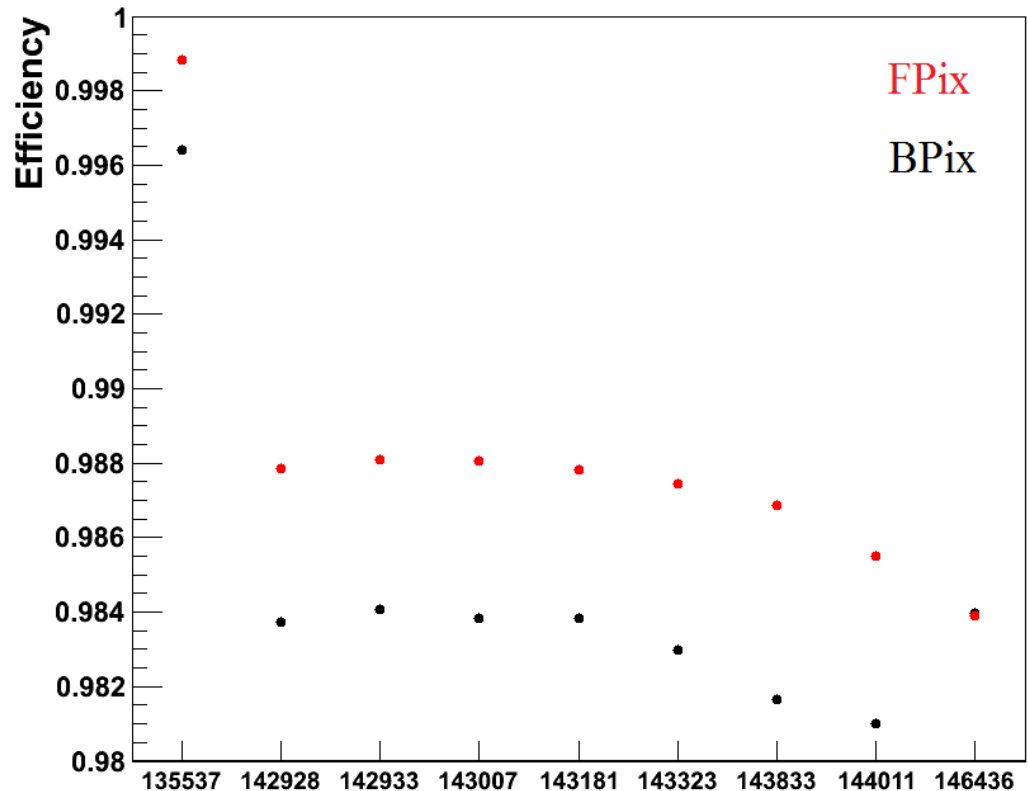
- Compared new calculation method with approved plot by using Run 135537
- Problem with Layer 1 is fixed (tighter do/dz cuts)



# Efficiency vs Runs in chronologic order

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- A decrease in efficiency is observed in recent runs
  - ~1.1 % Overall decrease
  - This is seen on all layers/disks
- Planning to investigate the source of this drop



# Next Objectives

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- Check efficiency dependence on distance between hits and clusters
- Estimate errors
- Finalize cuts
  - Try to include missing outer plaquettes in FPix disk 1
  - Check quality of track fit instead of cutting on number of strip hits
- Find reasons for efficiency loss in recent data
  - Probably need to check temporary problems with detector and read-out
  - Compile a „bad ROC” list

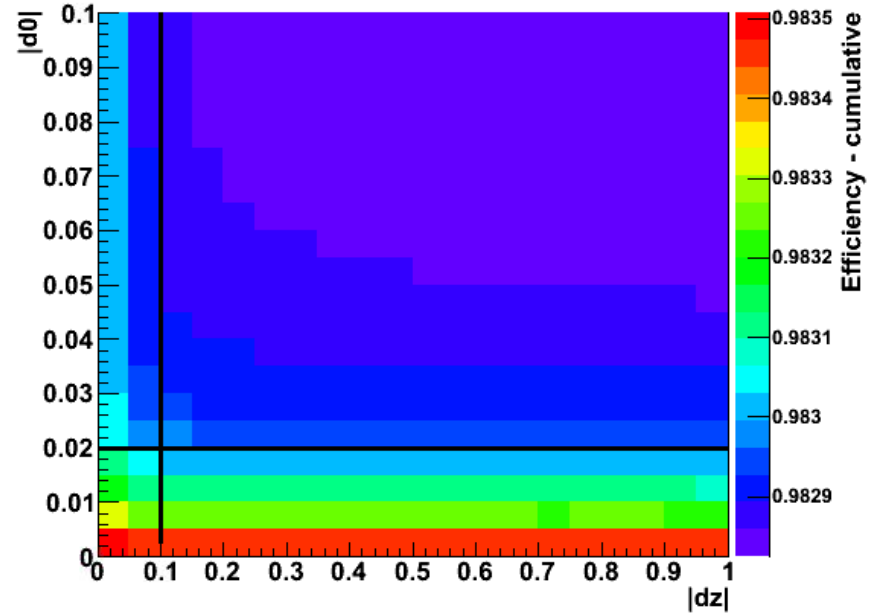
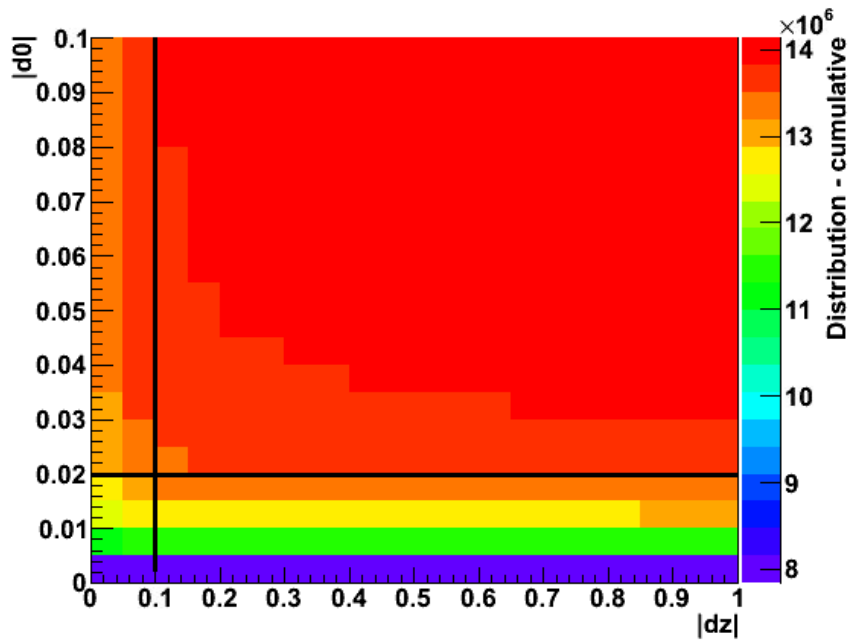
# Backup slides

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# $dz/d\phi$ for Layer 2

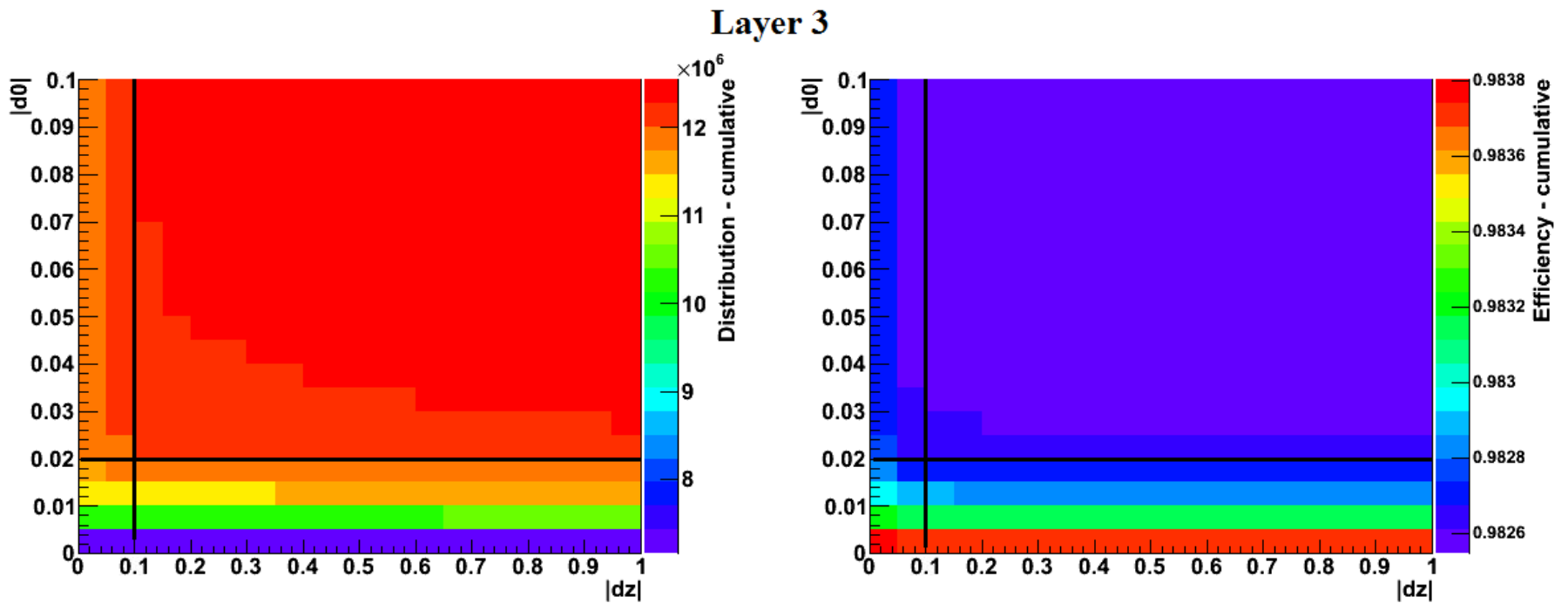
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## Layer 2



# $dz/d\phi$ for Layer 3

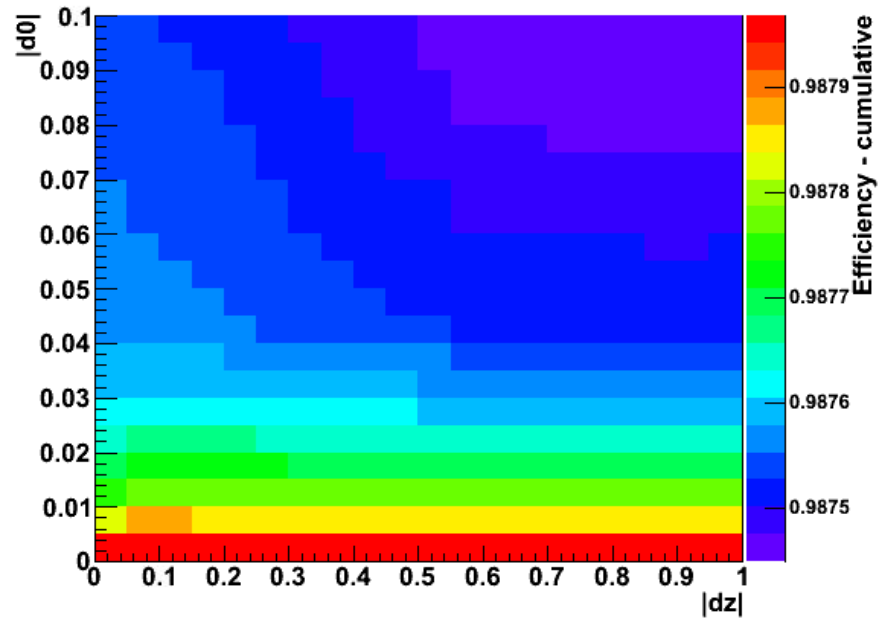
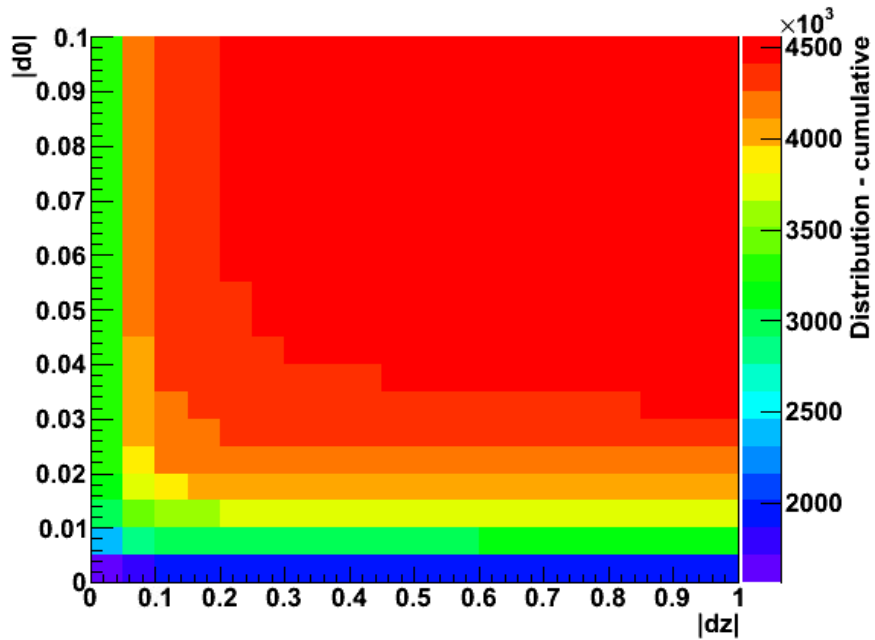
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# $dz/d\phi$ for FPix

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# Fiducial cut – Layer 1, Half Module

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