

# F2F TRACKING MEETING

## SUMMARY

EUGENIO PAOLONI

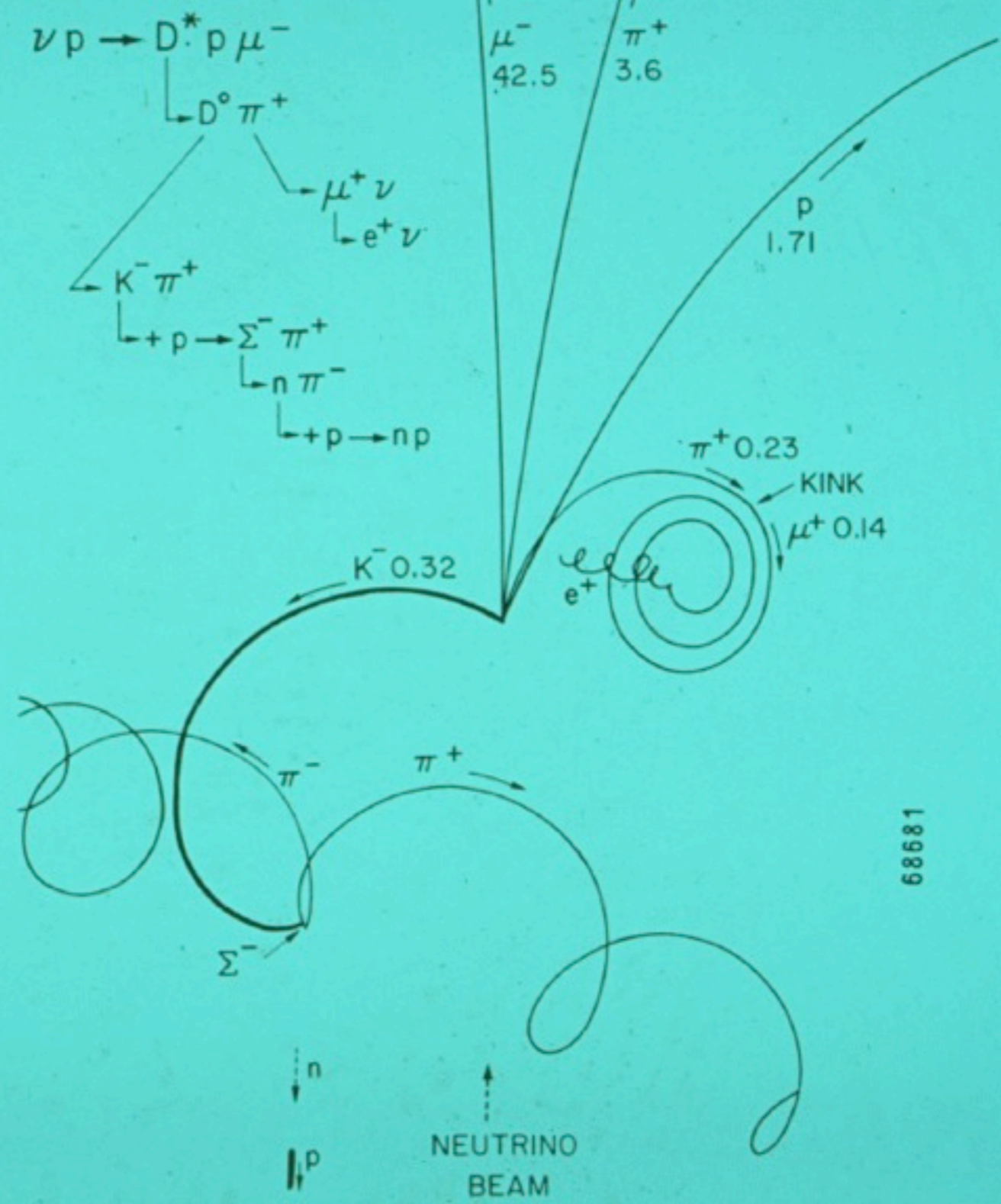
INFN - & UNIVERSITY OF PISA

ON BEHALF OF THE TRACING GROUP

AACHEN-BONN-CERN-MUNICH-OXFORD COLLABORATION

WA 21

EVENT 294/0995



68681

VXD MEETING PRAGUE, JANUARY THE 21<sup>TH</sup> 2015

MOMENTUM IN GeV/c

# Overview

- ◆ The focus of the meeting was mainly on on Track Reconstruction Software Quality Monitor
  - ◆ We had a serious bug affecting the resolution that went unnoticed for months and that was corrected by Jakob last week.
  - ◆ We must avoid that this will happen again.
    - ◆ Extensive set of validation plots.
    - ◆ Tools to quickly investigate on features / bugs
- ◆ We had also very interesting and reassuring status reports on the advances of the tracking reconstruction & simulation software, new ideas.
- ◆ Many new people attended the meeting. We hope that we made a good impression on them (for sure the social dinner beer was excellent).

# Validation Concept

- ◆ Define a reference release and a produce a reference plot with it
- ◆ Compare the plot made with new releases with the reference one and look for regressions
- ◆ Some key plots are missing at present

# VXD Contribution List

## "TrackFinderVXDStandAlone"

Session: VXD Pattern Reco 

Presented by **Mr. Jakob LETTENBICHLER, Eugenio PAOLONI** on **20 Jan 2015** at **13:30**

## Digitizers & Background Simulation

Session: VXD Simulation 

Presented by **Peter KVASNICKA** on **19 Jan 2015** at **17:00**

## STATUS OF DATA REDUCTION INCLUDING CLUSTER ANALYSIS

Session: Data Reduction News & Schedule Items Review 

Presented by **Dr. Martin HECK** on **20 Jan 2015** at **16:00**

## What we can learn from Testbeam for Local PXD Simulation and Clustering

Session: VXD Simulation 

Presented by **Mr. Benjamin SCHWENKER** on **19 Jan 2015** at **17:20**

## VXDTF studies: Current Status of TrackCand Converter Modules

Session: VXD Pattern Reco 

Presented by **Mr. Thomas MADLENER** on **20 Jan 2015** at **14:15**

## 6-Layer Tracking Tests

Session: VXD Pattern Reco 

Presented by **Leo KOCH** on **20 Jan 2015** at **14:35**

# Alignment, Validation

## Alignment Overview Talk

Session: Alignment 

Presented by **Dr. Sergey YASHCHENKO** on **19 Jan 2015** at **14:45**

## GBL & Millepede in basf2

Session: Fitting & MDST 


Presented by **Mr. Tadeas BILKA** on **19 Jan 2015** at **13:50**

## Genfit, KS, ...

Session: Fitting & MDST 

Presented by **Mr. Tobias SCHLÜTER** on **19 Jan 2015** at **13:00**

## Validation Plots

Session: Merging & Pattern Reco 2 

Presented by **Dr. Giulia CASAROSA** on **20 Jan 2015** at **11:00**

## Common Validation Code Base Discussion

Presented by **Dr. Thomas Hauth**

# CDC And Other Topics

## New Developments in the CDC Software

**Session:** CDC Simulation & Pattern Reco 1 ■

Presented by ??? ??? on 20 Jan 2015 at 09:30

## Selecting Good CDC Tracks

**Session:** Merging & Pattern Reco 2 ■

Presented by Nils BRAUN on 20 Jan 2015 at 10:30

## Track Merging

**Session:** Data Reduction News & Schedule Items Review ■

Presented by Mr. Benjamin OBERHOF on 20 Jan 2015 at 16:30

## TrackFinderCDCLegendre

**Session:** CDC Simulation & Pattern Reco 1 ■

Presented by Victor TRUSOV on 20 Jan 2015 at 09:00

## TrackFinderCDCLocal

**Session:** CDC Simulation & Pattern Reco 1 ■

Presented by Oliver FROST on 20 Jan 2015 at 08:30

## V0 object

**Session:** Fitting & MDST ■

Presented by Markus PRIM on 19 Jan 2015 at 13:30

# Current Performances



- ➔ used release r14908 (except otherwise stated), TrackingPerformanceEvaluation Module
  - Belle CDC pattern recognition (Trasan)
  - Merger of VXD TrackCand + CDC TrackCand uses MC truth information
  - no extrapolation from CDC to VXD and vice-versa

# Integrated Efficiency & Purity

<i>tracking</i> <sup>(*)</sup>	<b>VXD only</b> <i>(r14200)</i>	<b>CDC only</b> <i>(r14200)</i>	<b>VXD+CDC</b>
<b>purity (%)</b>	95.72±0.08	77.1±0.1	-
$\epsilon =$ <b>efficiency (%)</b>	68.4±0.2 <i>not updated see next slide</i>	75.3±0.1 <i>not updated</i>	82.0±0.1
$\epsilon' =$ <b>efficiency' (%)</b>	77.8±0.1	91.1±0.1	91.8±0.1

*(\*) numbers and plots shown are based on 8k Y(4S) events*

purity = probability to find an MCParticle associated to a Track, given a Track

$$\epsilon = \frac{\text{\# MCParticles with at least one associated Track}}{\text{\# MCParticles}}$$

physical efficiency

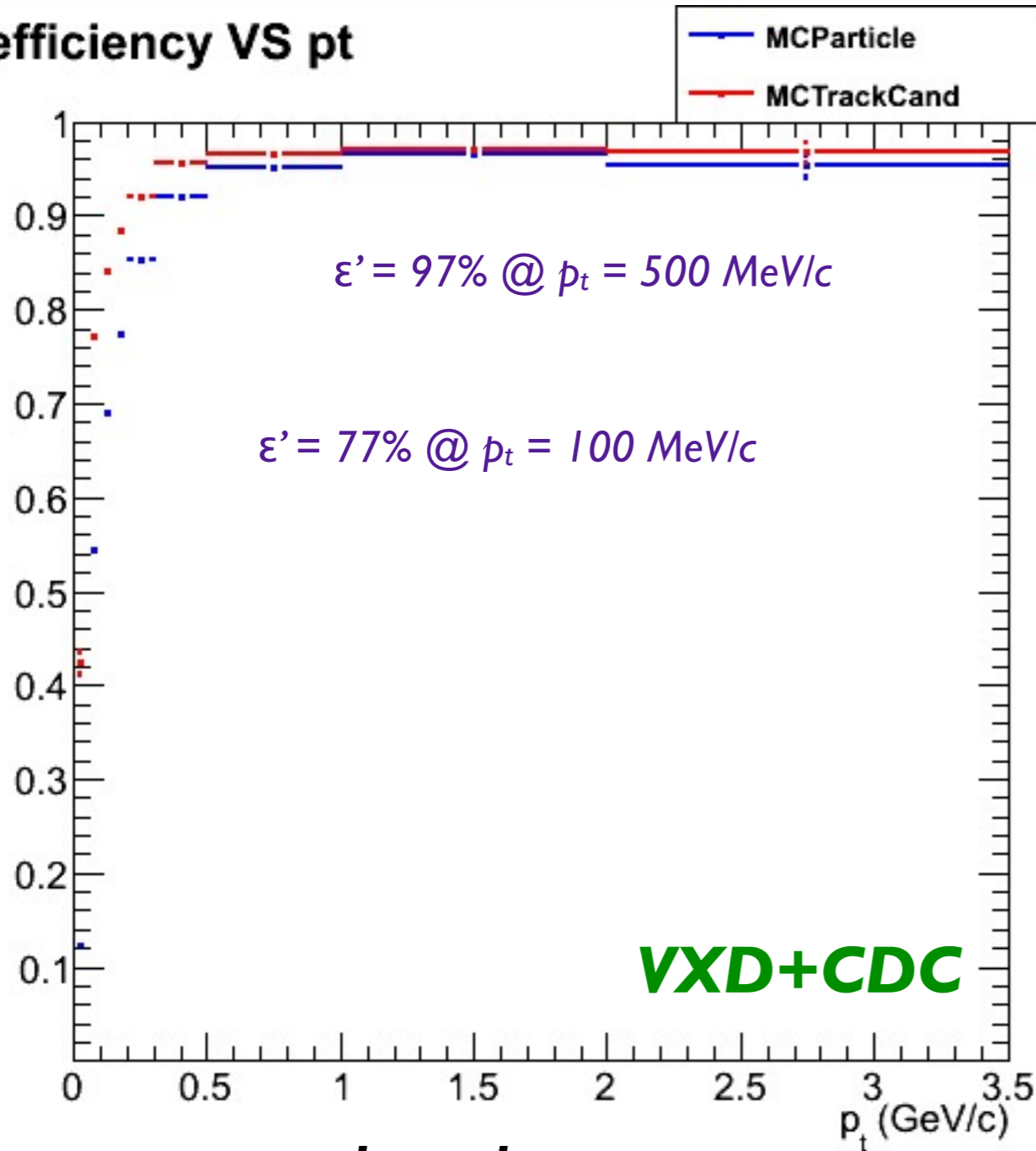
$$\epsilon' = \frac{\text{\# MCTrackCands with at least one associated Track}}{\text{\# MCTrackCands}}$$

geometrical acceptance and detector efficiency are factored out



# Efficiency VS Transverse Momentum

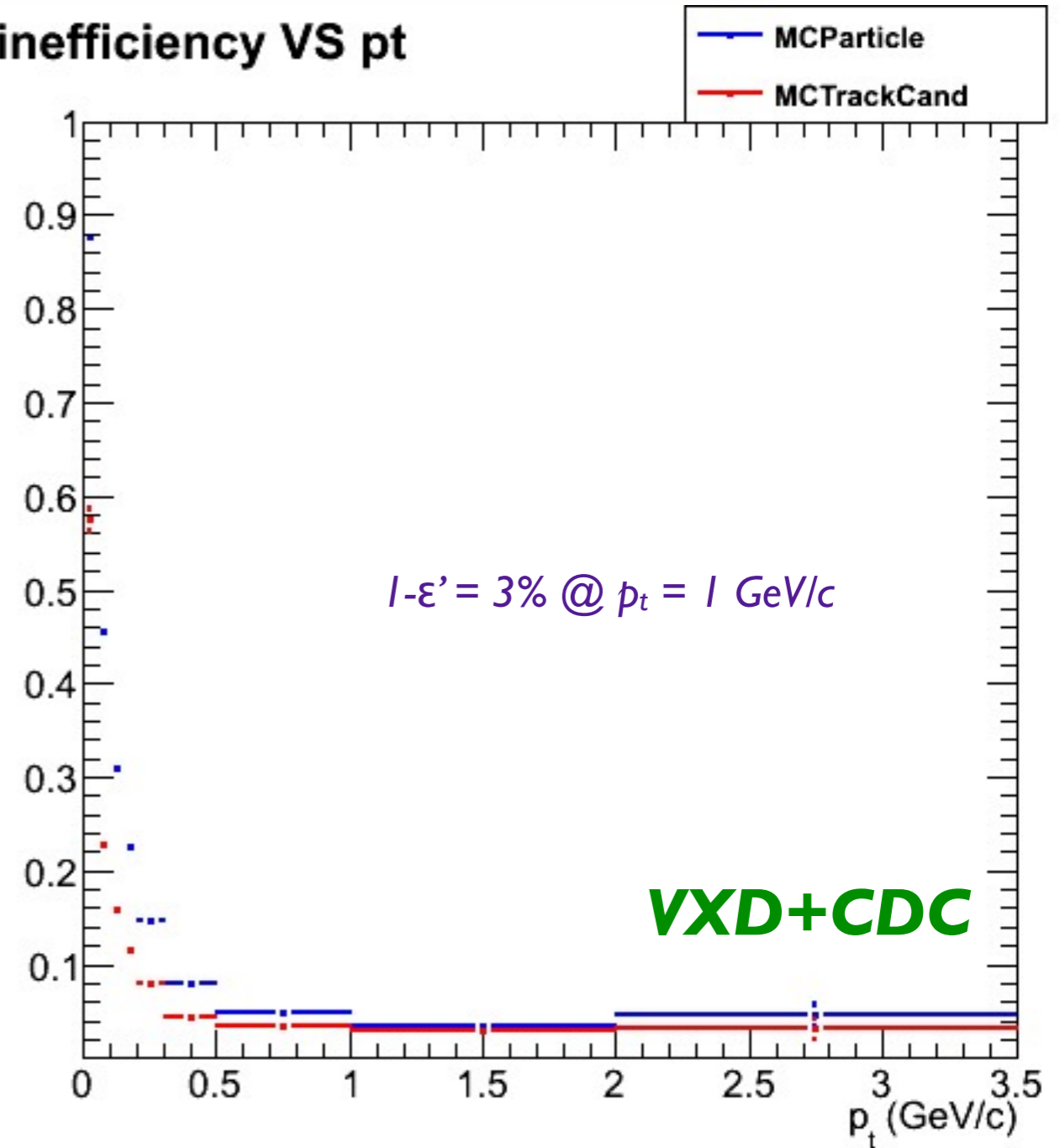
efficiency VS pt



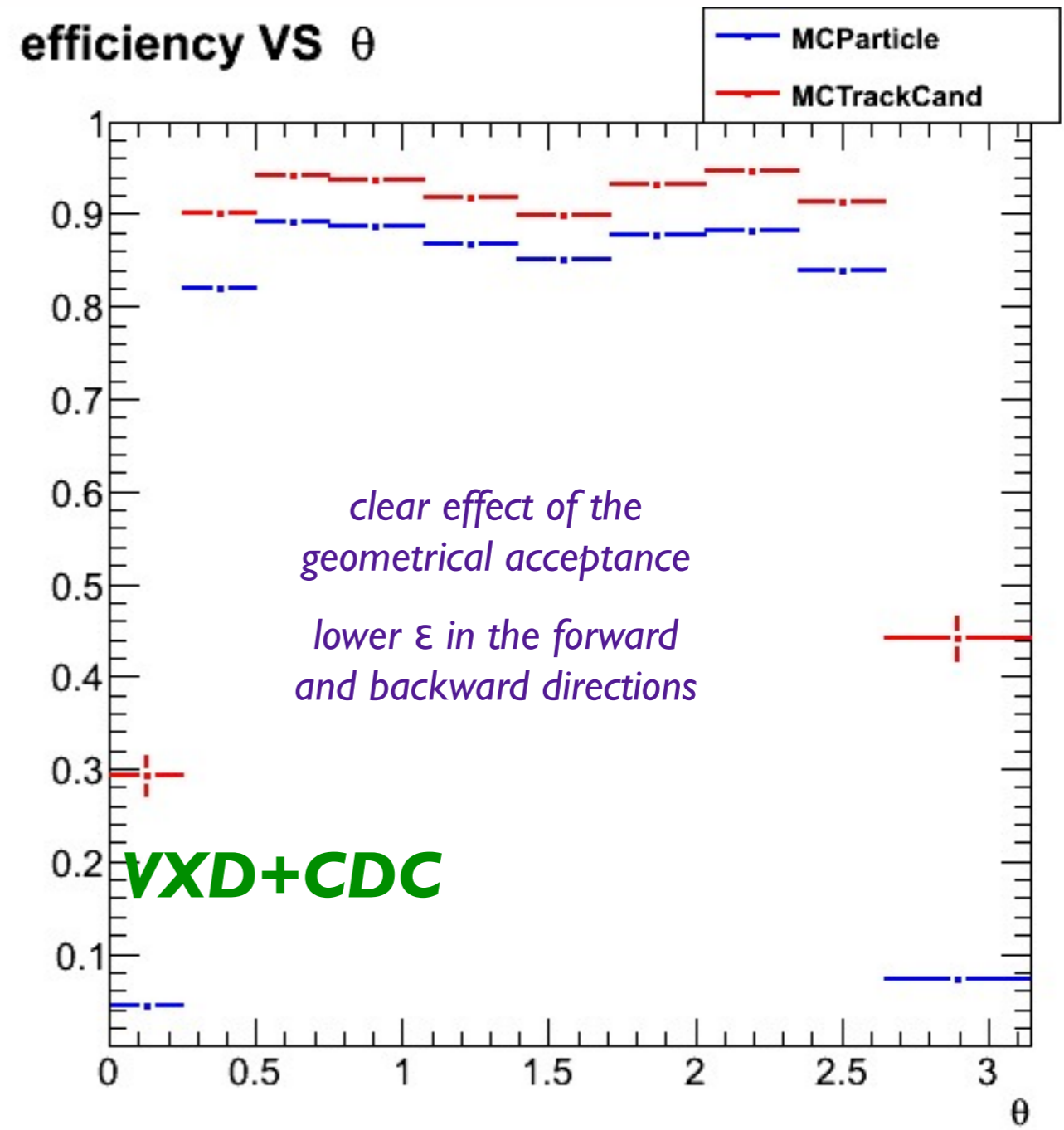
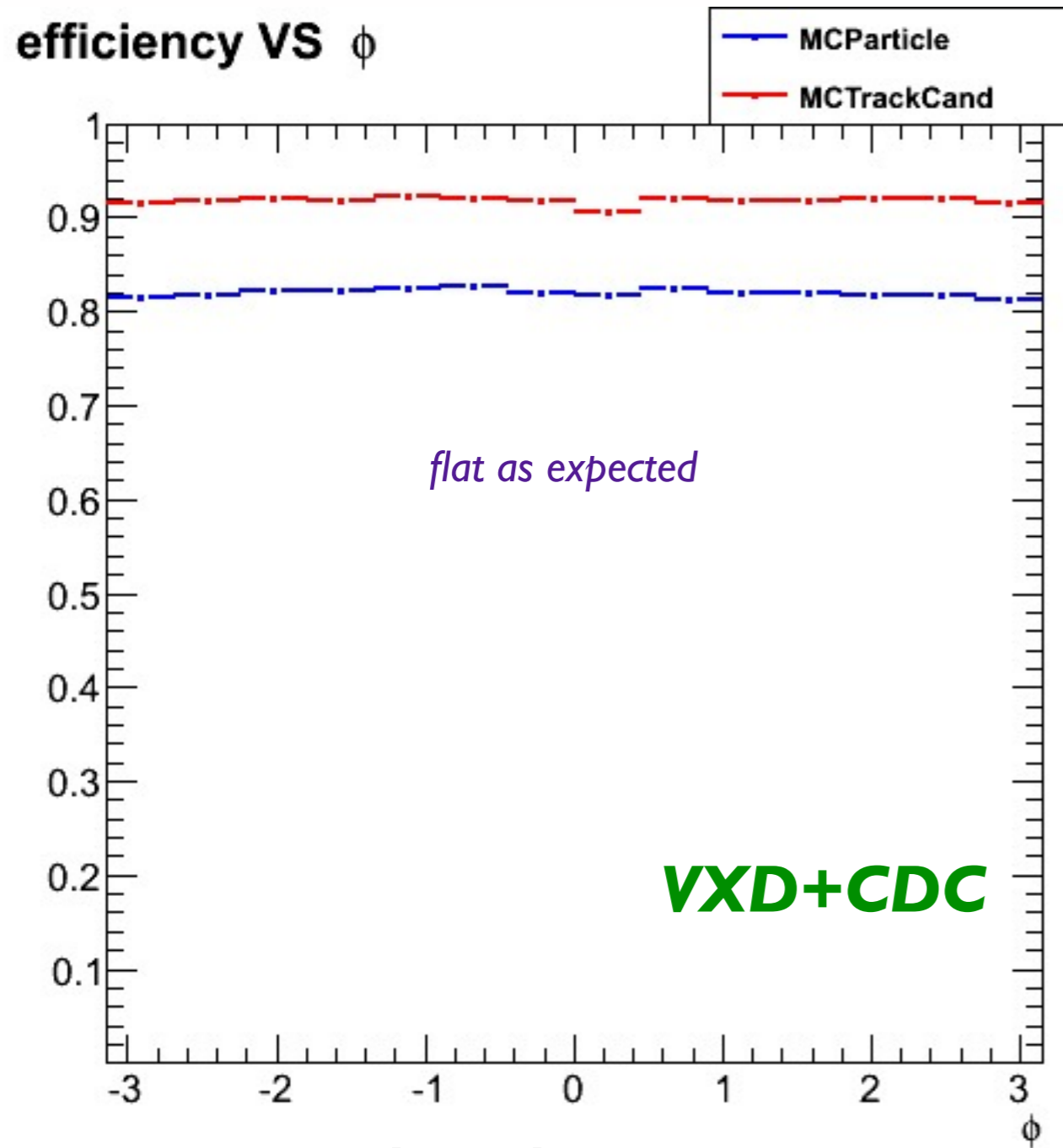
**legend:**

- $\epsilon$ , physical efficiency
- $\epsilon'$ , geometrical acceptance and detector efficiency factored out

inefficiency VS pt



# Efficiency VS Polar and Azimuthal Angles

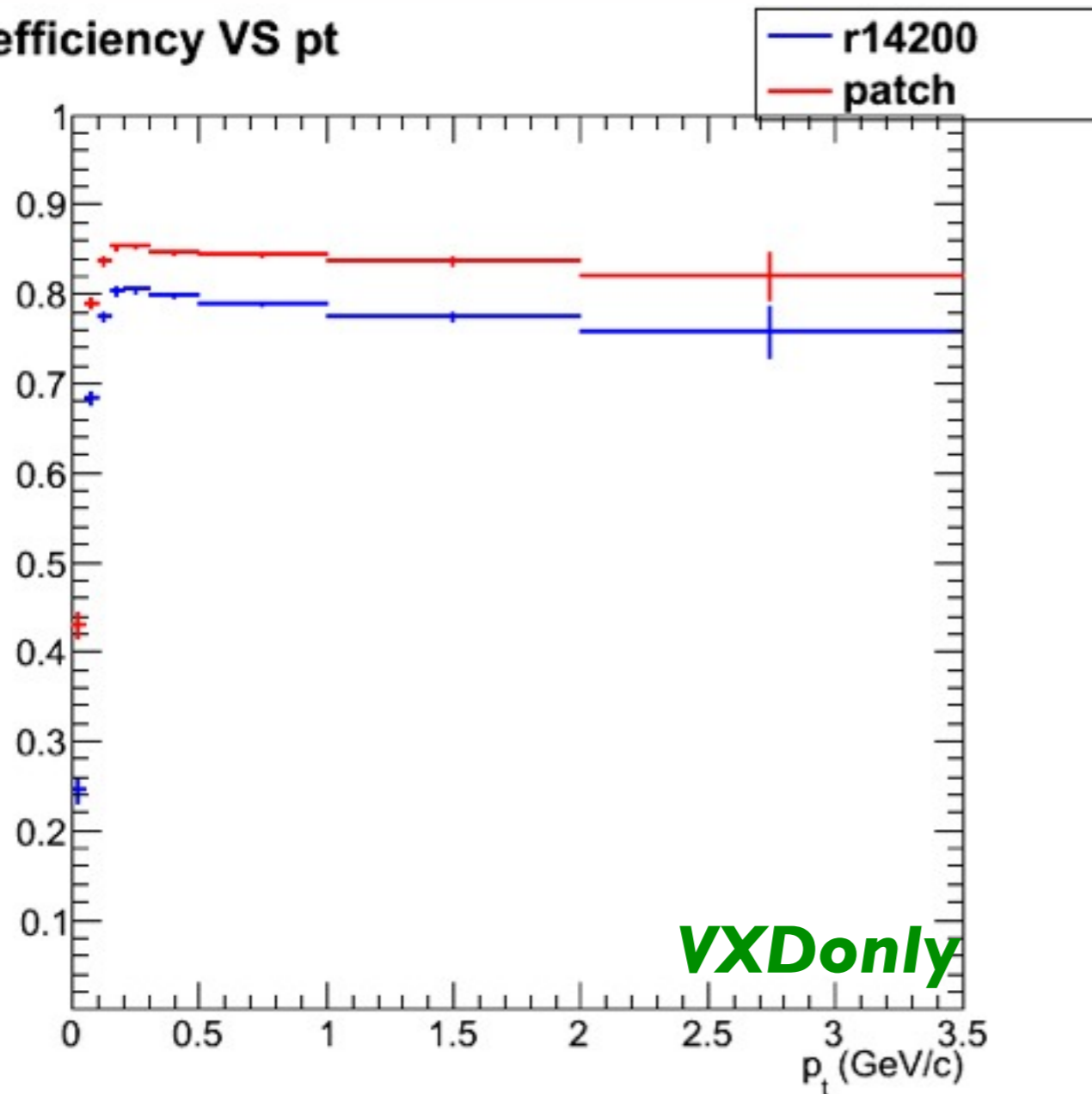


**legend:**

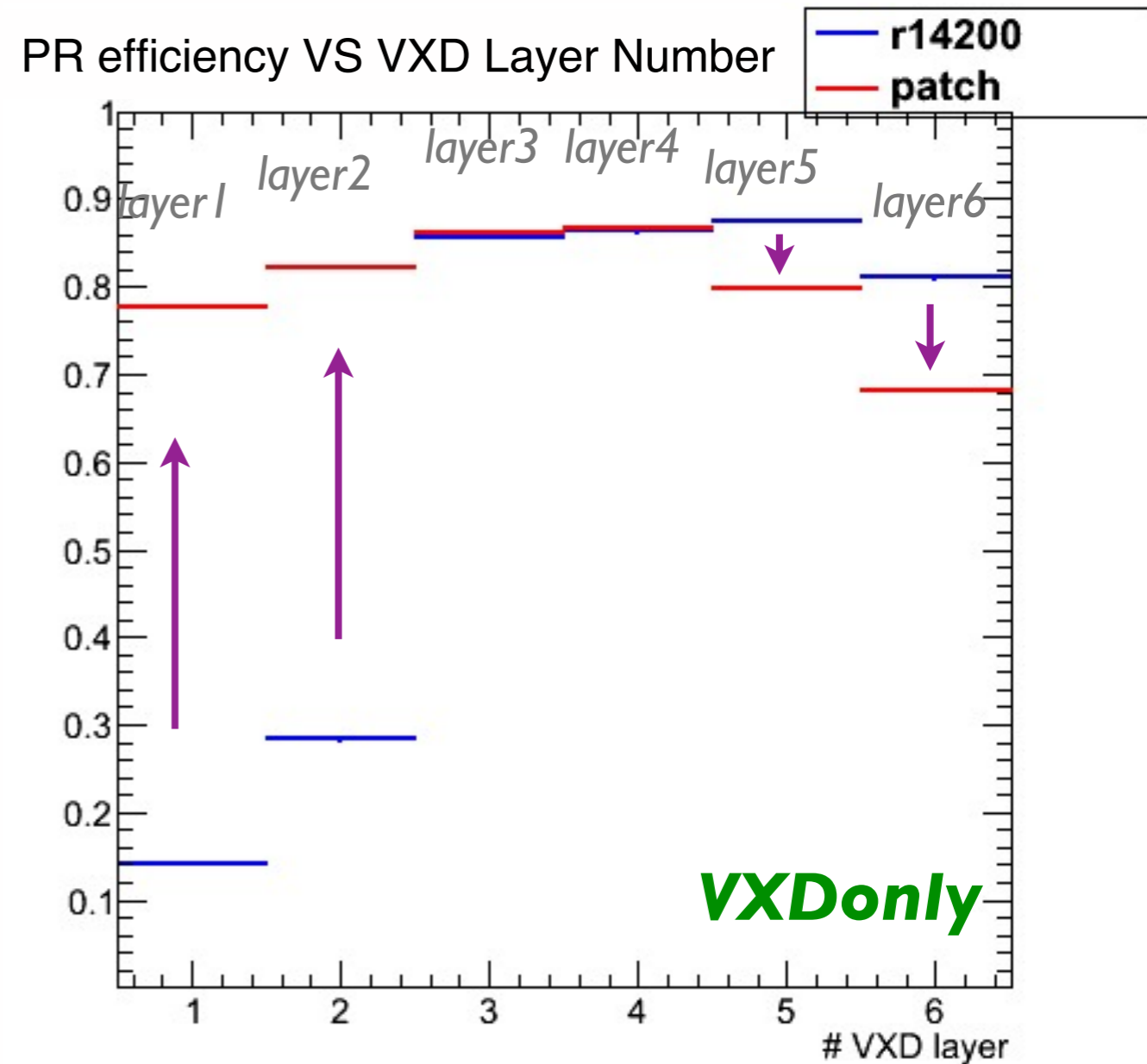
- $\epsilon$ , physical efficiency
- $\epsilon'$ , geometrical acceptance and detector efficiency factored out

# Efficiency VS $p_t$ and VXD Layers

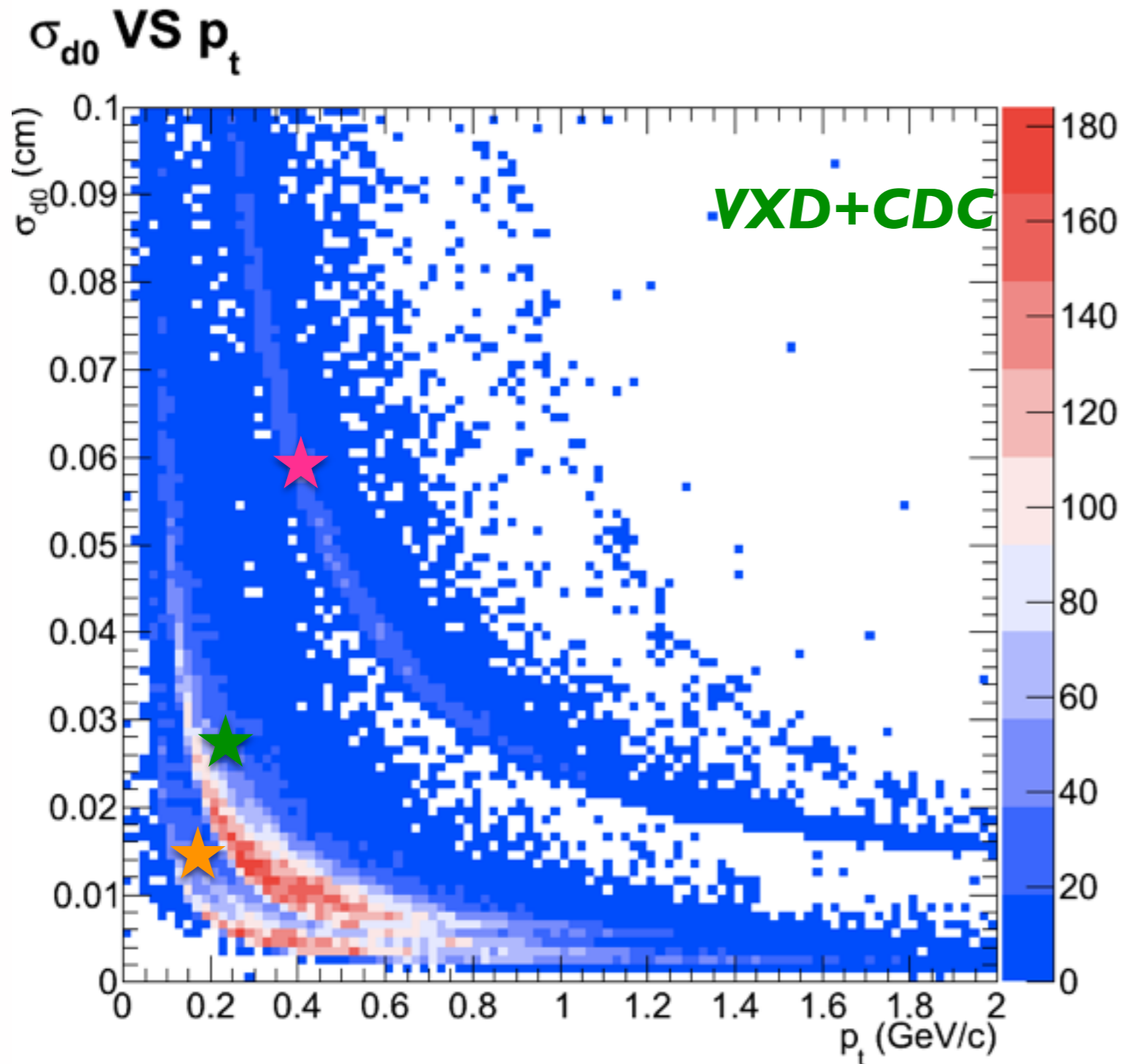
efficiency VS  $p_t$



PR efficiency VS VXD Layer Number



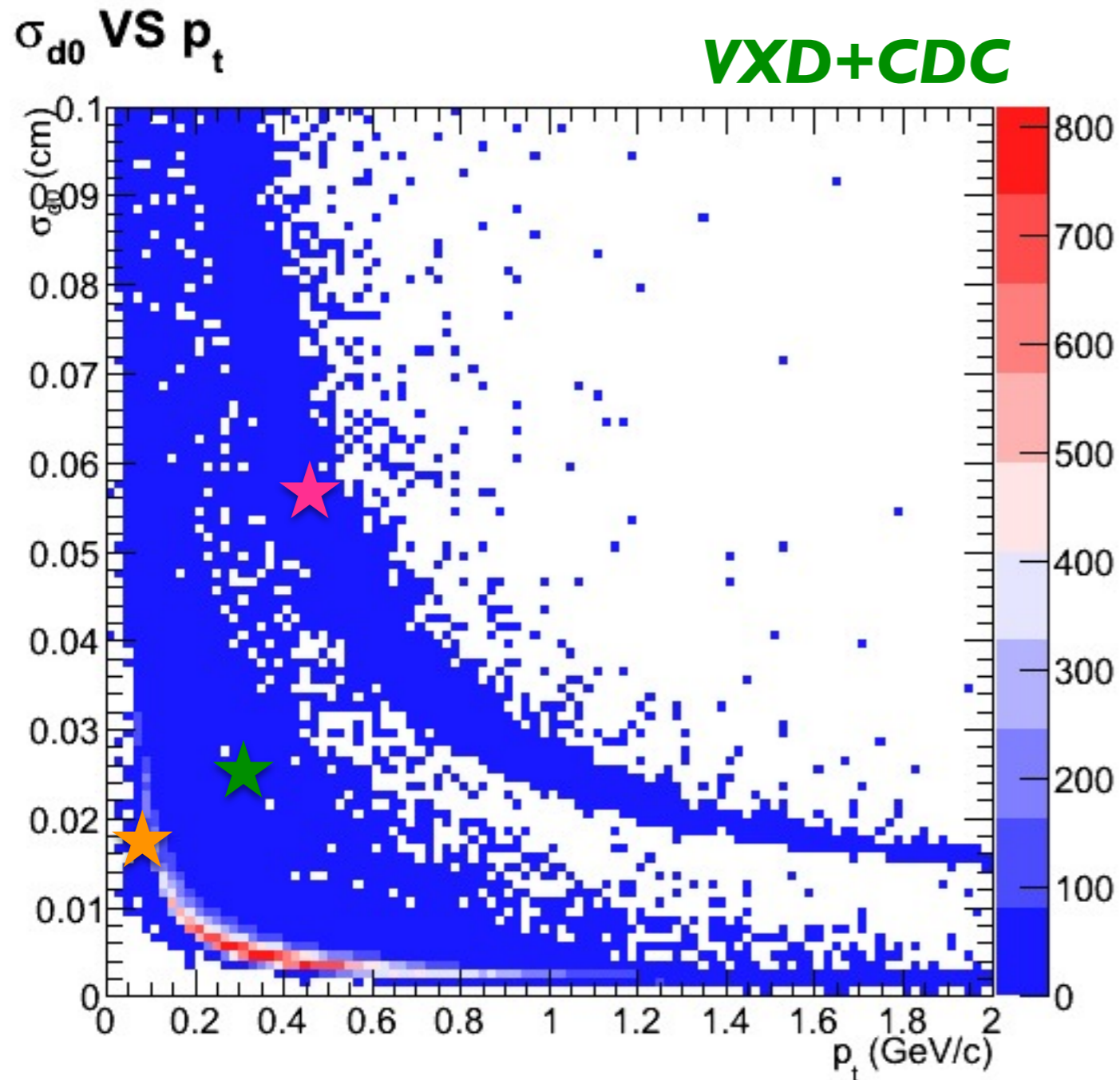
- ➔ improvement in efficiency VS  $p_t$
- ➔ huge increase of the efficiency on layers 1 and 2, but an undesired 10% decrease on outer layers shows up

$\sigma_{d0}$  VS transverse momentum

→ 3 families of tracks:

- ★ CDC only tracks
- ★ tracks with no PXD clusters attached
- ★ tracks with PXD clusters attached

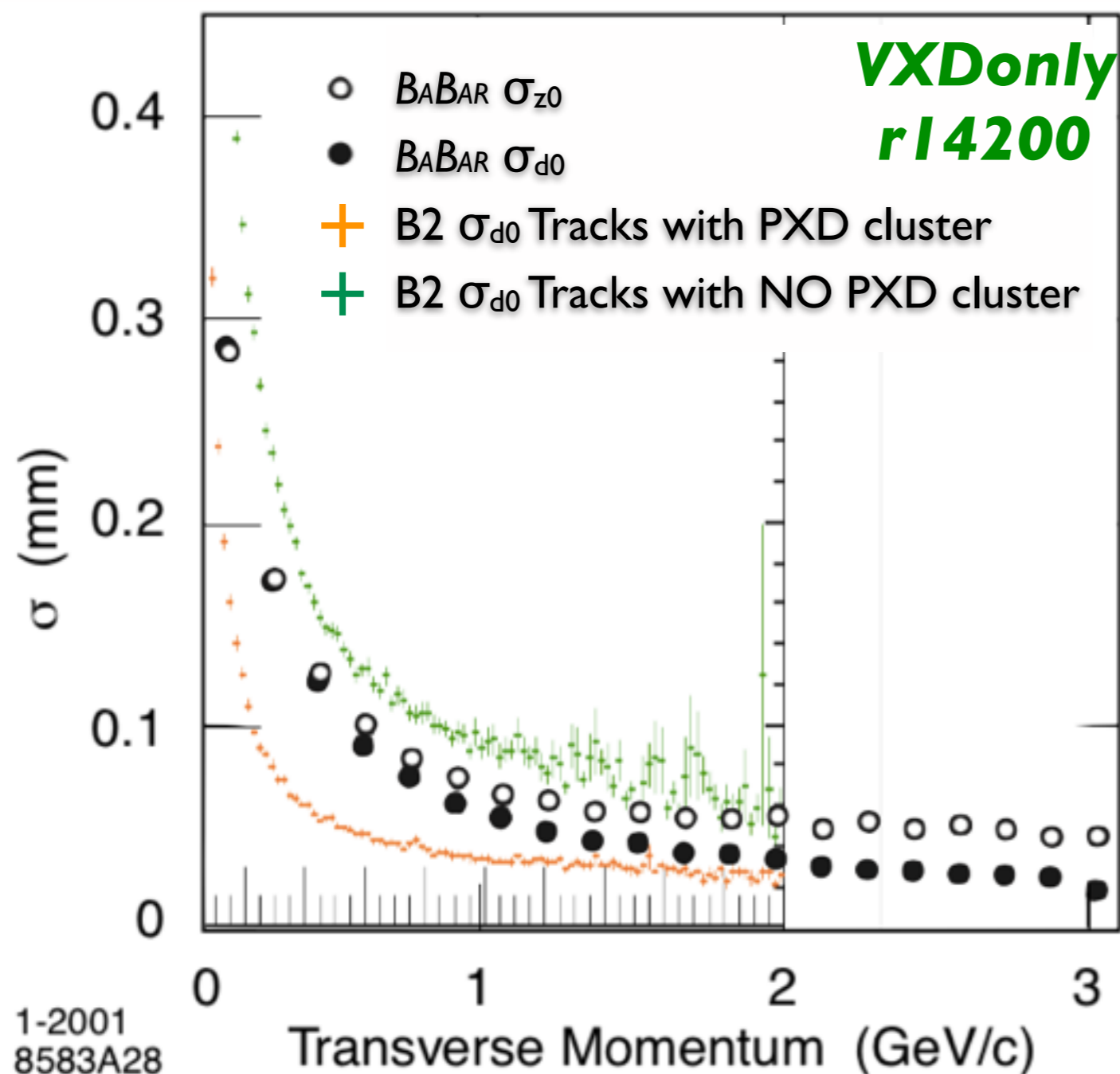
# $\sigma_{d0}$ VS transverse momentum



→ 3 families of tracks:

- ★ CDC only tracks
- ★ tracks with no PXD clusters attached
- ★ tracks with PXD clusters attached

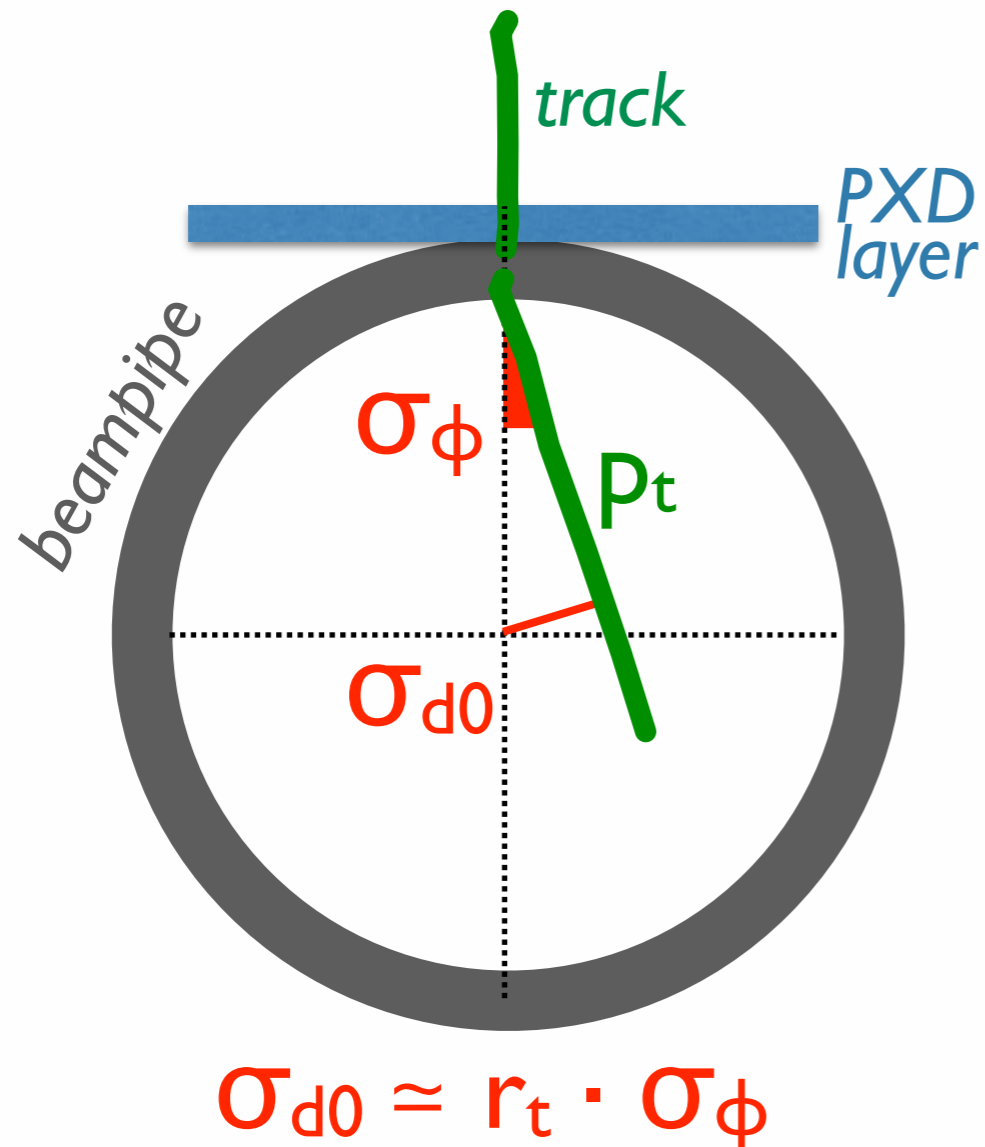
# Comparison with *BABAR* Tracking



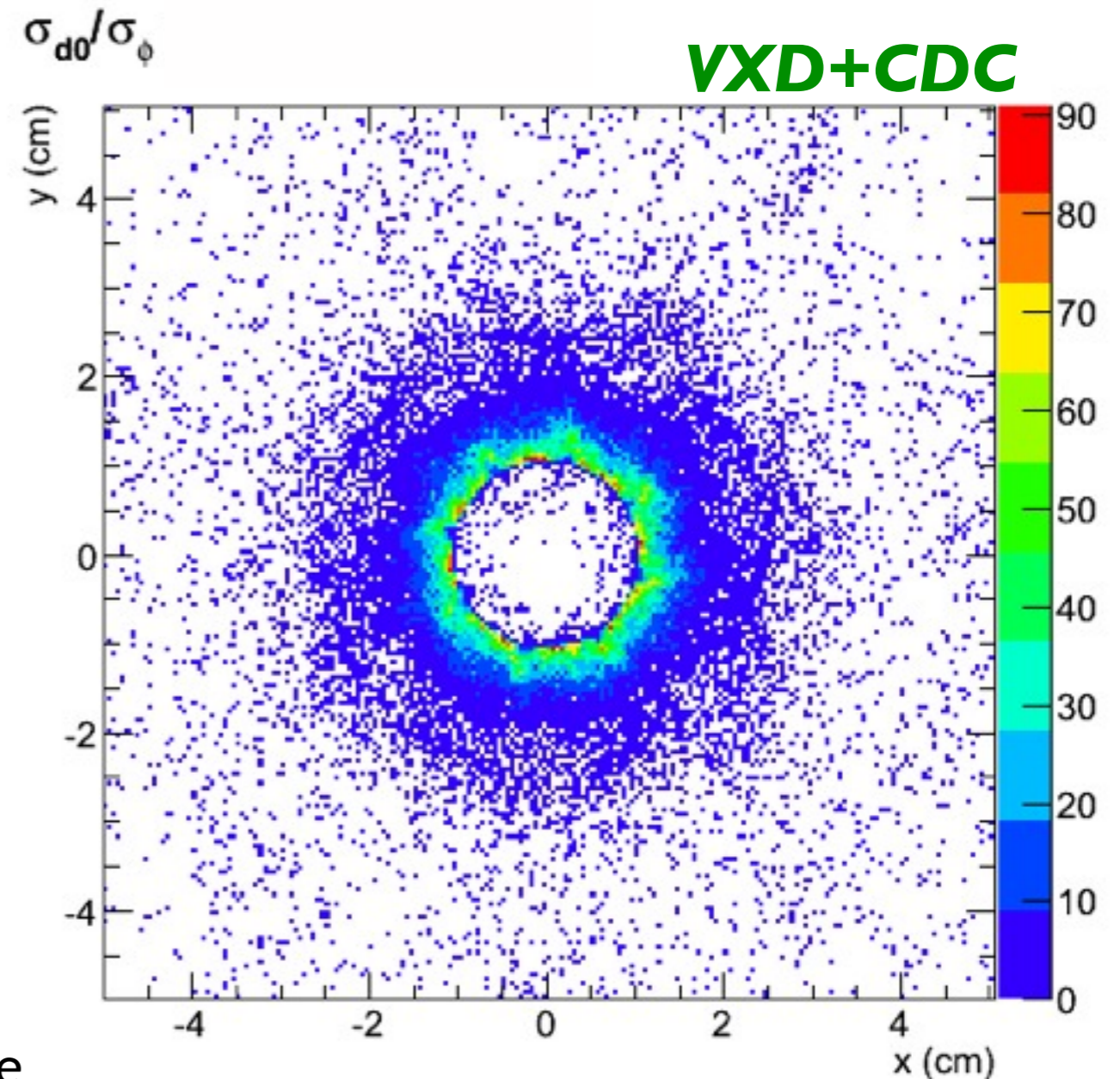
- ➔ Belle2 VXD Tracking when PXD clusters are used in the track fit performs better than *BABAR*
- ➔ Belle2 Tracking when no PXD clusters are used in the track fit performs worse than *BABAR*

# Relating Track Parameters Errors (1)

- Can relate the errors on  $d_0$  and  $\phi$  and estimate the distance between the origin and the nearest hit (i.e. the hit that has more weight in the  $d_0$  estimation)



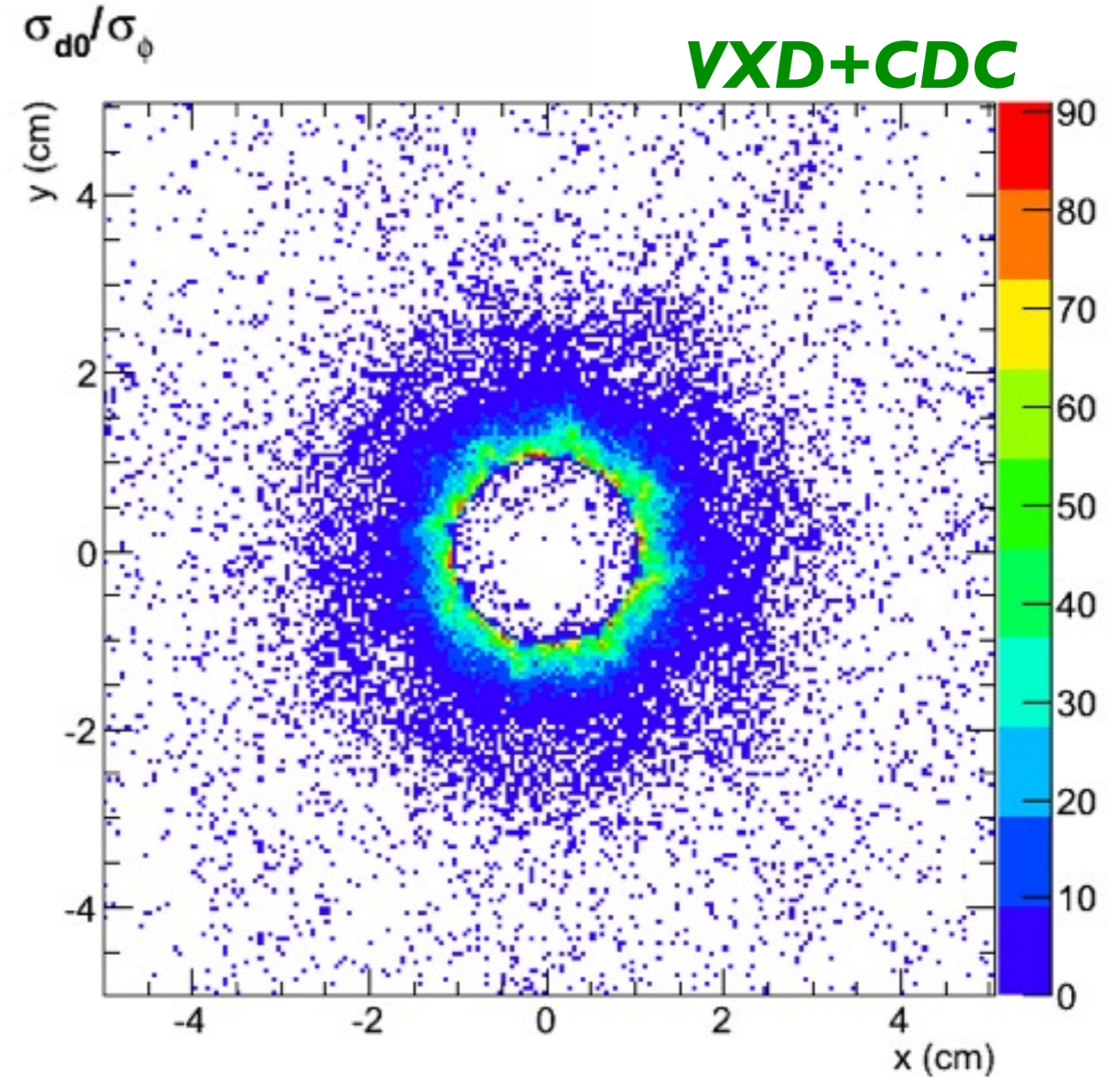
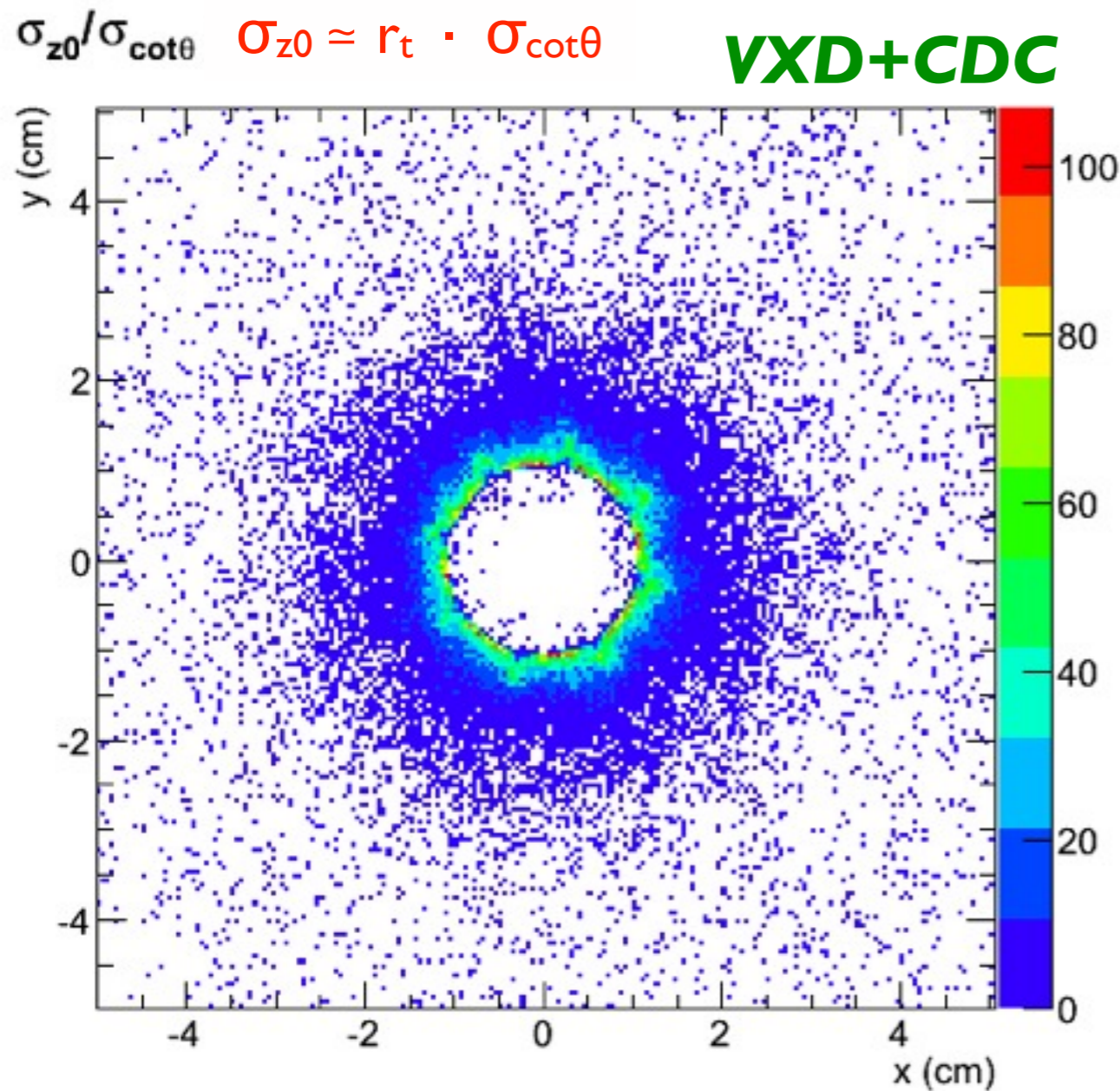
- valid when first hit is near the beam pipe
- neglecting detector hit resolution



MC-truth-information free plot!

# Relating Track Parameters Errors (2)

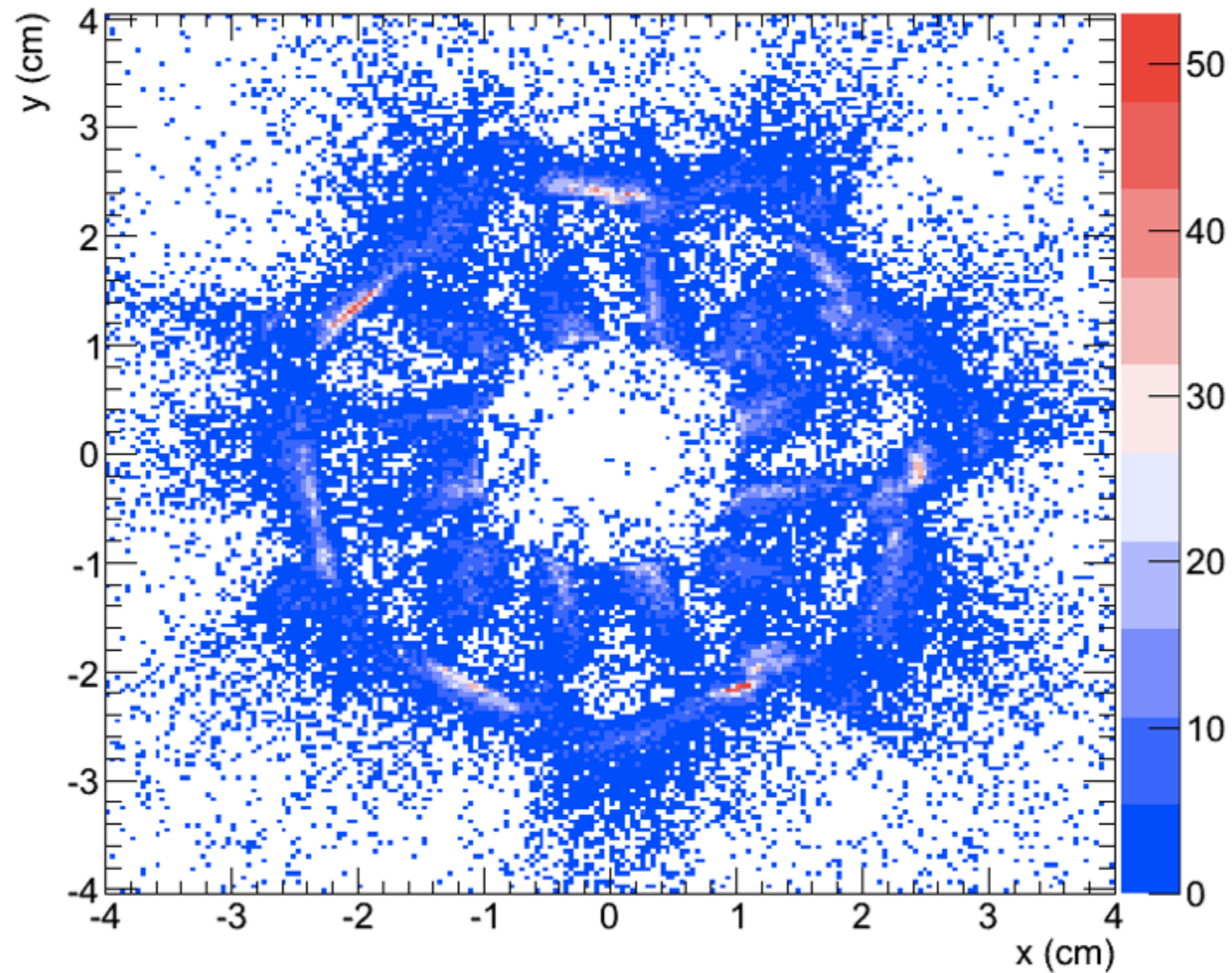
- Can also use the errors on  $z_0$  and  $\cot\theta$  to estimate the distance between the origin and the nearest hit (i.e. the hit that has more weight in the  $z_0$  estimation )



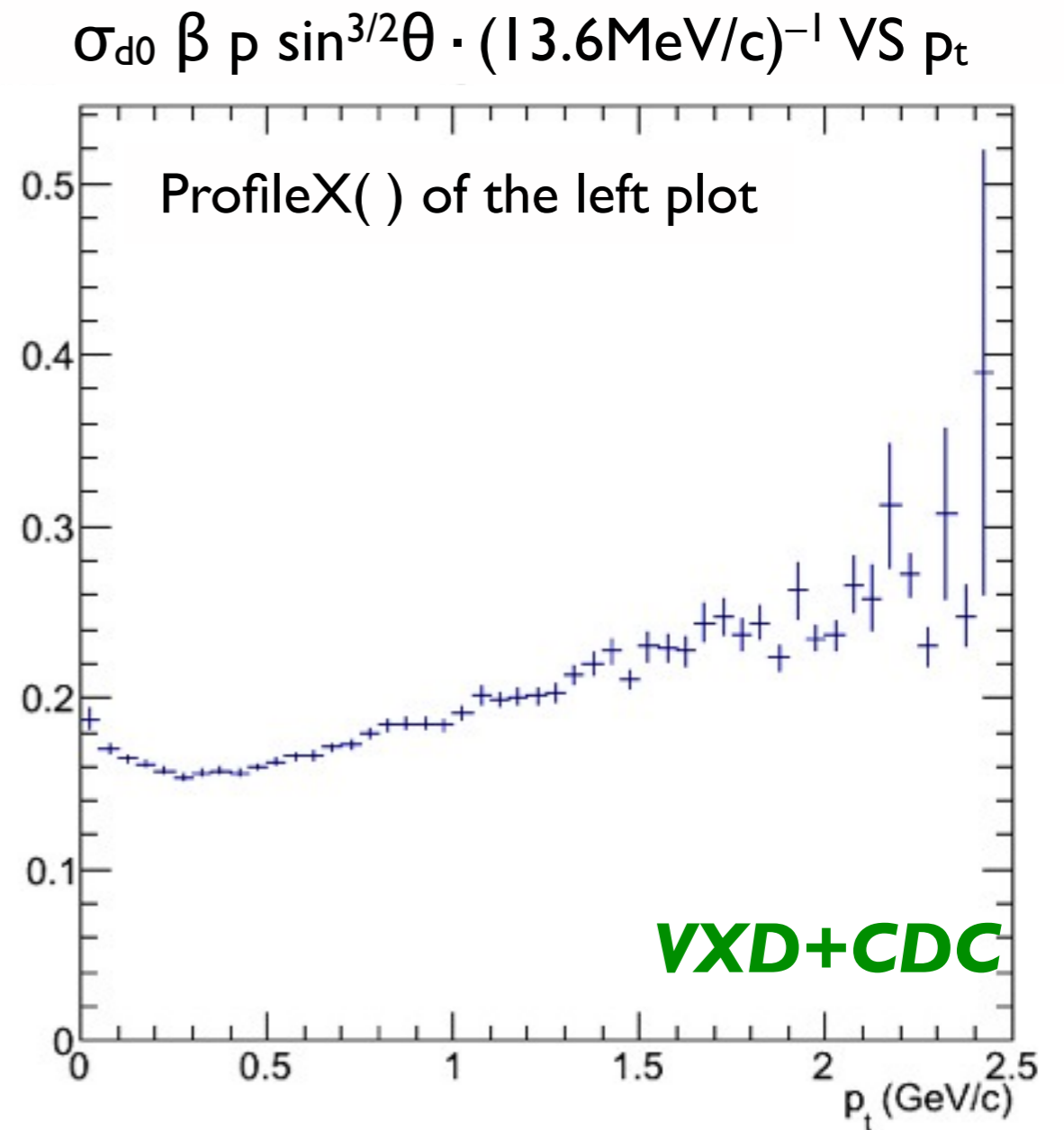
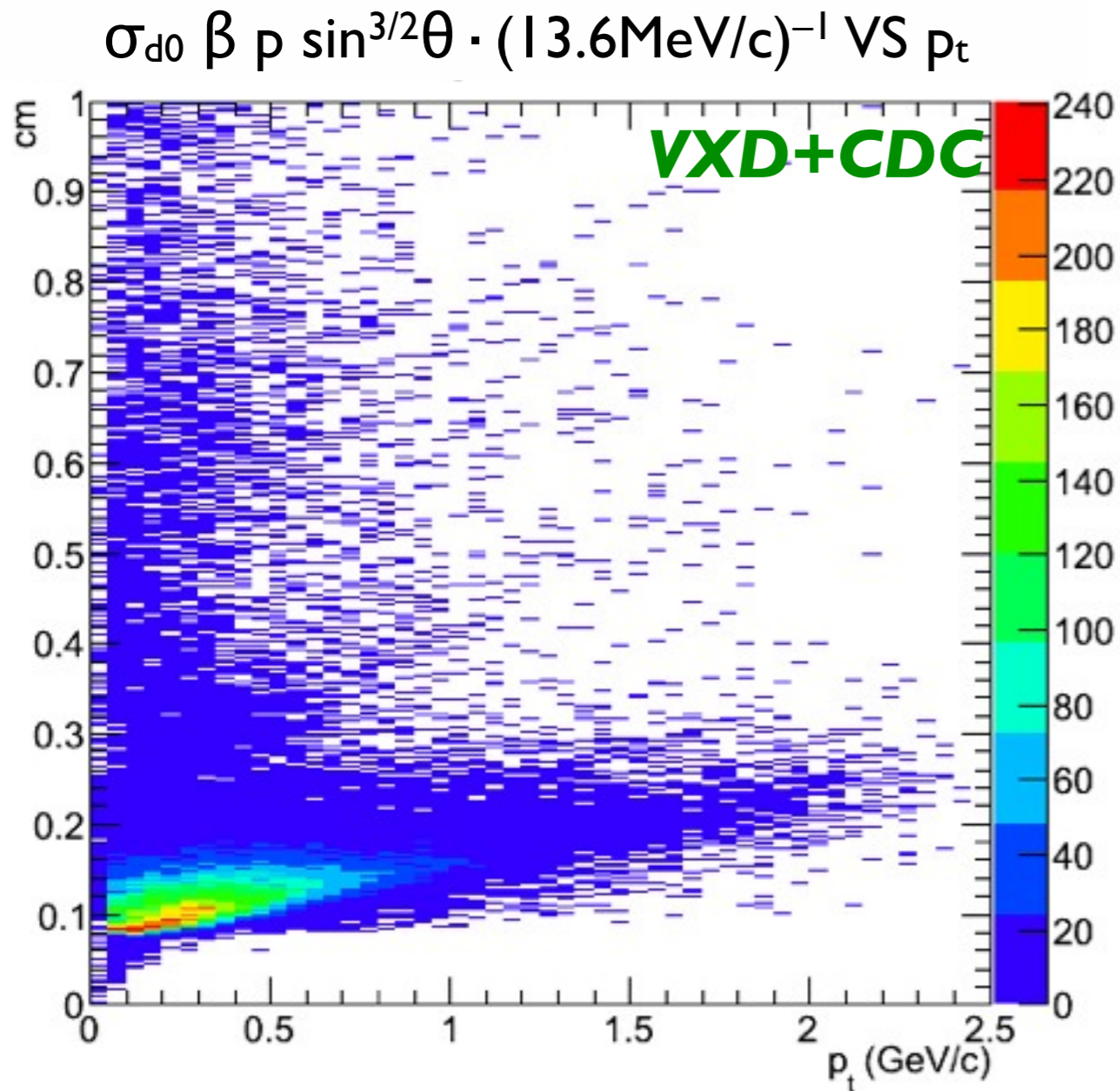
**MC-truth-information free plot!**



## Before Jakob Fix

 $\sigma_{d0}/\sigma_\phi$  projected on x,y

# Effect of Multiple Scattering



→ taking into account the error introduced by the multiple scattering of the first layer crossed by the track:

$$p_t \cdot \sigma_{d0} \beta p \sin^{3/2}\theta = \text{const}$$

# Pattern Recognition Efficiency & Purity

*not updated*

<i>Pattern Recognition</i>	VXD only	CDC only	VXD+CDC
<b>purity (%)</b>	94.88±0.08	75.5±0.1	-
$\epsilon =$ <b>efficiency (%)</b>	79.3±0.2	91.3±0.1	94.3±0.1

*not updated*

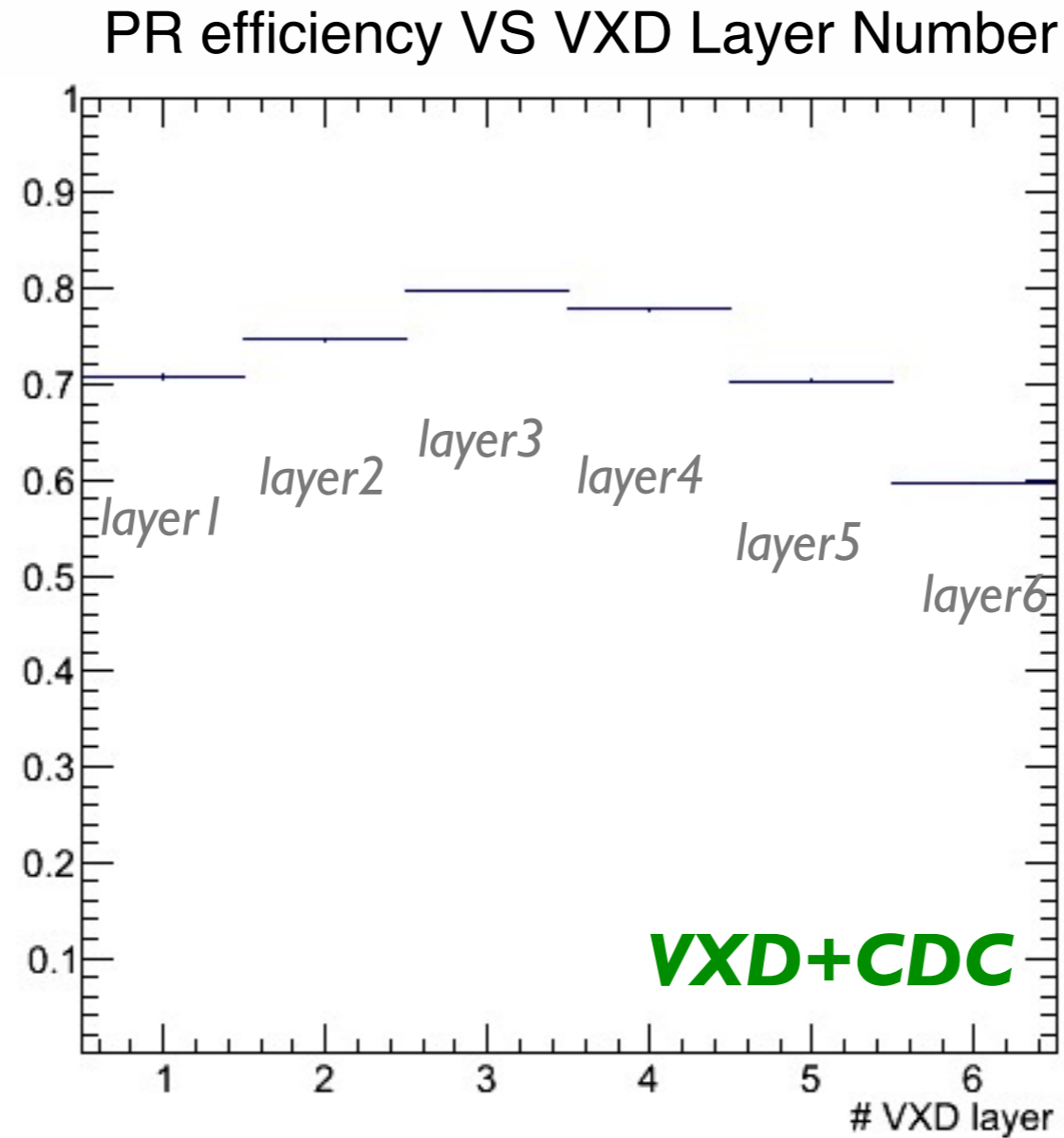
→ above numbers are relative to release r14200

- VXD only PR efficiency increased to 85% with the patch, same purity
- VXD+CDC PR efficiency increased to 96.1% with the patch

purity = probability to find an MCTrackCand associated to a TrackCand, given a TrackCand

$$\epsilon = \frac{\# \text{ MCTrackCand with at least one associated TrackCand}}{\# \text{ MCTrackCand}}$$

# PR Efficiency on VXD Layers



- Efficiency is maximum on layer3 (80%)
- Efficiency decreases from inner to the outer layers (70% on layer1, 60% on layer6)

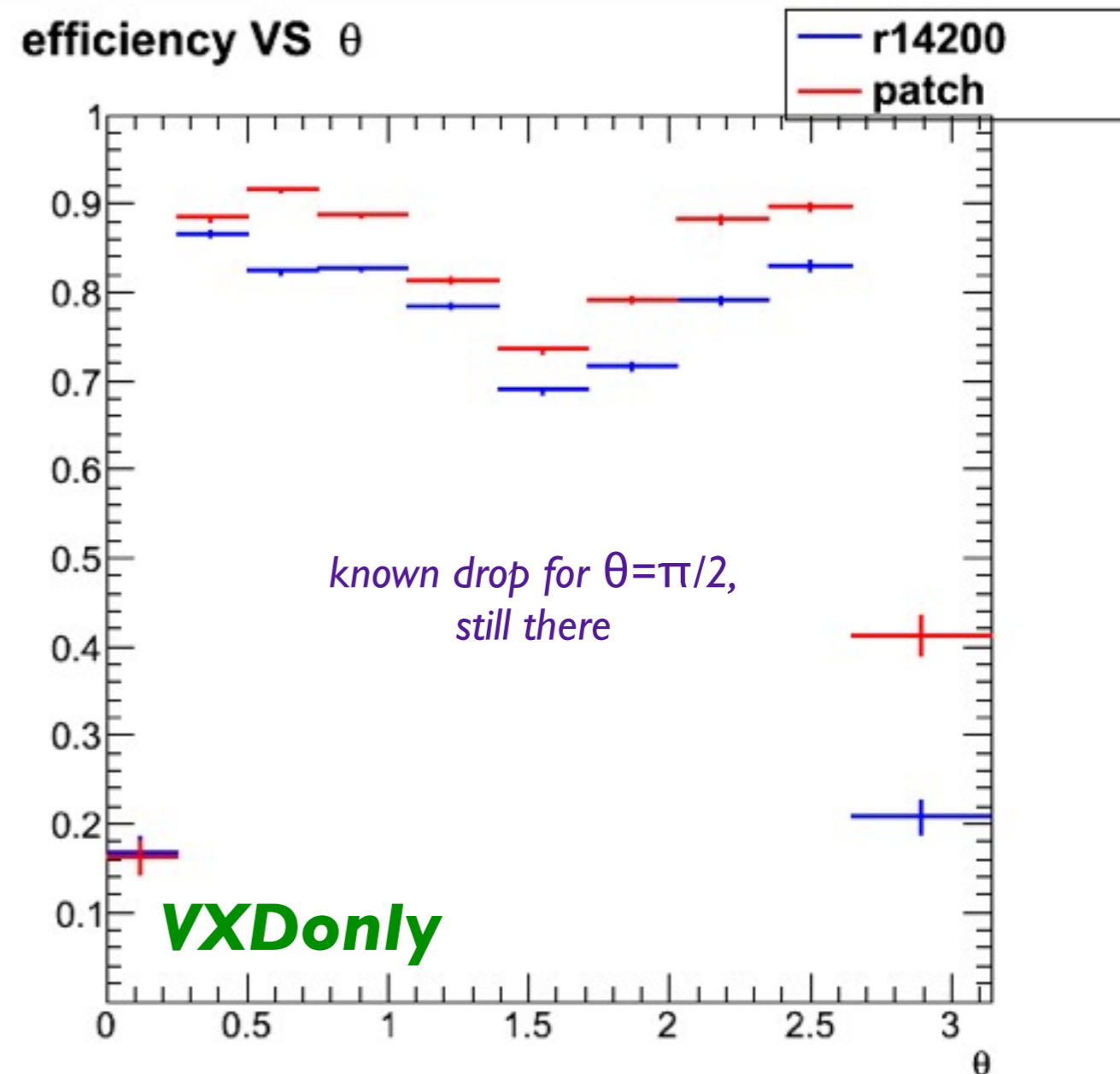
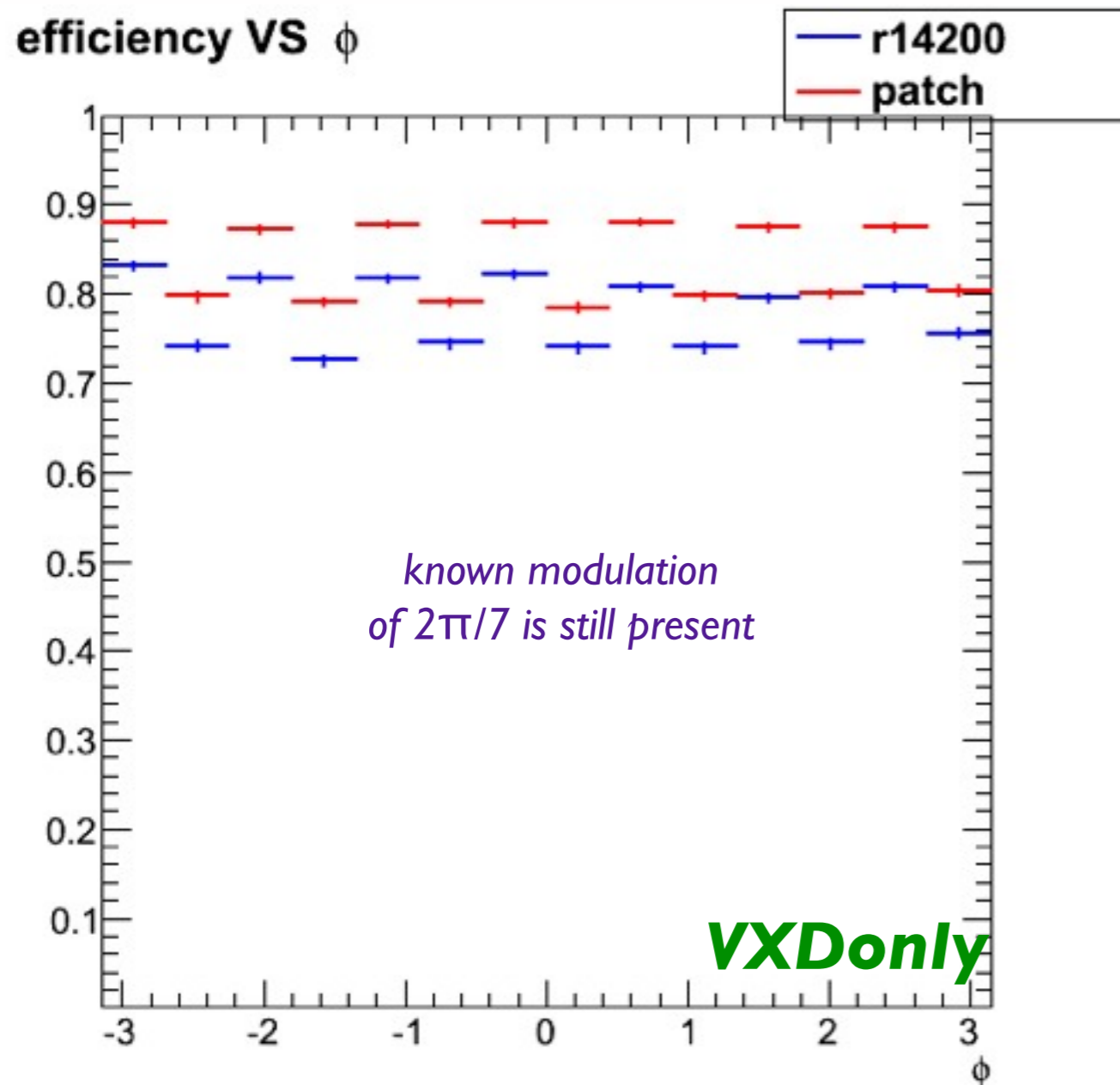
# How Jakob Fix Looks Like

→ compare **VXD only tracking** in **r14200** (before the patch) and **r14200+patch**

patch = svn update of:

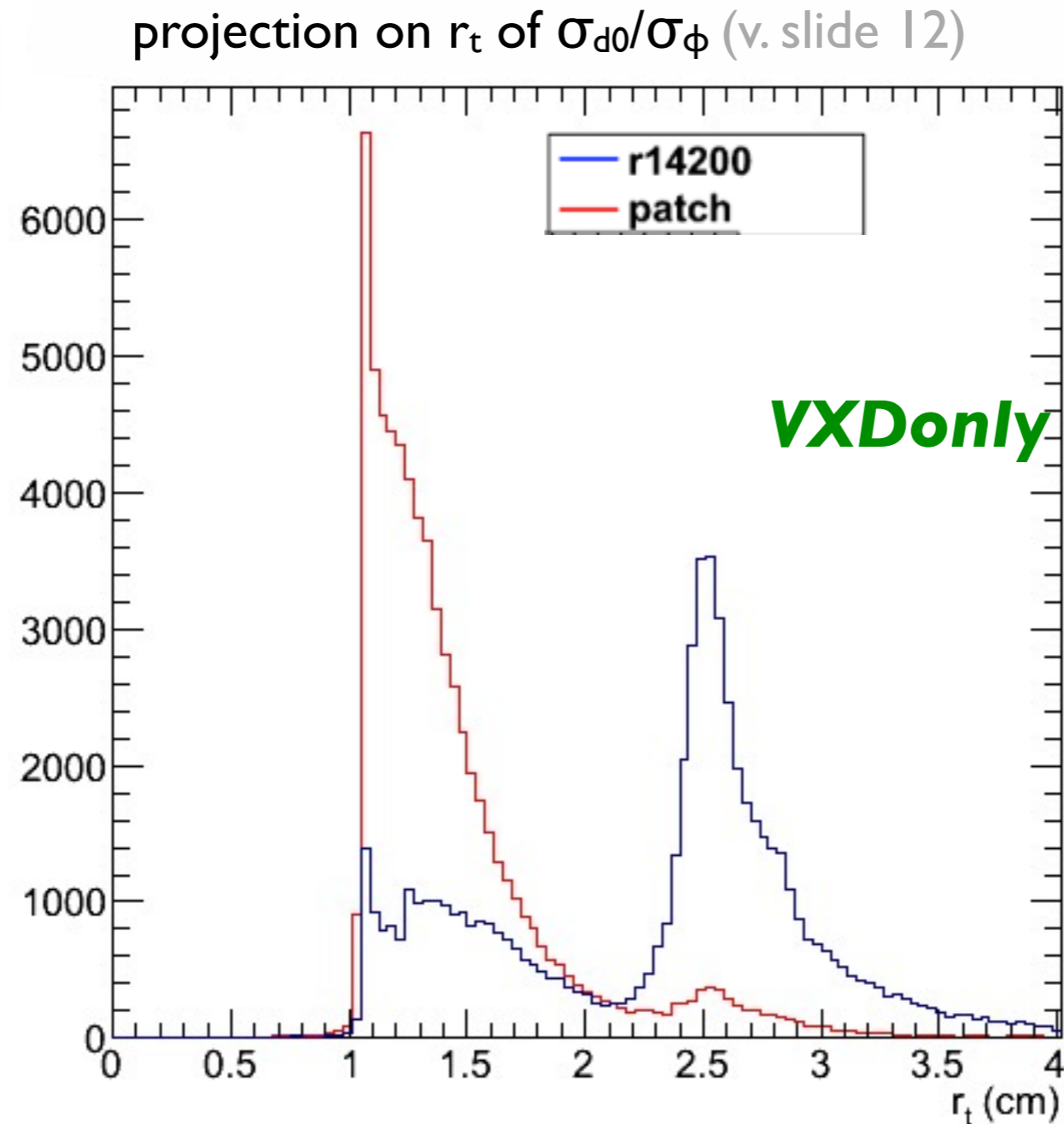
- tracking/modules/VXDTF/{include,src}/VXDTFModule.{h,cc}
- tracking/modules/VXDTFHelperTools/{include,src}/FilterCalculatorModule.{h,cc}
- tracking/spacePointCreation/{include,src}/spacepoint.{h,cc}
- tracking/vectorTools

# Efficiency VS Polar and Azimuthal Angles

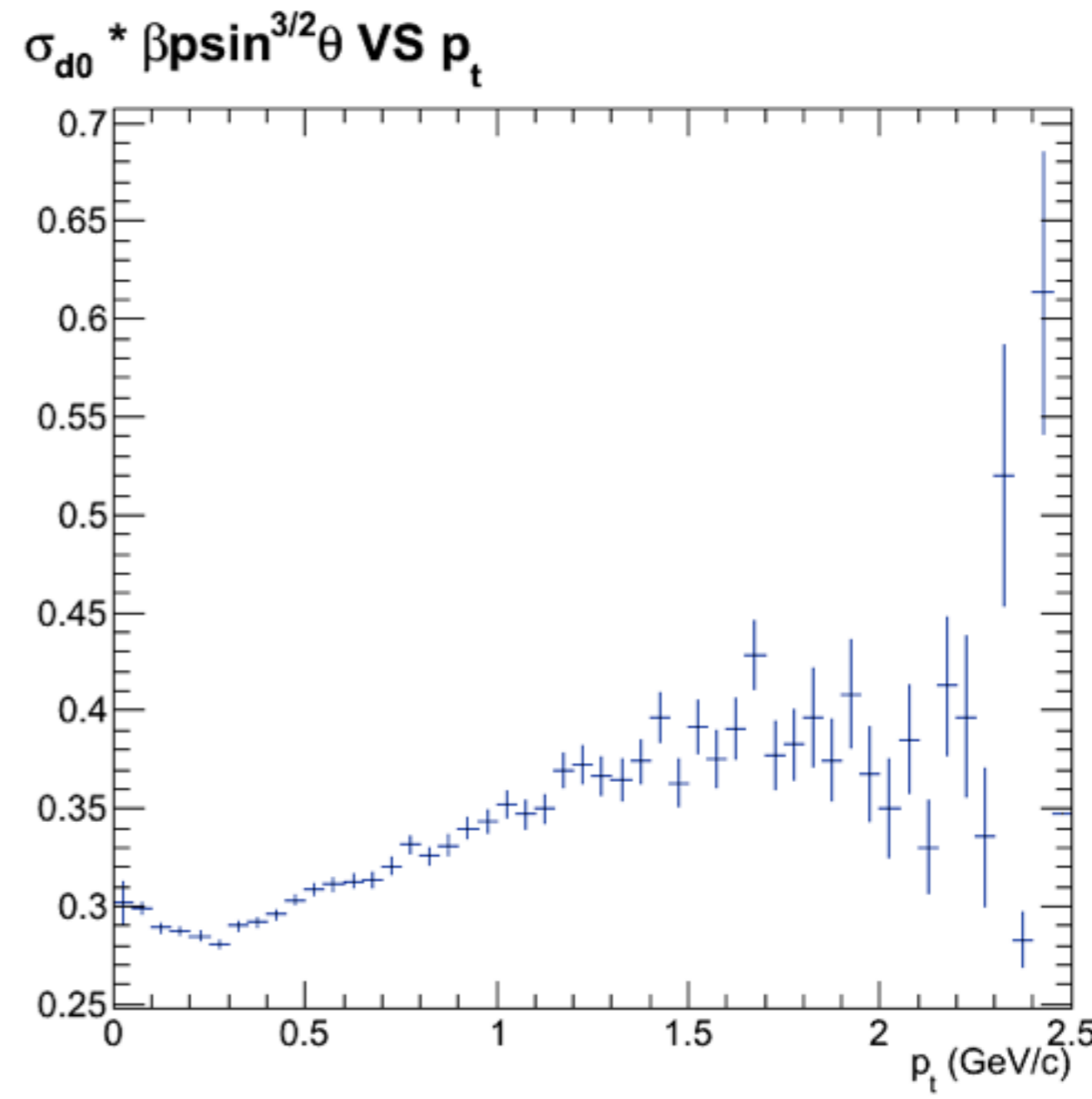
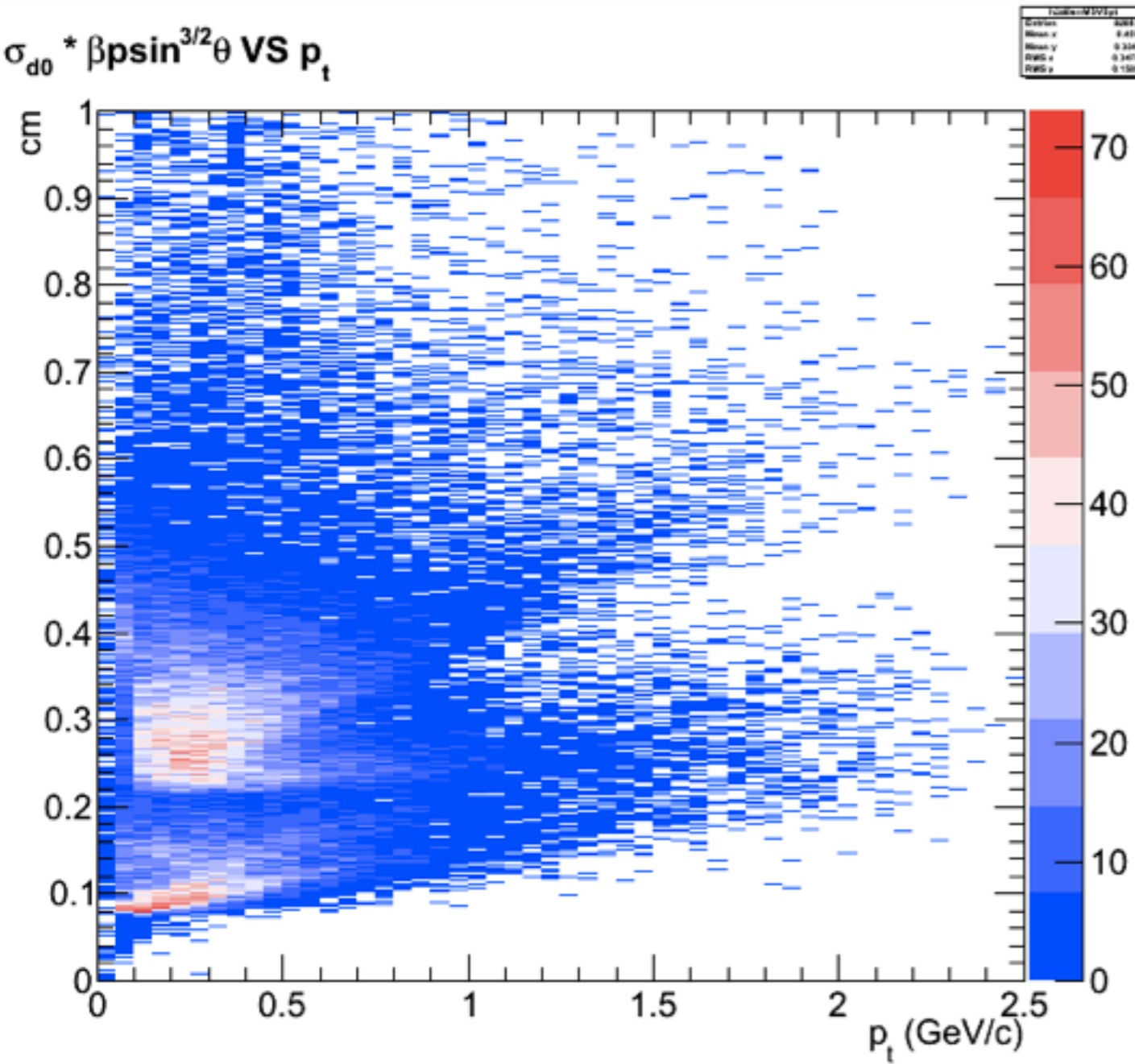


→ improvement in efficiency but undesired feature are still present

# Relating Track Parameters Errors



→ striking difference between the two curves





# Conclusions

- ◆ The tracking group is investing a significant fraction of the developers time into code validation and performance assessment.
- ◆ The VXDTF is undergoing a major re-engineering of the code. During this we hope to cure the bad features of the present VXDTF



**MAKE A GIFT  
TO YOURSELF  
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