



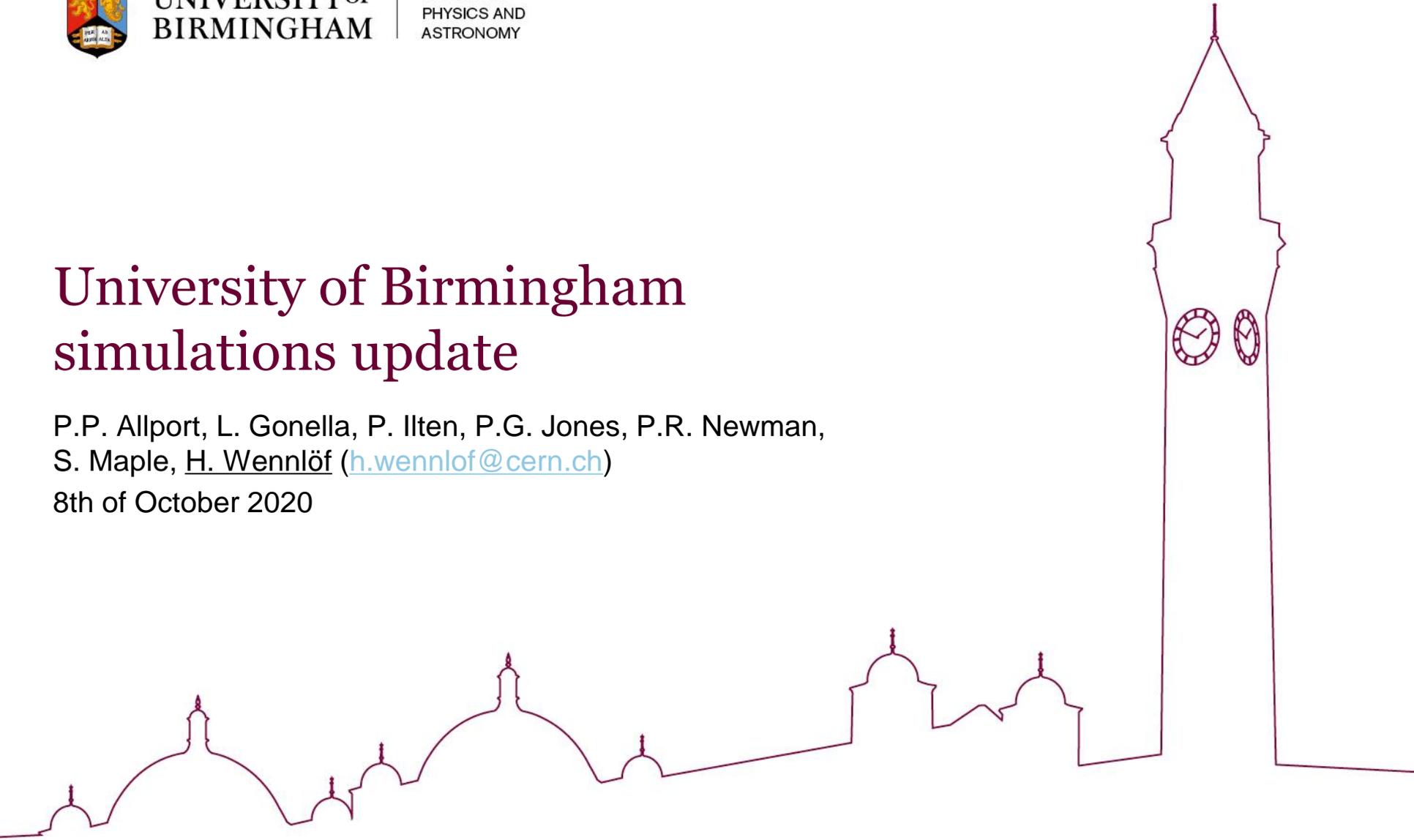
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University of Birmingham simulations update

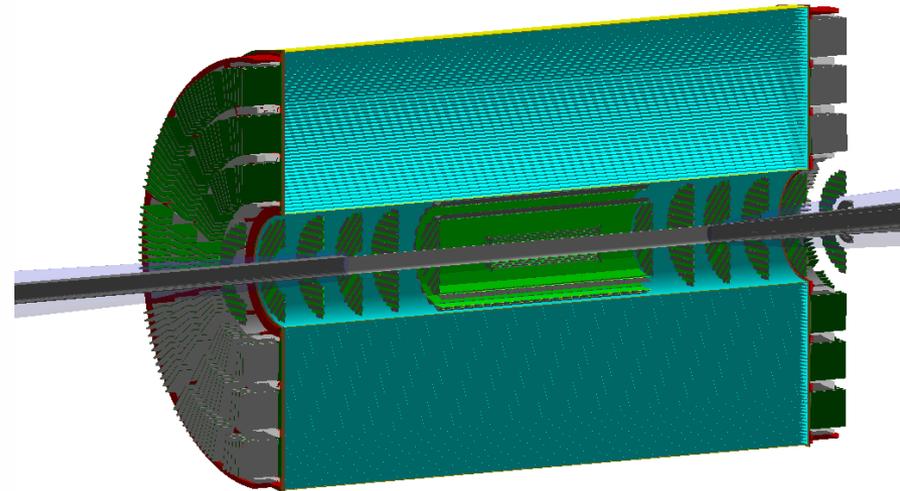
P.P. Allport, L. Gonella, P. Ilten, P.G. Jones, P.R. Newman,
S. Maple, H. Wennlöf (h.wennlof@cern.ch)

8th of October 2020

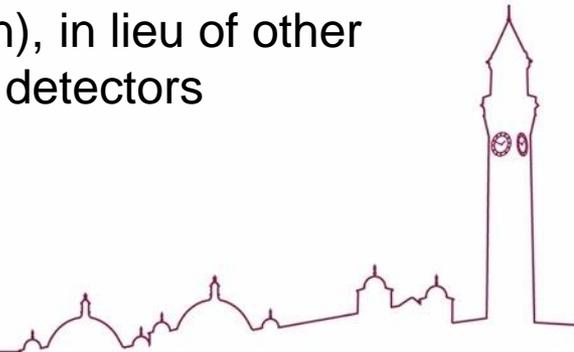


Study of low-momentum limit

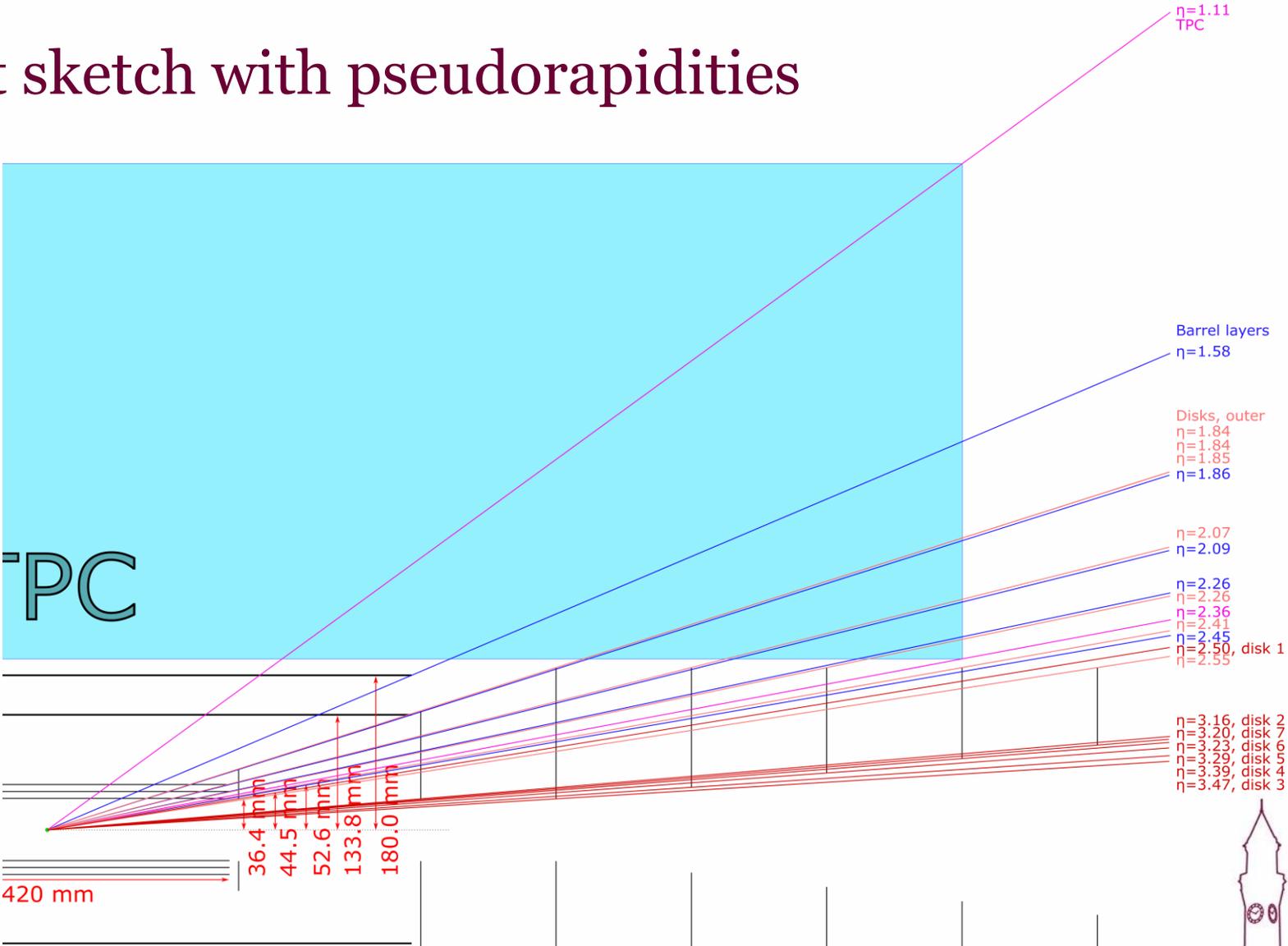
- Investigating pion and kaon low-momentum limit with the current baseline TPC hybrid tracker
- Sending single pions and kaons in pseudorapidity interval $-4 \leq \eta \leq 4$, flat distribution in p_T 0 to 0.5 GeV/c
- Checking for 1.5 T and 3.0 T
- Goal: determine which fraction of events can be reconstructed
 - Using Kalman filter reconstruction
- **Important: this is just about the fraction of events that can be reconstructed. No inference should be made about resolutions from these results.**



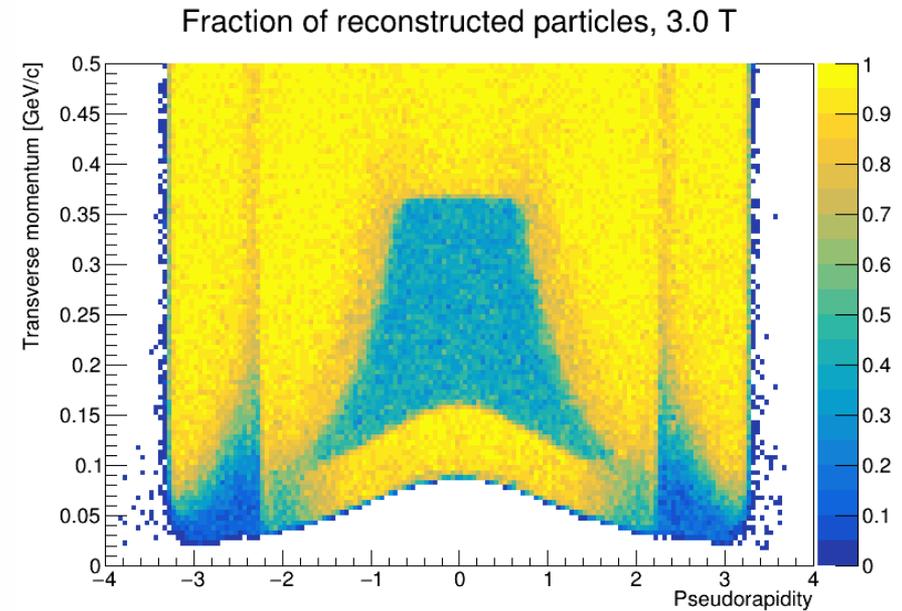
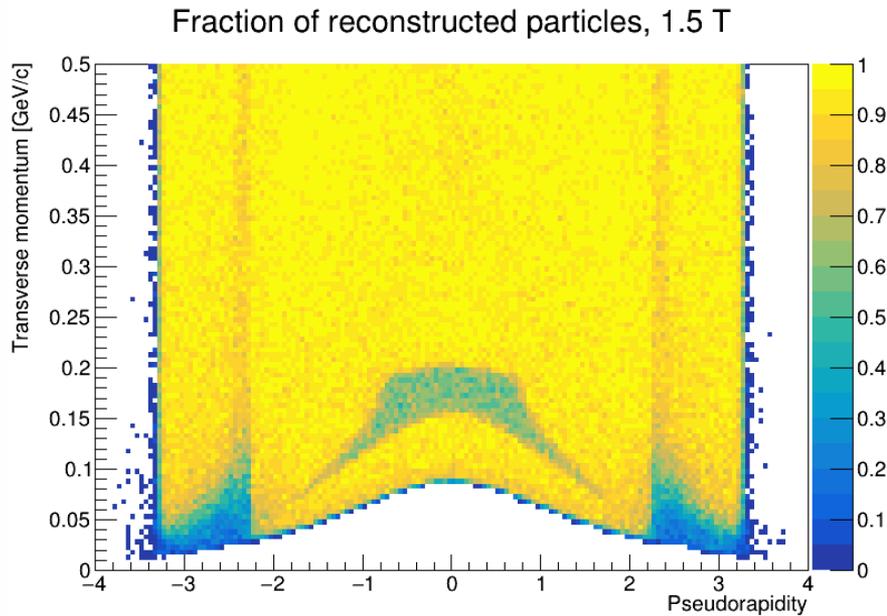
Note: “black hole” added outside (not shown), in lieu of other absorbing detectors



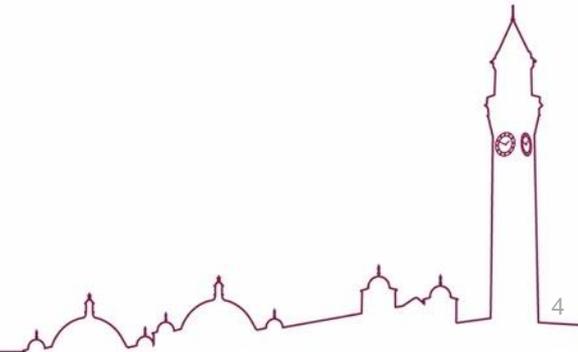
Layout sketch with pseudorapidities



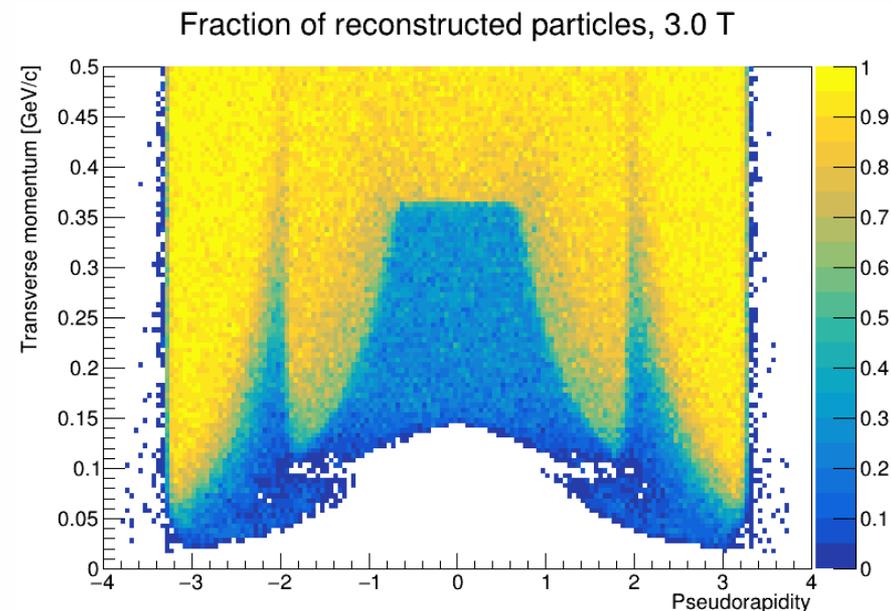
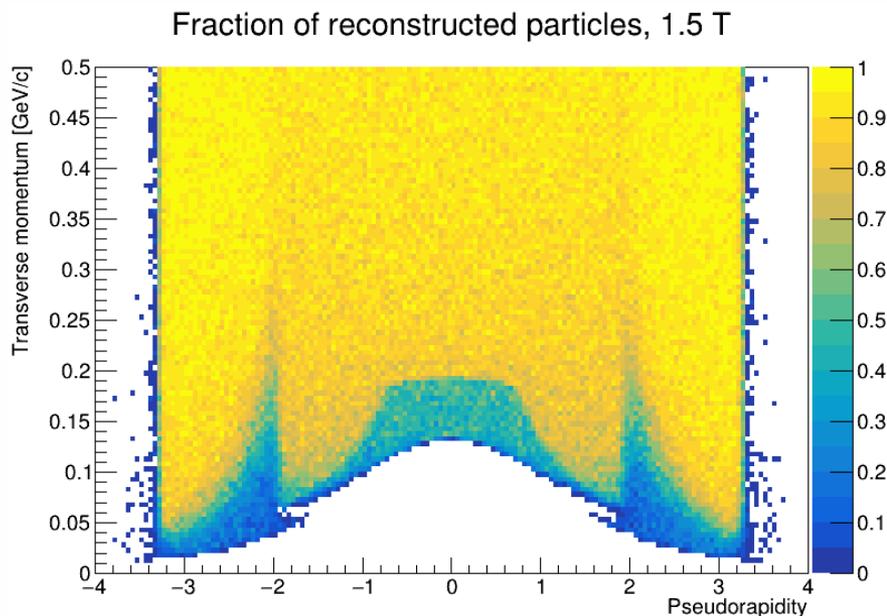
Kaon maps



- Transverse momentum vs pseudorapidity, colour is fraction of reconstructed events
- Yellow means 100% of events are reconstructed
- Some clear features visible



Kaon maps – no silicon barrel

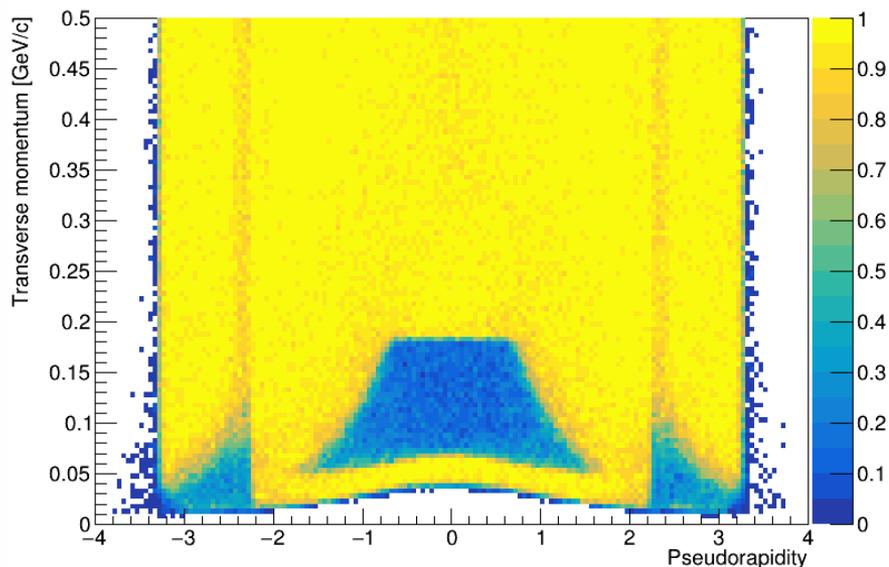


- Removed to investigate where inefficiencies come from
 - Mainly from **spiralling in the TPC**
 - Having the silicon barrel in place mitigates this
- Removing silicon barrel removes the “good region” in the centre at low p_T , and moves “bad region” edges in in pseudorapidity
 - Flicking between this slide and the previous makes this clearer

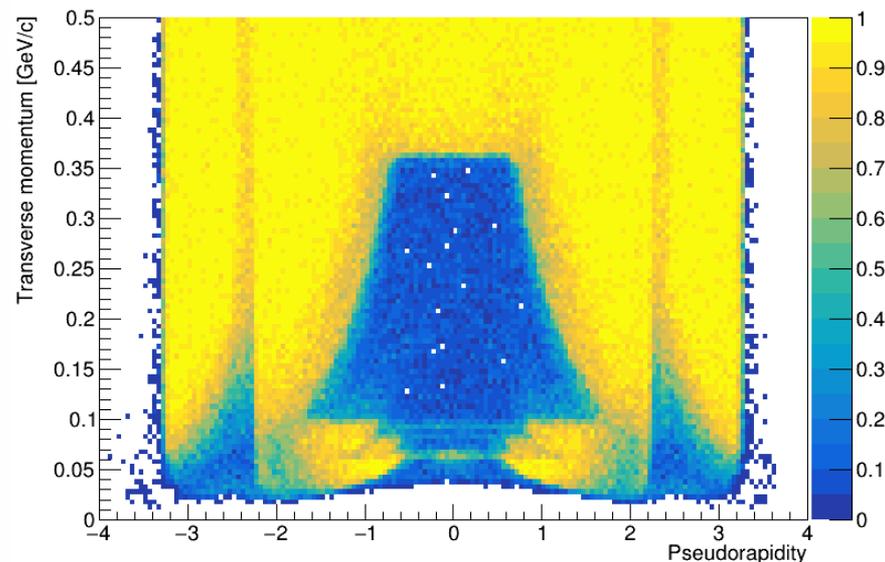


Pion maps

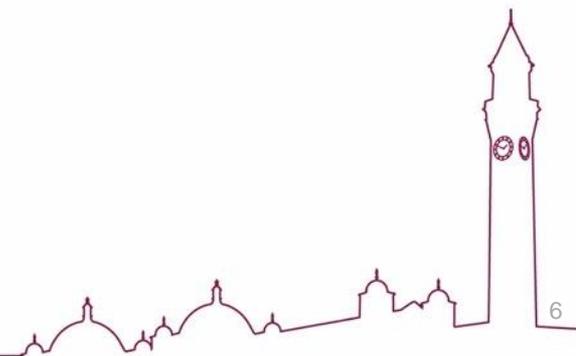
Fraction of reconstructed particles, 1.5 T



Fraction of reconstructed particles, 3.0 T



- Similar to the kaon maps, but more extreme
 - Lower lowest momentum
 - Larger and deeper “central” efficiency loss region

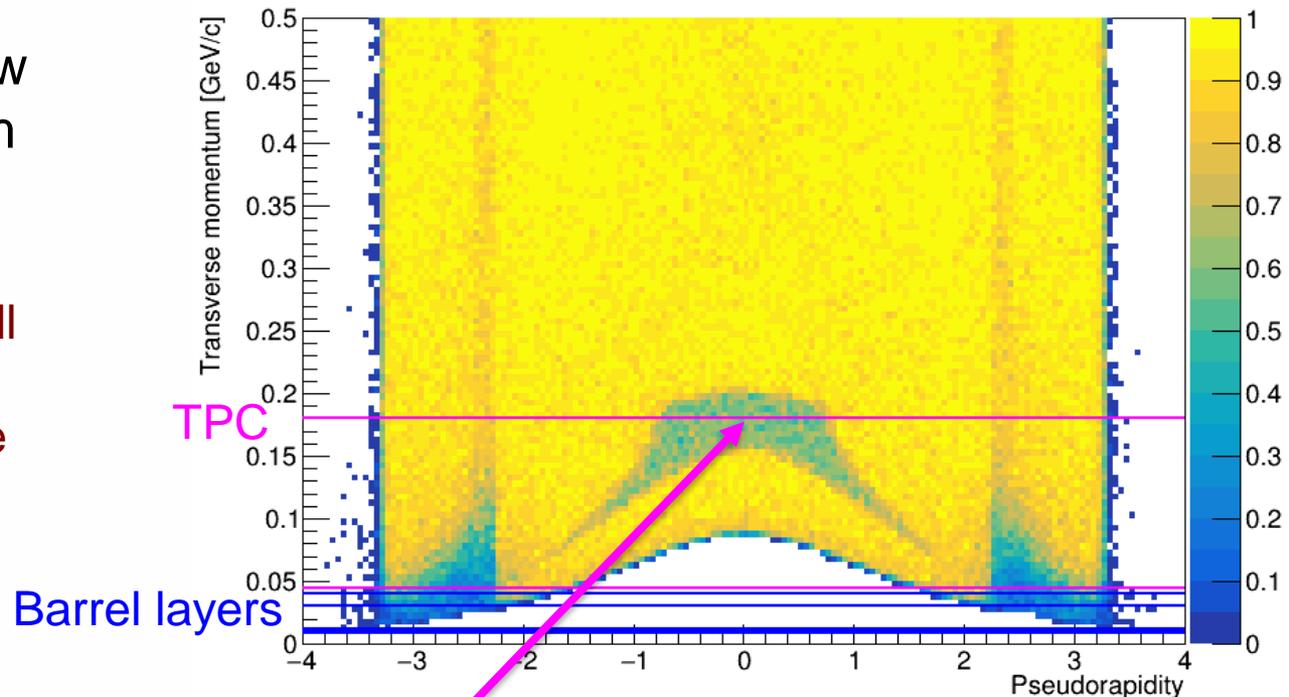


Lines of interest

- Adding lines in plot, to show special areas in detector
- Horizontal lines show spiralling momentum for certain radius
 - This, and all momenta below, will spiral inside the given detector edge
- Important note: y-axis is **initial** momentum. Energy loss in the material will push the spiralling momentum edge up a bit.

Kaons, 1.5 T

Fraction of reconstructed particles, 1.5 T



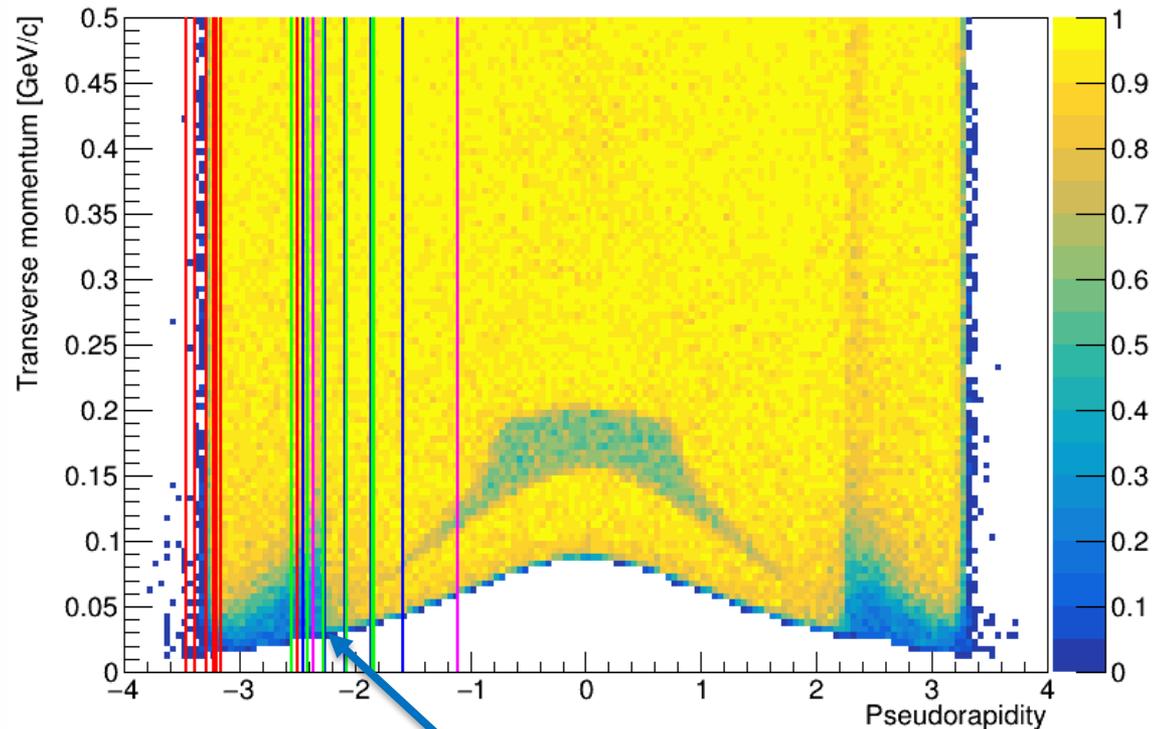
- Central inefficiency comes from **spiralling in TPC**, but effect is mitigated by silicon barrel

Lines of interest

- Vertical lines give pseudorapidity
- Magenta are TPC corners
- Blue is where barrel layers end
- Green is where disk outer edge is (i.e. where disks start to matter)
- Red is disk inner edge (i.e. where disk is no longer hit)
- Here: we lose reconstruction efficiency in η when **all but one of the barrel layers are missed.**

Kaons, 1.5 T

Fraction of reconstructed particles, 1.5 T

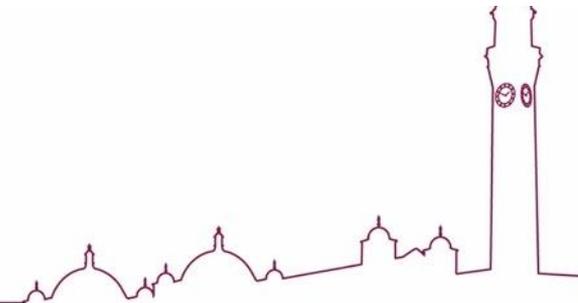
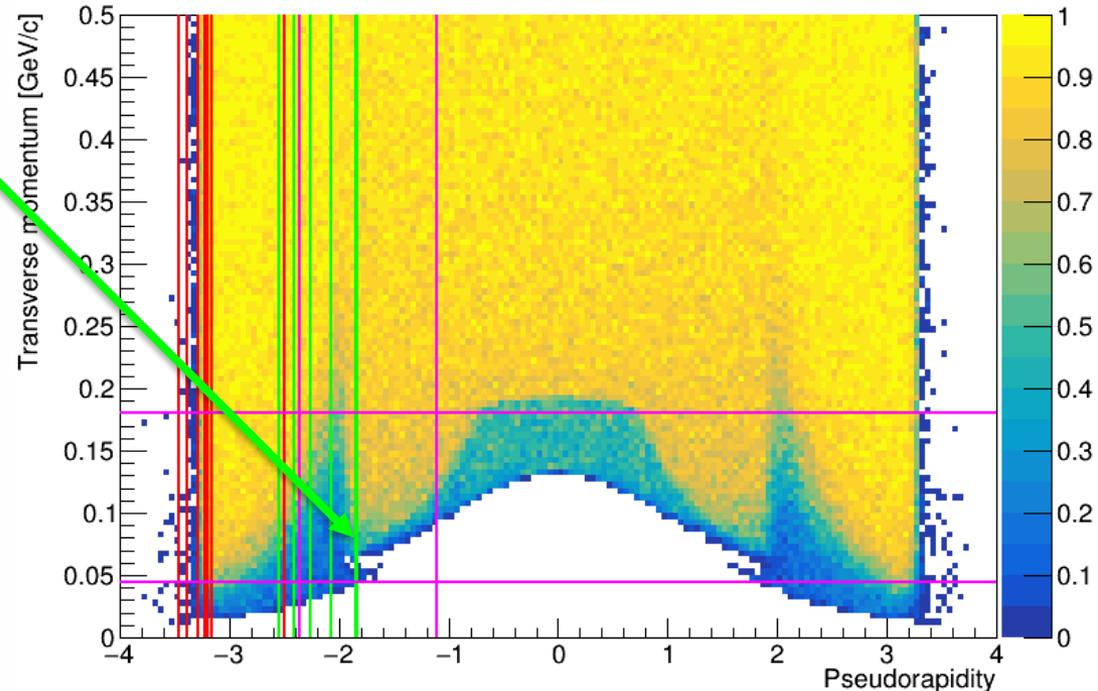


Lines of interest – no silicon barrel

- Disk material causes drop in reconstructed fraction here (three disks are added at $\eta = 1.86$)
- Remember: this is quite **unrelated to resolutions**. Adding disks will improve resolutions, but the added material might stop particles (and hence prevent reconstruction)

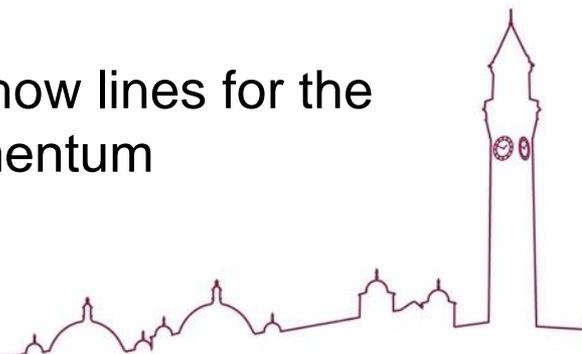
Kaons, 1.5 T

Fraction of reconstructed particles, 1.5 T



Projections

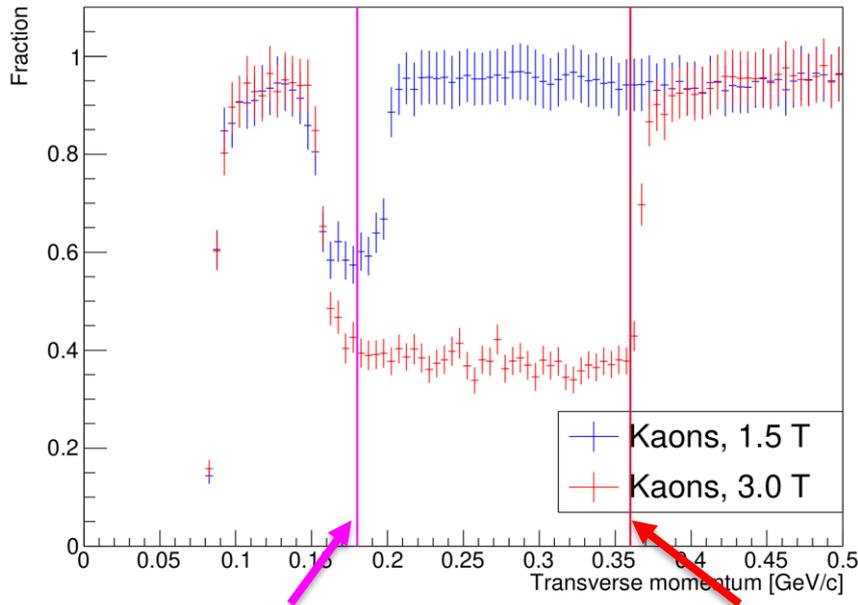
- Projections of the fraction of reconstructed particles made in pseudorapidity bins. Shown on the following slides
- Bins have size 0.5
- These plots can be used to match detector matrix requirements, for discussions with Physics WG
- This detector configuration is symmetric, so only plots between 0 and 4 in pseudorapidity are shown
- These plots make it possible to infer the minimum reconstructable momentum. Given here as when the fraction of reconstructed tracks is consistent with 0.9 or higher
 - This is colour coded; blue is for 1.5 T, red is for 3.0 T
- The first two plots (i.e. the more central regions) show lines for the “black hole” start radius, in terms of spiralling momentum



$$0.0 \leq \eta \leq 0.5$$

Kaons

Eta: 0.000000 to 0.500000



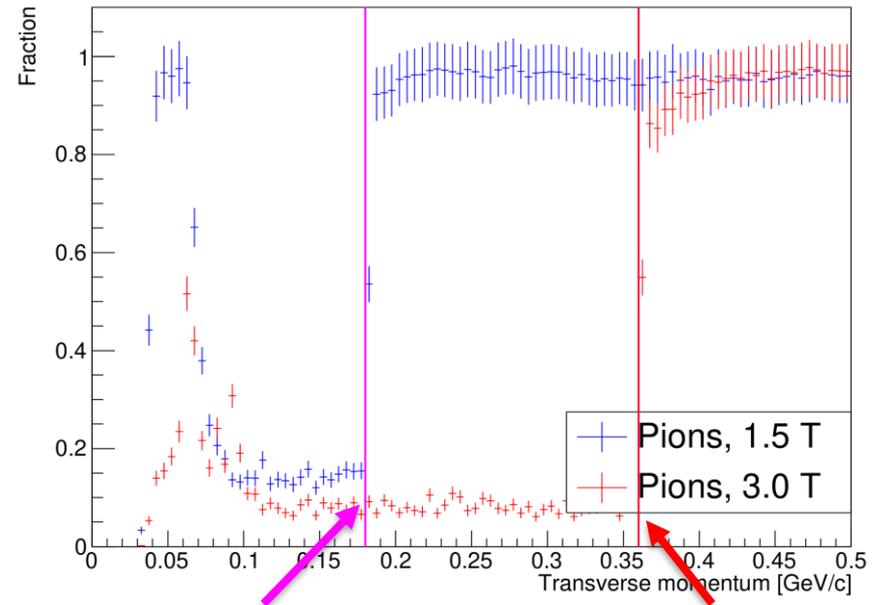
BH spiralling, 1.5 T

BH spiralling, 3.0 T

- Reconstructable momentum:
 - $100 \text{ MeV}/c \leq p_T \leq 150 \text{ MeV}/c$
 - $p_T \geq 210 \text{ MeV}/c$
 - $p_T \geq 380 \text{ MeV}/c$

Pions

Eta: 0.000000 to 0.500000



BH spiralling, 1.5 T

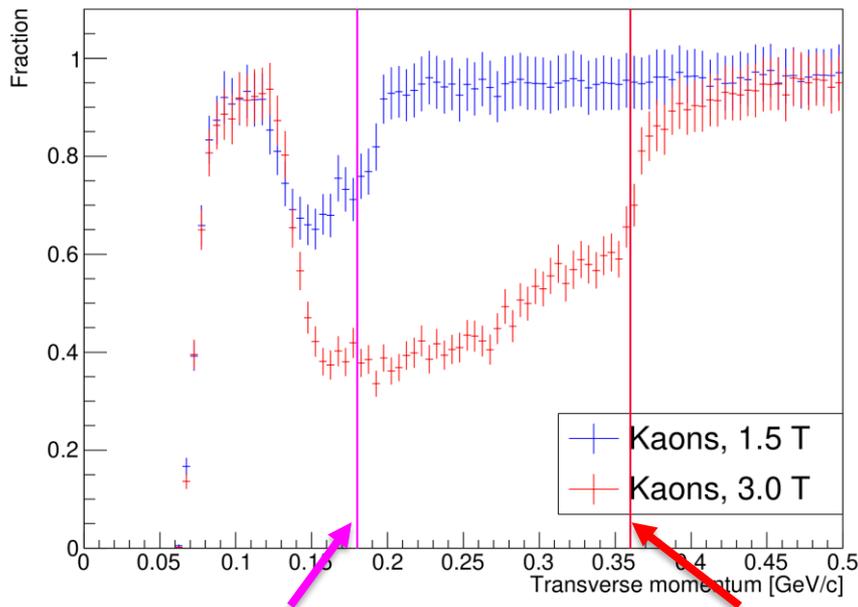
BH spiralling, 3.0 T

- Reconstructable momentum:
 - $50 \text{ MeV}/c \leq p_T \leq 65 \text{ MeV}/c$
 - $p_T \geq 190 \text{ MeV}/c$
 - $p_T \geq 370 \text{ MeV}/c$

$$0.5 \leq \eta \leq 1.0$$

Kaons

Eta: 0.500000 to 1.000000



BH spiralling, 1.5 T

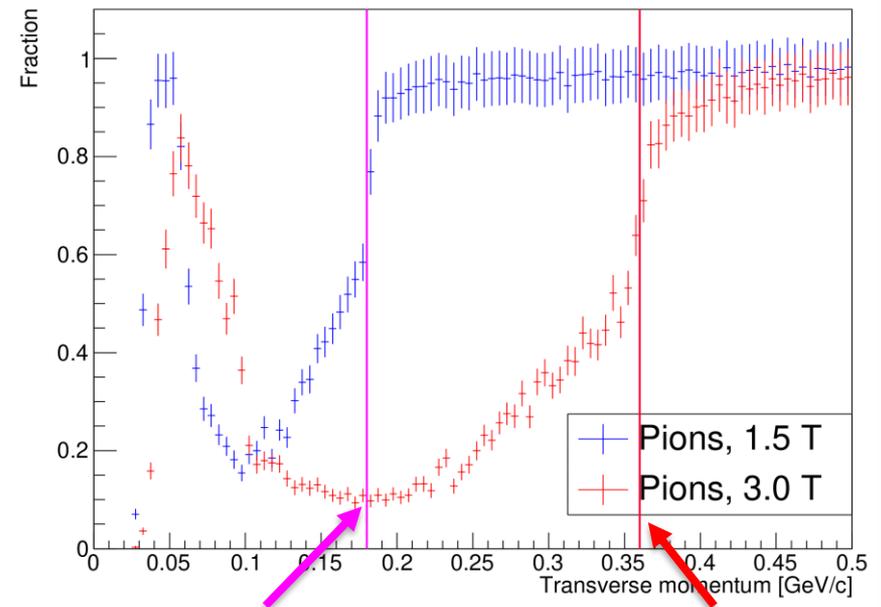
BH spiralling, 3.0 T

- Reconstructable momentum:

- $90 \text{ MeV}/c \leq p_T \leq 120 \text{ MeV}/c$
- $p_T \geq 200 \text{ MeV}/c$
- $p_T \geq 380 \text{ MeV}/c$

Pions

Eta: 0.500000 to 1.000000



BH spiralling, 1.5 T

BH spiralling, 3.0 T

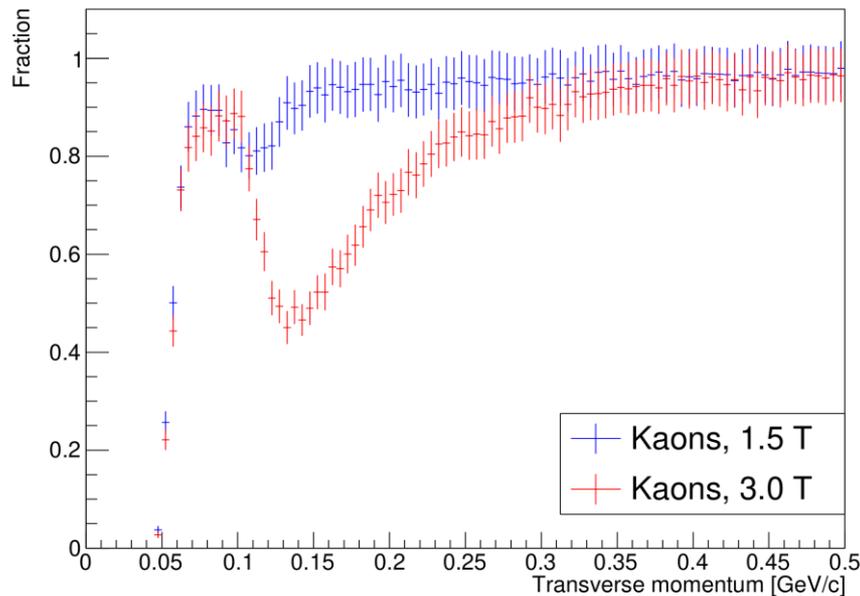
- Reconstructable momentum:

- $50 \text{ MeV}/c \leq p_T \leq 60 \text{ MeV}/c$
- $p_T \geq 190 \text{ MeV}/c$
- $p_T \geq 380 \text{ MeV}/c$

$$1.0 \leq \eta \leq 1.5$$

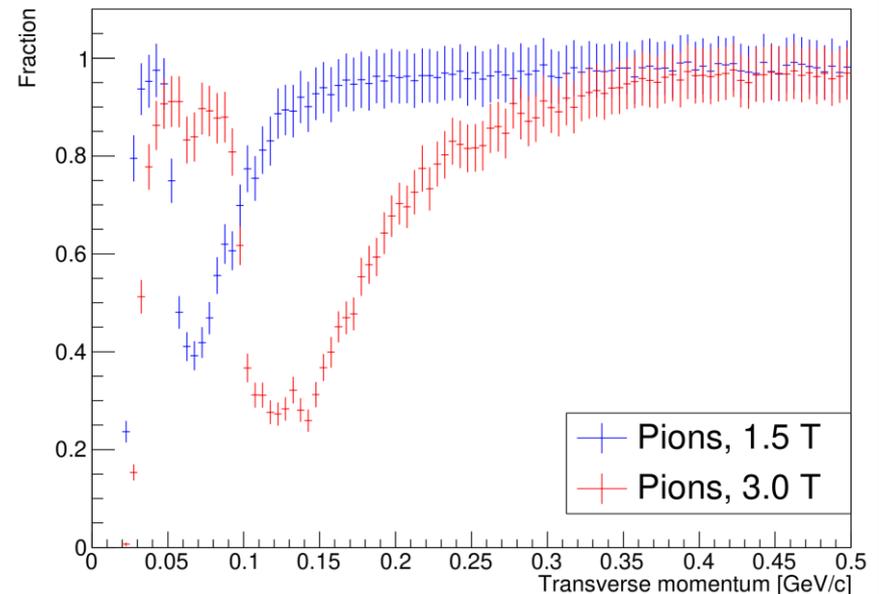
Kaons

Eta: 1.000000 to 1.500000



Pions

Eta: 1.000000 to 1.500000



Reconstructable momentum:

- $70 \text{ MeV}/c \leq p_T \leq 80 \text{ MeV}/c$
- $70 \text{ MeV}/c \leq p_T \leq 100 \text{ MeV}/c$
- $p_T \geq 130 \text{ MeV}/c$
- $p_T \geq 290 \text{ MeV}/c$

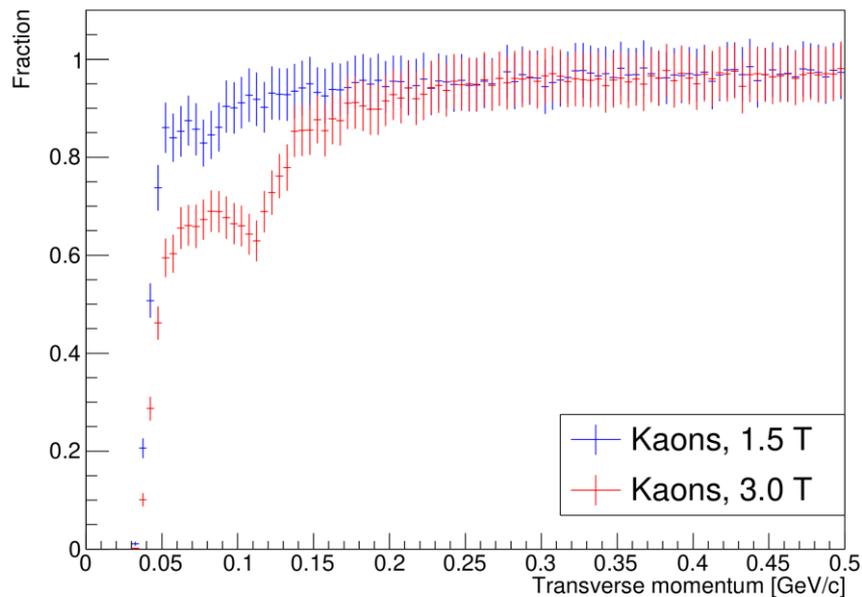
Reconstructable momentum:

- $40 \text{ MeV}/c \leq p_T \leq 50 \text{ MeV}/c$
- $50 \text{ MeV}/c \leq p_T \leq 60 \text{ MeV}/c$
- $p_T \geq 120 \text{ MeV}/c$
- $p_T \geq 280 \text{ MeV}/c$

$$1.5 \leq \eta \leq 2.0$$

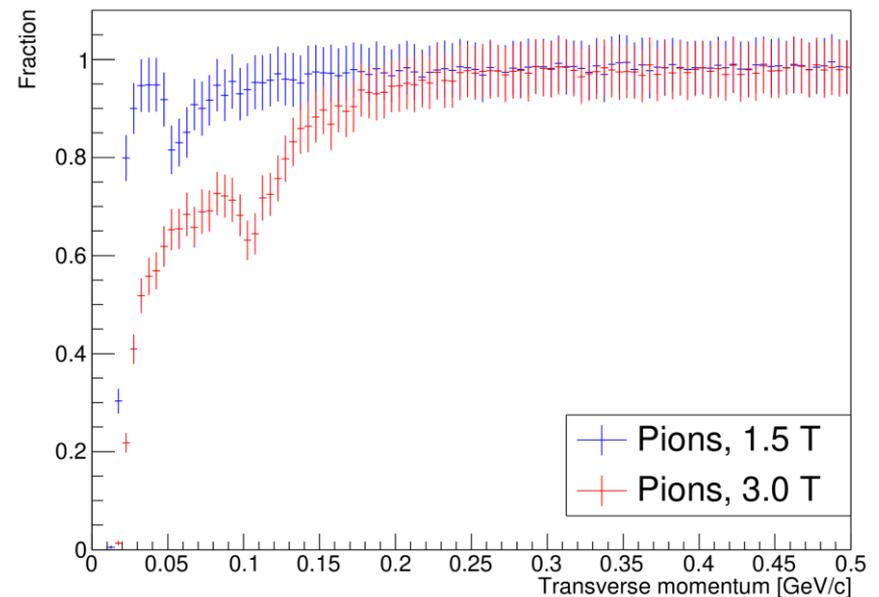
Kaons

Eta: 1.500000 to 2.000000



Pions

Eta: 1.500000 to 2.000000



- Reconstructable momentum:

- $p_T \geq 50 \text{ MeV/c}$
- $p_T \geq 160 \text{ MeV/c}$

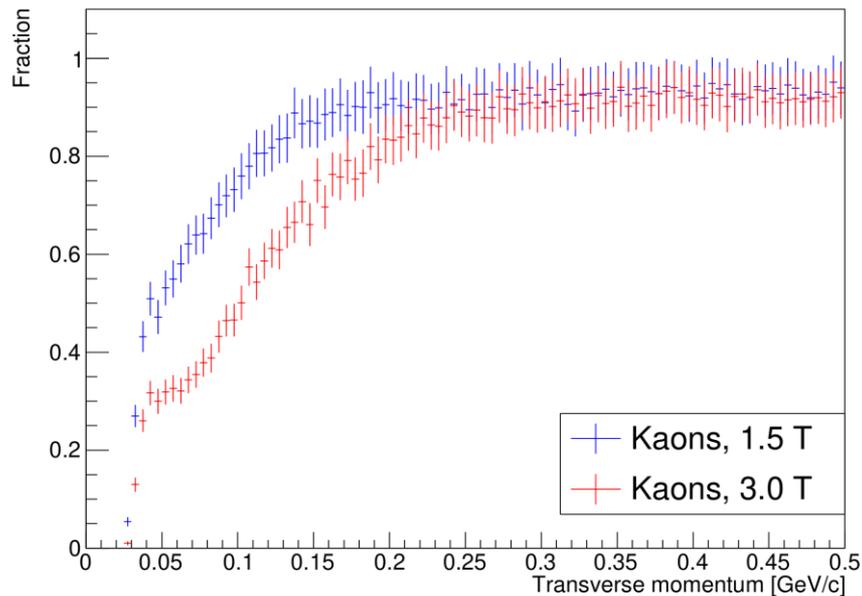
- Reconstructable momentum:

- $30 \text{ MeV/c} \leq p_T \leq 50 \text{ MeV/c}$
- $p_T \geq 70 \text{ MeV/c}$
- $p_T \geq 150 \text{ MeV/c}$

$$2.0 \leq \eta \leq 2.5$$

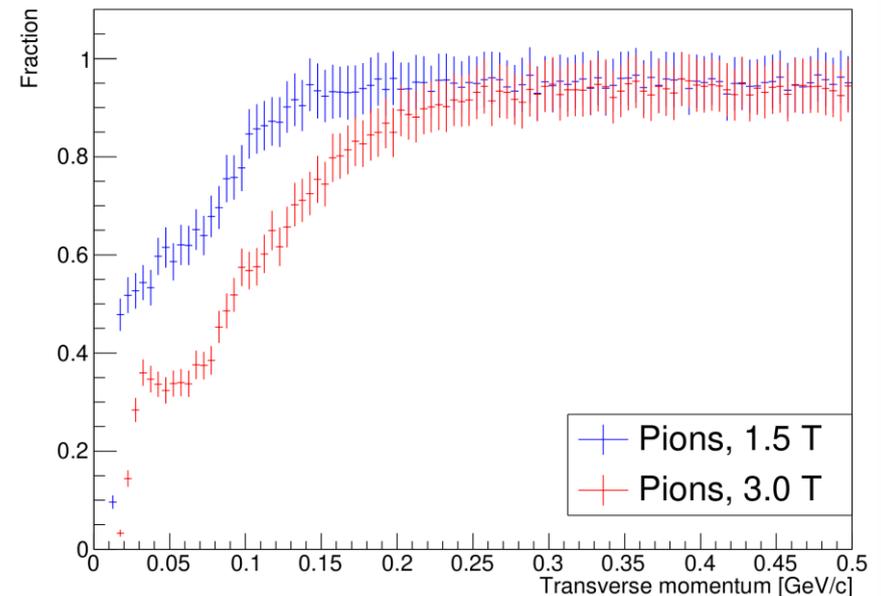
Kaons

Eta: 2.000000 to 2.500000



Pions

Eta: 2.000000 to 2.500000



- Reconstructable momentum:

- $p_T \geq 140 \text{ MeV}/c$
- $p_T \geq 220 \text{ MeV}/c$

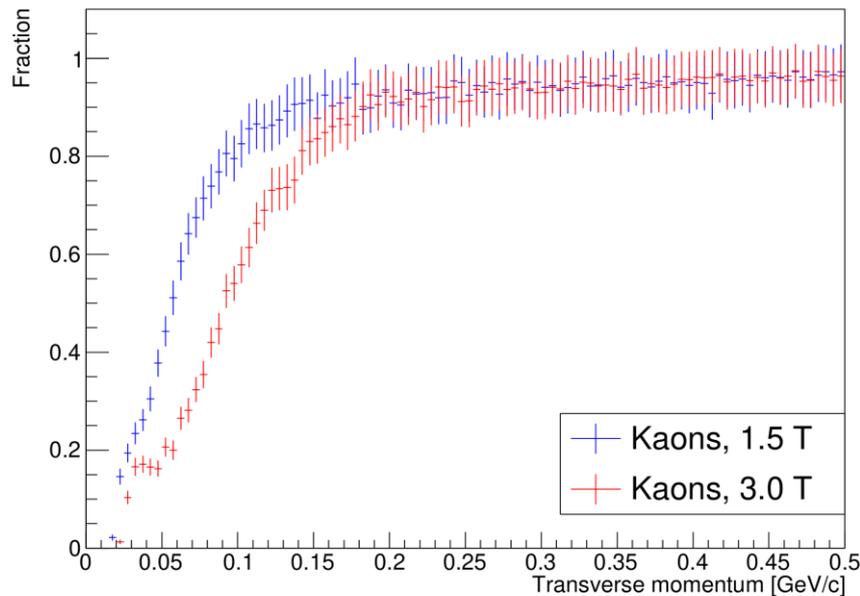
- Reconstructable momentum:

- $p_T \geq 130 \text{ MeV}/c$
- $p_T \geq 200 \text{ MeV}/c$

$$2.5 \leq \eta \leq 3.0$$

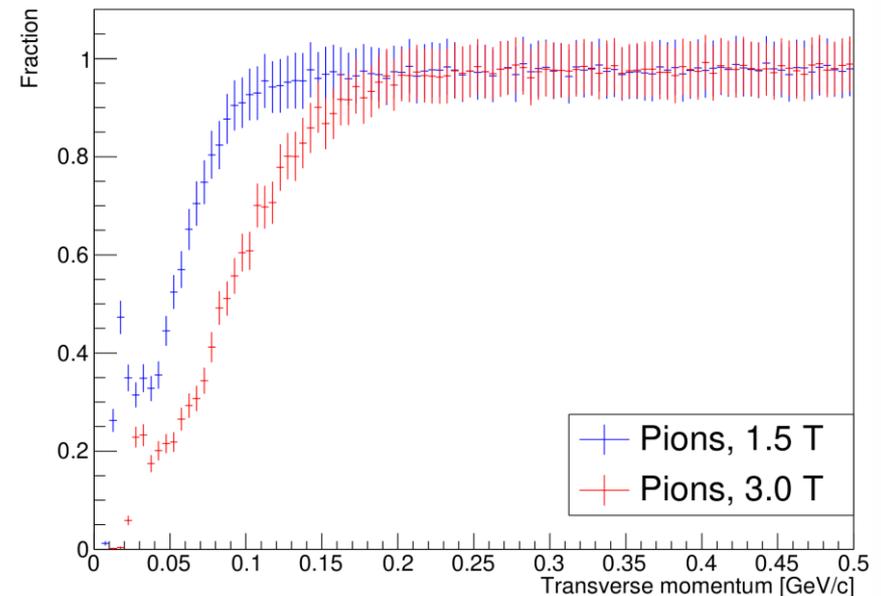
Kaons

Eta: 2.500000 to 3.000000



Pions

Eta: 2.500000 to 3.000000



- Reconstructable momentum:

- $p_T \geq 110 \text{ MeV/c}$
- $p_T \geq 180 \text{ MeV/c}$

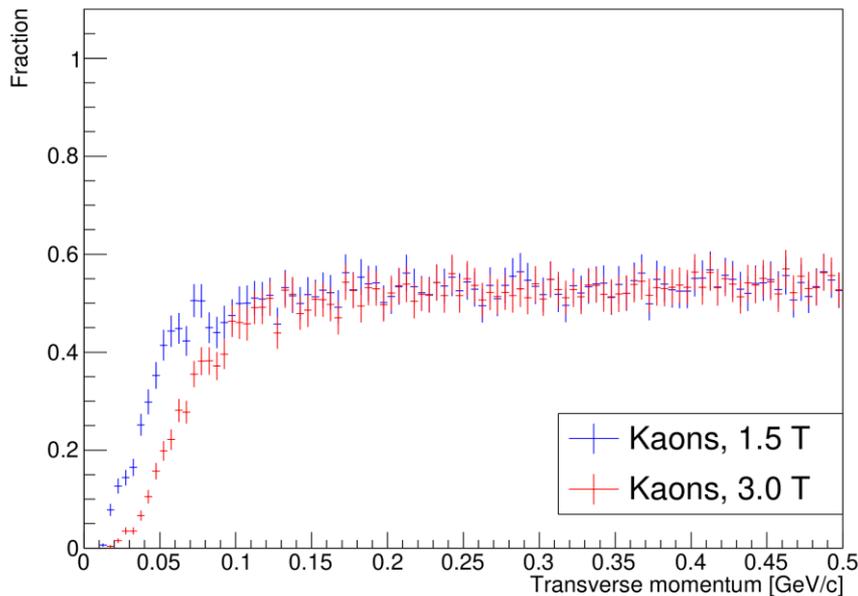
- Reconstructable momentum:

- $p_T \geq 100 \text{ MeV/c}$
- $p_T \geq 150 \text{ MeV/c}$

$3.0 \leq \eta \leq 3.5$

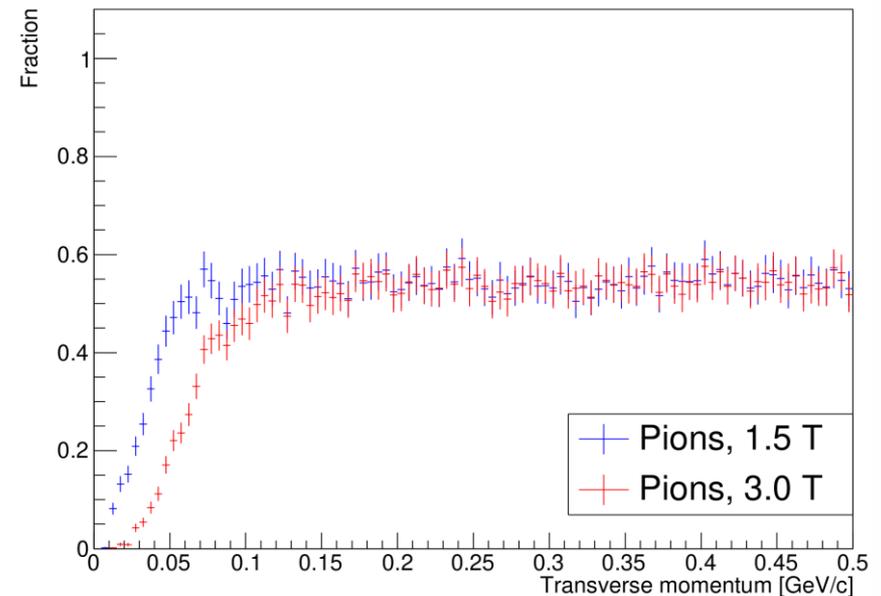
Kaons

Eta: 3.000000 to 3.500000



Pions

Eta: 3.000000 to 3.500000



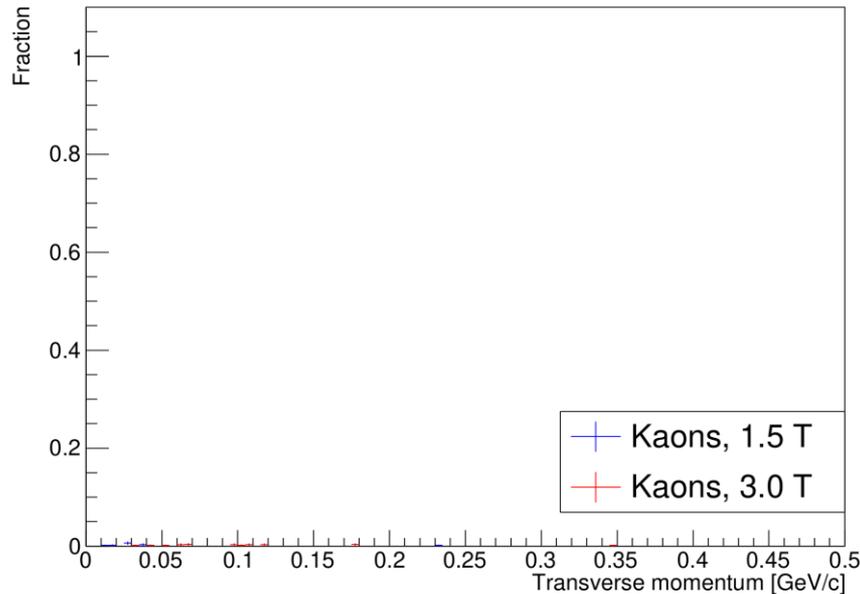
- Reconstructable momentum:
 - Detectors are missed in a large part of this interval, bringing the "average" over the interval down

- Reconstructable momentum:
 - Detectors are missed in a large part of this interval, bringing the "average" over the interval down

$$3.5 \leq \eta \leq 4.0$$

Kaons

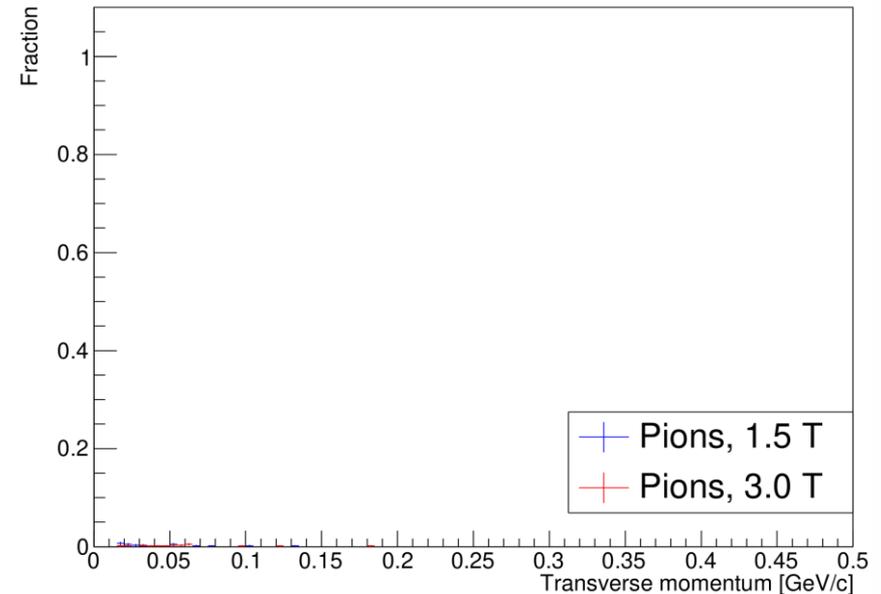
Eta: 3.500000 to 4.000000



- Reconstructable momentum:
 - All detectors are missed. Only noise remains

Pions

Eta: 3.500000 to 4.000000

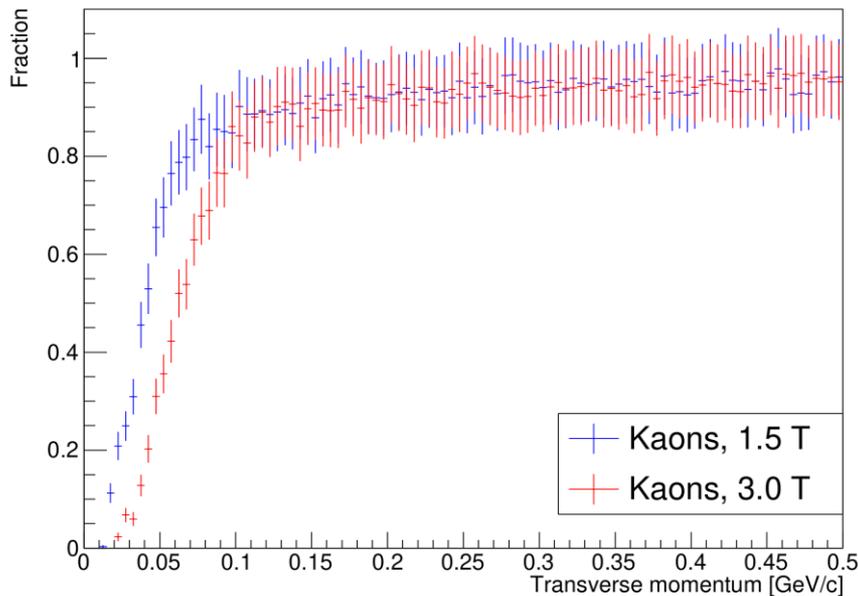


- Reconstructable momentum:
 - All detectors are missed. Only noise remains

Splitting $3.0 \leq \eta \leq 3.5$ into two; $3.0 \leq \eta \leq 3.25$

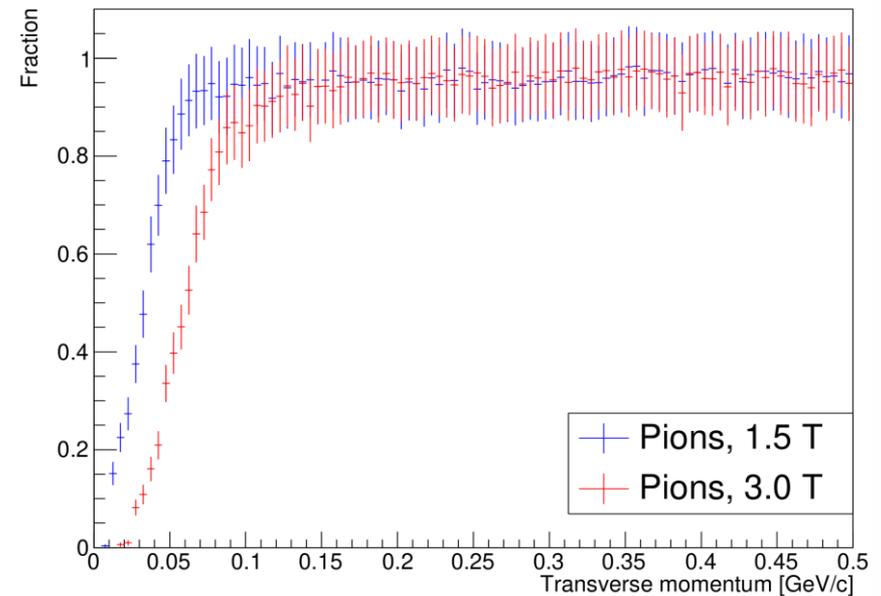
Kaons

Eta: 3.000000 to 3.250000



Pions

Eta: 3.000000 to 3.250000



- Reconstructable momentum (note that the error bars are larger):

- $p_T \geq 100 \text{ MeV/c}$
- $p_T \geq 110 \text{ MeV/c}$

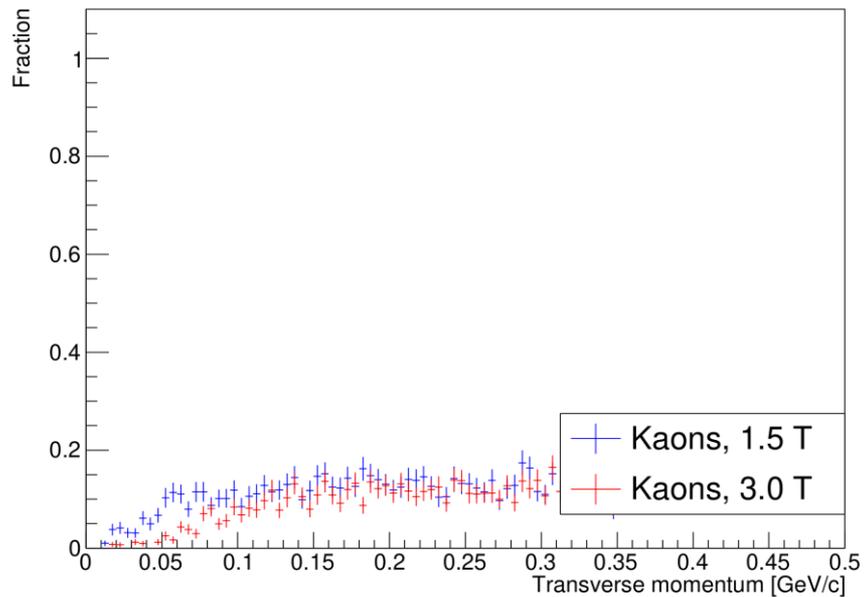
- Reconstructable momentum (note that the error bars are larger):

- $p_T \geq 60 \text{ MeV/c}$
- $p_T \geq 110 \text{ MeV/c}$

Splitting $3.0 \leq \eta \leq 3.5$ into two; $3.25 \leq \eta \leq 3.50$

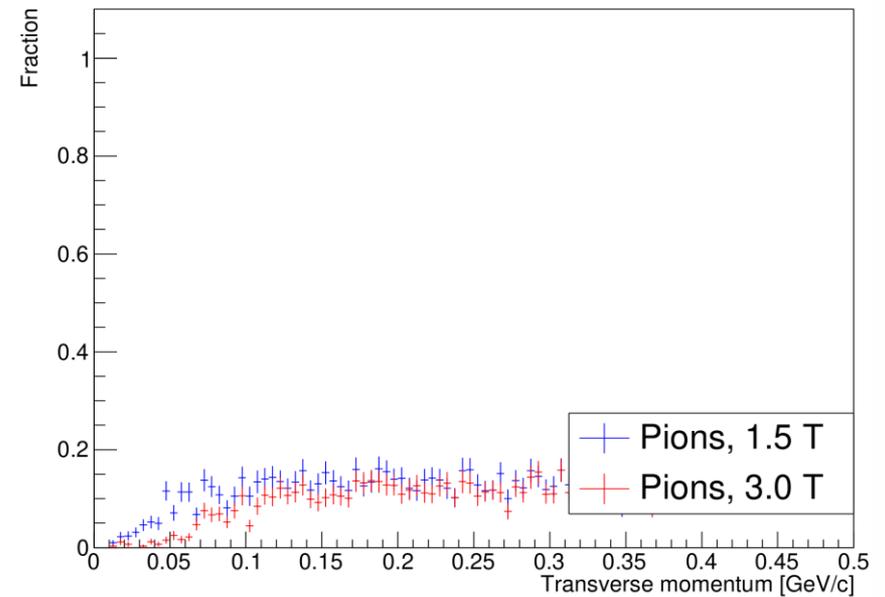
Kaons

Eta: 3.250000 to 3.500000



Pions

Eta: 3.250000 to 3.500000





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Backup slides

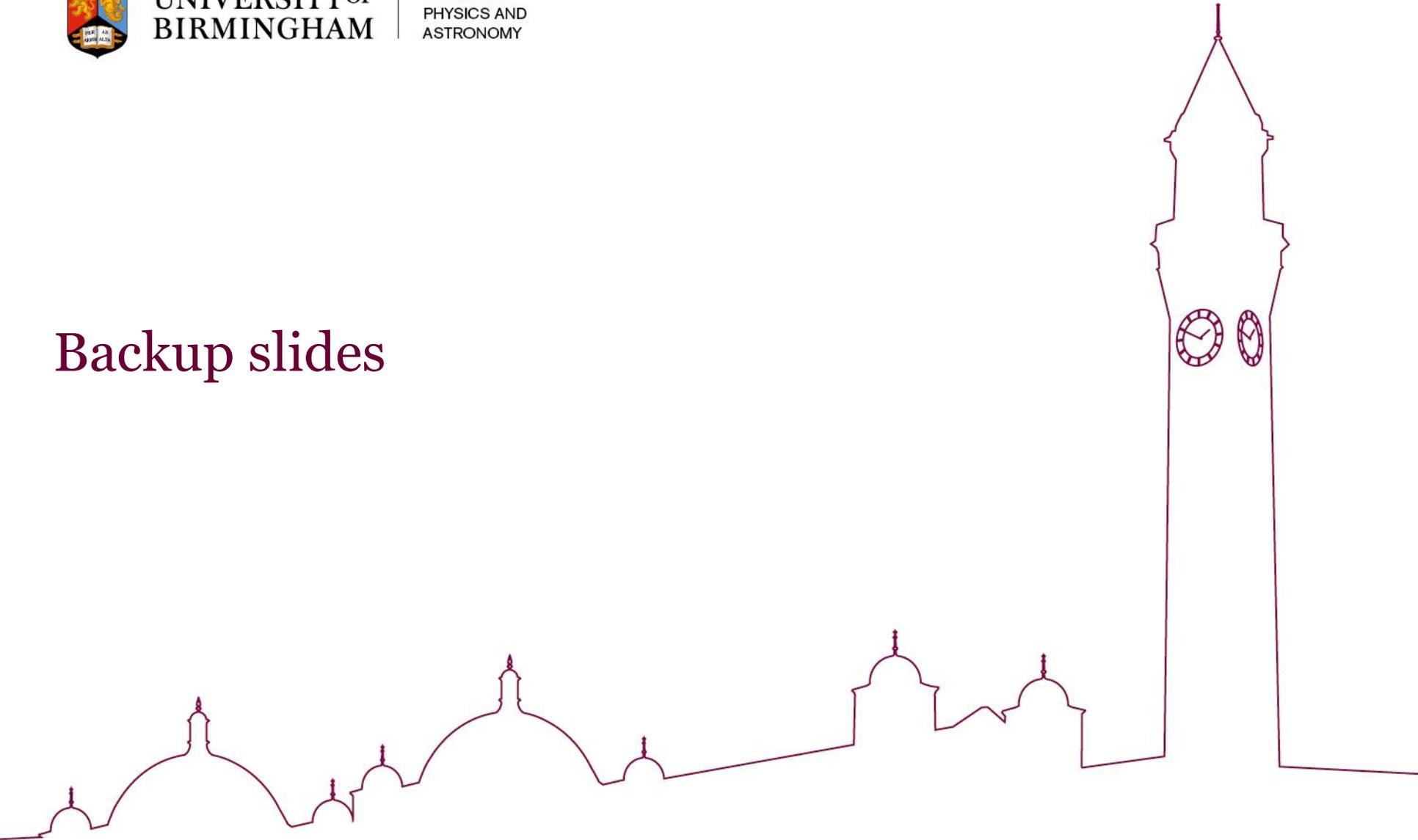
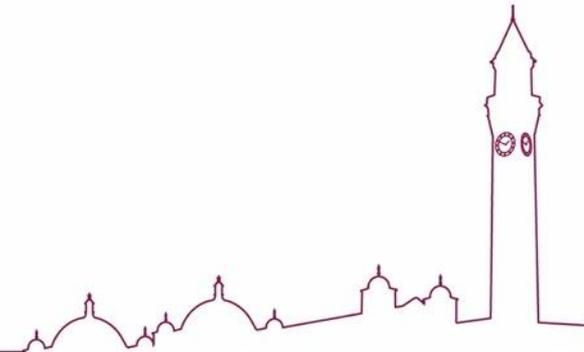


Table of spiralling momentum

Place	Radius	Spiralling momentum, 1.5 T	Spiralling momentum, 3.0 T
Innermost layer	36.4 mm	8.18 MeV/c	16.4 MeV/c
Middle inner layer	44.5 mm	10.0 MeV/c	20.0 MeV/c
Outermost inner layer	52.6 mm	11.8 MeV/c	23.7 MeV/c
Innermost outer layer	133.8 mm	30.1 MeV/c	60.2 MeV/c
Outer outer layer	180.0 mm	40.5 MeV/c	80.9 MeV/c
TPC start	200.0 mm	45.0 MeV/c	89.9 MeV/c
Black hole	800.0 mm	180 MeV/c	360 MeV/c

Table 3: Momentum for spiralling at different radii, for fields of 1.5 T and 3.0 T. This is all transverse momentum (or rather, orthogonal to the magnetic field). Important to note is that all momenta below this will spiral, too. This table shows the momentum for which the **diameter** of the circular track hits the given radius.



Full layout sketch

