

PID detector alignment

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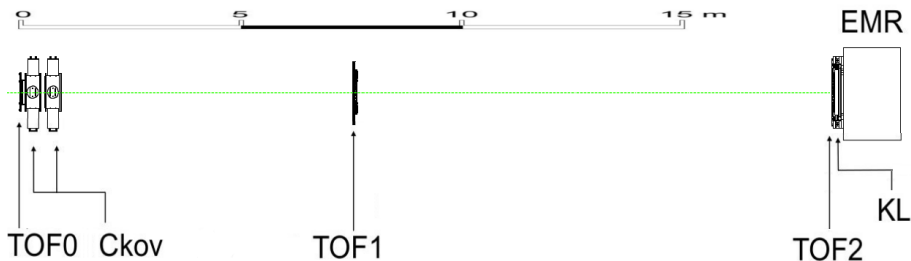
PID detectors alignment with the muon beam

Run 7417

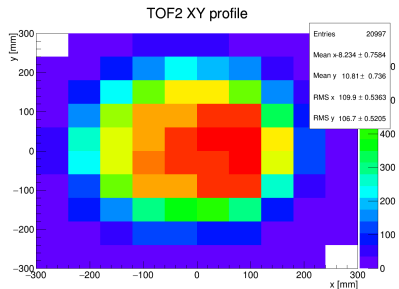
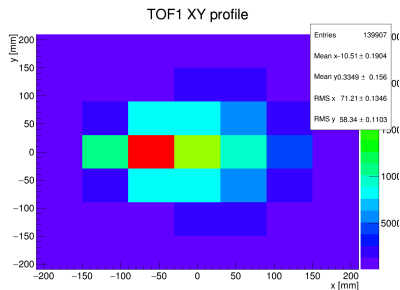
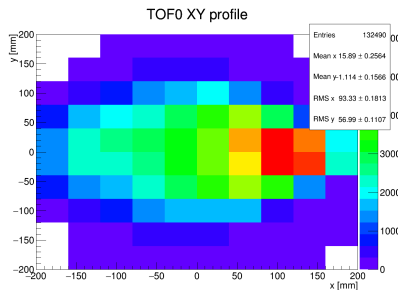
- 6π -200 MeV/ c muon beam, DS on
- 12347 spills, 158320 triggers at TOF1

Event selection

- **TOF0-2** and the **EMR** provide (x, y) , **KL** only y , **CKOVA-B** not
- No pre-selection, all the hits recorded in each of the PID detectors are plotted to construct a the beam profile

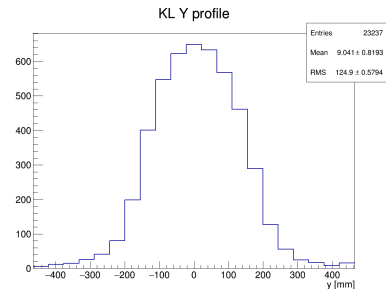


TOFs beam profiles and surveys



ID	x/y	Position [mm]	CDB [mm]
0	x	15.89 ± 0.26	-3.03
	y	-1.11 ± 0.16	-2.90
1	x	-10.51 ± 0.19	+5.56
	y	0.33 ± 0.16	+0.36
2	x	-8.23 ± 0.76	-13.92
	y	10.81 ± 0.74	+9.40

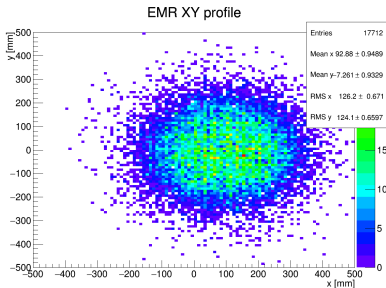
KL and EMR beam profiles



Measured y in the KL with respect to the CDB geometry (ID 70):

$$\rightarrow y = 9.04 \pm 0.82 \text{ mm}$$

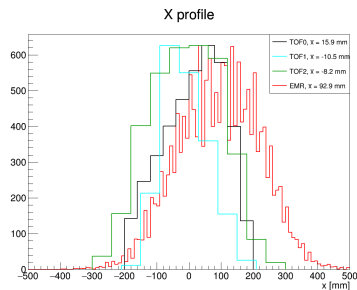
$$\rightarrow y_{\text{CDB}} = 11.9 \text{ mm}$$



EMR alignment data:

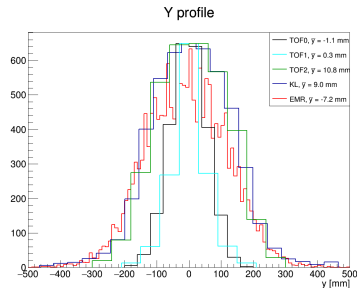
x/y	Position [mm]	CDB [mm]
δ_x	92.88 ± 0.95	84.29
δ_y	-7.26 ± 0.93	-5.63

Combined alignment with the beam axis



Combined X profile

Det.	Position [mm]	CDB [mm]
TOF0	$+15.89 \pm 0.26$	-3.03
TOF1	-10.51 ± 0.19	+5.56
TOF2	-8.23 ± 0.76	-13.92
EMR	$+92.88 \pm 0.95$	84.29



Combined Y profile

Det.	Position [mm]	CDB [mm]
TOF0	-1.11 ± 0.16	-2.90
TOF1	0.33 ± 0.16	+0.36
TOF2	10.81 ± 0.76	+9.40
KL	9.04 ± 0.82	11.9
EMR	-7.26 ± 0.93	-5.63

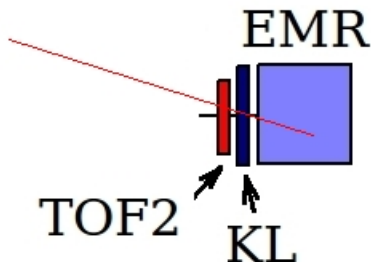
Downstream PID detector alignment

Run 7417

- 6π -200 MeV/ c muon beam, DS on
- 12347 spills, 158320 triggers at TOF1

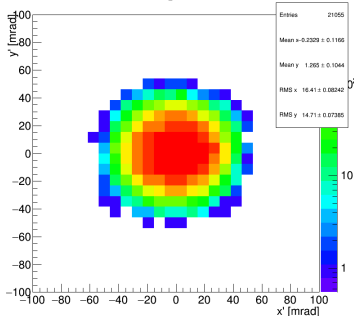
Event selection

- Single space-points in the 3 TOF stations, track in the EMR
- Fit the track in the EMR, reconstruct backwards into the KL and TOF2
- Fails beyond TOF2 as the emittance growth in KL is significant (see next)
- Assume CDB geometry (surveys)

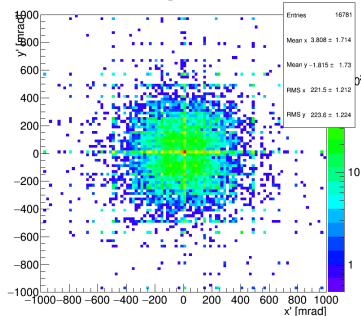


Emittance growth in the KL

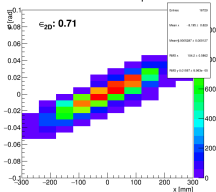
TOF12 XY angular distribution



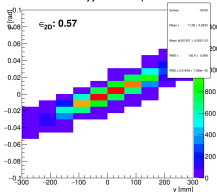
EMR XY angular distribution



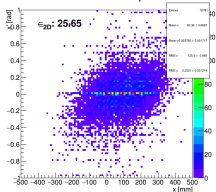
TOF2 x' beam ellipse



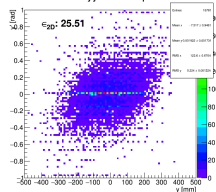
TOF2 y' beam ellipse



EMR x' beam ellipse



EMR y' beam ellipse



Distance fitting between the EMR and the KL (+ TOF2)

To find the right distance, plot the residuals for a wide range of distances

→ **-500 mm to 0 mm** offset in z scanned by steps of 2 mm

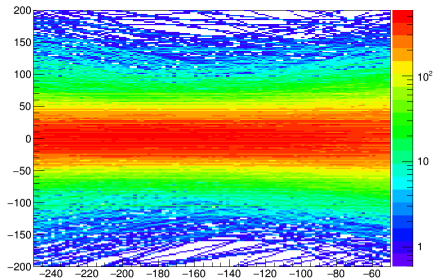
→ RMS residual calculated, minimized

The best fits for the KL and TOF2 are

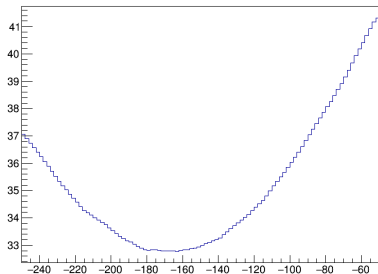
→ $z_{\text{KL}} - z_{\text{EMR}} = -163 \pm 1$ mm (\ll then CDB !)

→ $z_{\text{TOF2}} - z_{\text{EMR}} = -195 \pm 1$ mm (consistent for x, y res.)

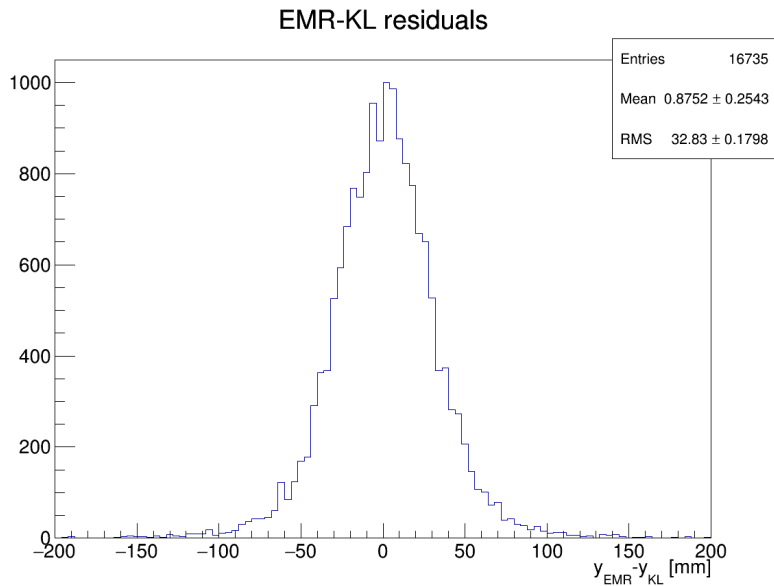
Mean residuals for different D(KL-EMR)



Best fit of distance D(KL-EMR)

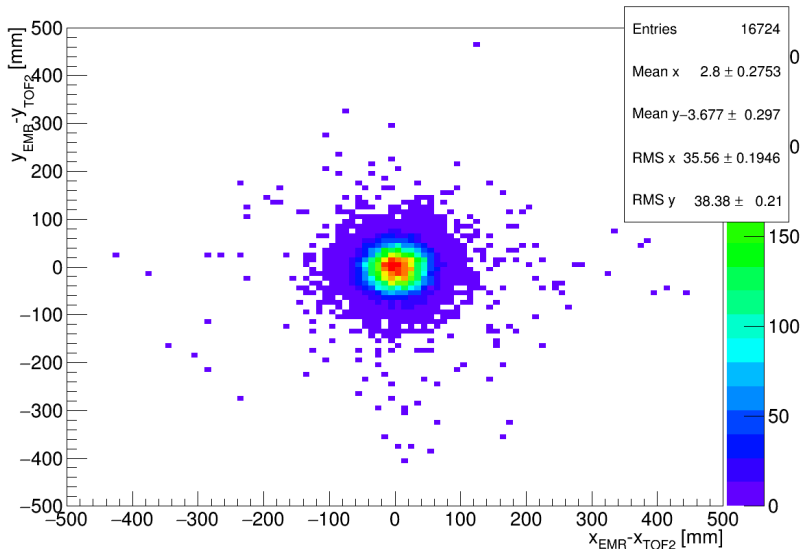


EMR-KL residuals (-163 mm)



EMR-TOF2 residuals (-195 mm)

EMR-TOF2 residuals



Further investigations

Run 7489 (Q789 OFF)

- 300 MeV/c pion reference beam, DS on
- 620 spills, 122128 triggers
- Expand backwards from TOF2→1 into TOF0
- $\mathcal{O}(10^3)$ space-points in TOF2
- $\mathcal{O}(10^2)$ tracks in after cuts...

Next task, use the tracker

- Extrapolate tracks upstream from TKU and downstream from TKD to check the consistency through the cooling channel
- 7489 was taken with the tracker DAQ off (unpacking failure), need to take a new run including tracker data

