Trigger downscaling checks

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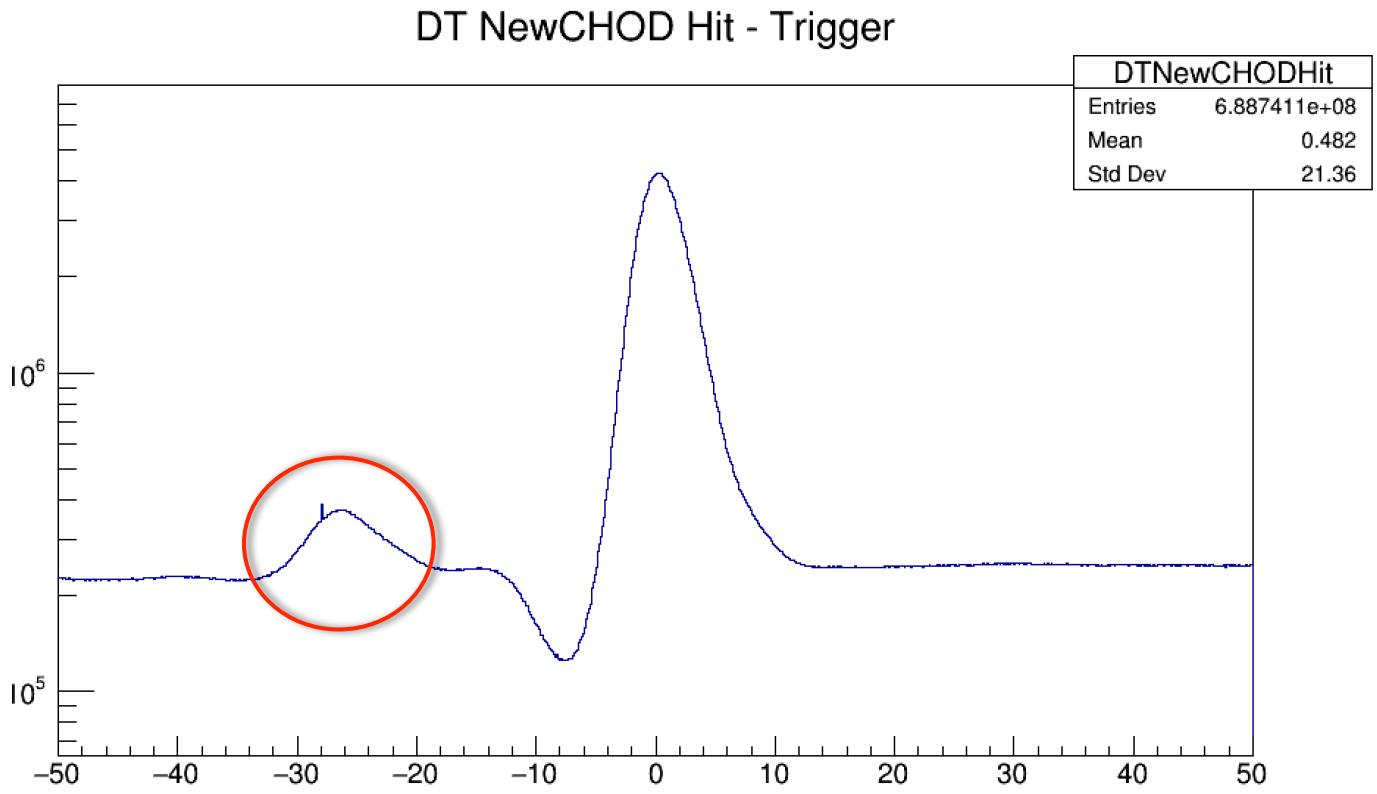
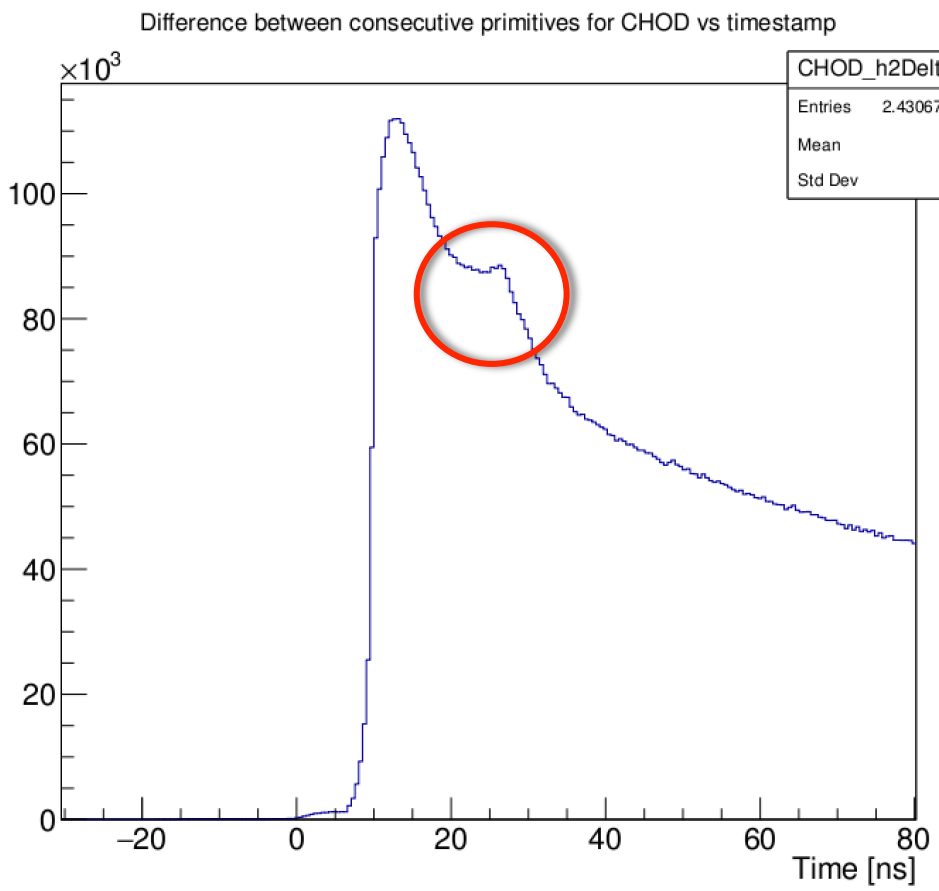
Italo's plots (2016 data taking):

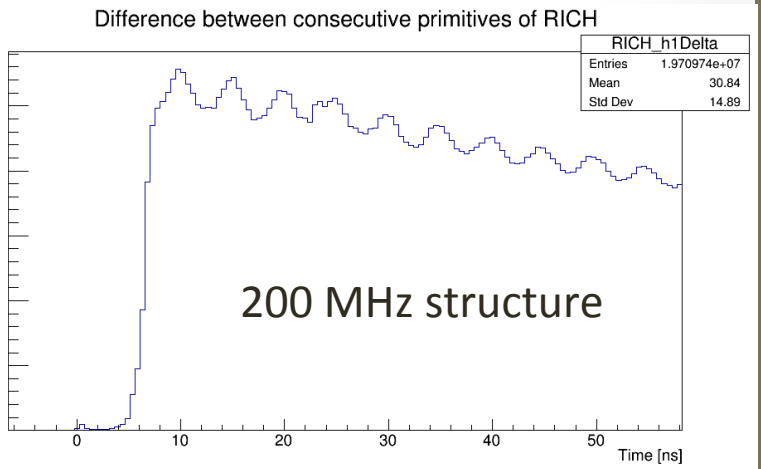


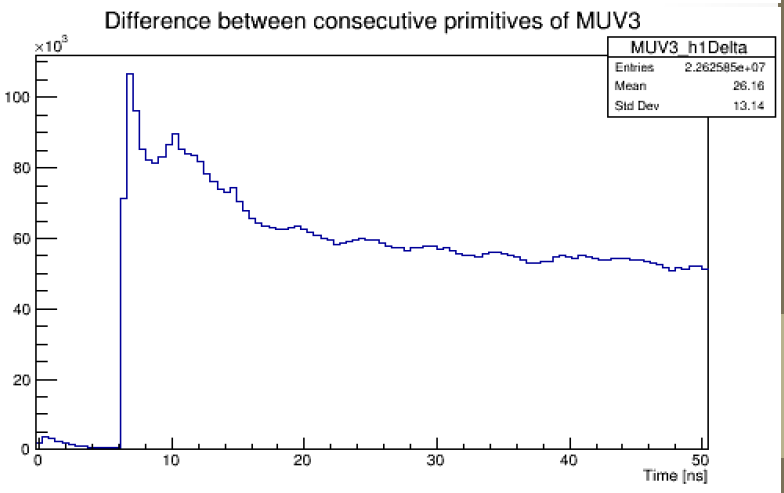
Checks

- Checks:
  - distance between two different primitives from CHOD detector.
  - $\pi^+\pi^0$ events selected using only LKr, checks for out-of-time peaks.
  - Total number of 3π and $\pi^+\pi^0$ from:
    - Mask0
    - MAsk5
    - Control
  - Branching ratio of $K\mu 2$ and $K\pi^+\pi^0$ normalized to $K3\pi$

Primitive profile run 6610 – burst 40







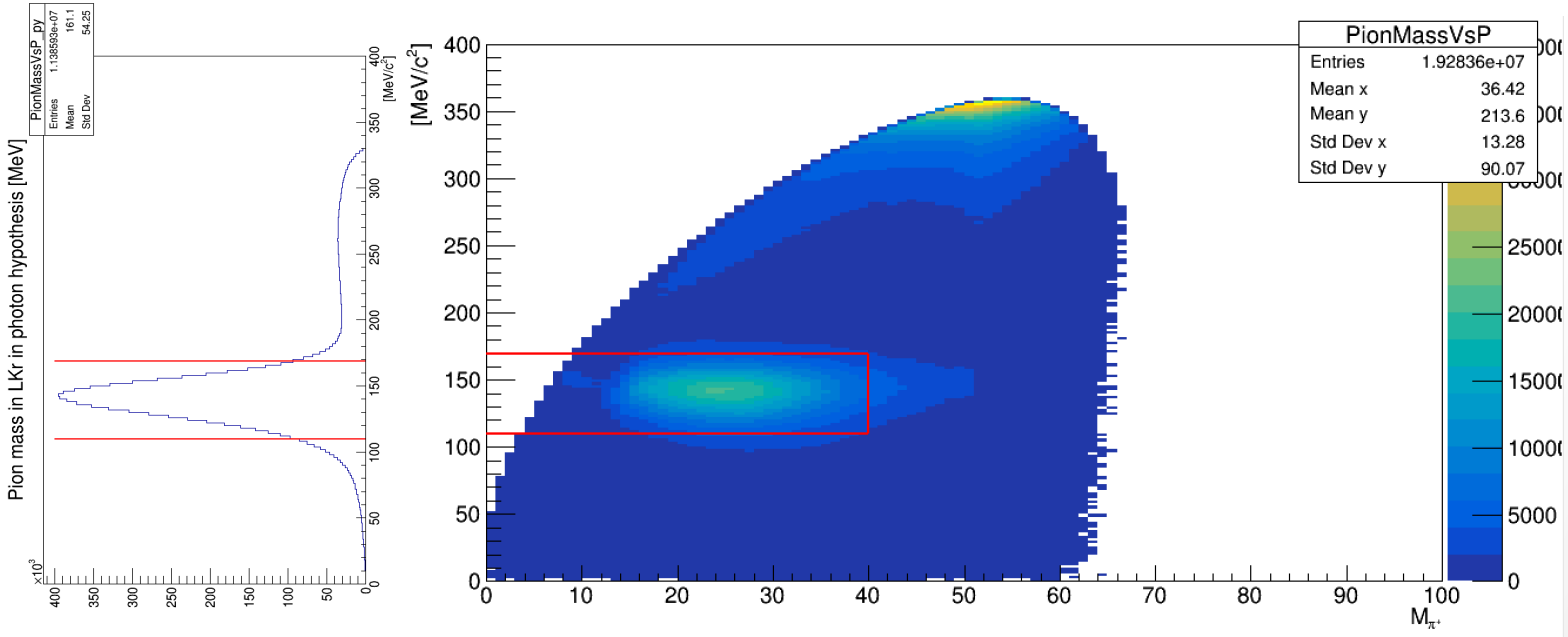
Data from 2016

- 30 golden run used:
- 6497, 6498, 6501, 6579, 6581, 6610, 6611, 6612, 6613, 6632, 6633, 6634, 6635, 6636, 6637, 6639, 6641, 6642, 6653, 6654, 6656, 6658, 6659, 6660, 6661, 6662, 6663, 6664, 6678, 6680.

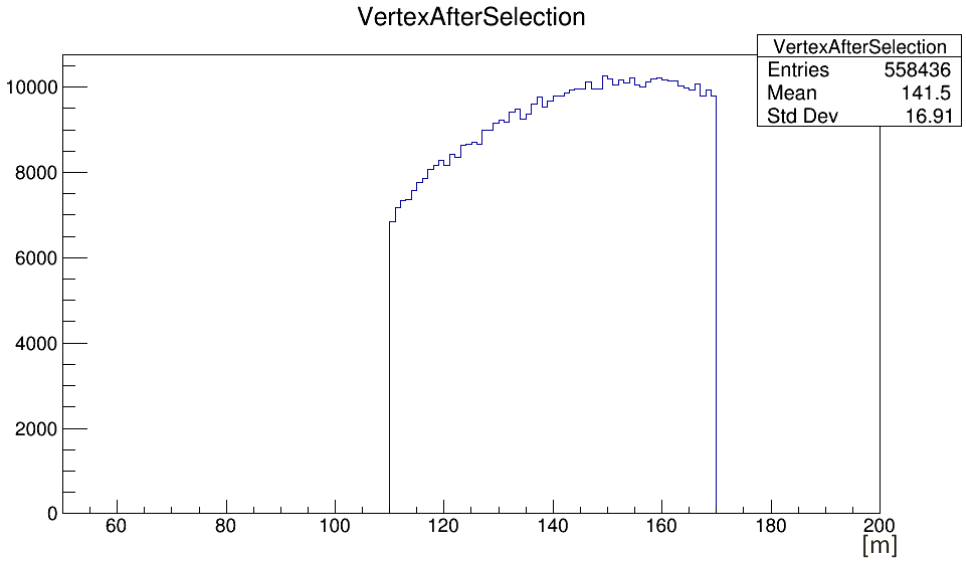
- Trigger used:
  - Mask0: RICH x Q1 x !MUV3 (x KTAG) / 200
  - Mask5: RICH x Qx (x CEDAR x STRAW x L1) / 50
  - Control Trigger / 400

Check $\pi^+\pi^0$

- LKr π^0 reconstruction, imposing π^0 mass and looking for derived z in the fiducal volume.
- No cut in time between photons => to probe out of time physics.
- MUV3 in Veto (no candidates at all)
- LAV in Veto (no candidates at all)
- IRC in Veto (no candidates at all)
- $P_{\pi+} < 40$ GeV

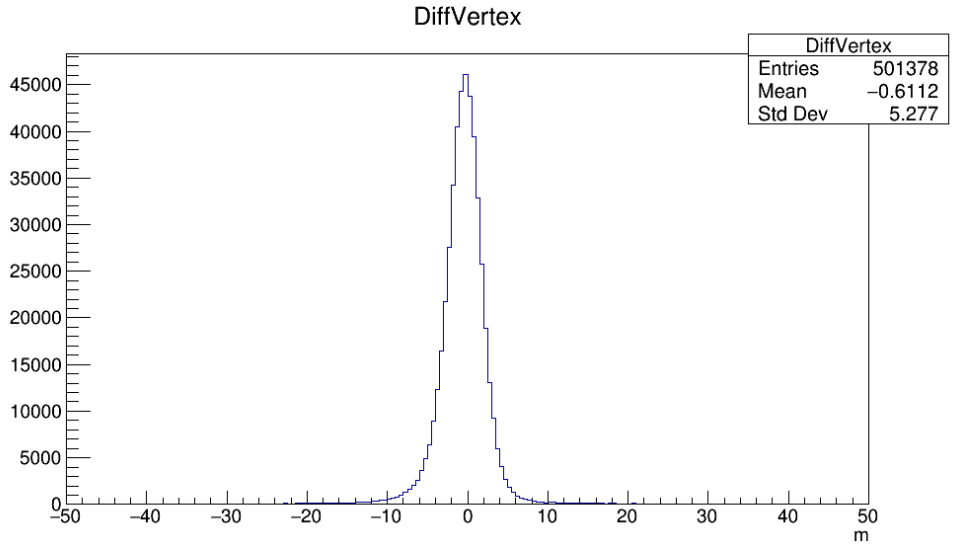


Check $\pi^+\pi^0$



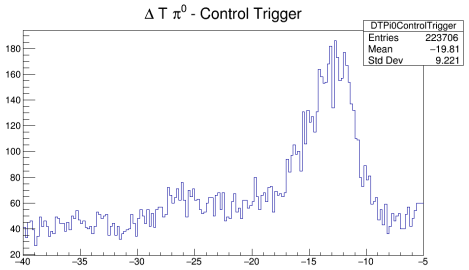
Vertex distribution of selected events

Consistency check with charged Z.
Charged Z not used to select events.

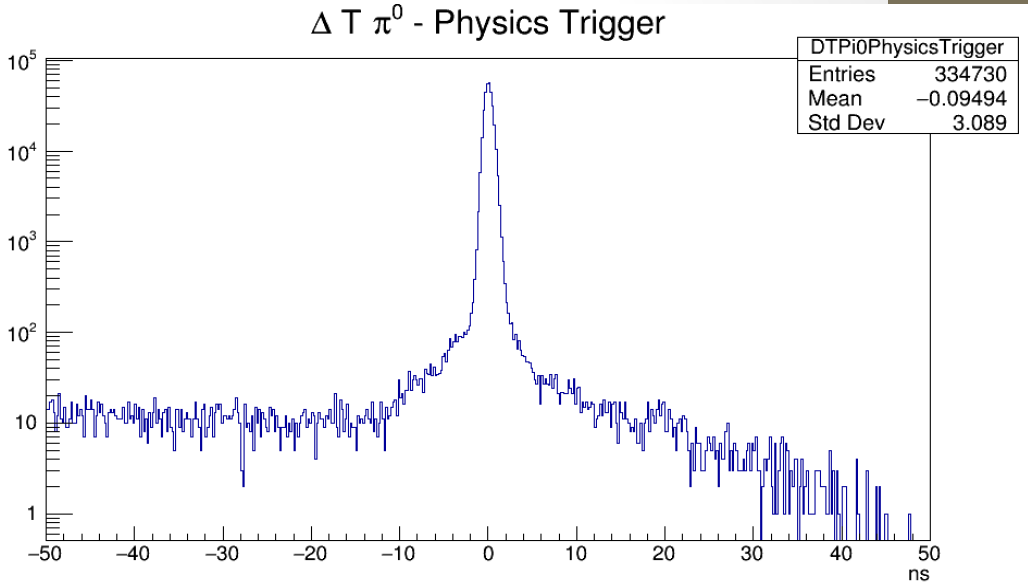


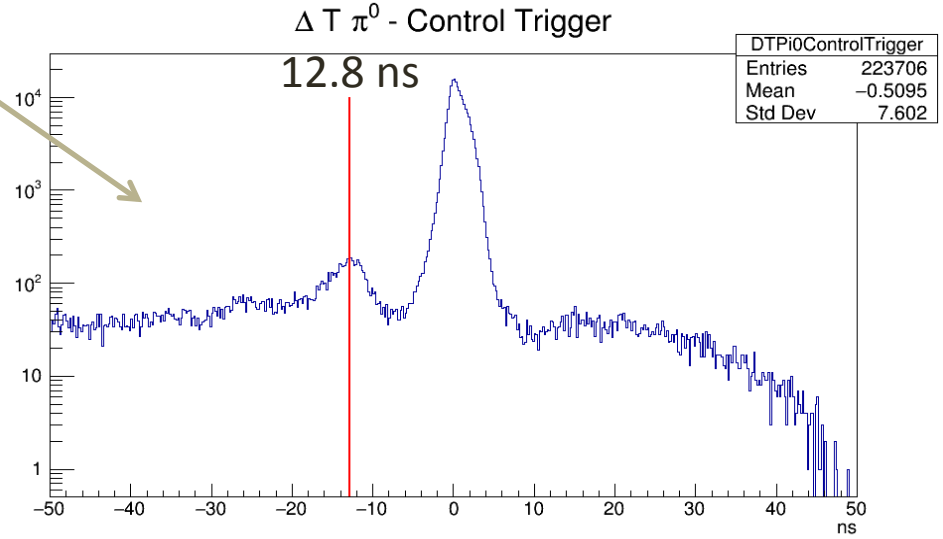
Check $\pi^+\pi^0$

π0 time:
mean value of the two photons time



about 2% of the main peak





Often those events have two primitives in L0TP, one in slot 0, triggering, while the other is in slot -1, 12.5 ns far form slot 0, by construction.

When the RICH primitive is present, it is in coincidence with the slot -1.

It seems a refiring after 12.8 ns. Why is it not at 25 ns?

Total number of K decays

k2π selection

- 1 and only one good, positive track in the spectrometer
- 1 cluster in CHOD in time (6 ns) with the trigger associated with the track.
- 1 KTAG in time (2.5 ns) with > 5 sectors
- 1 good GTK in time (1.5 ns)
- cda GTK/Straw < 2.5 cm
- Zvtx in fiducial volume
- 0.2 < E/p < 0.9
- Not MUV3
- *Not LAV*
- Not IRC/SAC
- 130 < π0 mass < 140 GeV
- Reconstruction of π0 with LKr, 125 < mass < 145
- 15 GeV < P < 50 GeV

Acceptance: 0.05

Kμ2 selection

- 1 and only one good, positive track in the spectrometer
- 1 cluster in CHOD in time (6 ns) with the trigger associated with the track.
- 1 KTAG in time (2.5 ns) with > 5 sectors
- 1 good GTK in time (1.5 ns)
- cda GTK/Straw < 2.5 cm **Acceptance: 0.21**
- Zvtx in fiducial volume
- E/p < 0.2
- 1 and only 1 candidate in MUV3 associated with track
- *Not LAV*
- Not IRC
- -0.002 < Missing mass squared < 0.002 GeV2
- 15 GeV < P < 50 GeV

k3π selection

- One good, positive vertex with 3 Tracks.
- 3 tracks in the 4 chambers of the spectrometer
- 3 cluster in CHOD in time (6 ns) with the trigger associated with the track.
- 1 KTAG in time (2.5 ns) with > 5 sectors
- 1 good GTK in time (1.5 ns)
- Distance between vertex and GTK projection < 5 mm
- Zvtx in fiducial volume
- Not MUV3
- *Not LAV*
- Not IRC/SAC
- 490< Invariant mass < 497 GeV

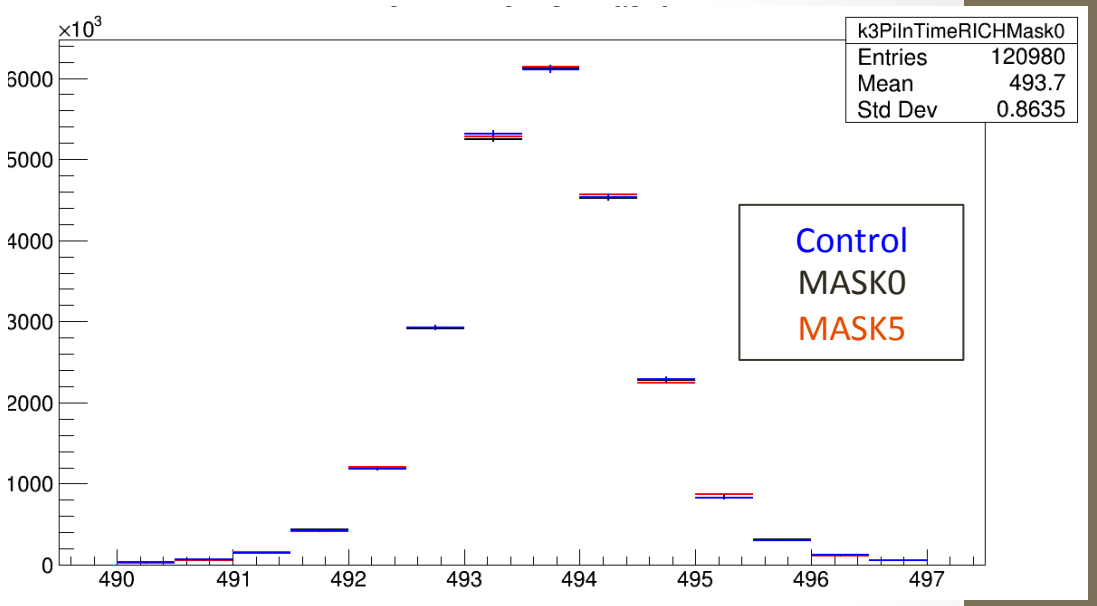
Acceptance: 0.053

K3π

N0 control = 60730 ± 246
N0 mask0 = 120980 ± 348
N0 mask5 = 441951 ± 665

L0 Mask0 Efficiency 0.9964 ± 0.0003
L0 Mask5 Efficiency 0.938 ± 0.001
L0 Cntrl Efficiency 0.9986 ± 0.0001

L1 Mask0 Efficiency 0.9995 ± 0.0004
L1 Mask5 Efficiency 0.968 ± 0.001



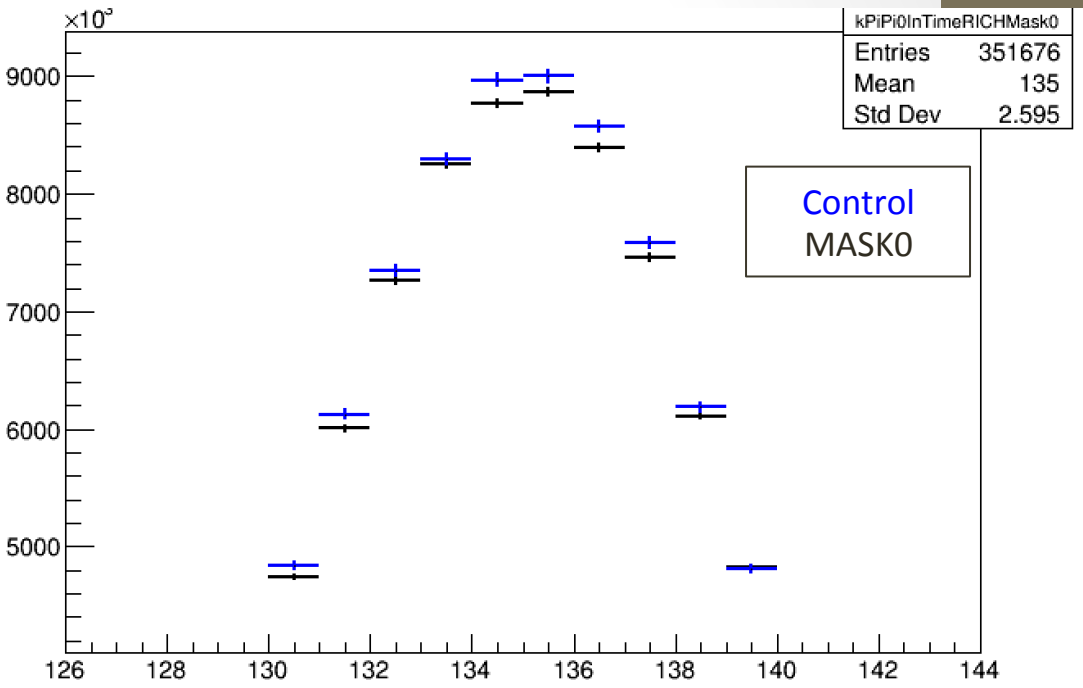
N = N0 * Downscaling * (1 / efficiencyL0) * 1/(efficiencyL1)
Statistical error: √[Downscaling² * (1/efficiencyL0)² * (1/efficiencyL1)² * N0]

Trigger	Value (only statistical)	Normalized to mask 0
Mask0	24293780 ± 69845	1
Mask5	24340380 ± 36613	0.998
Control	24326988 ± 98716	0.998

K2π

N0 = control 178742 ± 423
N0 = mask0 351676 ± 593

L0 Mask0 Efficiency 0.9958 ± 0.0001
L0 Cntrl Efficiency 0.9970 ± 0.0001
L1 Mask0 Efficiency 0.9994 ± 0.0003



NK2π = N0 * Downscaling * (1 / efficiencyL0) * 1/(efficiencyL1)
Statistical error: √[Downscaling^2 * (1/efficiencyL0)^2 * (1/efficiencyL1)^2 * N0]

Trigger	Value (only statistical)	Normalized to mask 0
Mask0	70672543 ± 119163	1
Control	71712339 ± 169621	0.986

Branching ratios

Kμ2 Branching ratio

- Kμ2: N0 Control 914313668 ± 605663.3

BR= (NKμ2 * 1/AcceptanceKμ2) / (NKnorm * 1/AcceptanceKnorm)

Error on the acceptance not considered, few montecarlo events analyzed. It has to be improved.

Normalized to π+π0

PDGValue:	3.074988 ± 0.01
Control Value:	3.035652 ± 0.03
Mask0 Value:	3.080316 ± 0.02

Normalized to Kπ3

PDG Value:	11.390	± 0.053
Control Value:	9.418	± 0.154
Mask0 Value:	9.430	± 0.111
Mask5 Value:	9.412	± 0.062

Kπ3 normalization not compatible with PDG

Kπ2 Branching ratio

PDG Value: 3.704 pm 0.021
Control Value: 3.102 pm 0.014
Mask0 Value: 3.061 pm 0.009

K3π normalization not compatible with PDG,
at the same level of Kμ2.

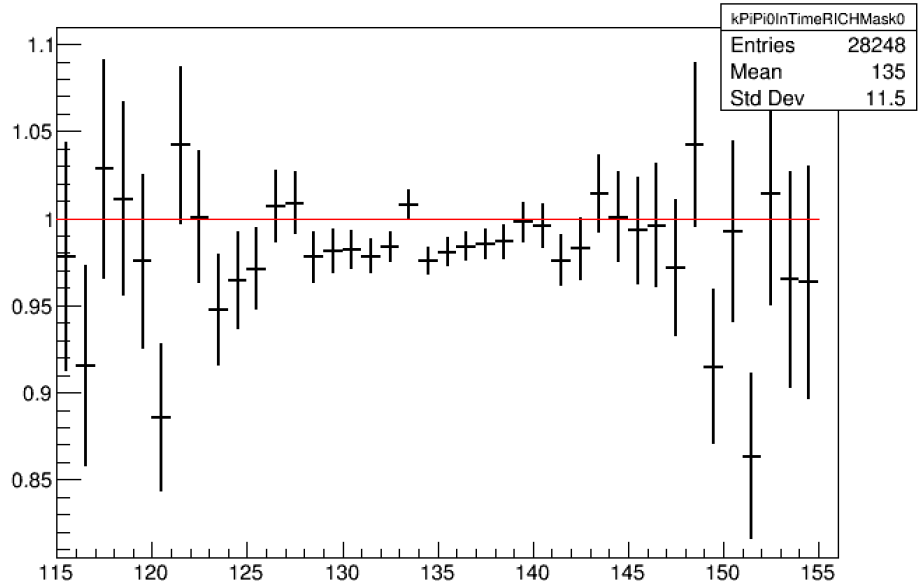
Missing K2π or Kμ2 with respect to K3π. Acceptance badly measured?
Random veto due to LKr? Same effect seems affecting both Kμ2 and K2π.

All the errors here reported are statistical. What about considering the fact that the dowscaling is truncated?
we can consider
$\sigma_{Downscaling}$ = Nbursts * (Downscaling / √ 12) / Nevents.

The errors increase, making all the measurements compatible.

Changing conditions

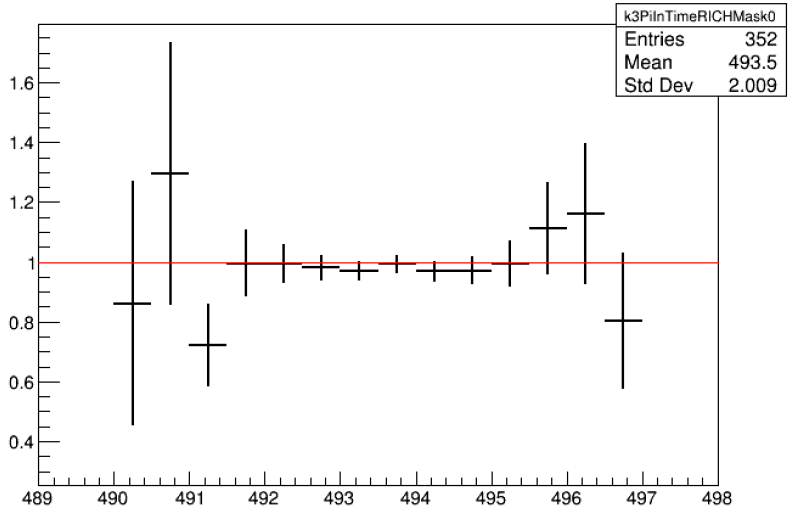
- Enlarging missing mass cut in K2π selection.



Trigger	Value (only statistical)	Normalized to mask 0
Mask0	94576790 ± 119163	1
Control	95937189 ± 137829	0.986

Changing conditions

- Veto for MIPs in K3π



Trigger	Value (only statistical)	Normalized to mask 0
Mask0	2691712 ± 23257	1
Mask5	2711461 ± 12229	0.993
Control	2747302 ± 33175	0.98

Changing conditions

```
********** K2 Pi Branching Ratio **********
Theoretical Value: 3.704301 pm 0.021433
Control Value:     4.651120 pm 0.427683
Mask0 Value:       4.679860 pm 0.307876
********** K Mu2 Branching Ratio **********
Normalized to PiPi0
Theoretical Value: 3.074988 pm 0.013037
Control Value:     3.353767 pm 0.019882
Mask0 Value:       3.402008 pm 0.015038
Normalized to 3Pi
Theoretical Value: 11.390681 pm 0.052810
Control Value:     15.598771 pm 3.900448
Mask0 Value:       15.920920 pm 2.852722
Mask5 Value:       15.804956 pm 1.490137
```

Background has to be understood.

Conclusions

- Evidences of refiring in NA48-CHOD. There are clear evidences both from Italo's plots and from the CHOD-primitive time distribution.
- Looking at out of time events using only calorimeter: about 2% of K2π appear out of time of 12.8 ns. Not compatible with Italo's events. What are they? Am I doing something wrong?
- Number of events for different masks are compatible. Big downscaling makes the numbers very sensitive to any perturbation: if there is a bias, the bias is multiplied of a factor 400 for the Control trigger.
- Branching ratio of Kμ2 compatible with PDG if normalized with K2π using the initial cut condition.
- Enlarging the π0 window and changing the acceptance, not anymore compatible.
- Background has to be understood.
- Normalization with K3π to be understood.

- The refiring effect seems not affecting the measurements at level of some %.

Suggestion

- The control trigger can be used to study the trigger efficiency, but for the normalization on K2π is much better to take events from trigger mask0:
  - RICH x Q1 x !MUV3 / 200

- Advantages:
  - all of its components are part of πνν mask.
  - L1 KTAG present both in πνν and mask0.
  - The RICH gives the time to the event, has for πνν.
  - Lower downscaling, more statistics

- Disadvantages:
  - They are not part of filtered data