Trigger studies for pp @4.5 GeV

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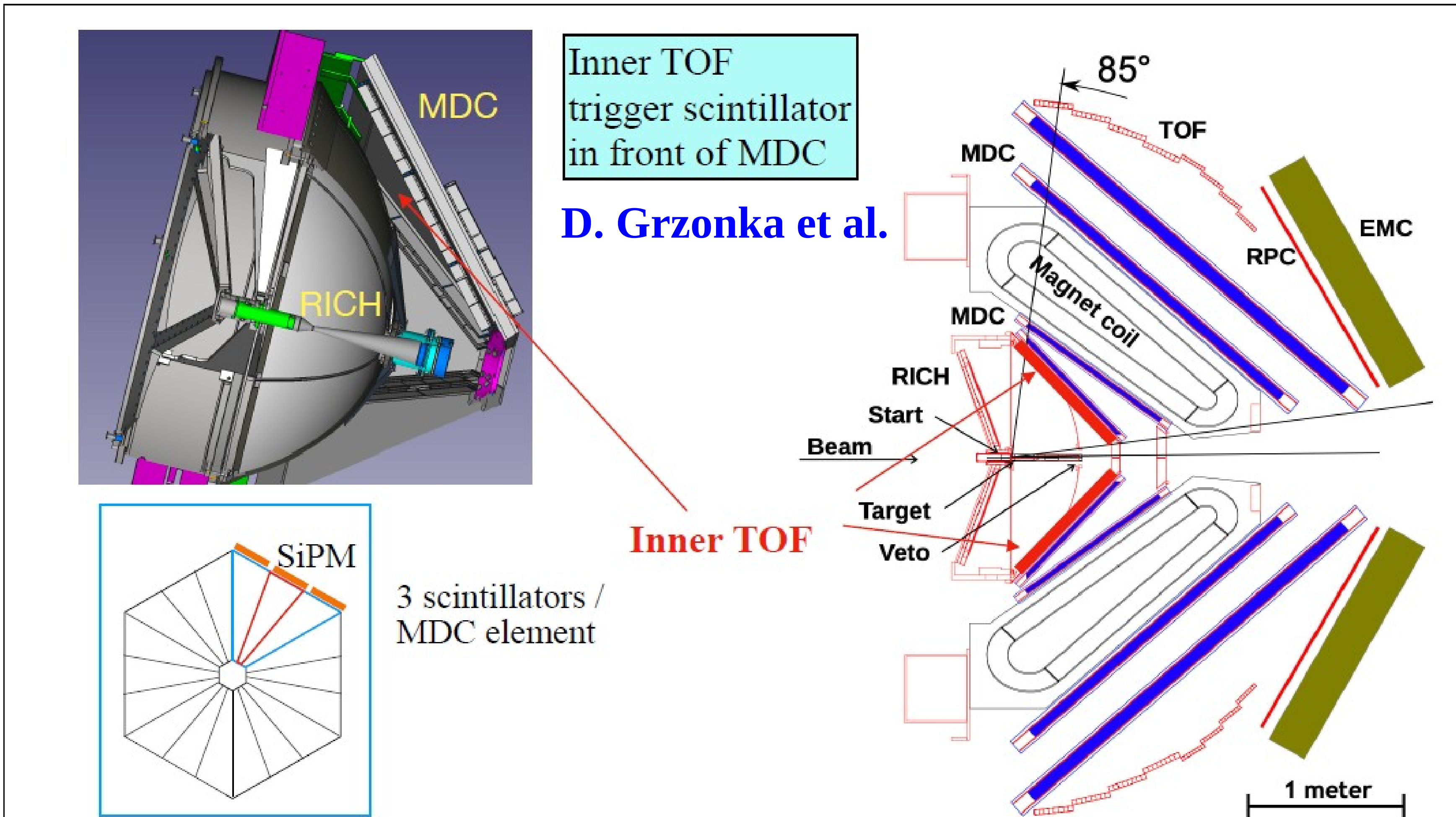
on behalf of the Trigger Group

10. 03. 2021

HADES/PANDA experiment p+p @ 4.5 GeV

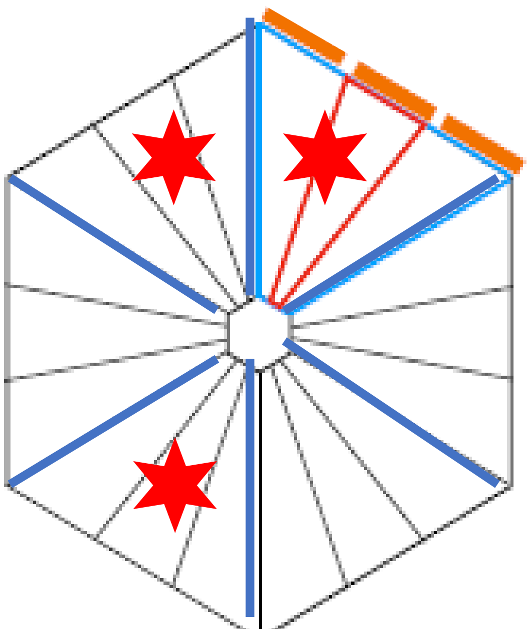
Proton beam: **$7.5*10^7$ p/sek** (L=1.5 $*10^{31}$ cm^2/sek)

- Trigger on inner TOF MUL>=3: trigger rate 50 kHz (~0.1 suppresion factor w.r.t reaction rate)

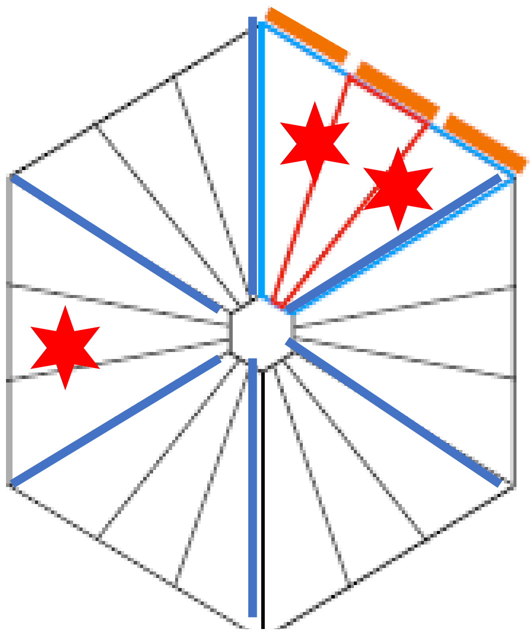


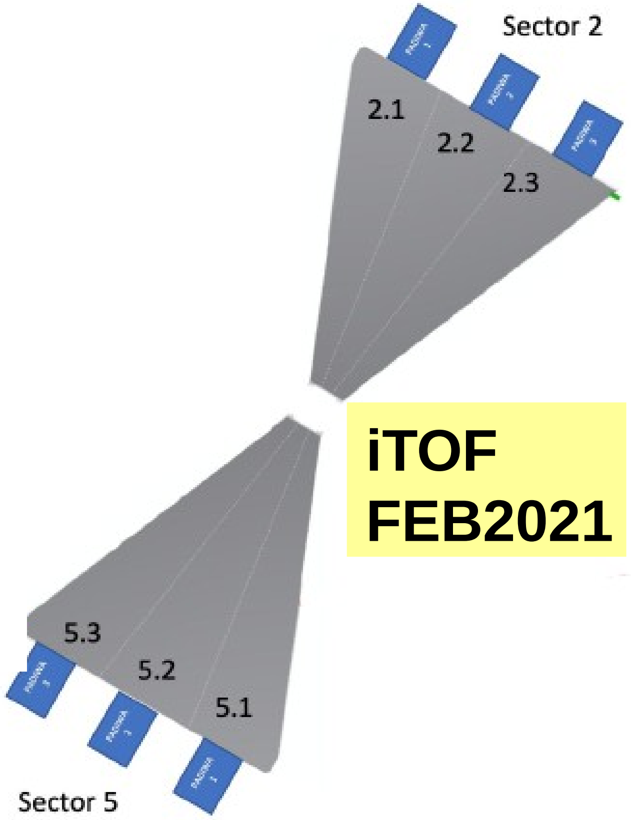
Main trigger

(implementation in logic of new trigger box-Jan Michel)



OR





iTOF
FEB2021

- Coincidence between sectors of Inner and Outer TOF required
- Only inner TOF

Trigger simulations

Benchmarking of event generators started: **GiBUU, RQMD rmf event generator**

↓

HGeant format

↓

DST production and trigger emulation

→ iTOF not yet implemented in Hgeant/Hydra

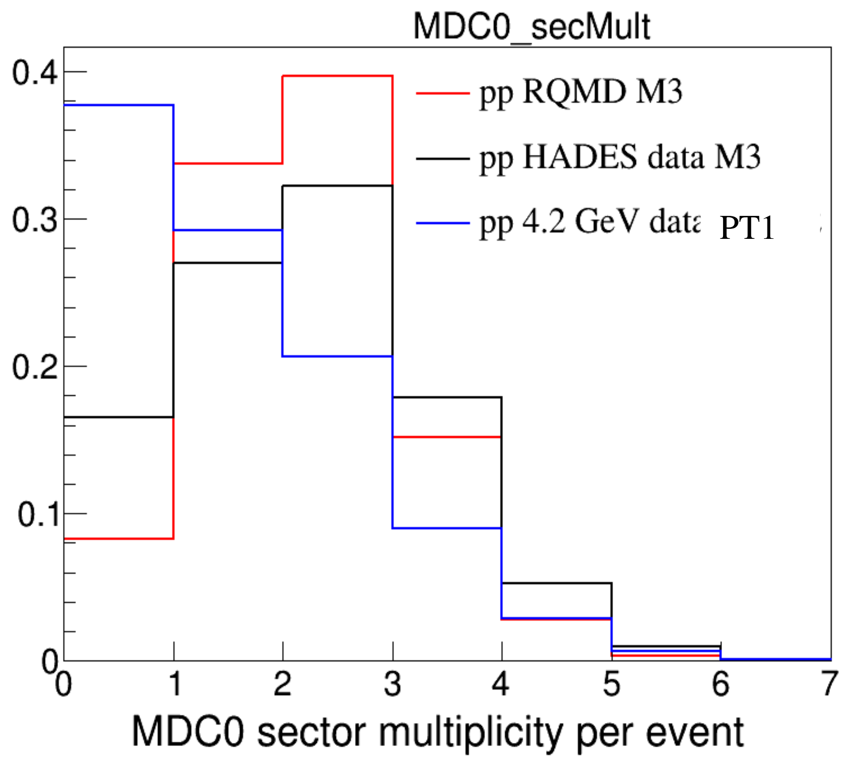
→ **inner MDC is used as inner TOF proxi**

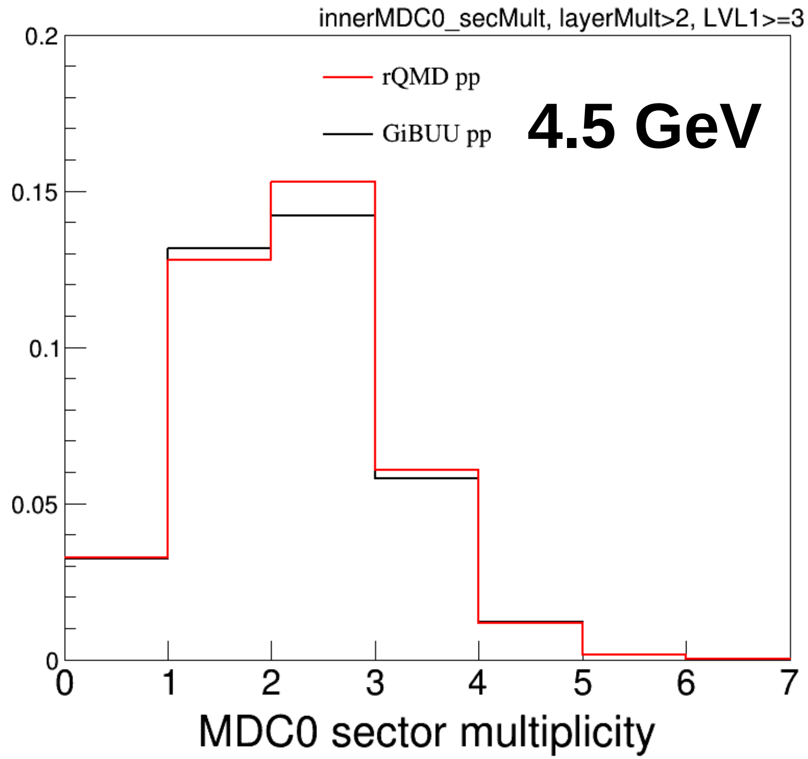
→ **MDC0 sector proxi: MDC0 layerMult >= 3**

→ phi angle of a given track was assigned to a given iTOF paddle

Triggering on inner TOF

Analysis of **pp @ 3.5 vs pp@ 4.2 GeV data/simulations**





M3=LVL1: (TOF||RPC)>=3
PT1: (TOF||RPC)>=2

→ no big differences between rQMD and GiBUU

Table 3: Table presents trigger reduction for the pp simulations for different trigger conditions.

number	**trigger condition**	pp GiBUU [%]	pp RQMD [%]
1)	LVL1>=3	38	39
2)	MDC0_secMult>=2	28	35
3)	MDC0_secMult>=2&&(TOF||RPC)	22	25
4)	MDC0_secMult>=3	8	9
5)	MDC0_secMult>=3&&(TOF||RPC)	5.5	5.6
6)	5)||MDC0_secMult==2 && nb_padd>=3	8.8	9.7

Estimated trigger rate with **6)** for pp and $7.5 \cdot 10^7$ prot/s:

$7.5 \cdot 10^7$/s*0.8%(target interaction)* **9%** (trigger suppression)= **54 kHz**

upper limit

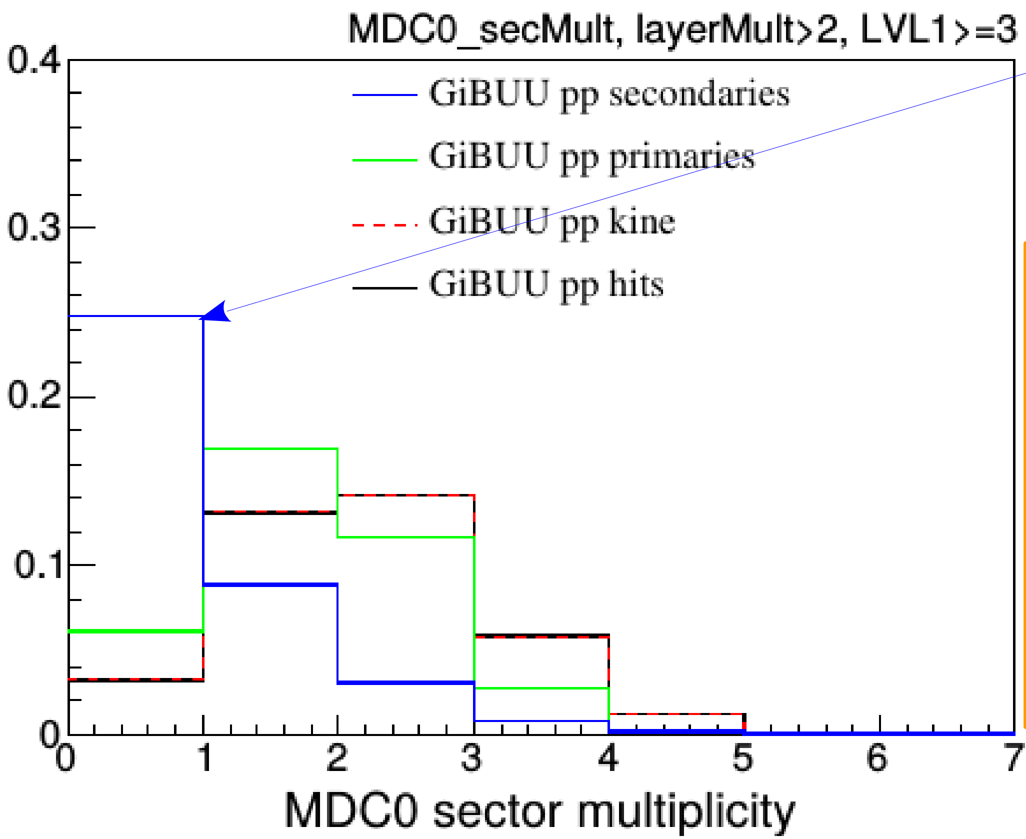
For FEB2021 trigger (**PT4**) was defined as:

(SUM(iTOF_paddles)>=2) && (SUM((RPC_sec || TOF_sec) && iTOF_sec) >=2)

prediction of the trigger rate is **~5%** (factor ~2 smaller than **6)**)

Contribution of primary and secondary paricles

→ in each event primary and secondary particles have been analyzed separately (geant kine)
→ each distribution normalized to total simulated events



particles which do not fulfill MDC0 layerMult >2 and LVL1>=3 conditions

LVL1>=3 && secMult>=3
29% (all particles)
13.5% (primary)
10.2% (secondary)

10.2/29=0.35

MDC0_secMult>=3 && (TOF||RPC)
5.5% (all particles)
2.3%(primary)
0.5%(secondary)

0.5/5.3=0.1

→ secondary particles contributes mostly as “empty events”
→ distributions for primary and total are very similar

FEB2021 TRIGGERS:

PT1 = mult_TOFRPC>=2 → **minimum bias**
PT3 = innerTOF && (TOF || RPC) → only sec.2 in trigger taken (by mistake)
PT4 = (SUM(iTOF_paddles)>=2)
&& (SUM((RPC_sec || TOF_sec) && iTOF_sec) >=2)

PT5 = VETO OR
PT6 = T0 OR

PT7 = STS OR (coincidence with T0)
PT8 = fRPC+hodoscopes

PT1/PT4/PT8
PT4

T_{beam} = 4.2 GeV

beam = $2x10^7$/spill => **$5*10^6$/s**

	EXPERIMENT FEB21 (scalers)	**SIMULATIONS** (Report)
PT1 TOFRPCmult>=2	**100 kHz**	-
PT1 TOFRPCmult>=3	**73 kHz**	**15 kHz***
PT4 FEB21	**3.2 kHz**	**2 kHz***
ratio PT4/PT1mult>=3	**0.044**	**0.13**

PT1/beam ~2%

higher rates from experiment than expected from the simulations due to outside the target interactions

* calculated as: $5*10^6$/s*0.8%(target interaction)*trigger suppression (slide6)

Numbers (scalers) estimated by Pavel Tlusty

Experimental rates scaled to $7.5*10^7$/sec (beam intensity assumed in the proposal):

PT1 TOF/RPC mult>=3: 1 MHz
simul: 230 kHz

→ rate is **5 times higher** with respect to simulations (outside the target interactions)

PT4: 48 kHz (<50 kHz)
simul: 30 kHz

→ PT4 only 1.6 **times higher** with respect to simulations

FOR MAIN TRIGGER 6) (slide 6)

→ exp. rate of PT4Feb21 ($5*10^6$/s+outside the target interactions) is: **3.2 kHz**
→ PT4Feb21 after extrapolation to $7.5*10^7$/s: **48 kHz**
→ simul. PT4Feb21 ($7.5*10^7$/s): **30 kHz**
→ simul. Trig. 6) ($7.5*10^7$/s): **54 kHz** (slide 6)

} **factor 1.8**

with the same beam conditions as in Feb21 we will have:

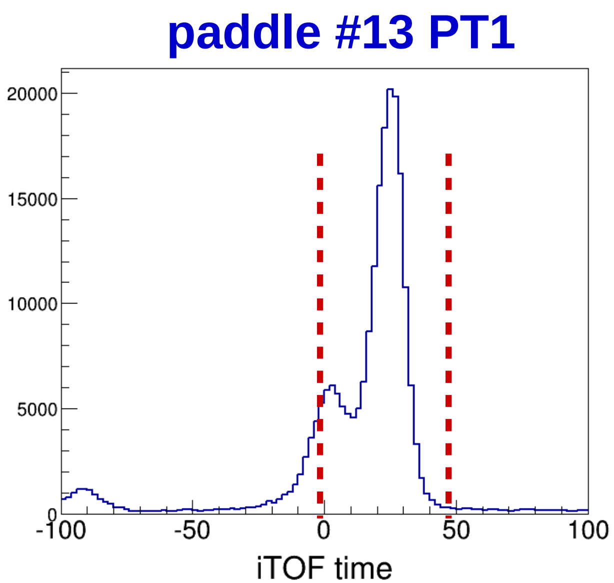
48 kHz x 1.8 = 86 kHz

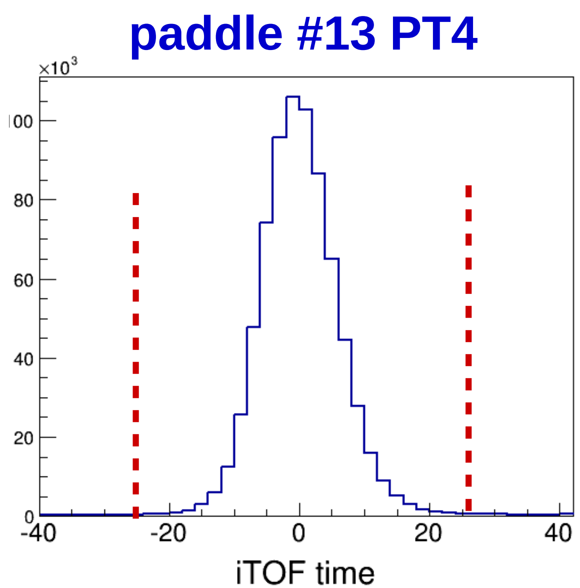
FEB2021 data – offline analysis of PT4

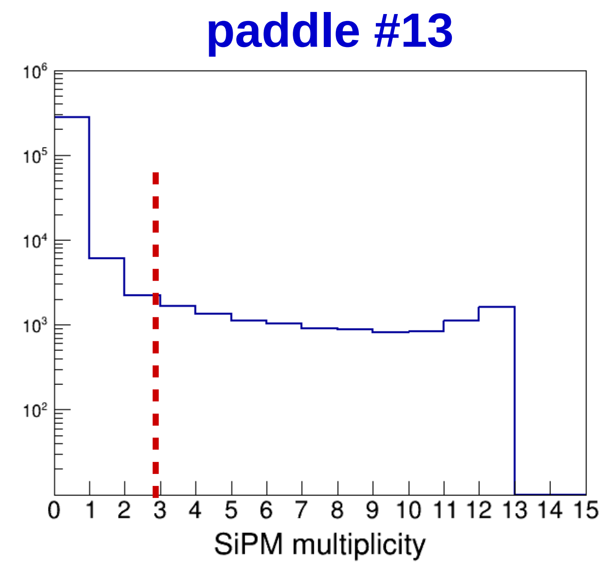
→ iTOF in **Start2Raw/Start2Cal** cathegory as modules 7 and 8

iTOF signal (Pavel, Jan):

1) time window: from 0- 50 ns (PT1) and -25 – 25 ns (PT4)
2) paddle = at least 3 SiPM's fired

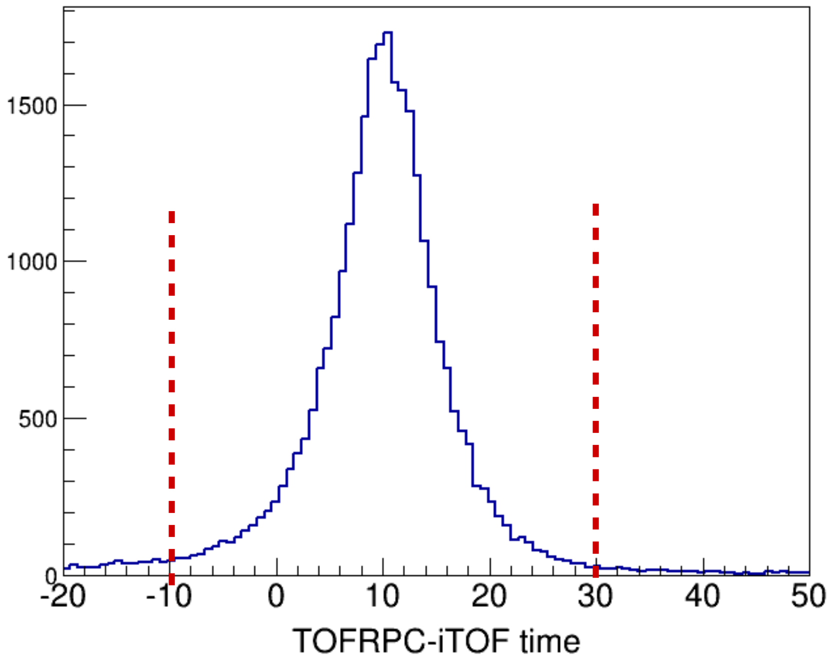






FEB2021 data – offline analysis of PT4

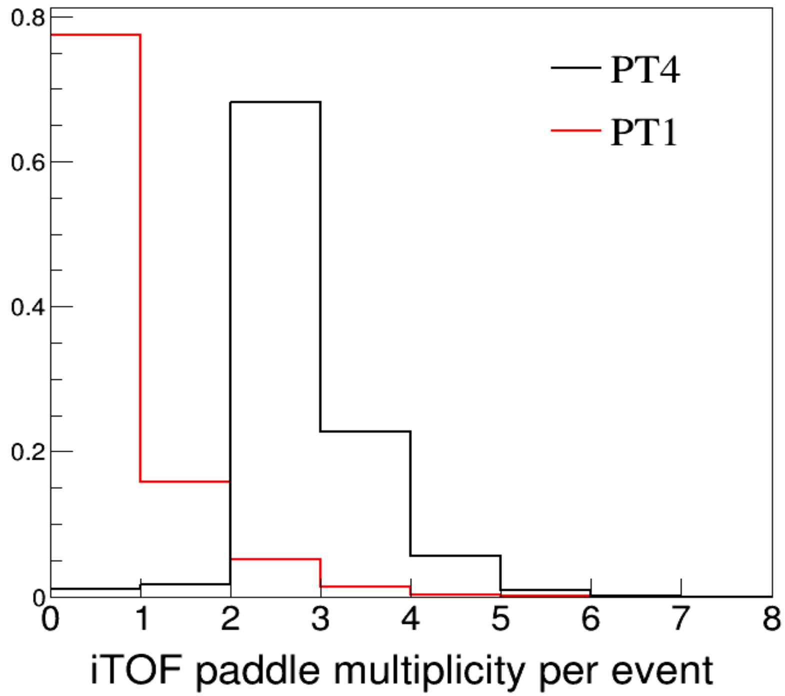
3) TOFRPC-iTOF coincidence time window taken into account,
4) dst with iTOF, TOF, RPC time calibration taken



Obtained ratios:

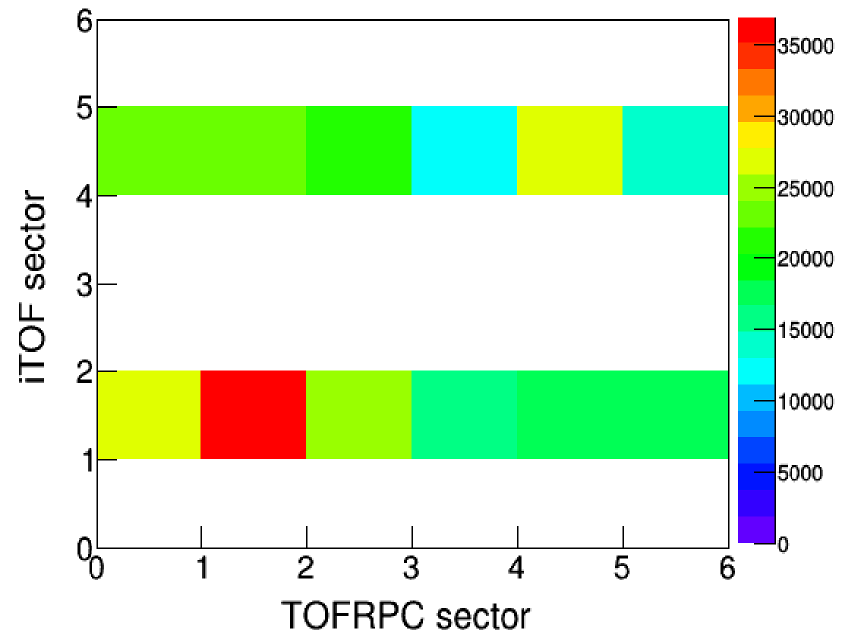
PT4"offline"/PT1mult>=2: ~ 2.3%
from scalers: 3.2%

FEB2021 data
– offline analysis

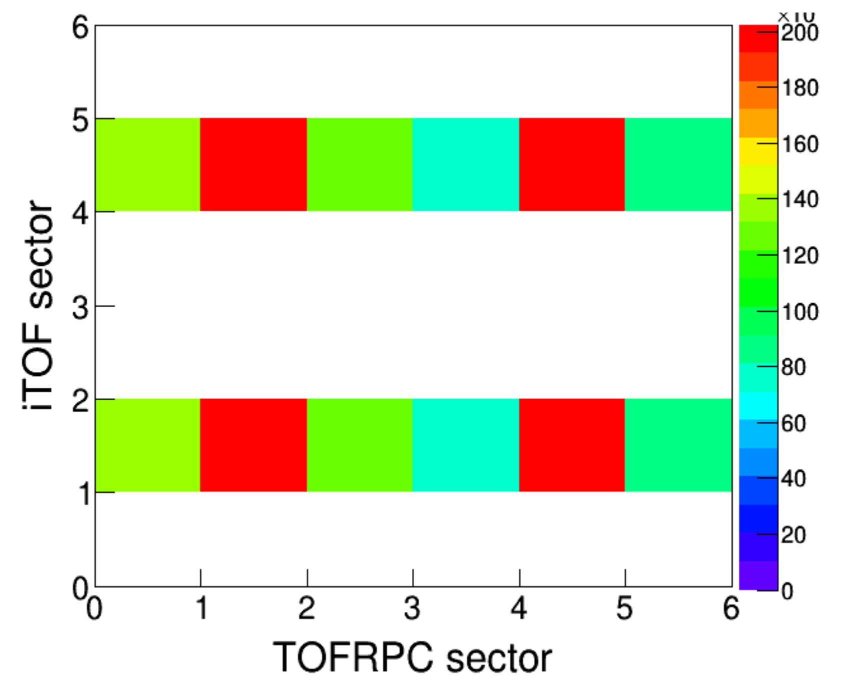


PT1 → a lot of “empty events”
PT4 → iTOF almost always multiplicity >=2

PT1



PT4



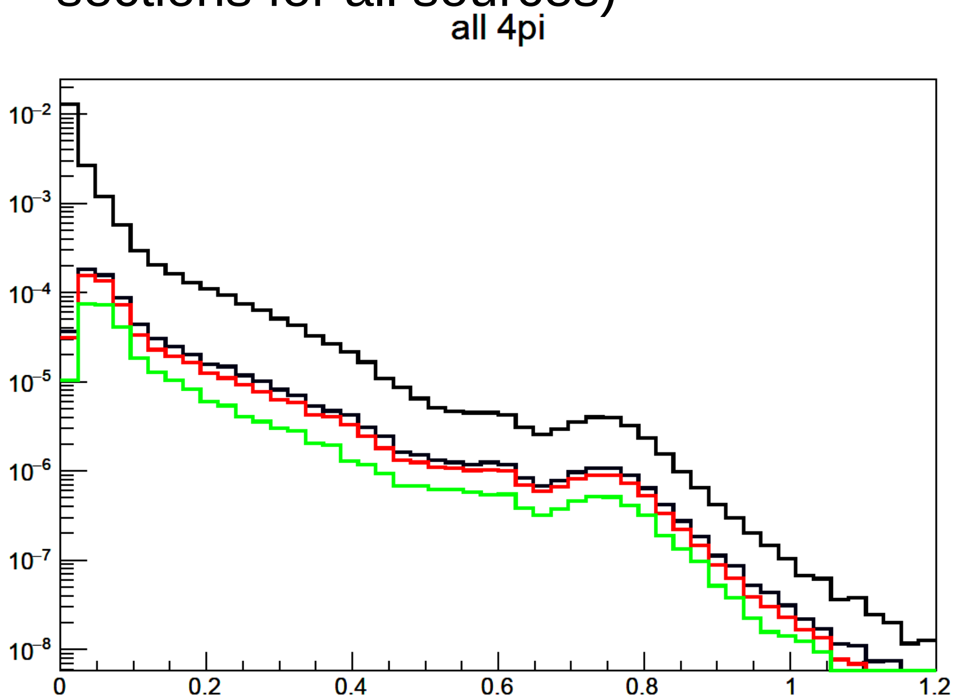
Outlook

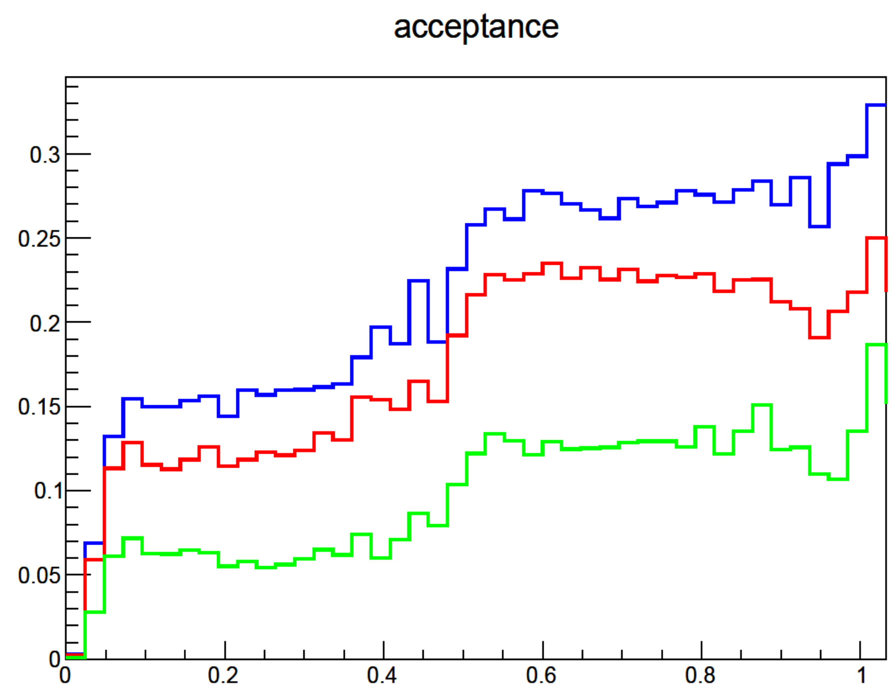
GOAL: studies of the trigger bias and the trigger reduction with dileptons using RQMD (JAM)/SMSH models.

→ see contribution from K. Piasecki

Preliminary studies

Simple model with inclusive e+e- from pp->ppX @ 4.5 GeV (same cross sections for all sources)





inclusive

in Hades acceptance

M3- 3 charged primary tracks in acc.

M3, but θ < 50 (M3 in smaller TOF)

Bias on dileptons detection from inclusive pp→ ppX
is induced by the condition **MDC0_secMult>=3 AND (TOF||RPC)**.
Adding the condition **OR MDC0_secMult==2 AND iTOF_pads>=3**
to the trigger 5) can help.

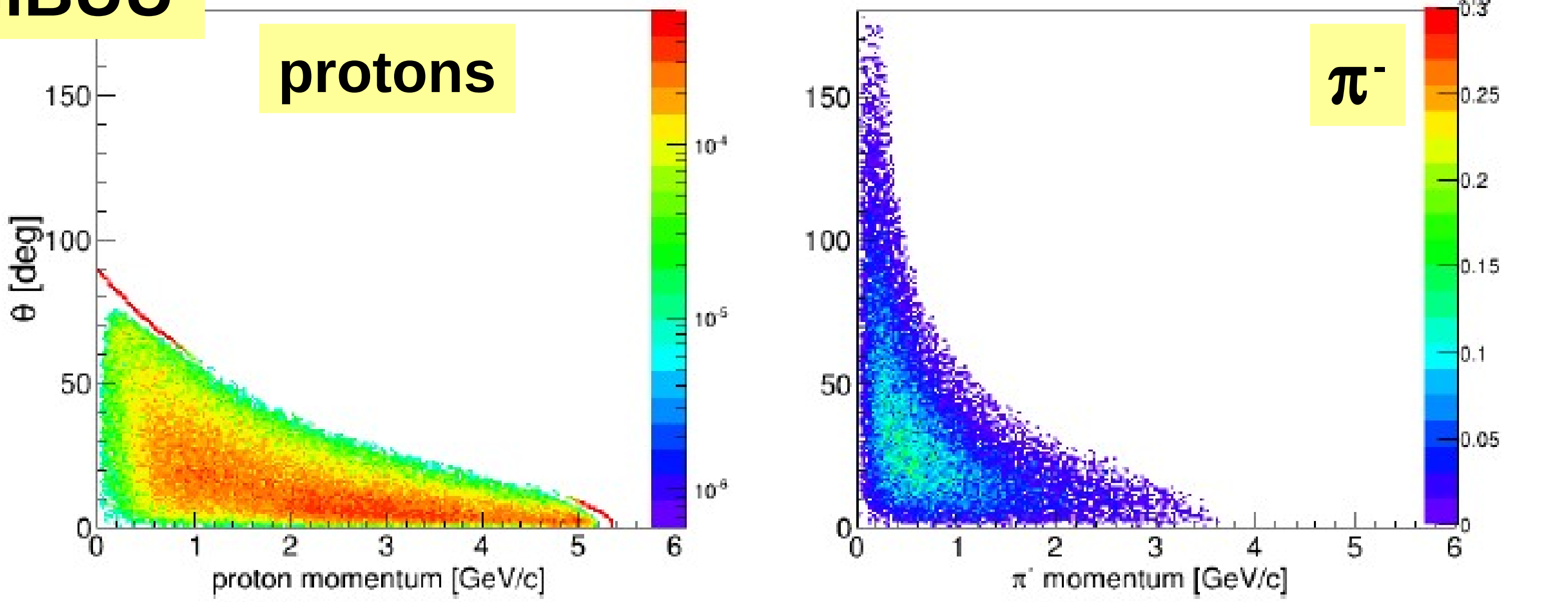
From the simulations:
→ hadronic background + dileptons (main sources η, ω, ρ, π^0 produced in RQMD)
→ meson decays into e+e- will be done in Pluto.

THANK YOU

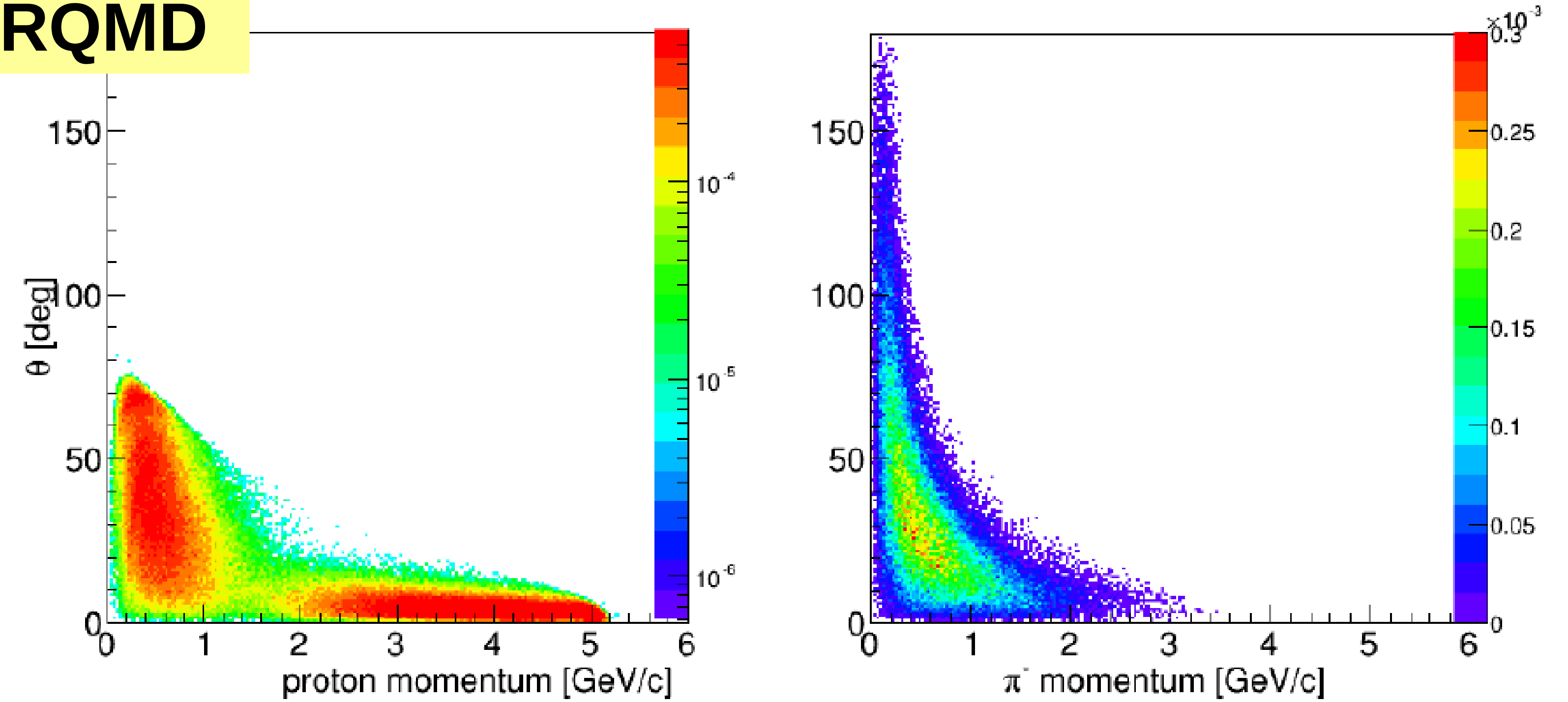
FOR YOUR

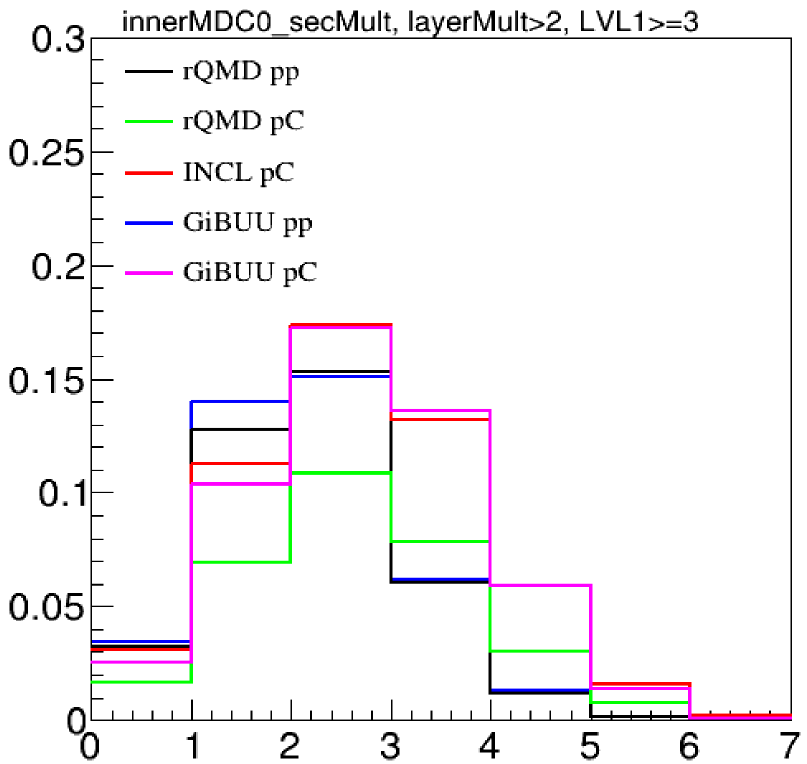
ATTENTION

pp@ 4.5 GiBUU



pp@ 4.5 RQMD




innerMDC0_secMult, layerMult>2, LVL1>=3
rQMD pp
rQMD pC
INCL pC
GiBUU pp
GiBUU pC
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
7