Trigger studies for the VHMPID detector

Feasibility of HPTD L1 Trigger System for VHMPID detector in ALICE

László Boldizsár KFKI RMKI, Budapest

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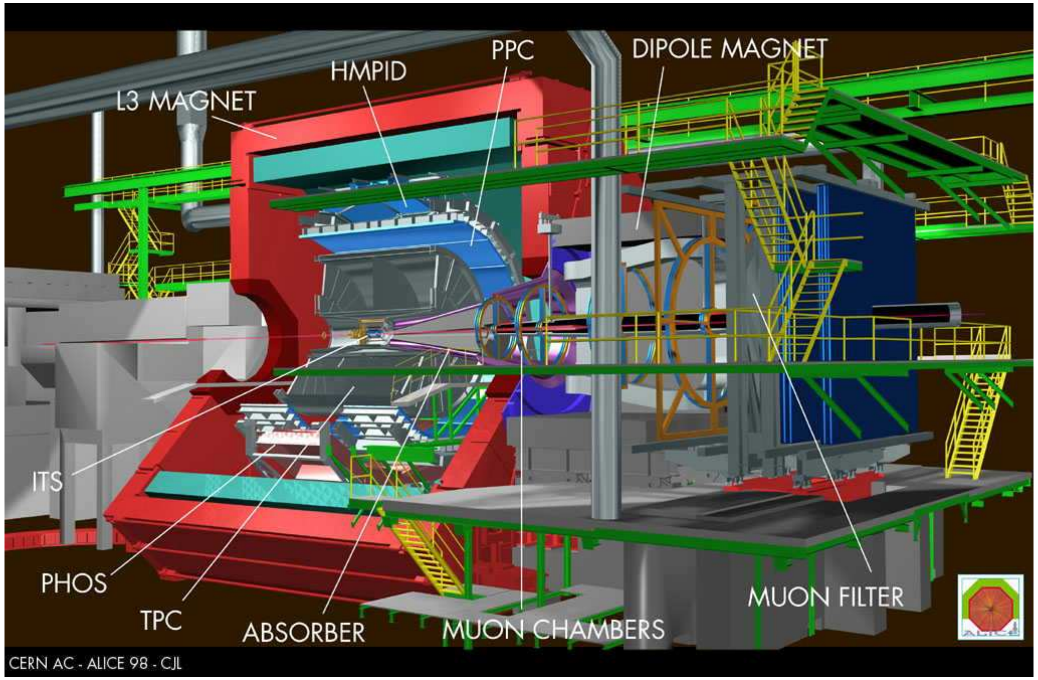


What does Trigger means?

1 pair (1:2.4)

2 pair (1:20)

drill (1:46)

straight (1:254)

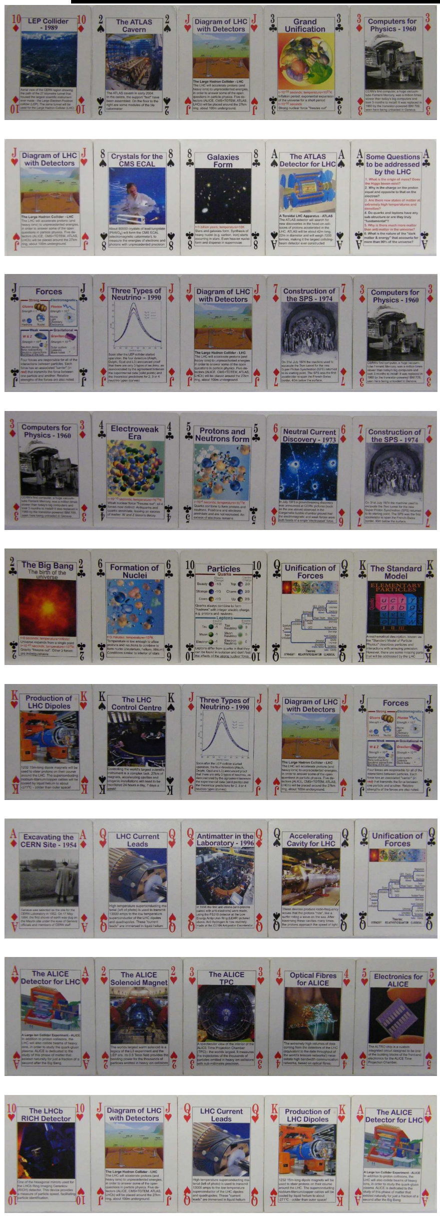
flush (1:508)

full (1:693)

poker (1:4164)

straight flush (1:72192)

royal flush (1:649739)



We just make the same what a profi poker player does...

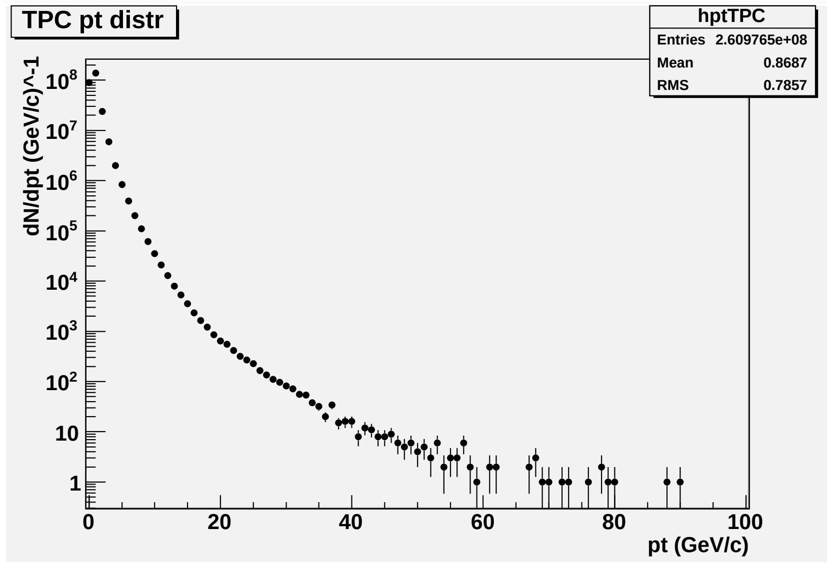
we select the rare, interesting events/hands and

fold the random (well-known-physics-type) events

HIJING MC simulation predicts the odds: $\sim$ 1:2000

when high-p_T (>10 GeV) particle in the VHMPID

(module-0; 5.5 TeV min. bias PbPb collisions)

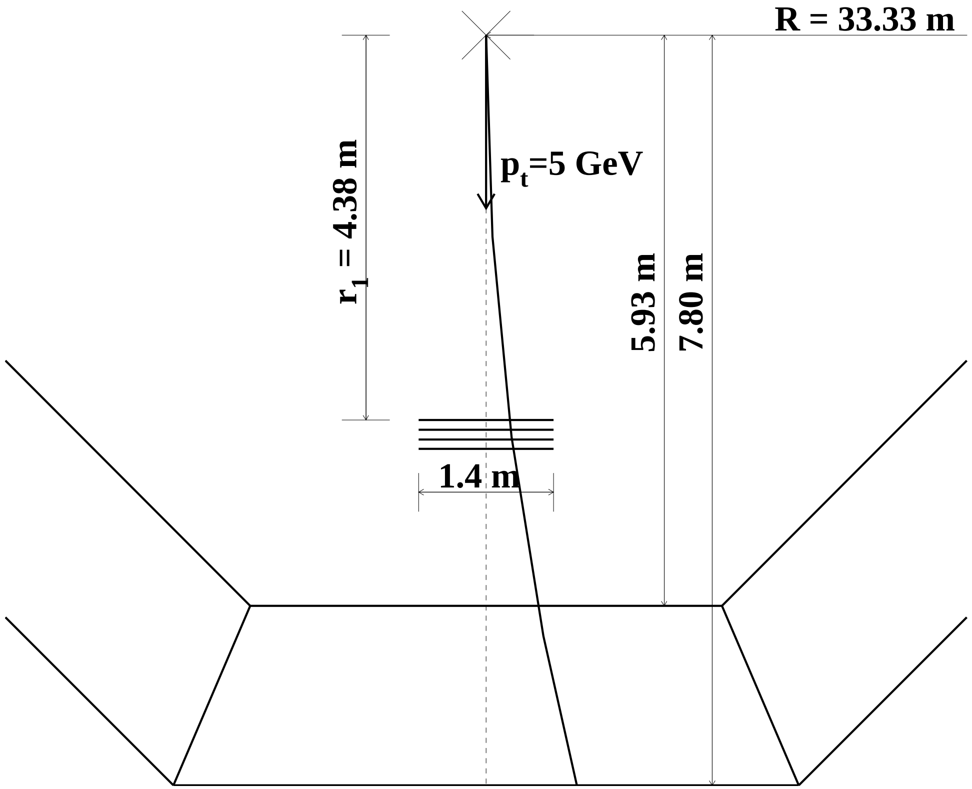


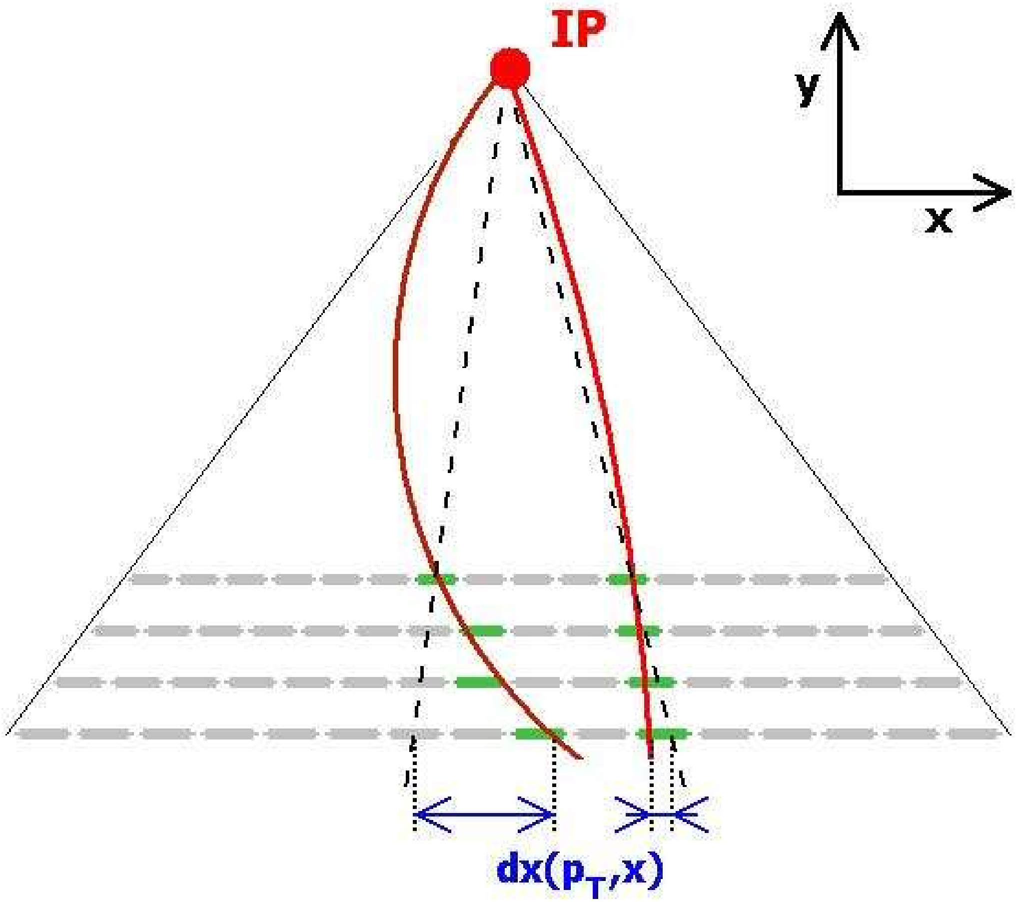
100k PbPb, central 2.76 TeV, Q0S0, +/-0.9 η

High p_T particle track is close to a straight line in the ALICE 0.5 T magnetic field! We use a highly segmented multilayer strip detector to measure and distinguish the tracks.

$p_t = p_{xy} = 0.3 \cdot z \cdot B_z \cdot R$ $z = 1$ $B_z = 0.5$ T

R [m] = 6.66 p_t [GeV]

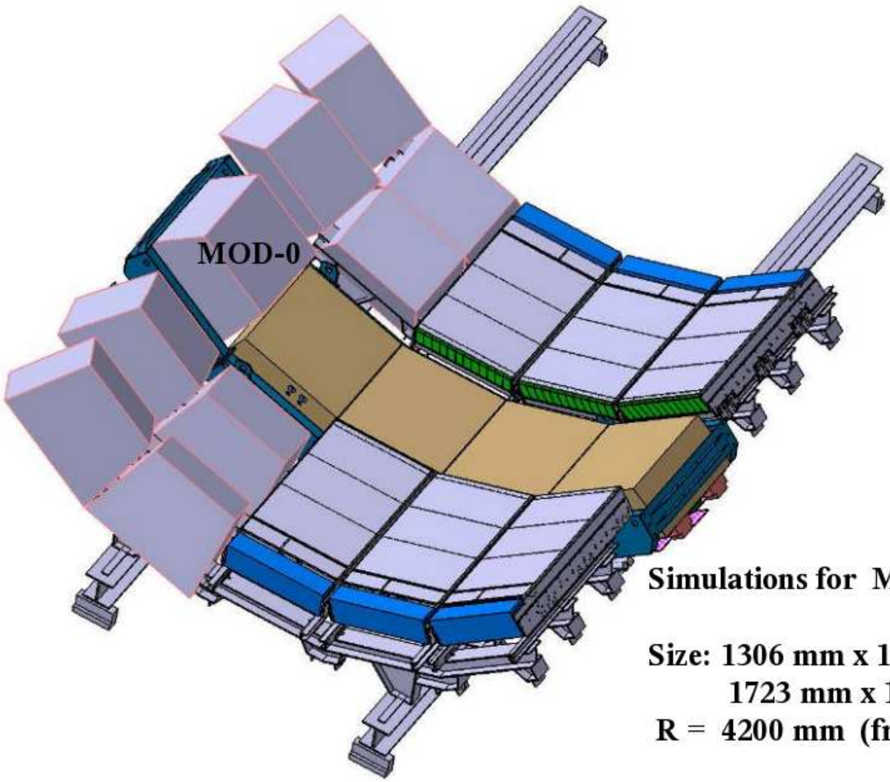




VHMPID and its trigger detector: HPTD

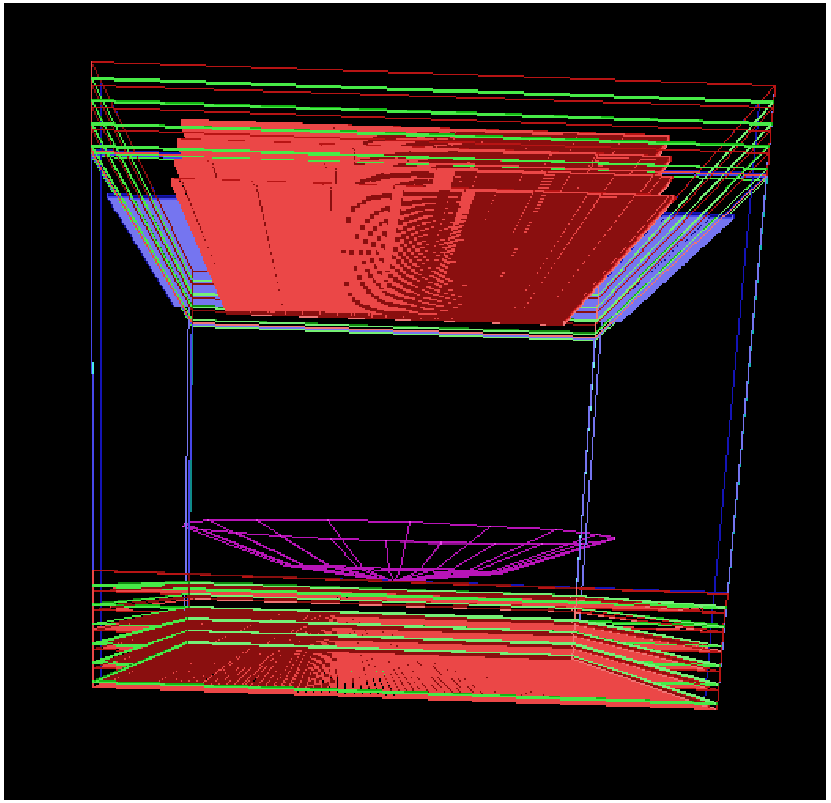
The dedicated trigger detector for the VHMPID: High-p_T Trigger Detector (HPTD).
HPTD serves L1 trigger signal at Pb-Pb collisions within the desired 5 μsec.

The HPTD is made of several layers of 'Close Cathode Chambers' above and under the VHMPID RICH module.



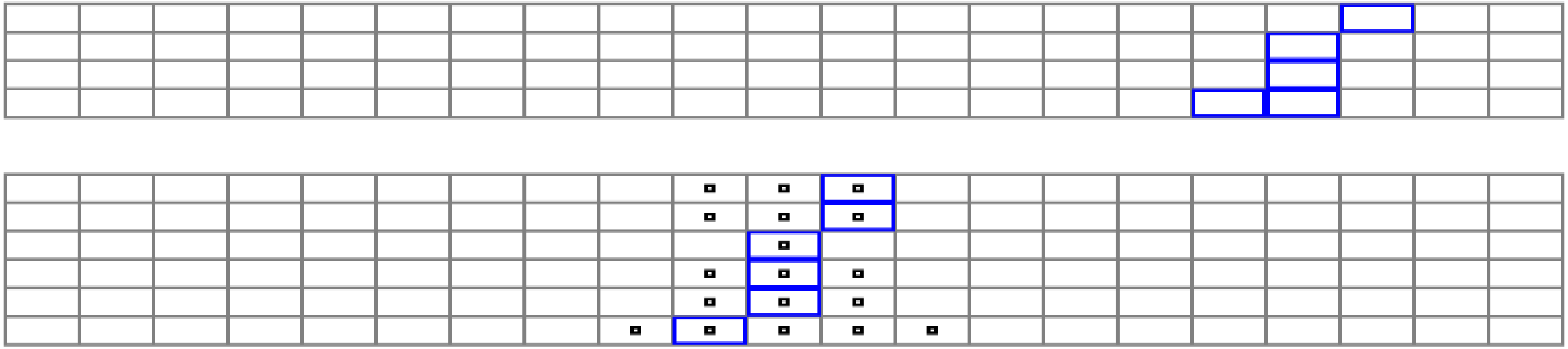
Simulations for MODULE – 0

Size: 1306 mm x 1350 mm (top)
1723 mm x 1350 mm (bottom)
R = 4200 mm (from collision point)



HPTD – Monte Carlo Simulations

As the charged particle path prolongs in the magnetic field the track leaves footsteps on each of the HPTD layers and produces a set of hits: a pad-pattern. The shape of the pattern is highly correlated with the transverse momentum of the particle.

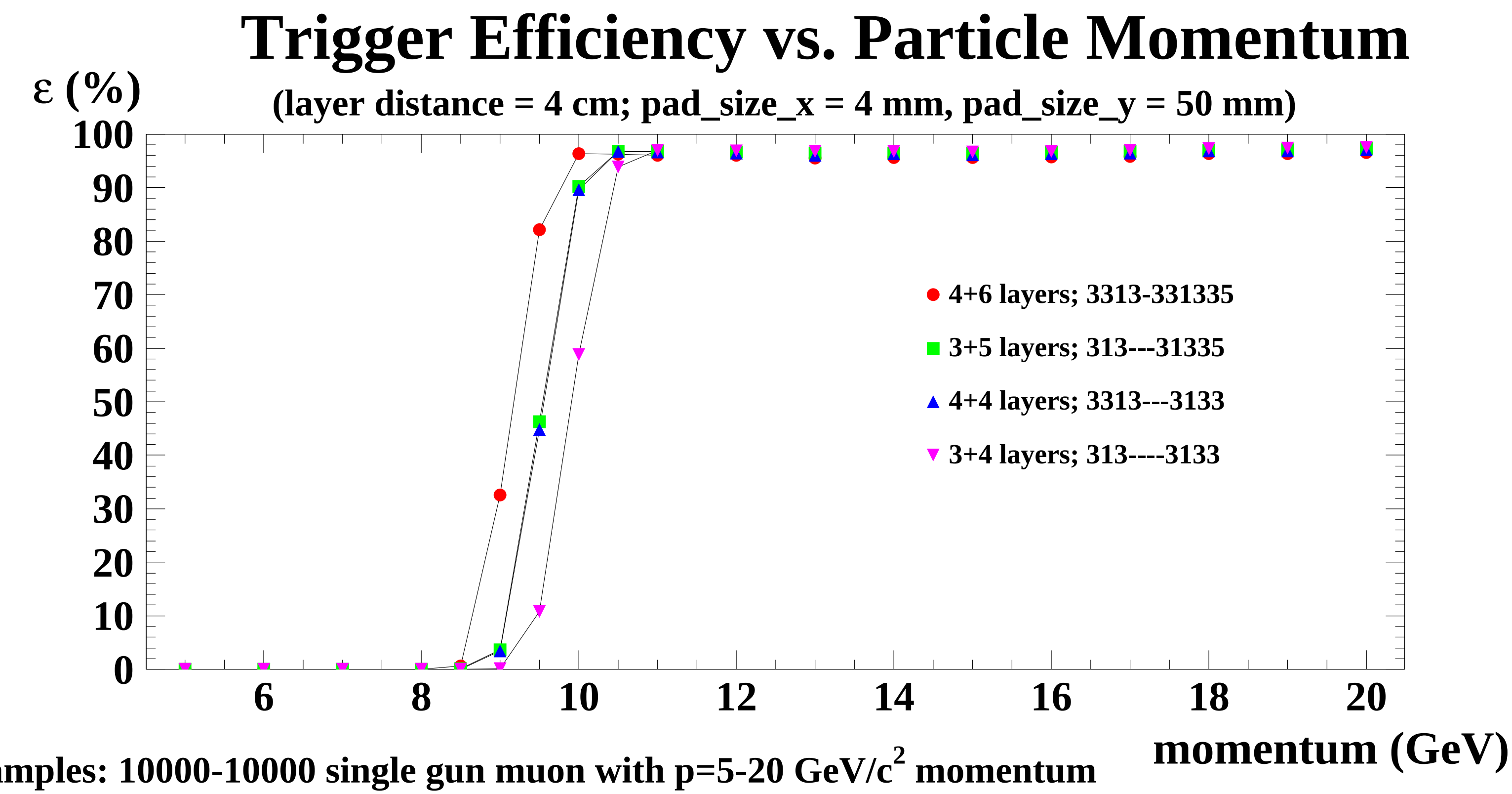


The performance have been studied by Monte Carlo simulations in AliRoot, the official simulation framework of the ALICE experiment to optimize the HPTD layout, segmentation and the pattern recognition algorithm.

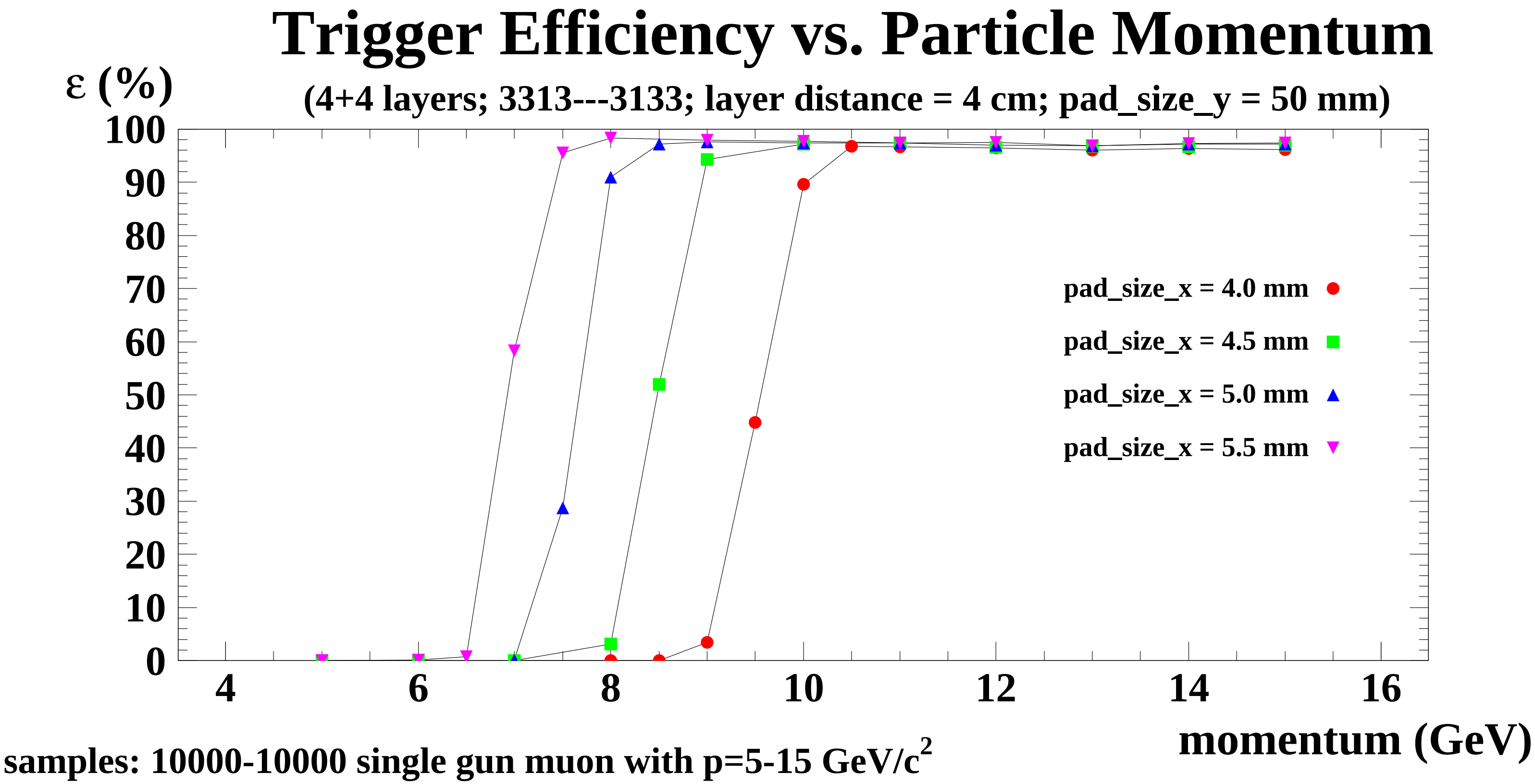
The simulations studied the optimum of the number of applied detector layers of the HMPID (between 6 and 10), the distance between the layers (3, 4, 5 cm), the possible pad with and pad lenght (3-6 mm, 5-15 cm), the trigger efficiencies, as the function of the particle momentum, and the trigger rate and purity in the HIJING Monte Carlo samples (PbPb coll. at 5.5 TeV, 10000 events, Q0S0).

Building up a set of typical patterns of high p_T particles (based on 200 000 single gun particle 10-30 GeV/c), and search these selected patterns in the simulated PbPb collisions events.

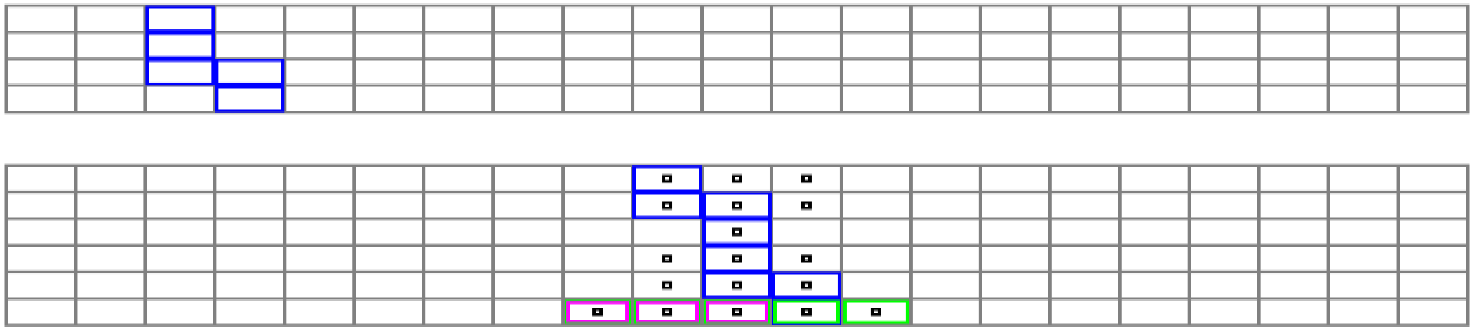
The trigger efficiency increase rapidly with the particle momentum at the treshold, it is saturated above 95% and the suppression of low momentum particles is very strong. (Four different layer layouts are shown.)



The threshold is tunable by the pad_size_x (or by the layout)!



A tipical PbPb event pattern



Event: 1813 Triggered HPT!

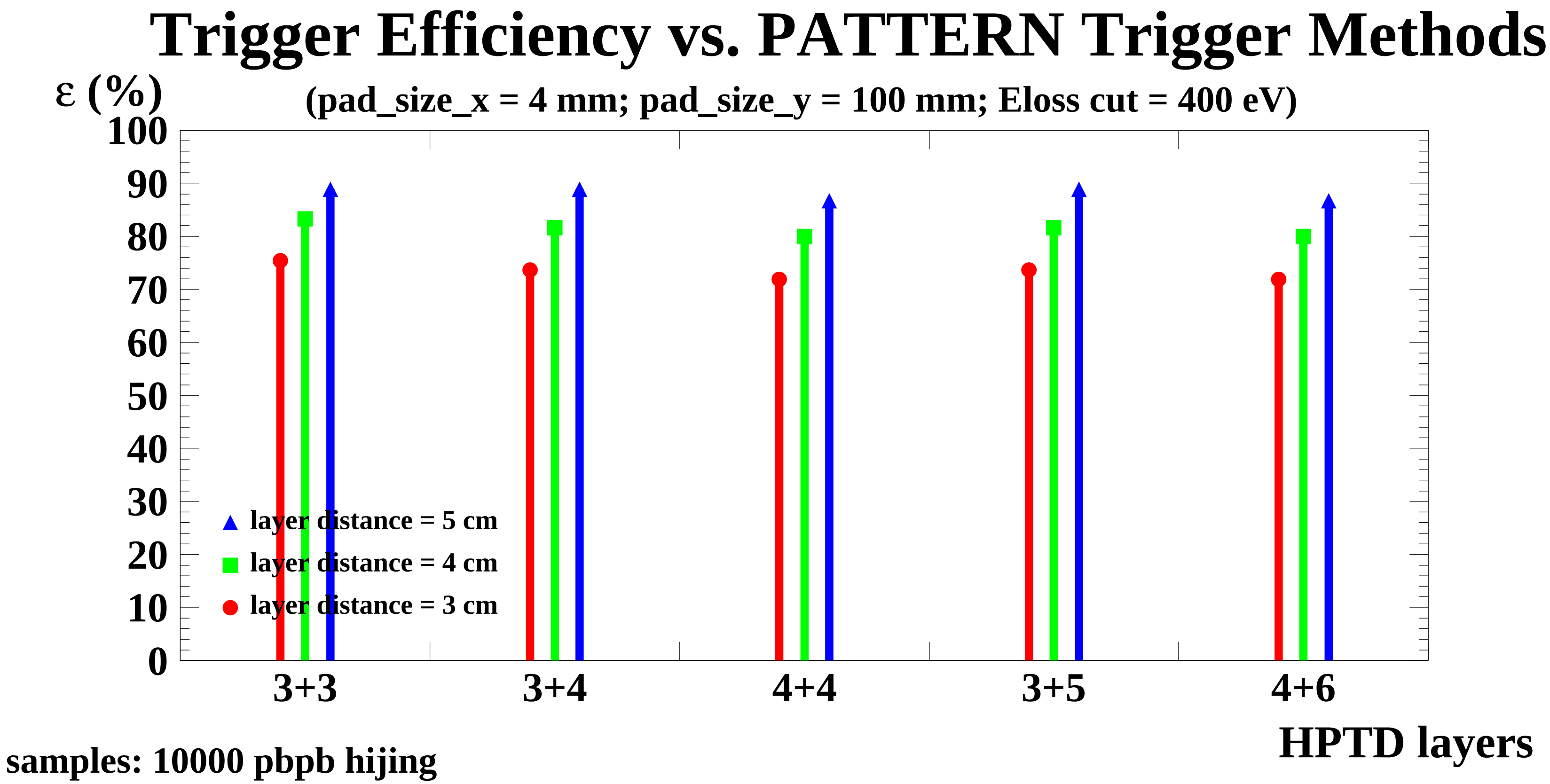
PadX: 308 PadY: 14
Triggering particle: p+
E= 12.990 GeV
Triggering particle: pi+
E= 0.580 GeV
Triggering particle: e-
E= 0.020 GeV

Y pad change!

TRG @	padx: **300**	pady: **15**	layer: **0**	eloss: 1076 eV	trlength: 427 cm
TRG @	padx: **300**	pady: **15**	layer: **1**	eloss: 1908 eV	trlength: 431 cm
TRG @	padx: **300**	pady: **15**	layer: **2**	eloss: 164 eV	trlength: 434 cm
TRG @	padx: **301**	pady: **15**	layer: **2**	eloss: 667 eV	trlength: 435 cm
TRG @	padx: **301**	pady: **15**	layer: **3**	eloss: 1089 eV	trlength: 439 cm
TRG @	padx: **307**	pady: **15**	layer: **4**	eloss: 1044 eV	trlength: 524 cm
TRG @	padx: **307**	pady: **15**	layer: **5**	eloss: 157 eV	trlength: 527 cm
TRG @	padx: **308**	pady: **15**	layer: **5**	eloss: 1717 eV	trlength: 528 cm
TRG @	padx: **308**	pady: **15**	layer: **6**	eloss: 1026 eV	trlength: 532 cm
TRG @	padx: **308**	pady: **15**	layer: **7**	eloss: 955 eV	trlength: 536 cm
TRG @	padx: **308**	pady: **15**	layer: **8**	eloss: 797 eV	trlength: 539 cm
TRG @	padx: **309**	pady: **15**	layer: **8**	eloss: 642 eV	trlength: 540 cm
TRG @	padx: **309**	pady: **15**	layer: **9**	eloss: 526 eV	trlength: 544 cm
TRG @	padx: **306**	pady: **16**	layer: **9**	eloss: 352 eV	trlength: 606 cm
TRG @	padx: **307**	pady: **16**	layer: **9**	eloss: 998 eV	trlength: 606 cm
TRG @	padx: **308**	pady: **16**	layer: **9**	eloss: 2383 eV	trlength: 607 cm
TRG @	padx: **309**	pady: **16**	layer: **9**	eloss: 995 eV	trlength: 607 cm
TRG @	padx: **310**	pady: **16**	layer: **9**	eloss: 116 eV	trlength: 608 cm
TRG @	padx: **308**	pady: **15**	layer: **9**	eloss: 72 eV	trlength: 20663 cm
TRG @	padx: **307**	pady: **15**	layer: **9**	eloss: 0 eV	trlength: 20664 cm
TRG @	padx: **306**	pady: **15**	layer: **9**	eloss: 0 eV	trlength: 20664 cm

Trigger efficiency

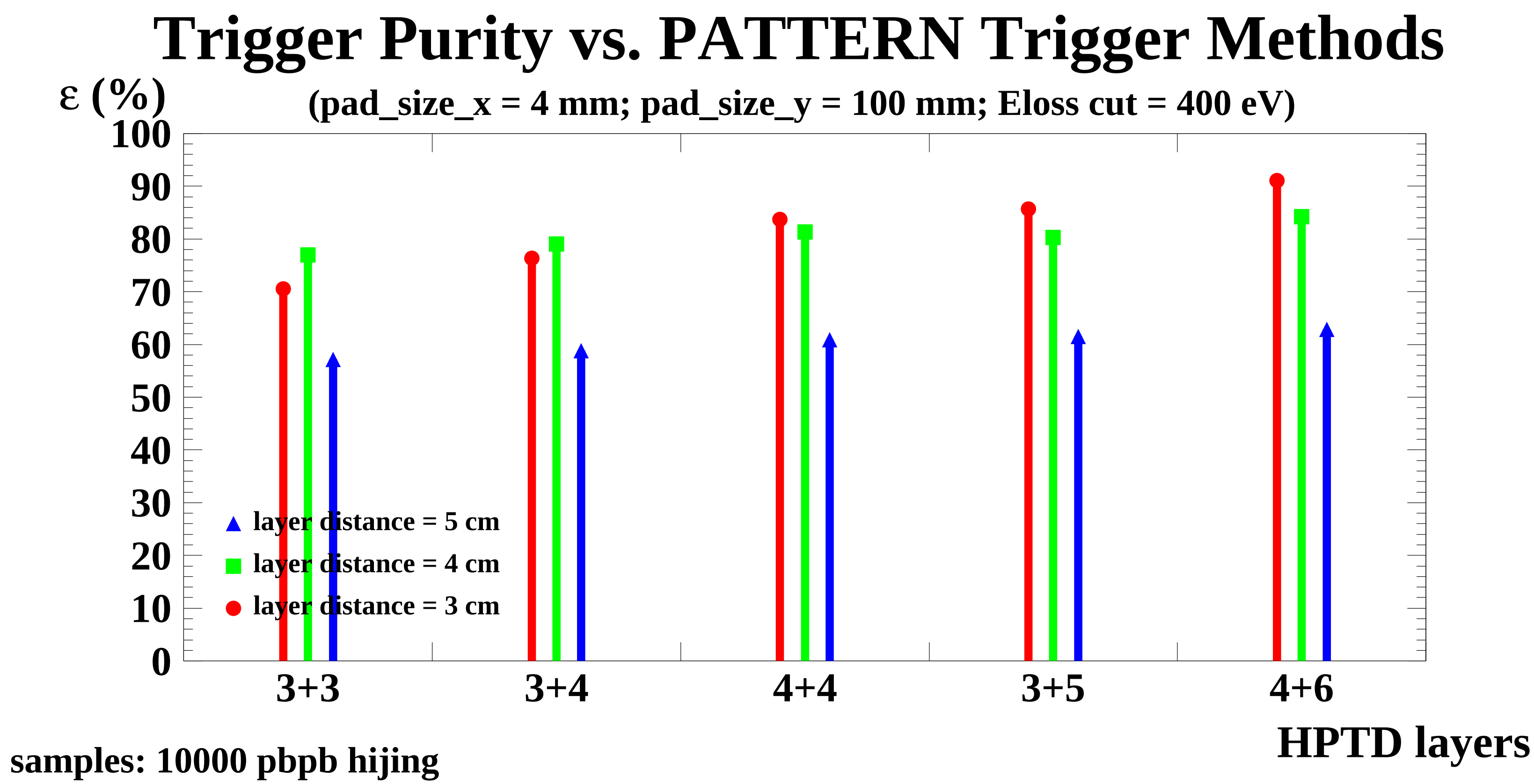
The summary of the trigger efficiencies in realistic event sample (10000 5.5 TeV central PbPb collisions, HIJING MC; 5 different layer layouts, 3 different layer distances).



The efficiency is higher if the layer distance is larger, and the efficiency is slightly lower if we use more layers (more constraints)...

Trigger purity

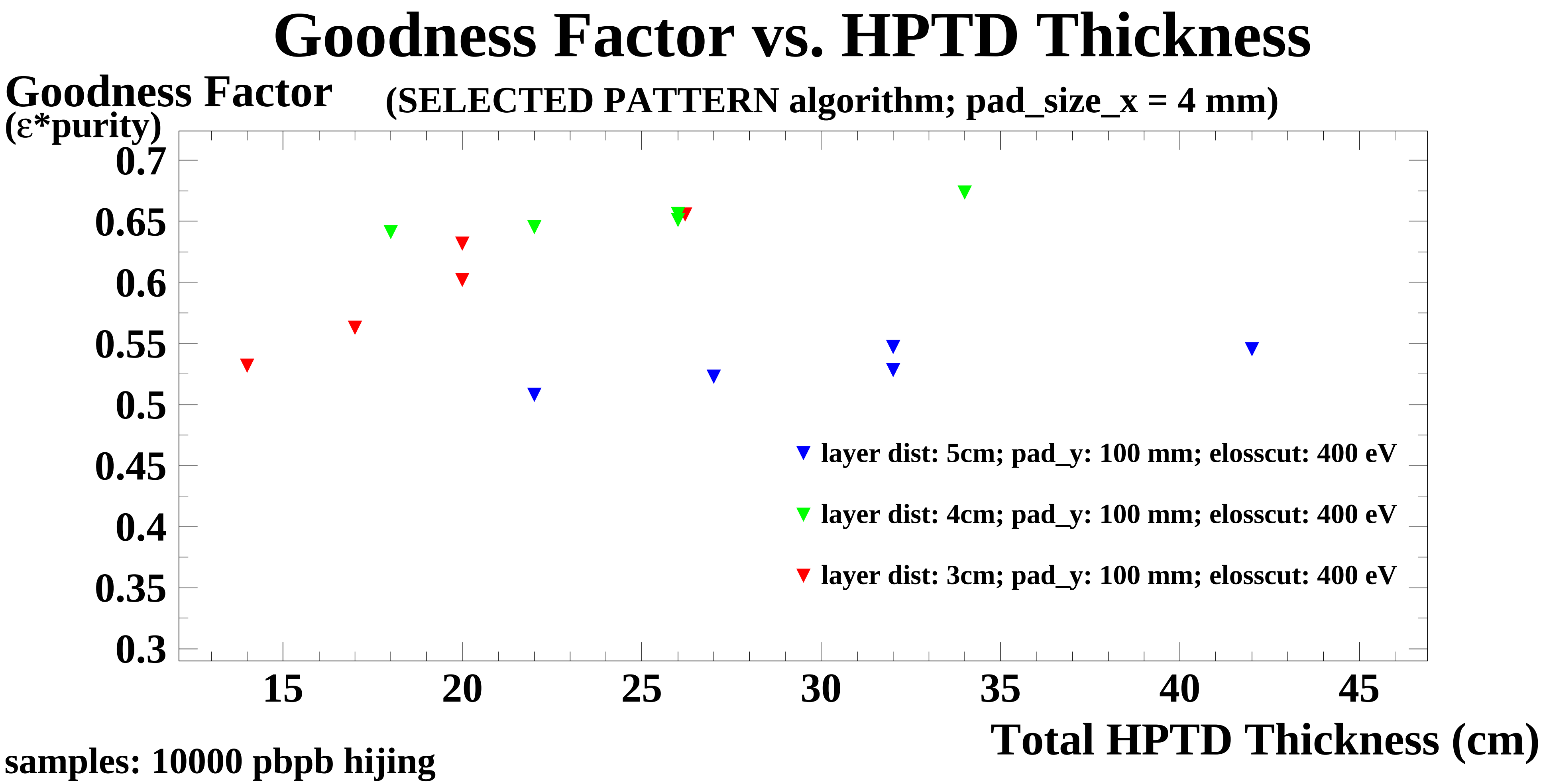
The summary of the trigger purities in realistic event sample (10000 5.5 TeV central PbPb collisions, HIJING MC; 5 different layer layouts, 3 different layer distances).



The purity is higher if we use more layers (more constraints), and the purity is lower if the layer distance is larger (the only exception is the 3 cm 3+3 and 3+4 layout because these are so weak constraints).

Optimization of Trigger Parameters

To find the optimum of the plenty layouts the product of efficiency and purity could help. We have also consider the necessary thickness of the HPTD, it is needed to keep as small as possible to ensure enough place to the Cherenkov modul.



Conclusions

- 6-10 layer HPTD could result good trigger signal with high efficiency and purity (80-90%).

- The optimal layout can be e.g. 4+4 HPTD layers, with 4 cm layer distances (13+13 cm total thickness), with 4 mm pad width and 10 cm pad length.

Thank you for your attention!