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Modification of the DIRAC downstream detectors (VH, HH, PR, MU)

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Abstract

Present report describes modification of the existing DIRAC downstream detectors for $A_{\pi K}$ detection: vertical hodoscopes (VH), horizontal hodoscopes (HH), preshowers (PR) and scintillation hodoscopes for muon identification (MU).

Contents

1 Pion and kaon tracing in magnetic field

Pions and kaons from $A_{\pi K}$ atom breakup were traced through the specrometer magnet and the downstream detectors using curvature radii of particles in magnetic field. $A_{\pi K}$ beam passed through the secondary beam axis ($0°$) or along the collimator left wall ($1°$). After that the πK pairs are retained which are detected by all the drift chambers. Other detectors are ignored.

In fig. 1 trajectories of π^- and K^+ from $A_{\pi K}$ breakup are shown when $A_{\pi K}$ beam passes through the secondary particle channel axis ($0°$). In this case K^+ are detectable in the momentum interval $4.5 \div 5$ GeV/c only.

In fig. 2 the trajectories are shown when $A_{\pi K}$ beam is rotated by $1°$ relative to the secondary particle channel axis (the beam passes along the left wall of the collimator). In this case the K^+ are detectable in the momentum interval $4 \div 11$ GeV/c.

In fig. 3 utmost trajectories (4 and 11 GeV/c) are shown when $A_{\pi K}$ beam is rotated by $1°$ relative to the secondary particle channel axis.

In fig. 4 utmost trajectories are shown jointly when the $A_{\pi K}$ beam passes at $0°$ and $1°$ relative to the secondary particle channel axis. From fig. 4 it is clear that it is enough to analyse the trajectories at $1°$ for the estimation of new horizontal dimensions of the VH, HH, PR and MU. The horizontal dimension of the existing CH (mirror dimension) are acceptable.

In fig.5 horizontal dimensions of pion and kaon beams detected by DC are shown.

In fig. 6 additions to VH, HH, PR and MU are measured. In the right arm I increased pion momentum (pions should be detected by DC).

Dimensions of downstream detectors and additions to them are available in table 1.

Table 1: *Dimensions of downstream detectors and additions to them.*

Det	W_D	Dist	W_π	W_K	Δ_π	Δ_K
DC1	800	1659				
DC2L	800	2025				
DC2R	800	2030				
DC3L	1120	2525				
DC3R	1120	2530				
DC4L	1280	3035				
DC4R	1280	3040				
VH	1302	3275	1285	364	58	48
HH	1307	3410	1338	380	91	81
CH_{fr}		3743	1461	416		
CH_{1m}		4743	1847	528		
CH_{mr}	3000	6300				
PR	2800	7056	2740	789	270	274
Abs_{fr}	3600	7185				
MU_1	3387	8397	3214	1036	258	481

Explanations to the table 1.
Det: detector transverse dimensions in mm.
W_D: width of detectors.
Dist: distance in mm from the magnet centre
to DC box centres,
to VH, HH centres,
to CH front side 1 (CH_{fr}),
to CH 1 m from front (CH_{1m}),
to CH mirrors (CH_{mr}),
to PR centre,
to absorber front side (Abs_{fr}),
to MU1 centre.
W_π: width of pion beam in mm.
W_K: width of kaom beam in mm.
Δ_π: addition to detectors for pion detection.
Δ_K: addition to detectors for kaon detection.

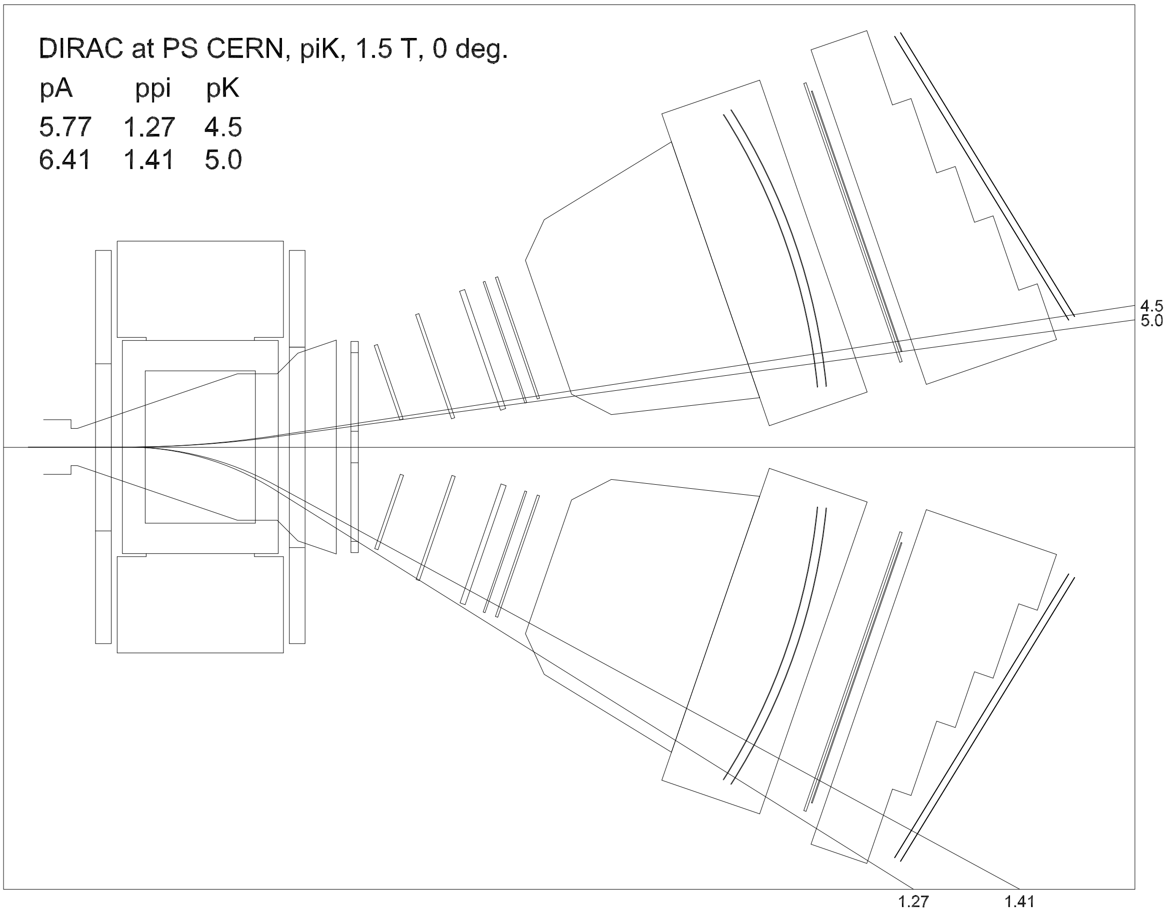

Figure 1: *Trajectories of* π^- *and* K^+ *from* $A_{\pi K}$ *breakup.* $A_{\pi K}$ *beam passes through the secondary particle channel axis. Numbers in the table are* $A_{\pi K}$, π^- *and* K^+ *momenta. Numbers on the trajectory lines are* π^- *and* K^+ *momenta.*

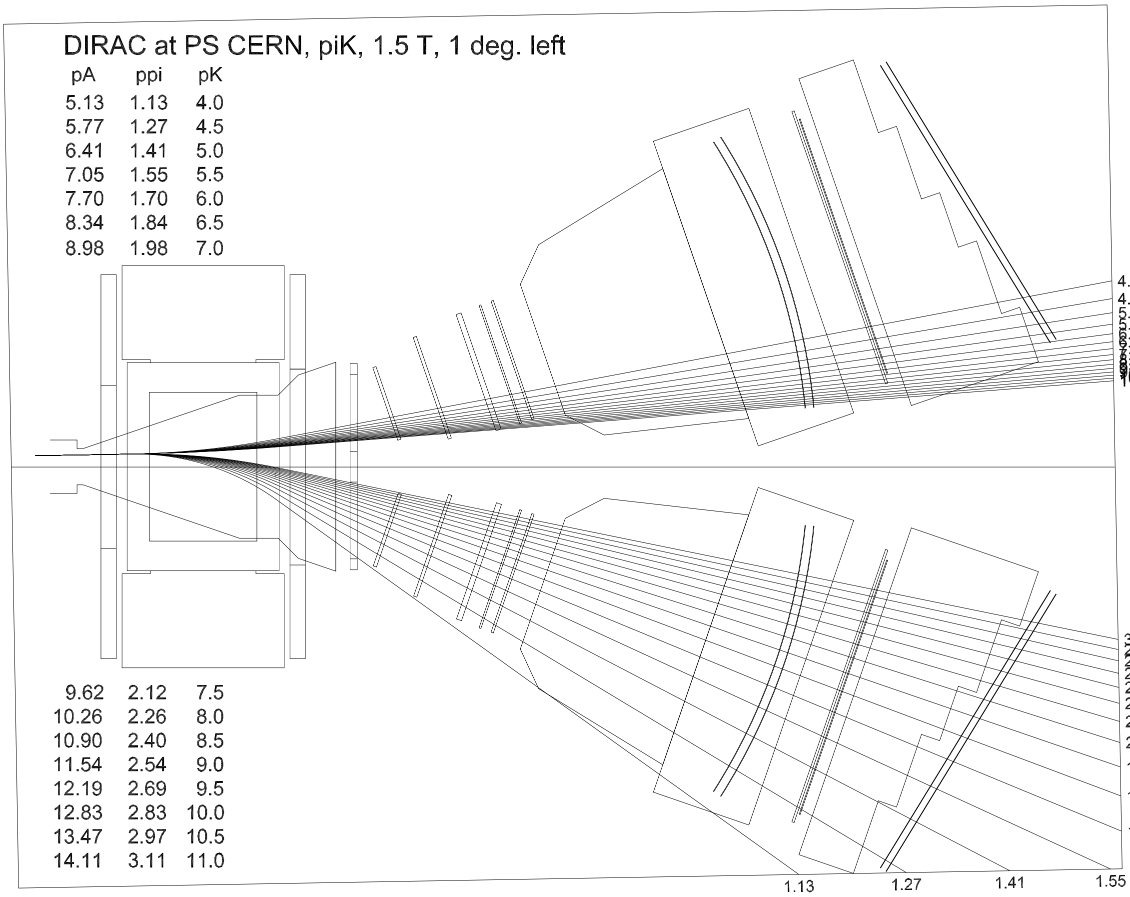

Figure 2: *Trajectories of* π^- *and* K^+ *from* $A_{\pi K}$ *breakup.* $A_{\pi K}$ *beam is rotated by* 1° *relative to the secondary particle channel axis. Numbers in the table are* $A_{\pi K}$, π^- *and* K^+ *momenta. Numbers on the trajectory lines are* π^- *and* K^+ *momenta.*

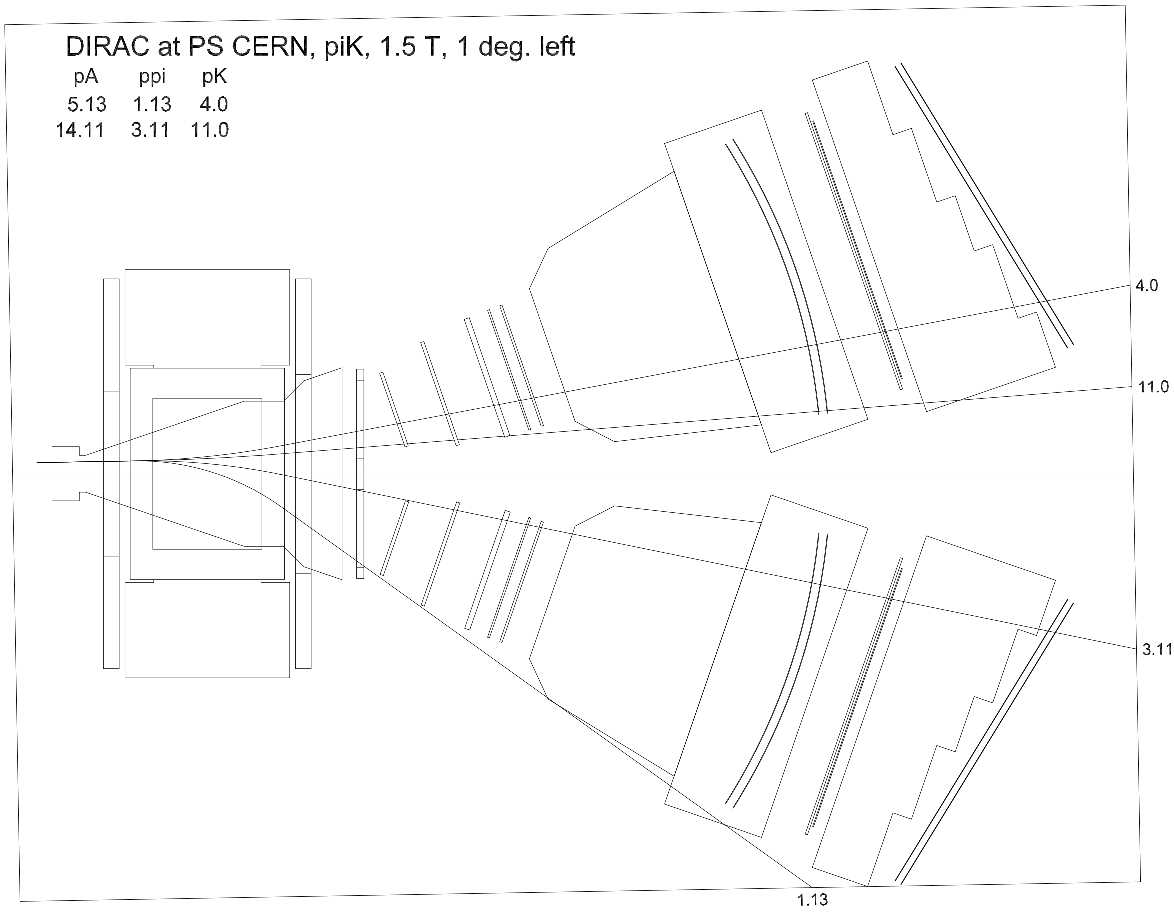

Figure 3: *Utmost trajectories of* π^- *and* K^+ *from* $A_{\pi K}$ *breakup.* $A_{\pi K}$ *beam is rotated by* 1° *relative to the secondary particle channel axis. Numbers in the table are* $A_{\pi K}$, π^- *and* K^+ *momenta. Numbers on the trajectory lines are* π^- *and* K^+ *momenta.*

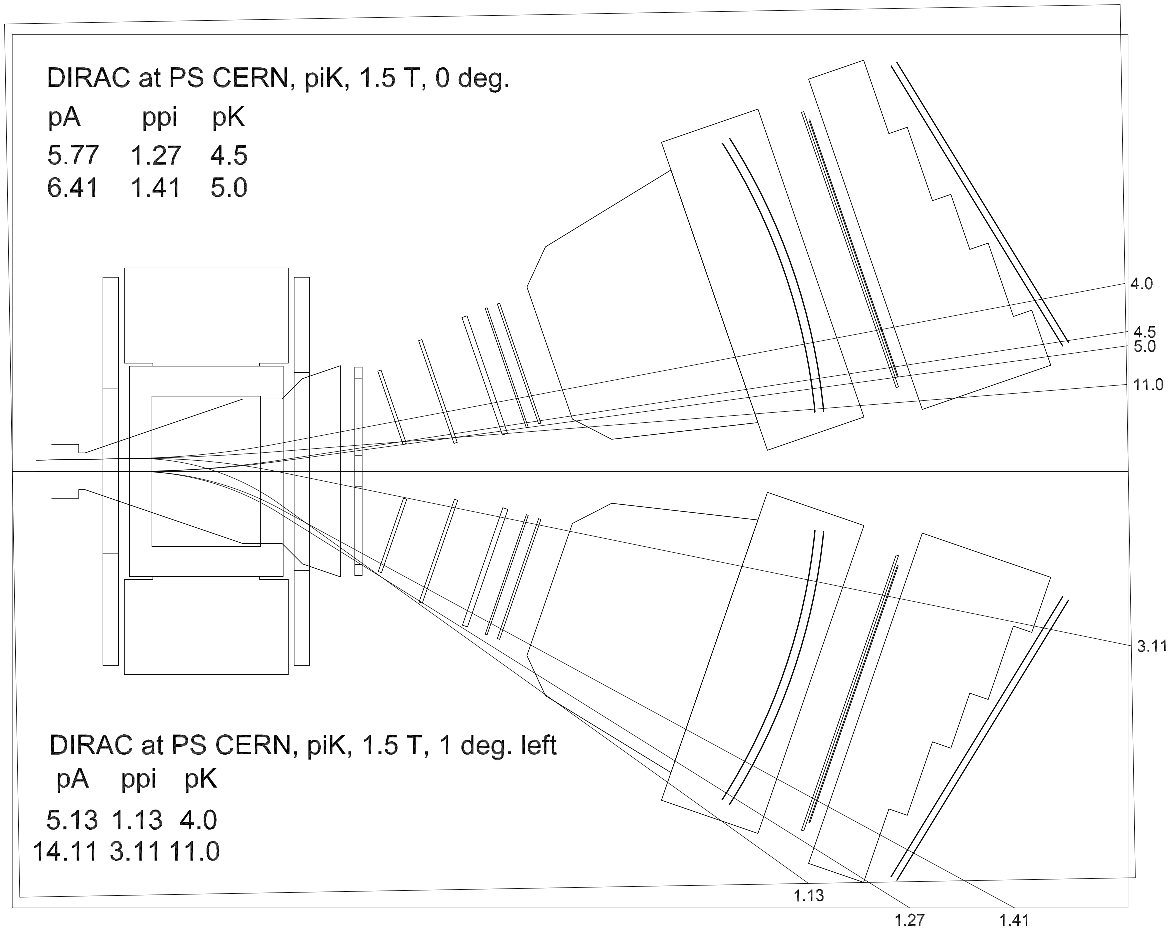

Figure 4: *The utmost trajectories are shown jointly when the* $A_{\pi K}$ *beam passes at* 0° *and* 1° *relative to the secondary particle channel axis.*

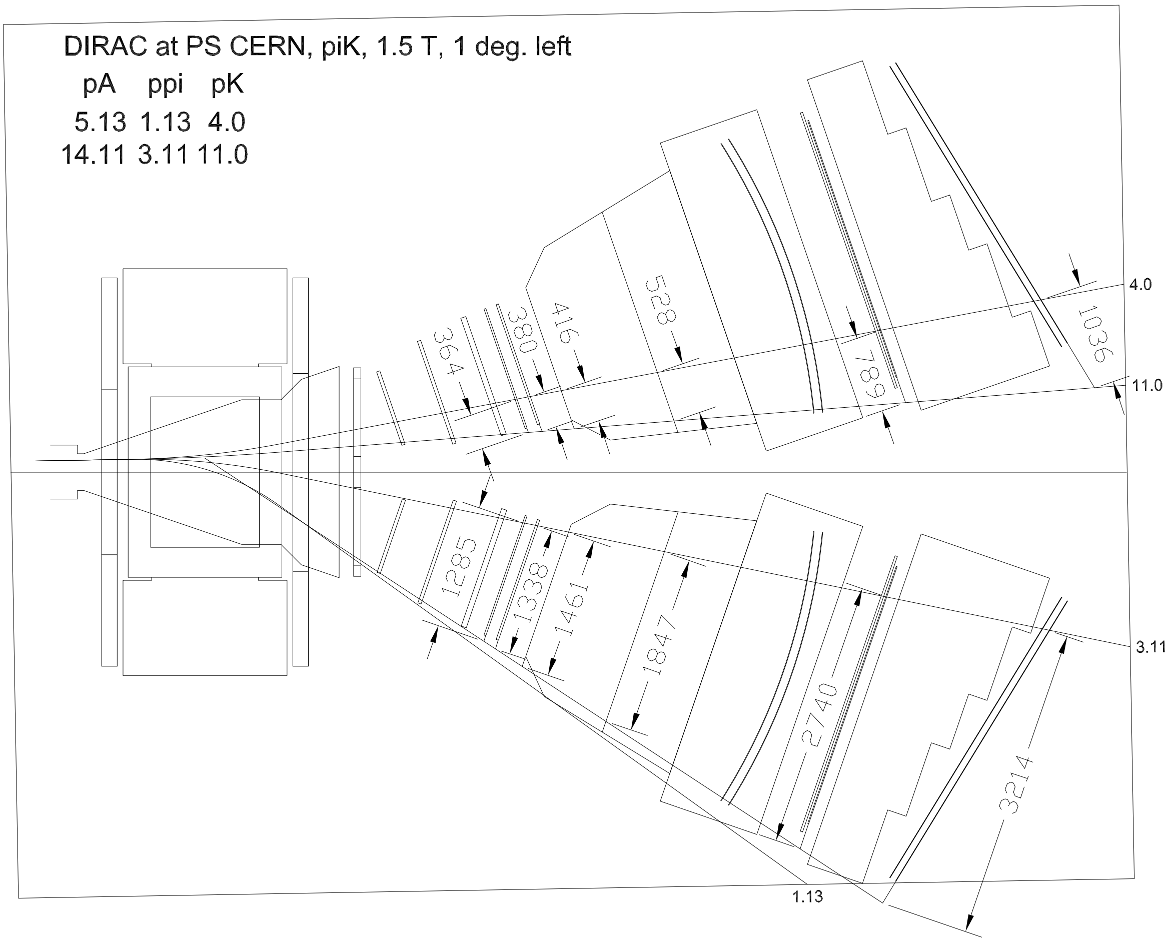

Figure 5: *Horizontal dimensions of pion and kaon beams in VH, HH, CH, PR and MU.*

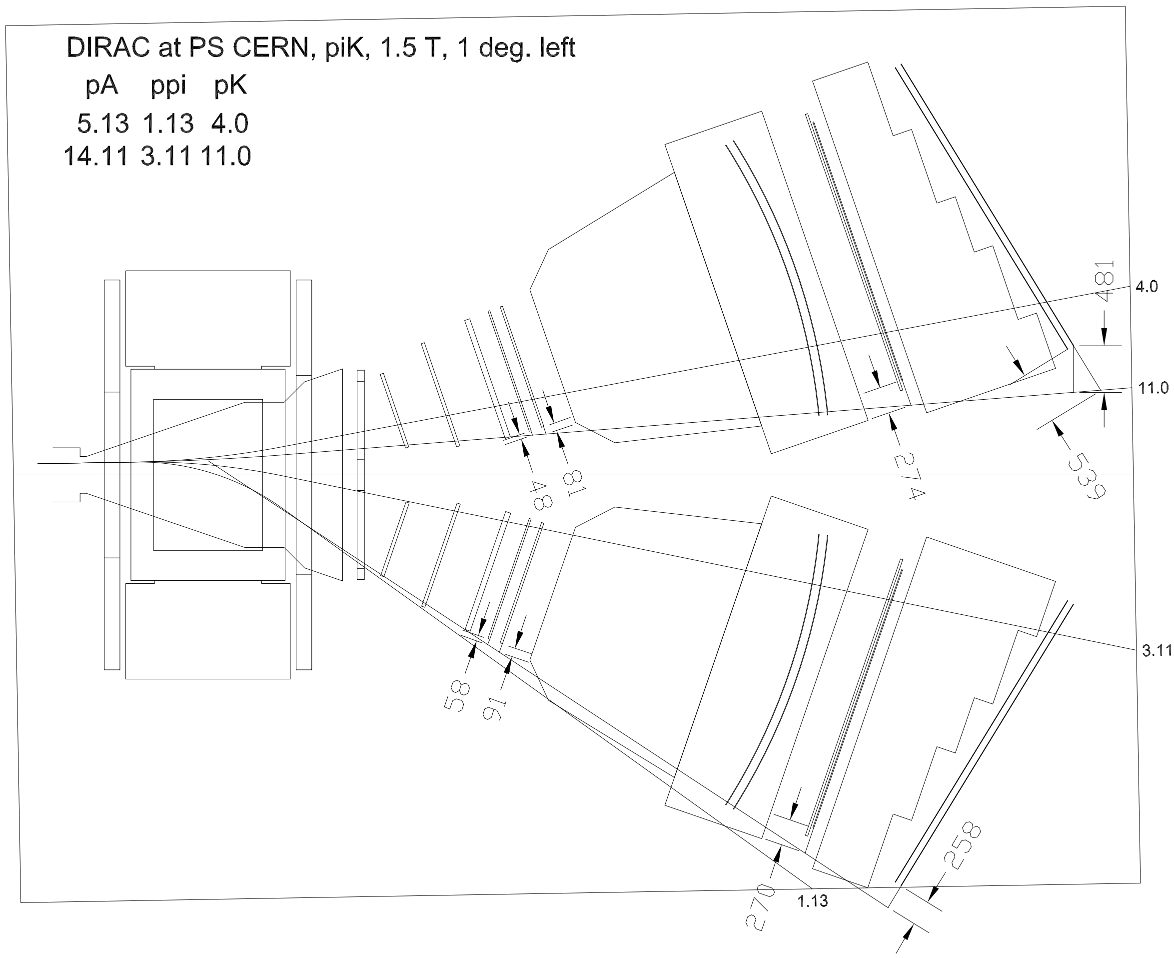

Figure 6: *Additions to VH, HH, PR and MU.*

2 Comparison of tracing and simulation

In order to choose dimensions of detectors, simulation of pions and kaons from $A_{\pi K}$ breakup was also performed (O.Gortchakov). Angular aperture of the secondary particle channel, pion and kaon decays and pion and kaon detection by DC were taken into account. Other detectors were ignored.

I transformed pion and kaon space distributions from simulation to AutoCAD and put together with pion and kaon trajectories from tracing (figs. 7, 8, 7). Tracing and simulation agree well. So table 1 is correct.

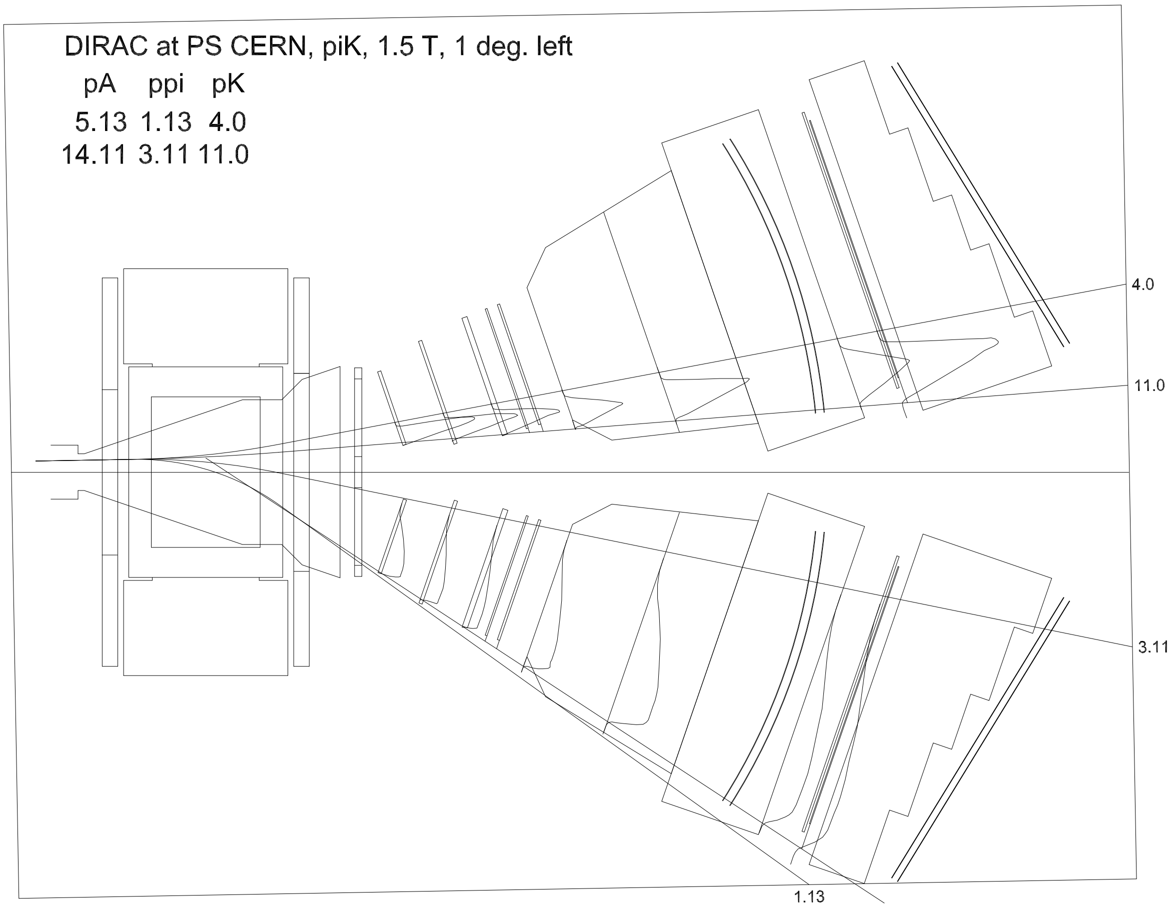

Figure 7: *Comparison of tracing and simulation*

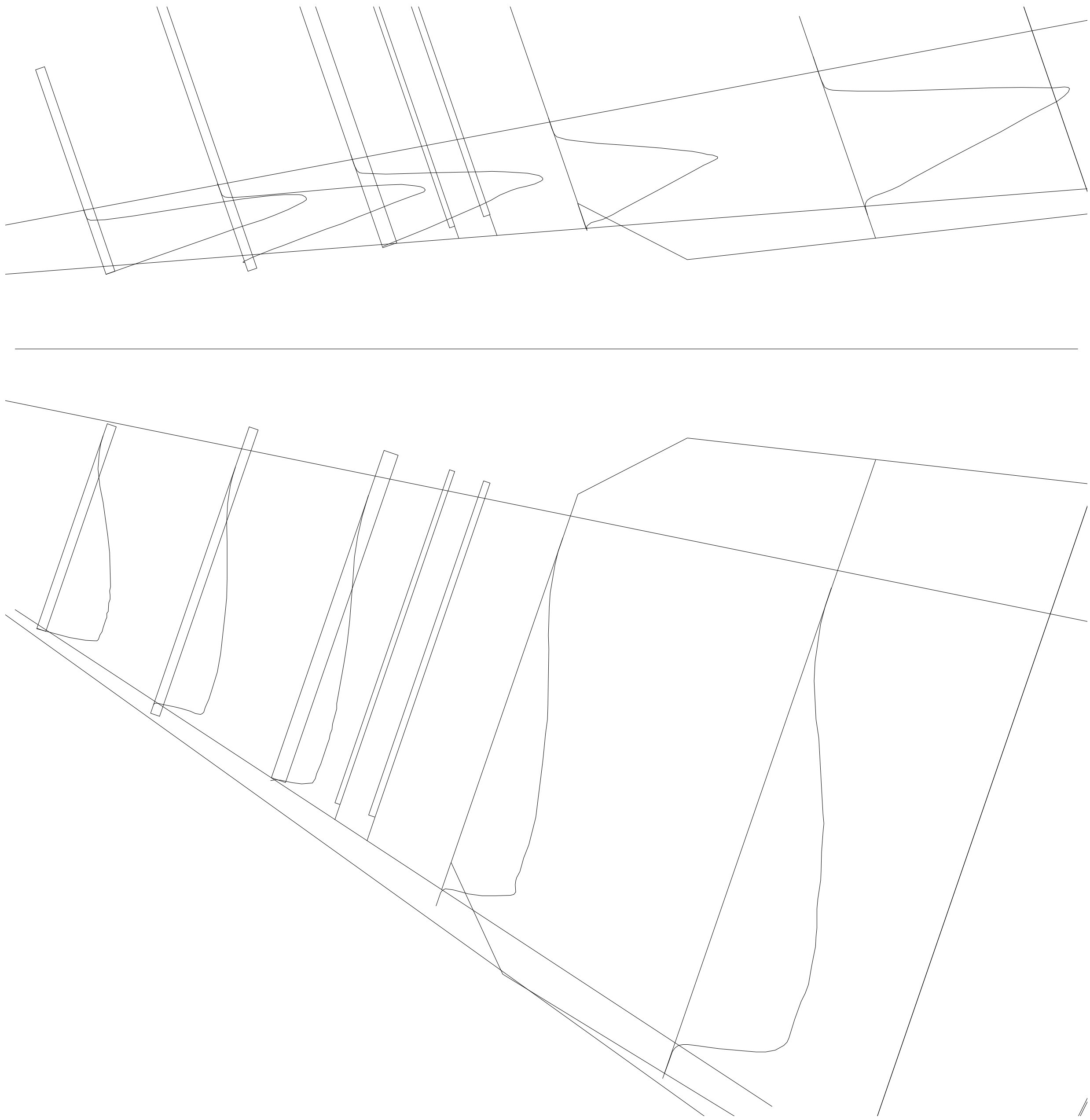

Figure 8: *Comparison of tracing and simulation*

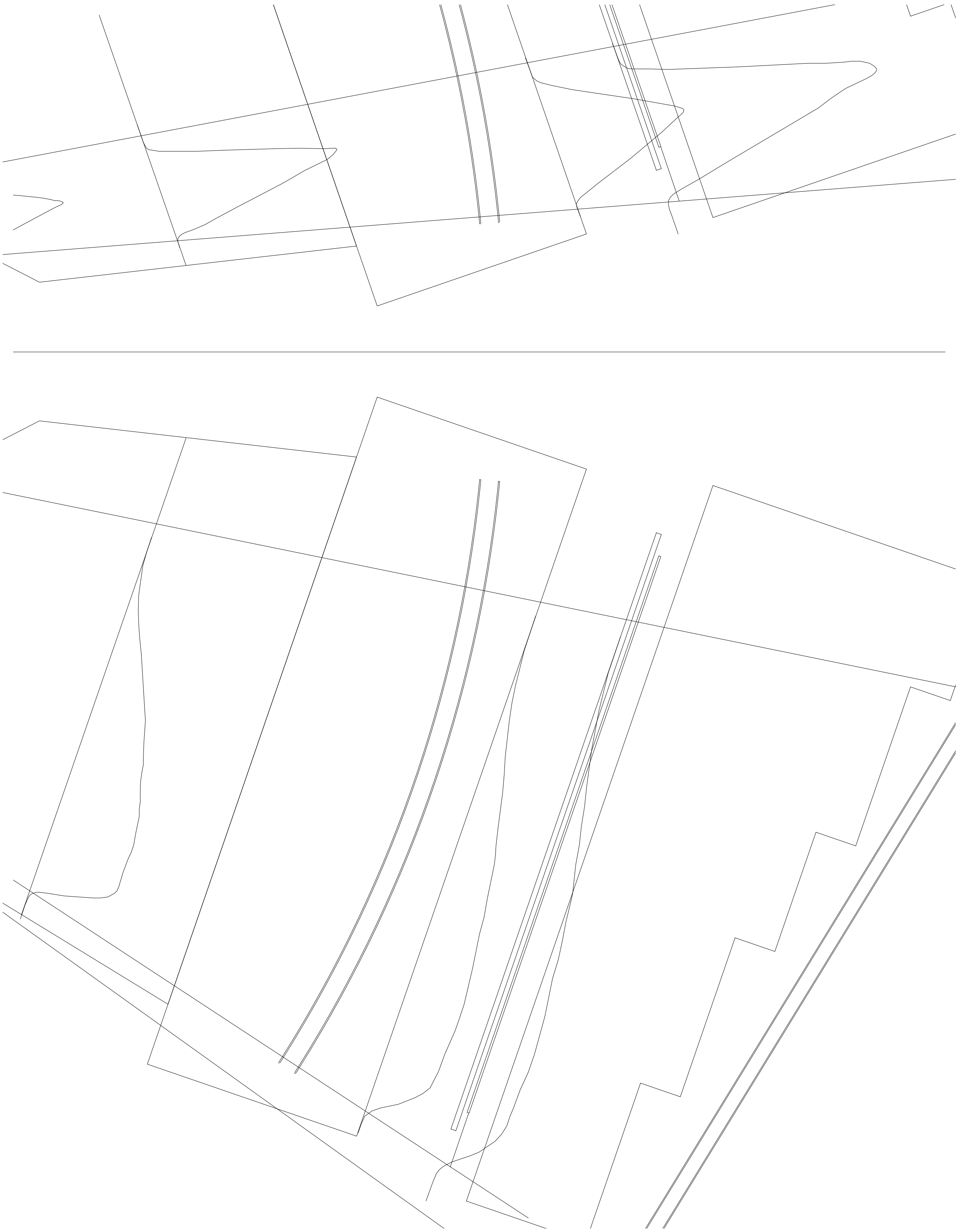

Figure 9: *Comparison of tracing and simulation*

3 Vertical hodoscopes

Horizontal dimension of VH is 1302 mm. VH consists of 18 scintillation slabs of 70 mm in width which were separated at the beginning by 2.5 mm gaps. Later the gaps were decreased. Probably these gaps now are equal to 1 mm each. Then the VH width now may be is 1277 mm. But I will use known me value 1302 mm.

If we add two slabs of 70 mm in width to the existing VH (4 slabs in total) it will be enough for $A_{\pi K}$ detection without losses when π and K are detected by DC.

In figs. 10 and 11 the existing and modified VH together with the support platform are shown. New VH do not interfere with DC. Only difficulty how to fix new VH on the platform when DC are already in the place. Solution is to fix new VH from back side with bolts as it was before and from front side with help of screw-clamps.

The simplest way to modify the VH support is to cut Al plates in the centre and to weld spacers to them (fig. 12). It is also necessary to manufacture additional 4 forks to fix new modules.

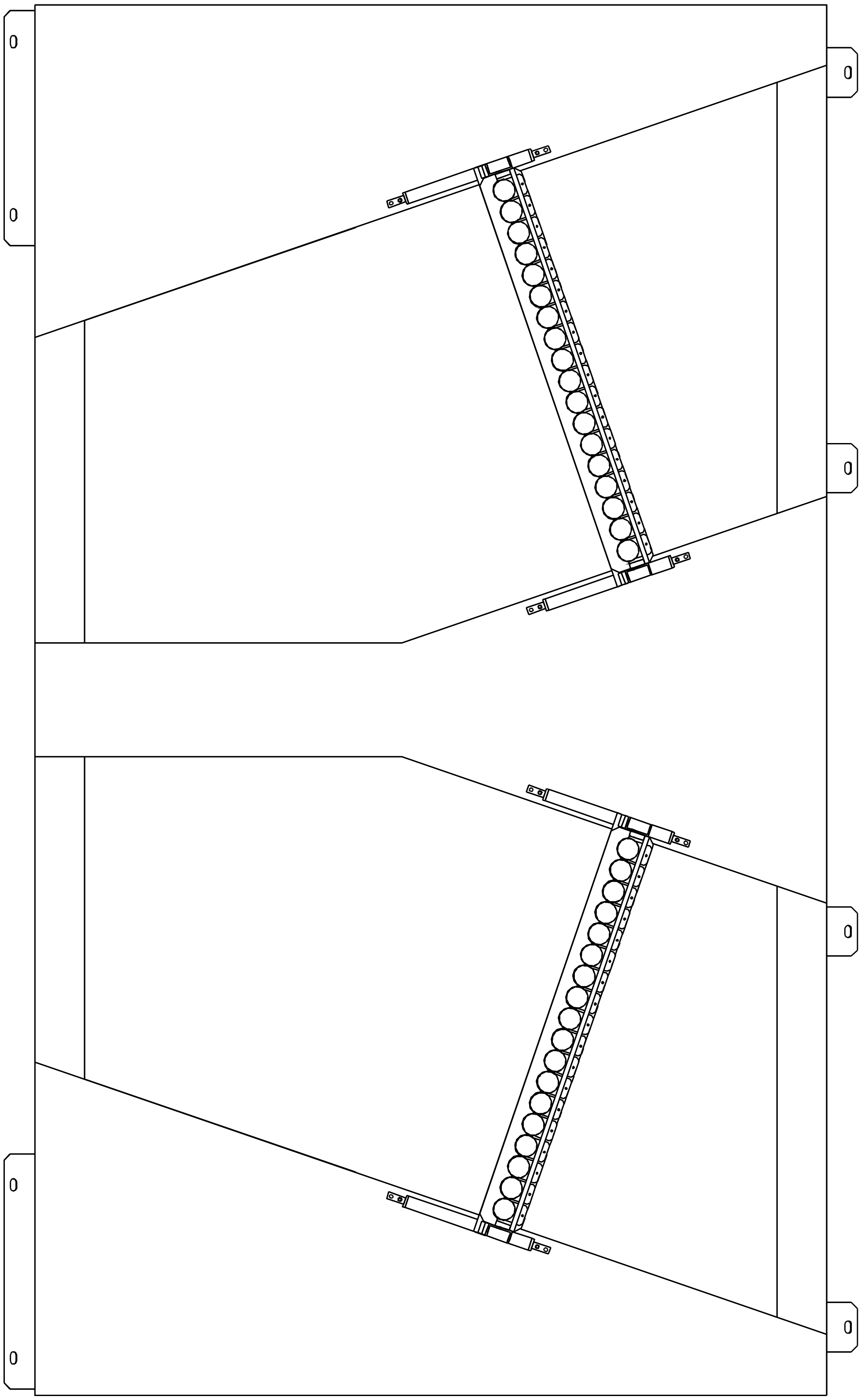

Figure 10: *Existing VH and platform.*

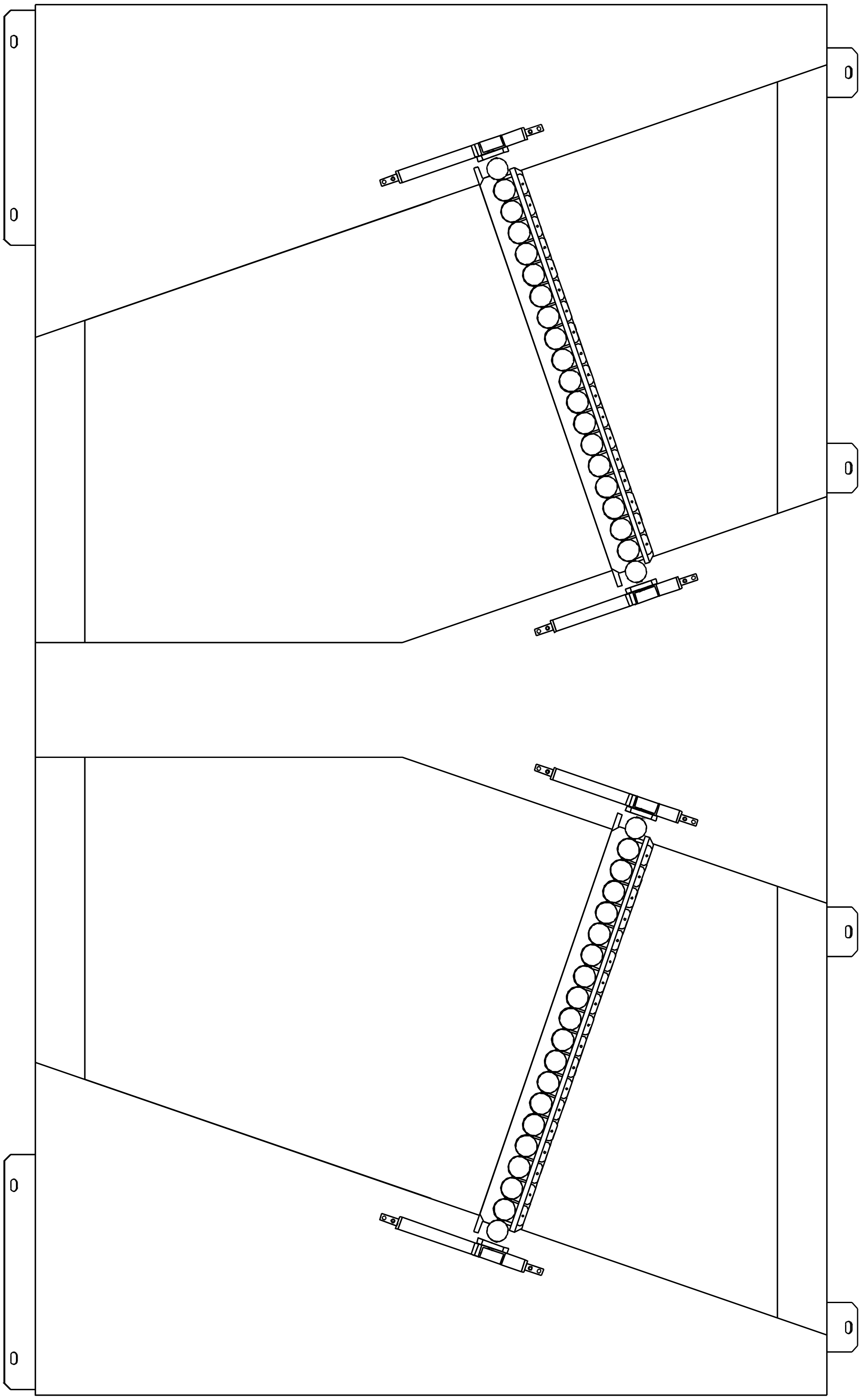

Figure 11: *New VH and platform.*

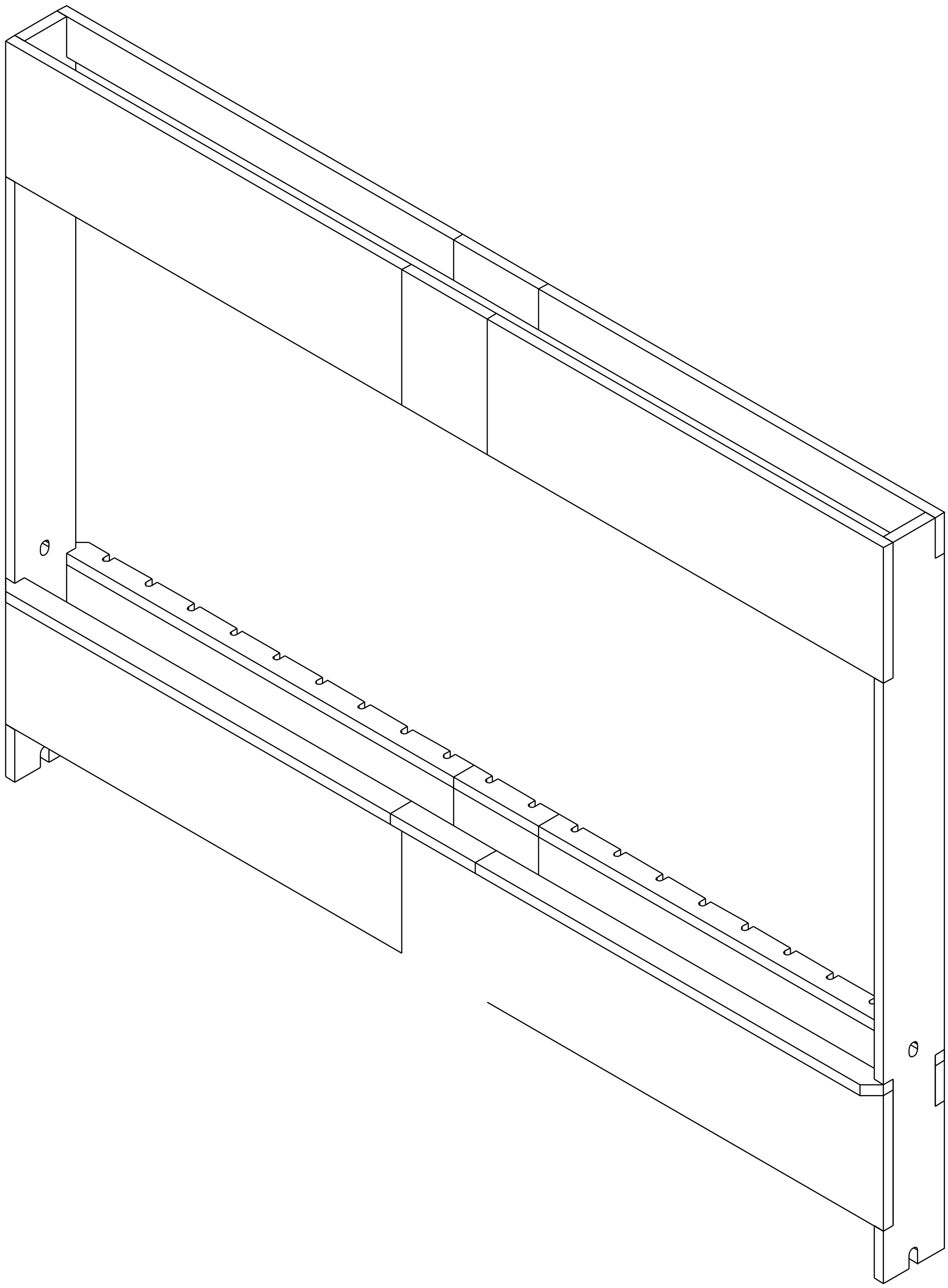

Figure 12: *VH support modification.*

4 Horizontal hodoscopes

Horizontal dimension of HH is 1307 mm. HH consists of 16 horizontal slabs separated by 1 mm gaps.

If we enlarge HH slabs by 200 mm it will be enough for $A_{\pi K}$ detection without losses when π and K are detected by DC. In figs. 13 and 14 the existing and modified HH are shown on the platform.

The simplest way to modify the HH support is to cut the frame in the centre and to weld spacers to it (15). In addition a small cut should be made at the bottom of the support.

In the new HHs the inward PM housings are separated by 144 mm. So it is necessary to find out how to to repaire PMs and how to connect HF and HV cables to the PMs.

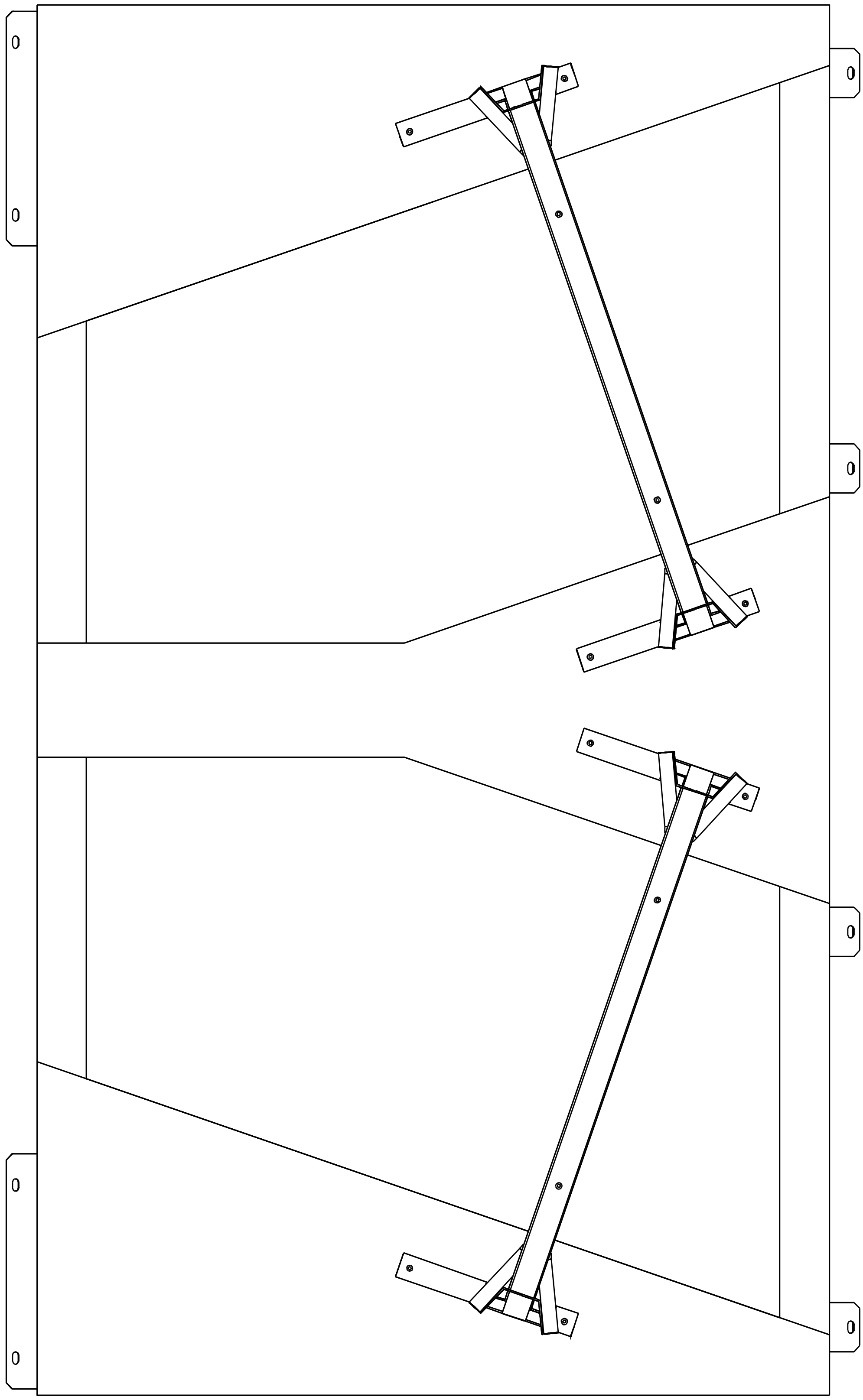

Figure 13: *Existing HH and platform.*

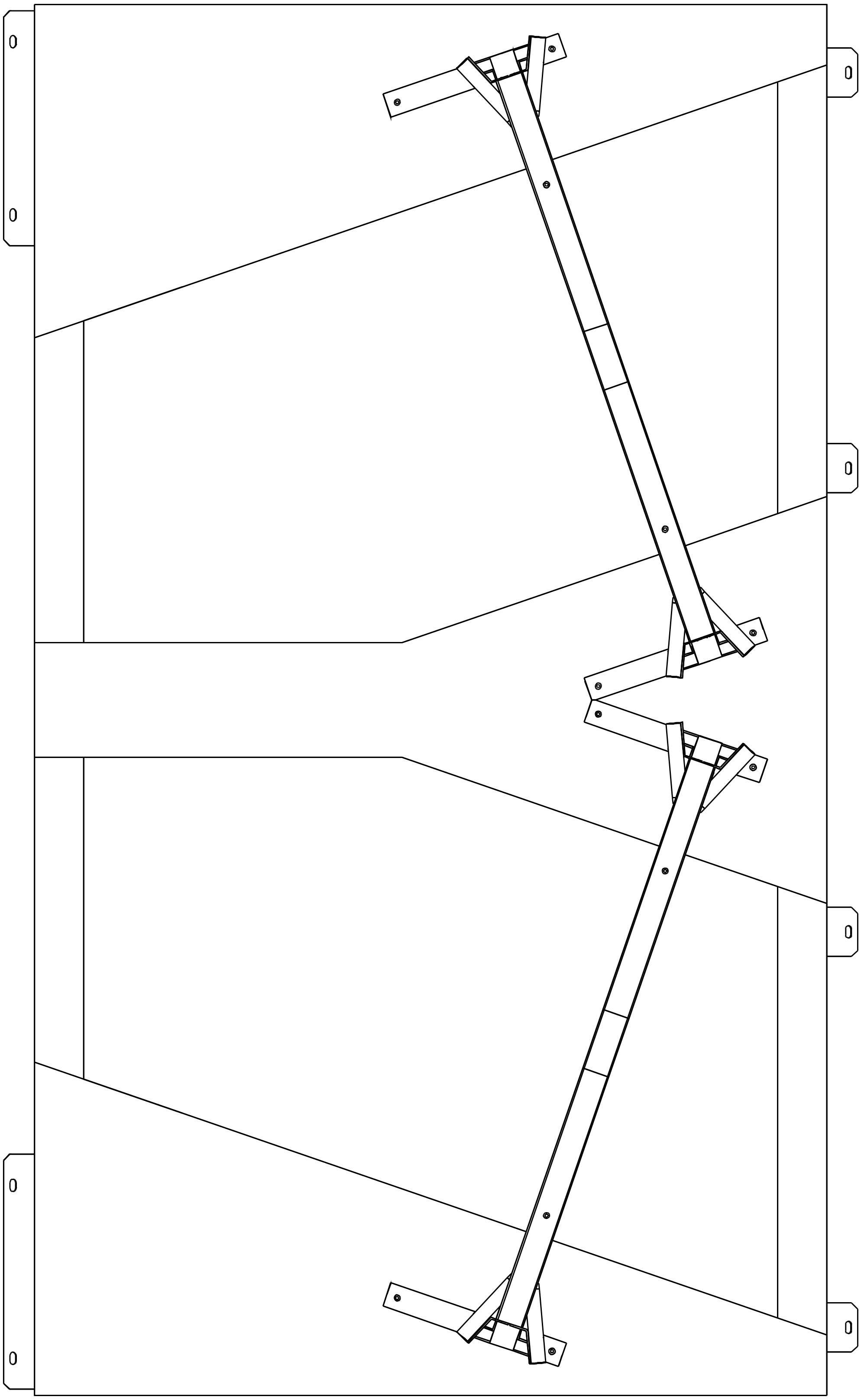

Figure 14: *New HH and platform.*

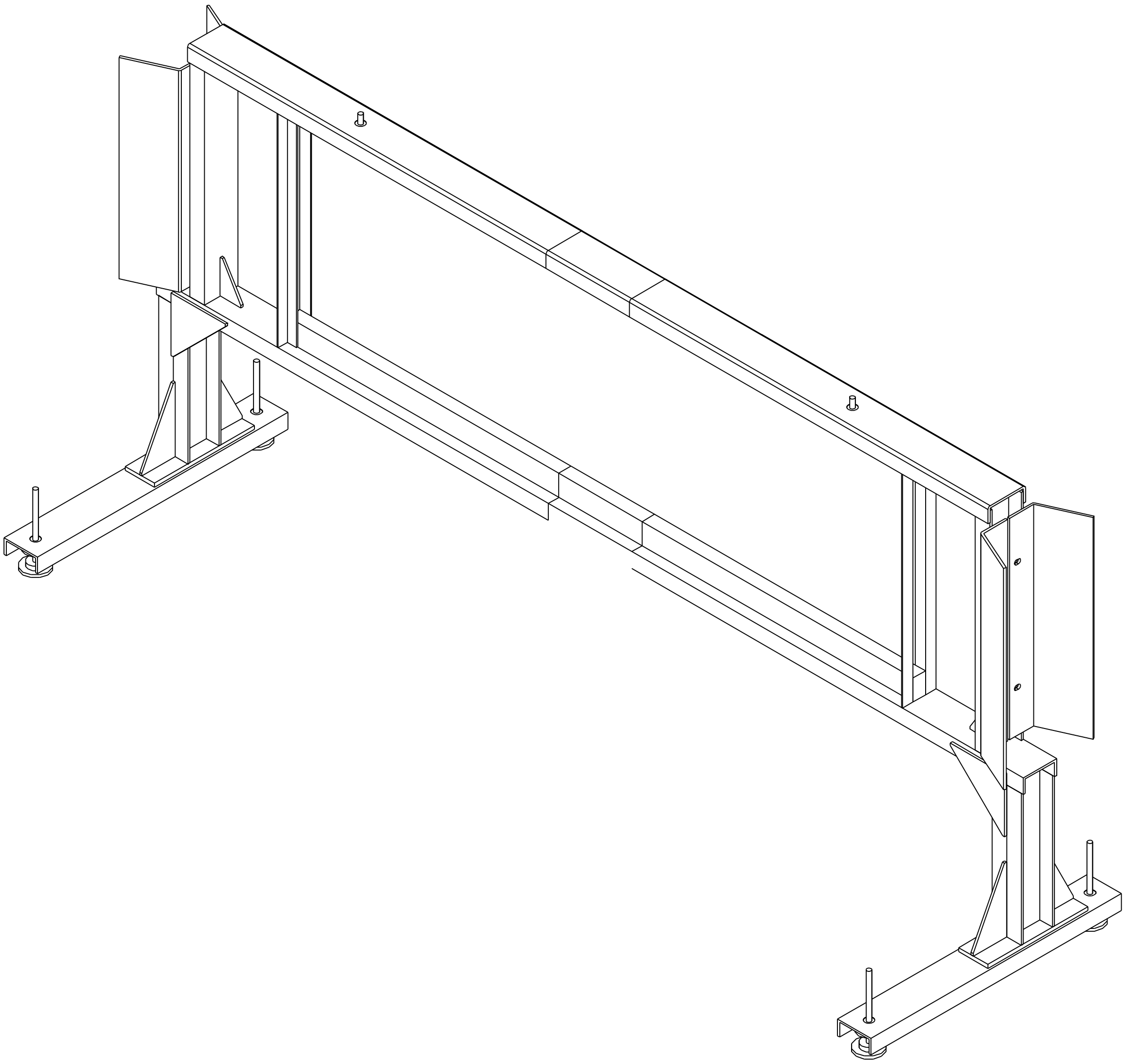

Figure 15: *HH support modification.*

5 Preshowers

Horizontal dimension of PR is 2800 mm. PR consists of 8 scintillation slabs of 350 mm in width practically without gaps.

If we add two slabs of 350 mm in width to the existing PR it will be enough for $A_{\pi K}$ detection without losses when π and K are detected by the DCs.

In figs. 16, 17, 18 the existing and modified PR are shown.

PR modification retains the existing PR without changes. Two PR modules of 350 mm each (4 modules in total) are attached to both sides of the existing PR.

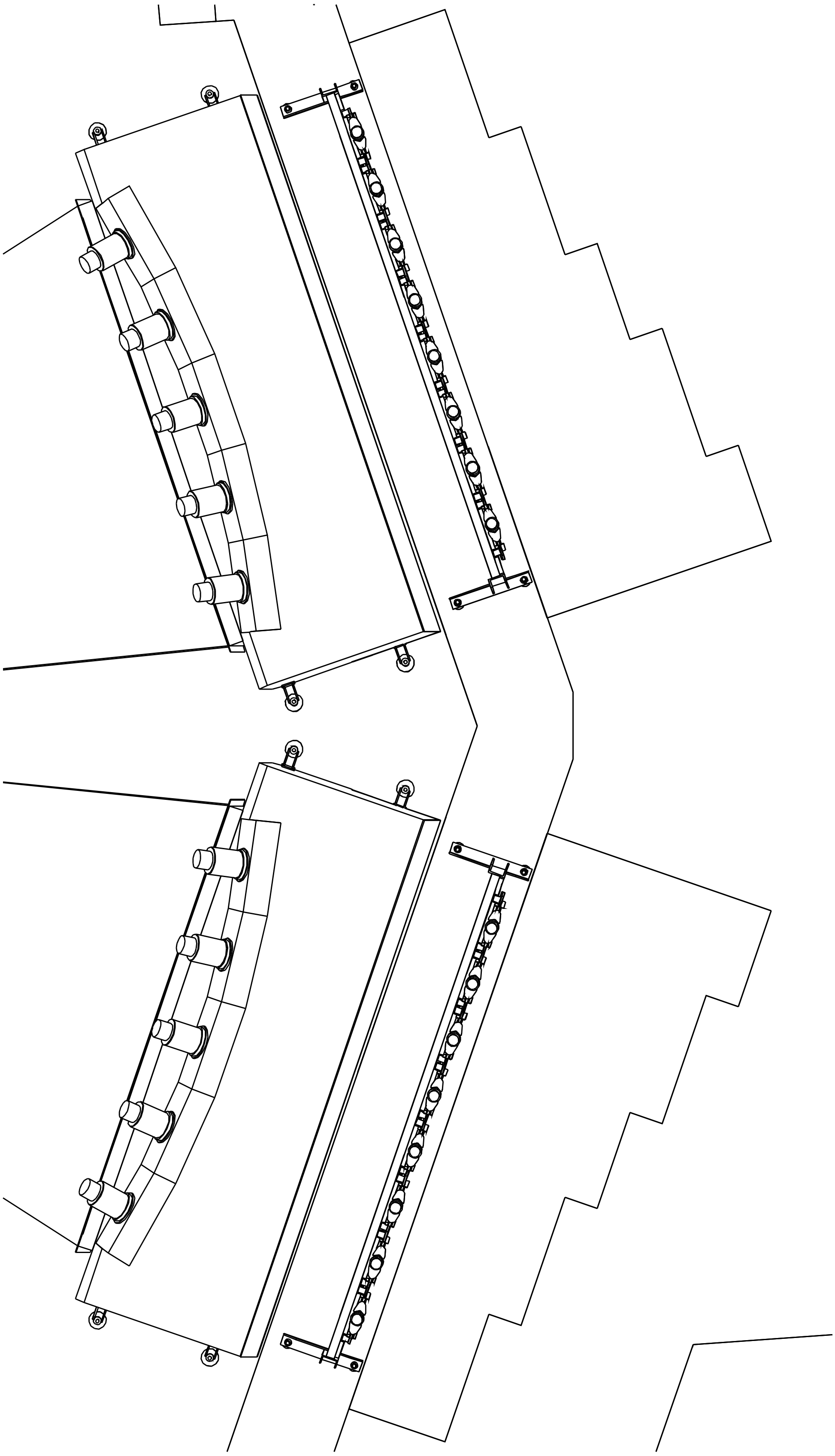

Figure 16: *Existing PR.*

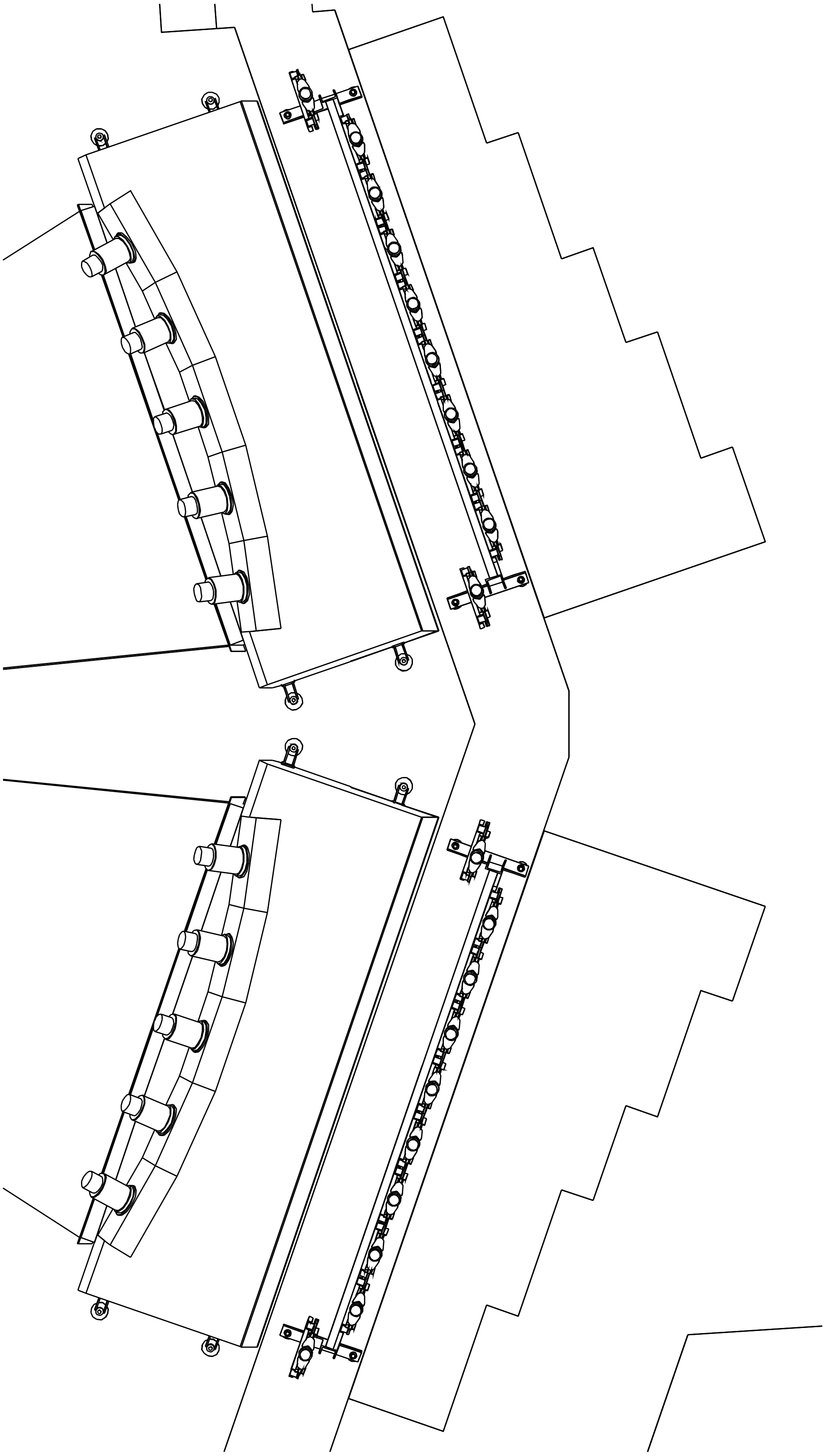

Figure 17: *New PR.*

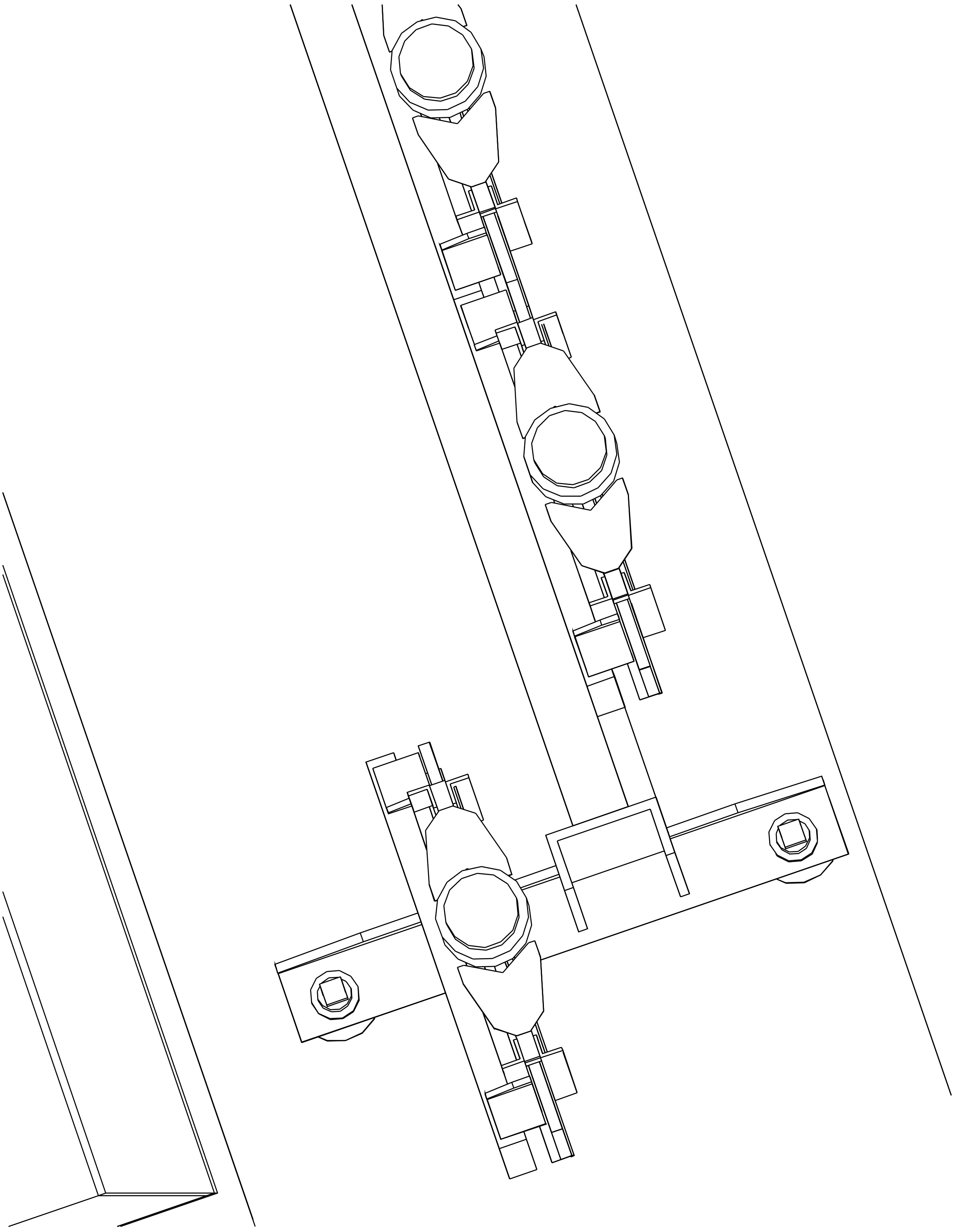

Figure 18: *New PR.*

6 Muon counters

Horizontal dimension of MU is 3387 mm. MU consists of 2 layers. Each layer consists of 28 scintillation slabs of 120 mm in width which are separated by 1 mm gaps.

If we add to each MU 4 twin slabs to the inner side and 2 twin slabs to the outer side (24 modules in total) and put them on the back side of the absorber it will be enough for $A_{\pi K}$ detection without losses when π and K are detected by the DC.

Also it is necessary to add pieces of steel to the absorbers to cover all muons detected by DC.

In fig. 19 the existing MU counters and additional scintillation slabs are shown. In the same figure the existing absorbers and additions to them are shown also. In figs. 20 and 21 the additional slabs are shown in details.

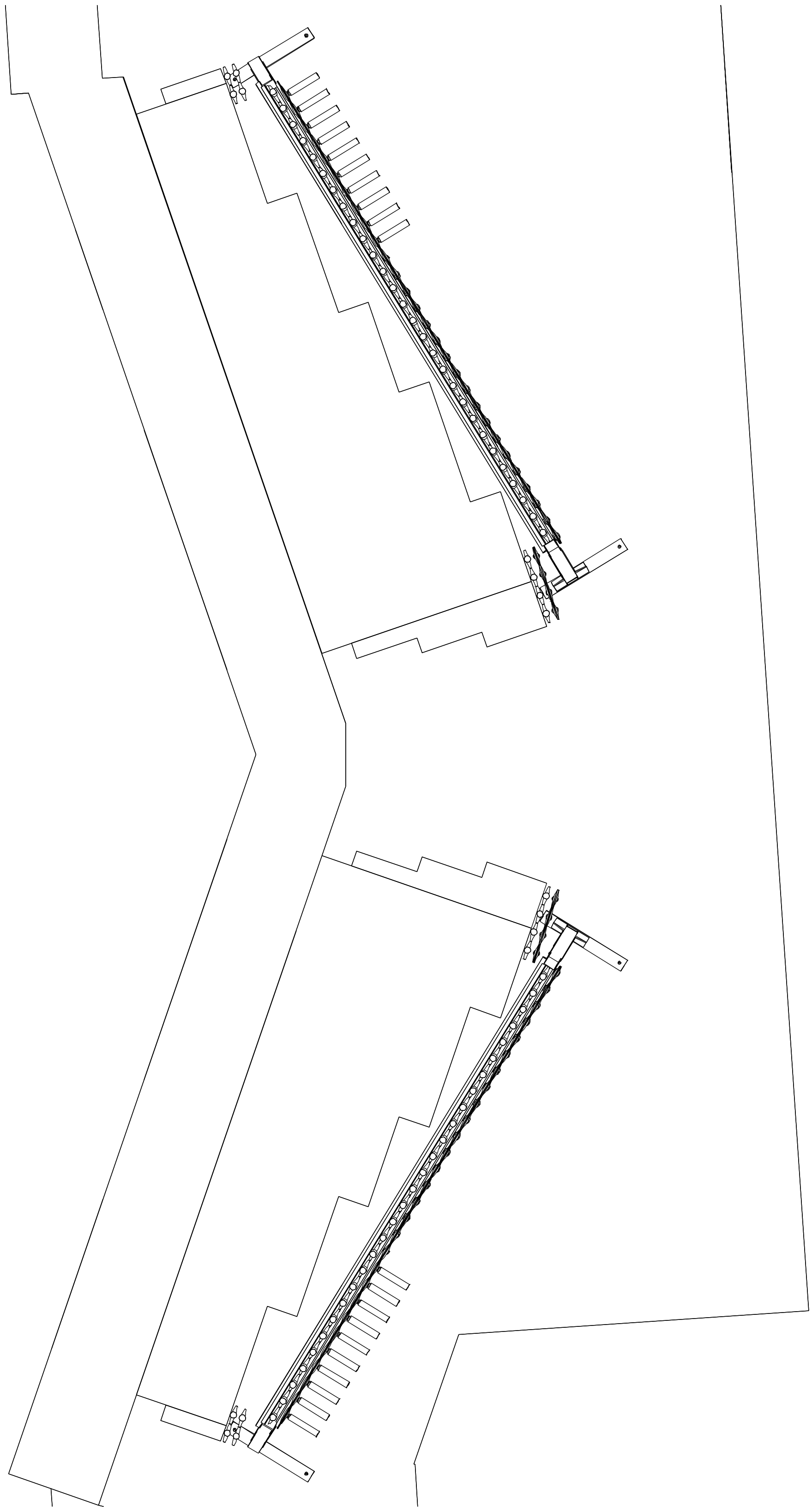

Figure 19: *Existing muon scintillation hodoscopes with additional slabs in inner and outer sides. Existing absorbers with additional pieces of steel in inner and outer sides.*

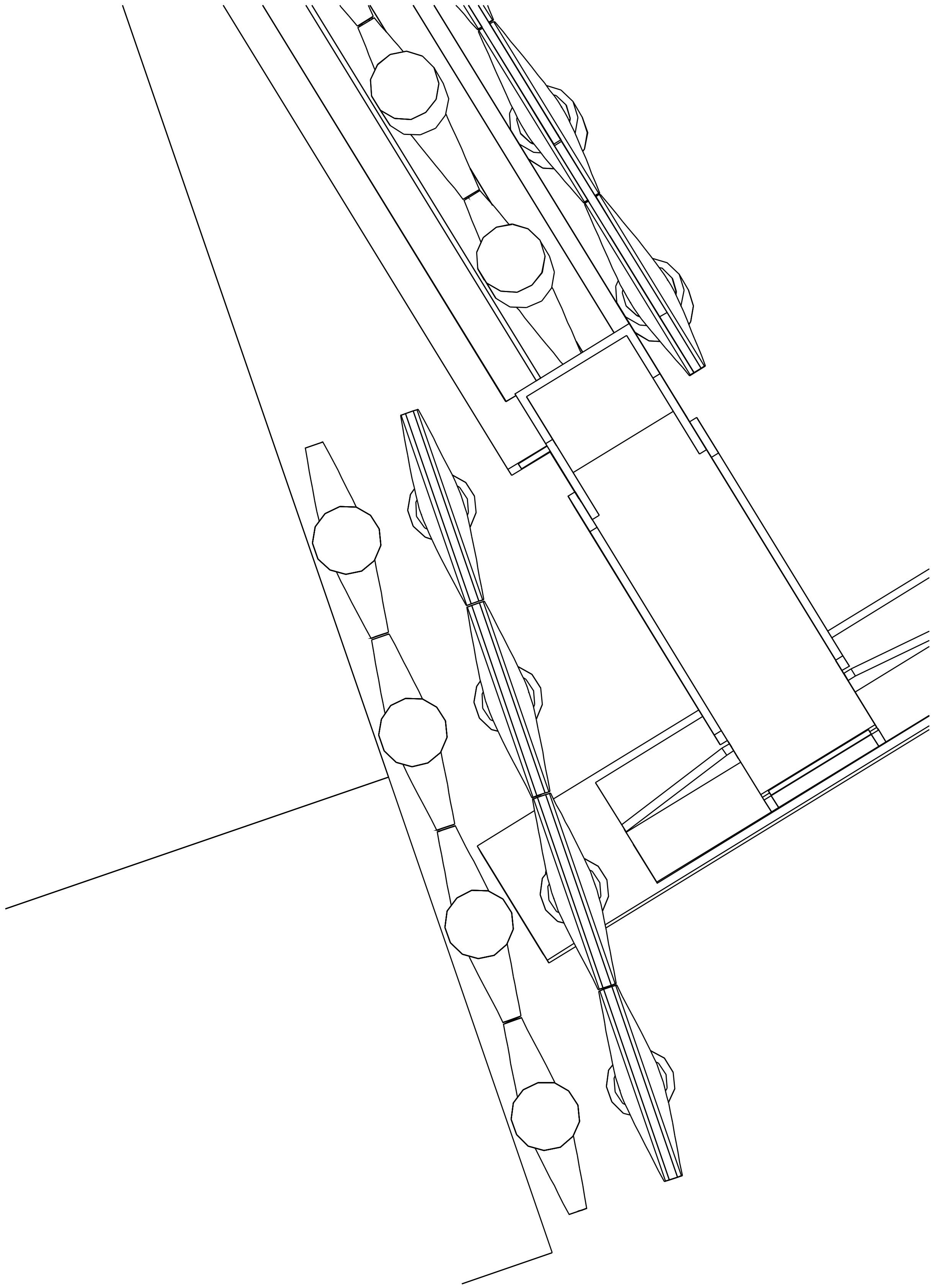

Figure 20: *The additional slabs in the inner side of MU.*

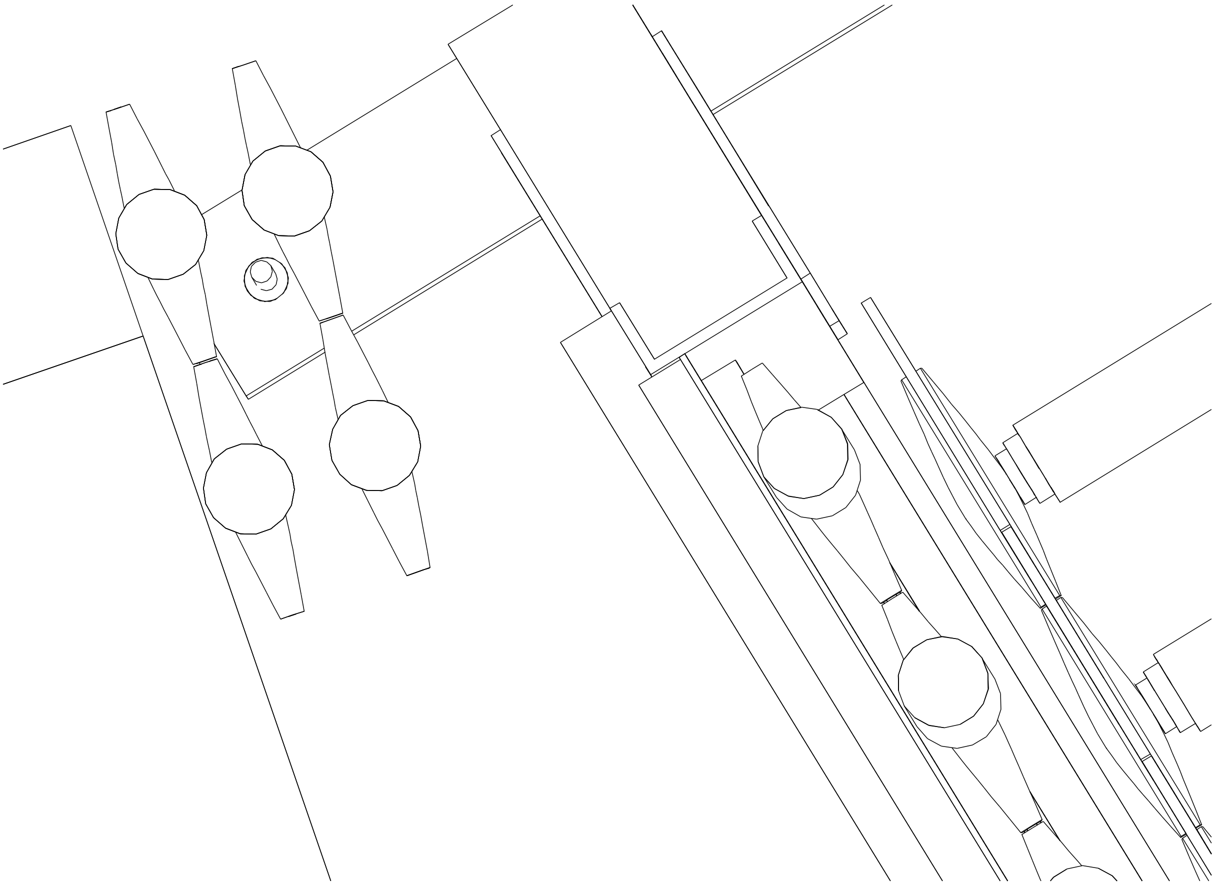

Figure 21: *The additional slabs in the outer side of MU.*