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Proposal of a Four Horn Capture Scheme

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Abstract

A scheme for pion capture using four horns instead of only one is proposed. The consequence of the reduction from 50 Hz to 12.5 Hz could be a major advantage for the target and power supply. A preliminary comparison between the yields with a straight injection is presented.

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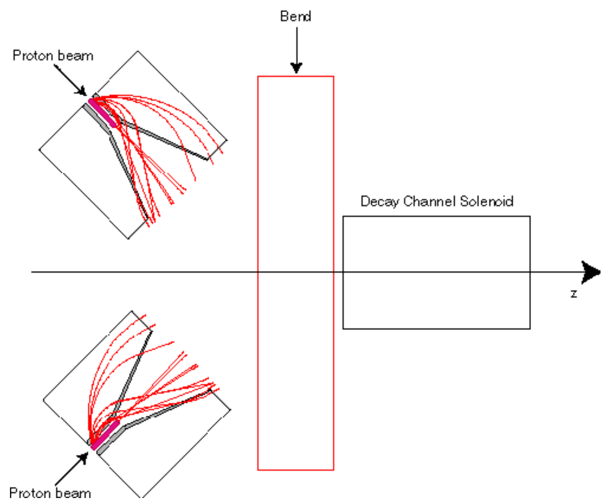

Figure 1: *The pion beam coming from one horn is corrected by the bend before the decay channel solenoid. The other two horns are not drawn and they are in the plane perpendicular to the one of the figure.*

1 Introduction

The present pion capture scheme [1] uses a horn pulsed at 50 Hz which injects the beam directly into the decay channel solenoid. The challenge in using one target and one horn is the high repetition rate required by the system. This will limit the current circulating in the horn and it imposes high stresses in the target.

In this note a system with four horns and four targets is proposed as a possible alternative to the traditional scheme. The repetition rate could be reduced to 12.5 Hz and the mechanical and thermal stresses would be more moderate having only 1 MW beam power per target. Moreover, this scheme could be used to increase the conventional neutrino beam proposed in [2] which does not suffer from the losses at the injection into the decay channel[2].

2 Proposed scheme

In Figure 1 the four horn scheme is presented. The proton beam coming from the proton driver is sent to one of the four lines and it impinges on one of

[2]In case of running the proton driver at 16 MW and having 4 MW per target.

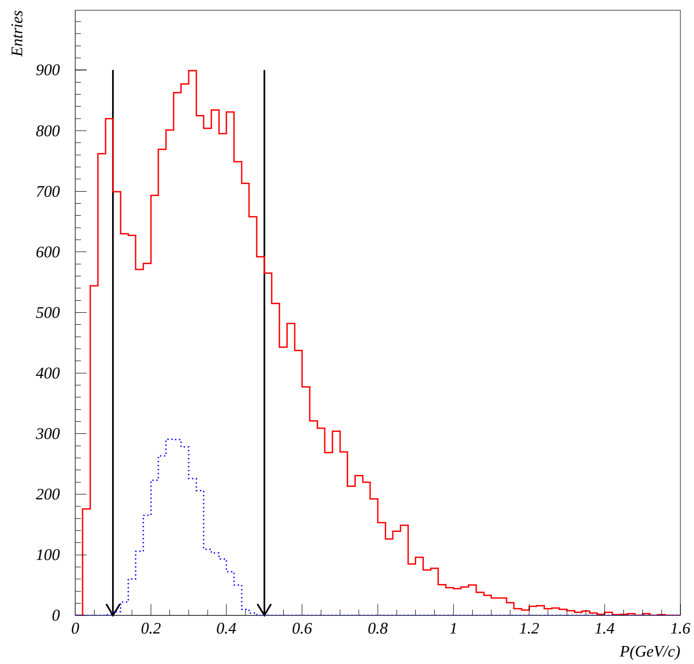

Figure 2: *Pion and muon momemtum at the end of the decay channel. In red (continous line) the distibution for the straight injection, in blue (dotted line) for the curved one. The arrows limit roughly the momentum interval accepted by the phase rotation section. The bend introduces the selection in energy.*

the targets. The system target/horn is the same as presented in [1], except that the beam axis and the horn axis are inclined by 45 degrees with respect to the decay channel axis. The pion beam is corrected by a pair of bending magnets, where the **B** field direction is varied according to the direction of the incoming beam. The field in the dipole is 0.7 T and the dipole is 1 m long. The beam is injected directly into the first decay channel solenoid, which is 4 m long with a radius of 30 cm and a field strenght of 1.8 T. A complete field map of this solenoid and of the 30 m long decay channel has been computed by `POISSON` [3] and implemented into a `MARS` [4] simulation.

The same field map is used as injecting section for the one-horn scheme. In this case the decay channel starts 50 cm after the horn, and the toroidal field of the horn should be superimposed to the fringe field of the solenoid. This effect was considered negligible in first approximation, since the length of the radial field damping is comparable to the solenoid aperture.

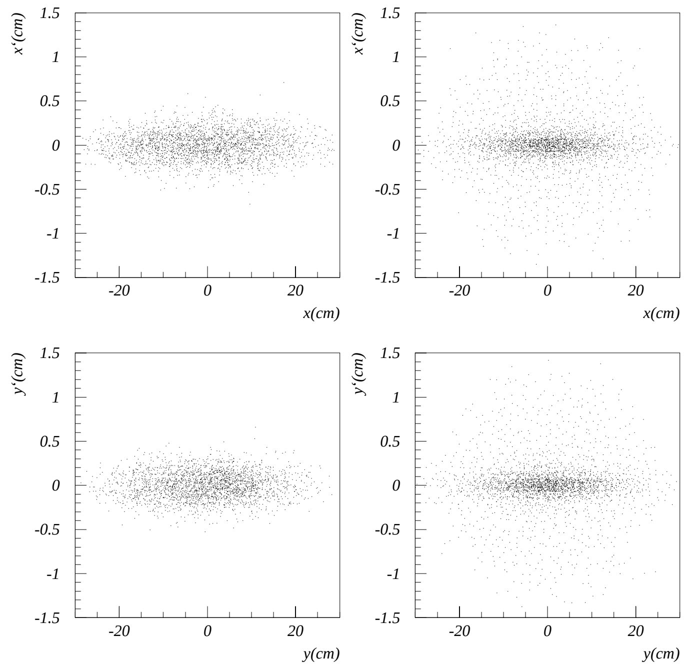

Figure 3: *The two transverse phase space planes for the curved injection (left) and the straight injection (right) at the end of the decay channel.*

3 Results

Pions and muons are counted at the end of the decay channel for both the straight injection and for the curved one. In the case of the curved injection, the bend introduces an energy selection in the beam, as is shown in Figure 2.

In Figure 3 the transverse phase space for both injections is presented.

The results of the simulation are summarised as follows. It is more convenient to compare the yields in the momentum interval delimited by the arrows in

Figure 2 between 0.1 GeV/c and 0.5 GeV/c. The phase rotation, in fact, will capture muons and pions in this energy range. In this case the rate between the two injection yields is **0.2**. The losses come from:

- mismatch between the horn, the bend and the solenoid.
- the acceptance of the system is smaller compared to the straight injection.

The losses due to the transport in the decay solenoid are negligible.

4 Conclusions

In this note the four horn scheme with a curved injection is presented. Further study is needed, as this preliminary study gives a lower limit to the yield that can be achieved with such a geometry.
Various solutions are already under study. By varying for example the proton beam axis or the angle of the bending, one could hope to have improvement of the flux. Moreover the final yield should be computed by tracking the particles through the phase rotation section.

References

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[3] Los Alamos Accelerator Code Group,"Poisson/Superfish Reference Manual".

[4] N.V. Mokhov, "The `MARS` Code System User's Guide", Fermilab-FN-628 (1995).
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