Proton Beamline to UCN Source

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The purpose of this short note is to present a first design of a beam line for an UCN source in the meson area. It assumes that M13 and M11 will be removed.

The layout of the beam line is shown in figure 1 and the beam envelopes are given in figure 2. A List of beam elements, including drifts, is given in table 1. This will make it possible to make a layout that can be overlain on a layout of the messon area.

The beam starts at quadrupole Q6 in BL1A. Two kickers, each kicking 5 mr, are placed on each side of the bending magnet for BL1B. Immediately after kicker K2 starts a large area of concrete, poured in place, that can not be removed. A septum is placed after that area, and preferably as close as possible. The beam is displaced by 6.5 cm at the start of the septum. The septum bends 115 mr. It would be better if it could bend more. It is followed by a normal bending magnet BN1, which bends the beam away from the axis by a further 15.34 degrees. The total angle with BL1A is then 22.5 degrees. It is unfortunate that the beam is only displaced from the BL1A axis by 22 cm at the entrance to BN1. This can only be made larger by increasing the bend angle of the septum, or by moving B1 further downstream. However, the latter possibility is limited by the requirement that the beam passes by the BL1A doublet Q7-Q8. Because of the possibly difficult construction of BN1 the field has been kept below 10 kG.

After BN1, the bend BN2 bends 45 degrees, for a total angle with the BL1A axis of 67.5 degrees. The neutron production assembly is 6 m downstream of BN2. The beam should be big there. Therefore, the two quadrupoles QN1 and QN2 between BN1 and BN2 are used to blow up the beam by focussing the beam more or less in the BN2 area, to create a large divergence. In the example given in figure 2, the final beamspot has a full size of 10 cm horizontally and 3 cm vertically. However, one can make any wanted beam size.

It is wortwhile to emphasize that the normal tuning of BL1A is not affected at all, because the fields of all quadrupoles in BL1A have been kept unchanged.

Since the aperture of the BL1A quadrupoles are 4 inch, it is desirable to make the aperture of the kickers at least 10 cm by 10 cm.

For the two quadrupoles QN1 and QN2 the two 8 inch diameter BELLONA quadrupoles, which are presently in M20, can be used, because they are not needed in the new M20. This assumes that they do not need to be radiation hard. Else they would have to be the same as the 4 inch diameter quadrupoles in BL1A such as Q5 and Q6.

Although the bending magnets in M11 could possibly be used, they are enormous magnets, with big apertures, which may be difficult to position. However, they are not radiation hard. It is probably better to use the here proposed magnet BN1. It is 1.6 m long, with an 18 kG field, and bends 45 degrees. The beam enters and exits normally. The magnet is curved and the aperture of presumably 10 cm by 10 cm follows the curvature of the central trajectory. Because it is fairly compact the price may be moderate.

There is some operational impact on BL1A in terms of relocating some monitors. The beamline for the UCN source also needs some monitoring equipment.

Table 1: Beamline Elements

Element	Length (m)	Field (kG)	radius (cm)	angle
BL1A Q6	0.5238	1.98	5.156	
drift	2.50			
kicker K1	0.75	0.24		5 mr
drift	2.50			
kicker K2	0.75	0.24		5 mr
drift	2.75			
septum	1.50	2.79		115 mr
drift	1.50			
bend BN1	1.00	9.73		15.34 deg
drift	1.00			
quad QN1	0.5238	3.00	5.156	
drift	3.00			
quad QN2	0.5238	3.00	5.156	
drift	1.00			
bend BN2	1.60	17.85		45.0 deg
drift	6.00			

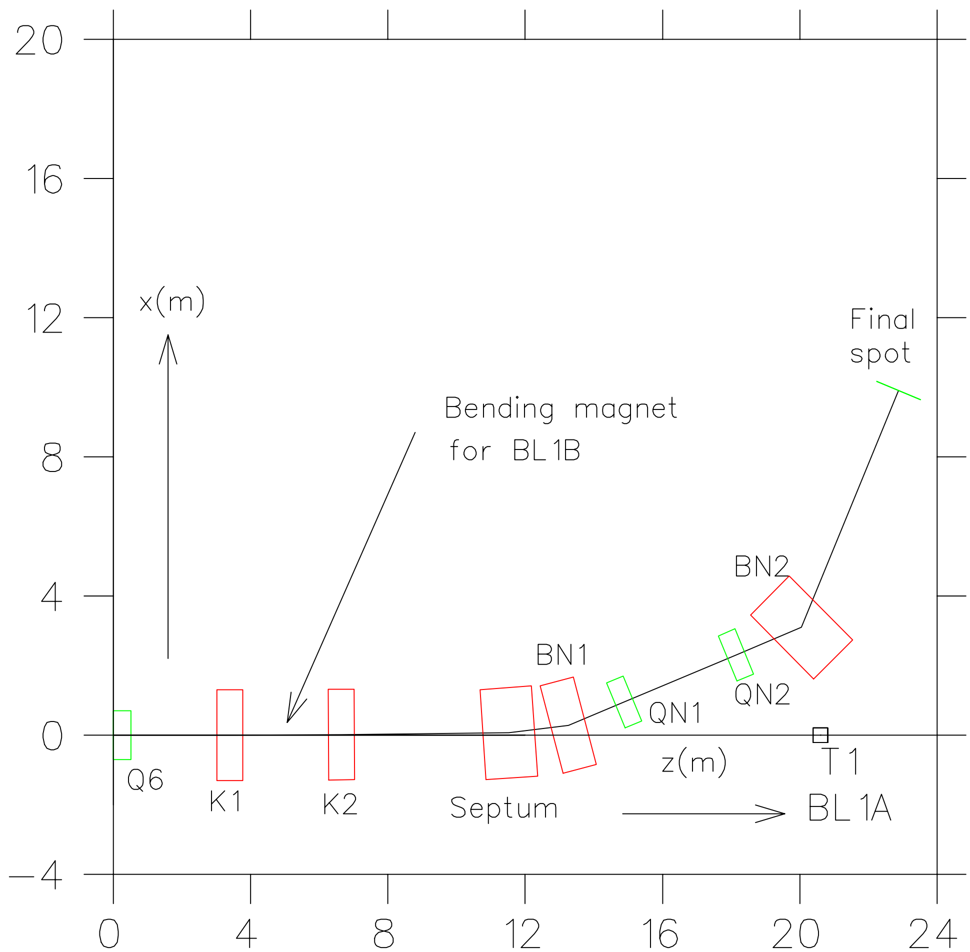

Figure 1: Layout of beamline

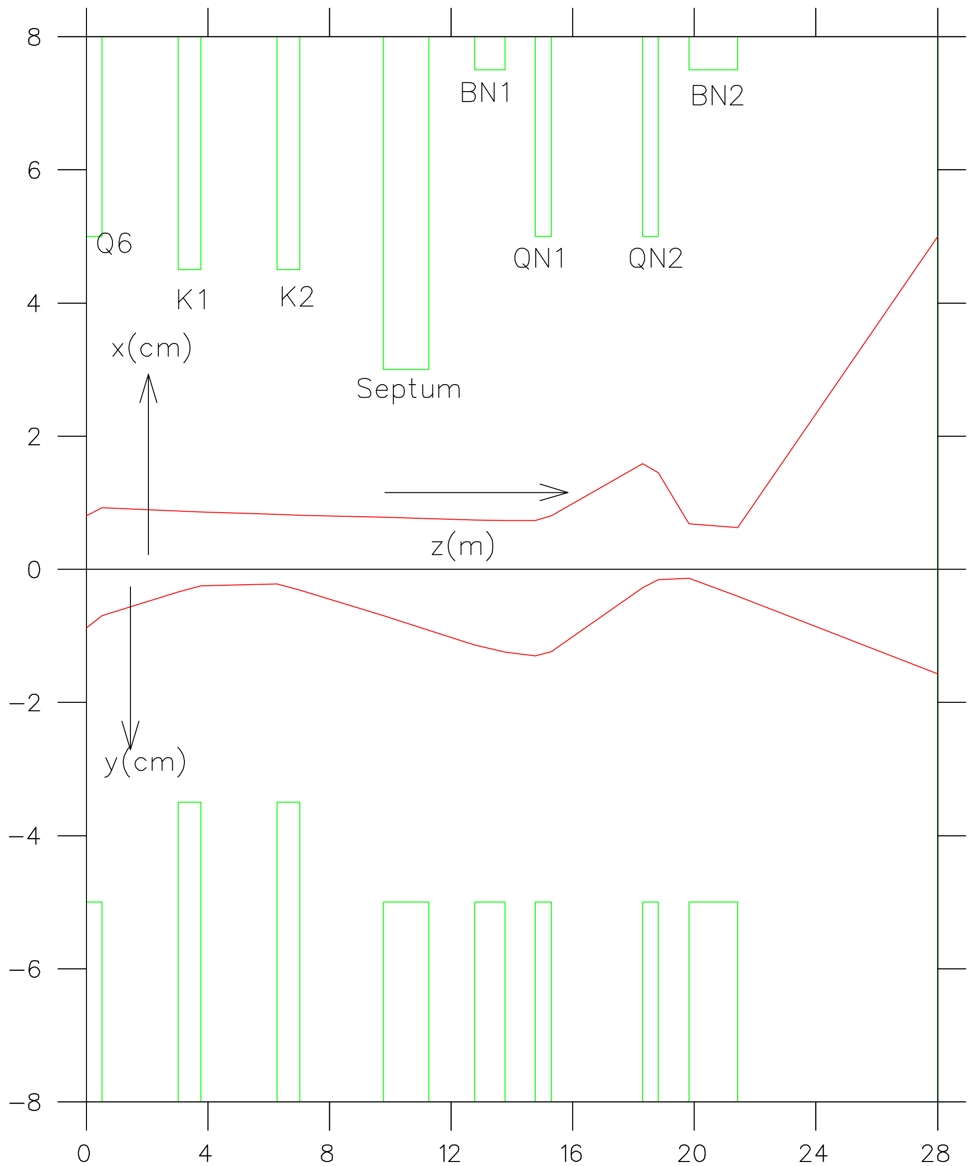

Figure 2: Beam envelopes