New layout of Amsterdam Pulse Stretcher

- revision a -

R. Maas and Y.Y. Wu

introduction

The status - at March 1988 - of the APS project has been reported in [1]; since then, some modifications to the design have been made. These changes will be reported below.

I Ring level

Fig. A1 of [1] shows that crossing between the Ring and the beam handling system (b.h.s.) will occur when all these systems are co-planar. Such a crossing is undesired for two reasons:

1) the four-way connection between the two lines may excite unwanted parasitic modes
2) coupling of the two vacuum systems is undesired, since the vacuum requirements of the two systems are different

For these reasons the ring level will be elevated by 15 cm with respect to the b.h.s.:

ring level (w.r.t. floor): 1450 mm
b.h.s. ( " " ): 1300 mm

II internal target area

The internal target area was originally situated at the location of M1-C1 (see p.3 of [11]); this place was chosen because a hall, designated for chemistry research, was sitting unused there (disadvantage of this location: part of the available space is occupied by the curve C1). It turns out, however, that extensive modifications to this hall are necessary in order to accommodate a big-byte magnetic spectrometer. The total cost of this operation (increasing the ceiling height; strengthen the floor around the spectrometer location) is such, that a new hall can be built for this money. It has been decided, therefore, to shift the internal target hall to the area around M5; at this location no interference from the curve (in this case C5) exists. This change made some modifications of the curved sections possible:

III curved section

In order to minimize the interference between the curved sections and the spectrometer in the original internal target hall, the curved sections had been designed rather 'tightly'. Since the constraint for such a compact design does not exist anymore, the new design allows a bit more space for monitors and orbit correctors. The total length of each curve has been increased by 1.52 m. Dimensions (in meters) are given in Fig. 1.

\[
\begin{align*}
&0.93 & 0.47 & 0.28 \\
&0.914 & 0.454 & 0.248
\end{align*}
\]

Fig. 1 Structure of single curve cell. Dimensions (in m.); top: yoke-to-yoke, bottom: eff. lengths of quads taken into account (c.f. Fig. 3 of [11]).

Machine functions of a complete curve are given in Fig. 2.

IV straight section

Since the design of various tunnel segments had started already, it was decided not to change the gross dimensions of the machine any more: the changes in the curved sections, therefore,
Machine functions of curve
solid: $\beta_x$ dashed: $\beta_y$ dot-dashed: $5\eta_x$
propagate to the dimensions of the straight ('matching') sections: the new dimensions are given in Fig. 3.

| Q1 | A-
|-----|
| 3.00 | 2.886 | 3.830 | 3.755 | 1.75

Fig. 3 Structure of matching cell (M3); quadrupole indicated by 'a' is shared by the curved section. Another matching cell (M4) is connected at 'b'. Dimensions have similar meaning as in Fig. 2 above (c.f. Fig. 2 of [1]). The location of the internal target is indicated by 'A'.

Machine functions of the matching section are given in Fig. 4.

V quadrupoles and sextupoles

A decision has been made regarding the physical dimensions of the ring quadrupoles and sextupoles, see [2]. The results are summarized below (total number of each item between square brackets):

**Curved section**
- Quadrupoles [36]:
  - $l_{\text{yoke}} = 18.0 \text{ cm}$
  - aperture = 7.5 cm
- Sextupoles [32]: identical to quads

**Straight section**
- Quadrupoles [32]:
  - $l_{\text{yoke}} = 25.0 \text{ cm}$
  - aperture = 11 cm

VI orbit correction scheme

Ring magnets cannot be aligned perfectly; there will always be a residual misalignment present. The effects of these misalignment may result in closed orbit (C.O.) deviations of

Machine functions in straight cell; $\nu_x = 7.6368$; $\nu_y = 7.22$

solid: $\beta_x$  dashed: $\beta_y$
1.5 cm; therefore, an orbit correction scheme (o.c.s.) is necessary. The present o.c.s. \cite{orbit_correction} is capable of keeping C.O. deviations well within 0.5 mm (typical rms-value is 0.1 mm). The main features of the o.c.s. will be reviewed briefly:

- **Curve**: each one of the four cells of a curve contains one beam position (x & y) monitor (BPM) and one vertical steering coil; one of the two dipoles in each cell acts as a horizontal corrector (in total 16 BPM-corrector units).

- **Straight**: each of the four straight sections (of two matching sections each) contains four BPM-corrector units; the correctors are combined x-y steering coils (in total 16 BPM-corrector units).

The results quoted in \cite{results} have been obtained with the program DIMAD \cite{DIMAD} - and with the 'old' geometry; simulations with MAD \cite{MAD} for the geometry as described in sec.'s III and VI yield results as quoted above (for smaller corrector values).

The o.c.s. has been tested for both Stretcher Mode ($v_x = 7.6368$, $v_y = 7.22$) and Storage Mode ($v_x = 7.61$, $v_y = 7.15$), and performs in both circumstances equally well.

**VII Dynamic Aperture Studies**

Work has started to determine the dynamic aperture of the machine in Storage Mode. Preliminary results indicate that no extravagant demands regarding the allowable harmonic contents of quadrupoles and sextupoles are necessary to ensure a stable $10\sigma$ area. However, more effort in this area is necessary. Gathering some 'statistics' in this area is a slow process due to the huge amounts of CPU time needed for the tracking.

** VIII Injection / Extraction**

The extracted beam from the PS is directed towards the e$^-$ end station; here two vertically oriented magnetic spectrometers momentum analyse both the scattered electron and some other knocked-out charged particle. The beam handling system (BHS) and the electron spectrometer form a dispersion matching system. Before impinging onto the target the electron beam is rotated over 90°; the horizontal plane, therefore, is the 'resolution' plane, i.e. the maximum resolving power $R$ of the BHS-spectrometer combination is given by (the

\begin{thebibliography}{9}
\bibitem{orbit_correction} Orbit correction scheme for the new ring, Y.Y. Wu, 88-07-05
\bibitem{DIMAD} R.V. Servranckx et al., SLAC Report 285, May 1985
\bibitem{MAD} F.C. Iselin and James Niederer, MAD Version 6, CERN/LEP-TH/87-33. April 1987
\end{thebibliography}
BHS possesses point-to-point imaging in the resolution plane) \( R = \frac{D_0}{2x_0} \) (\( x_0 \) is the monochromatic spot size at the source location, \( D_0 \) is the dispersion at the target location).

In case extraction from the PS takes place in the horizontal plane, the values of \( x_0 \) and \( \theta_0 \) depend on how well the resonant extraction process is controlled. The corresponding values in the other plane, \( y_0 \) and \( \phi_0 \), will be determined mainly from the injection procedure: a mismatch between the Twiss parameters \((\alpha,\beta)_{inj}\) and \((\alpha,\beta)_{PS}\) will result in emittance growth in the \( y-\phi \) plane. It seems that controlling these injection parameters is still easier than controlling the resonant extraction process. We therefore tried to set up the machine such, that extraction would occur in the \( y-\phi \) plane. This implies rotation of the extraction sextupoles over 30°. Apparently this results in a strong \( x-y \) coupling induced by these sextupoles; the result is a strongly deformed extraction triangle. This idea, therefore, had to be abandoned: extraction will take place in the \( x-\theta \) plane.

The C.O. will be vertically displaced during injection by two fast kickers; the location of these kickers is indicated in Fig. 5.

**IX beam handling system**

The beam handling system has been redesigned to accommodate beams of 850 MeV [6]. The main features of the existing, 500 MeV, design have been retained. Only the position of the final focussing triplet has been shifted to a location downstream of the optical rotator. This implies that tuning the system is only possible with a switched-on rotator (which was already the operating practice anyway).

Closed orbit bump at injection area

$k_1 = 2.0 \text{mr.}, \ k_2 = 2.05 \text{mr.}, \ x(k_1) = 1.0 \text{m after qm1}, \ x(k_2) = 1.686 \text{m after qm2}.$