3.2.4 Vacuum

To minimize the eddy currents induced on the surface of the vacuum chamber one needs a material with low conductivity. The primary choice is a thin stainless steel chamber, and a solution like the one adopted for the Bonn and ESRF synchrotrons -a 0.3mm thin pipe supported by ribs- looks very attractive. However one disadvantage of the large booster circumference is the corresponding required length of the vacuum pipe and the costs for such a chamber type would be prohibitive. To keep the costs within reasonable limits we need thus a simpler solution.

A round vacuum pipe with a diameter of 20mm was considered first. Lattice calculations showed the need for a larger horizontal aperture in order to have a reasonable energy acceptance of about $\pm 2\%$. The choice is now an elliptical beam pipe with inner dimensions of $30 \cdot 20$ mm^2 (see Figure f324_a). To make this pipe stable against the barometric pressure, without the use of ribs, we need a thickness d of about 0.7 mm. Eddy currents from the magnet ramping induce a time dependent sextupole component which is proportional to this pipe thickness d. The compensation of this effect with sextupole magnets is quite straightforward for our choice of 3Hz for the repetition rate.

We plan to install about 100 small pumps with an effective speed of about 10 l/s each. They will be positioned at the exit of the booster dipoles (see Figure f324_b).

The pressure in the vacuum chamber will be given by two contributions to the gas load: “thermally induced gas desorption” and “photon stimulated desorption” (PSD), a dynamical part, which is proportional to the beam current. We expect e.g. for CO molecules an initial desorption coefficient of about $2.5 \; 10^{-4}$ molecules/photon. Figure f324_c shows the dynamic pressure profile along the circumference under this assumption. This desorption coefficient can be improved with beam conditioning and starts to get substantially lower after a current integral of about 100mAh.

At zero beam current the average base pressure from thermal out gassing will be about 7nTorr.The heat load on the vacuum pipe by the synchrotron radiation will not be a problem, since with a current limit of about 10mA the average radiated power will be in the order of 1W/m. The heat load from eddy currents on the stainless steel surface will be even lower.

In a storage ring mode the energy of the booster will be limited to abaout 1.6 GeV, due to the cooling of the magnets.

References:

A novel low emittance lattice for high brilliance electron beams
W.D. Klotz, G. Mülhaupt, Another Lattice Model for High Brightness Synchrotron Radiation Sources ESRF-LAT-88-07, 1988

Figures:

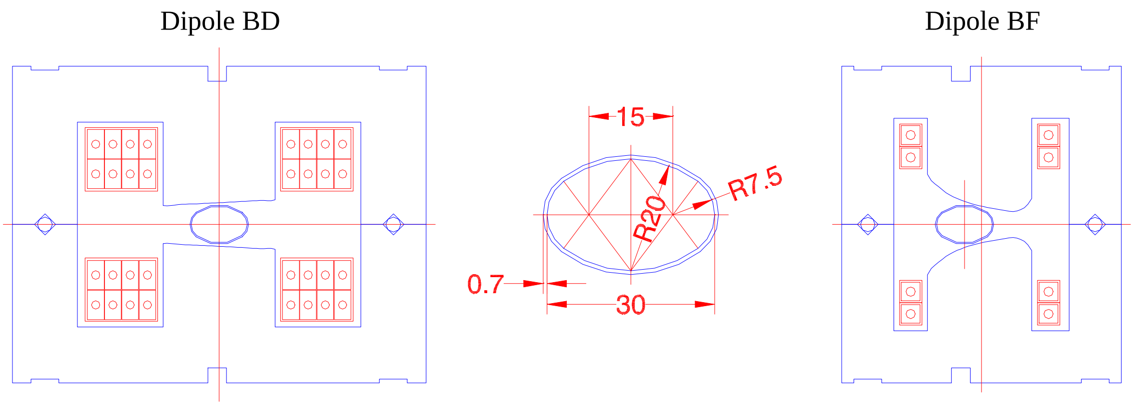

Figure f324_a: Cross section of the beam pipe with the dipoles BD and BF.

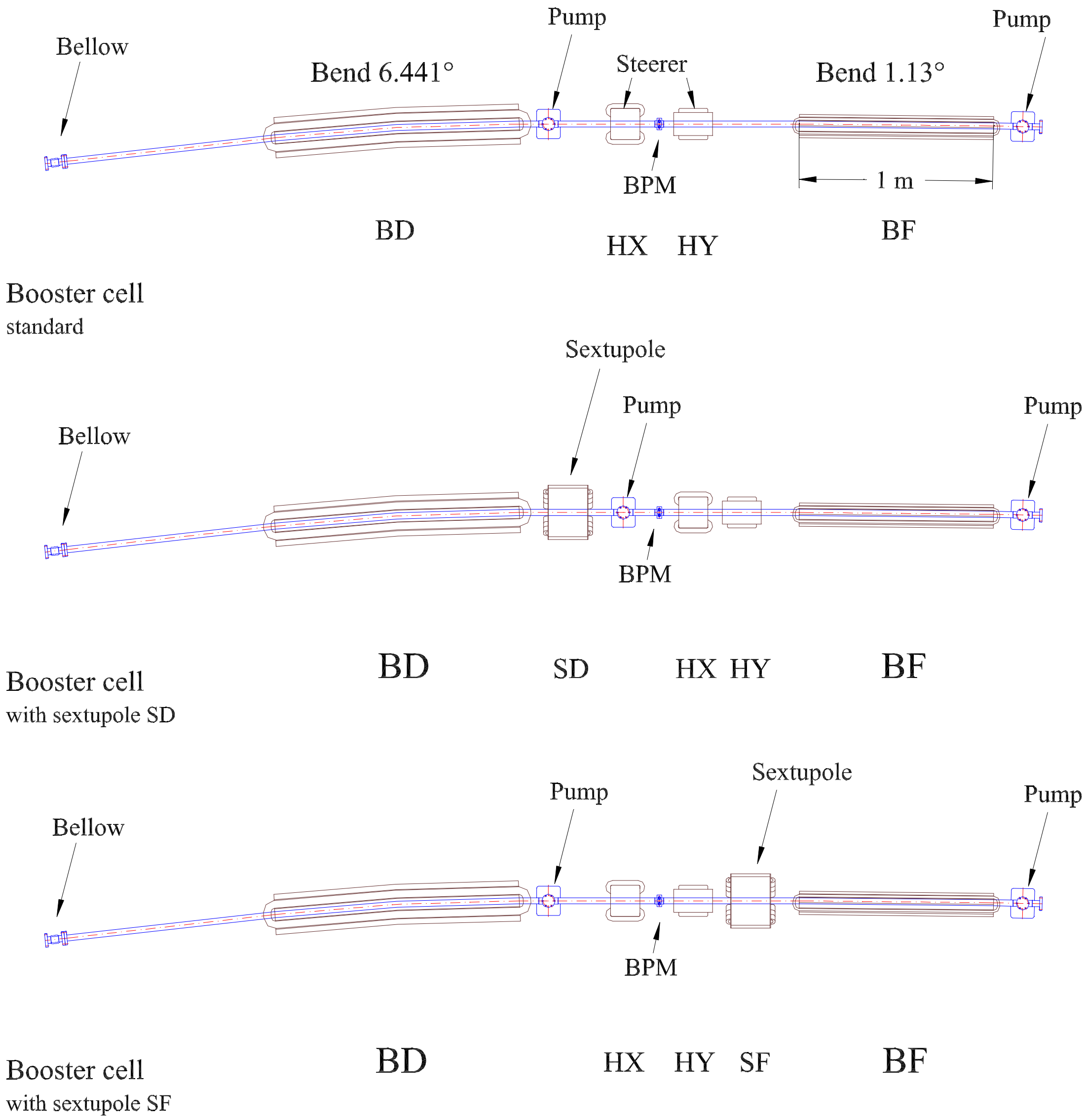

Figure f324_b: Top view of the FODO cells in the booster with the dipoles BD and BF. After each dipole a small pump is installed.

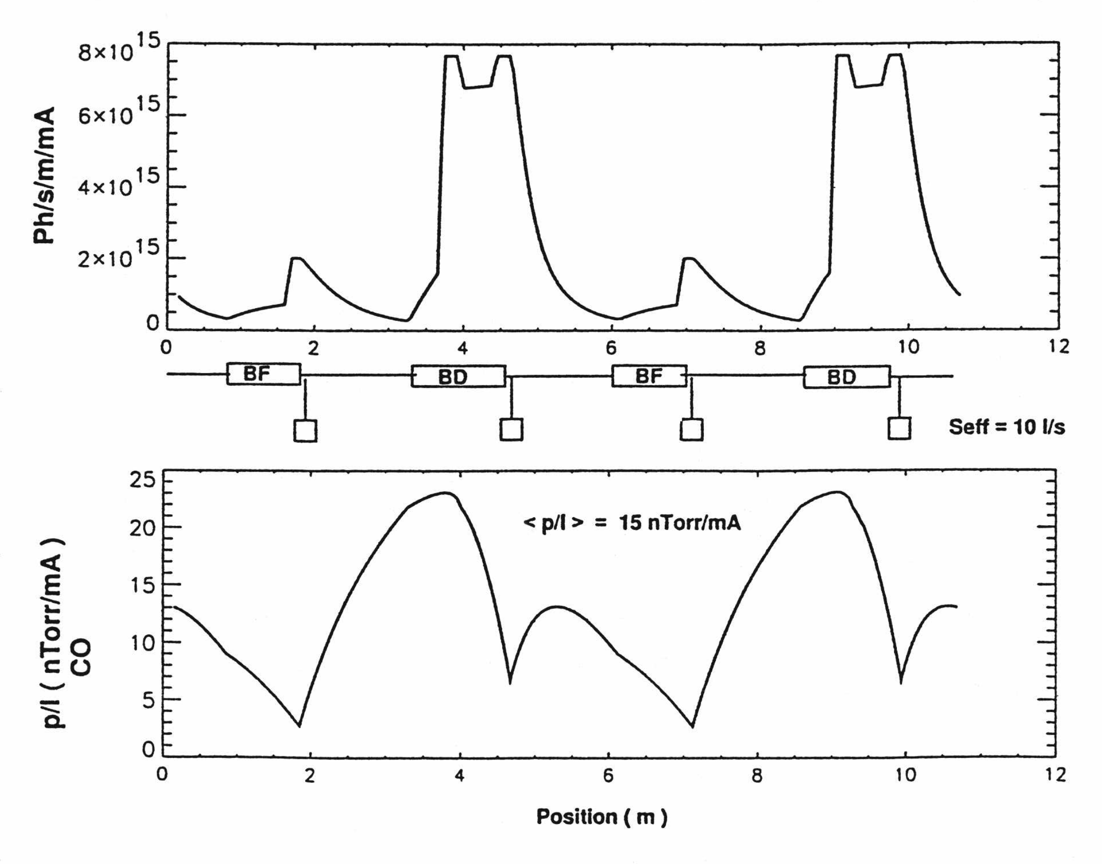

Figure f324_c: Dynamic pressure profile in the booster. The top part of the figure shows the number of photons per meter and mA hitting the vacuum pipe. The lower part shows the corresponding initial pressure per mA. The elliptical vacuum pipe has inner dimensions of 30*20mm and is pumped through small units with effective pumping speeds of 10 l/s.