applicable to alkali ions, which can be surface ionized on the foils by heating. In the meantime different methods to inject the high energy ions into the collection trap have been developed [36] and the method can be extended to a broader variety of ion species.

A crucial consideration for the dynamics of trapping is the combination of ion velocity and bunch duration. To fit a bunch of particles inside a trap of axial extension L the temporal spread needs to be less than $\Delta T \leq 2\ L/v_0$ . For the ISOLTRAP system the 30 μsec pulse length of the bunch extracted from the collection trap and the 10 eV energy spread in the bunch translate to a minimum axial dimension for the trap of 1.1 cm, which is a quite normal dimension for standard, hyperbolic, Penning traps. But in most other cases, a standard ion trap will not suit itself to fulfilling the above condition. An important step forward in this area was therefore provided by the introduction of cylindrical open-ended Penning traps by G. Gabrielse's group [37]. This allowed to build a trap with an arbitrary large ratio of axial to radial dimension, which was, at least in the central region, highly harmonic.

### 5.1.2. Trapping of Antiprotons from LEAR

It was this possibility which allowed the capture of antiprotons from the Low Energy Antiproton Ring (LEAR) at CERN. Antiprotons are circulating in this ring (which is actually a square with a 70 m circumference) at energies between 1.3 GeV and 5.9 MeV. For the trapping experiments only the lowest energy is of interest, especially since energy loss in a solid target (a foil) is used to bridge the enormous gap between the LEAR output energy and the trapping potential. LEAR can deliver both a slow, continuous spill, lasting approximately 1 hour with $10^6$ antiprotons/sec intensity, and a fast spill, where a fraction or all of the LEAR content is extracted in a single bunch. For a typical bunch length of 200 ns and a desired maximum energy of 30 keV a length of the trap of 50 cm is required, allowing for some jitter and rise time in the voltage switching, if one wants to capture all the antiprotons in the energy bin of 0 - 30 keV. Smaller traps at lower potentials can be used, if the maximum number is not of critical concern to the experiment, and the successful work in trapping and cooling several tens of thousand antiprotons by the PS196 collaboration [38] is exemplifying this. For experiment PS200 [39] as well as for many possible applications of ultra-low energy antiprotons for nuclear and atomic physics measurements [40] it is paramount to capture as many antiprotons as possible in a trap, and following the above course of arguments a trap of a total length of 50 cm was constructed. The trap structure consists of 7 electrodes: the entrance foil, a central region comprised of five cylinders (