The suggestion is to bias the magnetic field to increase the gradient and cut down on the beam spread. The magnet is planned to have ~ 1 cm aperture and may be incorporated into some other magnet body. There will be some bend involved but less than a degree (probably a few mrad). This magnet may also be used to degrade beam emittance but this has to be studied further.

F. Direct Extraction H^- Sources, P. W. Allison, LASL

These sources were developed in Novosibirsk and currently Fermilab is using one (a magnetron type) operationally with a 0.1% duty factor. A 4-mA average current source with 120-mA peak pulses should exceed the LAMPF requirements. With cooling this type of source should work.

The brightness of the direct extraction source is 1-2 orders of magnitude higher than for proton sources. Also,

$$B_{norm} = \frac{2i}{\pi^2(\varepsilon_{x,norm}\varepsilon_{y,norm})} = \frac{50A}{(cm\cdot mrad)^2}$$

for my source at the 50% contour level.

The advantages of a direct extraction source are:

- only negative ions are extracted
- gas can be pulsed so gas load is moderate
- the magnetron or Penning source is preferred over the duplasmatron because no electrons come out.

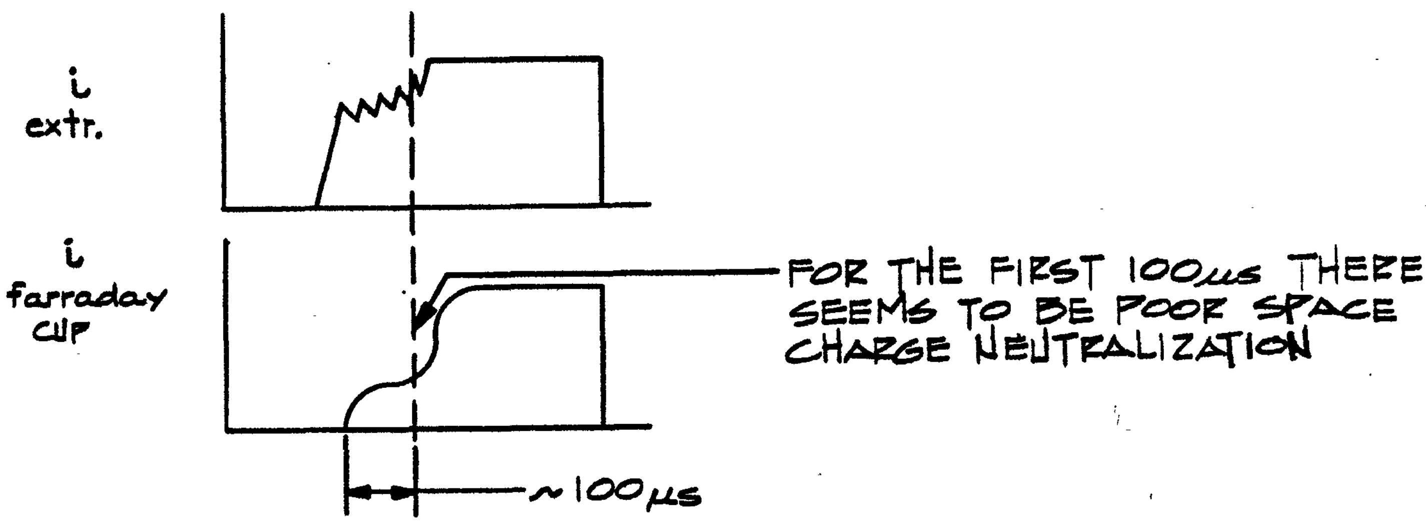
The disadvantages of a direct extraction source are:

- gas economy low, ~ 1%
- uses cesium, but consumption is low
- has never run 120 Hz, 40 mA, 500 μs
- long repair time (~ one day including conditioning)
- LAMPF source has about one month lifetime.

The lifetime is limited by erosion of materials. Insulators have to be good for about 20 kV. We are currently working on a 100-mA CW source with a spinning electrode (for cooling).

We have used both the cesium dichromate mixture and the cesium boiler but the mixture is simpler to handle. The ultimate choice is determined by which puts out a better supply of cesium, and so far the chromatic mixture seems the best. It has run all day here and for many days at Fermilab. There seems to be some conditioning time (~ one day) after being charged.

No attempts have yet been made to see how fast these sources can be pulsed. Nothing less than a few μs has been tried. It often takes about 200 μs for the discharge to become stable. This is possibly due to the time it takes for build up of cesium around the cathode. On turn off there is a burst of cesium out of the source from what has been trapped on the cathode.



Some test results here:

$$\varepsilon_{x,norm} = 0.05\,\pi\cdot cm\cdot mrad$$

$$\varepsilon_{y,norm} = 0.008\,\pi\cdot cm\cdot mrad$$

Lifetime (est) ~ 28-mA days

120 mA/ms pulse length @ 12.5 Hz
@ 40 mA current @ 30 Hz, 500 μs.