Zeitschrift: Helvetica Physica Acta
Band: 59 (1986)
Heft: 4

Artikel: Emittance quotations, a recommendation
Autor: Clausnitzer, G.
DOI: https://doi.org/10.5169/seals-115738

Helvetica Physica Acta
Vol. 59, 1986 696-697

018-0238/86/040696-02$1.50+0.20/0

EMITTANCE QUOTATIONS, A RECOMMENDATION

G. Clausnitzer

Strahlenzentrum, University of Giessen, D-6300 Giessen, FRG

Basics

Ions ermerging from a source are usually considered to form a conservative system; hence the volume occupied by this beam in the sixdimensional phase space (given by the momentum $\underline{p}$ and the position vector $\underline{r}$ of each particle) is a constant of motion (Liousville's theorem). For practical purposes this quantity is reduced to 4 dimensions by omitting the z-components (beam direction) and furthermore to 2 dimensions by assuming an axial symmetry. This components $p_r \cdot r$ are distributed such, that a fixed percentage of the beam is usually located within a elliptical area ε called the emittance

$$\varepsilon = \pi \cdot p_{r\,max} \cdot r_{max}$$

The radial momenta p_r (determined by the characteristics of the source) are measured by introducing the divergence of the beam $p_{r\,max} = \alpha_{max} \cdot p_z$ and the emittance quotation is given by

$$\varepsilon = \pi \cdot r_{max} \cdot \alpha_{max} \cdot p_z, \text{ nonrelativistically } p_z = m \cdot v_z = \sqrt{2q \cdot U \cdot m}$$

where p_z contains the properties of different ion-masses and -charges.

The practical units

Modern books on ion optics agree to the "normalized emittance" quotation

$$\varepsilon_n = \frac{1}{c} \cdot \varepsilon, \text{ relativistically } \varepsilon_n = \pi \cdot r_{max} \cdot \alpha_{max} \cdot \beta \cdot \gamma, \quad \beta = \frac{v}{c} \quad \gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

with the implicite understanding that $m = m_{proton} = 1$.

Others use the above nonrelativic relation, also with the -rarely mentioned- understanding, that the proton mass is unity. Emittance quotations can be compared only if all relevant information is given.

Recommendation

The Montana participants agreed to give the following two recommendations:

1. Quote ε_n with the beam fraction and a statement of ion-charge and -mass.
2. Use -if possible- a current measuring device sketched in Fig.1. r_{max} and α_{max} are determined from geometry. The measured current is certainly contained in $\varepsilon_n = \pi \cdot r_{max} \cdot \alpha_{max} \cdot \beta \cdot \gamma$. The beam fraction can easily be determined, if a sliding cup is used.

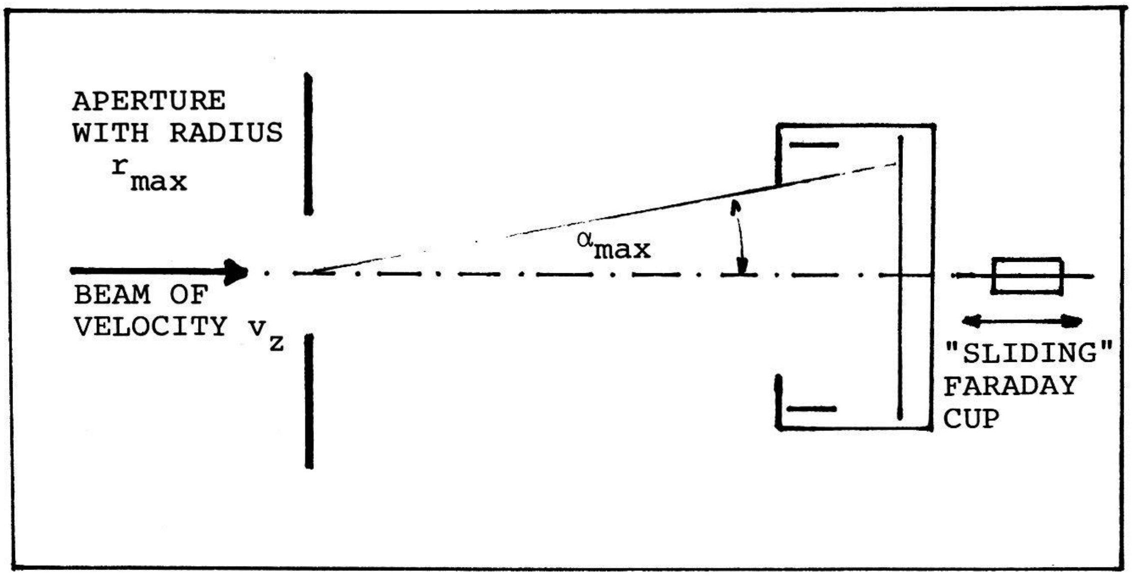

Fig.1 Current measuring device for emittance quotations.

Notice
We are aware, that this measuring apparatus does not accept "odd" phase space configurations. But since it defines an emittance, which resembles common accelerator acceptances rather well, we leave it to the experimenter, to match his beam as good as possible.