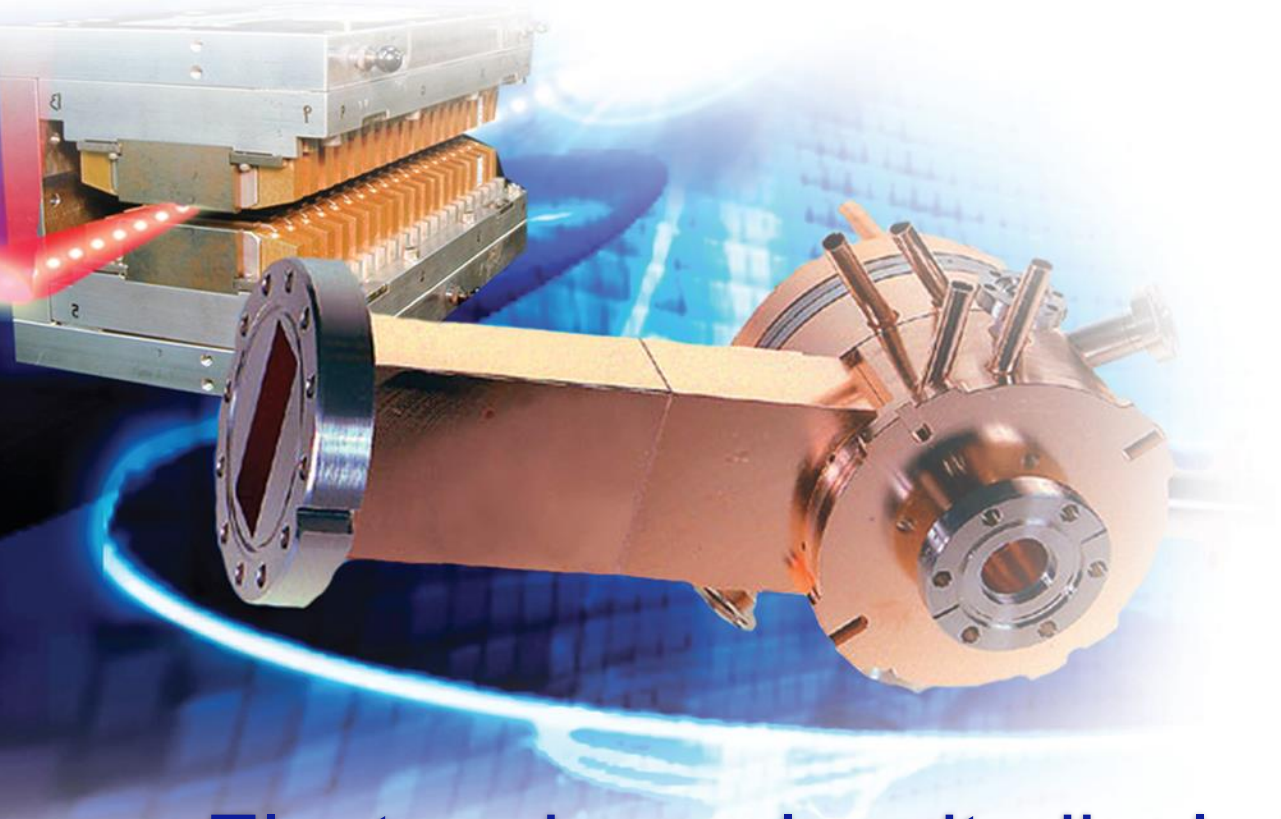


Electron beam longitudinal phase space restoration from the image after beam pass deflector cavity and spectrometer arm

by Mikhail Fedurin,
BNL ATF

BROOKHAVEN NATIONAL LABORATORY
a passion for discovery

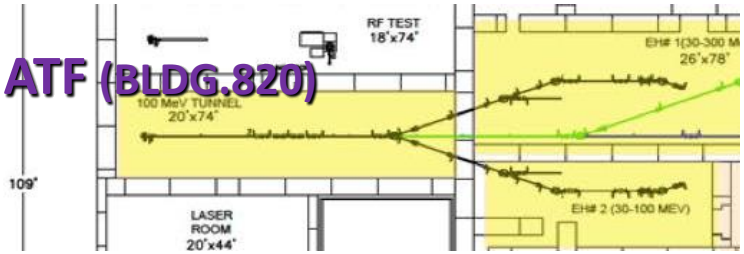
U.S. DEPARTMENT OF ENERGY | Office of Science

Main beam parameters

Parameter	Typical value / range	Best value
Energy	30-60 MeV	80 MeV
Charge	0.1 – 1 nC	3 nC
Repetition rate	1.5 Hz	10 Hz

Accelerator Test Facility

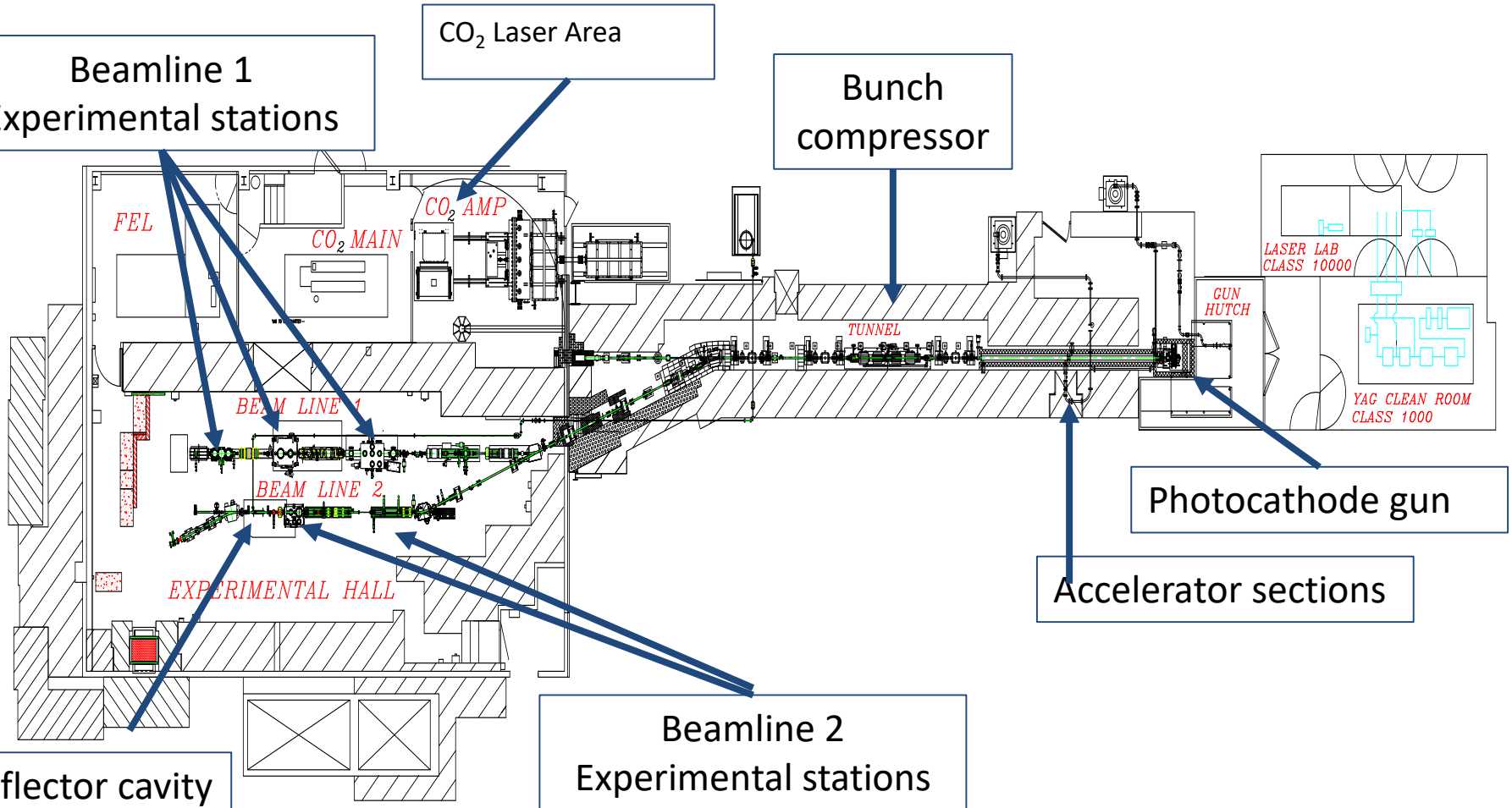
MAJOR FACILITY UPGRADE



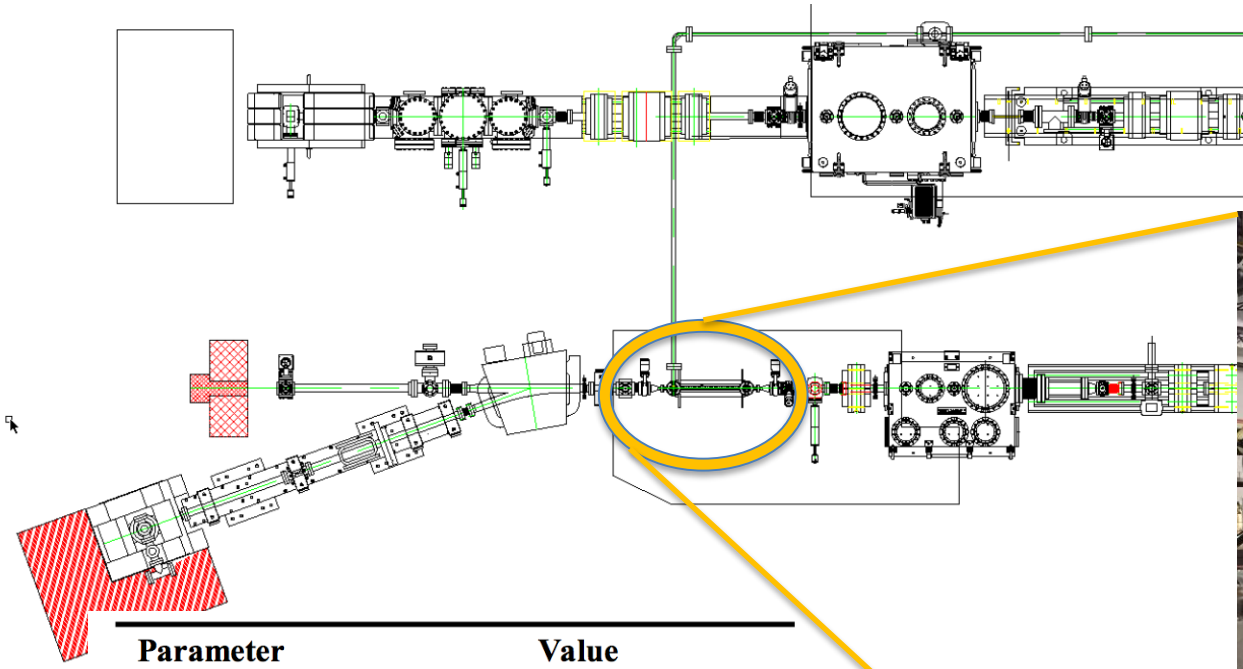
Exp. Halls:	Shielded area:	Total floor:
x5	x7	x3

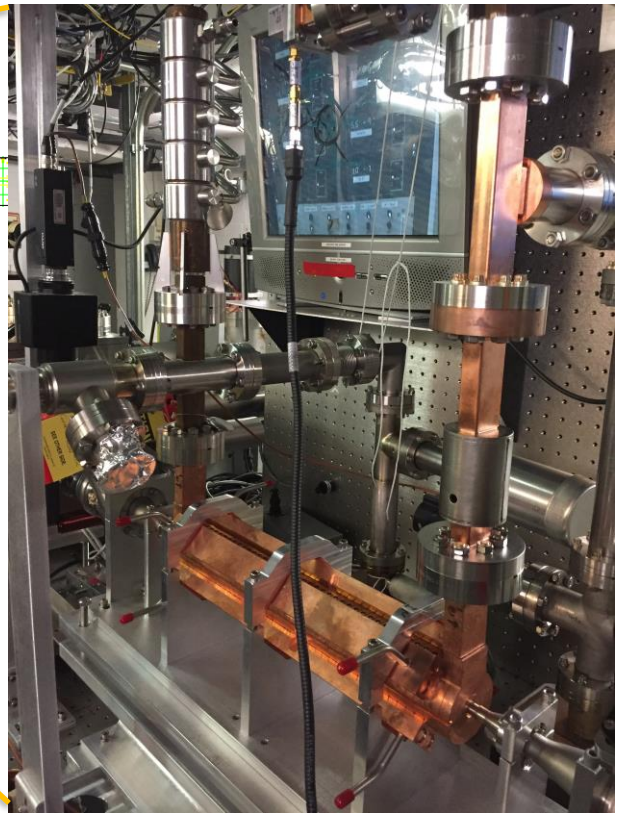
ATF II (BLDG.912)

Facility Overview



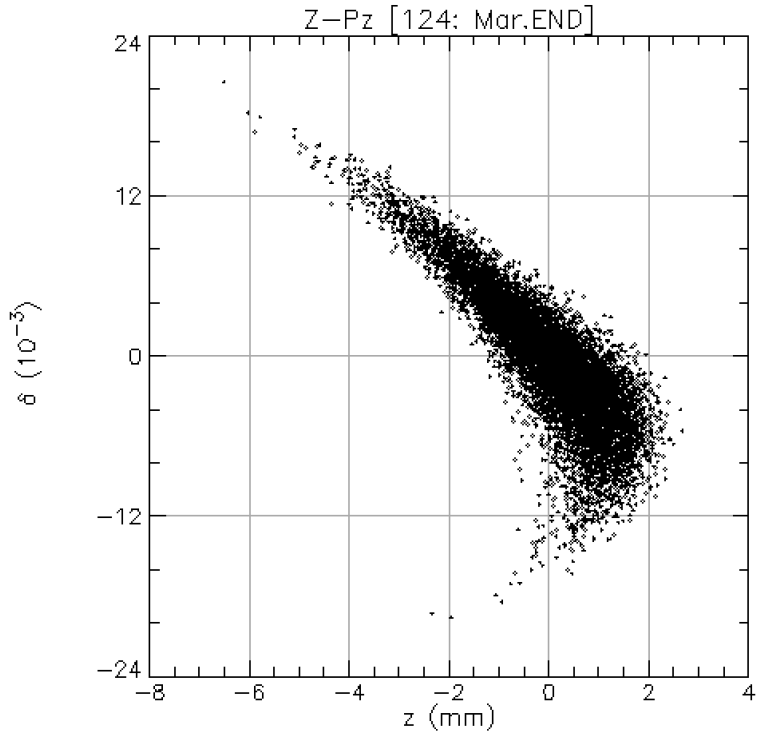
Deflector cavity at BL1

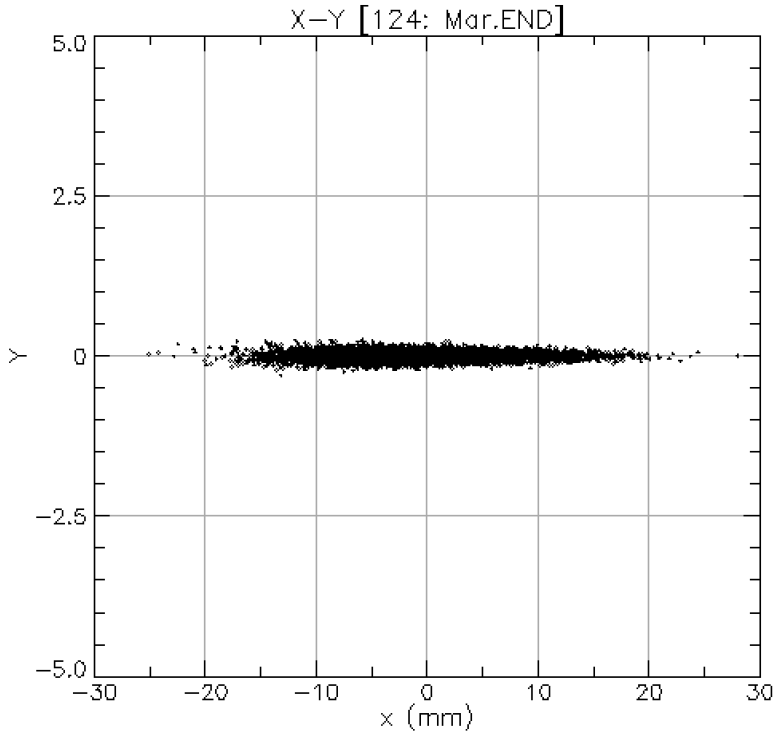




Parameter	Value
Field amplitude, $\sqrt{E/P^{1/2}}$	8.48 kV/mW$^{1/2}$
Group velocity, v_g	0.0267c
Attenuation factor, α	0.66 m^{-1}
Cavity length, L_T	0.46 m
Number of cells, N	53
Power ratio, P_{out}/P_{in}	0.55

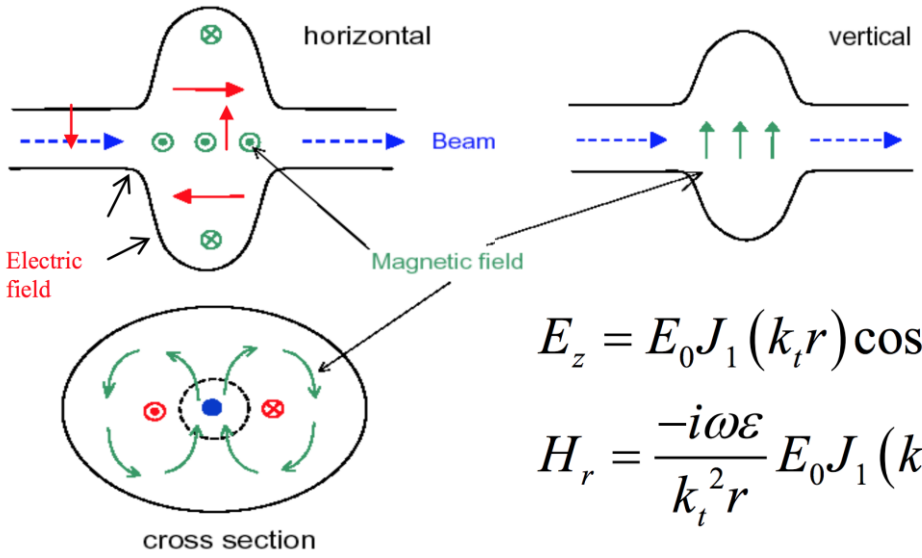
Beam phase space at spectrometer





D. Sagan, "Bmad: A Relativistic Charged Particle Simulation Library" NIMA, 558, pp 356-59 (2006)

Nature of image distortion



Electric field affect off axis particles – accelerate one and decelerate another side of the bunch

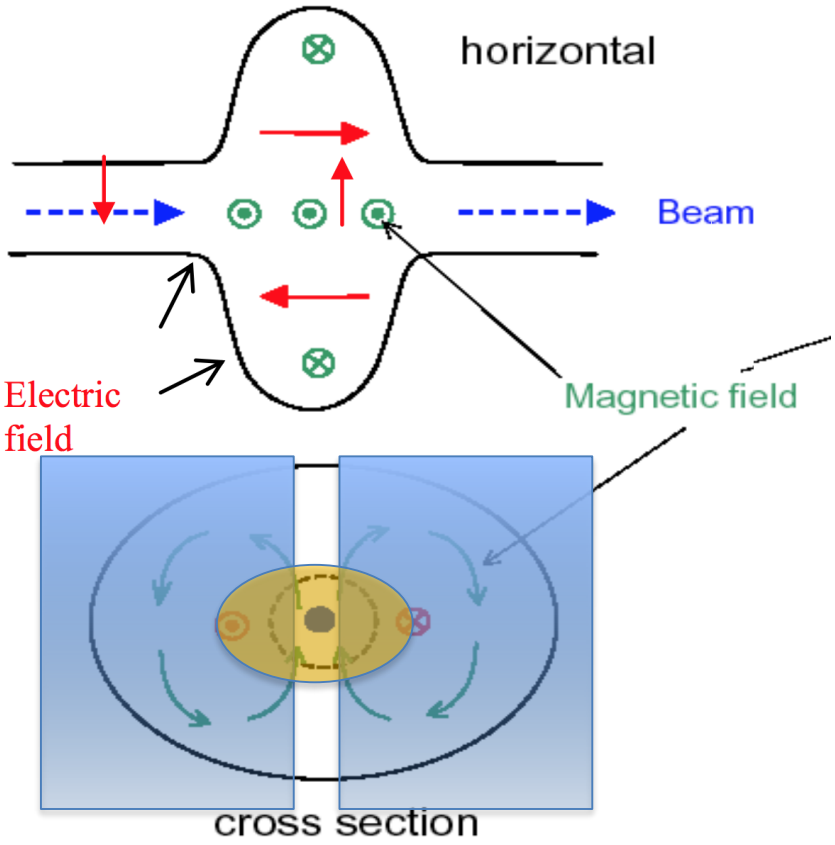
$$E_z = E_0 J_1(k_t r)\cos(\varphi),$$

$$H_r = \frac{-i\omega\varepsilon}{k_t^{\,2} r} E_0 J_1(k_t r)\sin(\varphi),$$

$$H_\varphi = \frac{-i\omega\varepsilon}{k_t} E_0 J_1'(k_t r)\cos(\varphi).$$

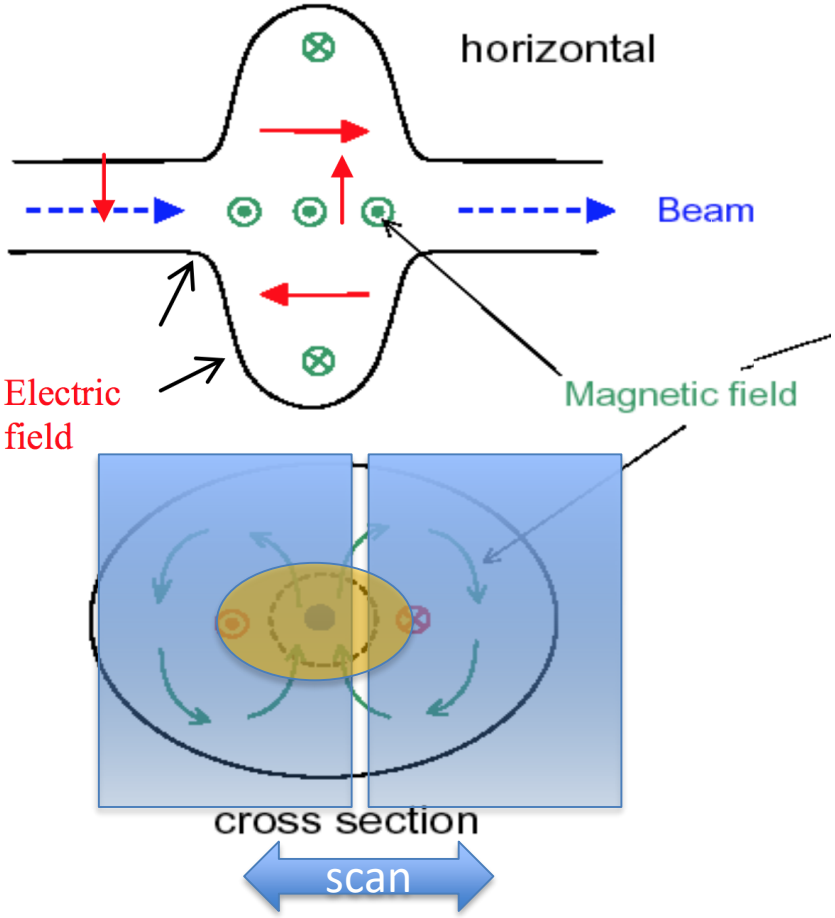
From “Transverse deflecting cavities” G.Burt, CAS 2010

Vertical slit method



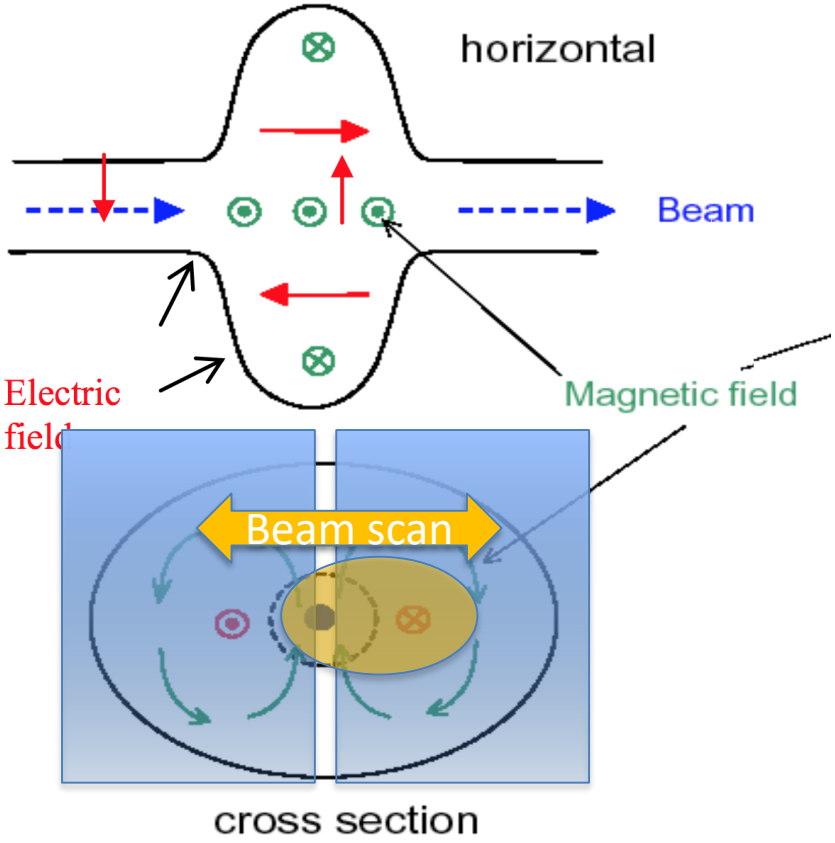
Beam sliced by slit collimator and then aligned with Deflector Cavity center should minimize beam distortion on spectrometer image

Vertical slit can be used for Deflector field parametrization



By scan of vertical slit position over the beam with postprocessing analysis of series of spectrometer images Deflector cavity field can be parameterized

..or vertical slit can be used for phase space beam tomography



On fixed slits position beam can be displaced horizontally to built phase space map for different beam crossections

Work plan

- Build and install vertical slit
- Made it possible for horizontal scan
- Map the field of Deflector cavity by slit scan
- Build “Spectrometer image vs Slit position” response matrix
- Apply response matrix on beam passed Deflector without slit collimator
- Model deflector field in tracking code, use it for future experiments

Thank you!