Jet Camera

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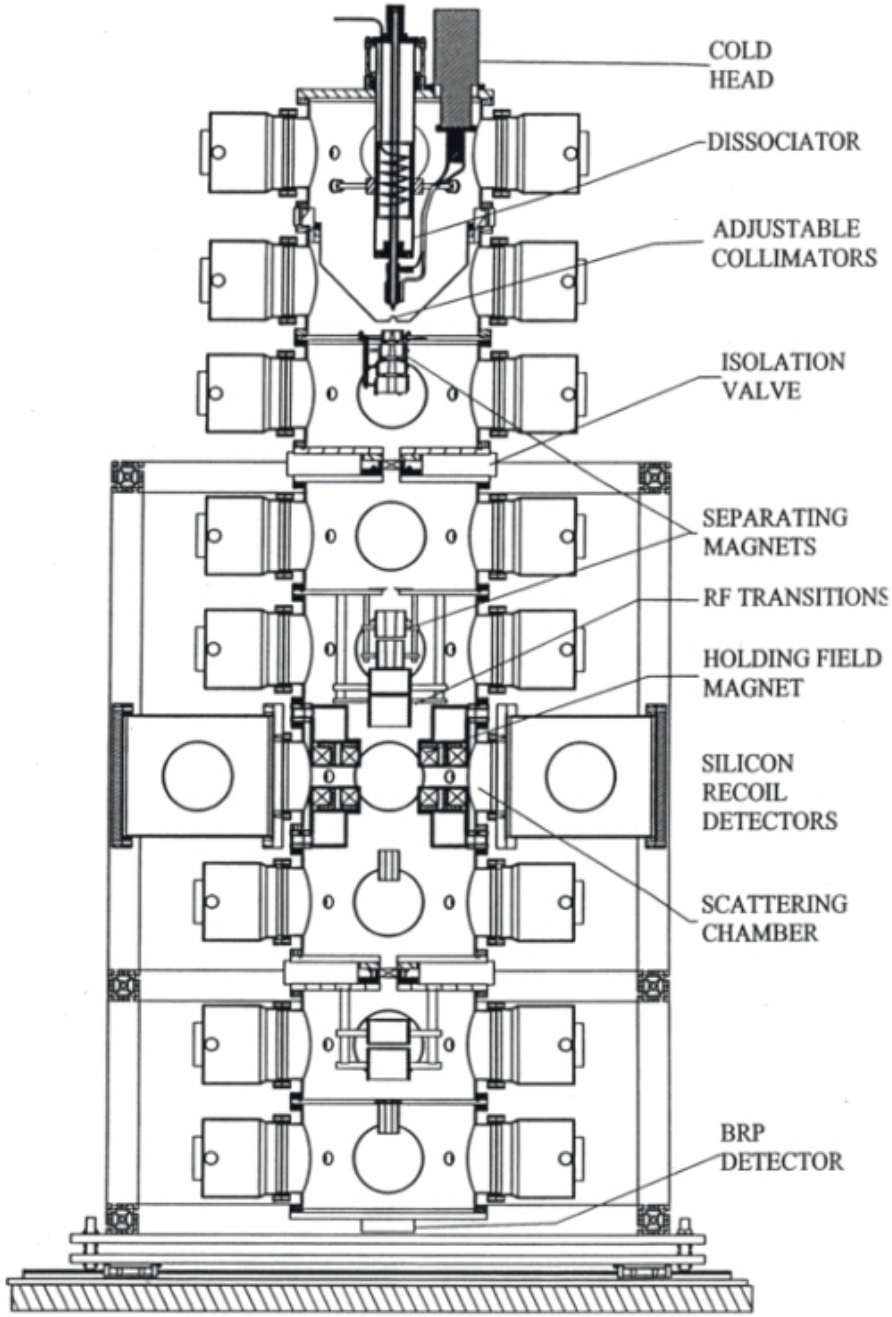
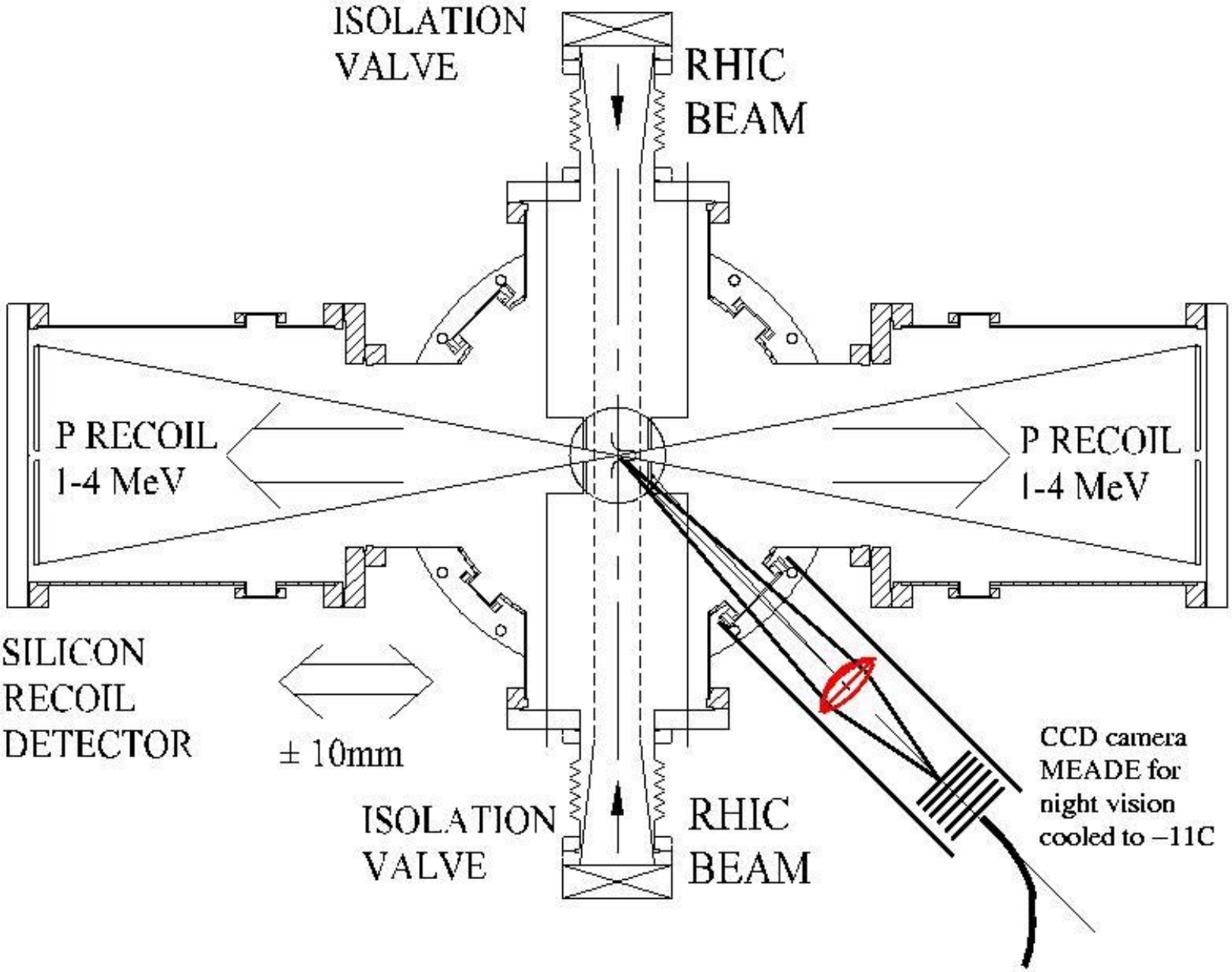
- **Purpose of the experiment:**
  - **Measurements of the optical signals not only from hydrogen but also from possible "impurities" within the jet, such as oxygen or water molecules. This would allow to parasitically and continuously monitor the composition of the jet by observing "impurities" signal strengths in real time to make corrections if needed.**
- **Experimental set up**
- **Results**
- **Previous proposal**
- **New proposal**

Experimental set up

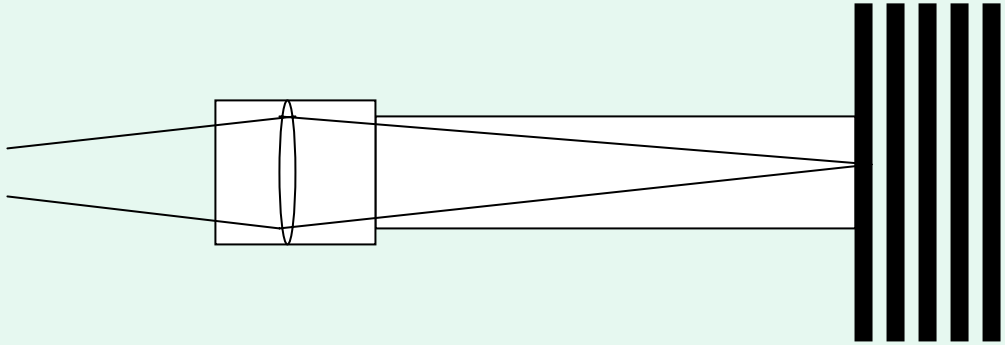
Atomic polarized Hydrogen Jet:

10^{12} atoms/cm^2




ISOLATION
VALVE
RHIC
BEAM
P RECOIL
1-4 MeV
P RECOIL
1-4 MeV
SILICON
RECOIL
DETECTOR
± 10mm
ISOLATION
VALVE
RHIC
BEAM
CCD camera
MEADE for
night vision
cooled to –11C

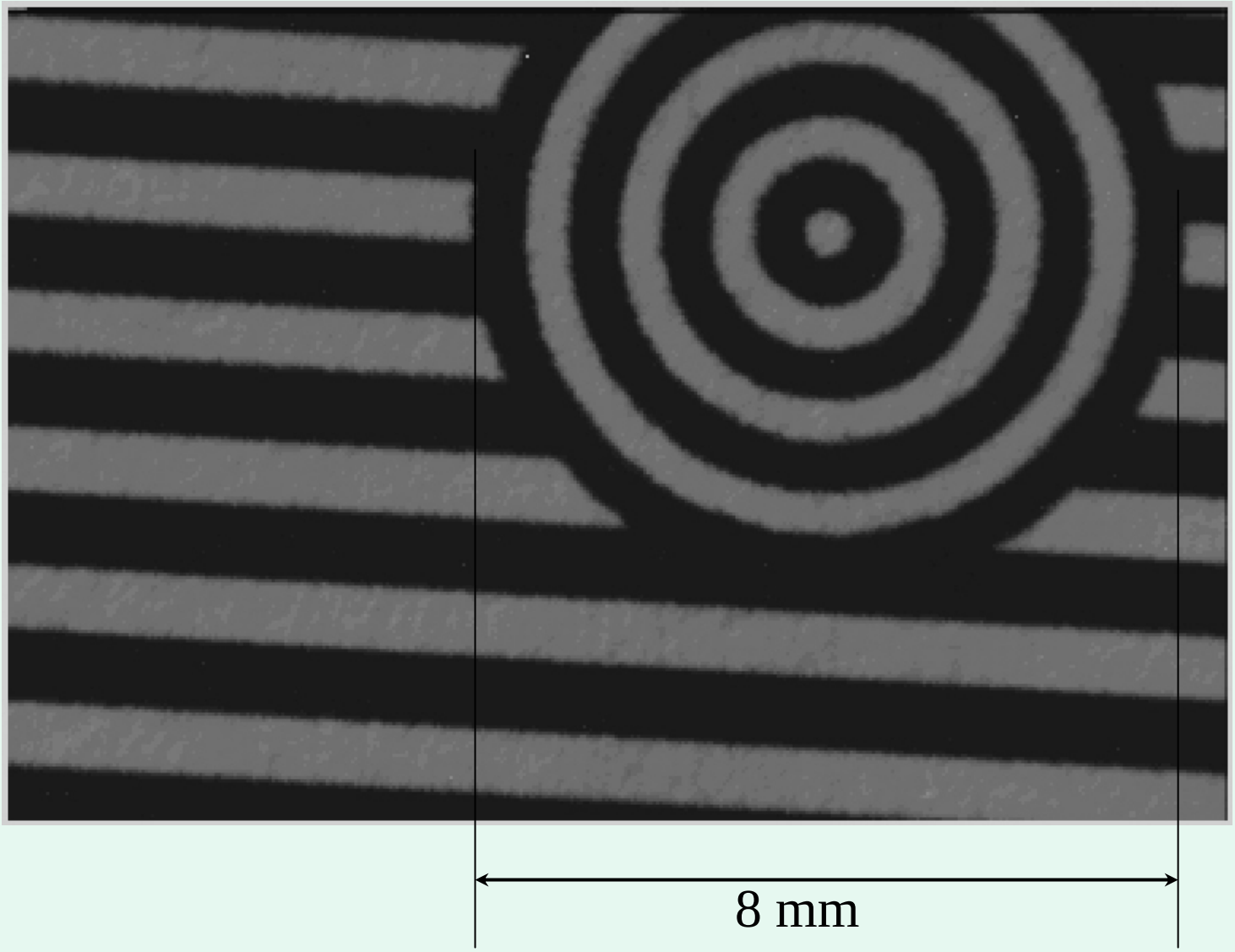
The camera:



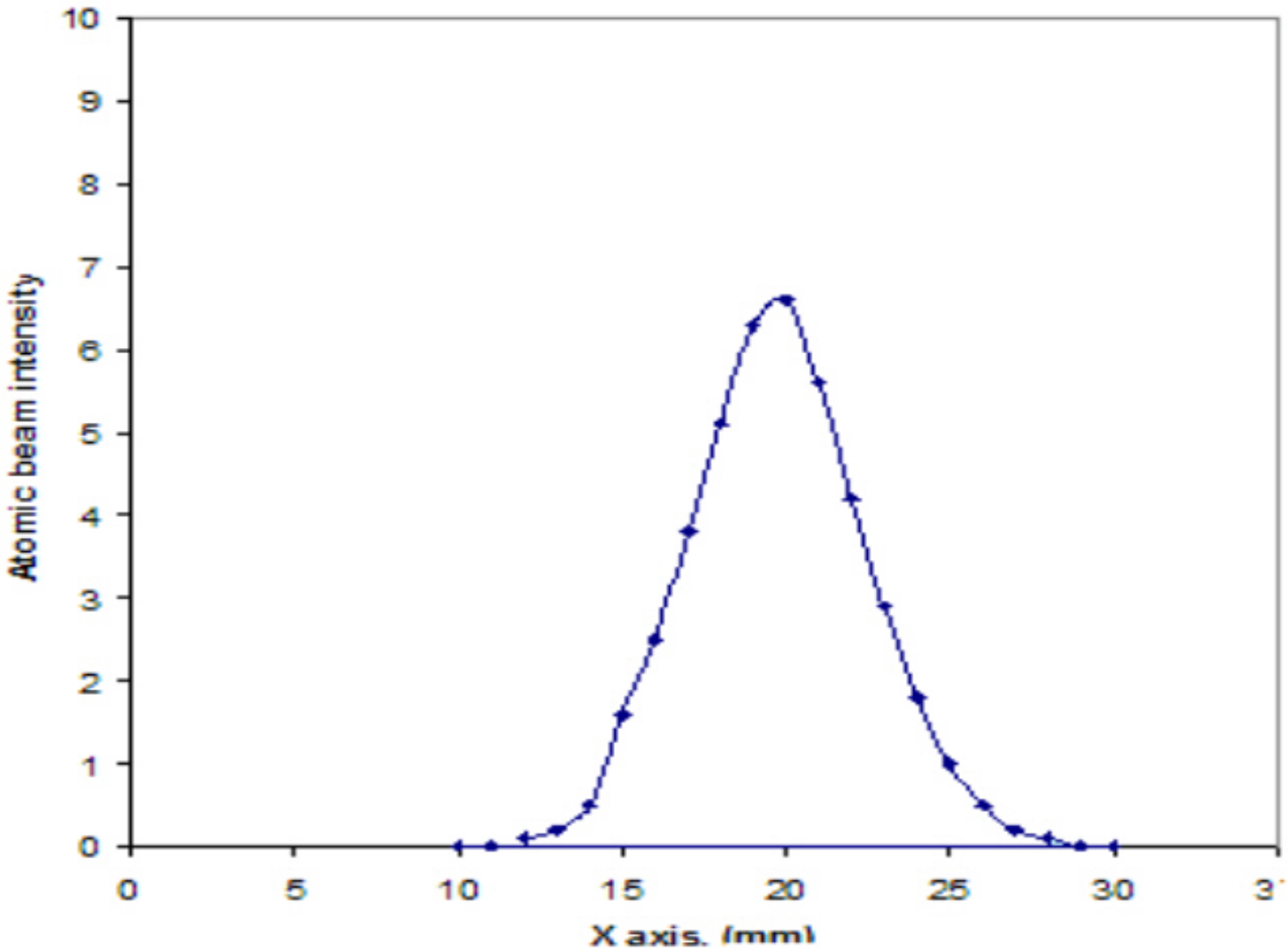
The first attempt in the experiment with a standard CCD camera was not successful. Replacing the camera by more sensitive one MEADE Pictor 416 – [borrowed from TANDEM with a program for the WINDOWS-98] resulted in very nice beam profiles, even with only a one-second-exposure time.

The camera is equipped with a thermoelectric cooling system that uses the Peltier Effect. The temperature of the CCD chip was usually around –12° C.

Camera positioning and ‘scaling’ measurements



Compression tube Measured JET PROFILE on the bench



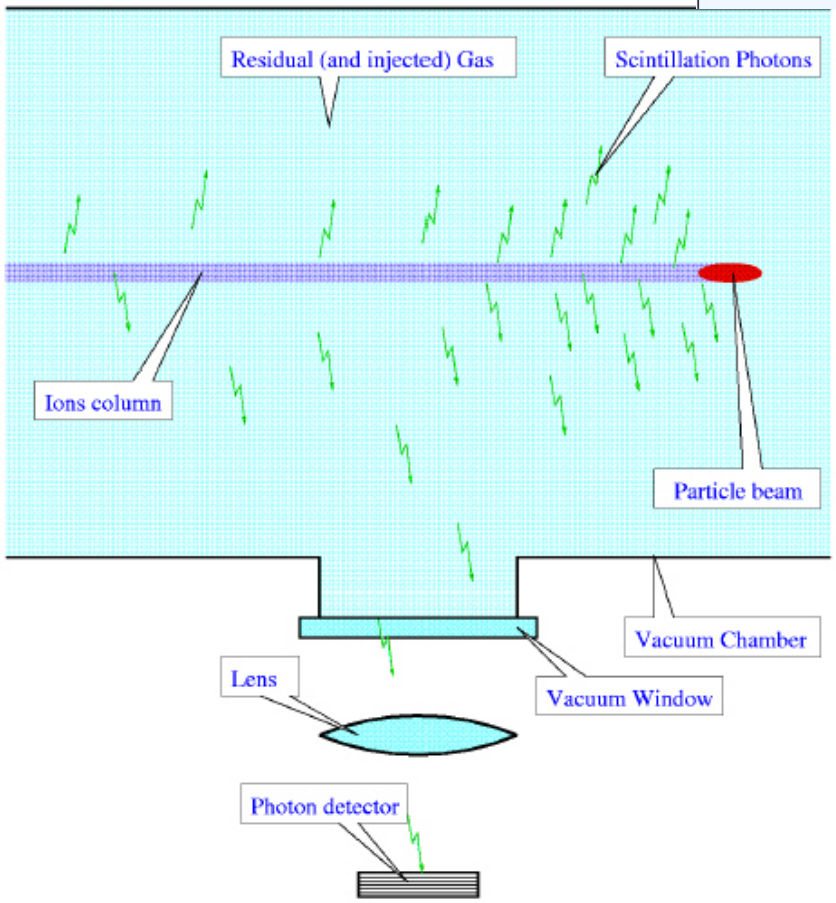
Bench measurements with the electron beam

- Grid monochrometer measurements

- CCD spectrum analyzer measurement
  - Calibration measurements with mercury lamp
  - Electron induced optical emission from the Hydrogen jet

- Photomultiplier set up with the narrow ‘Balmer’ line filters measurements
- Due to large background the signal was ‘hidden’.

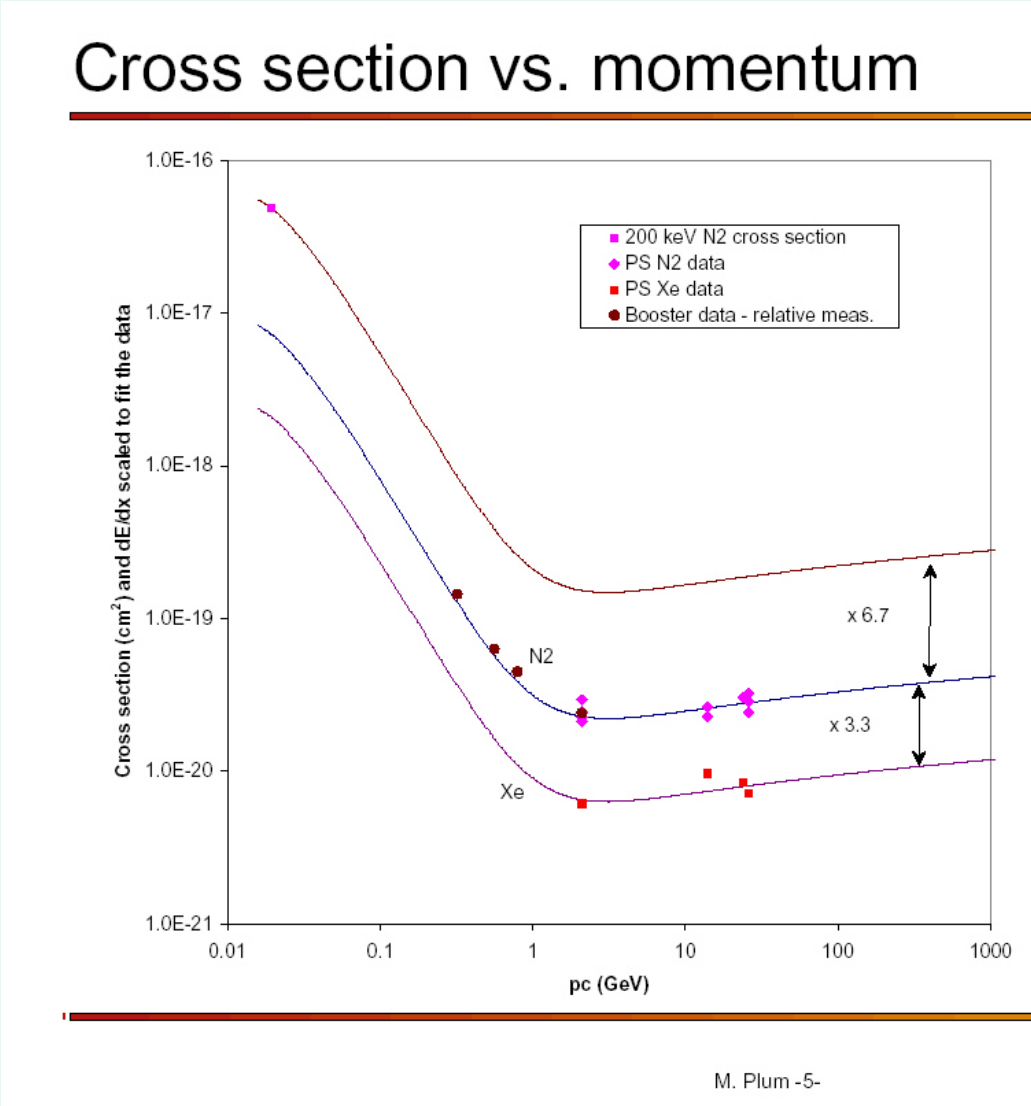
Gas Scintillation



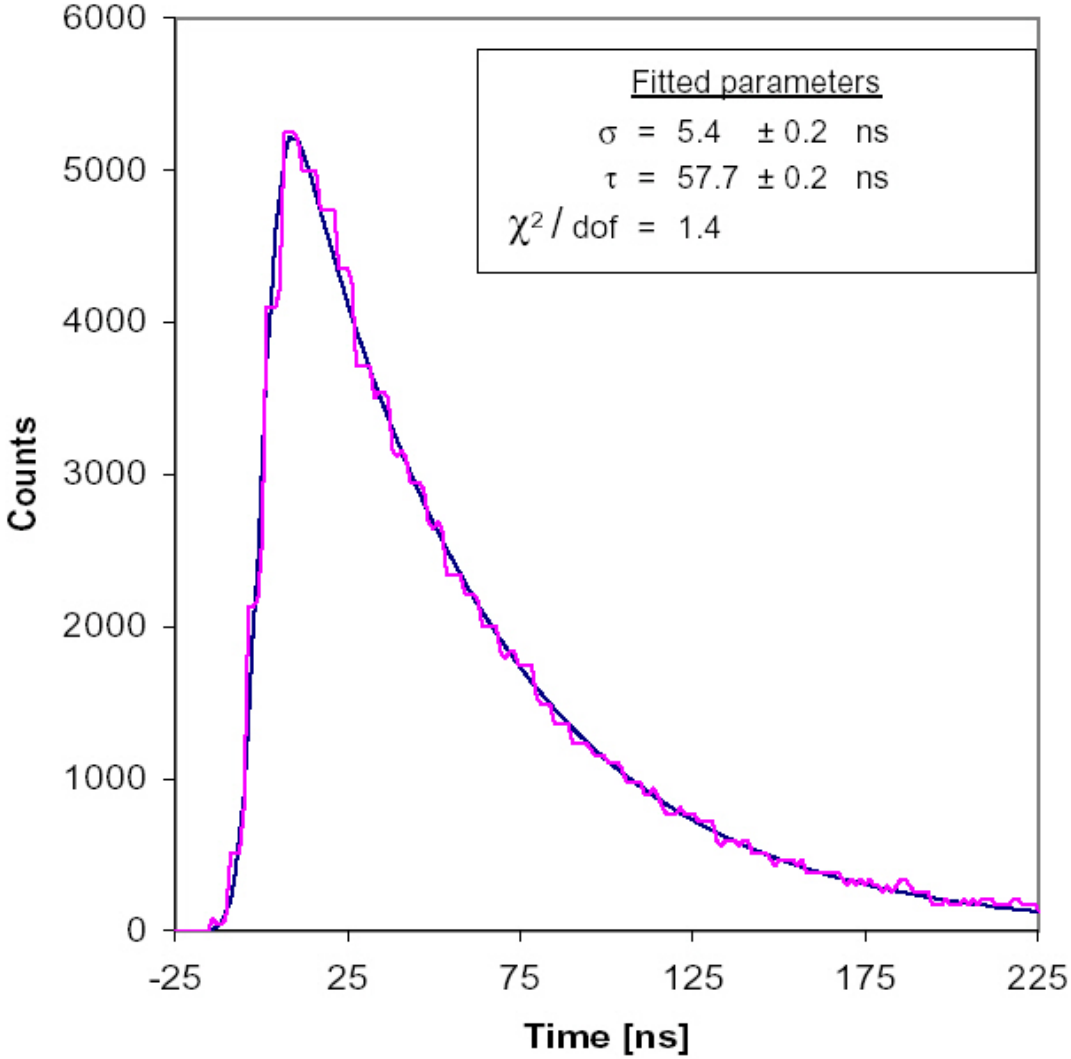
- Gas molecules in the beam pipe, from either residual or injected gas, interact with the passing particle beam.
- Electrons are promoted to excited states.
- When the electrons fall to lower energy orbitals, photons are emitted.
- Photons are collected to measure the profile.

The interaction of 100 GeV protons with the 'target' of hydrogen in the atomic produces hydrogen ions or atoms in excited states.

Cross section-Born approximation:



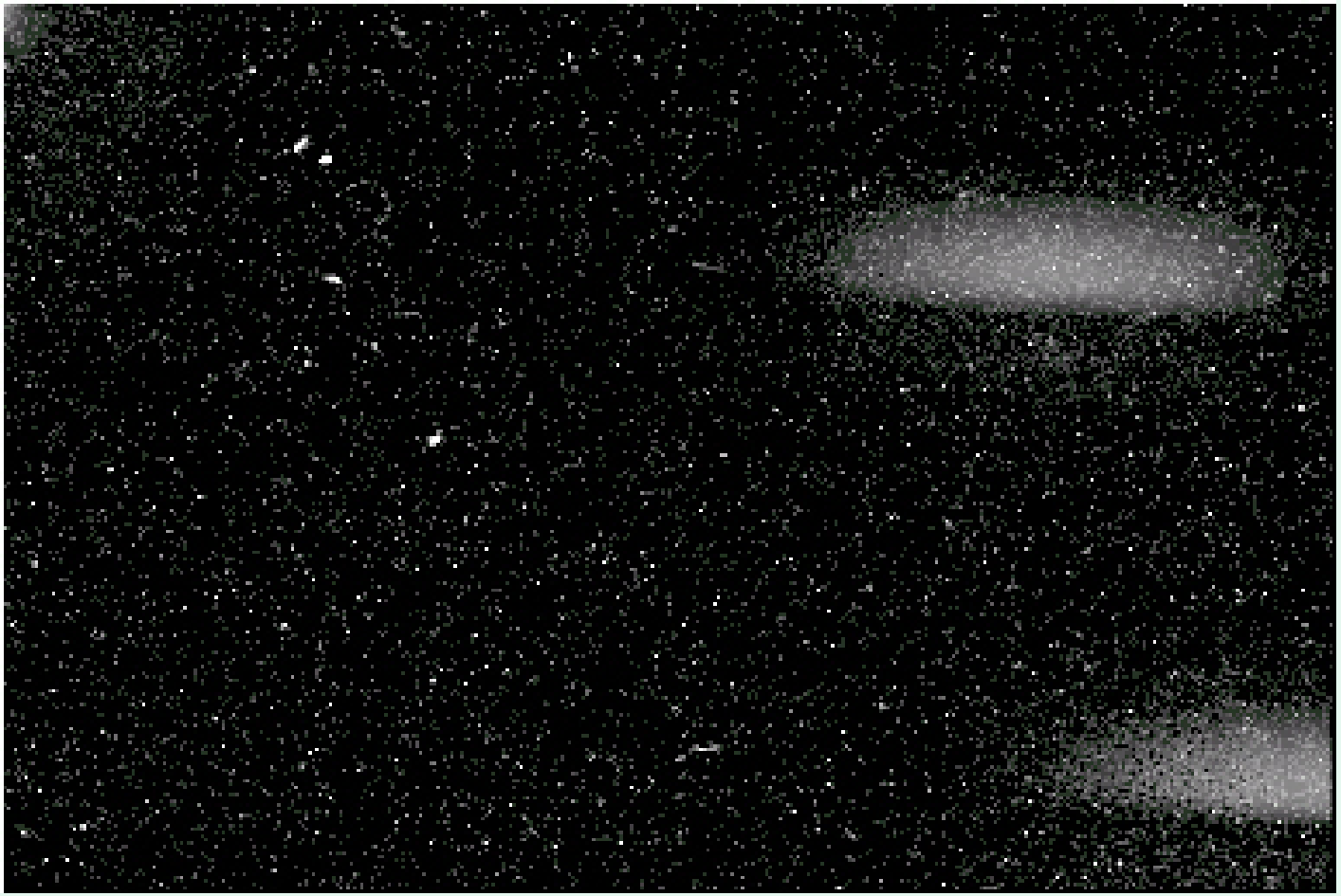
N_2 lifetime, no filter



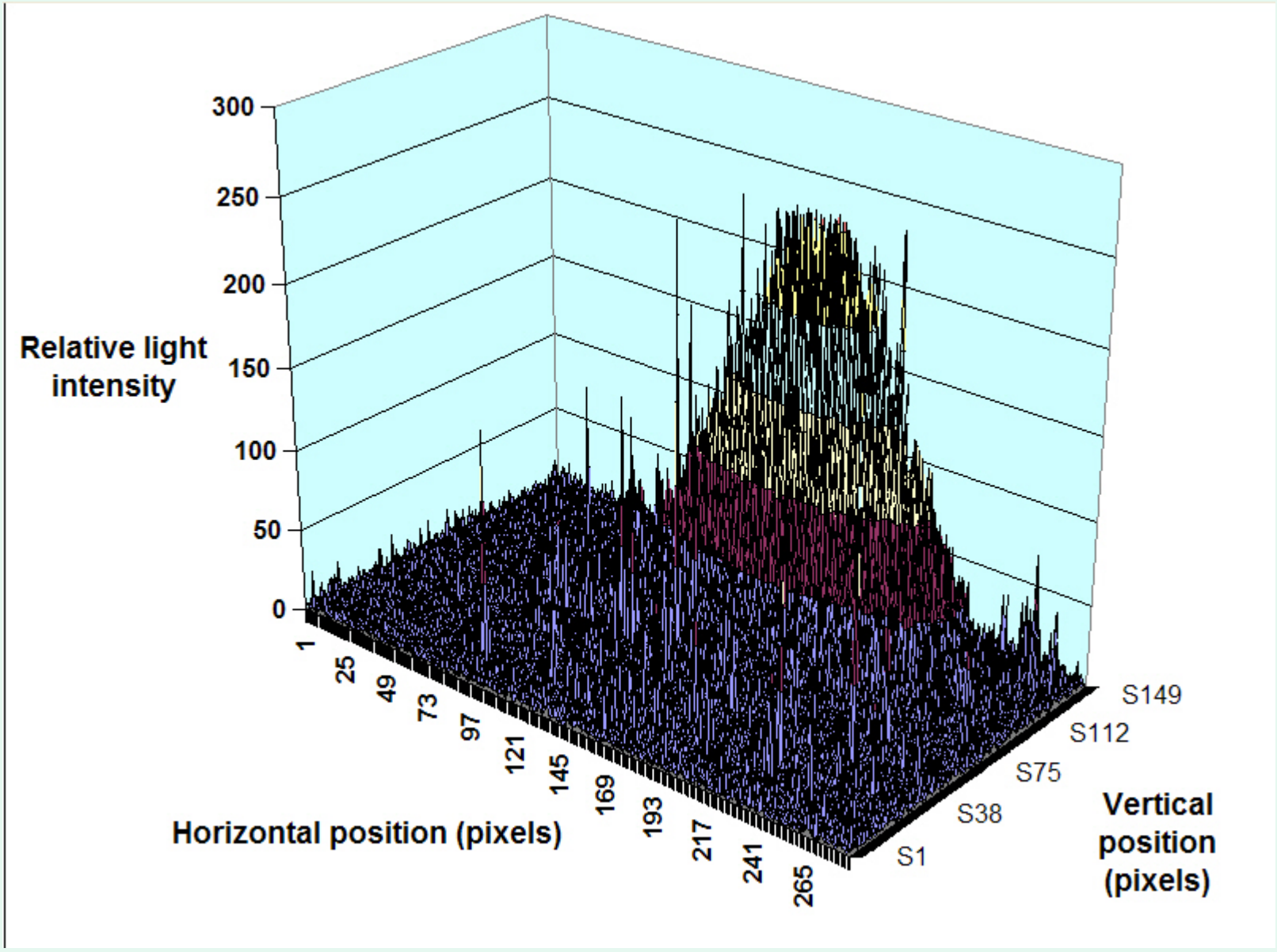
Gas pressure:
1.03×10^{-6} Torr

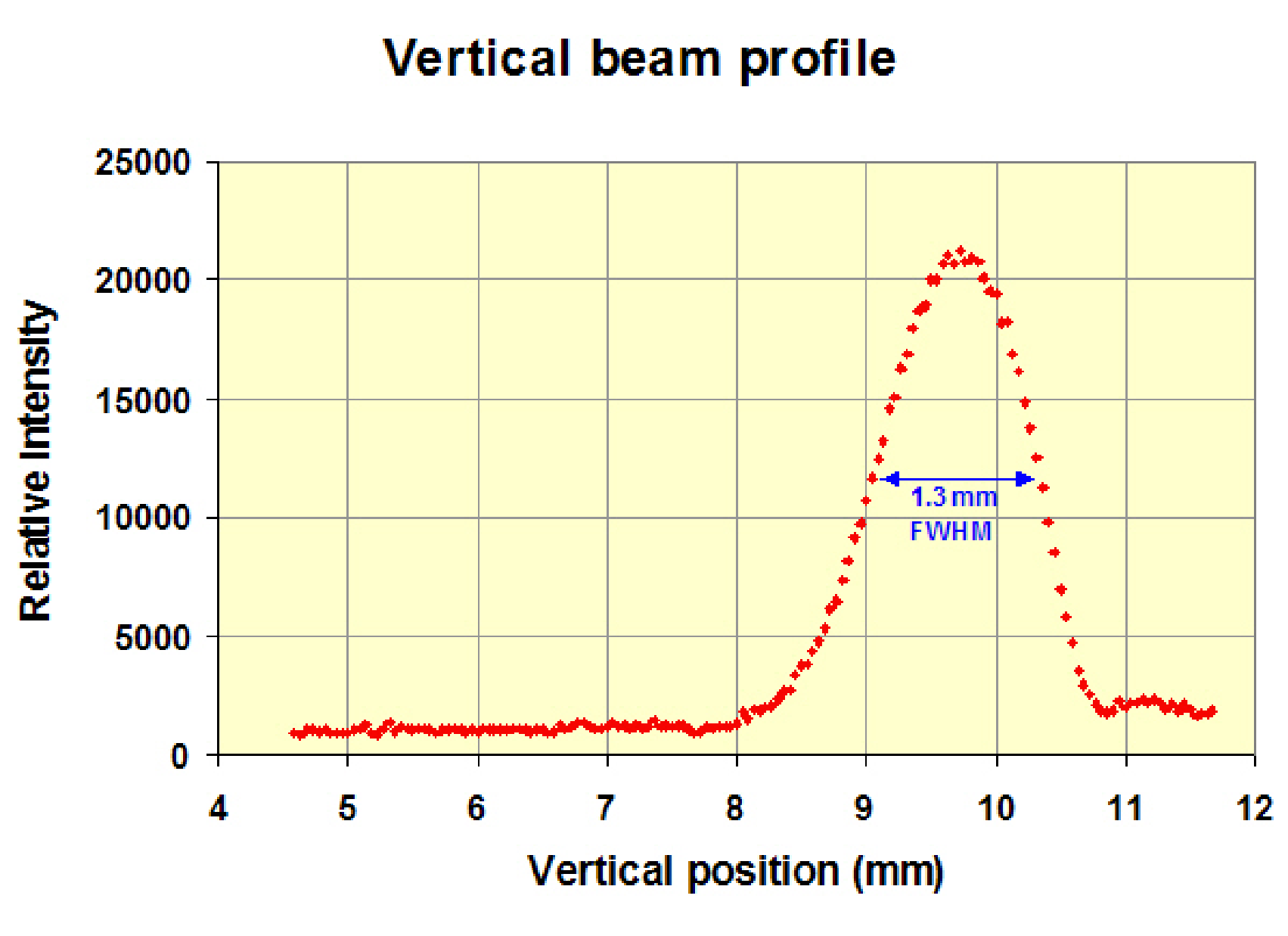
Beam momentum:
26 GeV/c

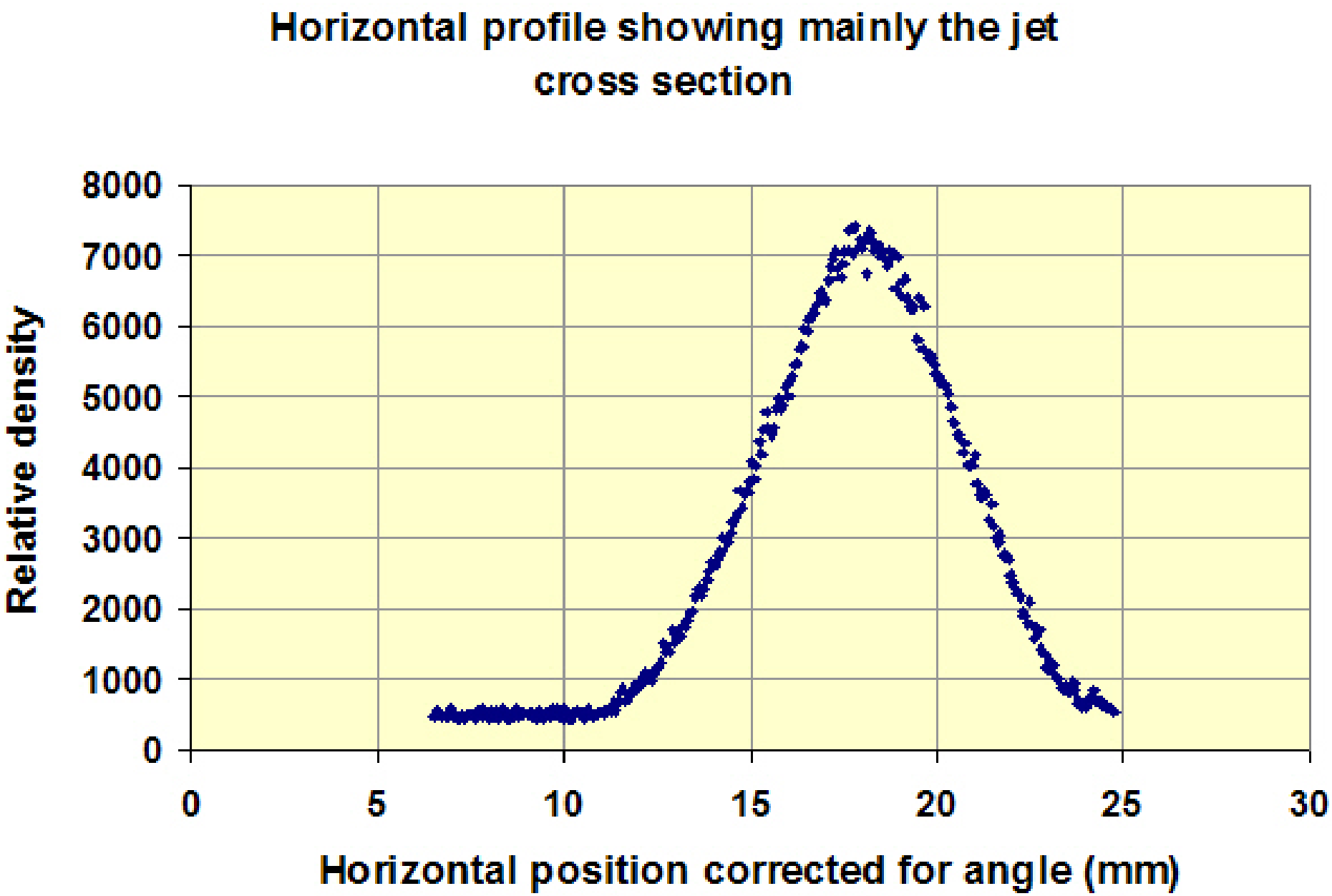
First Yellow and Blue beam profiles during the ramp



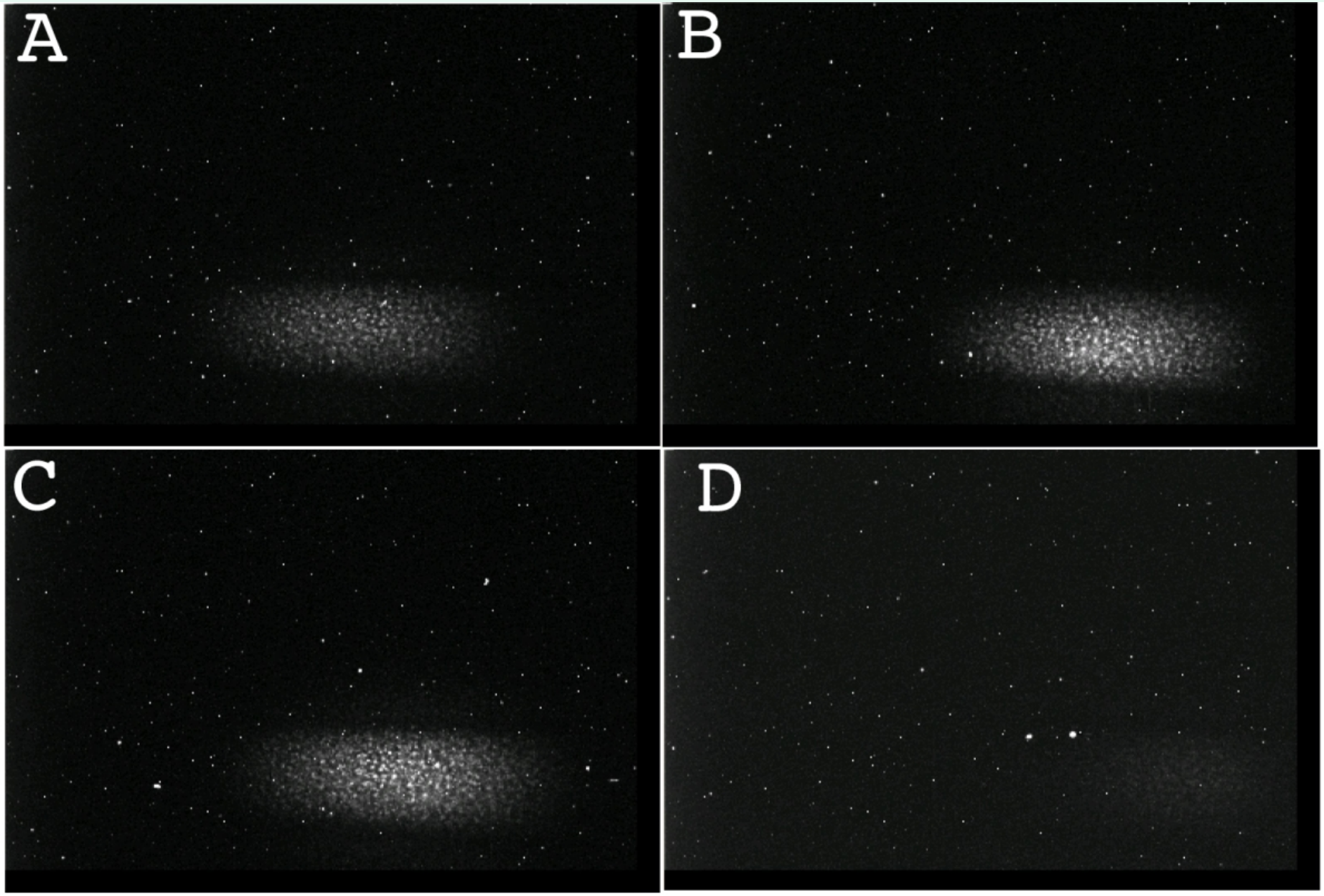
Reconstructed three dimensional beam profile

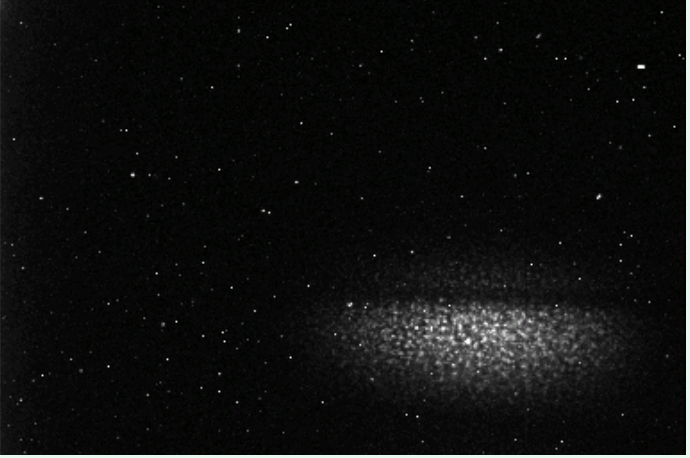


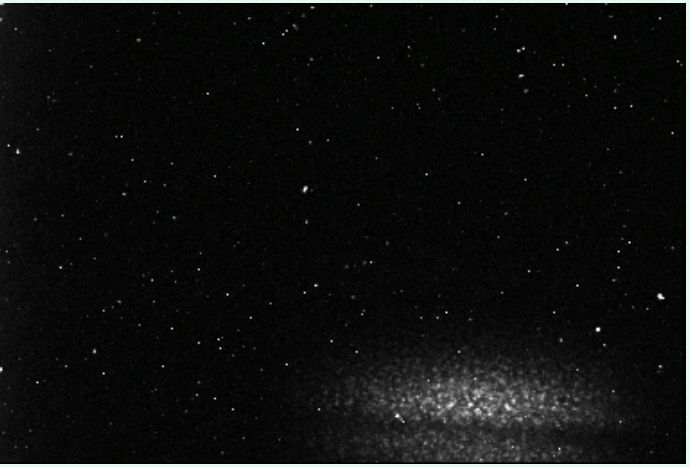

Vertical beam profile
Relative Intensity
25000
20000
15000
10000
5000
0
4
5
6
7
8
9
10
11
12
Vertical position (mm)
1.3 mm
FWHM

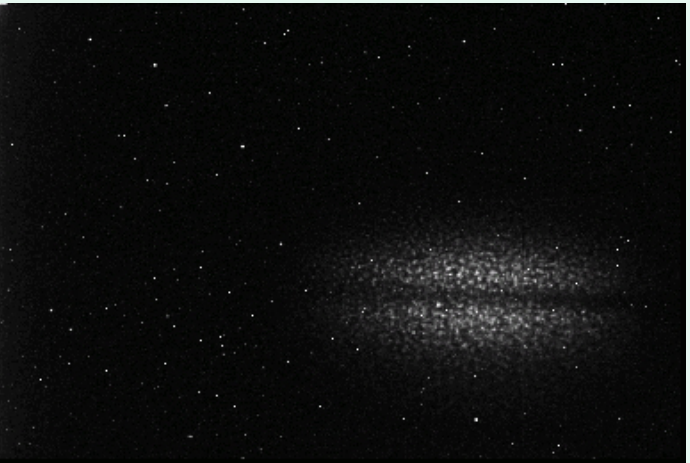

Horizontal profile showing mainly the jet cross section
Relative density
8000
7000
6000
5000
4000
3000
2000
1000
0
0
5
10
15
20
25
30
Horizontal position corrected for angle (mm)

HORIZONTAL SCAN

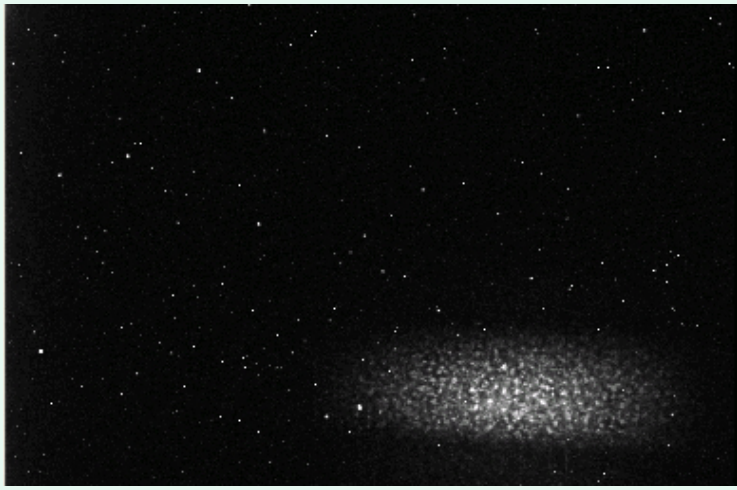




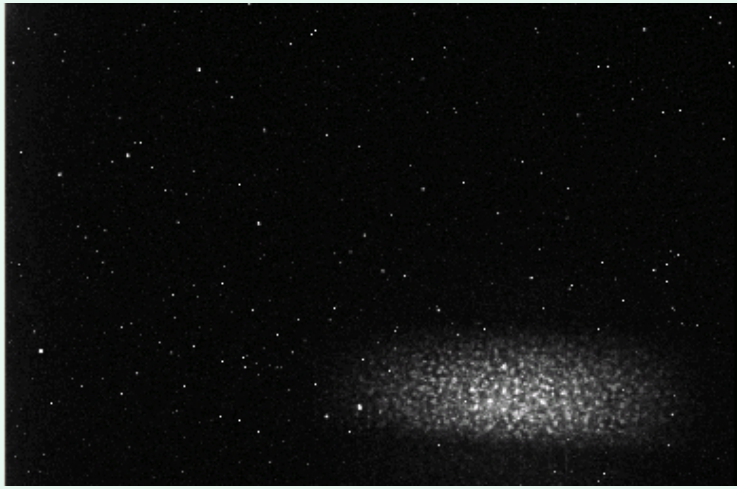




There are 0.762 mm thick RF mesh wires for shielding purposes close to the center of the chamber with.



vertical spacing of 3.175 mm



CERN SPS luminescence monitor

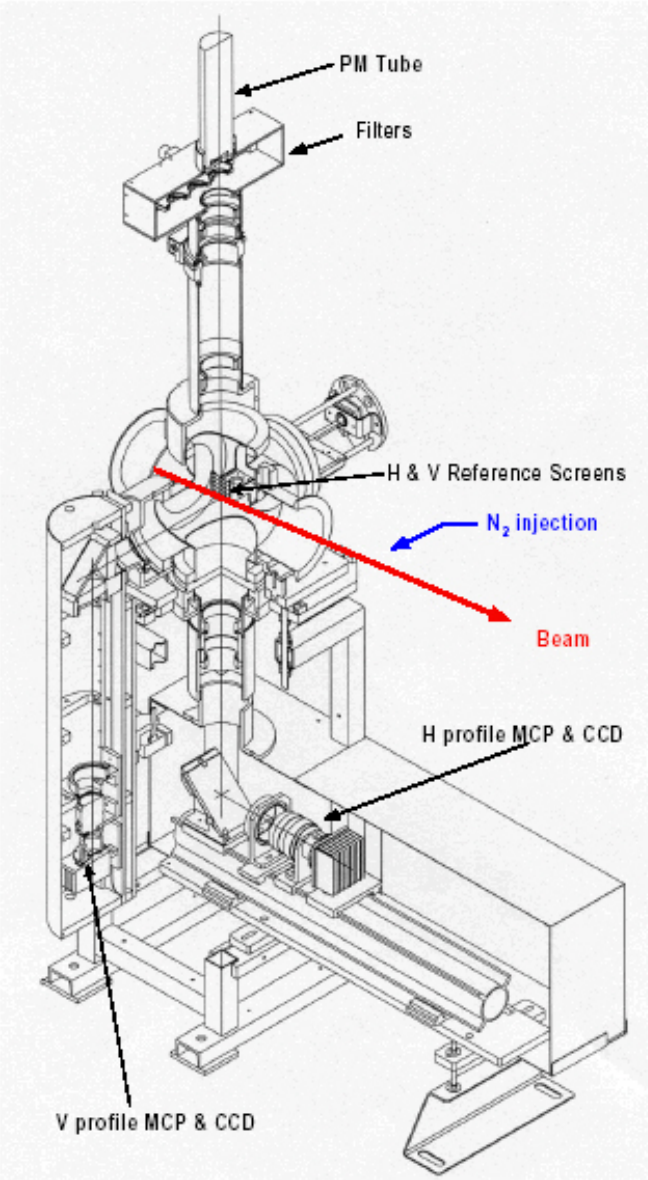


Figure 1 : The SPS Luminescence monitor: the side and bottom optics are used for vertical and horizontal profile measurements, the top one for intensity and time structure evaluations.

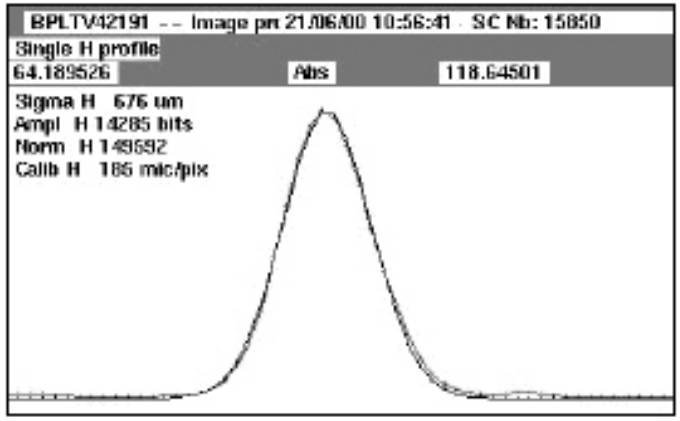
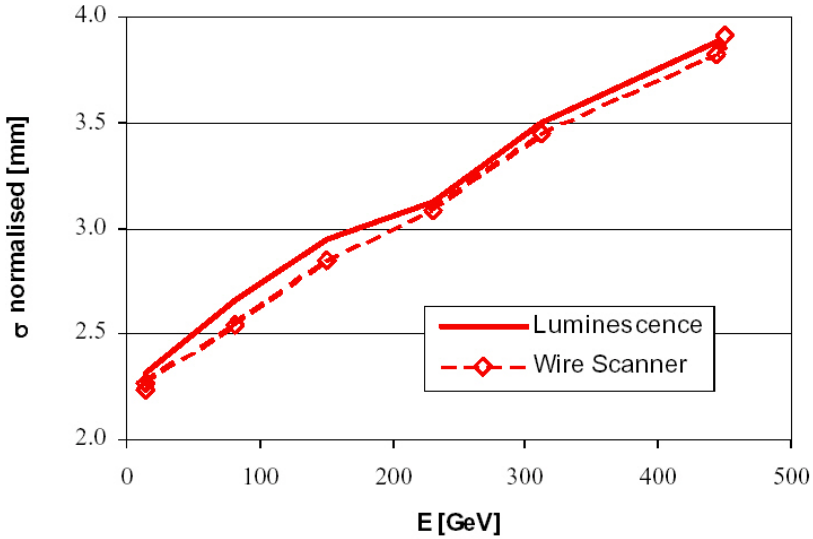
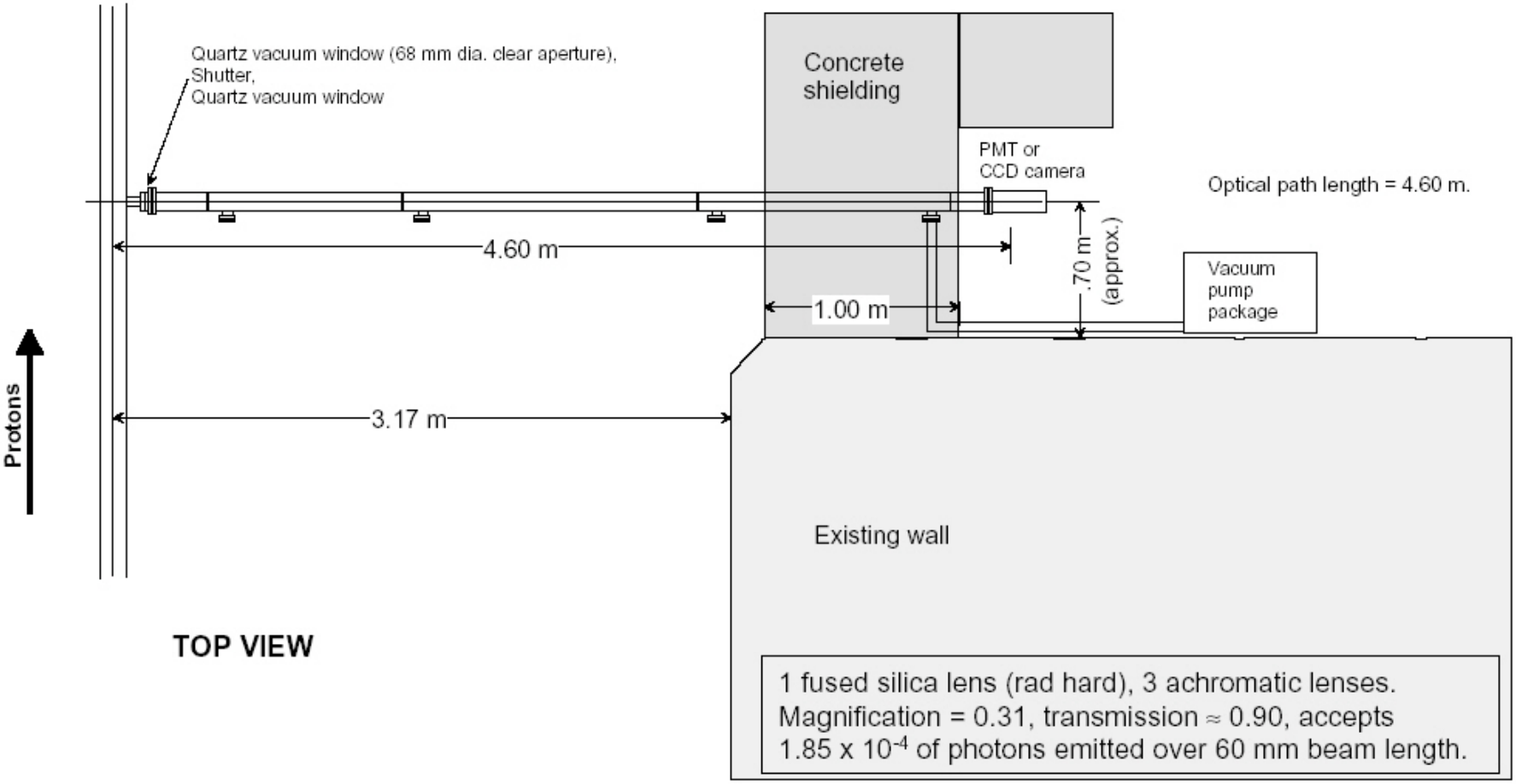


Figure 5: Single shot vertical profile and fit of a 2×10^{13} proton beam at 450 GeV and 6 10^{-5} Pa, $\sigma = 676\ \mu m$.



PS Optical System



An old proposal to built Beam Profile monitor

Coherent bremsstrahlung and edge magnet radiation as new possibilities to monitor collisions and transverse beam size at RHIC

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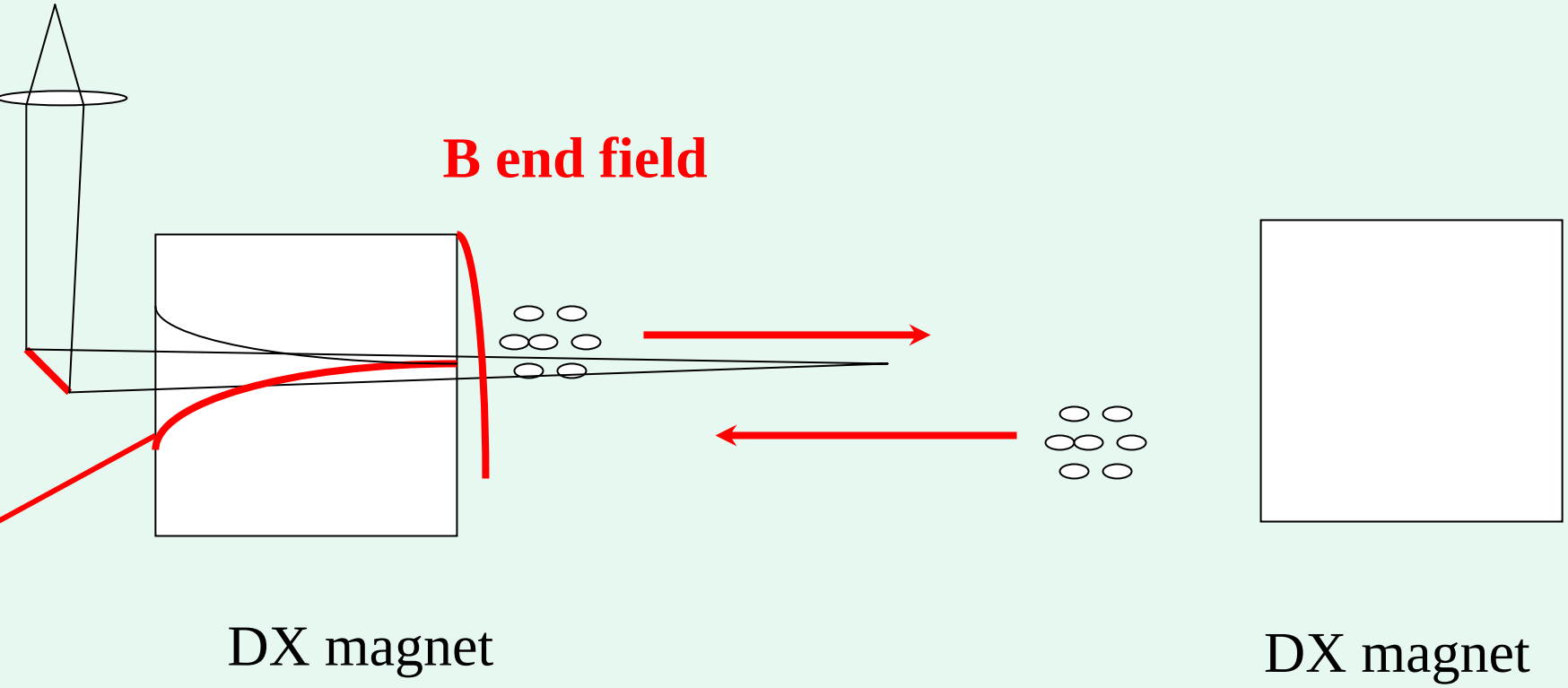
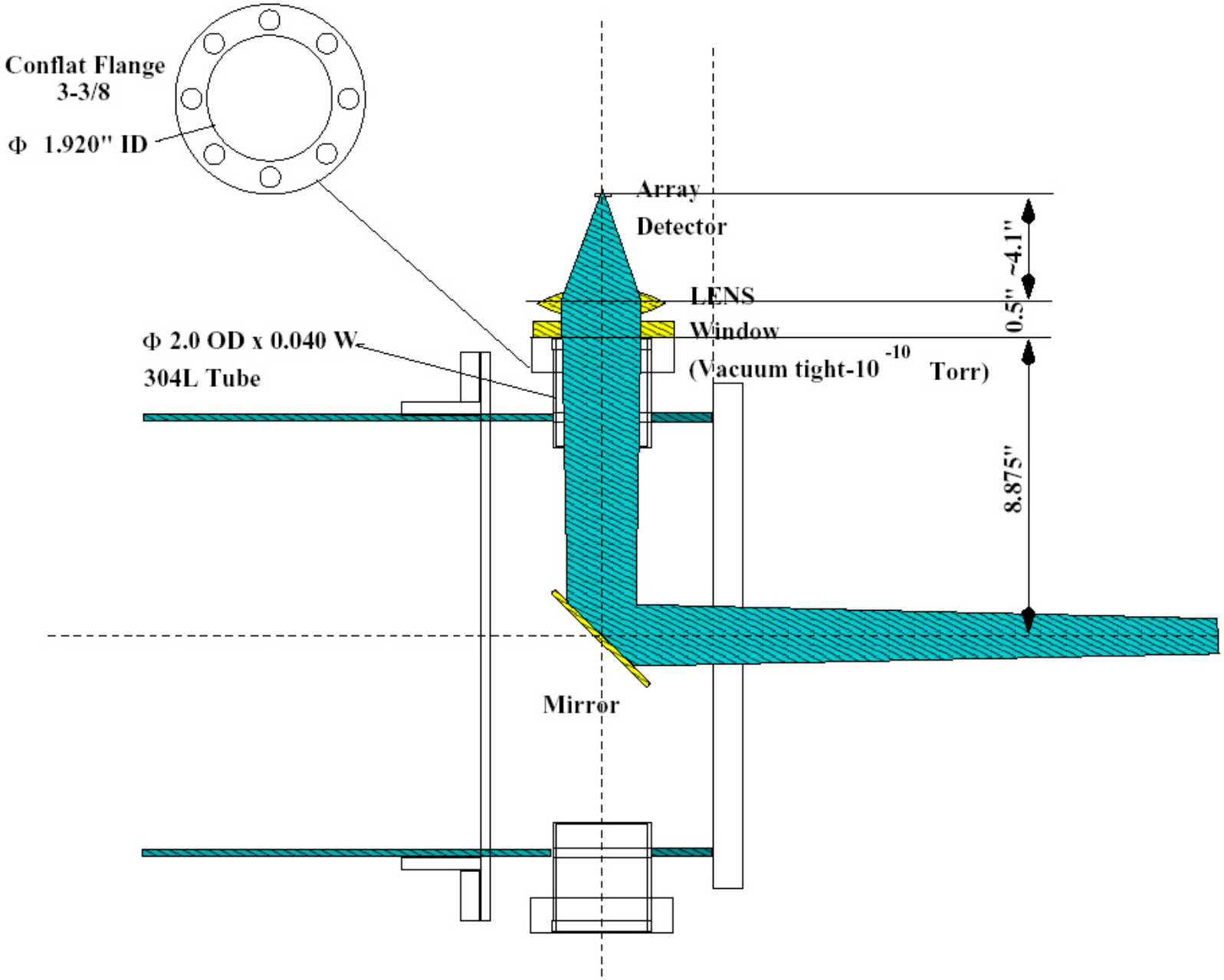
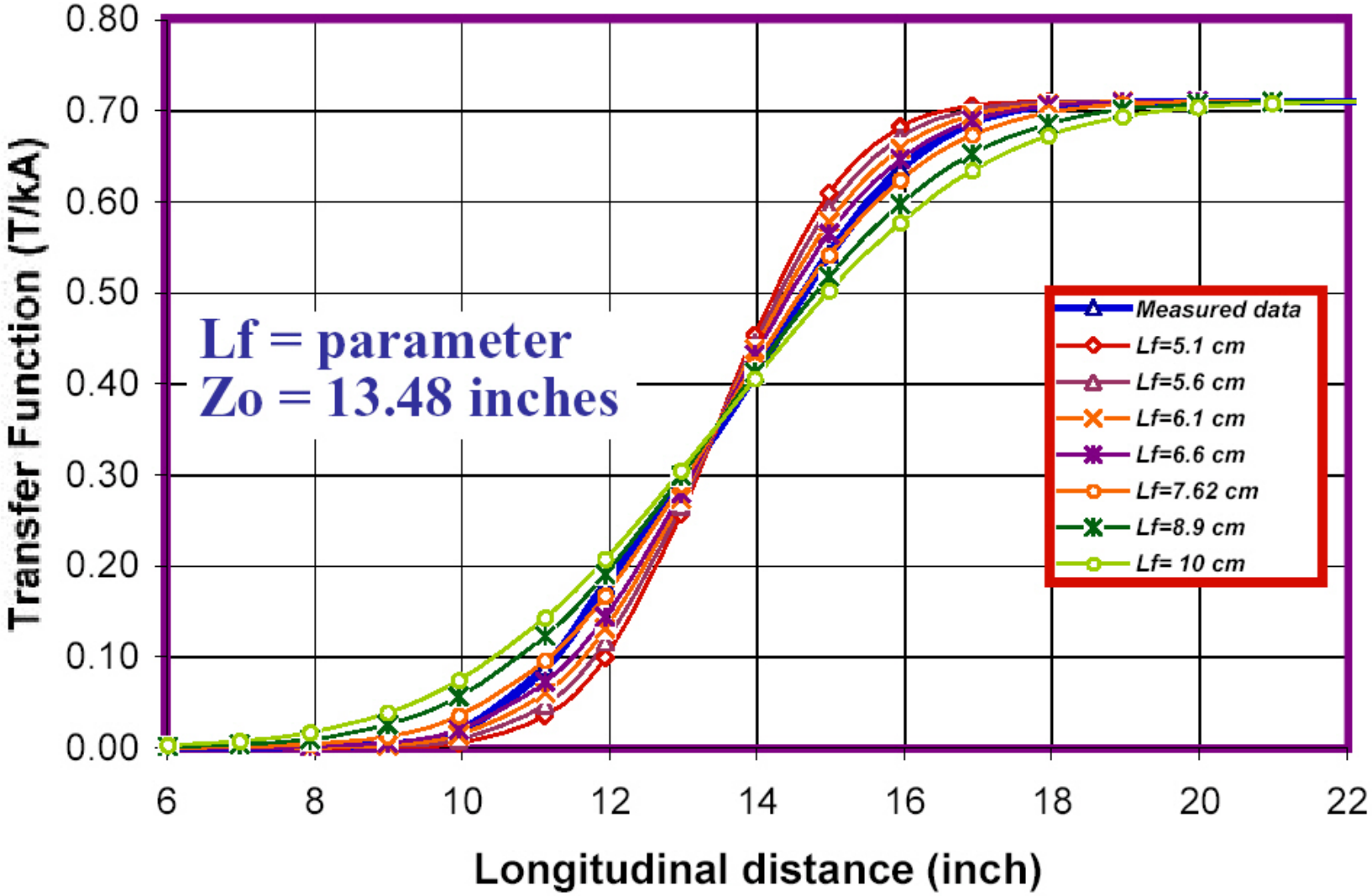
Abstract

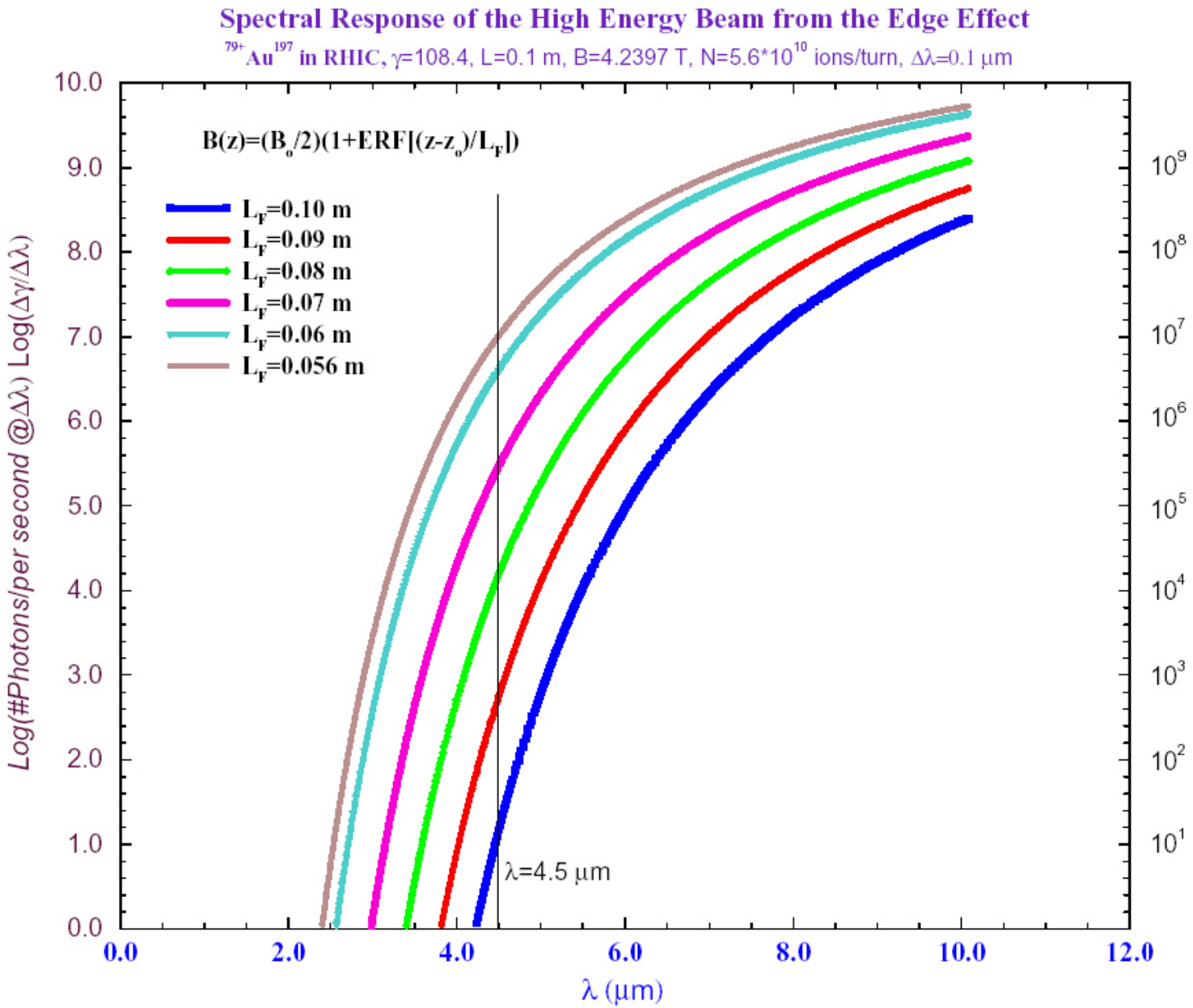
This is a proposal for an experiment in RHIC to measure the radiation of particles of one bunch in the collective field of the oncoming short bunch, called coherent bremsstrahlung (CBS). The effect of the CBS would be measured for the first time in the hadron colliders. The main characteristics of CBS for Au-Au, Au-p and p-p collisions at RHIC are calculated. An experimental set-up and a measurement plan to detect both edge magnet effect and CBS are presented. There are very important advantages to be considered from the RHIC operational side: First, the CBS can be a potential tool for optimizing collisions. In addition measurements of the beam parameters like: bunch length σ_z can be found from the critical wavelength of the CBS spectrum $\lambda_c \propto \sigma_z$; the transverse bunch size $\sigma_\perp$ is related to the photon rate $\dot{N}_\gamma \propto 1/\sigma_\perp{}^2$. A specific dependence of $\dot{N}_\gamma$ on the impact parameter between the beams allows for a fast control over the beam displacement and a possibility of the feedback development. During the last two RHIC runs in 1999 and 2001-2002 there were problems in measuring the transverse beam sizes-emittances in both planes. This experiment will allows us to measure the beam sizes using both effects: the CBS and from the optical radiation from the DX magnet edge effect. The emitted photons are in the infrared region of the spectrum and they do not affect conditions of the stored beams during collisions.


B end field
DX magnet
DX magnet


Conflat Flange
3-3/8
Φ 1.920" ID
Array
Detector
LENS
Window
(Vacuum tight-10 -10 Torr)
Φ 2.0 OD x 0.040 W
304L Tube
0.5"
~4.1"
8.875"
Mirror

Fitting the Dipole End Field Data
B(z)=Bo/2*{1+ERF[(Z-Zo)/Lf)]}




Spectral Response of the High Energy Beam from the Edge Effect
79+Au197 in RHIC, γ=108.4, L=0.1 m, B=4.2397 T, N=5.6*10^10 ions/turn, Δλ=0.1 μm
B(z)=(B_o/2)(1+ERF[(z-z_o)/L_F])
L_F=0.10 m
L_F=0.09 m
L_F=0.08 m
L_F=0.07 m
L_F=0.06 m
L_F=0.056 m
λ=4.5 μm
Log(#Photons/per second @Δλ) Log(Δγ/Δλ)
λ (μm)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
12.0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9

A proposal to built a new Luminescence Beam Profile monitor

REQUIREMENTS:

- **R&D on the gas JETS (or get them from JAPAN).**
- **Buy sensitive cameras and optical lenses for the transfer.**
- **Installation away from the radiation area.**