Investigation of pellet parameters with the Moscow-Jülich Pellet Target*

M.Büscher[b], A.Bukharov[c], V.Chernetsky[a], V.Chernyshev[a†], A.Gerasimov[a], P.Fedorets[a,b], A.Semenov[c]

The tests with the Pellet Target in 2005 focused on the investigation of nozzle-sluice coaxiality and on the study of the pellet velocities, angular and radial distributions. In order to fulfill these tasks, special software has been developed for precise determination of the axes of sluice and nozzle, which is used for the nozzle-sluice adjustment. This program analyses the images from CCD cameras in two projections (X and Y), estimates the shapes of the nozzle and sluice, and calculates their axes. The program provides information about the radial displacement of axes and the angle between them. Figure 1 presents the working window of the program. The change of the position and inclination of the nozzle is performed with adjustment units operated manually (at the moment). With this program the adjustment accuracy of nozzle-sluice axis is better than 40μm.

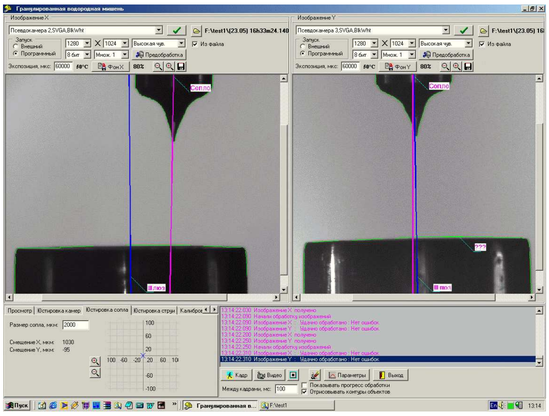

Fig. 1: CCD analysis program for precise determination of the axes of sluice (blue line) and nozzle (pink) in X and Y projections. Photos are taken before the adjustment.

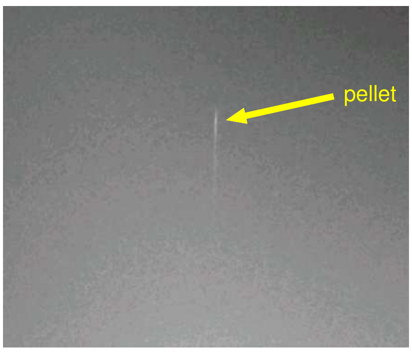

Fig. 2: Hydrogen pellet with diameter 25μm in the scattering chamber.

Two CCD cameras have been installed in addition to the two existing cameras. These cameras monitor the output from the sluice in the 1^{st} vacuum chamber. During tests with pellets any pair of CCD cameras can be moved for observation to the second vacuum chamber or to the scattering chamber.

In the test measurement in spring 2005, with improved coaxiality of the nozzle and sluice, hydrogen pellets with diameters of $\sim 25-30\mu$m have been observed in the scattering chamber for the first time (Fig. 2). This chamber is located ~ 1.3m below the triple-point chamber.

In April 2005 we started to investigate the velocity and angular distributions of pellets. Below we present the first results from the April test. The data from November test are currently under analysis.

In the first vacuum chamber, at the output of the sluice, the pellets are detected as a short tracks due to the sensitive time of the CCD. The track length depends on the velocity of the pellet. Thus the pellet velocities can be deduced by measuring the lengths of the track images. Figure 3 shows the measured velocity distribution of pellets in the 1^{st} vacuum chamber. The average velocity of hydrogen pellets is ~ 70m/s.

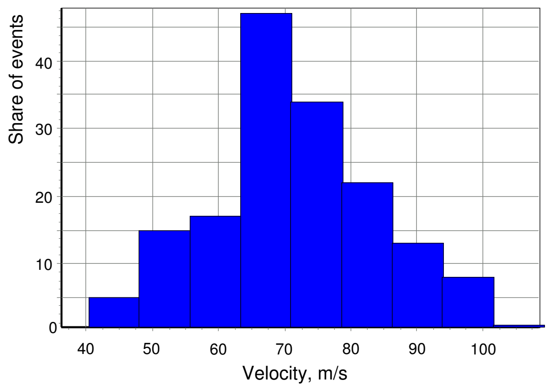

Fig. 3: Preliminary velocity distribution of pellets in the 1^{st} vacuum chamber.

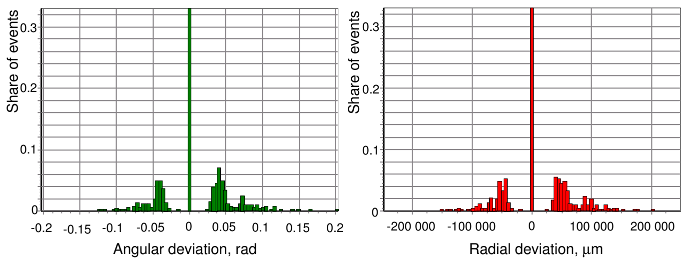

Fig. 4: Angular distribution of pellets in plane of the sluice (left) and the calculated distribution of radial displacement of pellets in a plane of the scattering chamber (L=120 cm from sluice)(right).

Figure 4(left) presents the measured angular distribution of pellets in the plane of the sluice. This angular distribution provides the possibility to calculate the radial displacement distribution of pellets at any distance from the sluice. For example, Fig. 4(right) shows the calculated radial displacement distribution in the scattering chamber. The angular distribution has a central line corresponding to direct pellets (about 30%) and tails from pellets, which interact with the sluice walls. Taking into account the geometrical acceptance of the channel (second sluice, diameter of the pipe) one finds, that only direct pellets are able to reach the scattering chamber. If one decreases the resolution, the shape of angular

distribution (and consequently the radial displacement distribution) changes and takes the shape of a broad Gaussian distribution.
Figure 5 shows the calculated distribution of radial displacement in the scattering chamber after taking into account the geometrical acceptance of the channel. Within of our resolution we can conclude that the radial displacement of pellets in the scattering chamber (distance 120 cm from sluice) is not worse than $\pm 200\mu$m.

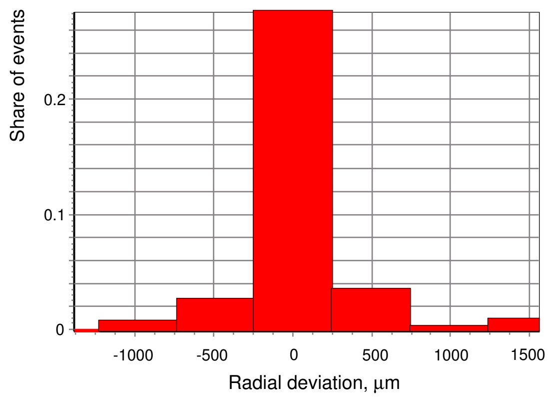

Fig. 5: Calculated distribution of a radial displacement of pellets in a plane of scattering chamber after taking into account the geometrical acceptance of the channel.

During the tests in the last two years stable (several hours) jet and pellet production from hydrogen and nitrogen with diameters of $\sim 25{-}30\mu$m has been achieved. The investigation of the regimes for jet and pellet production from argon is under way. An automatic filling system for liquid helium has been designed and is now being built in the workshops of FZJ. This system will allow long-term target operation (several days), which is limited now to a few hours due to the need to manually refill liquid helium.

[a]ITEP, Moscow
[b]IKP FZJ
[c]MPEI, Moscow
† deceased January 2006

∗Supported by grants EU-000419, RFFI03-02-04013, RFFI02-02-16349, DFG-436RUS-113/733.