Hydrogen droplet production with the ANKE pellet target*

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The main goal of the pellet-target activities during the year 2001 was to achieve stable production of liquid hydrogen jets and to break up these jets into micro-droplets of about 50 μm diameter by acoustical excitation. First attempts into this direction were made already in the beginning of 2000 at ITEP, and short-term injection of hydrogen jets into the target cryostat [1] was achieved [2]. These results could be reproduced in Nov. 2000 and in the beginning of 2001, during test runs with the target cryostat at the test setup in the COSY hall. During the first tests short pulses of hydrogen jets and, consequently, only the production of single droplets was observed. It was concluded that adequate temperature and pressure conditions inside the triple-point chamber (TPC), needed for the production of hydrogen droplets, were reached, but that the stability of those parameters was insufficient. These problems could be solved in May and Dec. 2001, and stable production of hydrogen jets was achieved. Simultaneously, a sonic generator for the breakup of the jets into droplets was tested.

Both, the cryogenic nozzle for jet production as well as the sonic generator were developed and tested at MPEI. These tests were performed with water instead of hydrogen: it is expected that hydrogen jets can be broken into droplets at the same generator power since the surface tension of hydrogen is lower than that of water. Our test confirmed this expectation and it could be shown that droplet formation from water and hydrogen takes place under similar conditions. The operation frequency during all tests was around 3 kHz.

For the test runs with hydrogen a nozzle having an injection hole of 60 μm diameter was used. Fig. 1 shows the break-up of the hydrogen jet into droplets of ~ 70 μm diameter. Stable droplet production, as shown in the figure, was achieved over long time periods of several hours. From the picture the jet and droplet velocities can be estimated. The former depends on the pressure in the supply channel for the liquid hydrogen. In order to decrease the distance between individual droplets, the generator frequency must be increased (and, simultaneously, to guarantee stable droplet produciton the jet velocity). Systematical investigations of frequency and velocity boundary conditions for stable droplet production are foreseen for future tests. During the test runs in Dec. 2001 it could also be verified that with the existing target cryostat it will be possible to produce droplets of liquid nitrogen.

In order to achieve stable hydrogen-jet production the temperatures and pressures inside the cryostat must be stabilized on a level of not worse than 5%. New temperature and pressure control systems have been developed for this purpose. Currently, the temperatures are measured at 8 points with silicon diode sensors DT-470 and DT-471 (Cryophysics). They provide an average accuracy for the temperature measurements of about 10 mK. The pressures are measured at 12 points with APR260, TPR260 and PKR250 sensors and MaxiGauge controllers (PFEIFFER). The data from all sensors can be transfered to a PC-based visualizing system using LabView for further analyses.

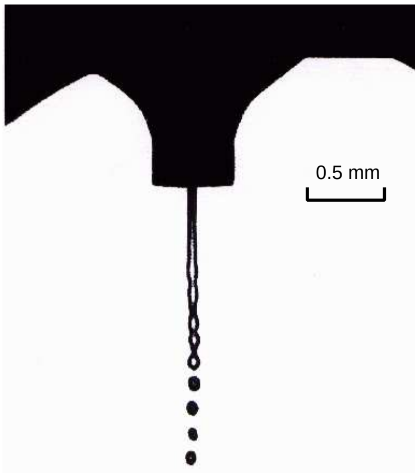

Fig. 1: Stroboscopic picture of liquid hydrogen-droplet production in the triple-point chamber (TPC) of the ANKE pellet target. The temperature (pressure) in the TPC were $T = 14$ K ($p = 100$ mbar).

During the year 2001 the target cryostat has been substantially modified. In order to decrease the temperature gradient along the gas condensation system a new, more effective, heat eschange head was installed. To allow for more precise measurements of the temperare and pressures, sensors were installed inside the heat exchange lines of the hydrogen and helium flows. This required to design and build special housings for the temperature sensors and of capillars for the pressure sensors. For a better control of the gas flows, low power heaters were installed in the hydrogen and helium supply lines.

The main tasks for the target development during the year 2002 will be:

- A fast, high-resolution diagnostic system will be installed allowing to measure the size and velocity of the produced droplets and/or pellets.
- Production of frozen pellets from the droplets.

References:

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