N NBI DEVELOPMENT STATUS IN KURCHATOV INSTITUTE

Presented by Kulygin

RRC Kurchatov Institute, Moscow, Russia

Negative Ion Based NBI related activity in Kurchatov Institute:•Experimental confirmation of ITER NBI design decisions
•ITER NBI Beam Line Component fabrication technology preparation
•Beam Transmission and Power Deposition calculations
•PNX-U experiment continuation.
•Elementary processes investigation

Calorimeter mock-up test. V.K. Naumov A.A. Panasenkov V.V. Platonov T.P. Soldatova
•The calorimeter mock-up consists of 9 (4 “front” and 5 “back”) STEs. Each STE has 20 mm OD and cooling channel 16 mm in diameter with twisted tape inside that corresponds to ITER calorimeter. The mock-up is supplied with 7 thermo-probes for monitoring of beam position and power density.
•As distinct from the ITER calorimeter design, the mock-up has swirl tubes elements (STE) with only one short bent leg at the water outlet side and fixed connection at the water inlet side. This is done to increase stresses and, correspondingly, to decrease the required number of test beam pulses.
Table 1 presents calculated thermo-hydraulic and thermo-mechanical parameters of the most heated bronze STE at the end of 1 s pulse. Structural STE material – CuCrZr-alloy, cooling channel diameter – 16 mm, wall thickness - 2 mm., twist tape pitch - 50 mm. Height of the STE supporting leg at water outlet side - 0.1 m./ Water inlet temperature – 25 C.

Maximum power density, MW/m^2	20	25
Power load, kW	160	200
Water flow rate, l/s	1.65	2.4
Maximum heat flux at the inner channel surface/CHF, MW/m^2	24/24.3	30.1/30.4
Bulk water temperature rise, ^{O}C	23	20
Maximum temperature at the STE surface, ^{O}C	320	360
Maximum bending of tube elastic line, mm	6	6.6
Max. equivalent stress by Mises/ Nominal yield stress, MPa	260/243	310/232
Max. total strain (elastically calculated), %	0.2	0.24
Allowable number of monotonic fatigue cycles	6.2x10^3	$<10^3$

Regimes of the calorimeter mock-up loading with 1 s hydrogen beam.

Power density MW/m^2	**Number of pulses**
20	**8600**
25	**1200**
30	**200**

Some details:

- In the beginning, after some hundreds of beam pulses small leakage occurred in two STEs – not a good brazing in our shop of bronze tubes with stainless steel adapters. They were repaired by an additional brazing on place but finally we were forced to seal one of them with rubber.
- At PD = 20 MW/m^2 number of test pulses exceeded allowable number by 40%.
- At PD ³ 25 MW/m^2 equivalent stress exceeded 3S_m limit (ITER SDC) for long pulse monotonic cycles.No changes in the STEs geometry or in a state of operability were observed.

Electrostatic Residual Ion Dump experiment.
E.D. Dlougach, V.V. Kuznetsov, A.A. Panasenkov, V.V. Platonov, T.P. Soldatova.

Experimental investigation of the electrostatic RID concept is now started at test stand IREK. This experiment uses positive ion beam and two panels (one panel is under negative potential) which simulate the RID channel.

ITER NBI Beam Line Component fabrication technology preparation
A.A. Panasenkov, V.P. Ukhov, E.V. Alexandrov, M.A. Barinov, V.S. Petrov,
L.Yu. Arkusski (NIIAT), V.A. Lykhin ("Salyut")

Technology equipment for bronze tubes fabrication was prepared and pilot batch of the tubes (20 mm in diameter) was produced. Experimental induction bonding of the bronze tubes with stainless steel tubes was fulfilled with use of copper alloy solder. Vacuum testing of the junctions were done before and after mechanical loading.

Beam Transmission and Power Deposition calculations E.D. Dlougach, A.A. Panasenkov

- For ITER beam duct design modification
- For SINGAP case of the ITER NBI accelerator

PNX-U experiment continuation
V.A. Zhiltsov, A.A. Skovoroda, I.V. Moskalenko, A.V. Spitsyn , S.V. Yanchenkov
Plasma neutralizer development experiments at PNX-U were continued in the line of detailed investigation of transport mechanism and more precise plasma parameter measurements using new diagnostics.(See report on PN development status).

Elementary processes investigation .V.A. Belyaev, M.M. Dubrovin, A.A. Terentev
To measure cross sections of the processes

•$H^- + H^- \longrightarrow H^- + H^0 + e$ - 0.75 eV

•$H^- + H^- \longrightarrow 2H^0 + 2e$ - 1.51 eV

•$H^- + H^- \longrightarrow H^0 + H^+ + 3e$ - 15.11 eV

•$H^- + H^- \longrightarrow 2H^+ + 4e$ - 28.7 eV

To check a possibility of the process •$H^- + H^- \longrightarrow H_2^- + e$

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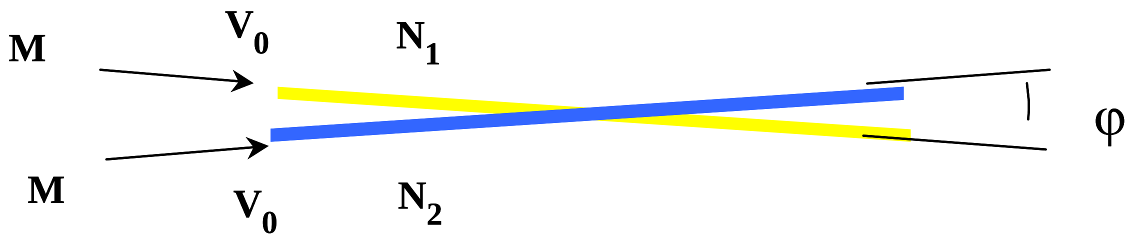

x(w) = [2 (1 – cosw)]$^{1/2}$/ sinw **» 1** if **¢w10o** (the accuracy is 0.5%)

s = n$_{eff}$ v$_0$h / N$_1$N$_2$ **sD / s = DE / 2E**

E = Mv$_0^2$ / 2– energy of particles in the laboratory frame

(**v = wv$_0$** – relative velocity of collision particles),

W = Ew^2 ! 2 – total kinetic energy of collision particles in the center of mass frame.

DW / W = DE / E + 2wD / w Number of effective collisions/sec. is

n$_{eff}$ = **N$_1$N$_2$ s x(w) / v$_0$h**

The scheme of the modern DIVO setup