#### STATUS OF THE dd-GAMMA EXPERIMENT

D.L. Demin, V.V. Filchenkov, N.N. Grafov, K.I. Gritsaj, A.D. Konin, S.V. Medved', A.I. Rudenko, V.P. Vol'nykh

Joint Institute for Nuclear Research, Dubna, 141980, Russia

The task understanding and the state of art of the experimental study of rare reaction  $d + d \rightarrow {}^{4}\text{He} + \gamma + 23.8 \ MeV$  in  $dd\mu$  molecule are presented. The experiment in the discussion is the one allowing the measurement of the reaction yield from a *p*-wave relative motion of deuterons in a molecule  $dd\mu$ . The results of the experiment are of great importance in verifying modern models of few-nucleon systems. Project MU-CATALYSIS JINR

Project statistics in 2001-2006:

Collaboration with other scientific centers: TUDelft (Delft, Netherlands), INP (Krakow, Poland), MUCATEX (Moscow), VNIIEF (Sarov), ITEP (Moscow), SSC KI (Moscow)

-The number of **publications** in refereed journals: **8** 

-Participation in the conferences: MuCF-01 (2001, Shimoda, Japan), EXA-02 (2002, Vienna, Austria), Yadro-2006 (2006, Sarov, Russia)

-Awards in scientific conquests: First prize JINR 2002, First prize JINR 2004

-Sources of extra budget financing: -Contracts with Agency "Rosatom" 01.2.00308953; 01.2.00308957; 0120.0407763.

Grants RFBR 01-02-16425; 02-02-16805; 03-02-16876; 04-02-16918; 06-02-16391.

Grant INTAS 05-7953

**Grant ISTC #3487** (Approved without funding)

# Dubna effort in search for muon induced radiative deuteron capture





#### VALENTIN ZINOV 1931-2006

# "Investigation of the nuclear fusion reactions in muonic deuterium and tritium"

Goal of the Project is obtaining of new experimental data on Muon Catalyzed Fusion (MCF) in the areas, where they are absent or ambiguous.

The experiments will be conducted in JINR (Dubna, Russia) at the installation TRITON. The Project is divided into separate tasks.

In the current task by means of muon catalysis we address phenomena in dd fusion, which have not been previously investigated and are at the frontier of nuclear few-body physics. For this purpose we propose an experiment to study the **muon-catalyzed radiative deuteron capture** from muonic deuterium molecules

 $dd\mu \rightarrow 4He\mu$  +  $\gamma$  +23.8MeV.

We will measure the relative yield of this rare reaction from the p-wave state of deuterons in a muonic deuterium molecule with sensitivity of **10**<sup>-7</sup> with respect to main fusion channels. (*Task duration 2007-2008 according INTAS 05-7953 grant*)



The equipment was developed for the study of probability of strongly suppressed process of **deuteron radiative capture** from the state of deuterium muonic molecule at room temperature, the preliminary measurements have been made - less than **10**<sup>-5</sup> per one muonic molecule formed.

Physics of Atomic Nuclei, Vol. 65, No. 10 (2002)1178



Proposed experimental setup: PS – plastic scintillator, BGO - crystal



New method for high-background measurements in development: Spike – PS, further exponent - BGO



16 Dec 2005 16:49:29

Ch1 Fall

3.36ns

Low res

Ch1 Fall

6.85ns

Low signal



Two modifications of gamma-detectors are created based on the crystals BGO (Ø127x60мм). First working modification is combined BGO+plastic (sandwich-type), the second modification is a test one without plastic (bare-BGO). The beginning of the development of the third modification starts, which will be the variant of BGO+plastic viewed by a single photo-multiplier. This **third concurs against the first** modification to be applied in the main measurement.



The experimental measurements of bare BGO detector modification (background conditions including cosmic radiation) in the experimental area of JINR Phasotron, the exposure was taken during 4 hours



The experimental spectrum Co-60, obtained with the gamma-detector. It is seen from the figure that gamma-lines 1.17, 1.33 MeV are at the edge of resolution (we give here the old picture, because of identity of the results)



Two-dimension plot in the detector's energy space of signal-shape branches: "only BGO" – corresponds to long type of signal, "only plastic" – corresponds to short signal type in (At axis X – is depicted integrated over 30ns the short component of a response signal, at axis Y – the total length integrated response)

#### Yu. Vinogradov et al. (VNIIEF, 2006) internal report



The experimental spectrum of gamma-quanta obtained at EGP-10 (gammaspikes are having complicated structure) (At X-axis is Energy in "keV", At Y-axis is response in "pulses/keV")

#### V.Vol'nykh report (this conference)



The modeling of the processes in registration of (1.17+1.33=) **1.25; 2.5 MeV** gamma-quanta in the test version of gamma-detector using GEANT-4 tool

## V.Vol'nykh report (this conference)



### THE FUTURE PLAN

NEXT task is to ascertain the exotic MCF mechanisms in deuterium, revealing at very low temperatures. This task consists in the measurements of MCF parameters in solid, liquid and gaseous **normal** and **ortho-deuterium T=6-35 K** and determination of the role of different mechanisms influencing on **ddµ** molecule formation.

#### STATUS: target technological problems solved

#### Task duration 2008-2009

The most interesting FOLLOWING task is to determine parameters of MCF d+t reaction at high temperatures, where theory predicts the high intensity of the process and experimental data are absent. This task consists in the measurements of MCF parameters in **D/T** and **H/D/T** mixtures at high temperatures **900-1600 K** and pressures (~1kbar).

**STATUS:** Sarov party have the idea of how to produce the tritium target

(High temperature tritium target needs extra budget funding 200 kEuro)

Task duration beyond 2009