Cold Fusion Synthesis of Helium Isotopes in Interaction of Deuterium and of Hydrogen Nuclei with Metals

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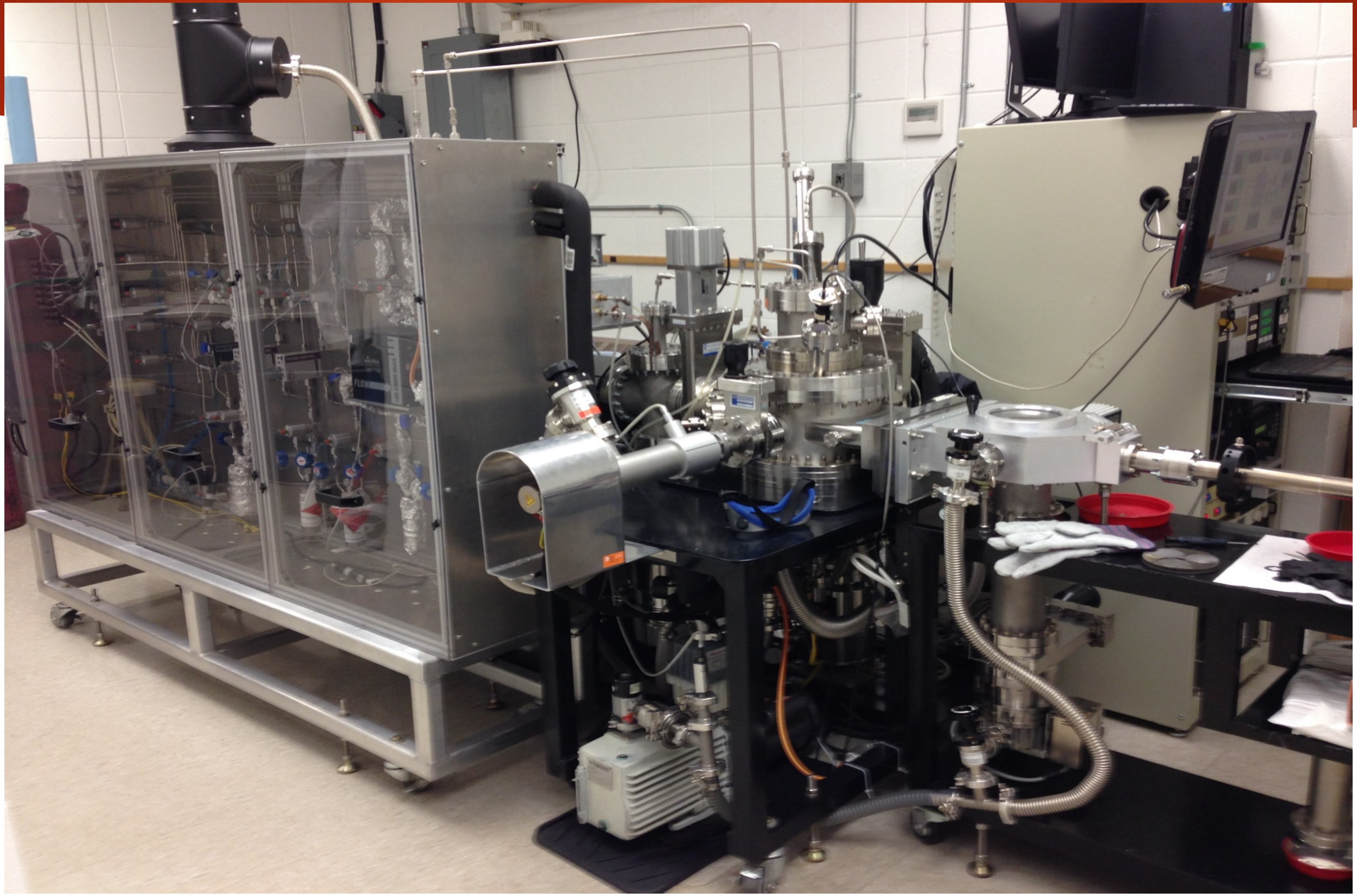
Experiments

Equipment



Experimental scheme

- A. Metals: Mo, Ir
- Metal crystal lattices: BCC, FCC, D and H can be incorporated in the lattices
- Equipment: two connected vacuum chambers (main chamber and low pressure chamber (LPC)), control block, mass analyzer, plasma source operating with the inflating gas flow, heater of the sample holder, stainless steel metal grid (acting as anode for additional plasma measurements), detector for neutrons and gamma-rays and other detector for alpha, beta and gamma rays.
- B. Initial vacuum environment: ~10^{-6} Torr
- C. The initial environment contains hydrogen: H and H_2 at ~10^{-7} Torr
- D. External inflation of gas non-flammable mixture: 4.5% D_2 and 95.5% N_2
- E. The concentrations of both ^3He and ^4HeH in the inflating gas flow are less than 10^{-11} Torr

Treatment of the results

- Rule in mass analysis applied in the circumstances of the experiments:

If there are acceptable results about presence and about amounts of N_2 (parasite or inflated), H_2 (parasite), H (parasite), H_2O (parasite), O_2 (parasite) and inflated He (^4He and ^3He), it is normal that:

i) Results about mass of ~3 atomic units – T or ^3He or DH – to be accepted in a way, in which they appear;

ii) Results about mass of ~4 atomic units – ^4He or D_2 – to be accepted in a way, in which they appear;

iii) Results about mass of ~5 atomic units – ^4HeH – to be accepted in a way, in which they appear.

Distinguished treatment of the results

- 1. Distinguishing between ^{3}He, T and DH

T: $^{6}Li + n \rightarrow \mathbf{{}^{4}He + T}$ **----- there are no initial** ^{6}Li and n

$^{7}Li + n \rightarrow \mathbf{{}^{4}He + T + n}$ **----- there are no initial** ^{7}Li and n

$^{10}B + n \rightarrow \mathbf{2\ {}^{4}He + T}$ **----- there are no initial** ^{10}B and n

$D + n \rightarrow \mathbf{T}$ **----- there is no initial n**

$^{3}He + n \rightarrow \mathbf{H + T}$ **----- there is no initial n**

$^{14}N + n \rightarrow \mathbf{{}^{12}C + T}$ **----- there is no initial n (>4 MeV)**

DH: $NaH + D_2O \rightarrow \mathbf{DH + NaOD}$ **----- there are no initial** NaH and D_2O

Conclusion: Data about 3 atomic units pertain to ^{3}He

Distinguished treatment of the results

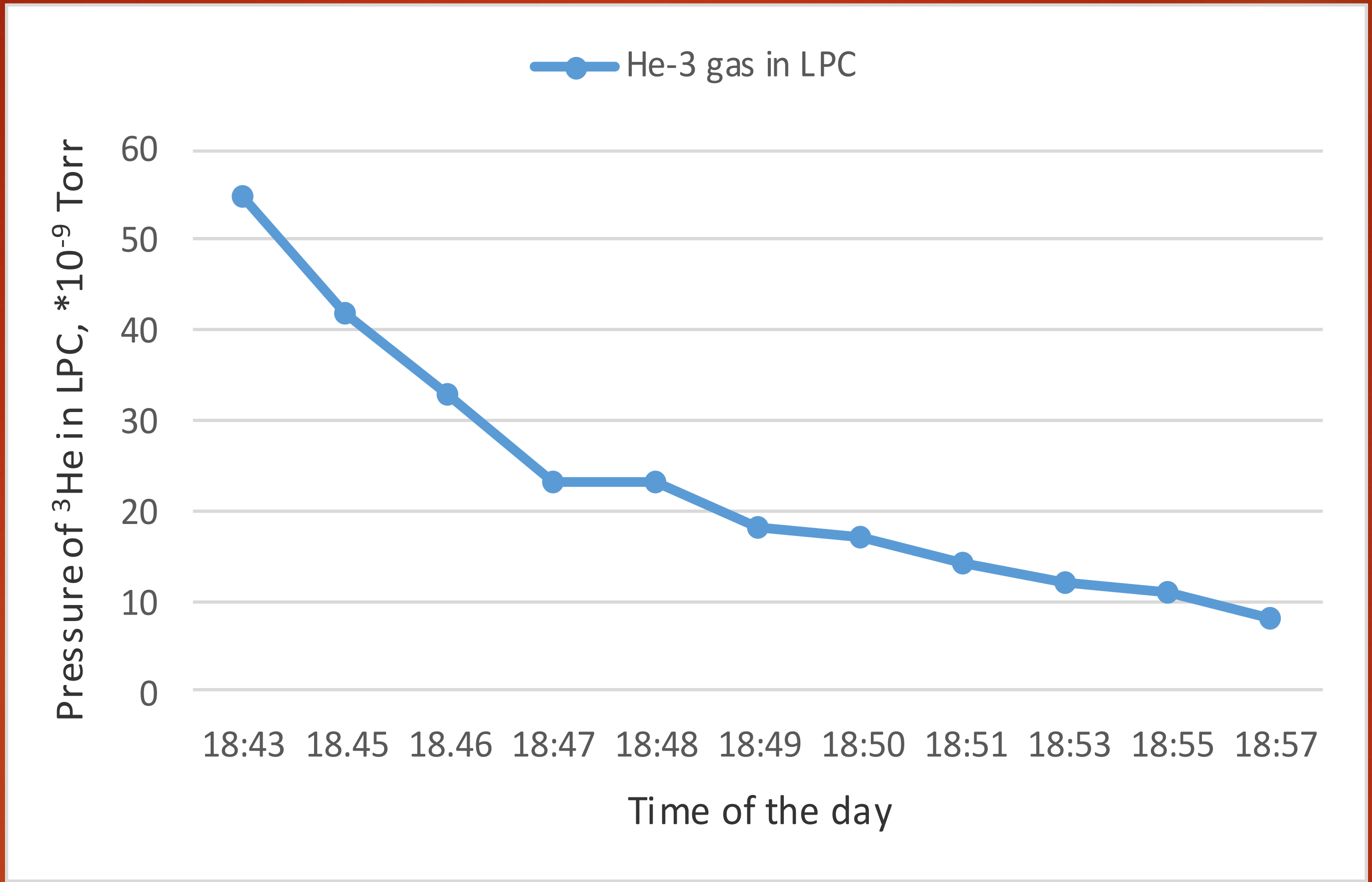
2. Distinguishing between ^4He and D_2

Cannot be distinguished.

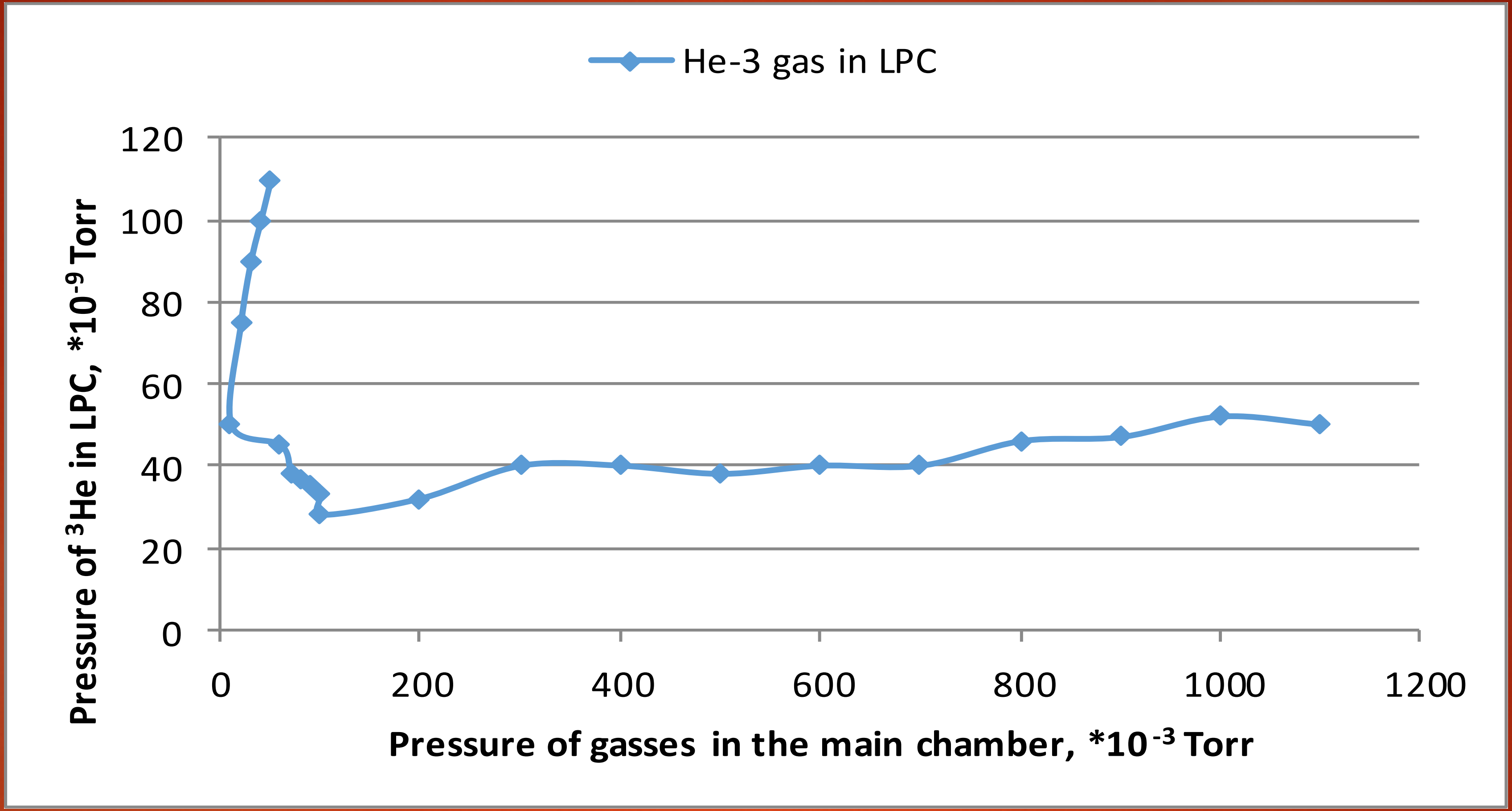
^4HeH indicates that ^4He is part of gas mixture $^4He/D_2$

3. Additional optical spectroscopy measurements must be carried out for proofs about presence and quantities of both ^3He and ^4He

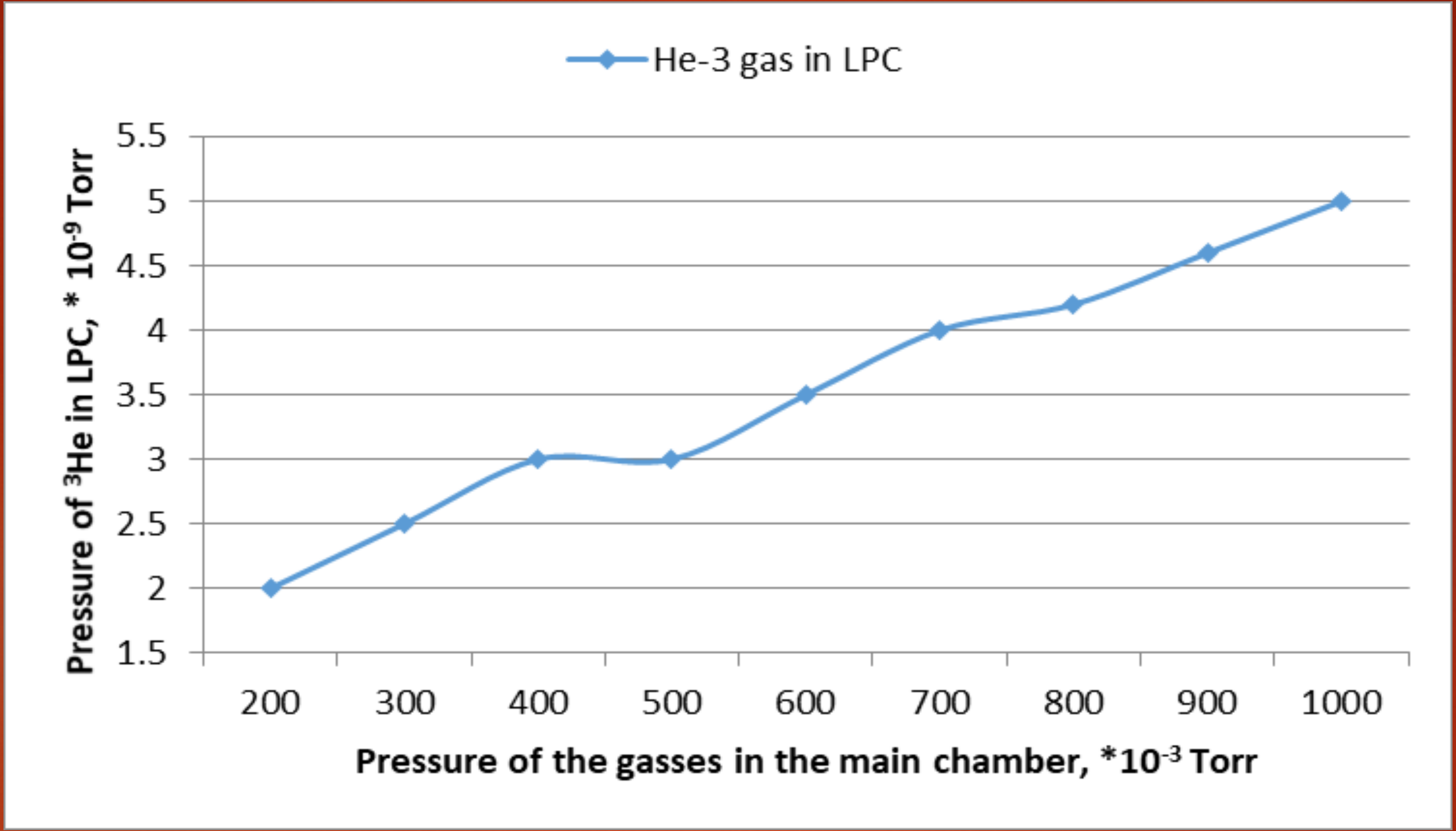
Experiments about ^3He



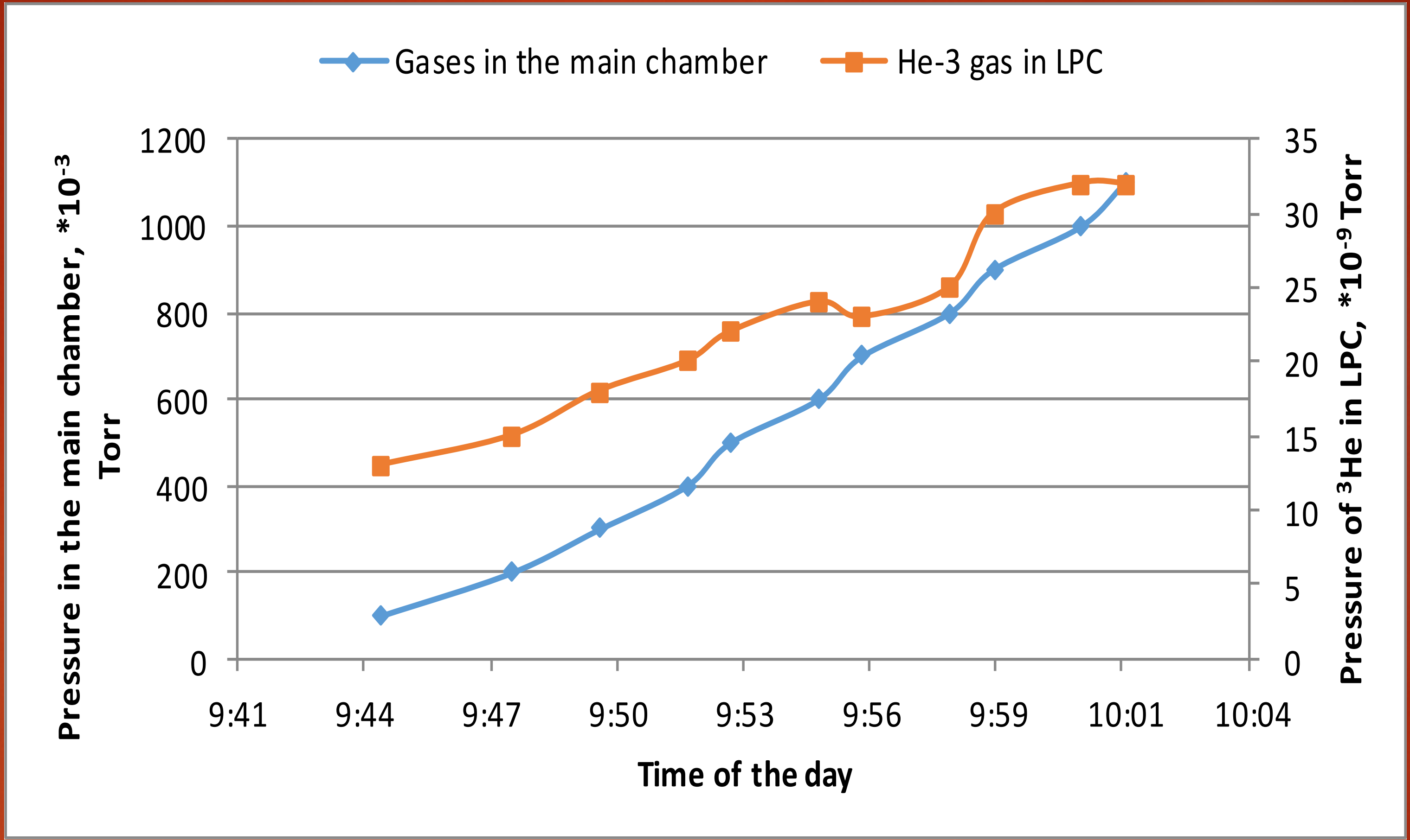
Dependence of ^{3}He pressure in LPC vs the time for constant pressure in the main chamber 300 mTorr (after initial degassing)



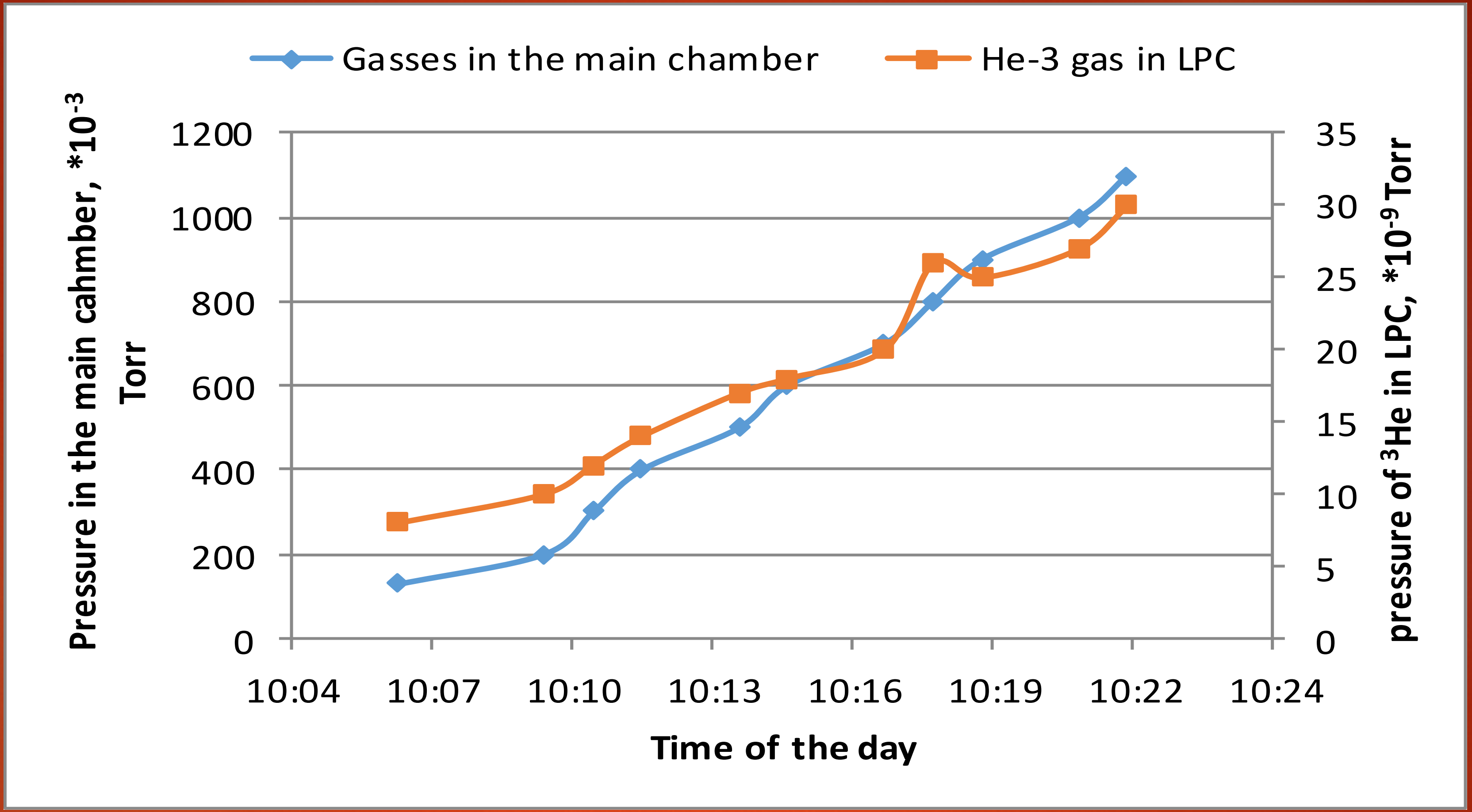
Dependence of ^{3}He pressure in LPC vs pressure of the gasses in the main chamber (after initial degassing)



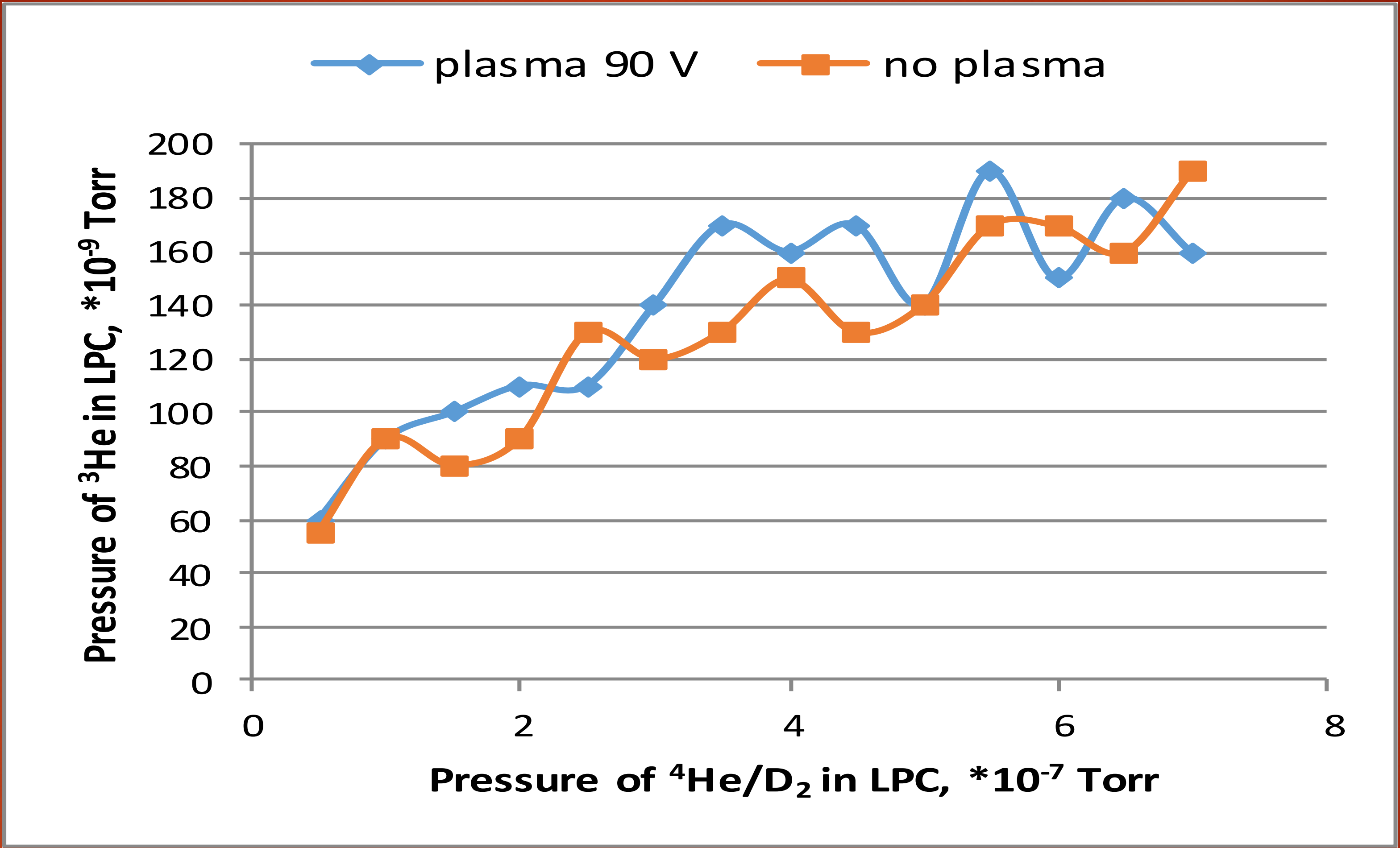
Dependence of ^{3}He pressure in LPC vs pressure of the gasses in the main chamber for room temperature of the sample holder



Dependence of ^{3}He pressure in LPC vs pressure of the gasses in the main chamber and vs. the time at temperature 284^{0} C of the sample holder

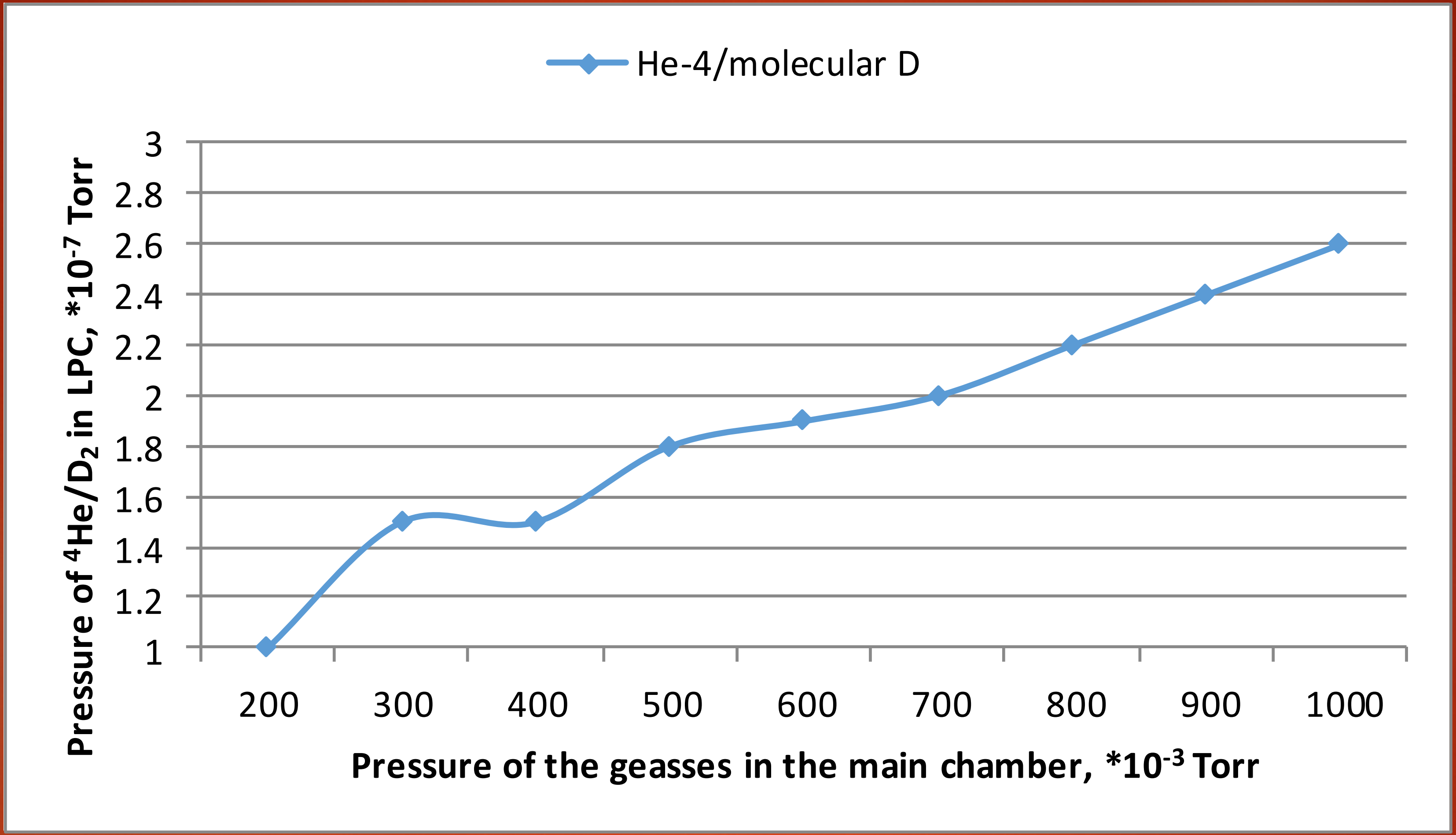


Dependence of ^{3}He pressure in LPC vs pressure of the gasses in the main chamber and vs. the time at temperature 377^{0} C of the sample holder

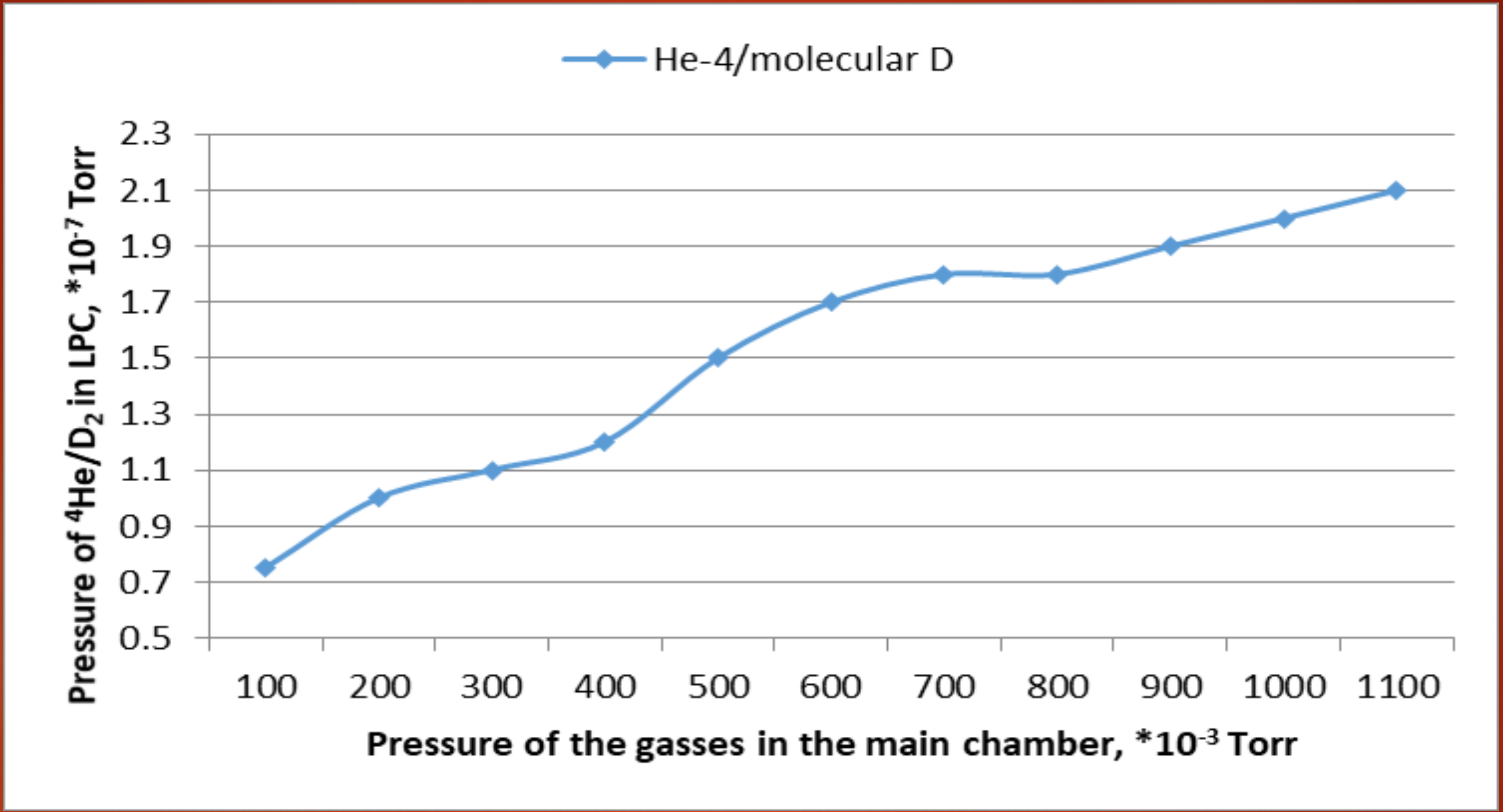


Dependence of ^3He pressure in LPC vs. pressure of $^4He/D_2$ gasses in LPC at room temperature of the sample holder for two modes – without plasma and with 90 V DC plasma

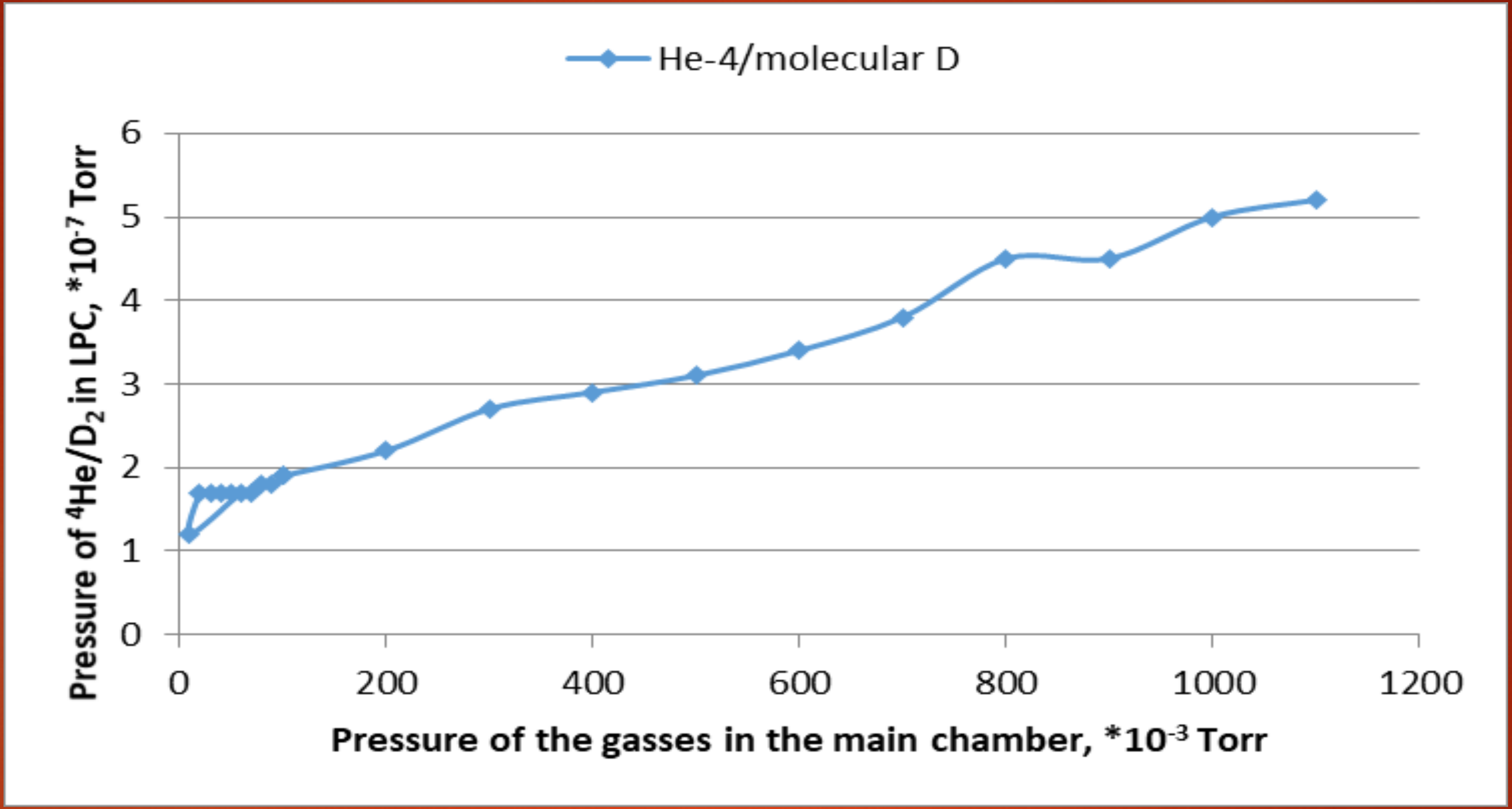
Experiments about ^{4}He



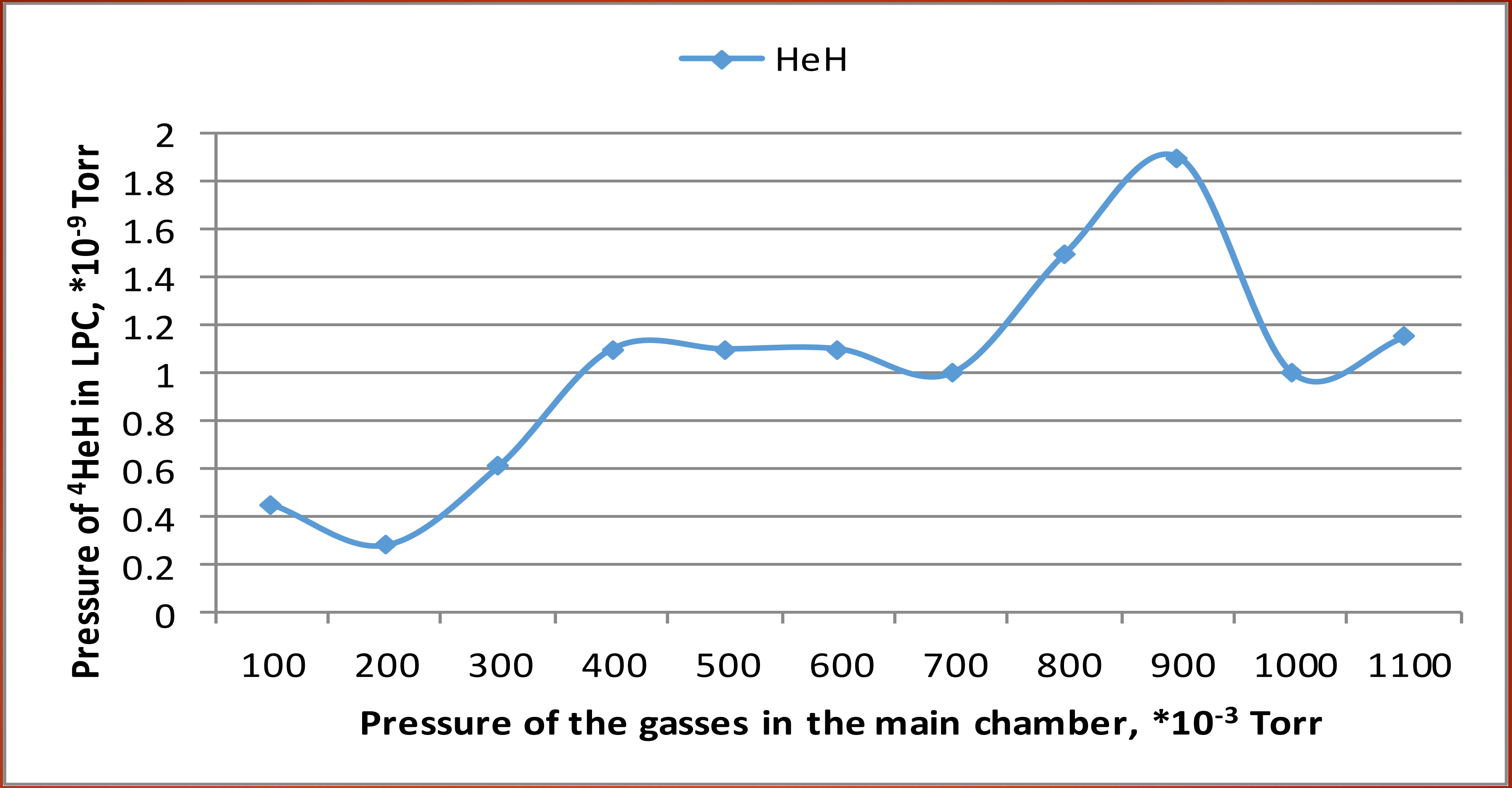
Dependence of $^4He/D_2$ pressure in LPC vs. pressure of the gasses in the main chamber at room temperature of the sample holder



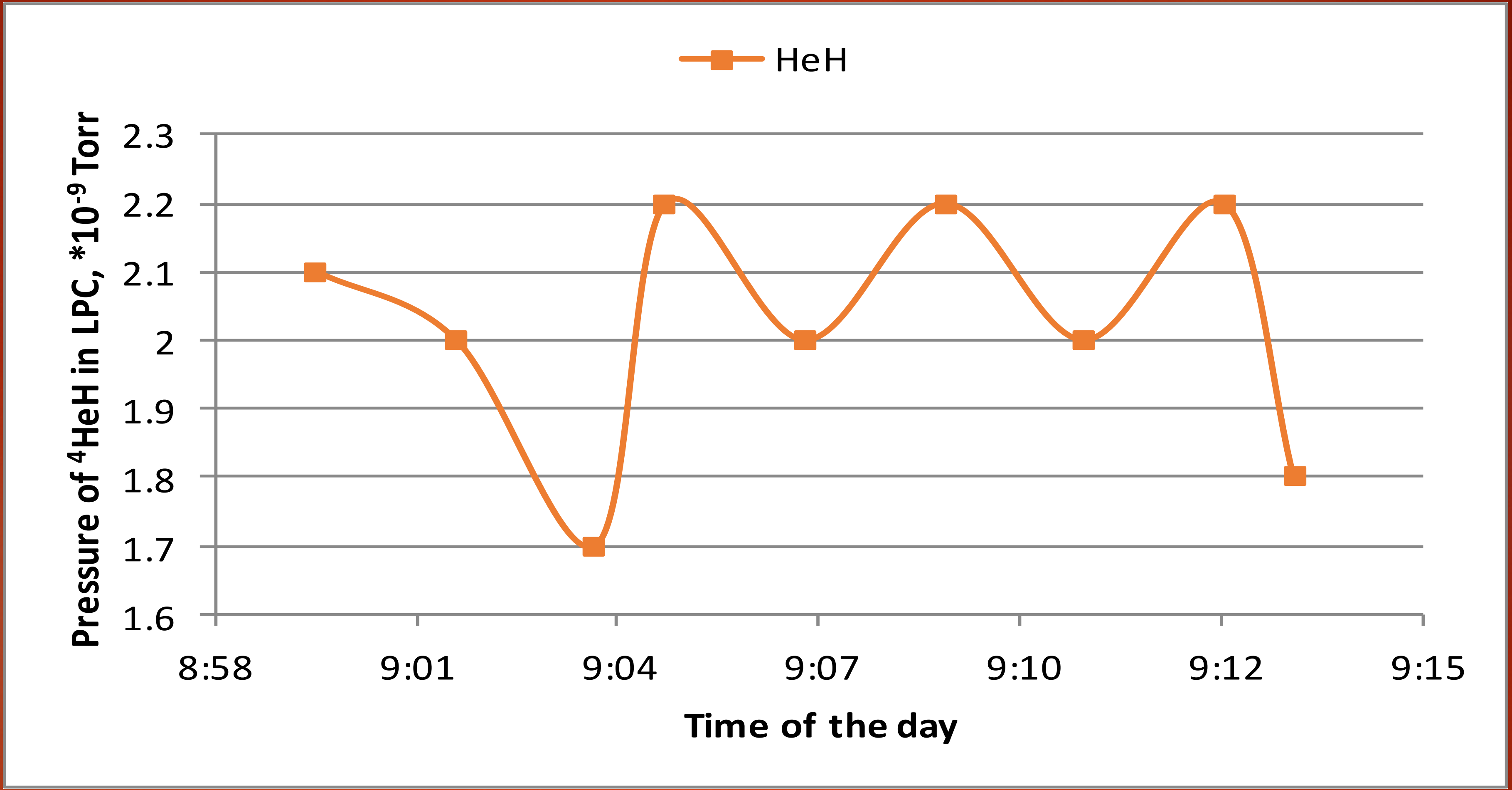
Dependence of $^4He/D_2$ pressure in LPC vs. pressure of the gasses in the main chamber at room temperature of the sample holder



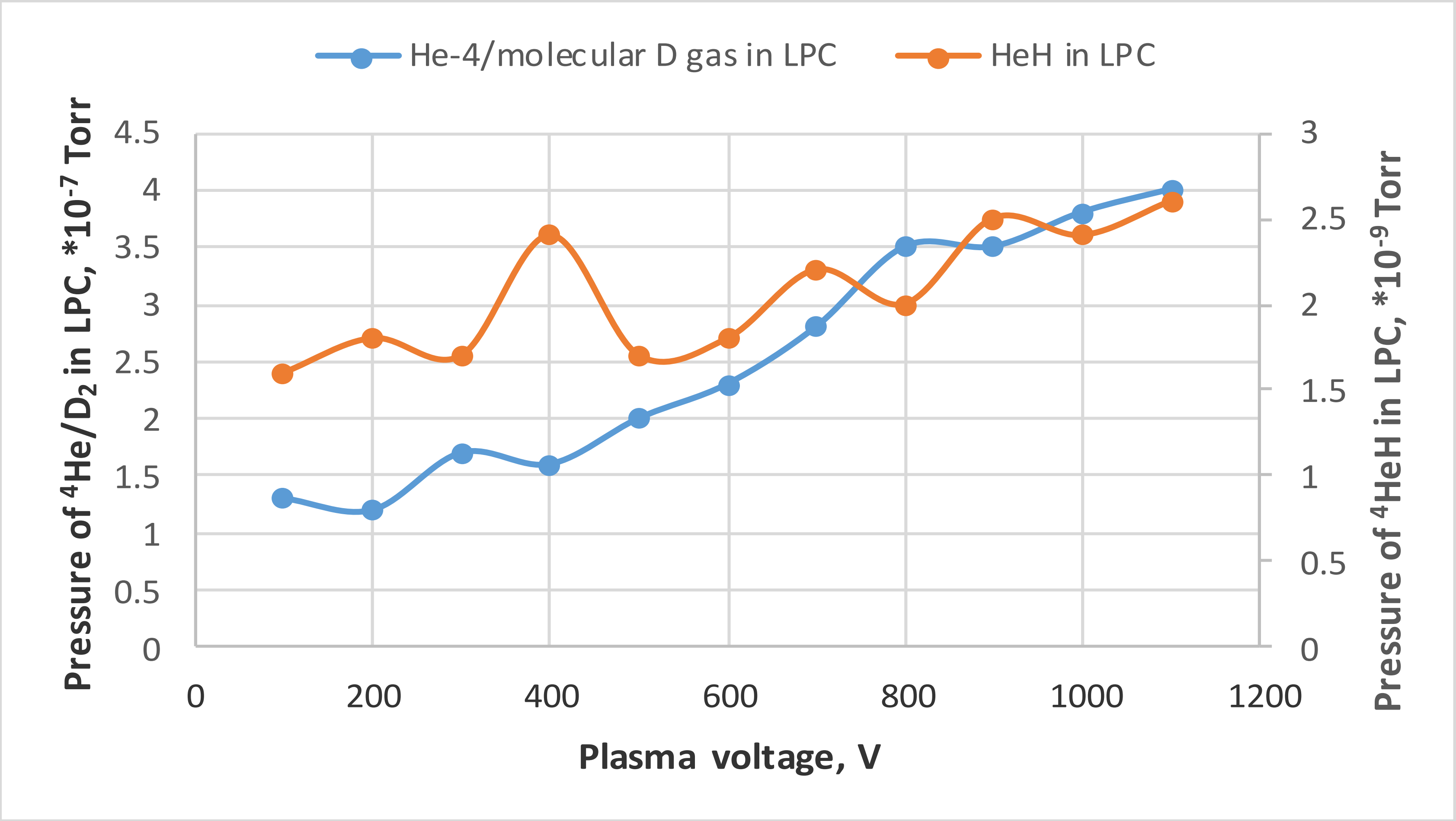
Dependence of $^4He/D_2$ pressure in LPC vs. pressure of the gasses in the main chamber at room temperature of the sample holder



Dependence of HeH pressure in LPC vs. pressure of the gasses in the main chamber at room temperature of the sample holder

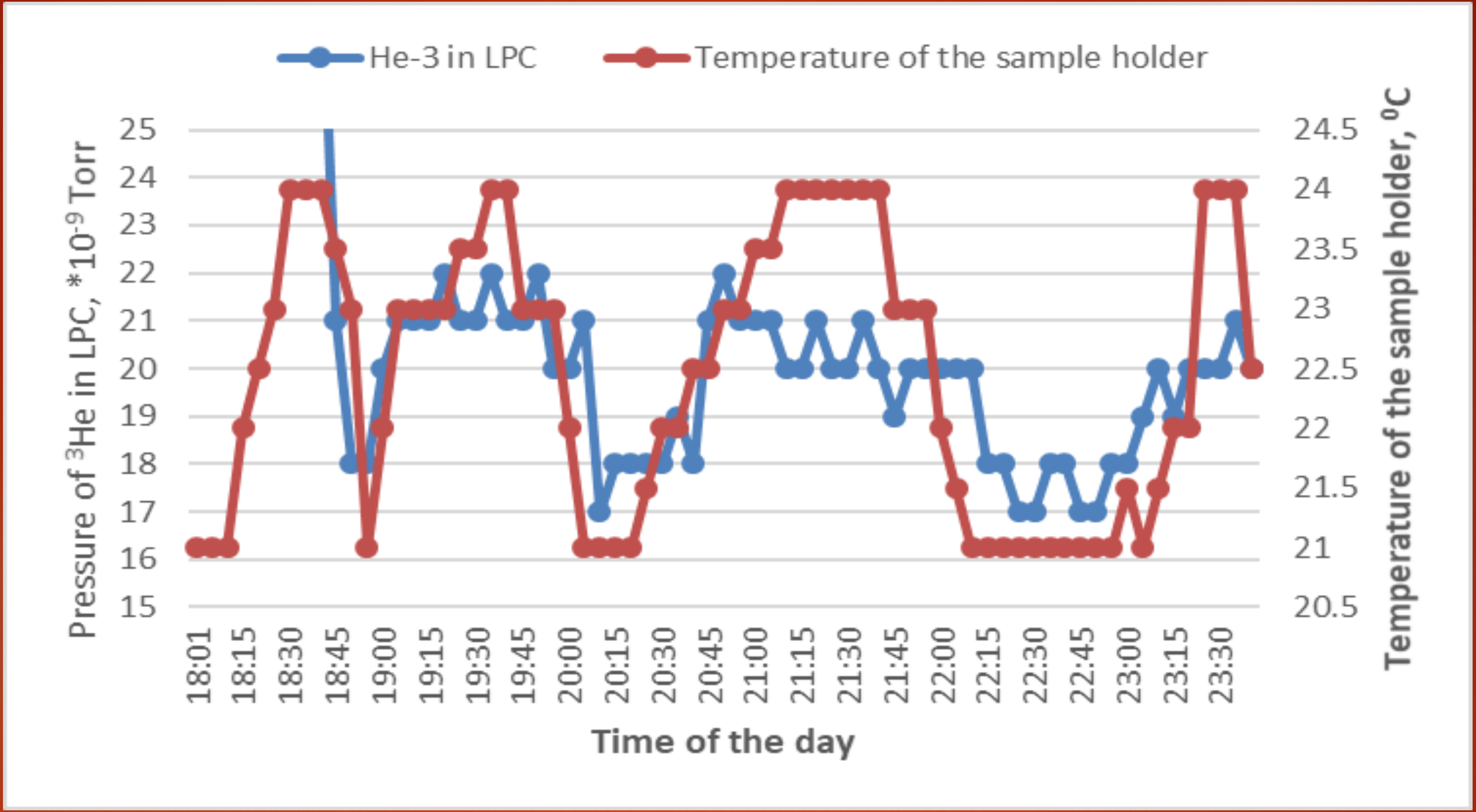


Dependence of HeH pressure in LPC vs. the time at room temperature of the sample holder



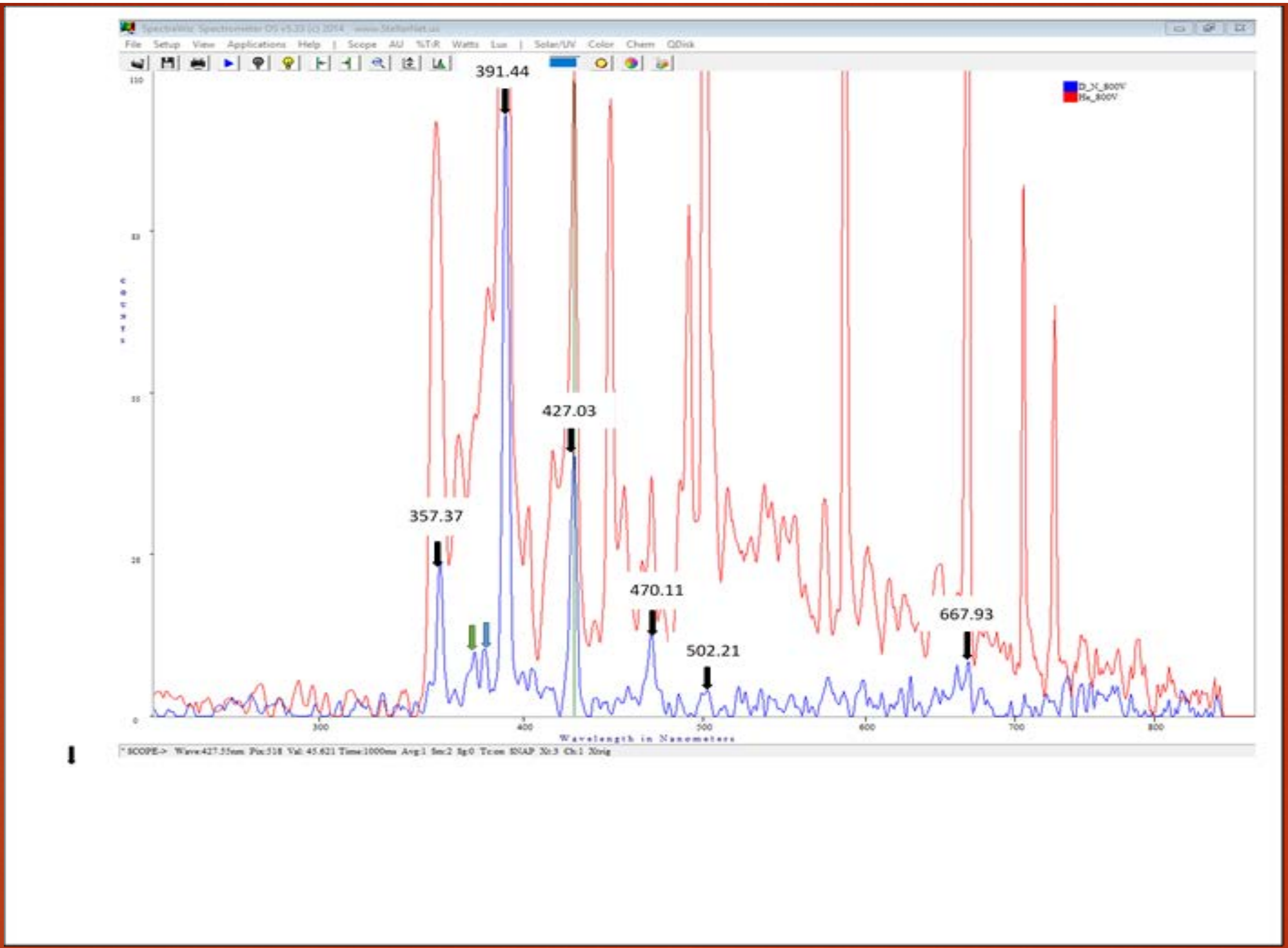
Dependence of HeH pressure in LPC vs. pressure of $^4He/D_2$ in LPC and vs. plasma voltage at room temperature of the sample holder. Dependence of $^4He/D_2$ amount on the plasma voltage.

Generated heat



Temperature of the sample holder vs. the time and ^{3}He pressure in LPC vs. time. Correlation between both graphs is apparent.

Optical spectral experiments



Aligned spectra of plasma of the gasses in the main chamber and of only helium plasma in the main chamber

Radiation during the experiments

- No radiation (including gamma rays and neutrons) greater that the normal background was detected during the experiments carried out.
- It can be assumed that three possible reasons may have place:
- *i)* The radiation (if there is any) has been relatively low due to low amounts of interacting nuclei and it couldn't be detected by the detectors that were placed outside of the chamber; or
- *ii)* There was no radiation at all due to the relatively low kinetic energies of the interacting nuclei; or
- *Iii)* The theory predicts that it is not necessary radiation to be expected.
- However the question about the radiation is actual and proper experiments must be organized.

Outcomes from the experiments

- Nuclear synthesis of ^{3}He was registered during the experiments and the scheme was $D + H \rightarrow {}^{3}He$ + energy;

- Nuclear synthesis of ^{4}He was registered during the experiments and the scheme was $D + D \rightarrow {}^{4}He$ + energy;

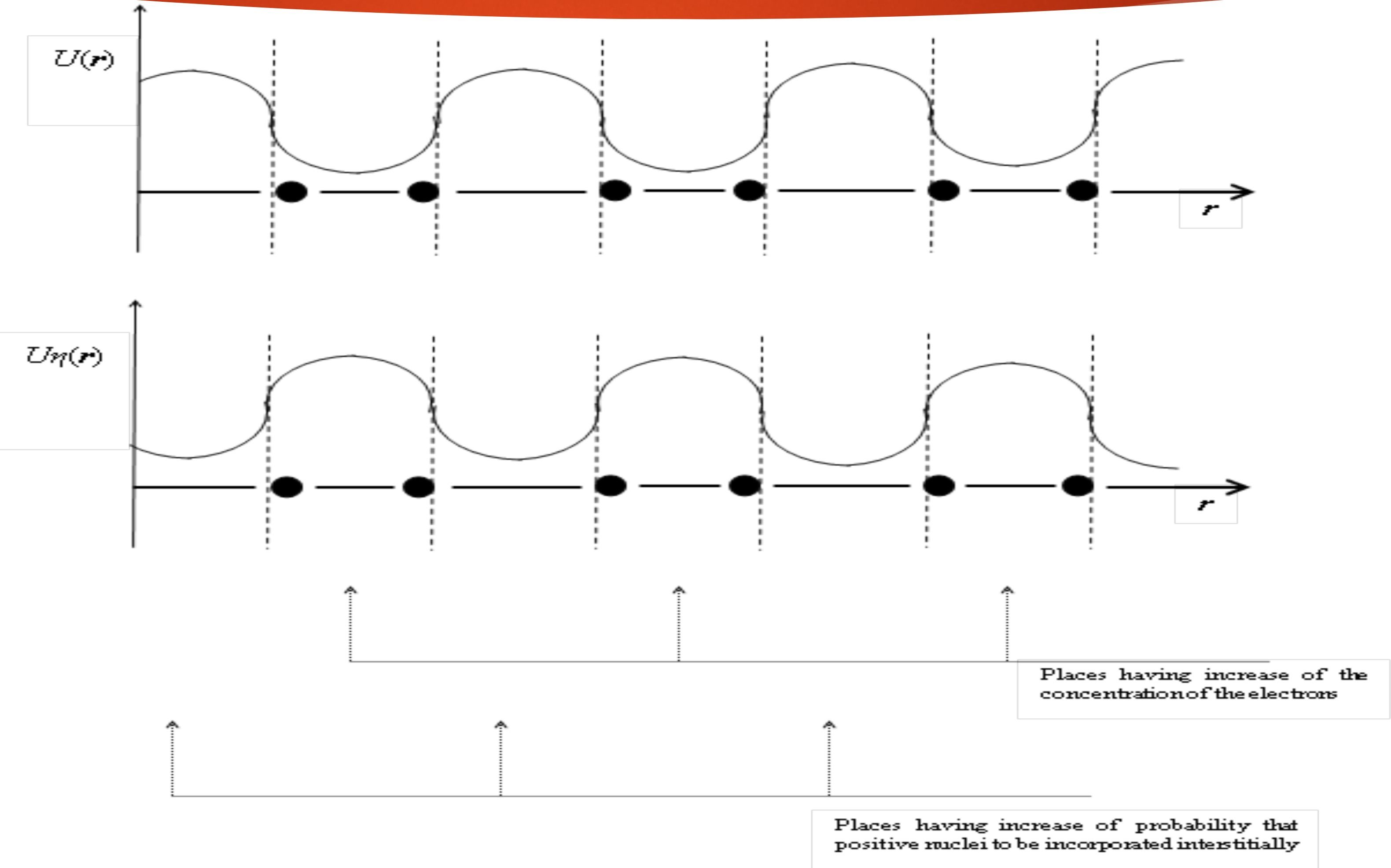
- The released energy, which was detected, was heat.

- The increase of the temperature increases of the amounts of both ^{3}He and ^{4}He.

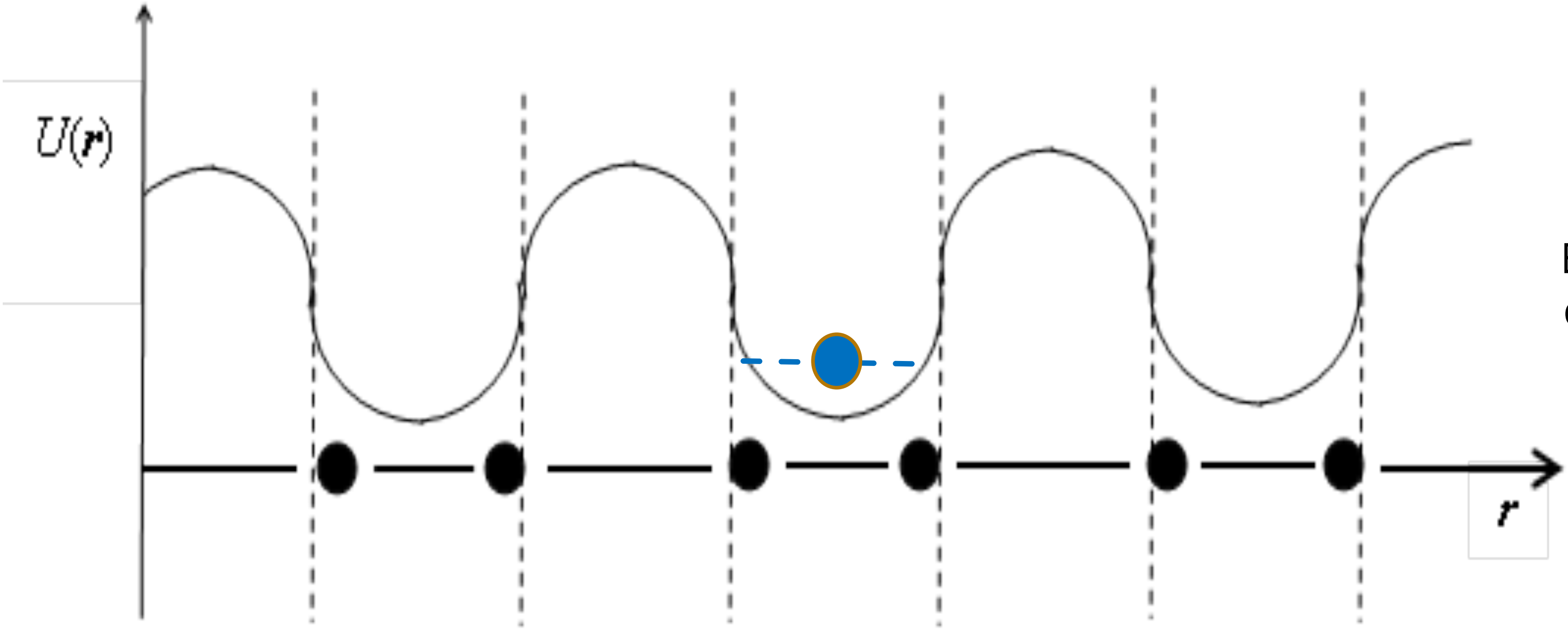
- The increase of the kinetic energies of both D and H increases the amounts of both ^{3}He and ^{4}He.

Theory

Fluctuation potentials in an atomic chain



Electron non-zone effective mass



Electron non-zone effective mass
$m^e{}_{eff,r}$

Electron level in the well

Electron non-zone effective mass (cnt.)

- Derivation of the Hamiltonian of the second quantization

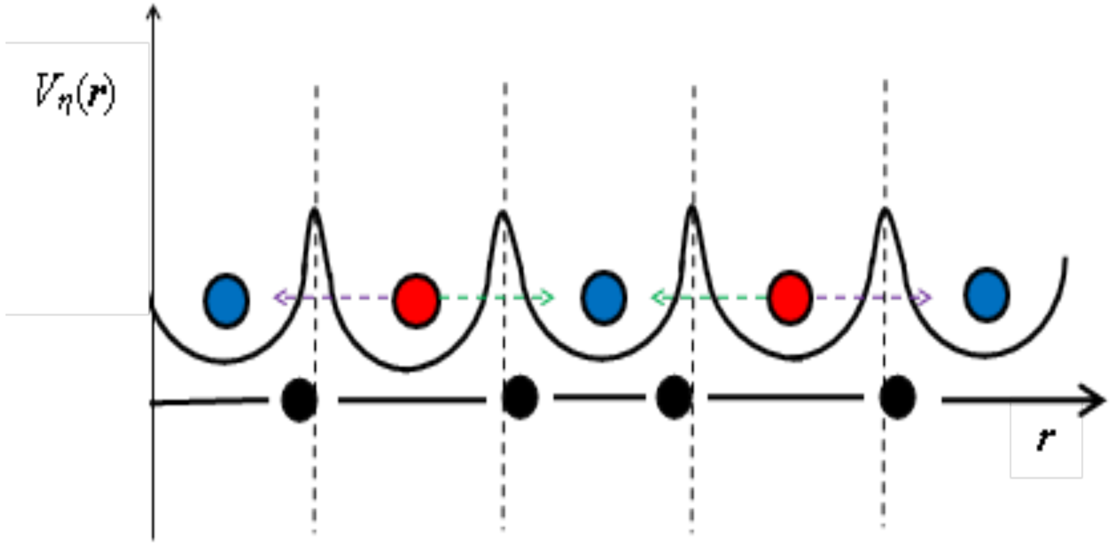
$$\Downarrow$$

- $$m^{e}_{eff,r} \sim \exp\left[\, f\,(W)\right]$$

W – vectors of longitudinal lattice vibrations

Conclusion: If the temperature (T) increases $m^{e}_{eff,r}$ increases.

Potential pertaining to interstitially incorporated nuclei



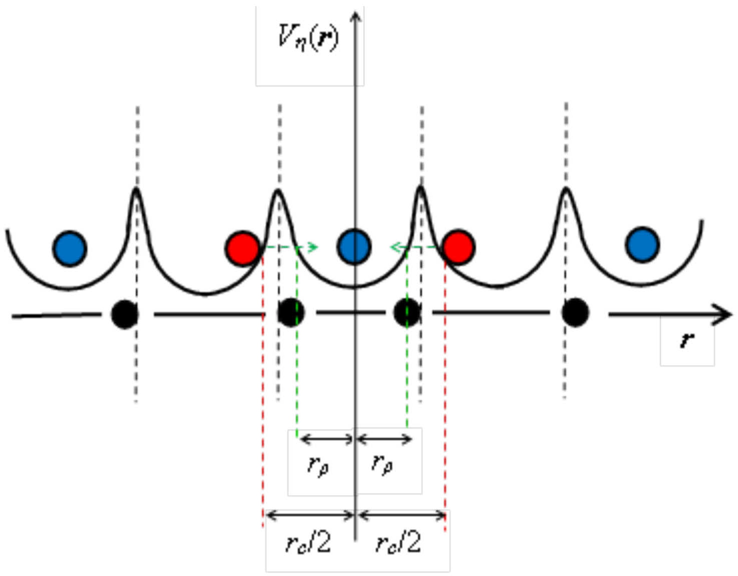
Localized electron

D or H nucleus

$$V_\eta(\boldsymbol{r}) \approx U_\eta(\boldsymbol{r}) + \frac{e^2}{4\pi\varepsilon r_c} - \frac{e^2}{4\pi\varepsilon r_{el}} - \frac{e^2}{4\pi\varepsilon r_{er}}$$

M_D, M_H << M_I

Quantum tunneling of the nuclei and the transmission coefficients



Transmission coefficient for the structure D|-|D

$$D_{D|\text{-}|D} = \exp\{-\frac{4M_D}{\hbar}[\int_{r_c/2}^{r_\rho}\sqrt{V_\eta(\boldsymbol{r}) - E_r}\,dr + \int_{-r_c/2}^{-r_\rho}\sqrt{V_\eta(\boldsymbol{r}) - E_l}\,dr]\}$$

Transmission coefficient for the structure D|-|H

$$D_{D|\text{-}|H} = \exp\{-\frac{2}{\hbar}\int_{r_c/2}^{r_\rho}\sqrt{2M_H[V_\eta(\boldsymbol{r}) - E_r]}\,dr - \frac{2}{\hbar}\int_{-r_c/2}^{-r_\rho}\sqrt{2M_D[V_\eta(\boldsymbol{r}) - E_l]}\,dr\}$$

$$D_{D|\text{-}|H} > D_{D|\text{-}|D}$$

i) If $\boldsymbol{r_c}$ decreases (T increases) both $D_{D|\text{-}|H} > D_{D|\text{-}|D}$ increase;

ii) If either E_r or E_l (or both) increase both $D_{D|\text{-}|H} > D_{D|\text{-}|D}$ increase.

Number operator in the fusion well

- For both structures D|-|D and D|-|H the number operator in the fusion well is:

  - $\check{N} = D_l\, c^{+}_{\boldsymbol{kl}\ Sl}\, c_{\boldsymbol{kl}\ Sl} + D_r\, c^{+}_{\boldsymbol{kr}\ Sr}\, c_{\boldsymbol{kr}\ Sr}$

- D_l and D_r transmission coefficients of both the left barrier and the right barrier respectively

Fusion reactions and released energies

- i) Fusion reaction based on the structure D|-|D
- $D + D \longrightarrow {}^{4}He + 28.30$ MeV

- ii) Fusion reaction based on the structure D|-|H
- $D + H \longrightarrow {}^{3}He + 7.222$ MeV

- (Fusion reactions based on both structures D|-|T and HH|-|HH were not studied)
- The types of the released must have further investigation – currently it is assumed that only head is released.

Theoretical outcomes and their connections with the experimental outcomes

- *i)* Increase of the temperature (T) increases the probabilities for both fusion reactions – it is connected with the experimental facts that the concentrations of both ^4He and ^3He increase with the increase of the temperature;
- *ii)* Increase of the kinetic energies of the interacting nuclei (D and D, and D and H) increases the probability for both fusion reactions – it is connected with the experimental facts that the concentrations of both ^4He and ^3He increase with the increase of the plasma voltage;
- *Iii)* The released energies of the fusion reactions partially destroy the crystal lattice making that the corresponding regions not to be able to participate in immediate further reactions – it corresponds to the cyclic change of the temperature that was observed experimentally, i.e. time for recovery of the crystal lattice is needed in order fusion reactions to be re-established again;
- *iv)* Any partial destroy of the crystal lattice (mechanical or as result of fusion reaction) brings the corresponding destroyed regions out of order regarding the fusion reaction.

Thank you!

- *Q & A*