CURRENT STATUS OF DEVELOPMENT OF THE D-D NEUTRON GENERATOR FOR CALIBRATION OF THE DS-20K DETECTOR

M. Gromov[1], A. Chepurnov[1], A. Klenin[1], A. Kubankin[1], A. Oleinik[1]

[1]Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University
[2]Belgorod State University, Belgorod, Russia

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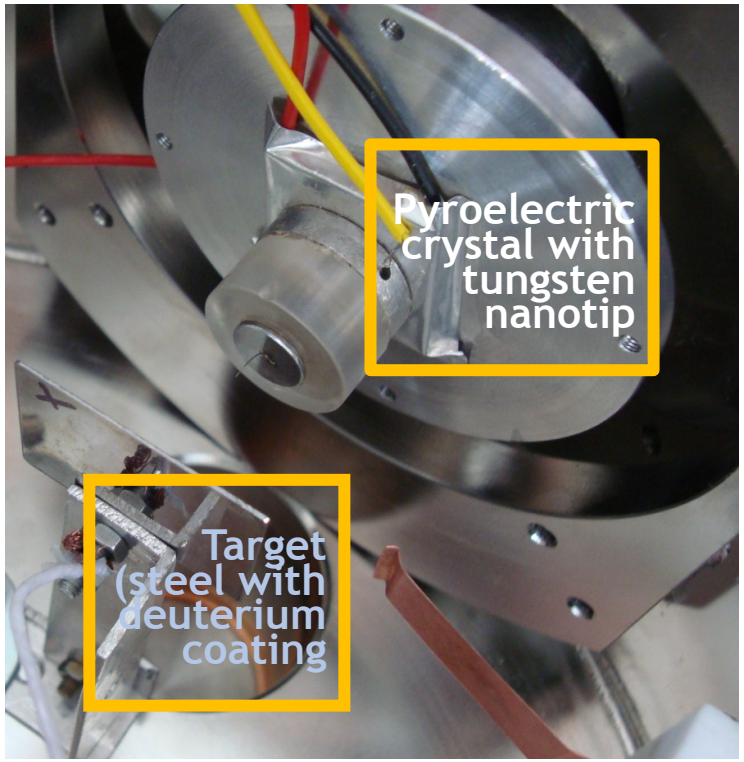
PREHISTORY

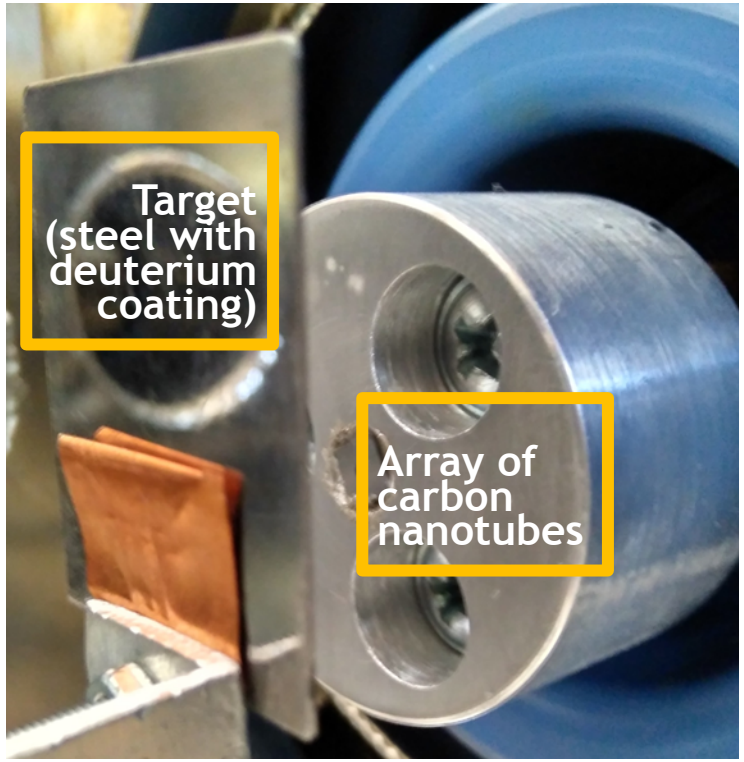
The main aim is the development of compact, controllable and ultralow-intensity neutron gun compatible with construction of the detector

1. Pyroelectric neutron generator



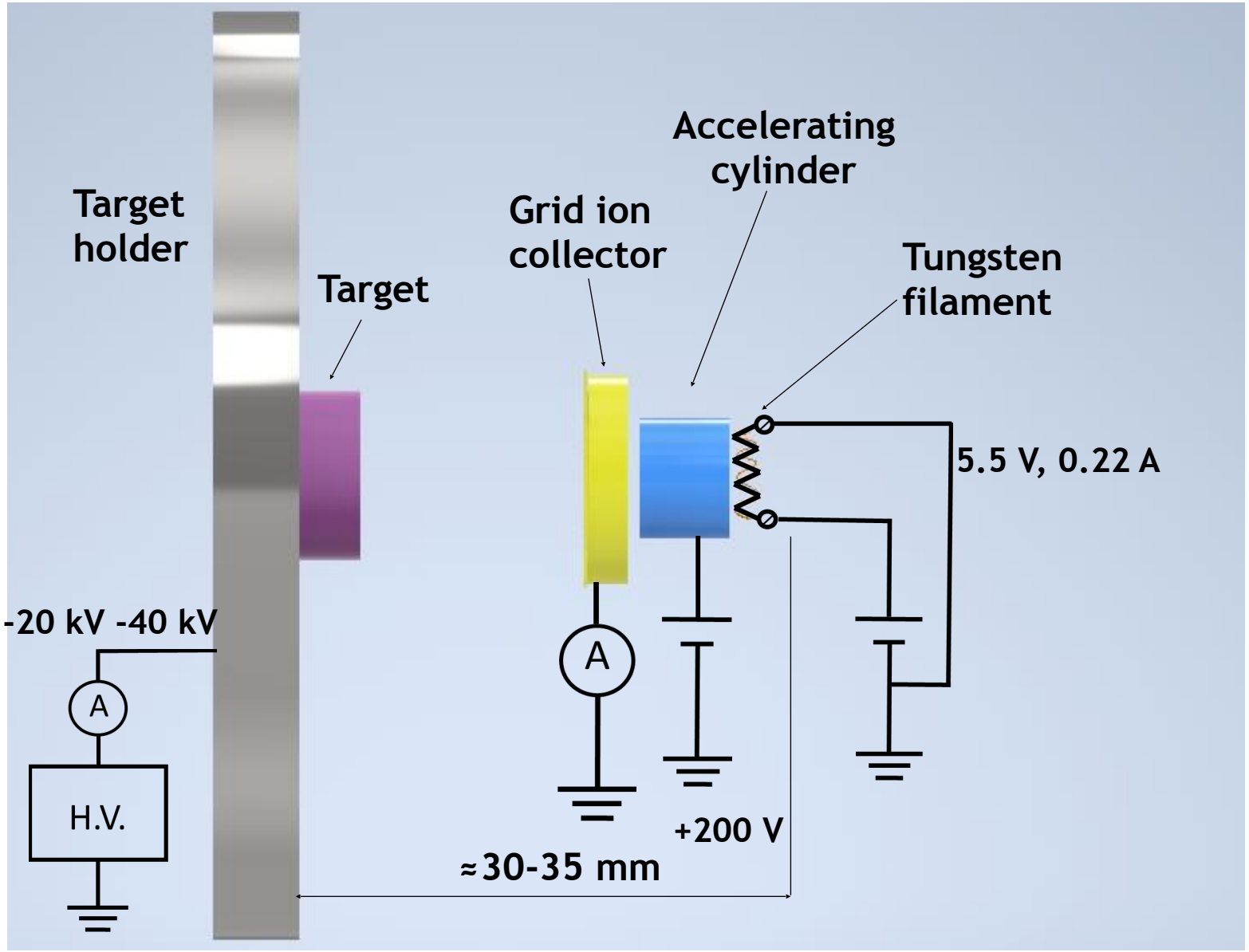
- ✗ Unstable electric potential (high probability of breakdowns)
- ✗ Fast degradation of ionizators (several thermal cycle, 1-2 hours)

2. Nanotube-based neutron generator



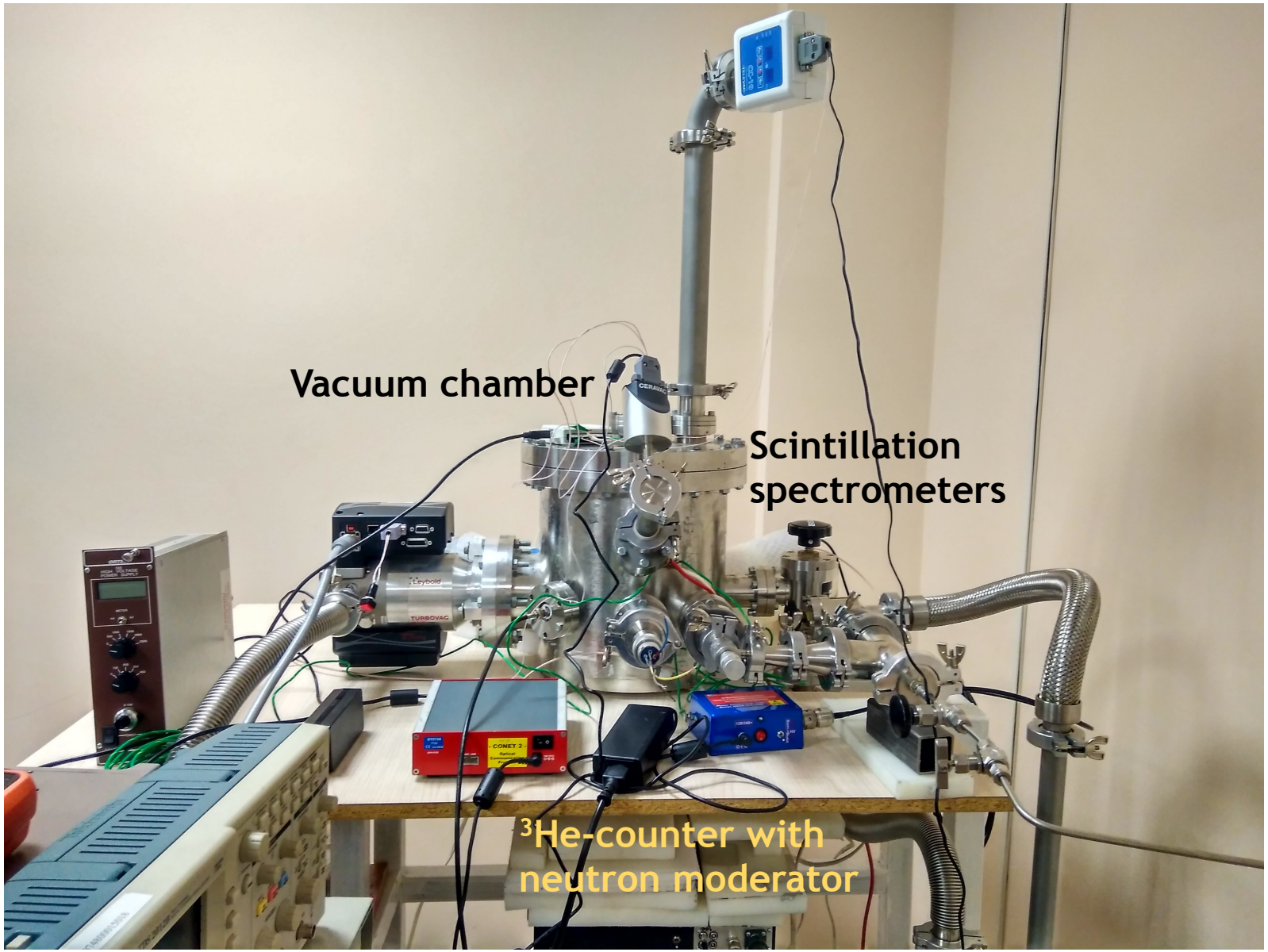
- ✗ Pulsed nature of neutron generation
- ✗ Unpredictable behaviour of the generator

CURRENT CONFIGURATION OF DD-GUN



- Operating principle
  - emitted electrons generate ions by impact ionization and hit the cylinder
  - generated D^+ ions accelerate to the target, which at negative HV
- Ion source
  - tungsten filament as a electron emitter
  - accelerating cylinder and electron collector
  - grid ion collector
- Target
  - titanium deuteride prepared by cold isostatic pressing of the TiD_2 powder
- Desired parameters of the gun
  - ion current: up to 1.5 mkA
  - ion energy: up to 30 keV
  - desirable neutron yield: up to 200 n/s in 4π

EXPERIMENTAL SETUP



- **Neutron measurement**
  - **^{3}He-counter**
  - **Scintillation pectrometers (SDMF, Russia)**

All instruments were calibrated at neutron source in Lebedev Physical Institute in Moscow

- **Current measurement**
  - **Keithley 6485 (grid)**
  - **Internal currentmeter of HV source (target)**

- **Pressure measurement**
  - **Televac CC-10**
  - **Ceravac CTR-100 (insensitive to a type of gas)**

MEASUREMENT PLAN AND PRELIMINARY RESULTS

Type of configuration (HV, target)	Pressure (mTorr)	Ion current (mkA)	Total measurement duration (hours)	Expected neutron flux (n/s in 4π)	Obtained neutron flux (n/s in 4π)
Background	0.01-atmosphere	> 0.01	< 100	-	10±2
-20 kV, TiD_2	1±0.2	≈1-1.2	<10	8-10	background level
-30 kV, TiD_2	1±0.2	measurement in progress	<10	50-70	measurement in progress
-40 kV, TiD_2	1±0.2	measurement in progress	<10	200-250	measurement in progress

The TiD_2 target after 20 hours of ion irradiation

New tests with deuterated film target, which have higher deuterium density than TiD_2, are possible. Adjusting the ion source (defocusing) allows to distribute the ion flux over the surface, which should increase the target resource. *(in the coming months)*

ISSUES TO IMPLEMENT THE GENERATOR INTO THE DETECTOR

The DD-generator is developed based on limitations of diameter of 38 mm and length of 70 mm

The DD-generator body is ready and based on high electric-strength ceramic (based on ZnO)

Diameter of the generator body is 32 mm, the height is 60 mm

The prototype of special HV source for the DD-generator

Diameter of the source is 30 mm, the height is 60 mm

- ❑ **Heat production**
  - need special simulation
  - power consumption of current configuration: <40 W (only HV, filament and cylinder voltage sources)
- ❑ **Radioactivity budget**
  - Will be calculated ….
- ❑ **Cables**
  - In common, it is required low voltage lines for the filament, cylinder and for the HV source
- ❑ **Lifetime**
  - Will be measured (It is expected that the main limit will be the filament)

In case of the source and generator built together: total length at least 12 cm

CONCLUSION

- The proposed approach is based on impact ionization of deuterium and applying negative HV to the target.

- The stable ion flux is obtained at level 1-1.2 mkA (it should be enough for achieving the desirable neutron flux).

- The prototypes of the generator body and HV source are prepared. Its tests are coming soon.

- The next steps will be:
  - Measurement of neutron flux according to plan above
  - Refinement of target and new test with target based on deuterium film (if it is necessary)
  - The start of DD-generator tests in the body and definition of its lifetime