Response of semiconductor boron based radiation detectors to high flux of thermal neutrons

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   - Typical spectra
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   - Charge transport properties estimation
4. Experiments on nuclear reactor
   - Experimental setup
   - Typical spectra
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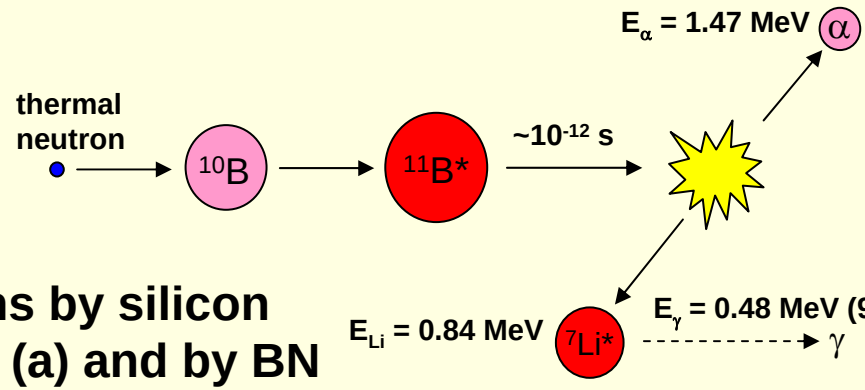
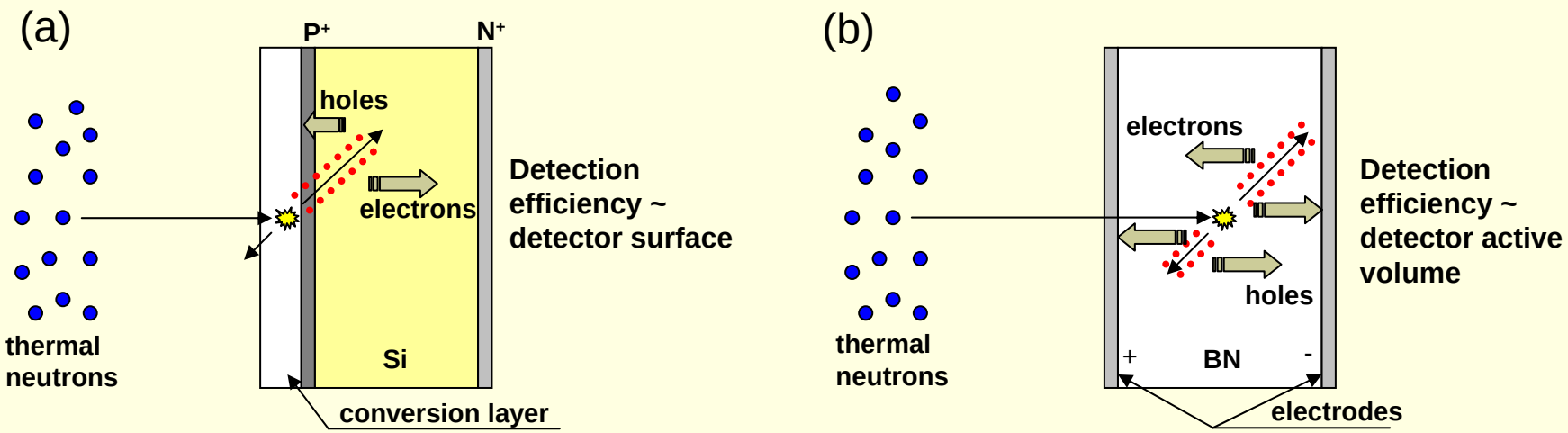
Main idea

Layout of neutron reaction with ^{10}B:

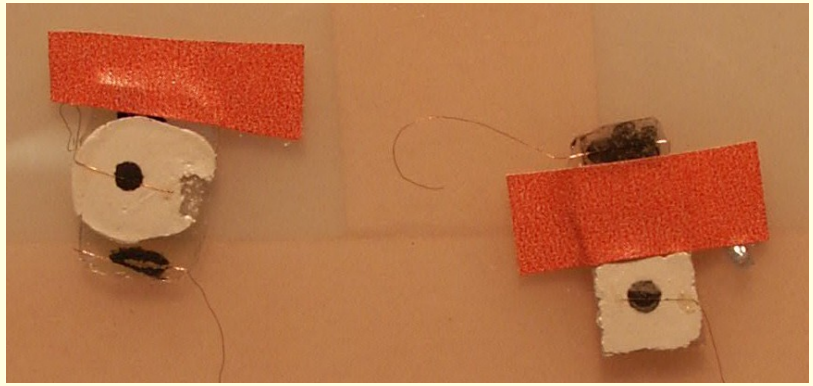


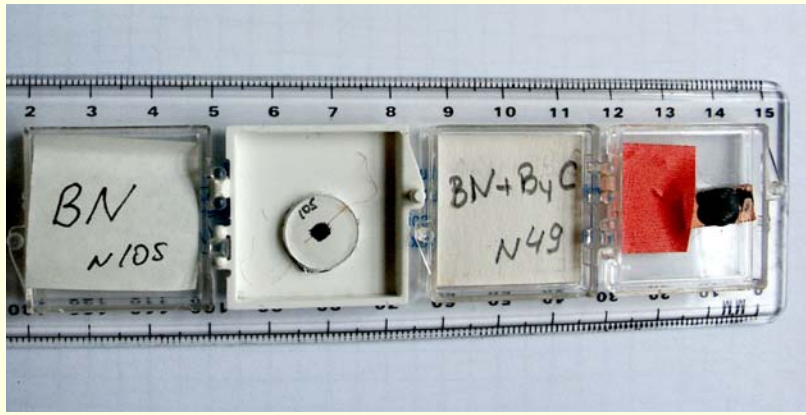
Detection principle of thermal neutrons by silicon sensor covered by a conversion layer (a) and by BN detector (b):



Description of studied samples

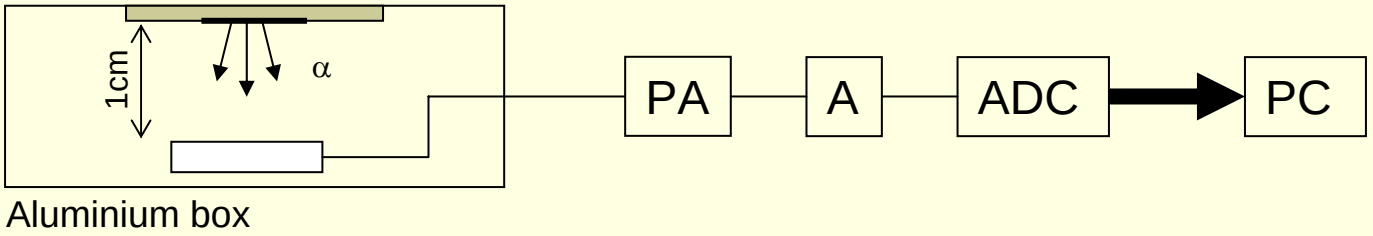
- Detectors:
  - prepared by Prof. Schieber from Hebrew University in Jerusalem;
  - made from two differential materials.
- Material 1 (white samples):
  - planar composite polycrystalline semiconductor bounded with plastic binders and coated with different metal electrodes;
  - hexagonal natural BN (50%) and plastic binder (50%) => only 10% of volume is occupied by ^{10}B.
- Material 2 (black sample):
  - BN intermingled with B_4C





Alpha spectroscopy

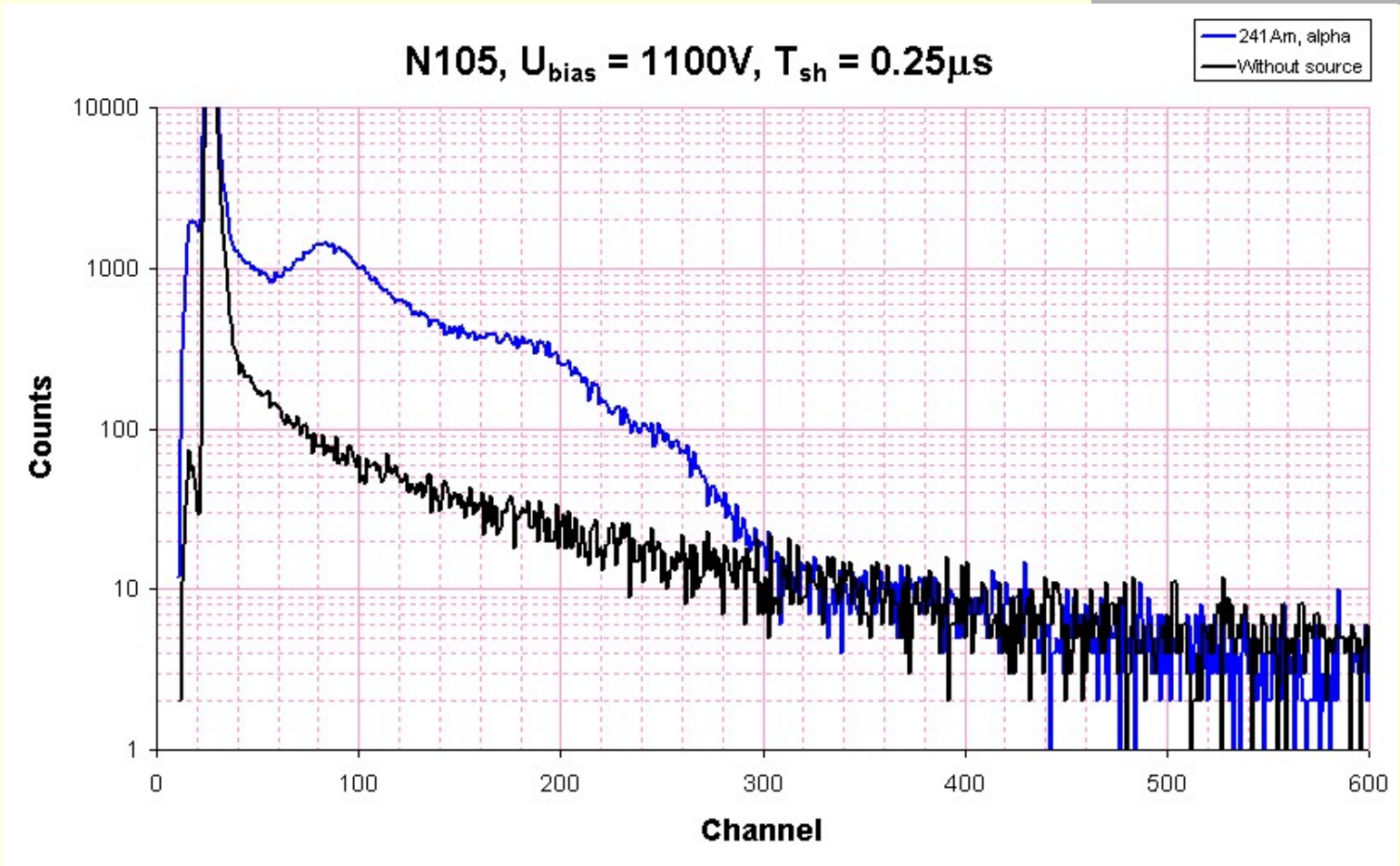
- Experimental setup



- α – alpha particles emitted by ^{241}Am (T_α ~ 5.5MeV)
- PA – charge sensitive preamplifier
- A – linear amplifier with semi-gaussian shaping
  - Coarse gain: 50x (for Si) and 1000x (for BN)
  - Shaping time: 0.25 μs
- ADC – analog-to-digital converter
- PC – personal computer

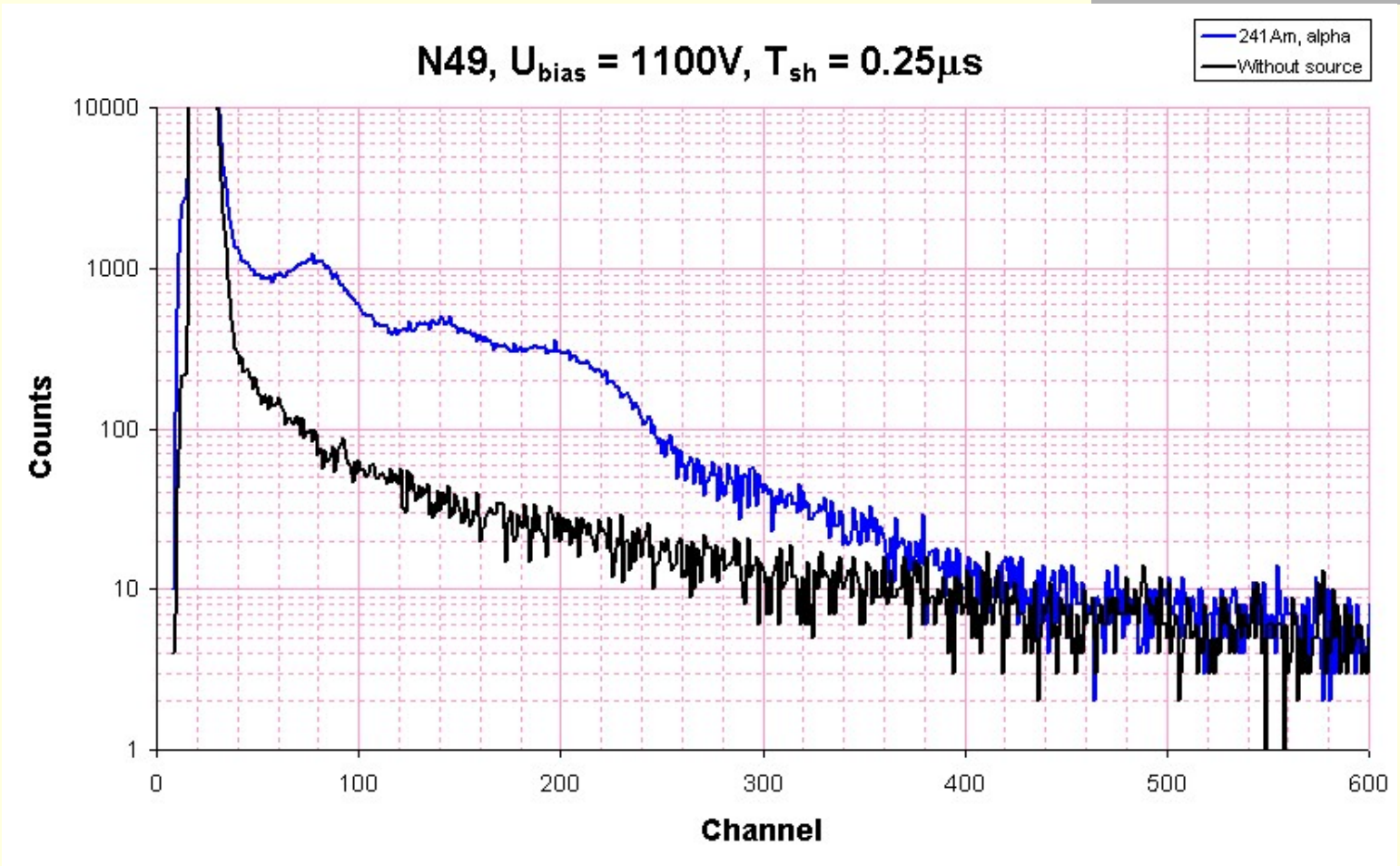
Alpha spectroscopy

- Typical alpha spectrum of BN detector



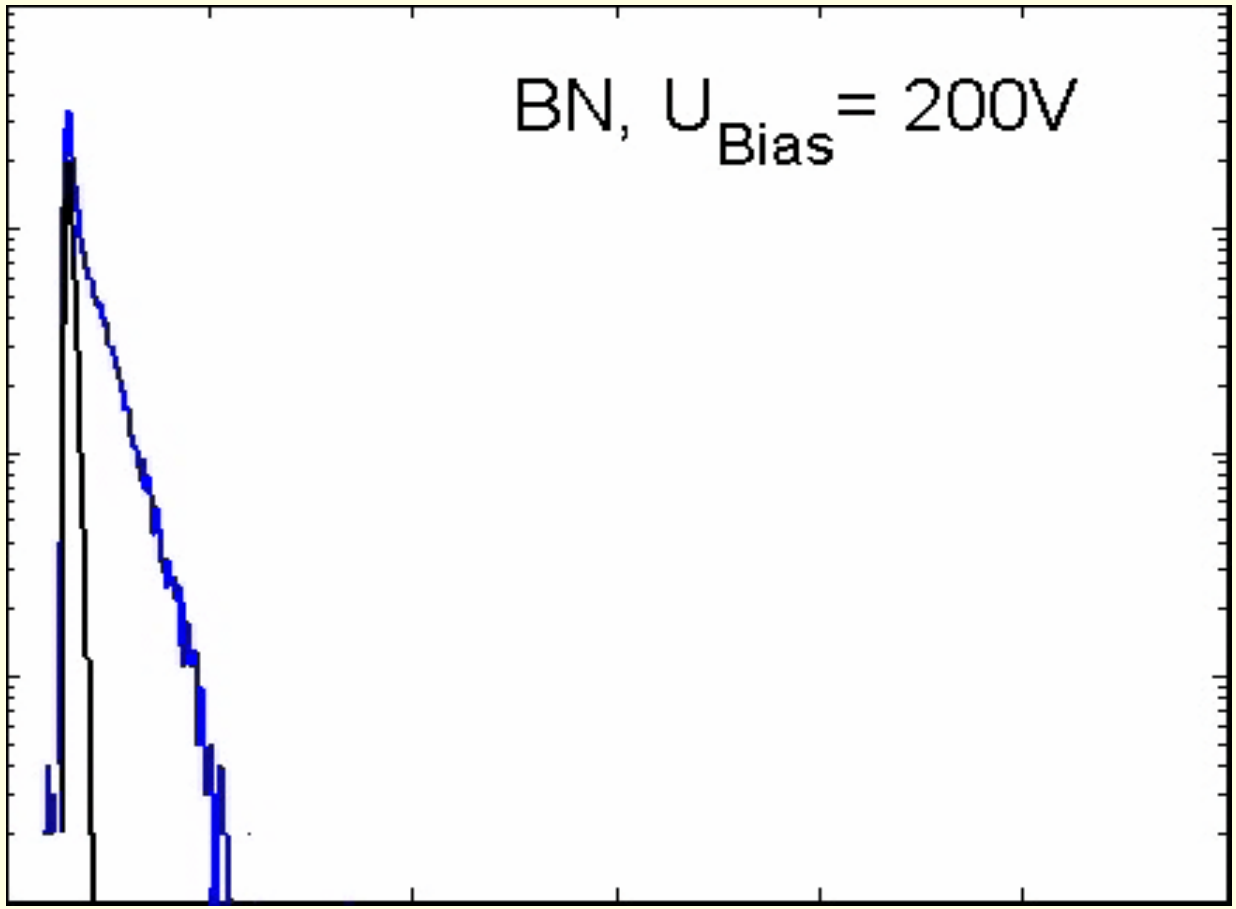
Alpha spectroscopy

- Typical alpha spectrum of $BN+B_4C$ detector



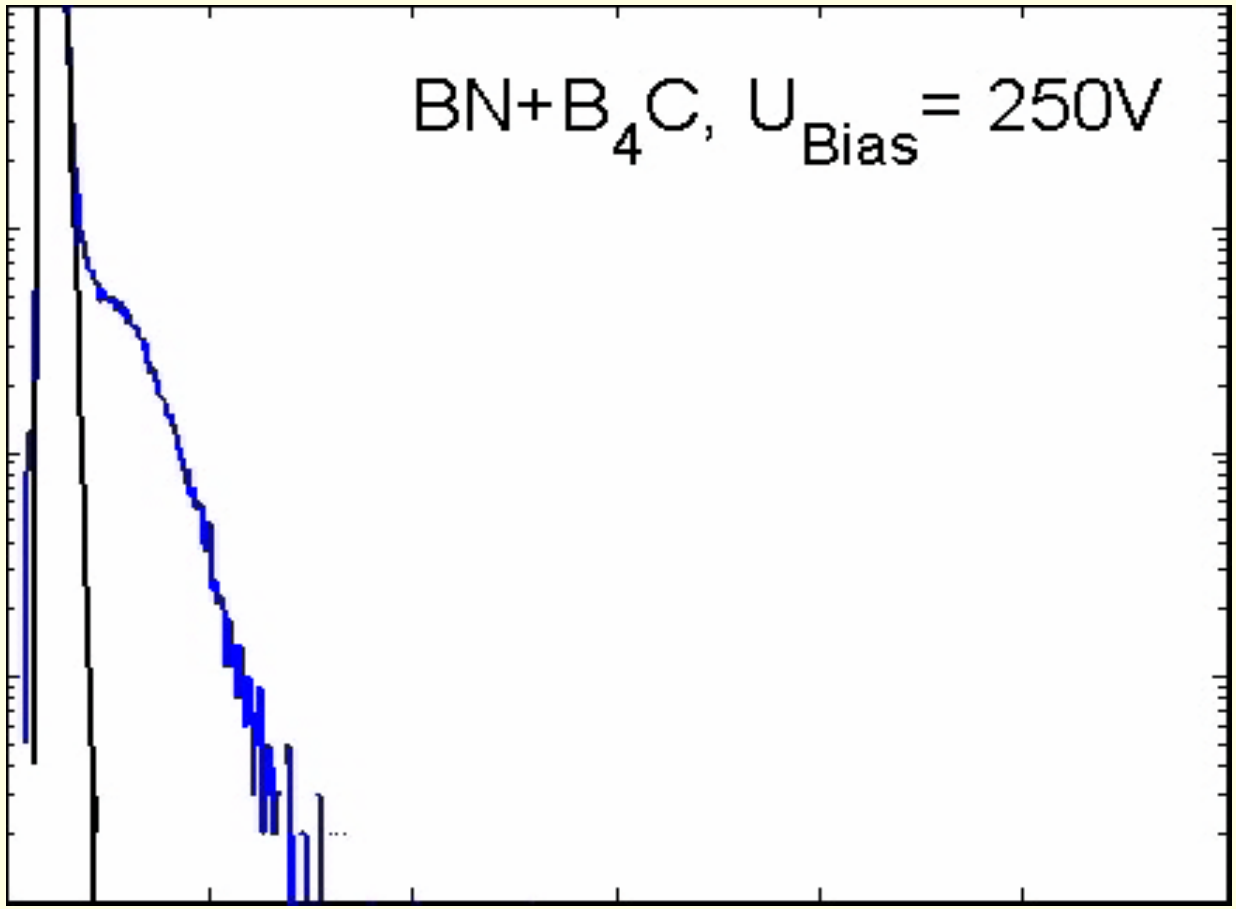
Alpha spectroscopy

- Evolution of spectrum in dependence on bias



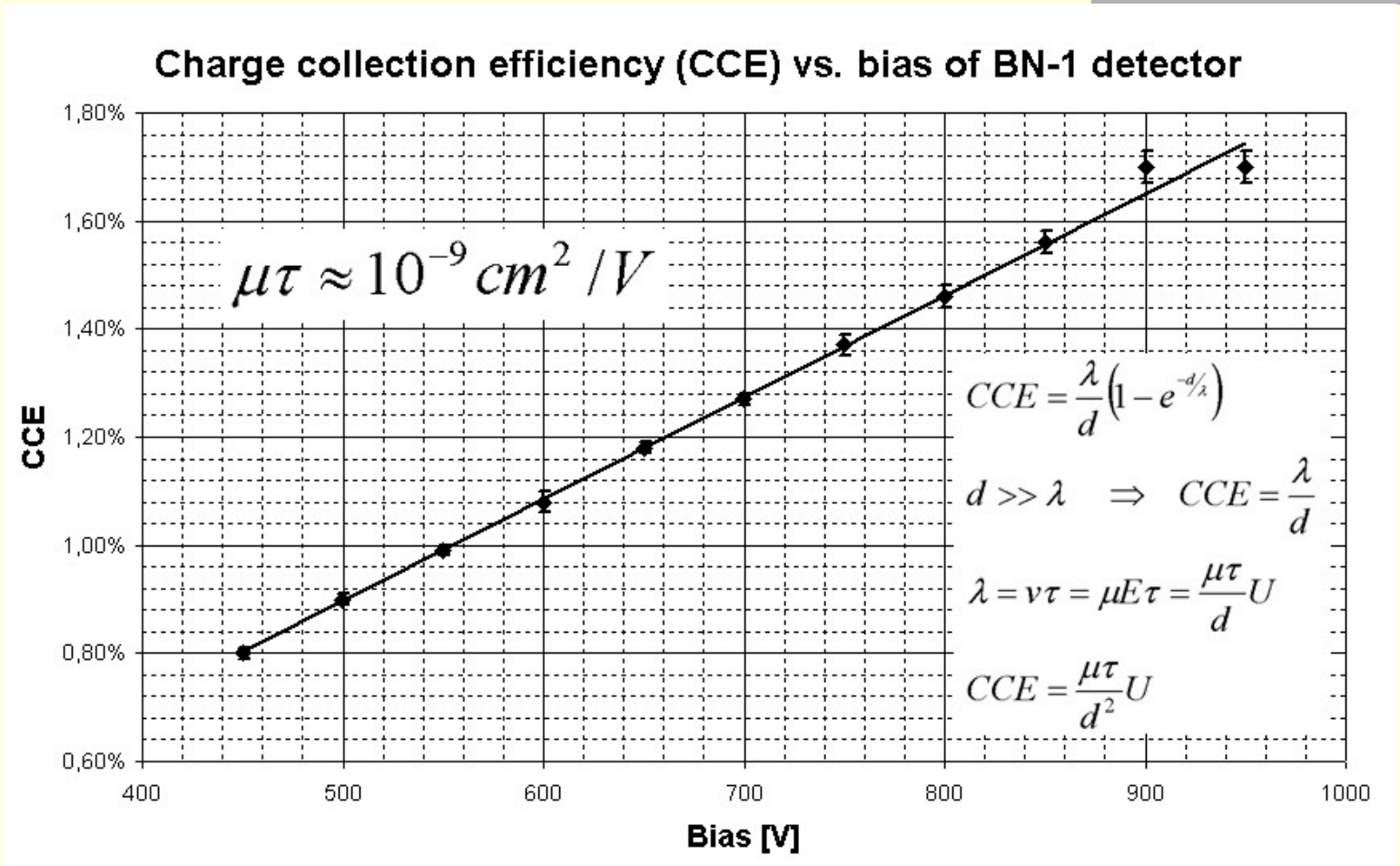
Alpha spectroscopy

- Evolution of spectrum in dependence on bias



Alpha spectroscopy

- Charge transport properties estimation

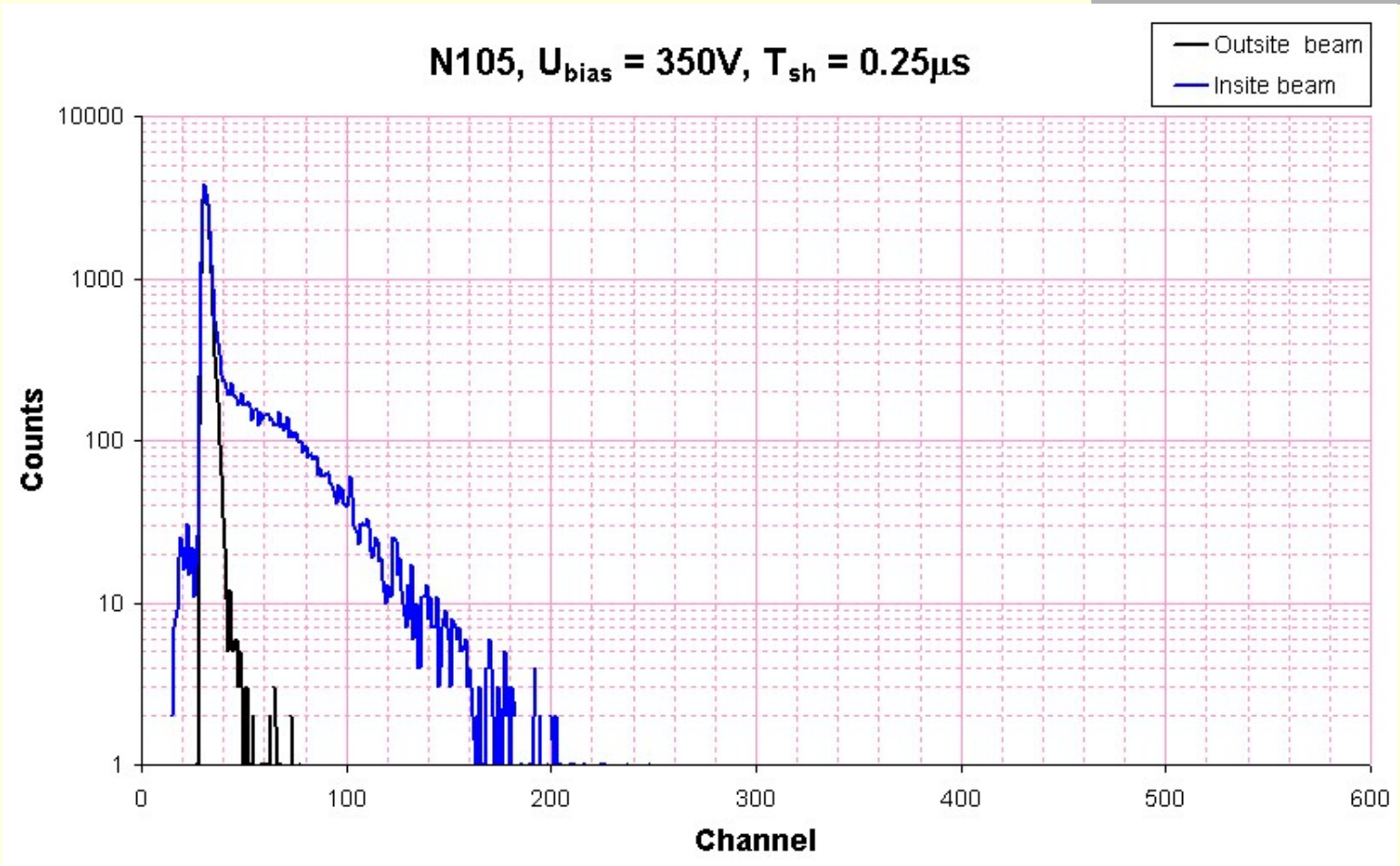


Experiments on nuclear reactor
- Experimental setup

- Thermal-neutron source:
  - Nuclear power reactor LVR15 in Rez near Prague
- Neutron flux:
  - ~10^7 n/(cm^2s)
- Read-out electronic chain:
  - same as for alpha spectroscopy

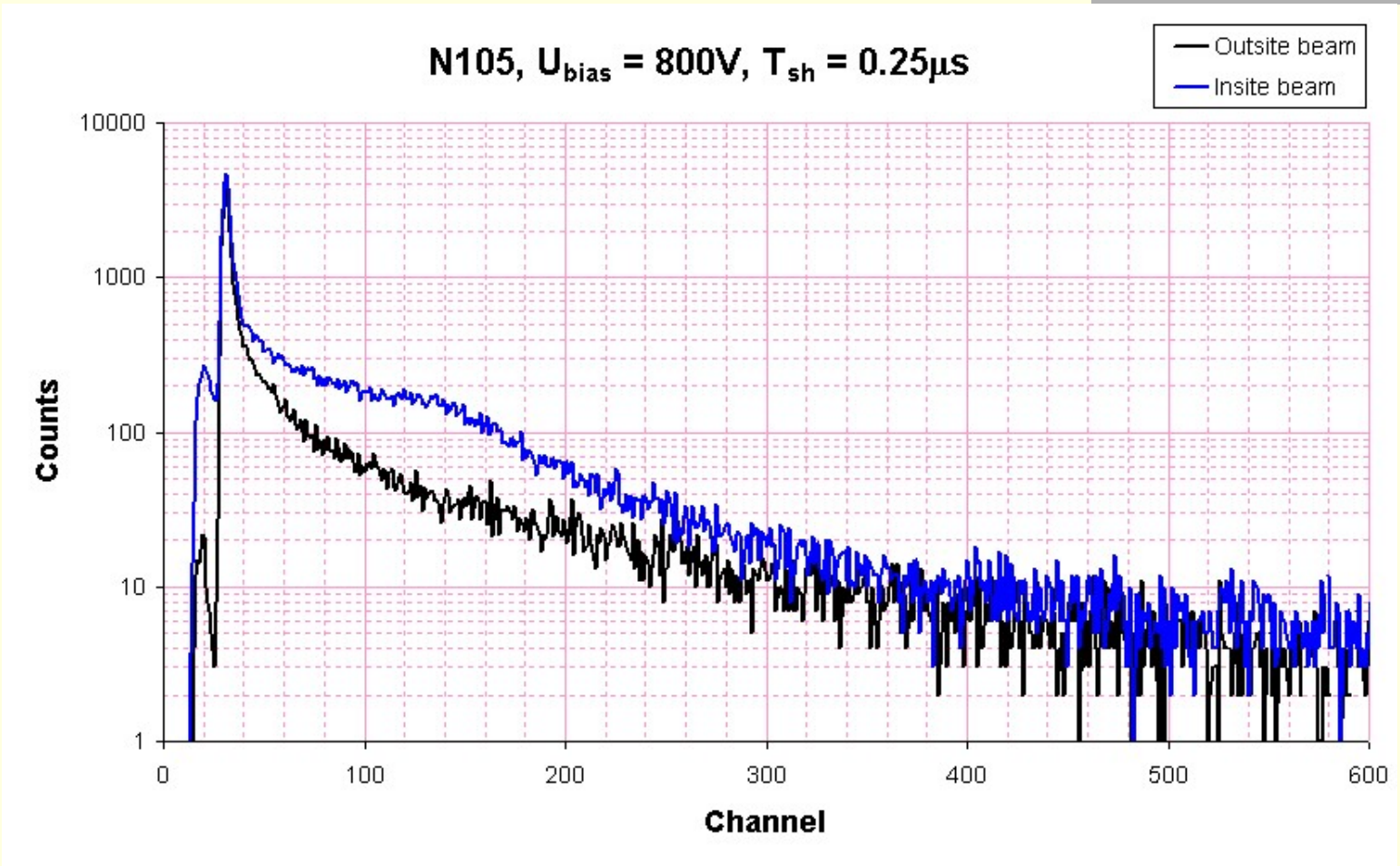
Experiments on nuclear reactor

- Typical thermal neutron spectrum of BN det.



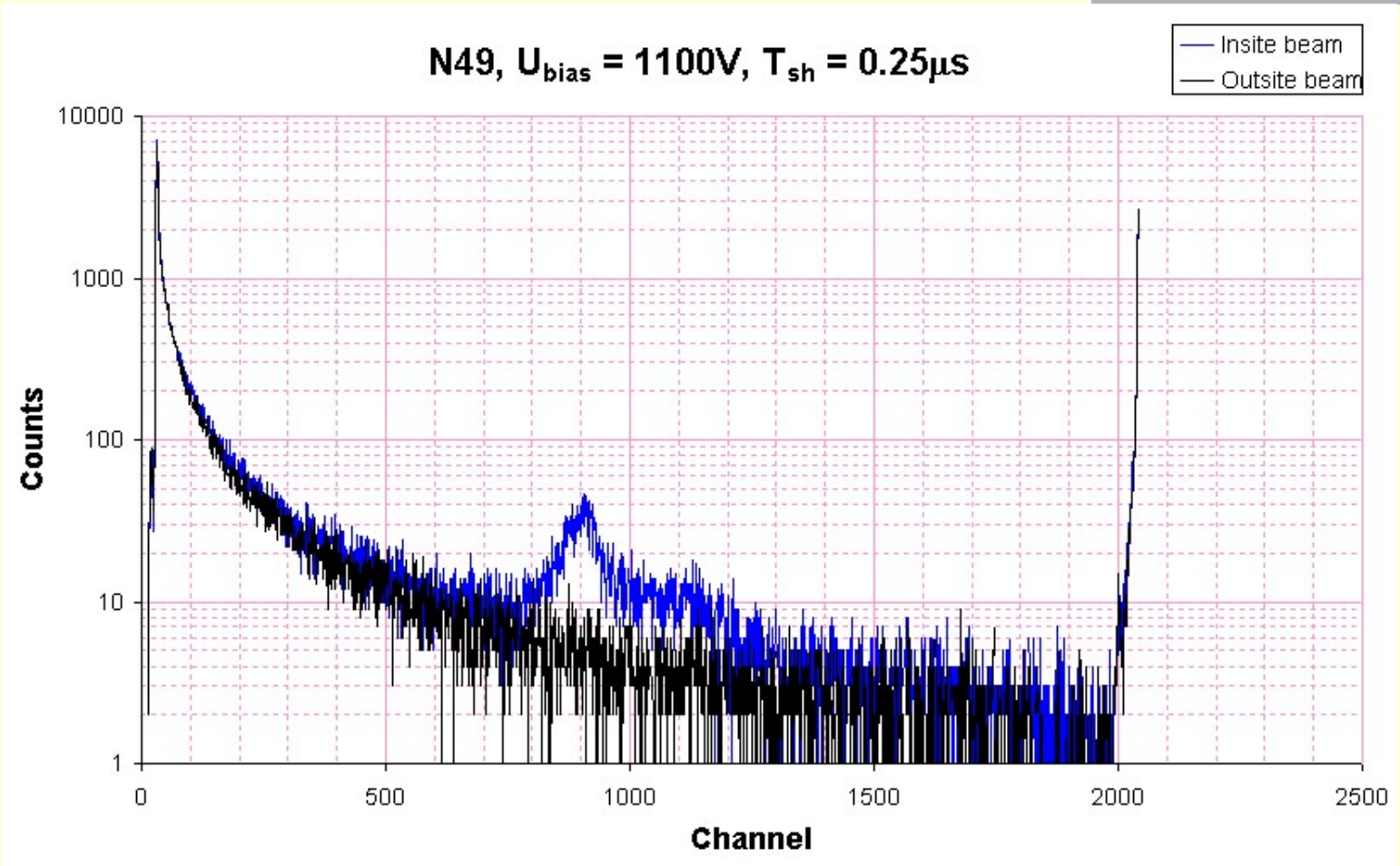
Experiments on nuclear reactor

- Typical thermal neutron spectrum of BN det.



Experiments on nuclear reactor

- Typical neutron spectrum of $BN+B_4C$ det.



Conclusion

- 3 BN and 1 BN+B_4C samples were tested
  1. by alpha spectroscopy,
  2. in high flux of thermal neutrons.
- Alpha spectroscopy results are:
  1. spectroscopy signals are very small;
  2. spectra consist of three or more peaks;
  3. CCE is on the level of several percent;
  4. $\mu\tau \sim 10^{-9}$ cm^2/V;
- Thermal-neutron spectroscopy results are:
  1. every samples are sensitive on thermal neutrons and, furthermore, they show greater signals in comparison with the alpha spectroscopy;
  2. BN samples have not neutron spectra separated from the noise;
  3. BN+B_4C sample shows unexpected high signals as response on thermal neutrons and it has the neutron spectrum purely separated from noise.