

Development of Nano-sized graphene material for neutron intensity enhancement below cold neutrons

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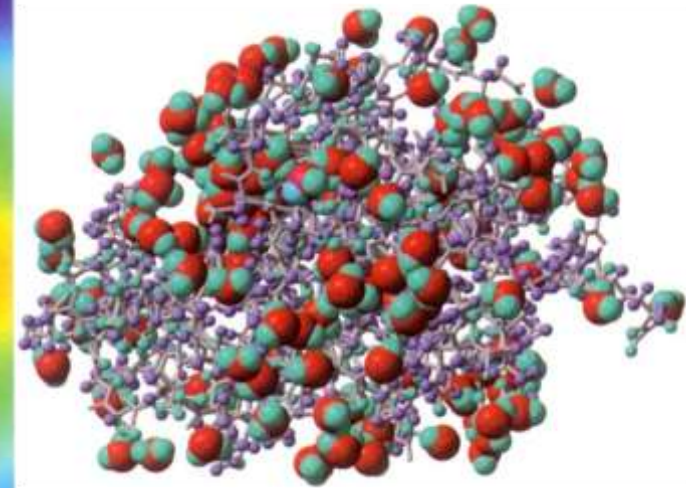
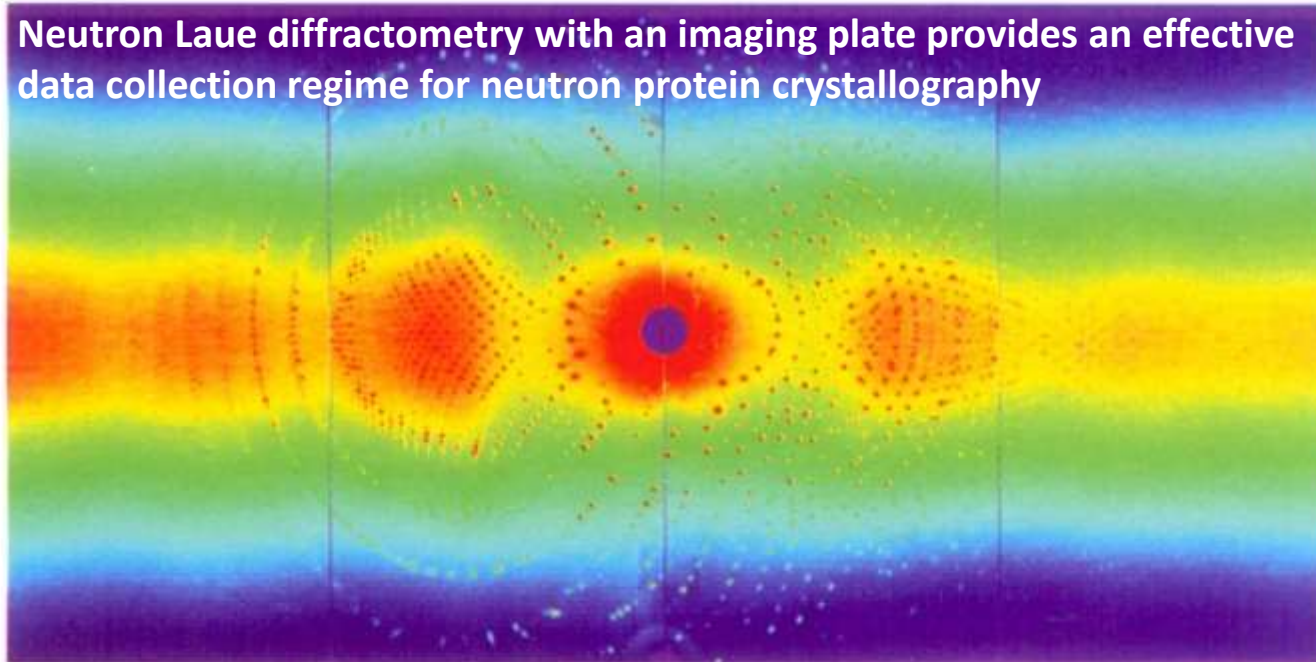
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1μm

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Neutron Laue diffractometry with an imaging plate provides an effective data collection regime for neutron protein crystallography



3-dimensional arrangement of lysozyme molecule and 157 water molecules

- Measurement time: 10 days at ILL grenoble (Nuclear research reactor 58MW)
- $\sim 1/1000$, intensity of synchrotron radiation source (X ray)
- $\sim 1/1,000,000$ in produced neutrons, reached at sample position

Web site of Protein Structure Database

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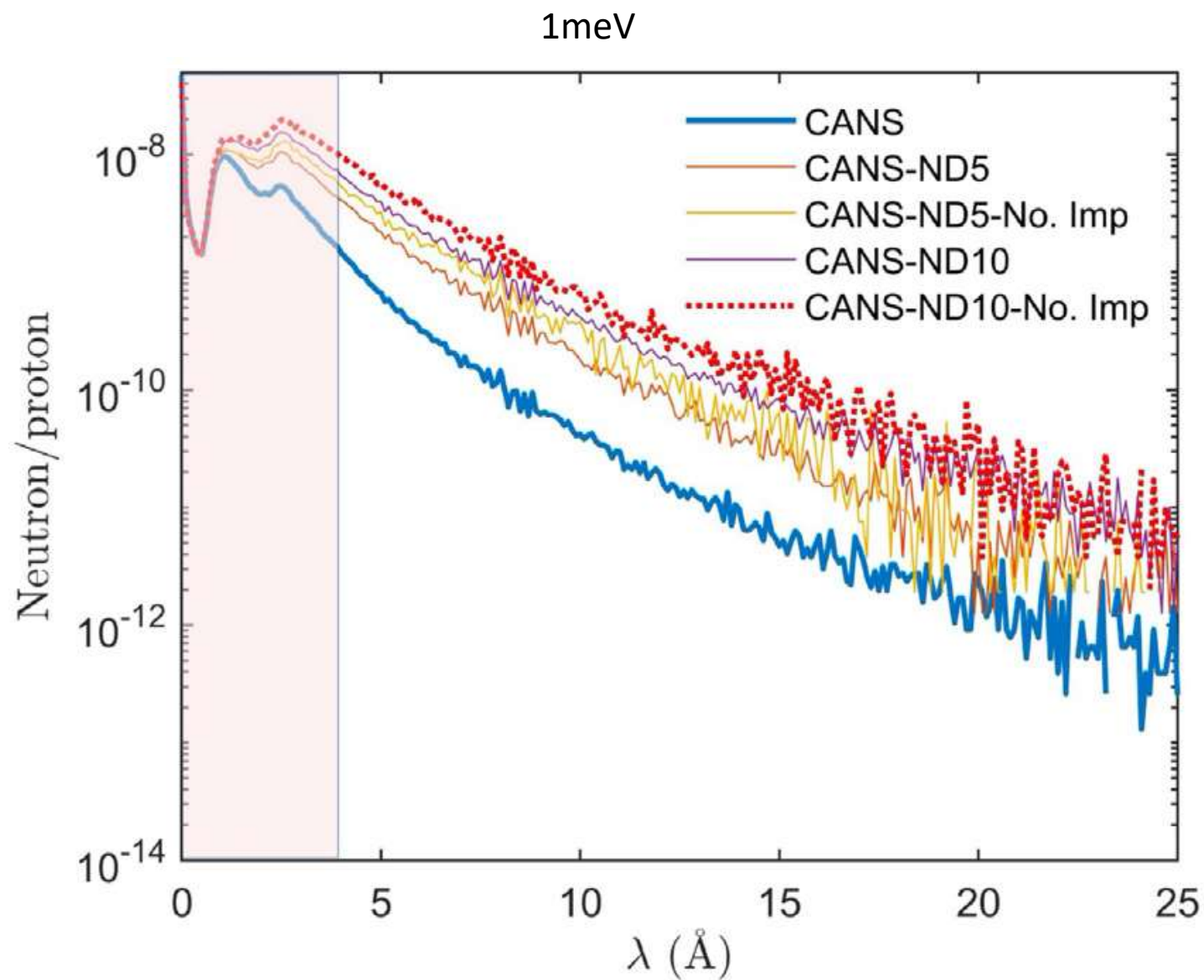
The image shows a screenshot of the RCSB PDB homepage. A blue overlay box on the right contains the following text:

- Established in 1971
- 200,000 registrations reached on 2023.
- Plays important role in structure determination, such as COVIT-19.
- 86% of structures, determined by X-rays.
- Only 212 (0.1%), registered using neutrons.

A red overlay box in the center contains the following text:

- Why so few registrations?
- Because the neutron intensity is low.

The website interface includes a navigation bar with links: RCSB PDB, Deposit, Search, Visualize, Analyze, Download. The main header displays the RCSB PDB logo and statistics: 200,708 Structures from the PDB and 1,000,357 Computed Structure Models (CSM). A sidebar on the left lists: Welcome, Deposit, Search, Visualize, Analyze, Download, Learn. The main content area features a welcome message, a list of data types (Experimentally-determined 3D structures, Computed Structure Models (CSM)), and a section for COVID-19 Coronavirus Resources. A 'January Molecule of the Month' section displays 'Plastic-eating Enzymes' with a 3D model. The bottom section includes 'Latest Entries', 'Features & Highlights' (PDB Reaches a New Milestone: 200,000+ Entries), and 'News' (Paper Published: Delivering PDB Structures and CSMs at RCSB.org).



Nanodiamond

- In 2002, concept of coherent neutron scattering, by V. V. Nesvizhevsky san.
- In 2008, he discovered Nanodiamonds
- This development was proceeded worldwide with IAEA, etc.
- Main challenge is to molding to on the wall neutron extraction hole as a neutron reflector.



Nano-sized graphene

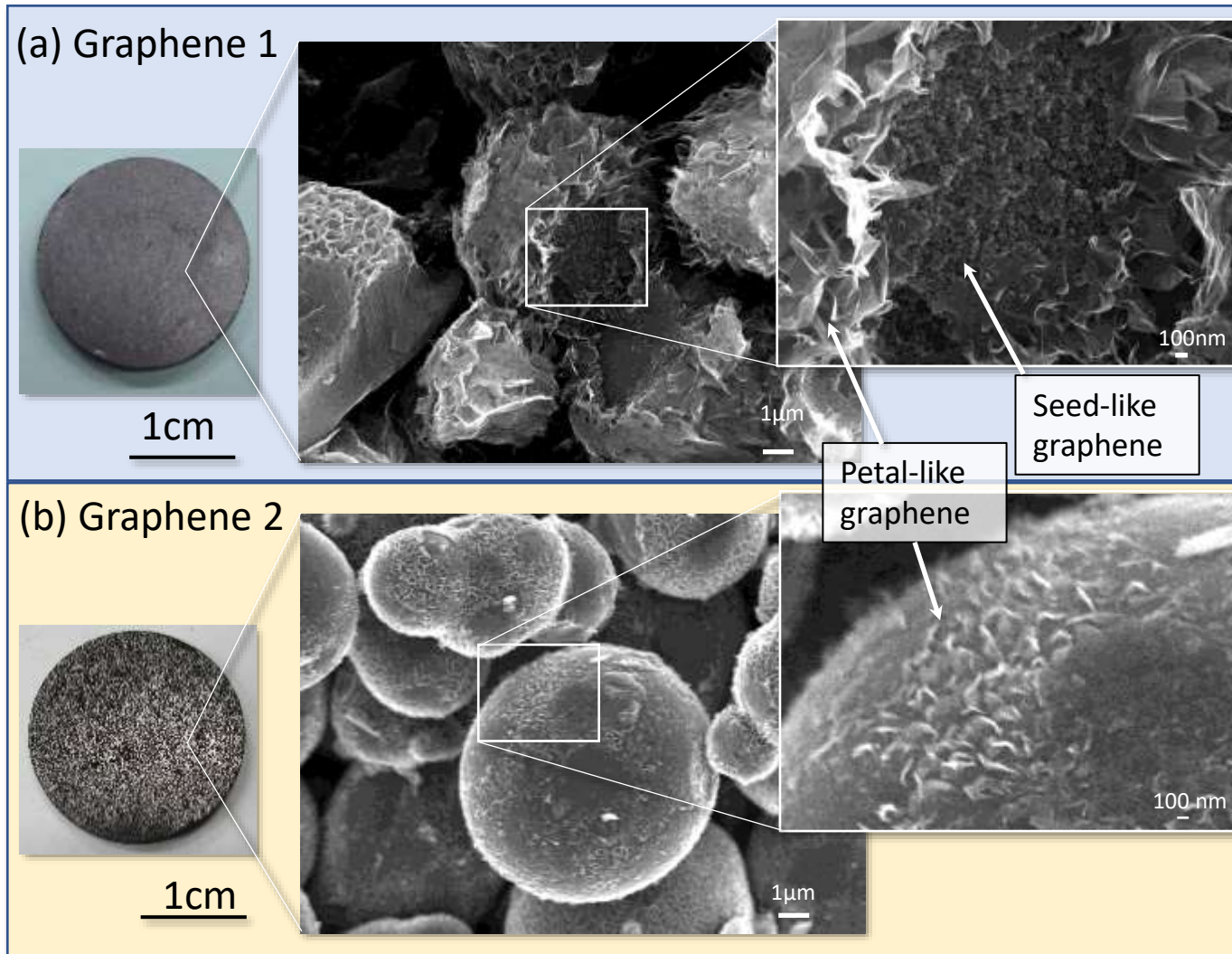
6/10

- Focused on graphene, a carbon-based material similar to nanodiamonds.
- Strong bonding (sp^2) between carbons in graphene is expected to use in more radiation resistance than that of nanodiamonds.
- Chemical vapor deposition can produce nano-sized graphene particles on the surface and inside of carbonized phenolic resin particles.
- Graphene is expected to form into clumps due to high van der Waals forces.

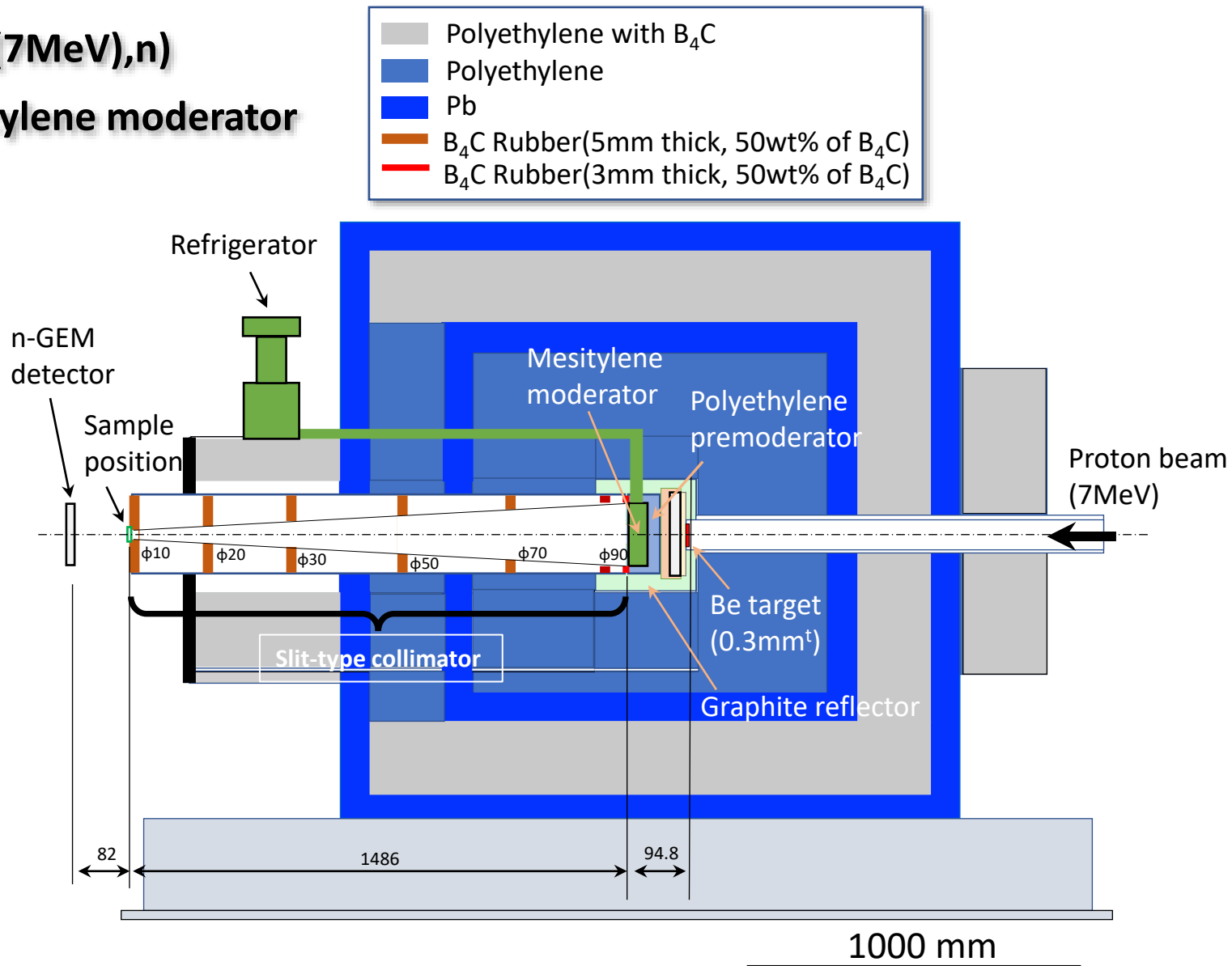
1 μ m



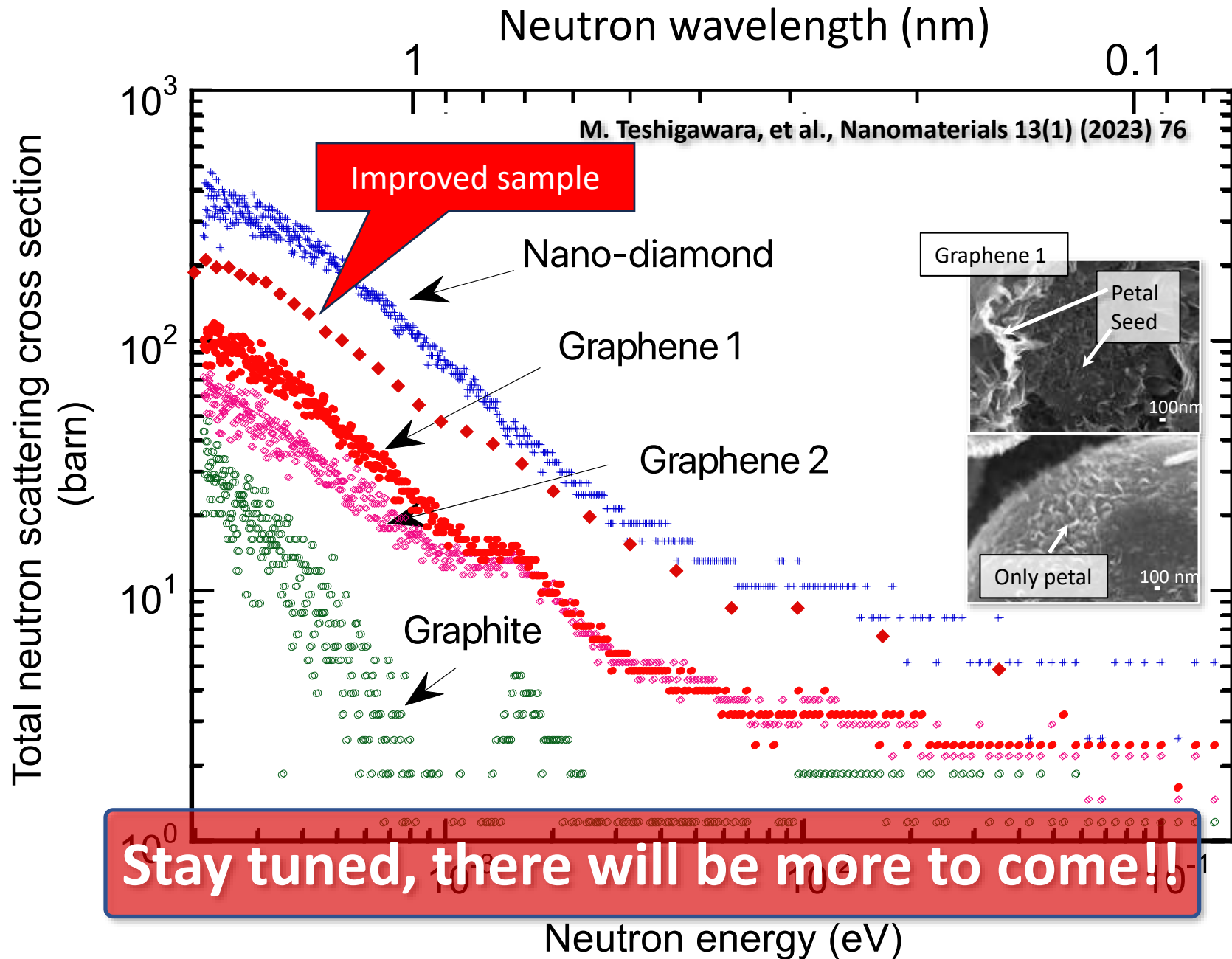
- (a) Graphene 1, which formed petal-like graphene and nm-sized granular seeds, called as “seed-like graphene”;
- (b) Graphene 2, which formed Petal-like graphene, but no seed-like graphene.



- **Be(p (7MeV),n)**
- **Mesitylene moderator**







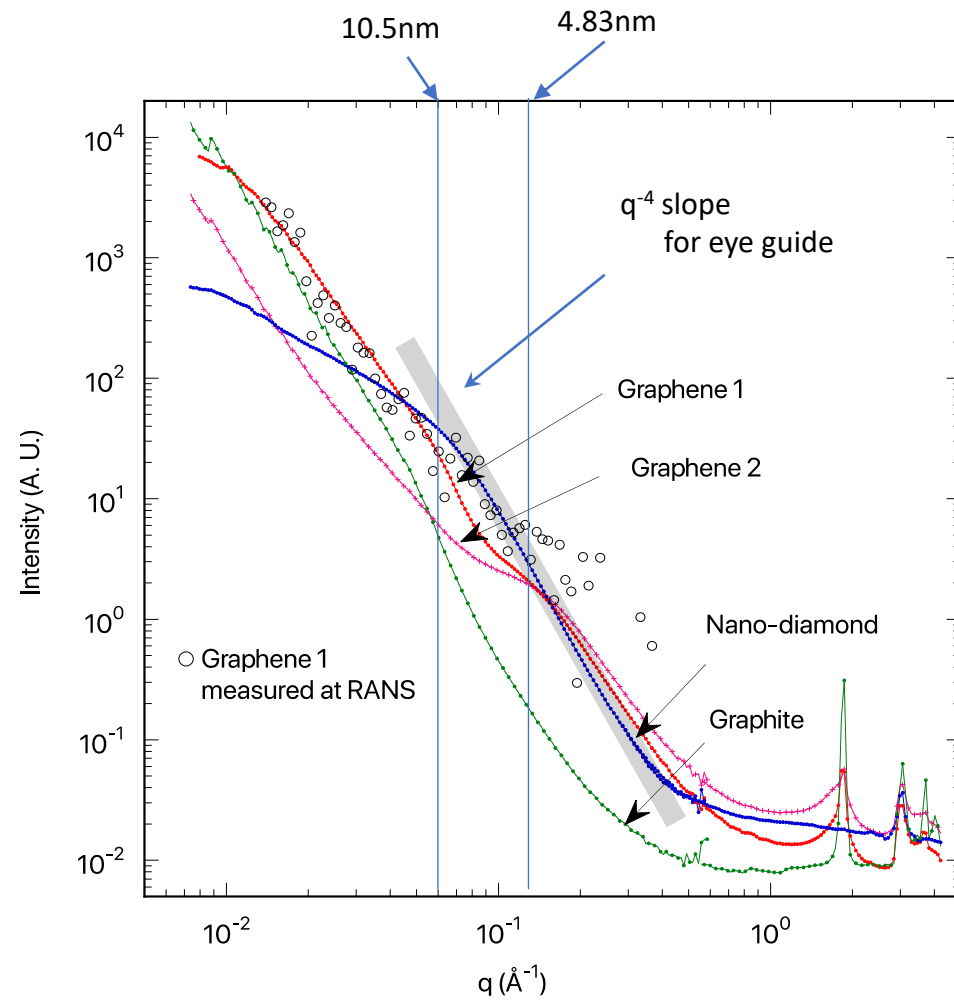


Figure 7. Small-angle neutron scattering measurements.

