Advanced experimental techniques for assessing micro structural and mechanical change induced by irradiation environment

- Positron annihilation lifetime measurements

  Most of experimental studies have been performed by transmission electron microscopy (TEM) after growing to observable void formation. The observation of point defects and their clusters under the resolution limits are impossible to detect. Positron annihilation lifetime measurement is adopted to detect point defect processes during the incubation period.

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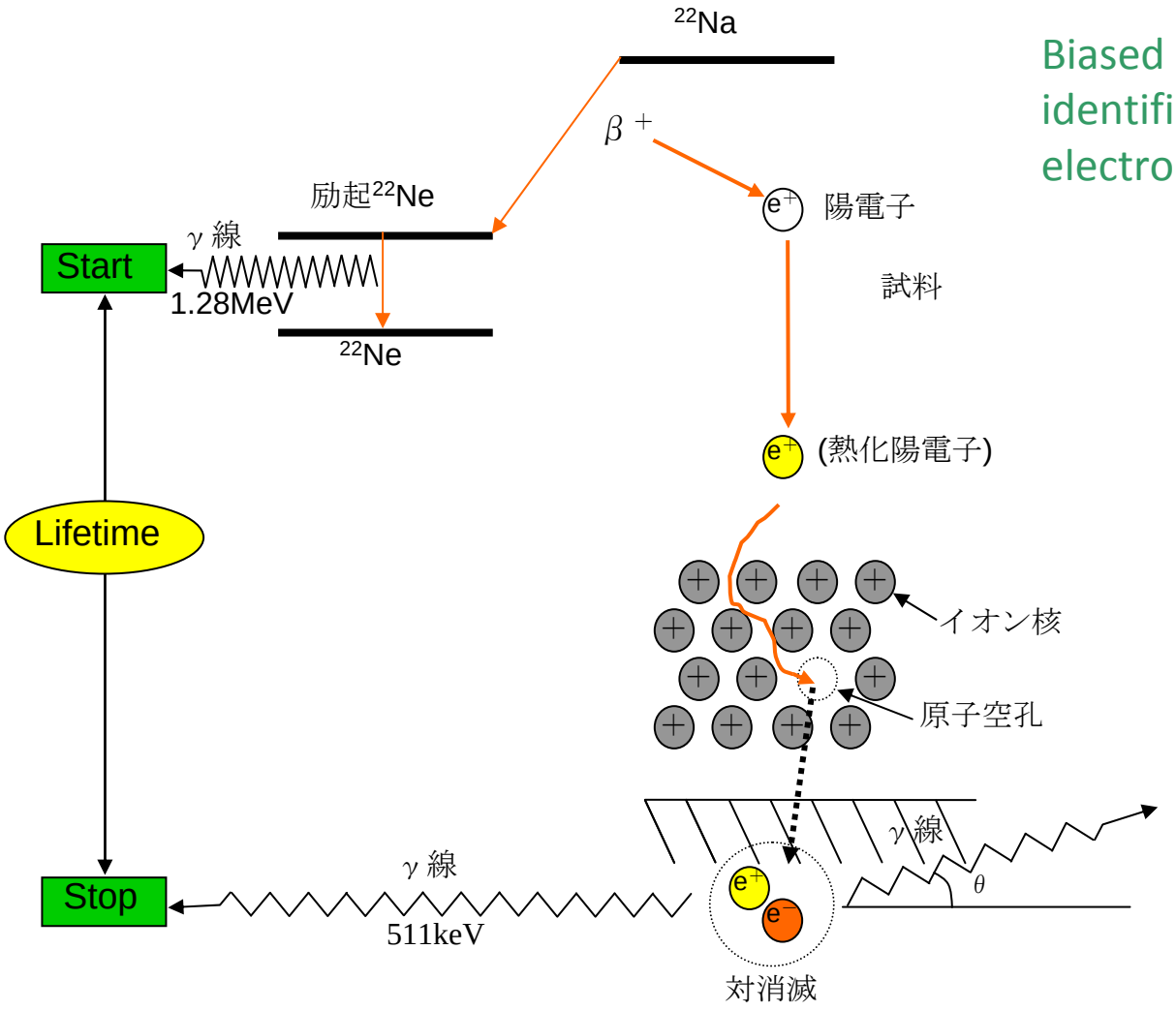
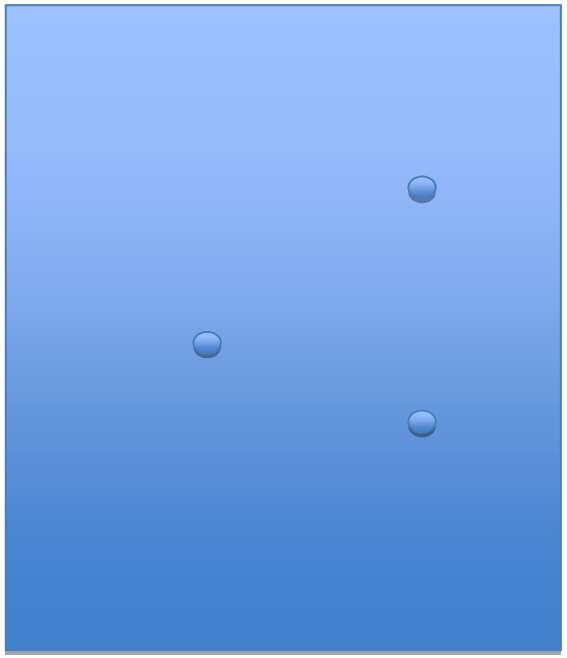
Lifetime: a size of void cluster

Biased angle from 180° : atom identification at the sink site from electron momentum

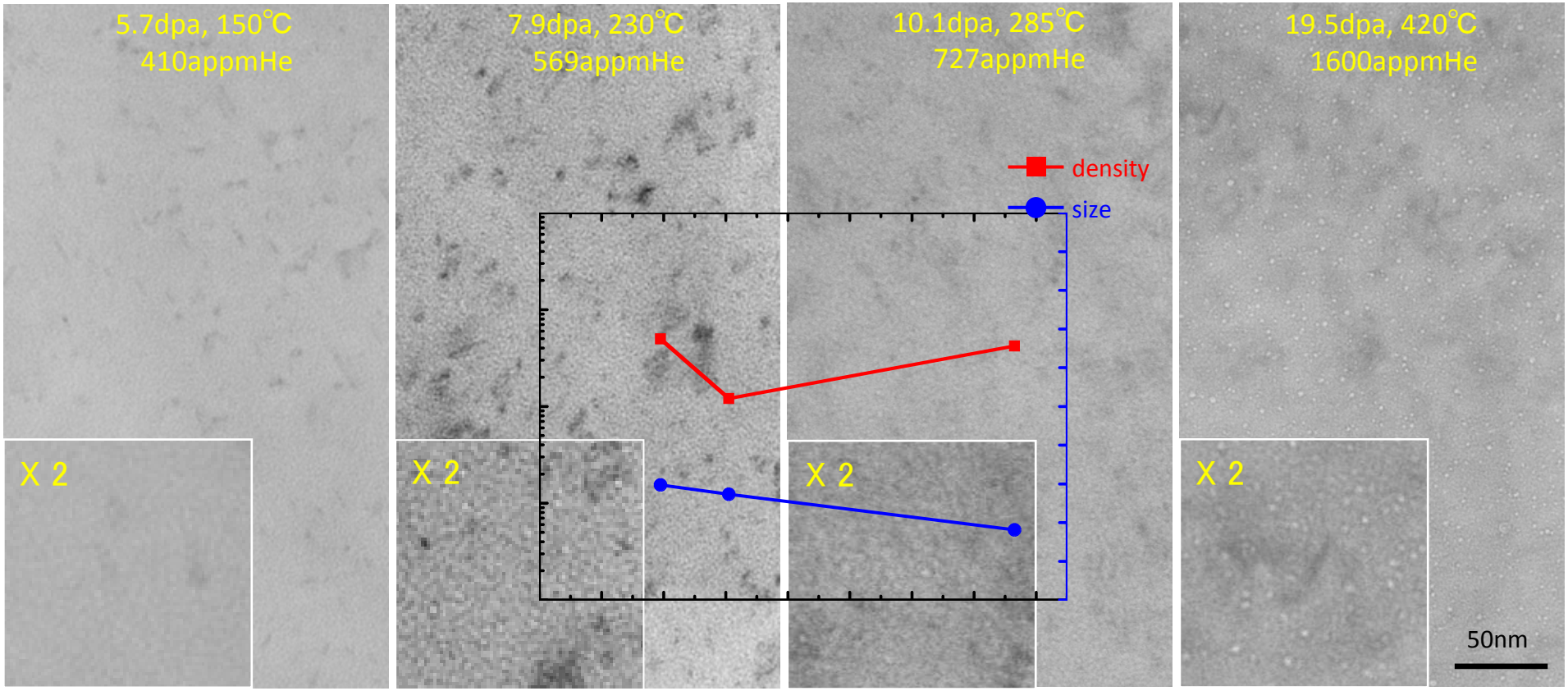


- Small Angle Neutron Scattering (SANS) and TEM

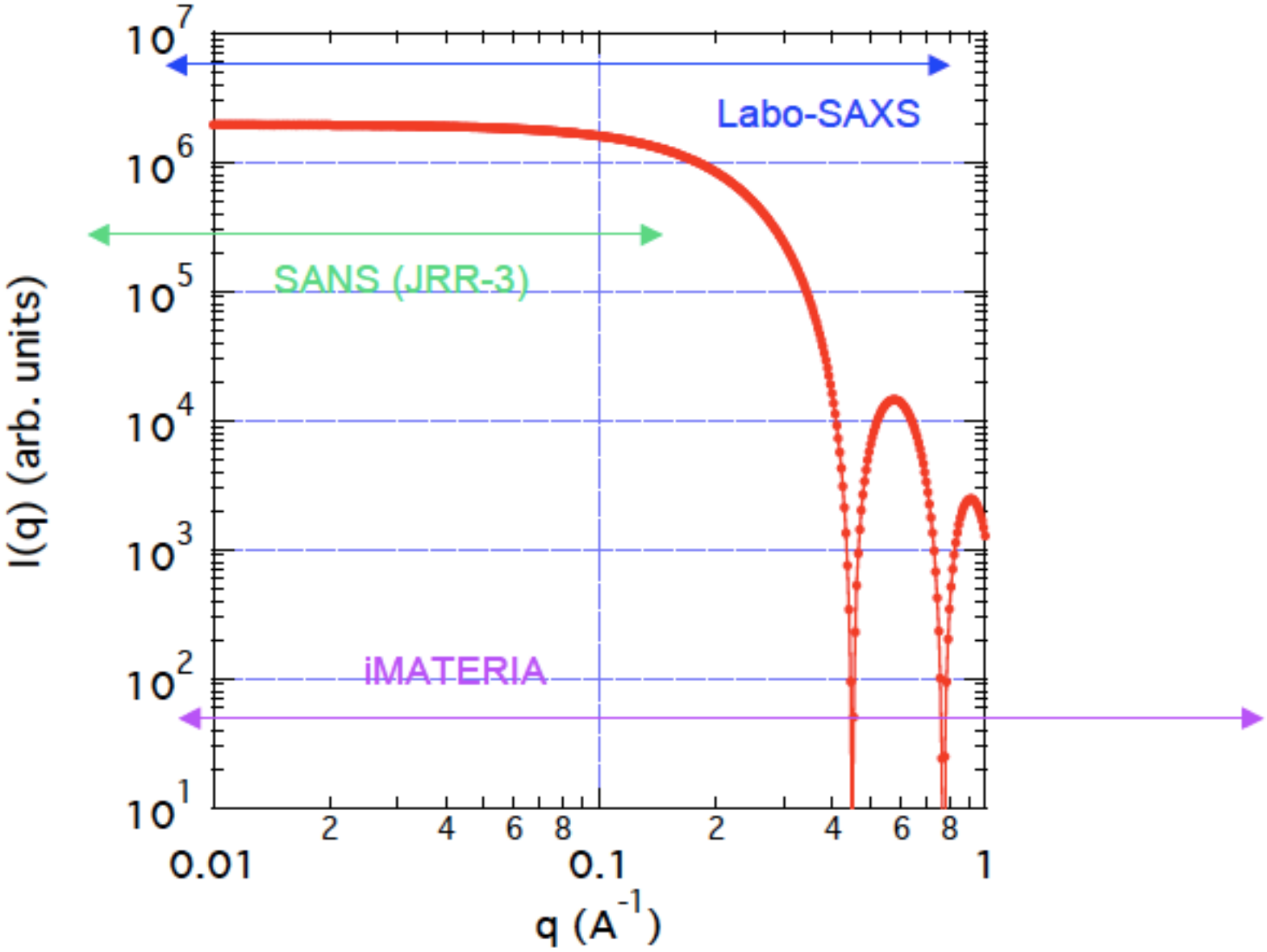


Averaged information in larger volume!

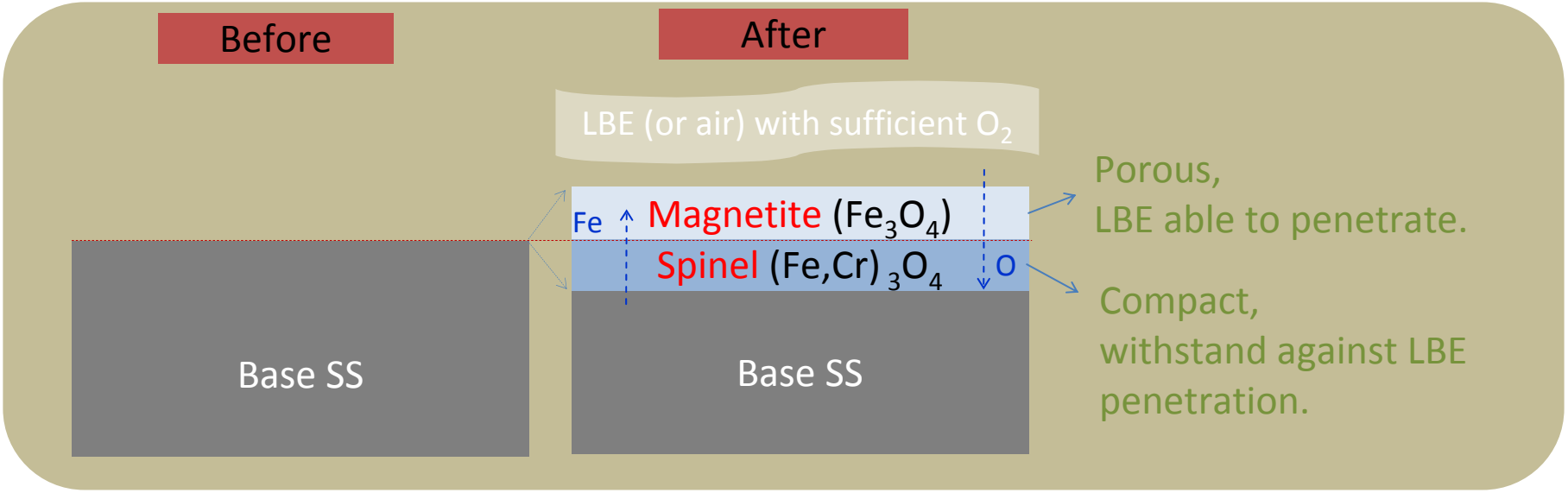
Microstructure of JPCA : He bubbles



Scattering function for 2nm dia. particles



Early oxide layer formation investigation



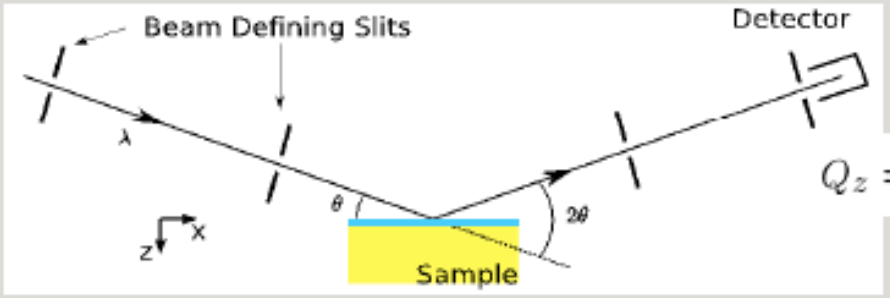
?

- Which oxide layer starts to form, and when?
- When is the duplex layer formed?
- What is the sequence of formation?
- What are the conditions?

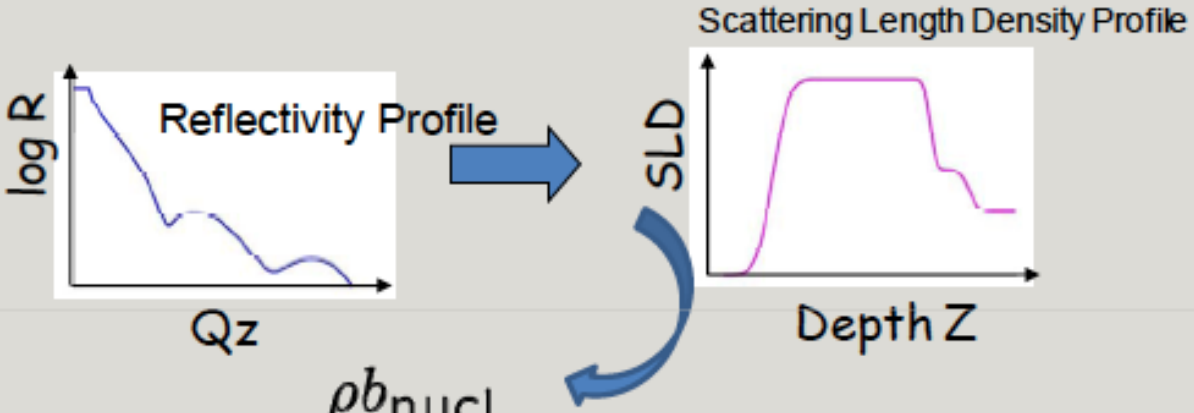
A special device is needed for ultra-thin oxide layer (~nm) analysis

Experimental & Procedure

Why Neutron Reflectometry?



$$Q_z = \frac{4\pi \sin\theta}{\lambda}$$



$$\rho b_{nucl}$$

number density — nuclear scattering length

$$b_{nucl} = \sum_i f_i b_{nucl}^i$$

fraction of the *i*th nucleus — nuclear scattering length of the *i*th nucleus

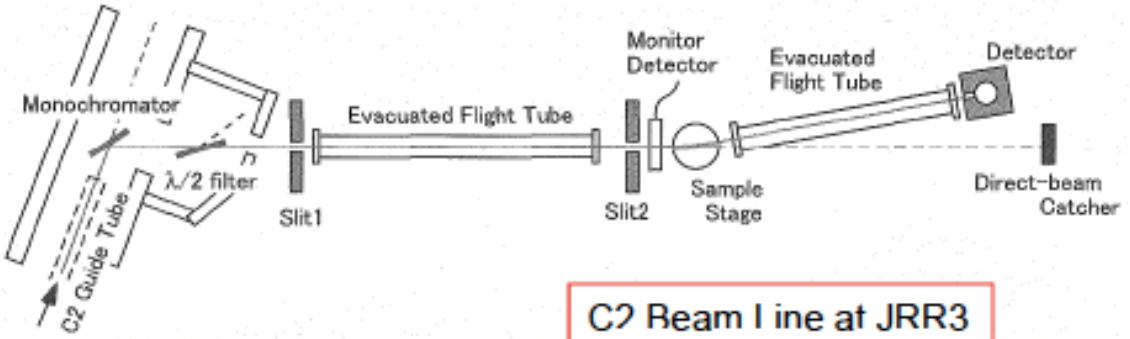
Capability to determine (ultra-thin layer/s):

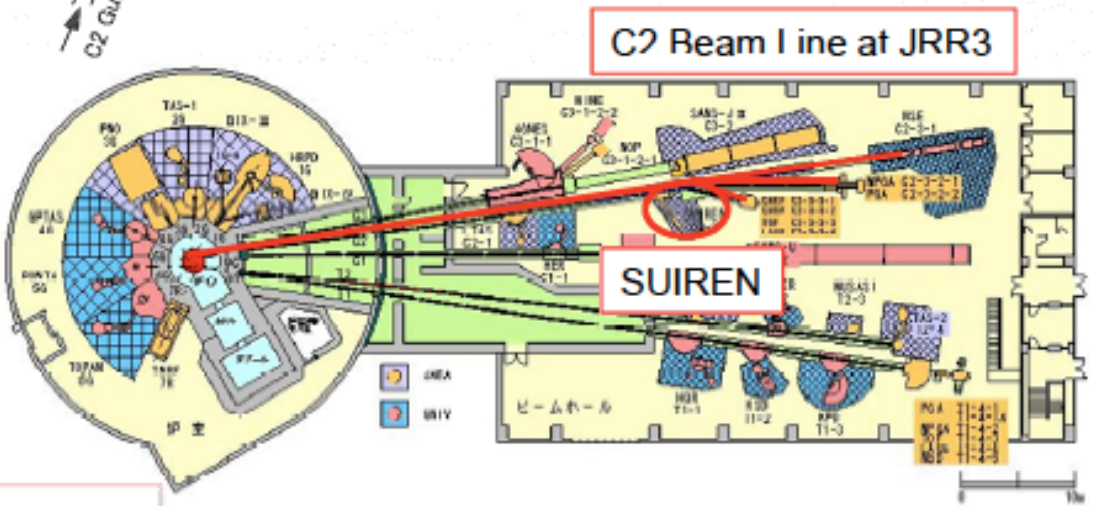
1. Layer Thickness.
2. Layer Densities.
3. Number of Layers.
4. Interfacial Roughness.

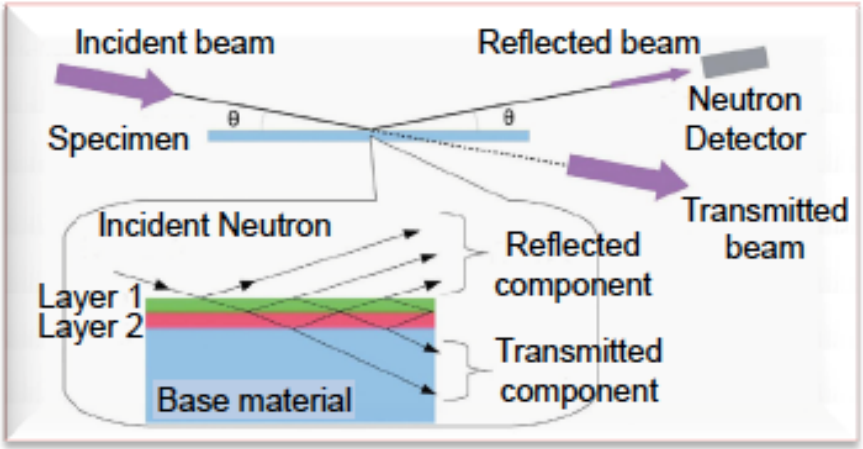
Analysis data is done using "Parrat32" computer code (**assumption:** interfacial roughness << thickness of layer).

Experimental & Procedure

SUIREN: Apparatus for SUrface and Interface Investigations with REflection of Neutrons







Parameter	Conditions
Neutron wavelength	**3.93 Å**
Beam size	80 (length) × 20 (width) mm^2
Detector	^{3}He detector, 1 dimension sensitivity ^{3}He detector. Container length: 100mm