INTRODUCTION TO NEUTRON SCATTERING

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-- Why Use Neutrons?
-- Neutron Sources
-- Continuous *vs* Time-of-Flight
-- Neutron Sources in the US
-- The NIST Neutron Scattering Facilities
-- Neutron interactions
-- Elastic *vs* Inelastic Scattering
-- Coherent and Incoherent Scattering
-- Neutron Scattering Lengths and Contrast Factors
-- Introduction to SANS

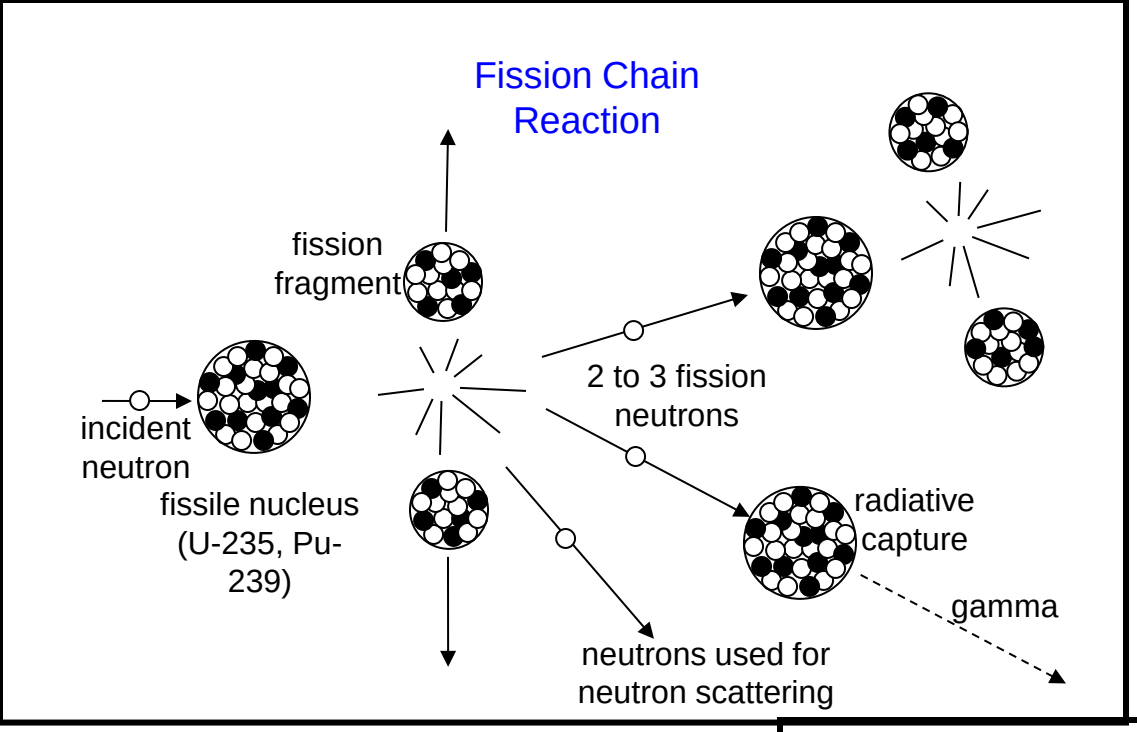
WHY USE NEUTRONS?

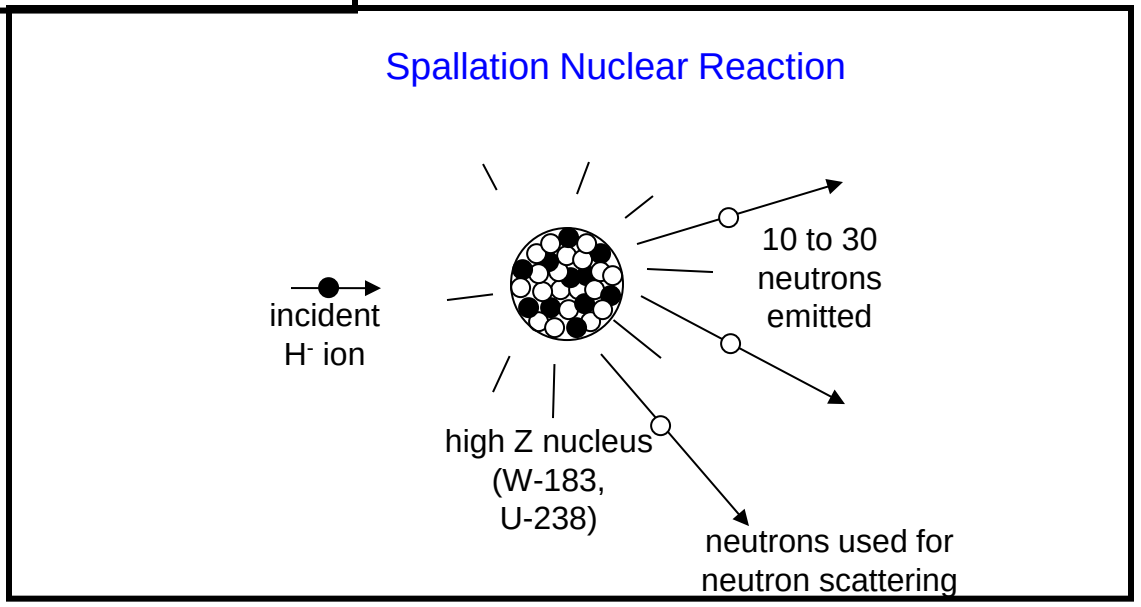
-- Neutrons interact through short-range nuclear interactions. They have no charge and are very penetrating and do not destroy samples.

-- Neutron wavelengths are comparable to atomic sizes and interdistance spacings.

-- Neutrons interactions with hydrogen and deuterium are widely different making the deuterium labeling method an advantage.

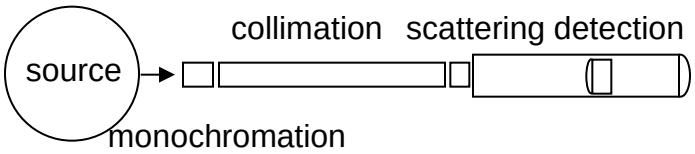
NEUTRON SOURCES

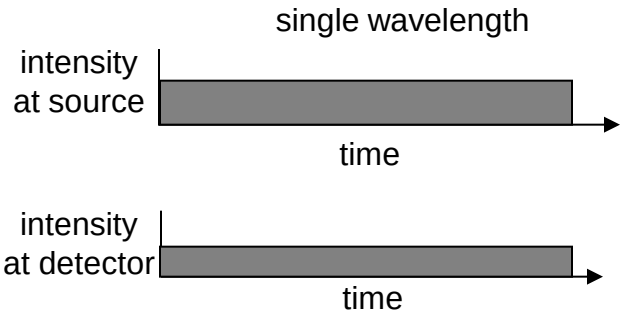




CONTINUOUS VS TIME-OF-FLIGHT

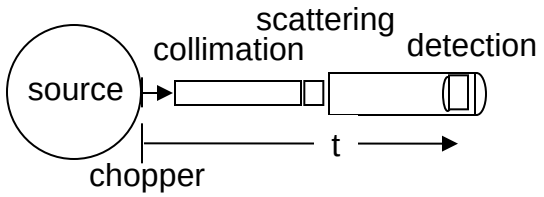
Continuous Reactors

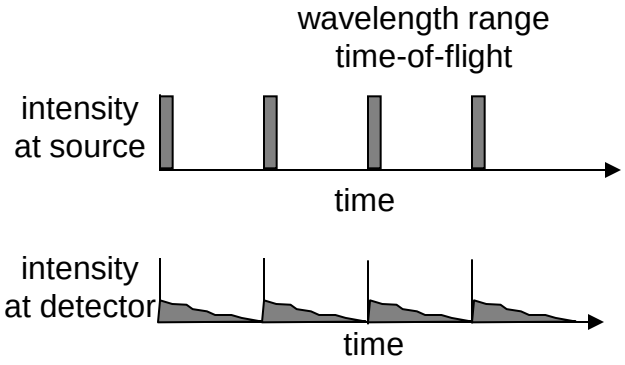




Measure some of the neutrons all of the time

Pulsed Sources





Measure all of the neutrons some of the time

NEUTRON SOURCES IN THE US

Continuous Sources:

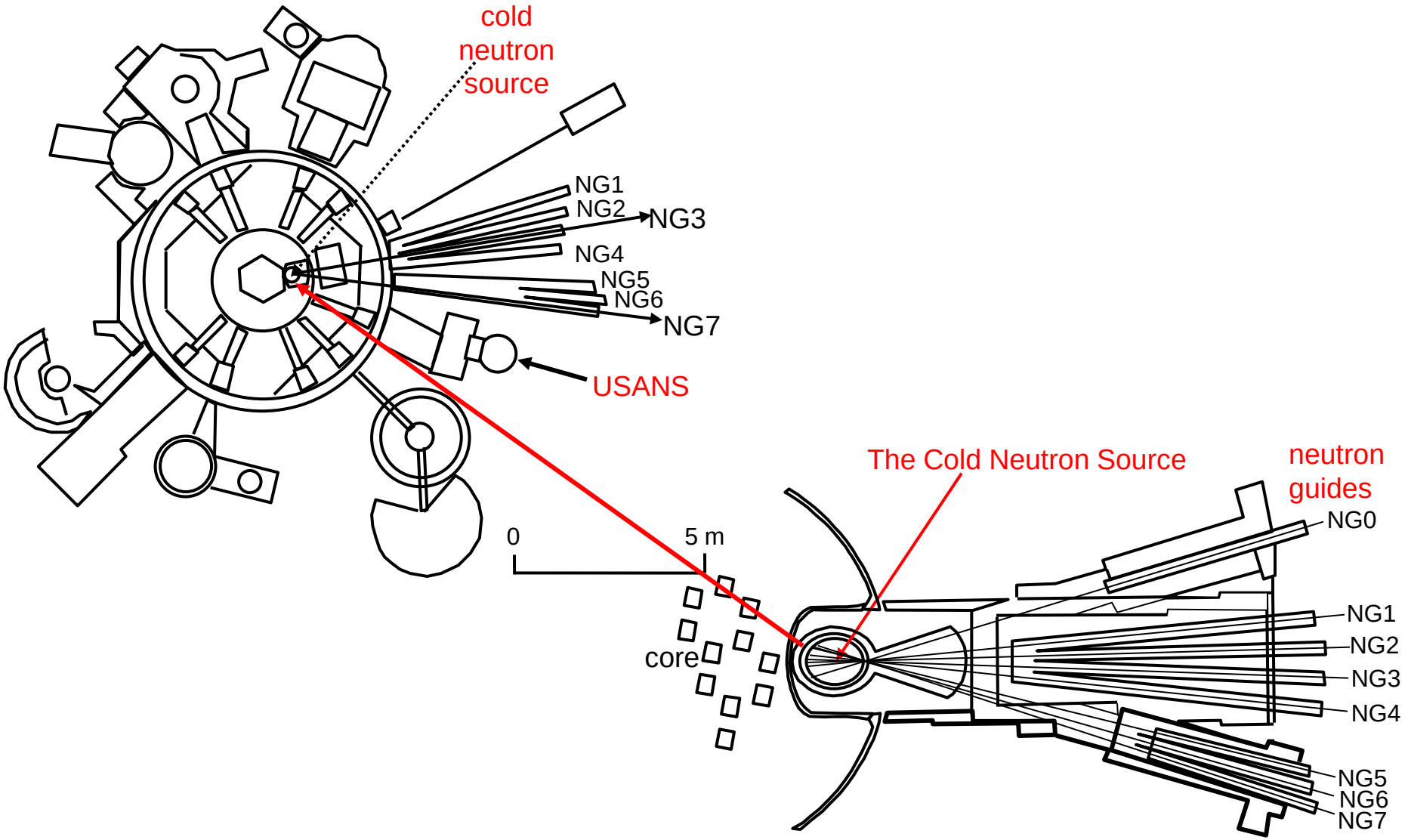
-- **HFIR**-**Oak Ridge** National Laboratory. http://neutrons.ornl.gov.
-- **NIST**-National Institute of Standards and Technology. http://www.ncnr.nist.gov.

Pulsed Sources:

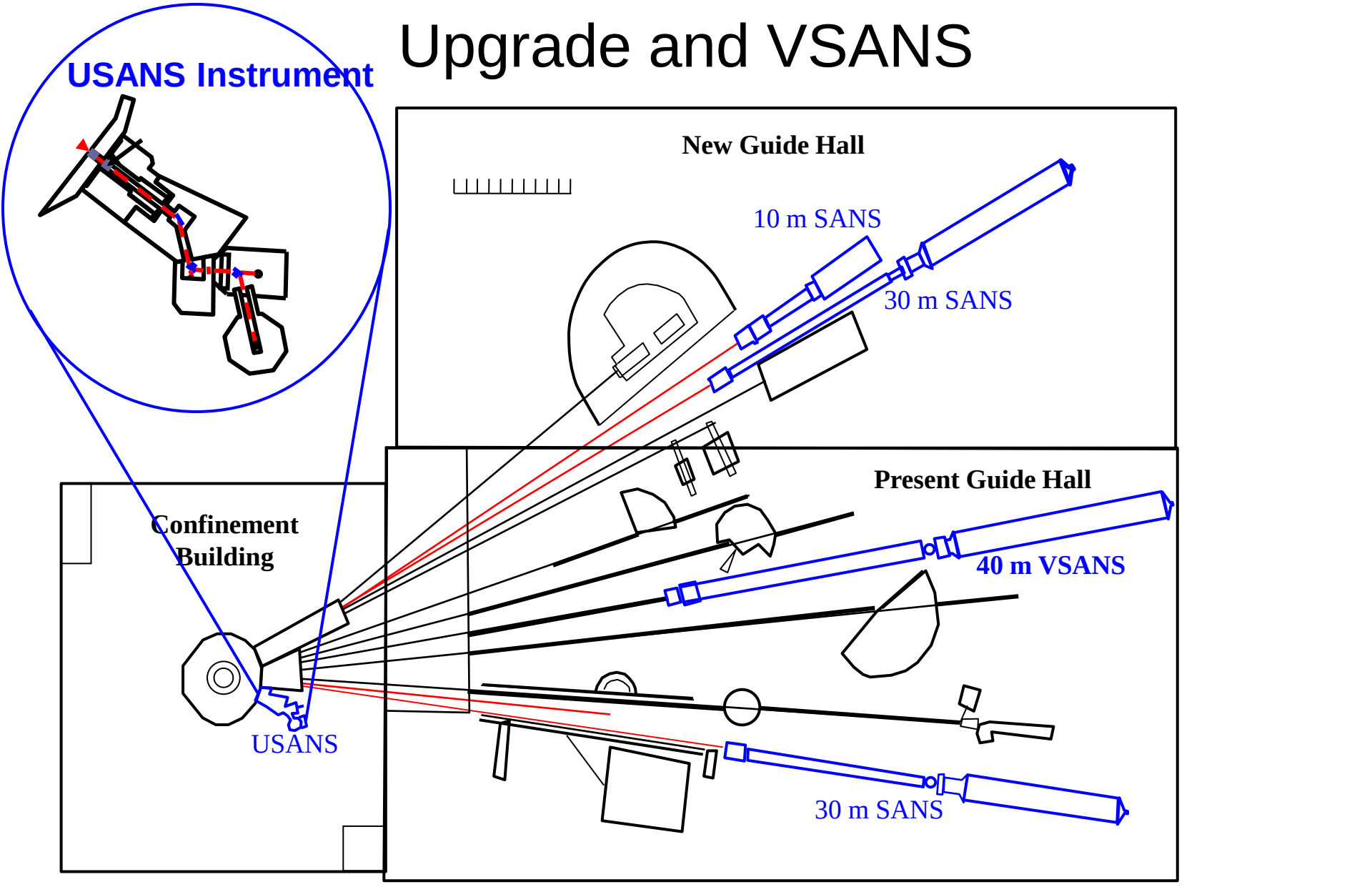
-- WNR/PSR LANSCE (**Los Alamos**). http://lansce.lanl.gov
-- **SNS** (**Oak Ridge** National Lab). http://www.sns.gov.

NIST Thermal Instruments

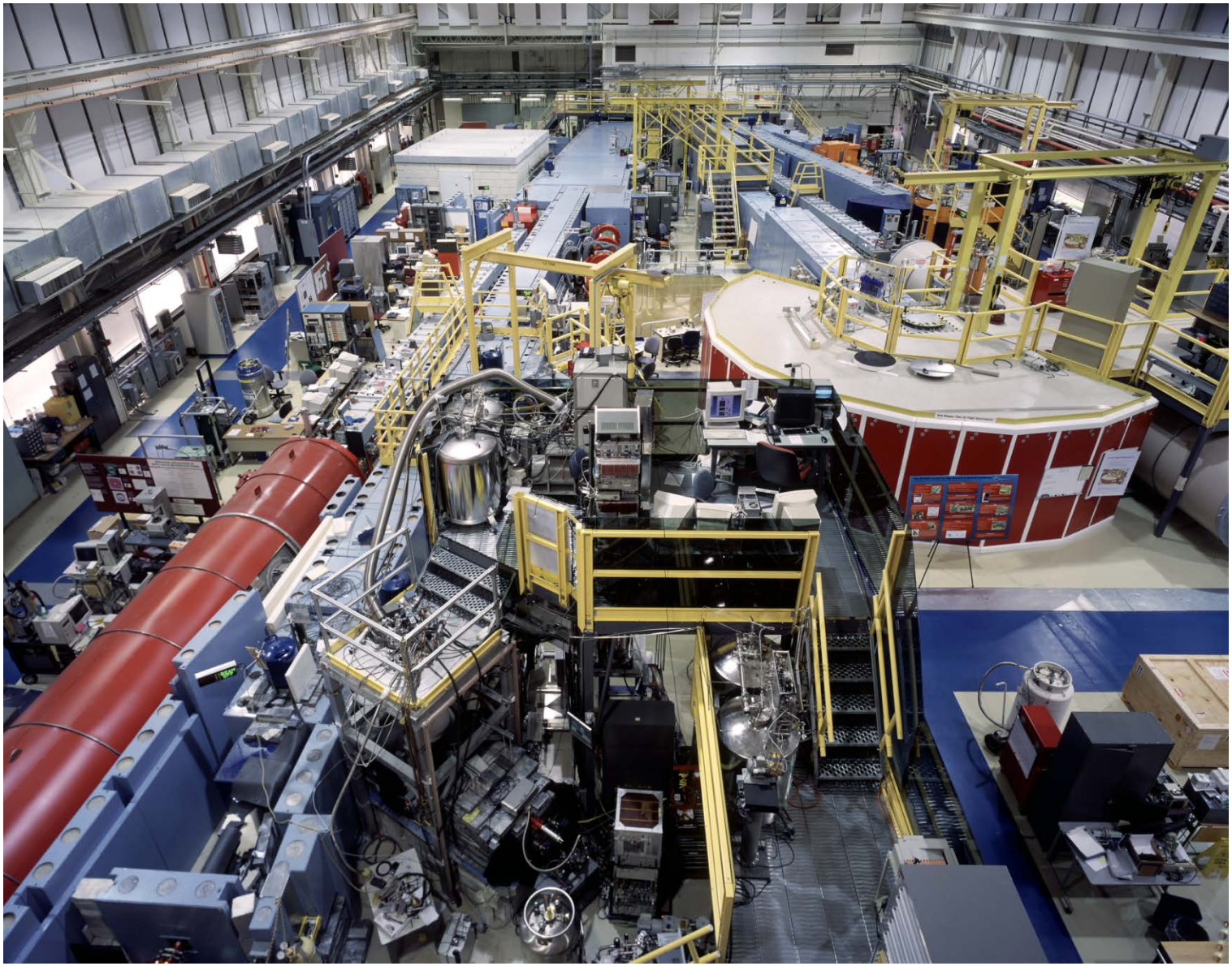
THE NIST NEUTRON SOURCE



Upgrade and VSANS

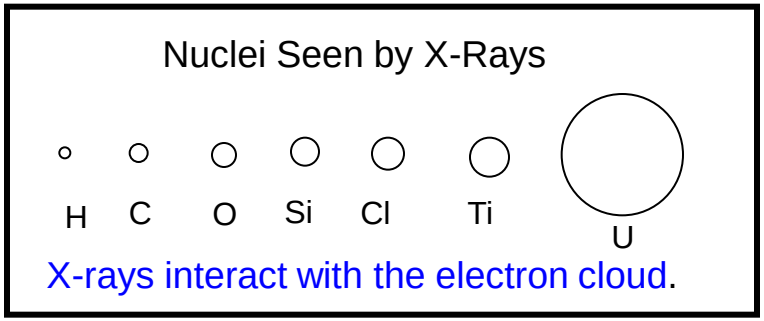


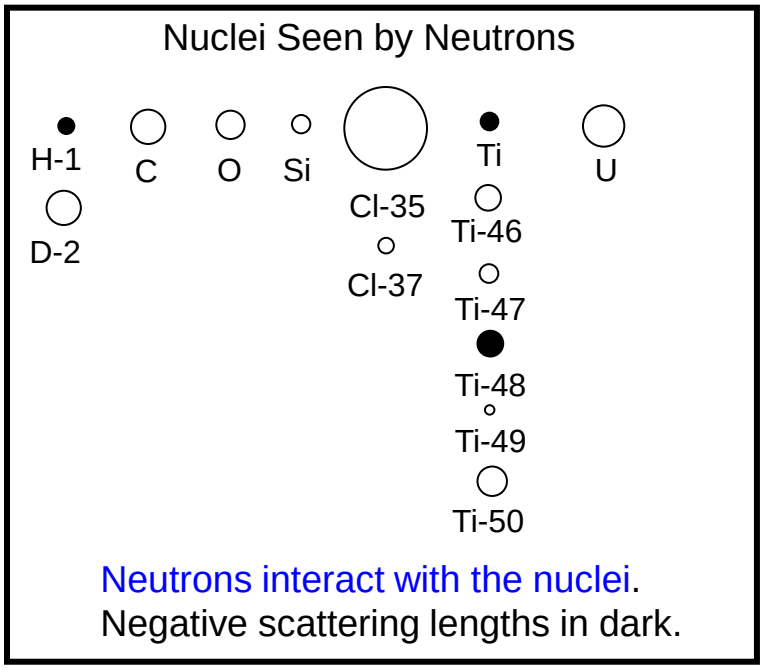
The NIST Guide Hall



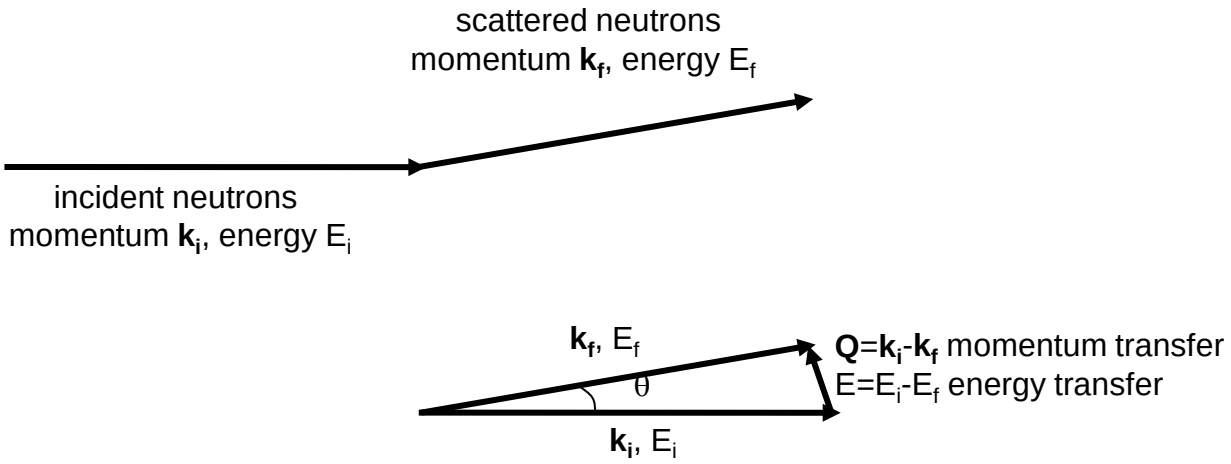
The NIST New Guide Hall

NEUTRON INTERACTIONS





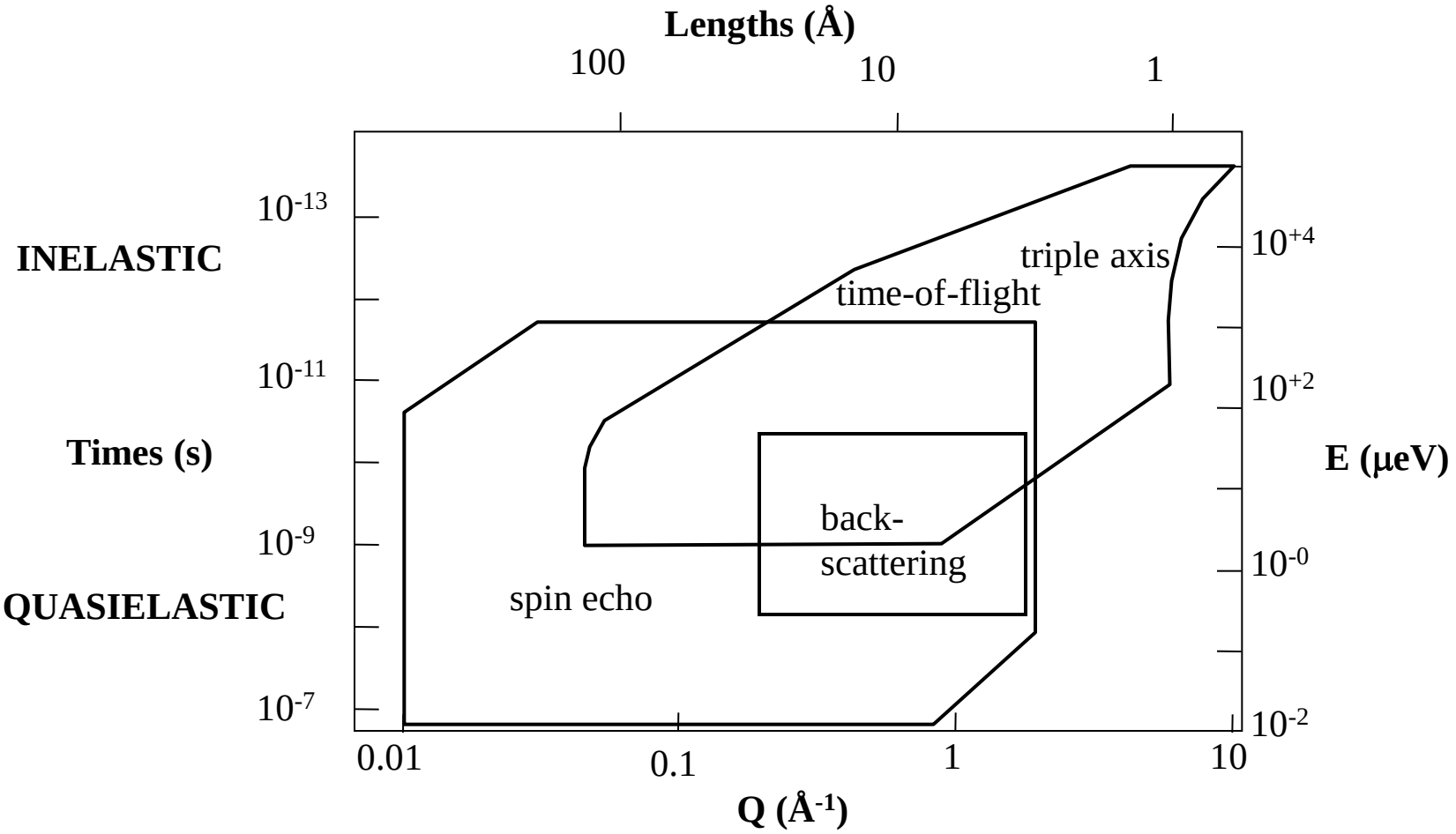
ELASTIC *vs* INELASTIC NEUTRON SCATTERING

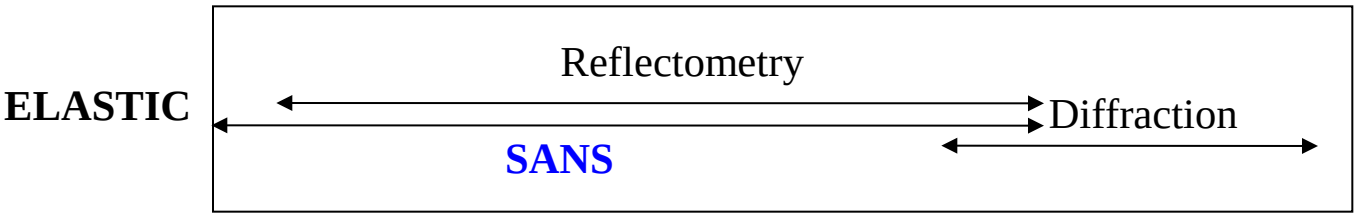


Elastic scattering corresponds to E=0. Investigate structures.

SANS and NR are elastic scattering techniques.

NEUTRON SCATTERING TECHNIQUES





SCATTERING LENGTH DENSITY CALCULATOR

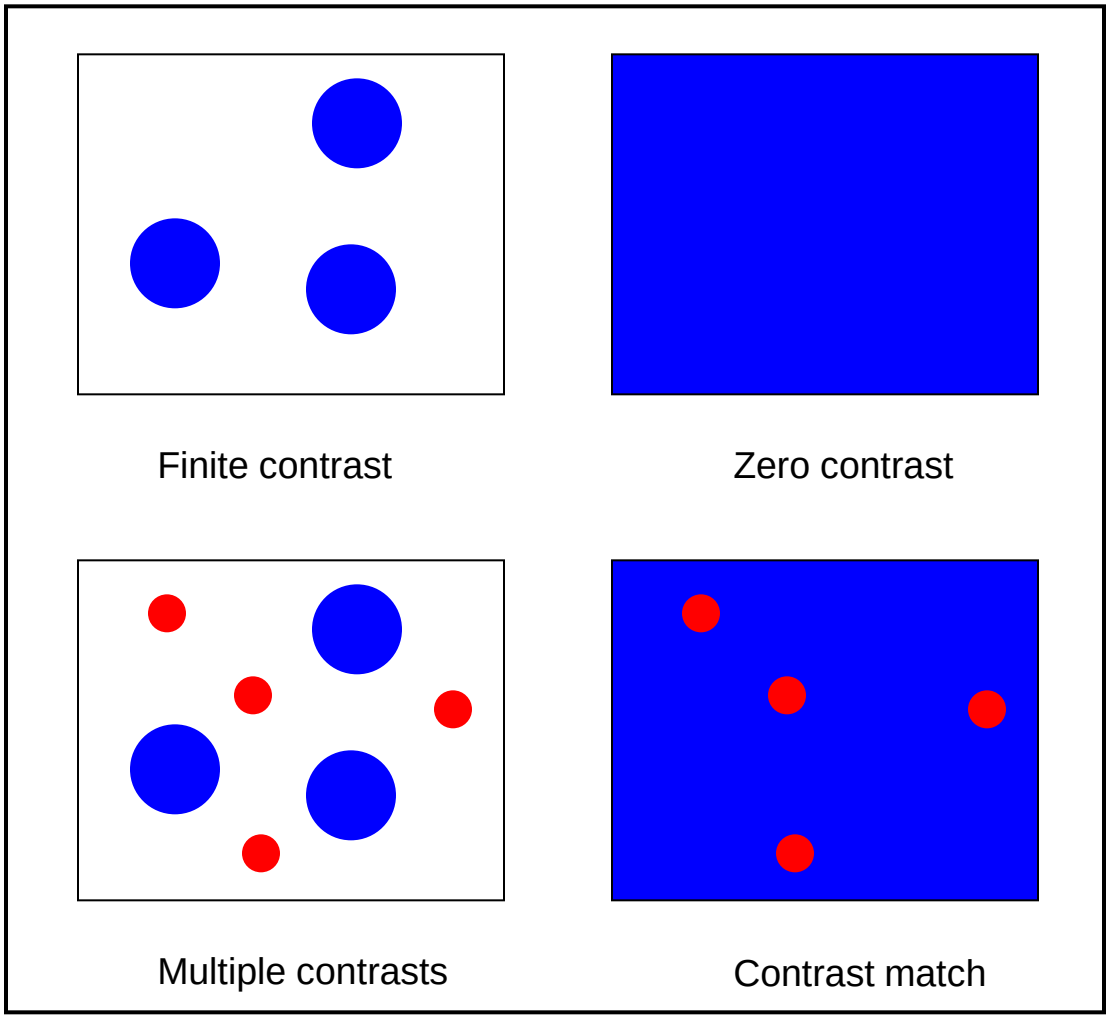
Web address: http://www.ncnr.nist.gov/resources/sldcalc.html

Input: Compound: D_2O
Density: 1.11 g/ml

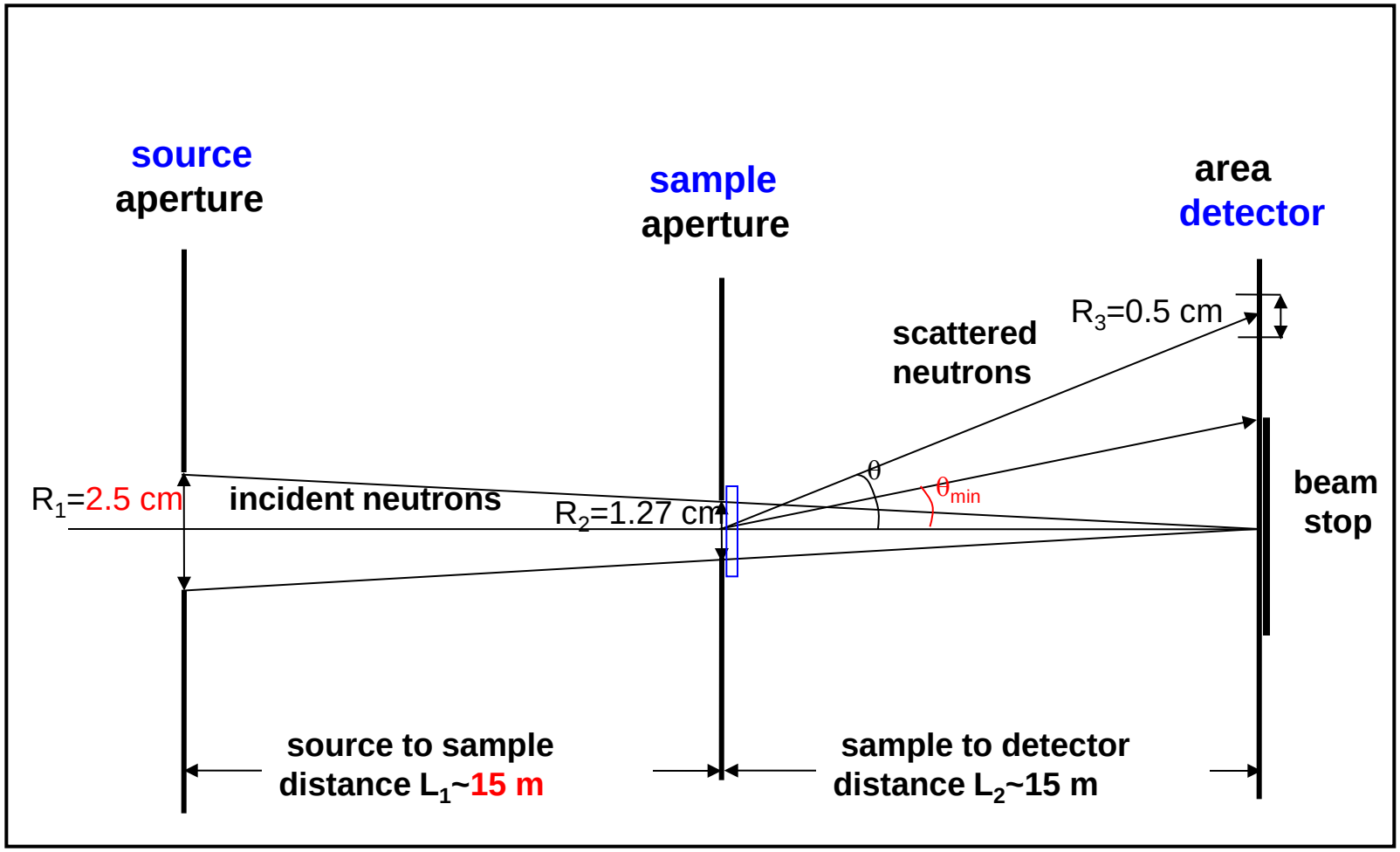
Output: Neutron Scattering Length Density: $6.39*10^{-6}$ $Å^{-2}$

Scattering length density: $\rho_A = \frac{b_A}{v_A} = \frac{\text{scattering length}}{\text{volume}}$

The Contrast Match Method

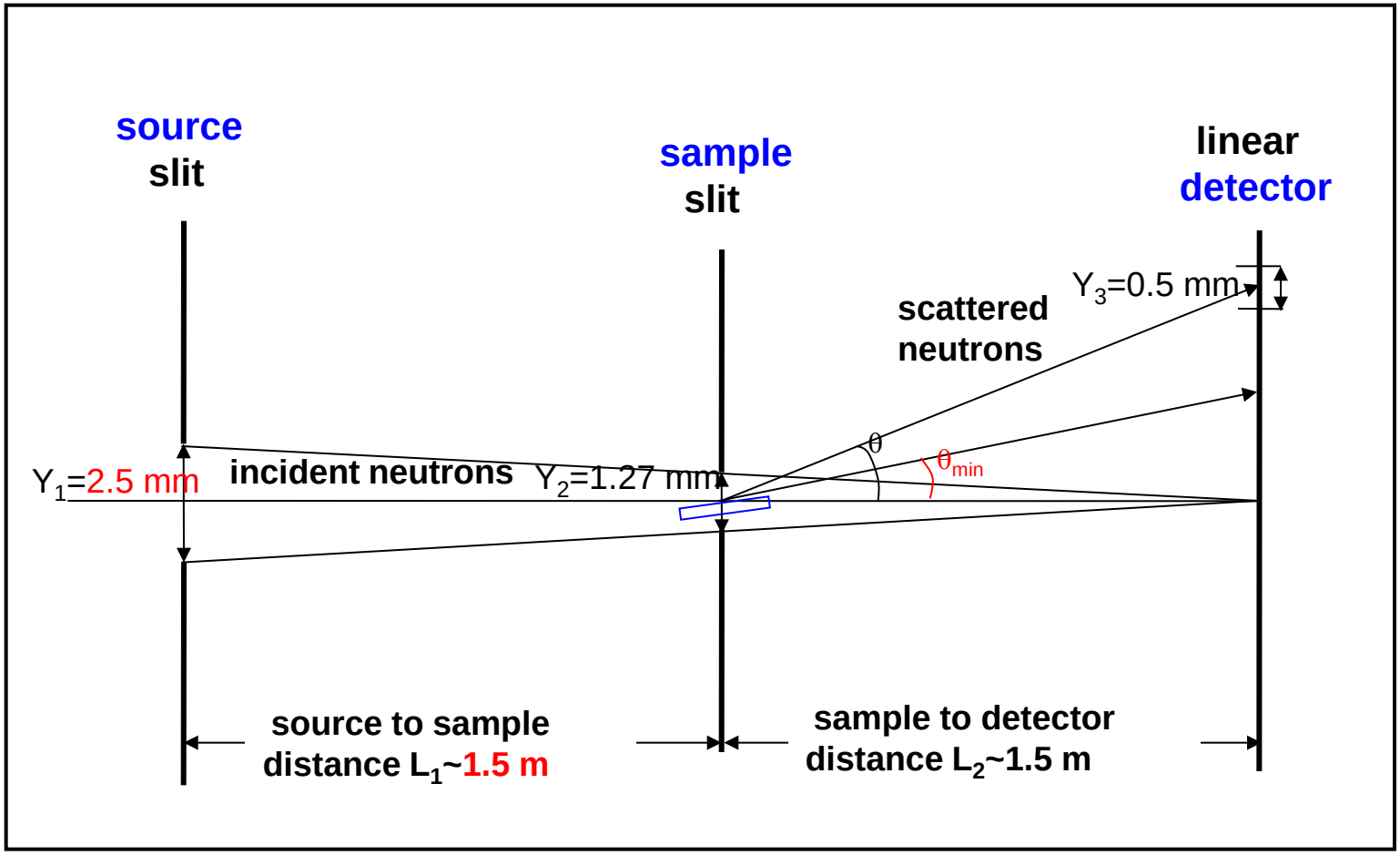


SANS GEOMETRY



$$\theta_{min} = (R_1+R_2)/L_1+R_2/L_2+R_3/L_2 \sim 3.7*10^{-3}\ \text{Rad} \sim 0.2^{o}$$

REFLECTOMETRY GEOMETRY



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