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Radial Collimators, Reducing SE Background on the SEPD

Giving SE Equipment a Helping Hand

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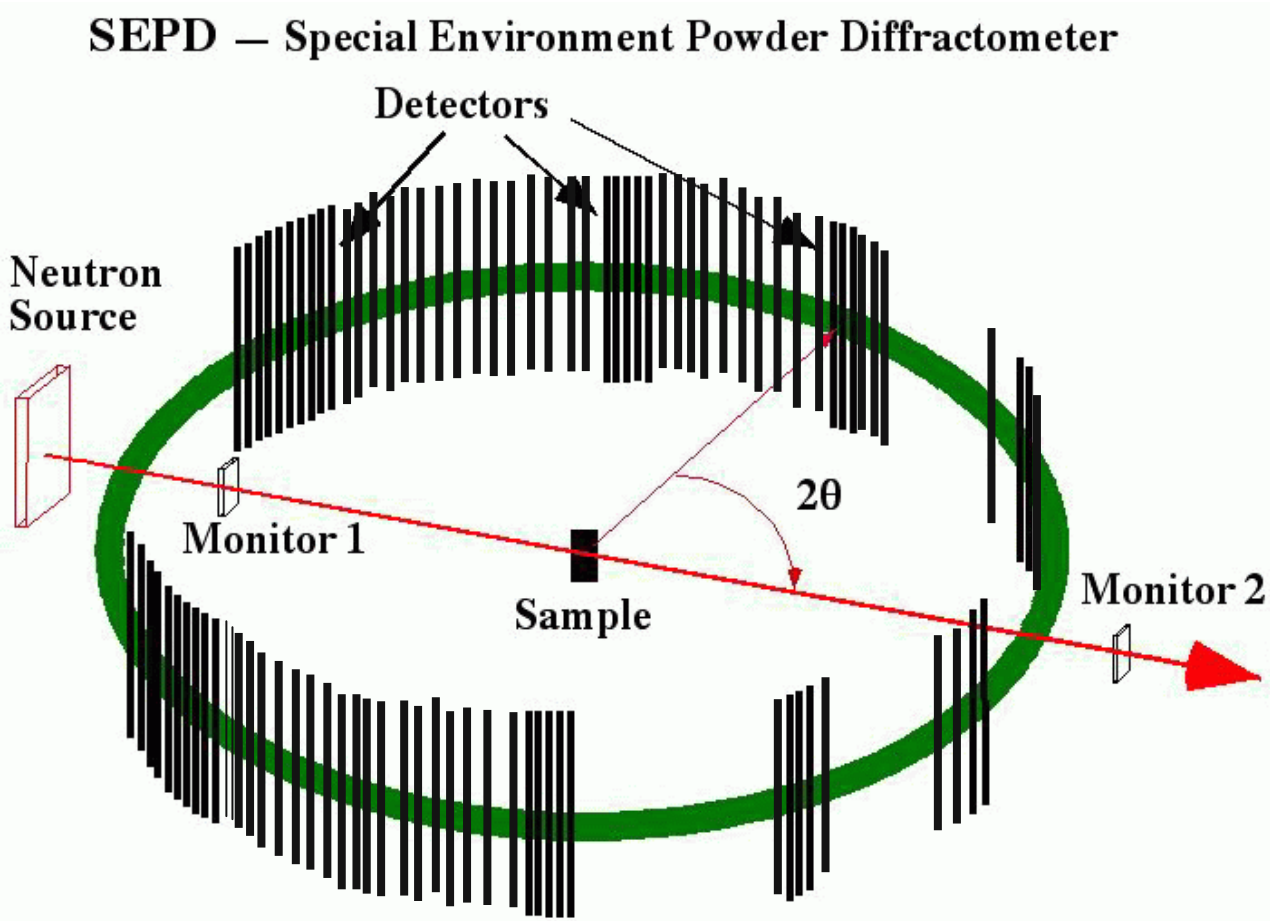
Proposed SEPD Upgrades

- Detectors and Electronics
- Neutron Guide
- T0 Chopper
- Delayed Neutron Chopper
- Radial Collimator-*Allow use of various SE equipment like 7 T Magnet*
- Shielding Improvements
- Data Acquisition Electronics

Ultimate Result of Upgrade!

- *"It should be possible to achieve the best signal-to-noise ratio of any pulsed-source time-of-flight diffractometer."* Dr. J.D. Jorgensen
- Counted rate increase of 3-9 with minimal effect on resolution
- d-spacing range extended to 30Å in first frame
- Improve resolution at low angles
- Reduced backgrounds
  - Up to a factor of 2 for routine data collection
  - Novel improvements for special environments

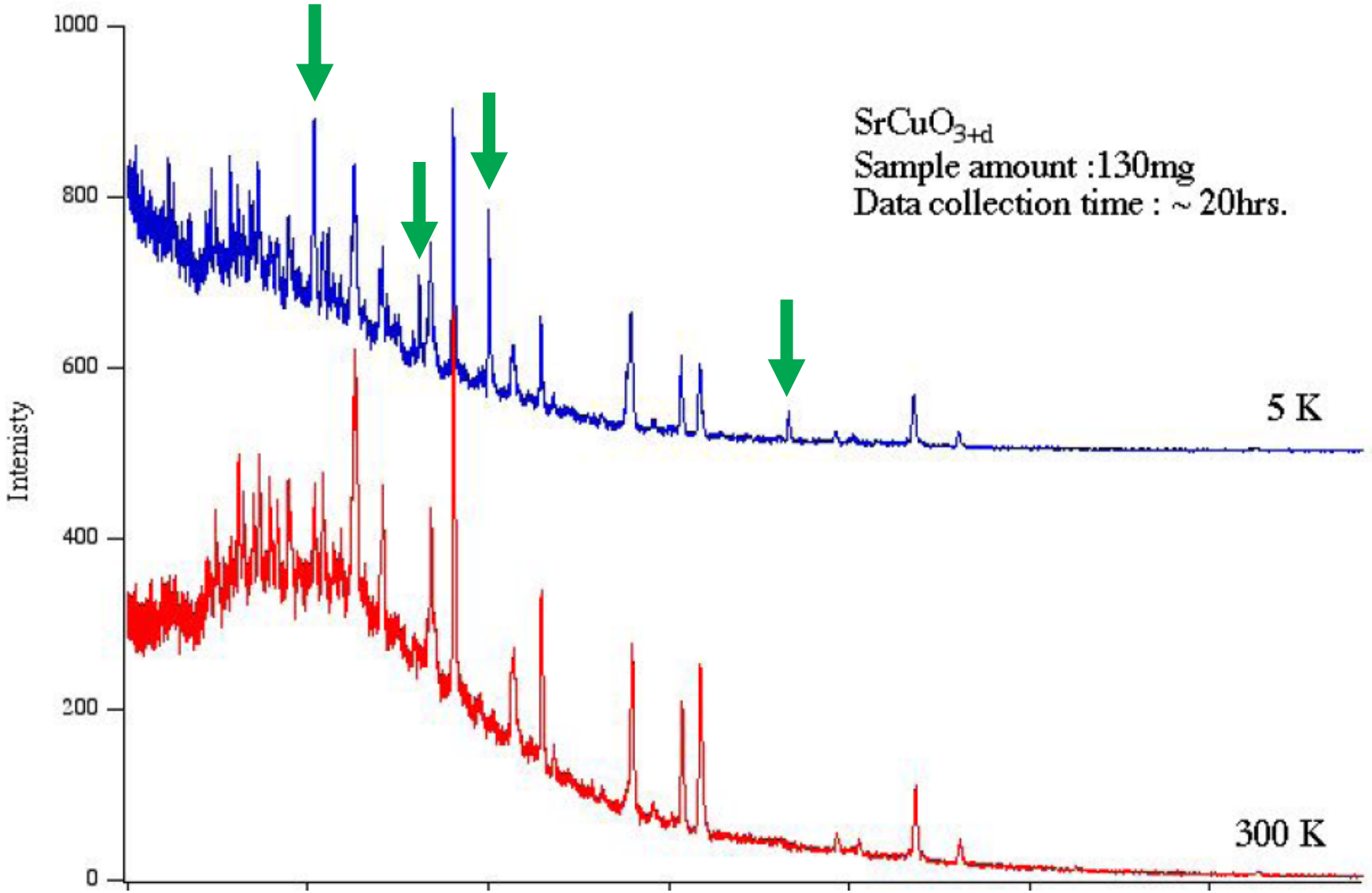
Sketch of SEPD



Description

Beam Line	F5
Moderator	100K liquid methane
Wavelength Range (frame overlap limit)	0.5 - 7.55 Å
Beam Size	1.27 cm wide, 5 cm high
Thermal Flux on Sample	1 x 10^7 neutrons cm^{-2} s^{-1}
Moderator-to-Sample Distance	14 m
Scattered Flight Path	1.5 m
Detectors	10 atm ^{3}He proportional counters; 1.27 cm dia x 38 cm long
Sample Amount	0.05 - 20 g
Typical Data Collection Times	5 h for 5 g, 24 h for 0.1 g for precision Rietveld refinements
Time-Dependent Studies	useful data in ~5 min for large samples in favorable cases

Clean data very good signal-to-noise

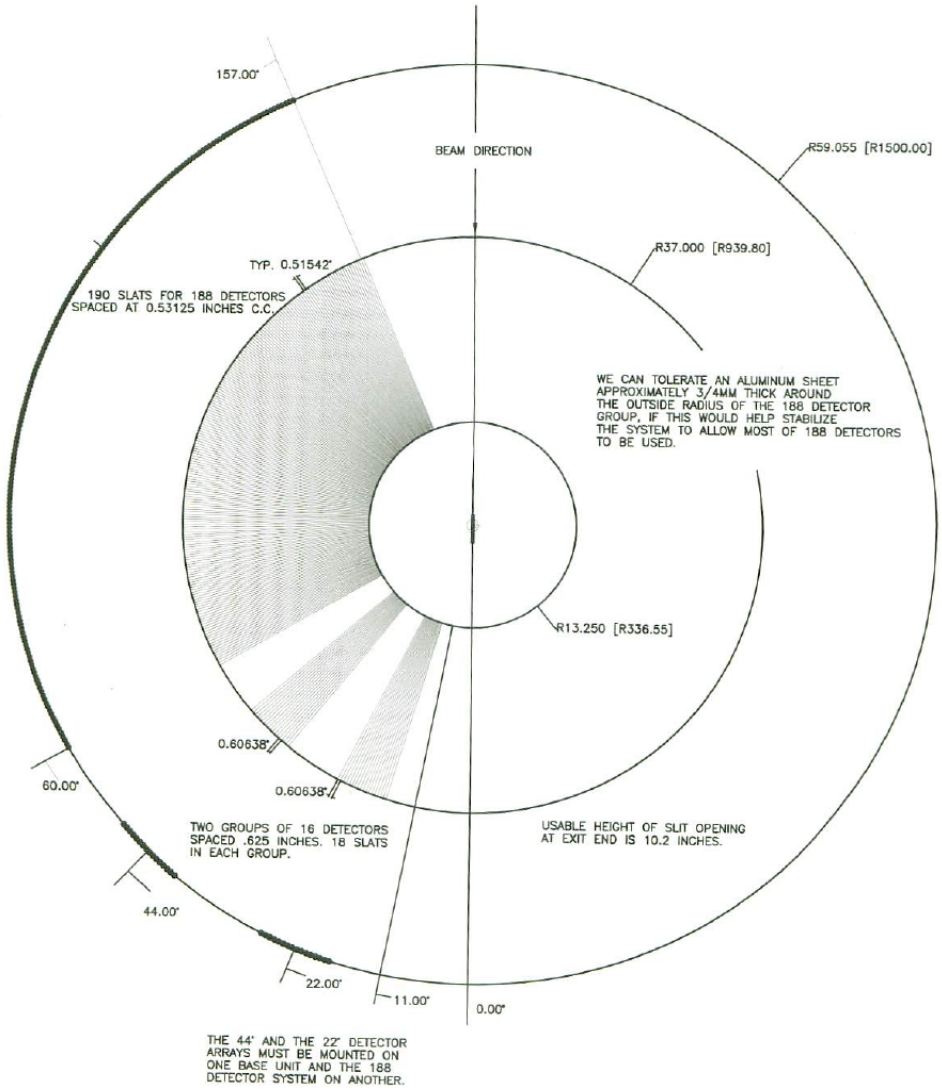


Can we improve signal-to-noise?

- Yes, by reducing SE background noise contribution with use of Radial Collimator

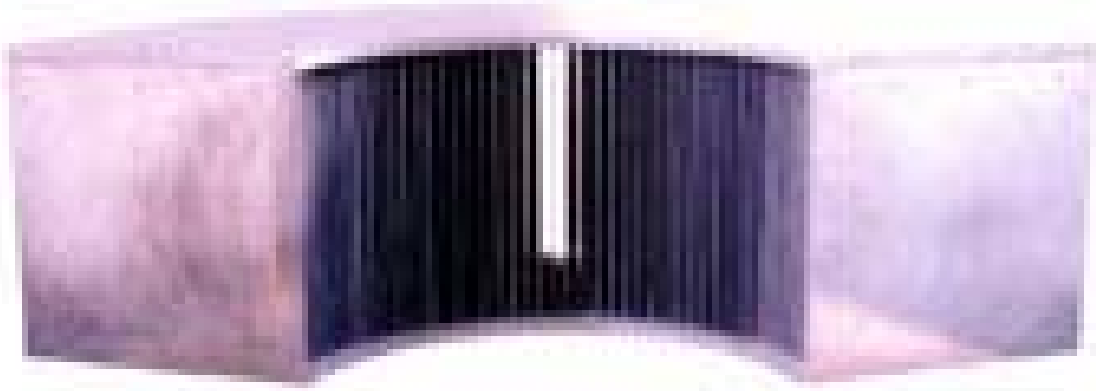
SEPD Collimator Layout

- Detector Banks One Side
  - 22°, 44°
    - *16 LPSD each*
    - *18 Slats*
  - 60° to 157°
    - *188 Detectors*
    - *190 Slats*

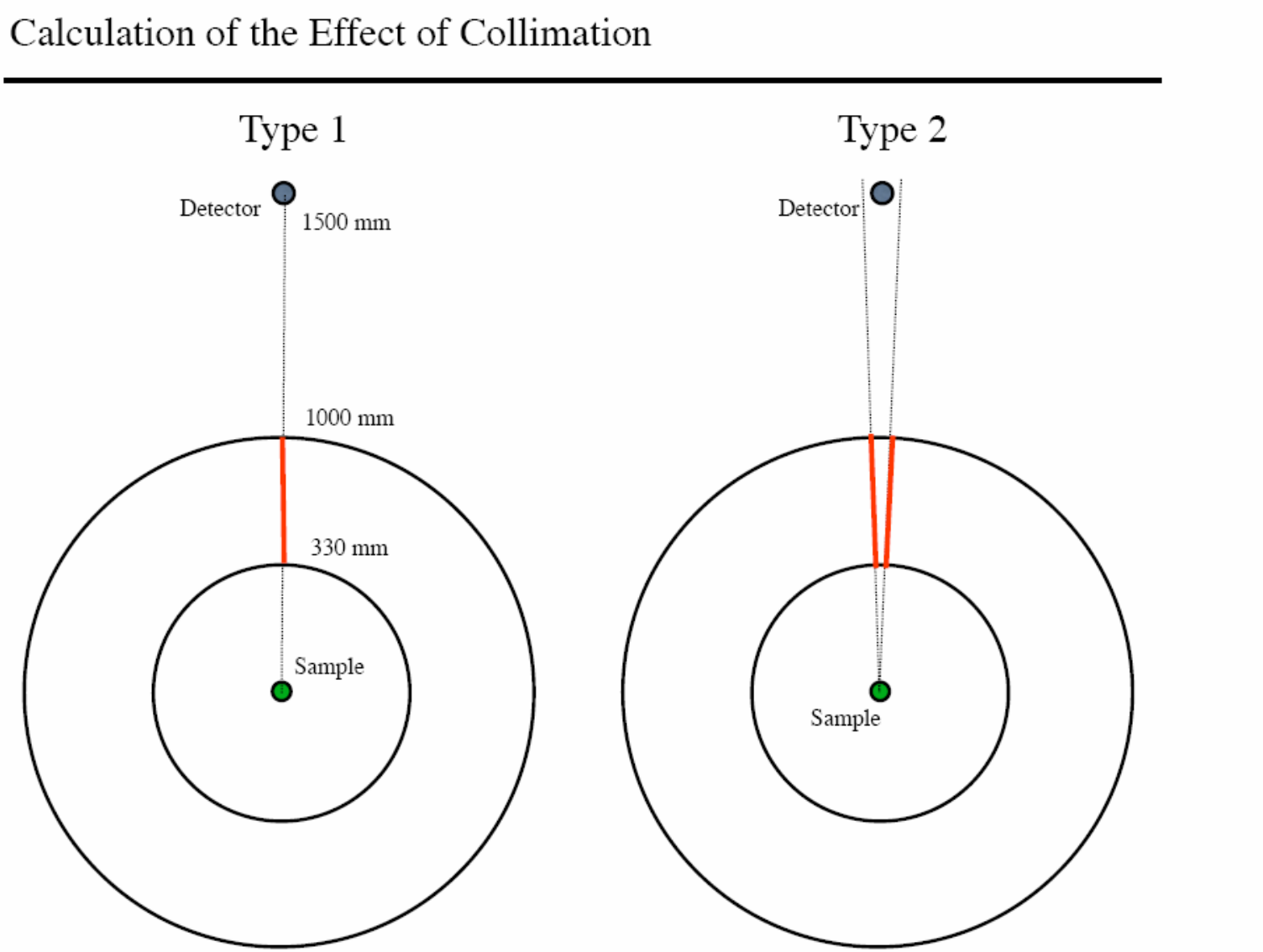


Fixed Blade Radial Collimator half-circle

euro collimators



Vane Alignment Options



Neutron Transmission from a Sample

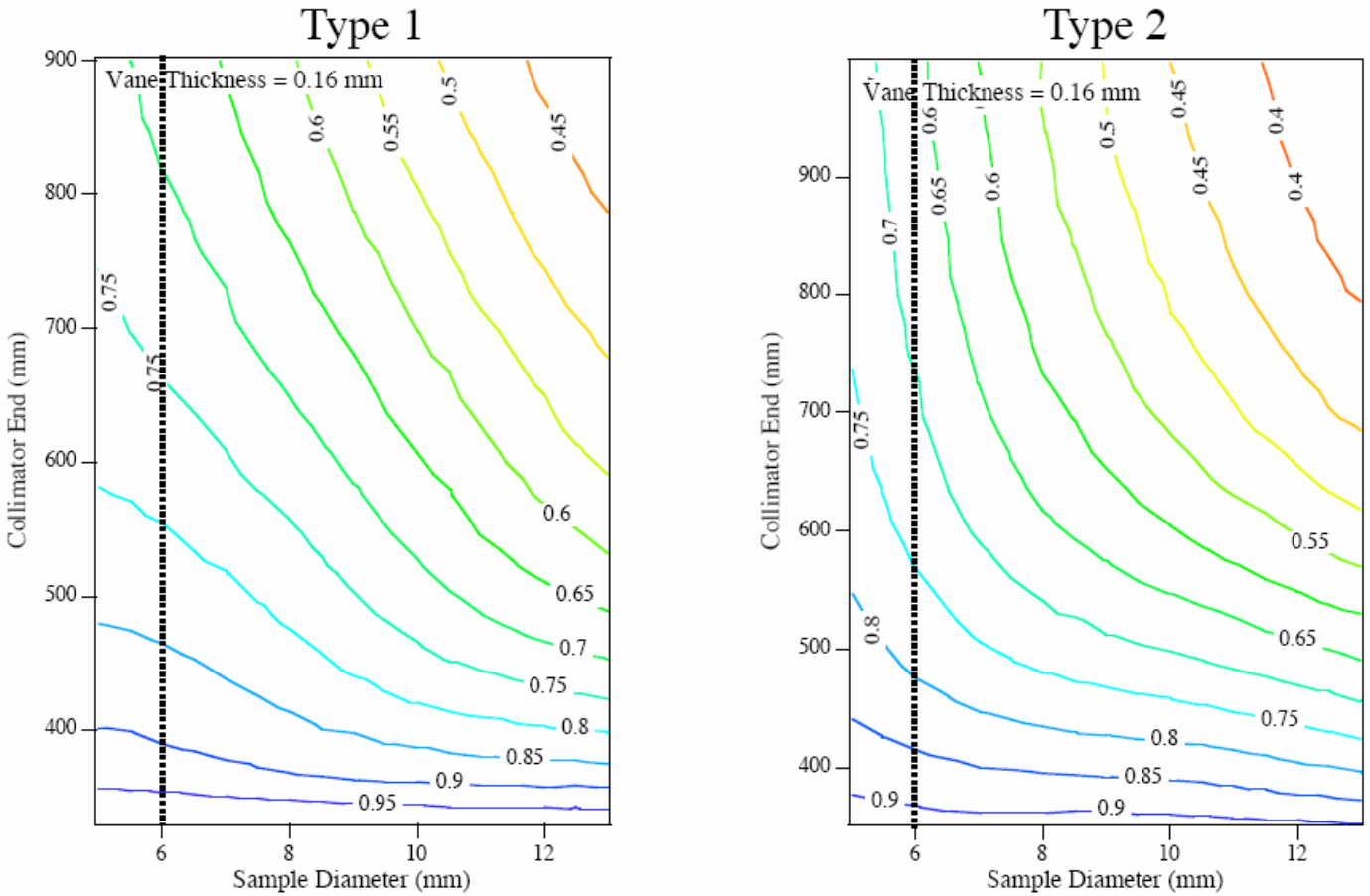
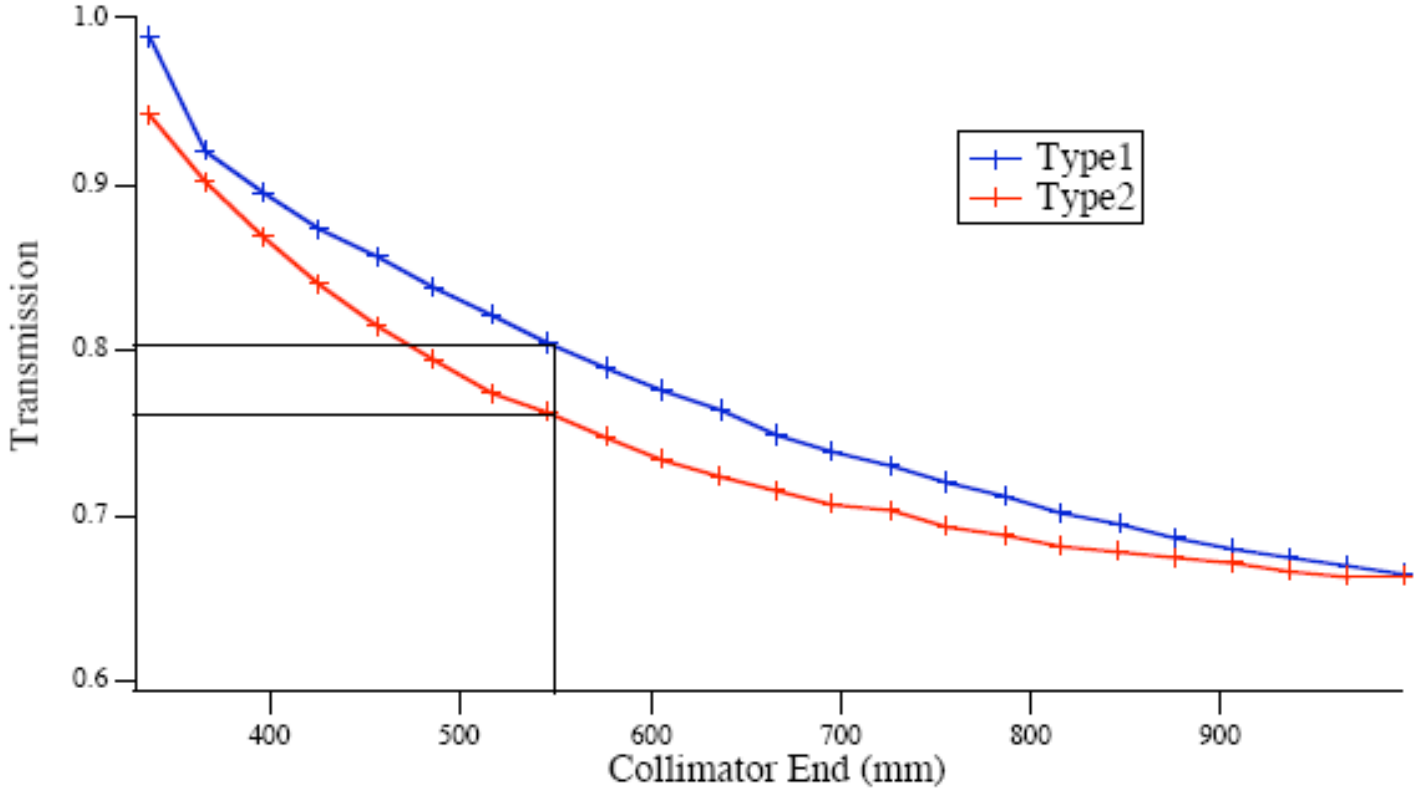


Fig. 1 Neutron Transmission from a sample to a detector with a Type 1(left) and Type 2(right) collimator. A collimator starts from 336.55 mm and the vane thickness was assumed at 0.16 mm.

Neutron Transmission from a Sample

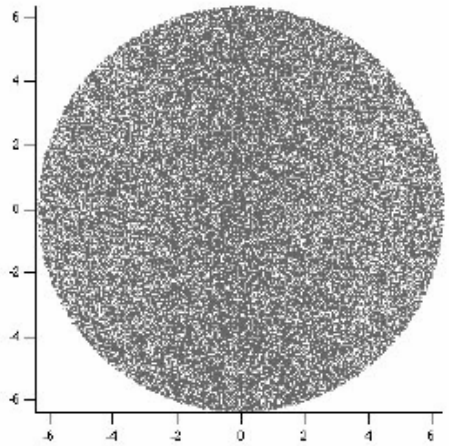
Sample diameter = 6.0 mm

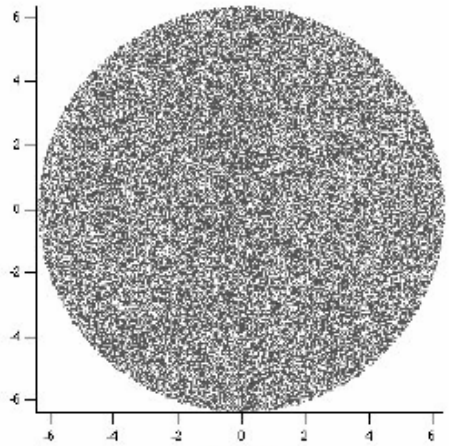


Distribution of the Neutron on the Sample and the Detector

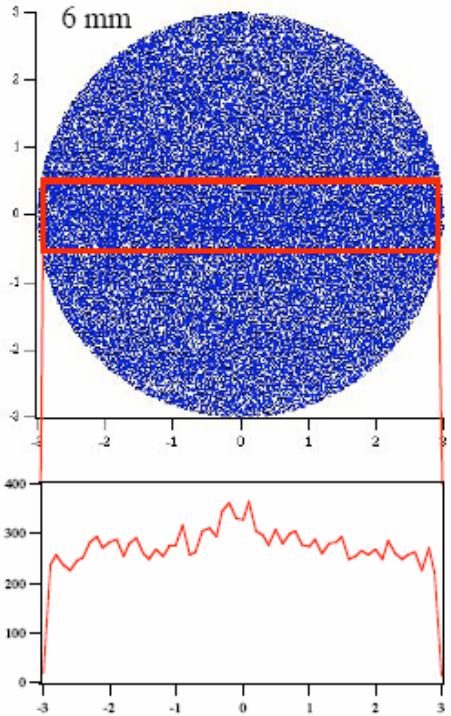
Type 1

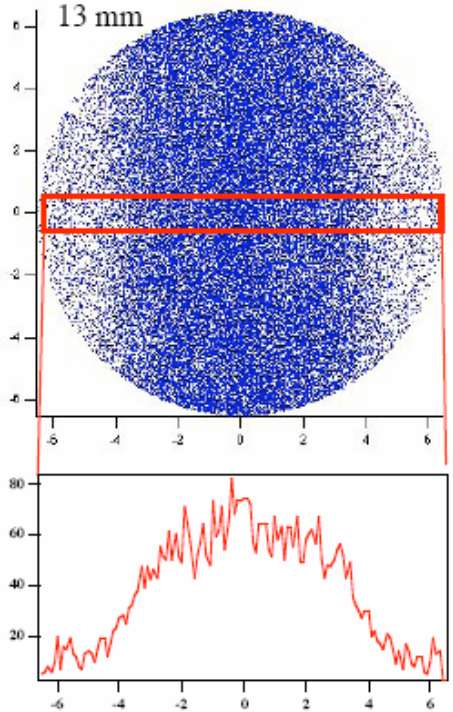
Detector





Sample

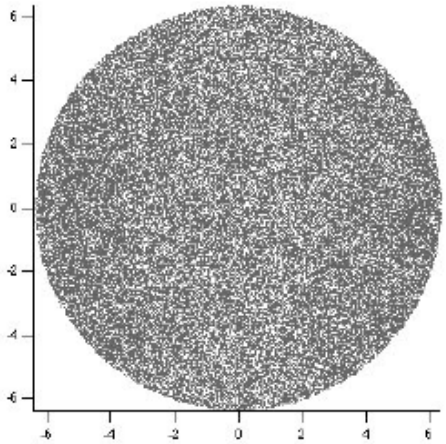


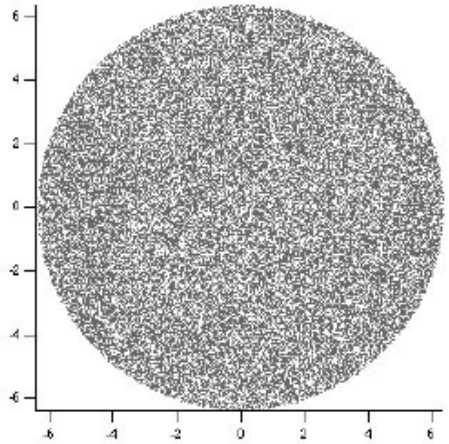


Distribution of the Neutron on the Sample and the Detector

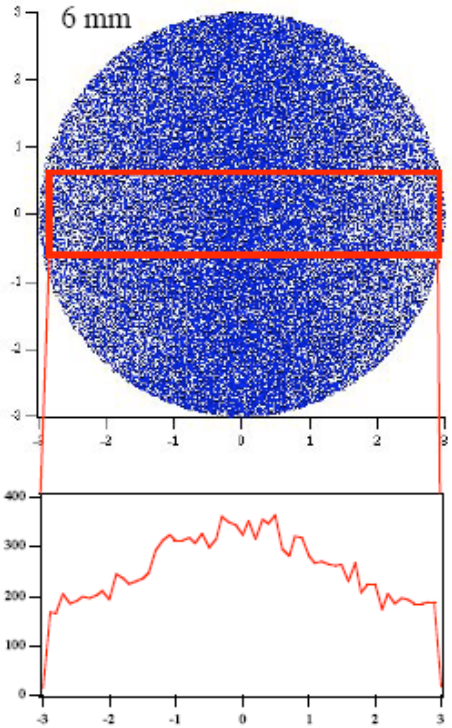
Type 2

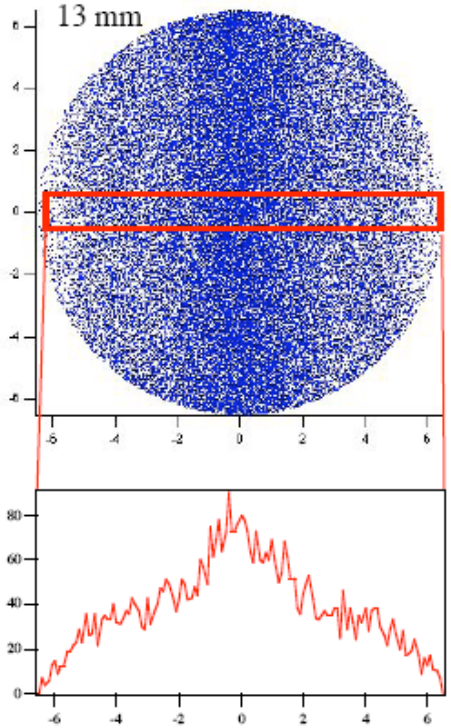
Detector



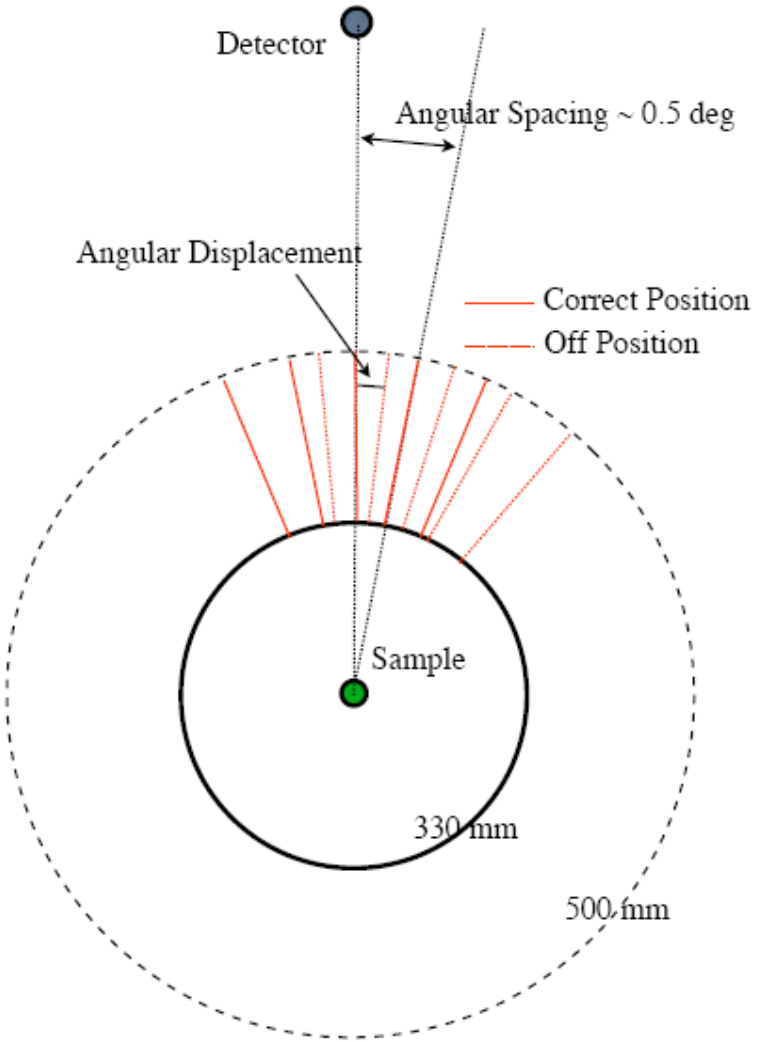


Sample





Neutron Transmission with Type 1 collimator
< with Angular Displacement >



Sample Size : 6 mm
Collimator End : 550 mm (length = 213.45 mm)

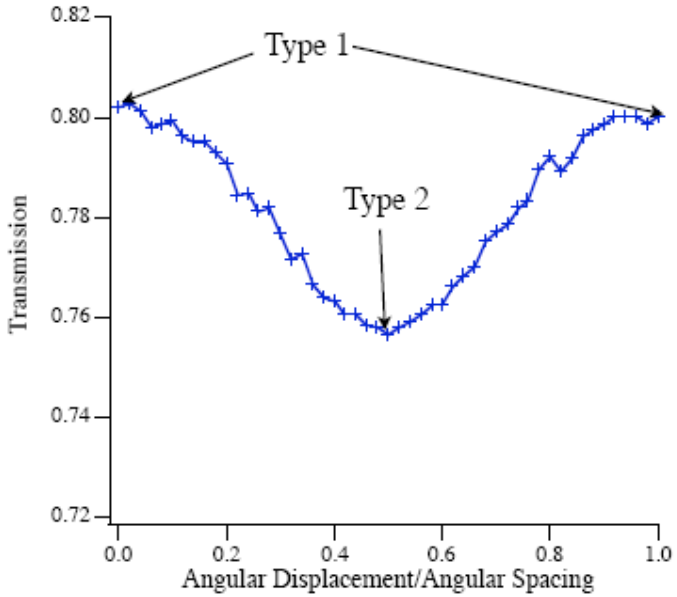
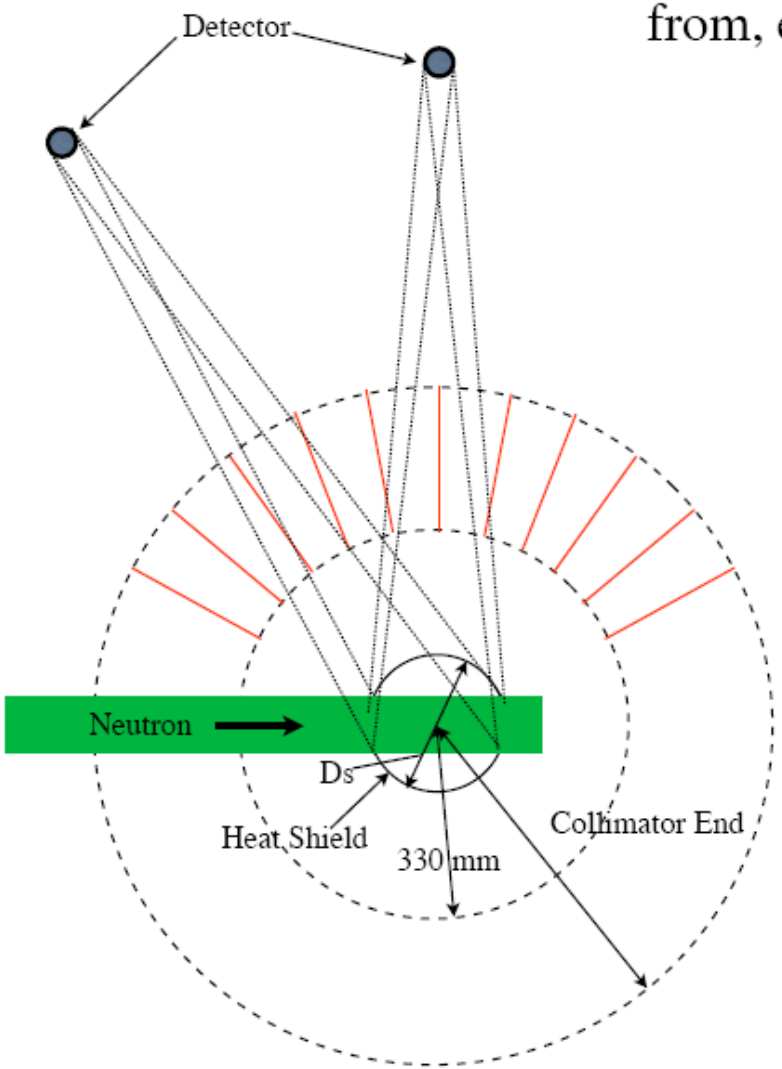
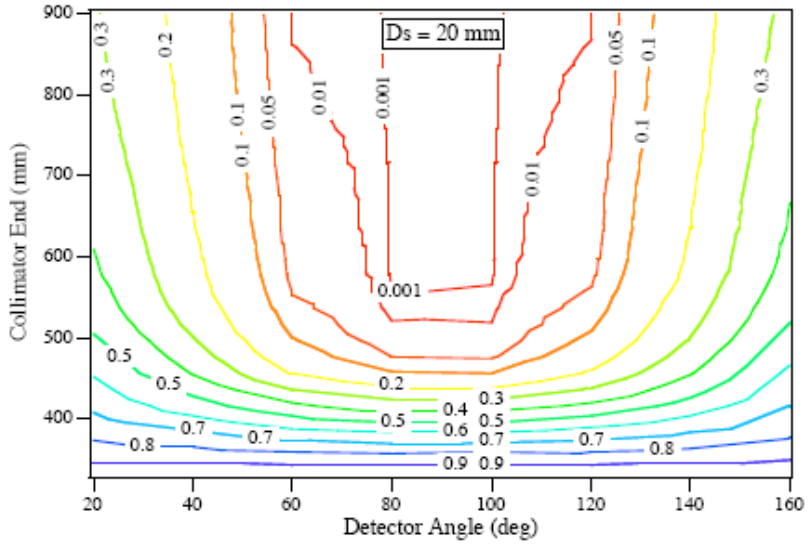


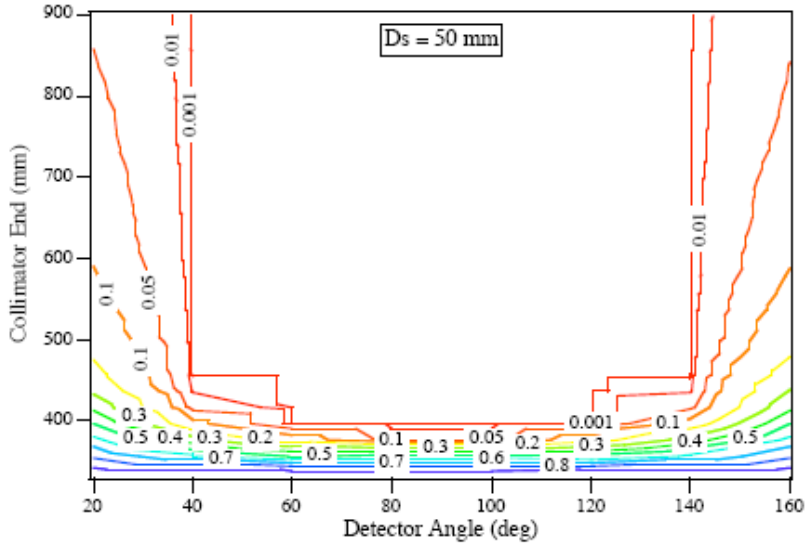
Fig. 4-2 Transmission from the sample to the detector with angular displacement of collimators. The transmission at 0, 1.0 and 0.5 correspond to type 1 and type 2 collimator, respectively.

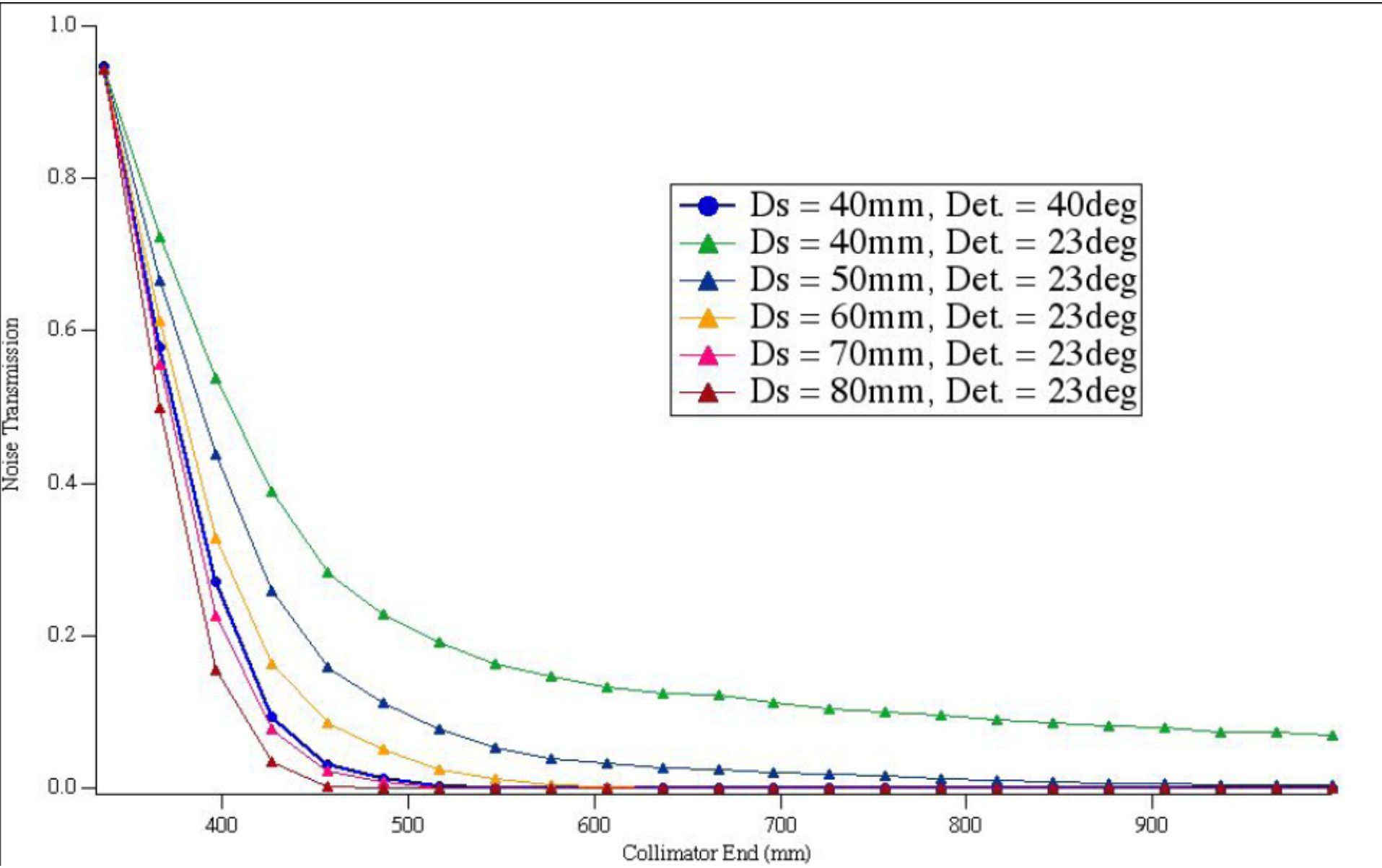
Shielding Effect against Noises comes from, eg, Heat Shield



Incident Neutron Size :12.7 mm
Ds : Diameter of a Heat Shield

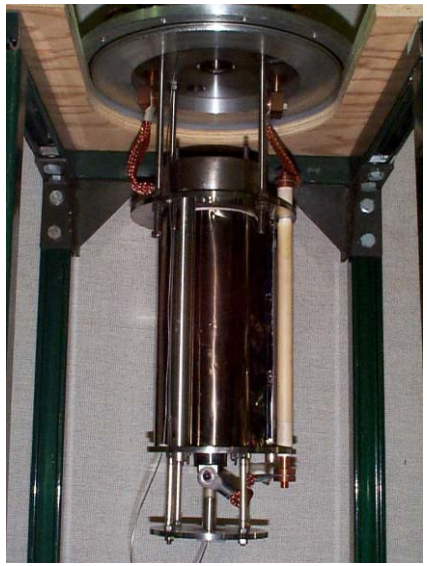





1.0
0.8
0.6
0.4
0.2
0.0
Noise Transmission
400
500
600
700
800
900
Collimator End (mm)
Ds = 40mm, Det. = 40deg
Ds = 40mm, Det. = 23deg
Ds = 50mm, Det. = 23deg
Ds = 60mm, Det. = 23deg
Ds = 70mm, Det. = 23deg
Ds = 80mm, Det. = 23deg

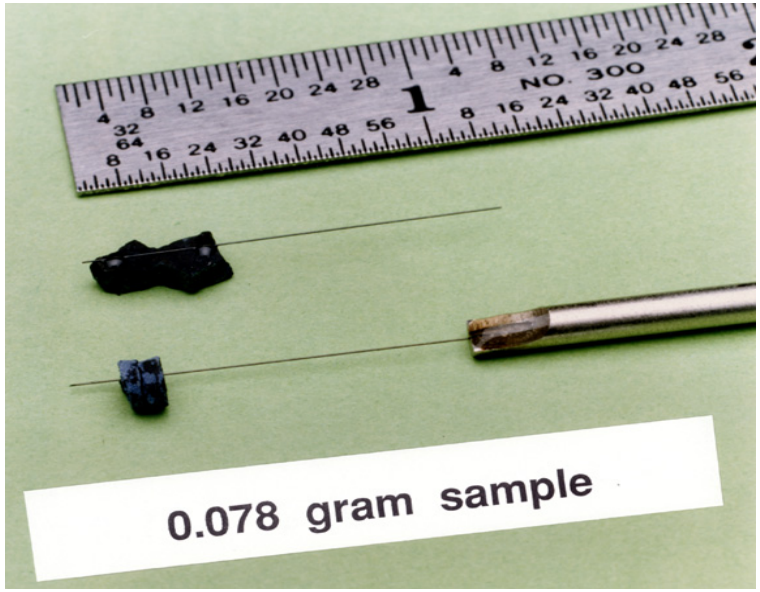
Reduced Background for Various SE Equipment

7 T Magnets



Furnaces with
large heat shields

Novel SE Equipment e.g.



Conclusions:

- Upgrade will make the SEPD an influential instrument for the study of magnetic structures, large-cell structures and small samples.
- Radial Collimator will reduce background noise from many pieces of SE equipment
  - Radial Collimator will open up novel design approaches for new SE equipment
  - Allow the study of small samples with good signal-to-noise ratio
- Fill a niche in the neutron scattering community suite of instruments
- Do the best with what you have…

Acknowledgements

- James D. Jorgensen
- Bob Kleb
- Ryoji Kiyanagi