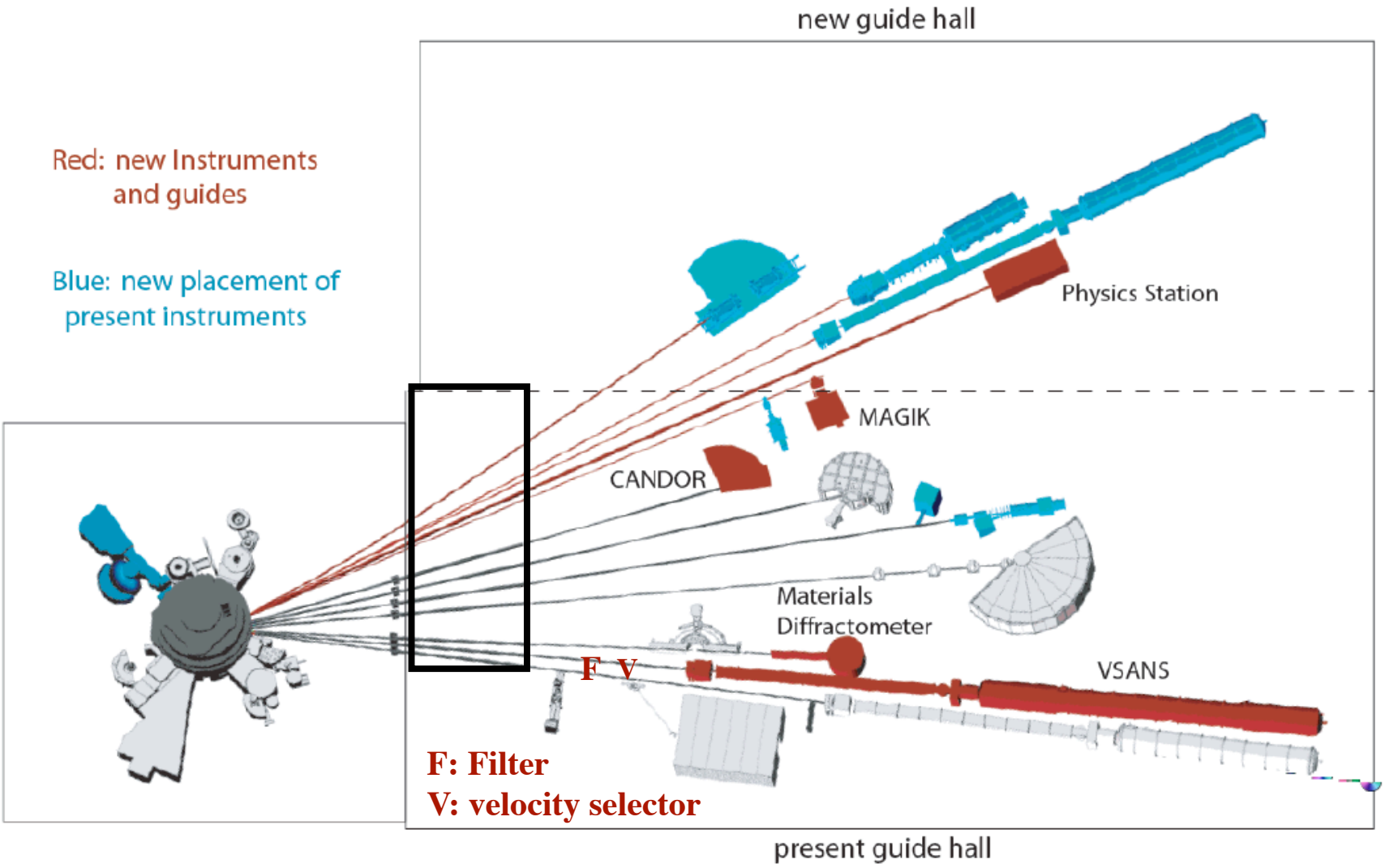
New VSANS instrument: completion 2012

$Q_{min} = 2x10^{-4}$ Å^{-1}



A.Objective Statement Revised 2/13/2008

The VSANS instrument has the following objectives:

1. To provide the widest, and most useful, Q-range accessible on a single SANS instrument worldwide (to 2 x 10^{-4} $Å^{-1}$ to 1.0 $Å^{-1}$) thereby enabling nano- to microscale (isotropic or anisotropic) structure, ranging from 1 nm to 1500 nm, to be characterized with maximum efficiency. The low-Q limit of the VSANS instrument represents roughly a factor of 5 improvement over the existing 30-m SANS instruments.

2. To provide a beam current of at least 1 x 10^4 n/sec for the highest resolution measurements with background on the detector of less than 0.1 % of the beam current to assure that even weak scattering signals may be measured at the low-Q limit of the instrument.

3. To provide the option for high-resolution measurements (DQ/Q ~ 3 %) thereby enabling the capability to characterize highly ordered large-scale structures.

4. To provide the option for high intensity beam current (~ 10^6 n/sec on sample) and low-Q (2 x 10^{-4} Å^{-1}), albeit with slit-smearing, in order to enable rapid measurements over the entire Q-range of the instrument.

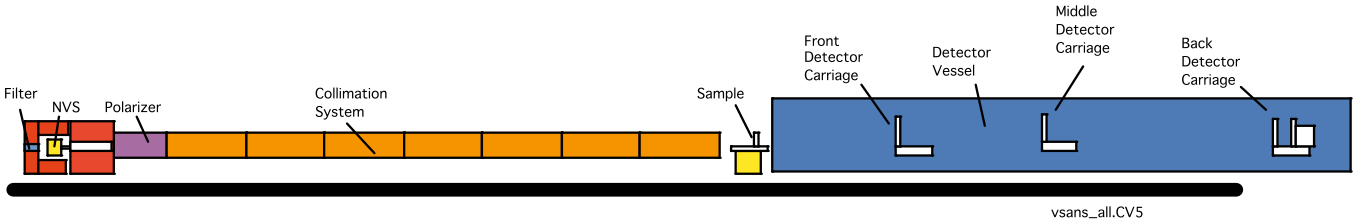
5. To provide intuitive control and feedback regarding all aspects of the instrument configuration and measurement status to facilitate operation by users with minimal assistance from instrument scientists.

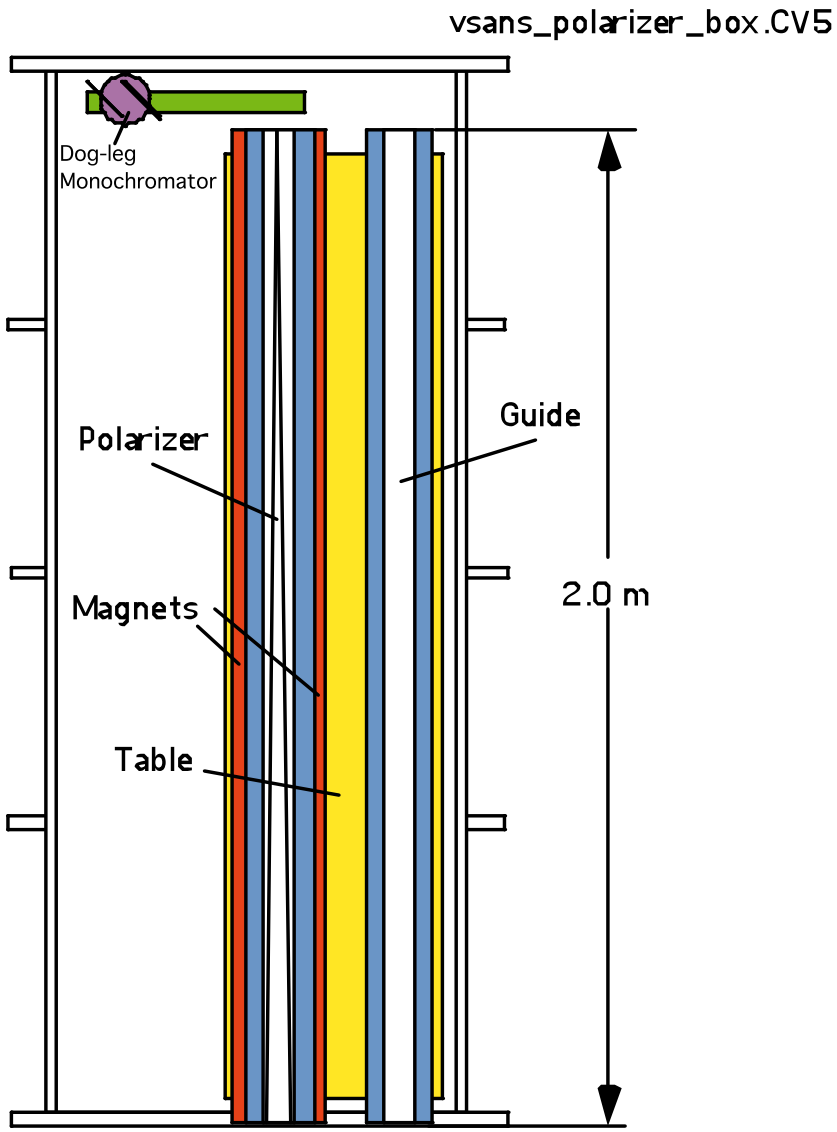
6. To achieve Phase I operational status by 01/11. Objectives 2, 3 and 4 shall be met in Phase I, and objective 1 shall be partially met in that measurements from 10^{-3} Å^{-1} to 2 x 10^{-4} Å^{-1} will be possible with narrow slit collimation only (suitable for axially symmetric, but not anisotropic scattering patterns).

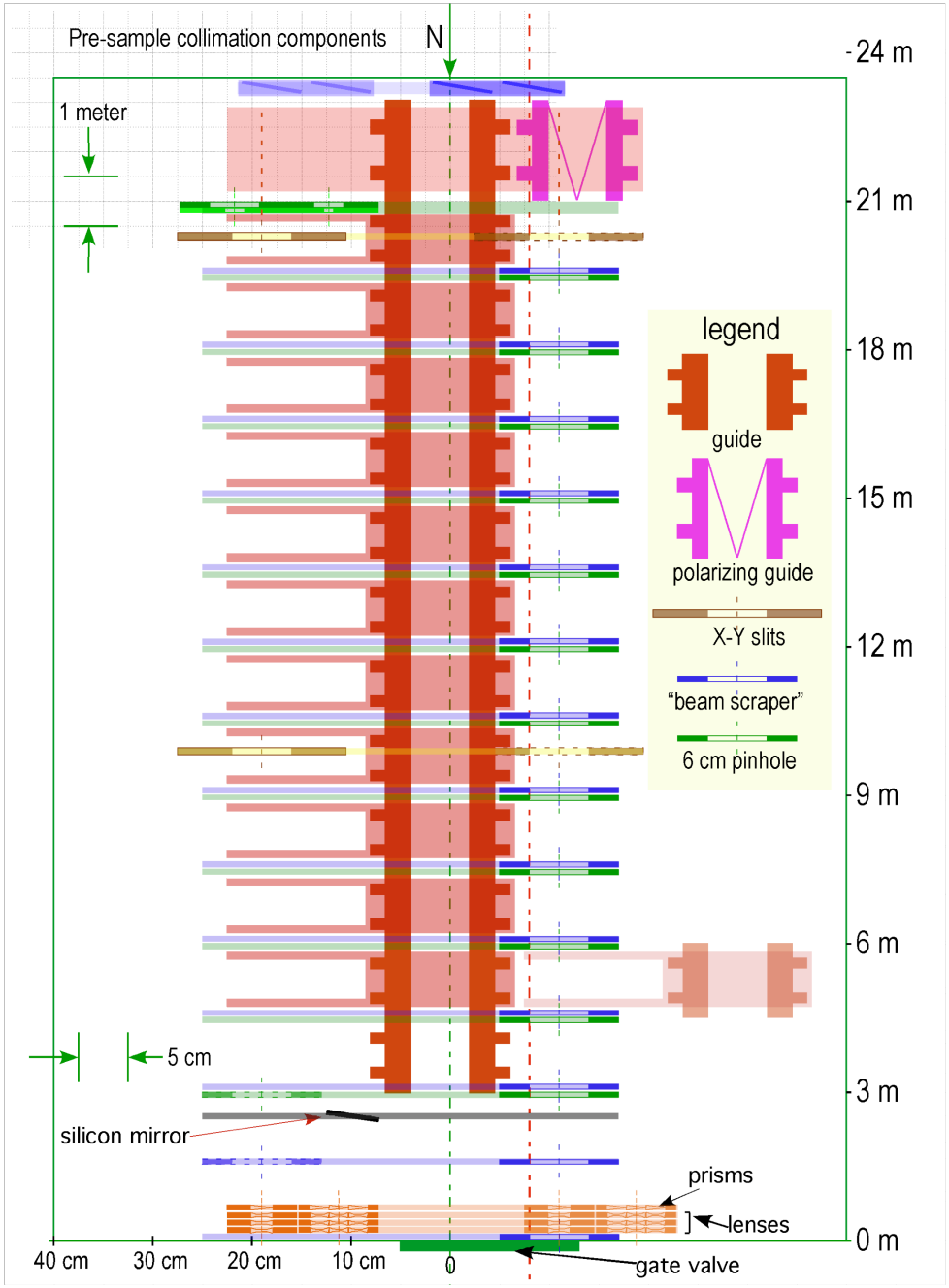
7. To be available to general users by 01/12. Objective 5 must be met to achieve this milestone.

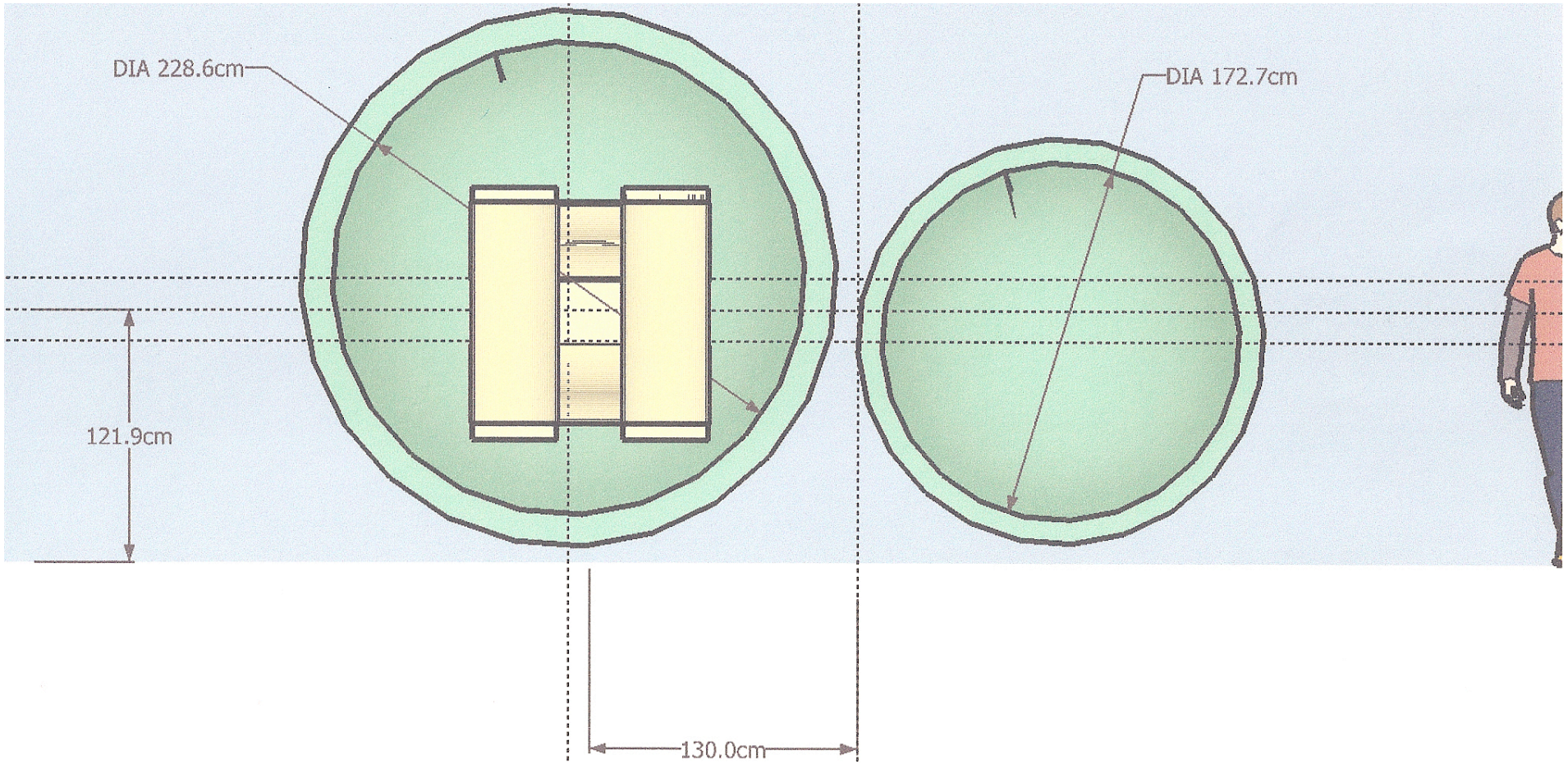
8. To achieve Phase II operation by 01/13. Phase II requires achieving objective 1 for even weak, anisotropic scattering samples, which implies circularly symmetric beam collimation under all measurement conditions.

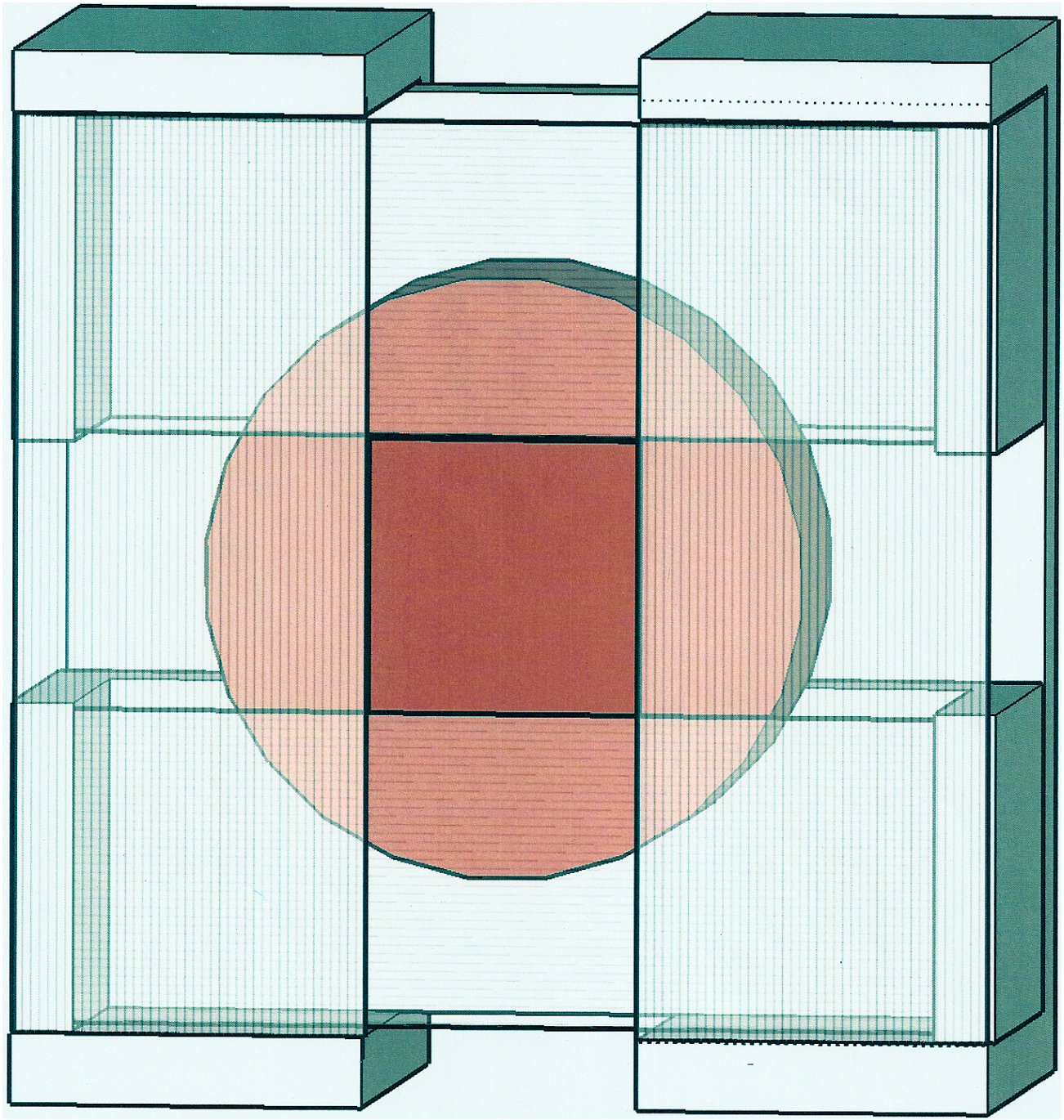
9. To add polarized beam, with polarization analysis, capability by 01/14. This objective must be included in the planning for Phase I so as not to preclude this enhancement in VSANS capability.

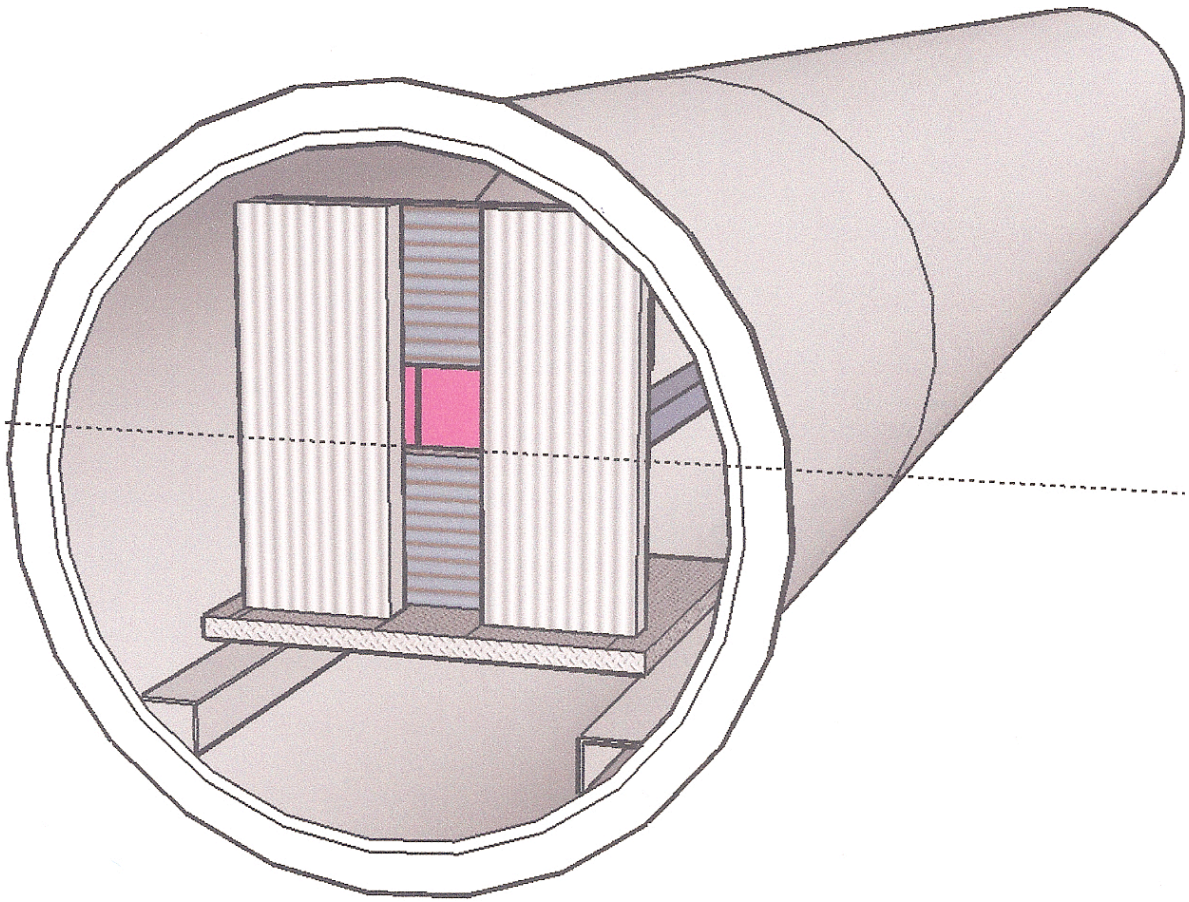

Filter
NVS
Polarizer
Collimation System
Sample
Front Detector Carriage
Detector Vessel
Middle Detector Carriage
Back Detector Carriage
vsans_all.CV5

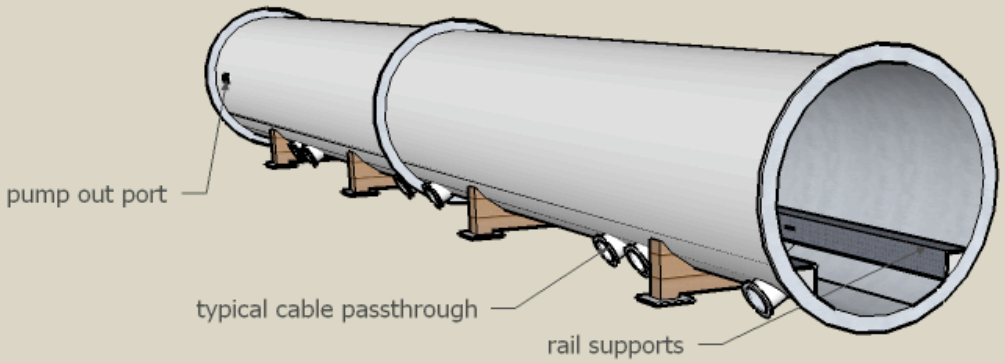

vsans_polarizer_box.CV5
Dog-leg
Monochromator
Polarizer
Guide
Magnets
Table
2.0 m

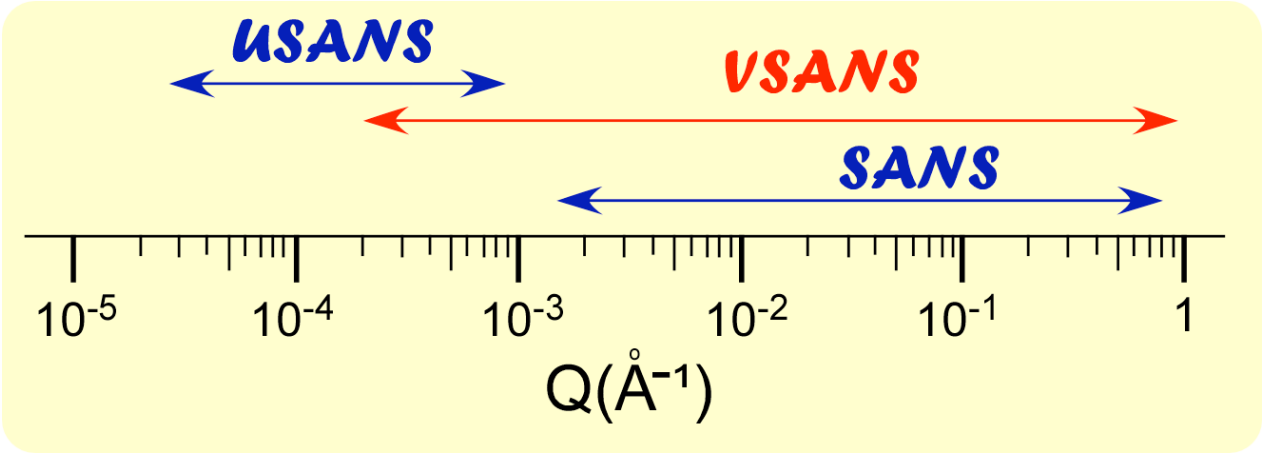

Pre-sample collimation components
N
24 m
1 meter
21 m
18 m
15 m
12 m
9 m
6 m
3 m
0 m
legend
guide
polarizing guide
X-Y slits
"beam scraper"
6 cm pinhole
5 cm
silicon mirror
prisms
lenses
40 cm
30 cm
20 cm
10 cm
0
gate valve

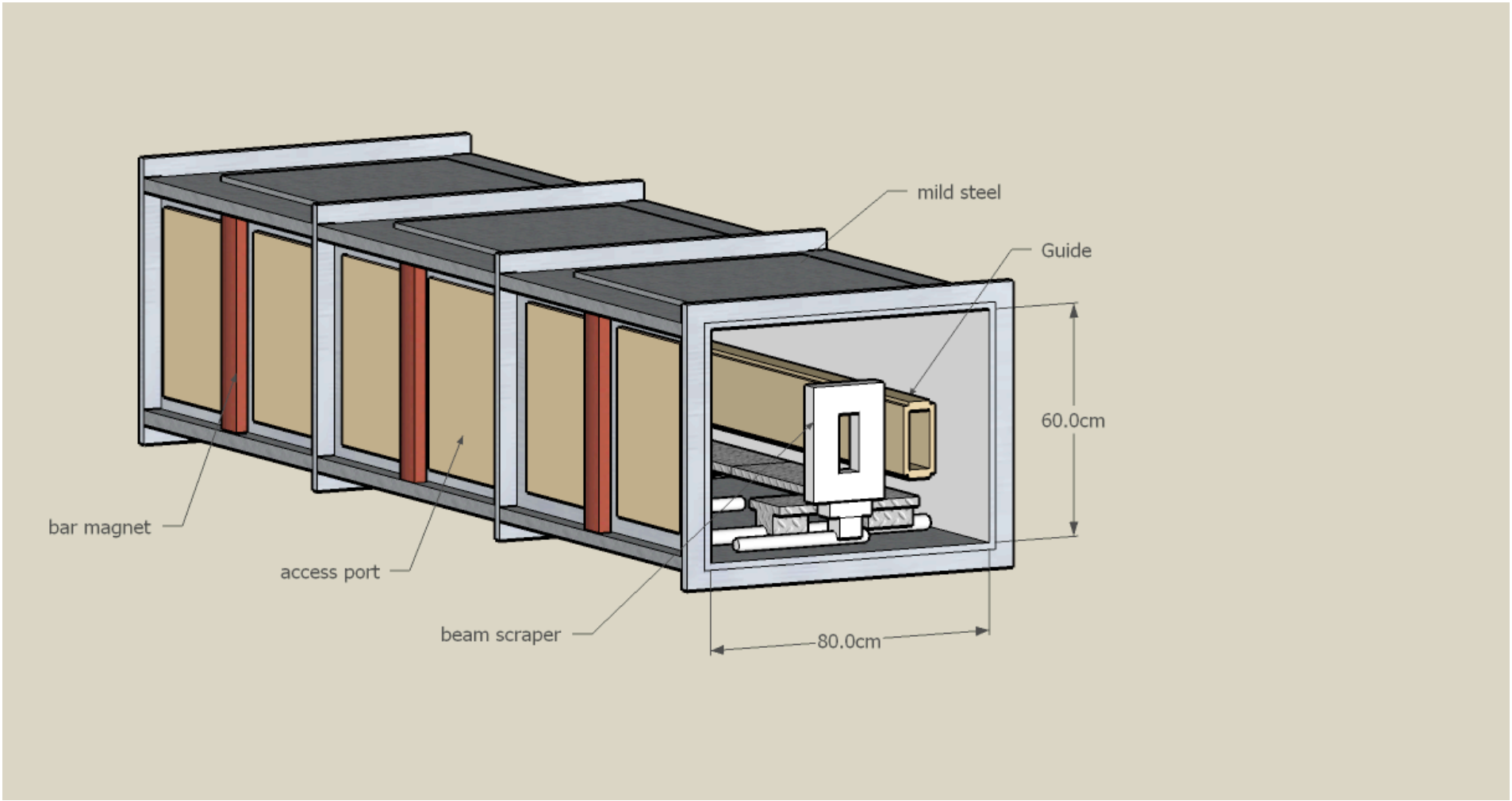

DIA 228.6cm
DIA 172.7cm
121.9cm
130.0cm

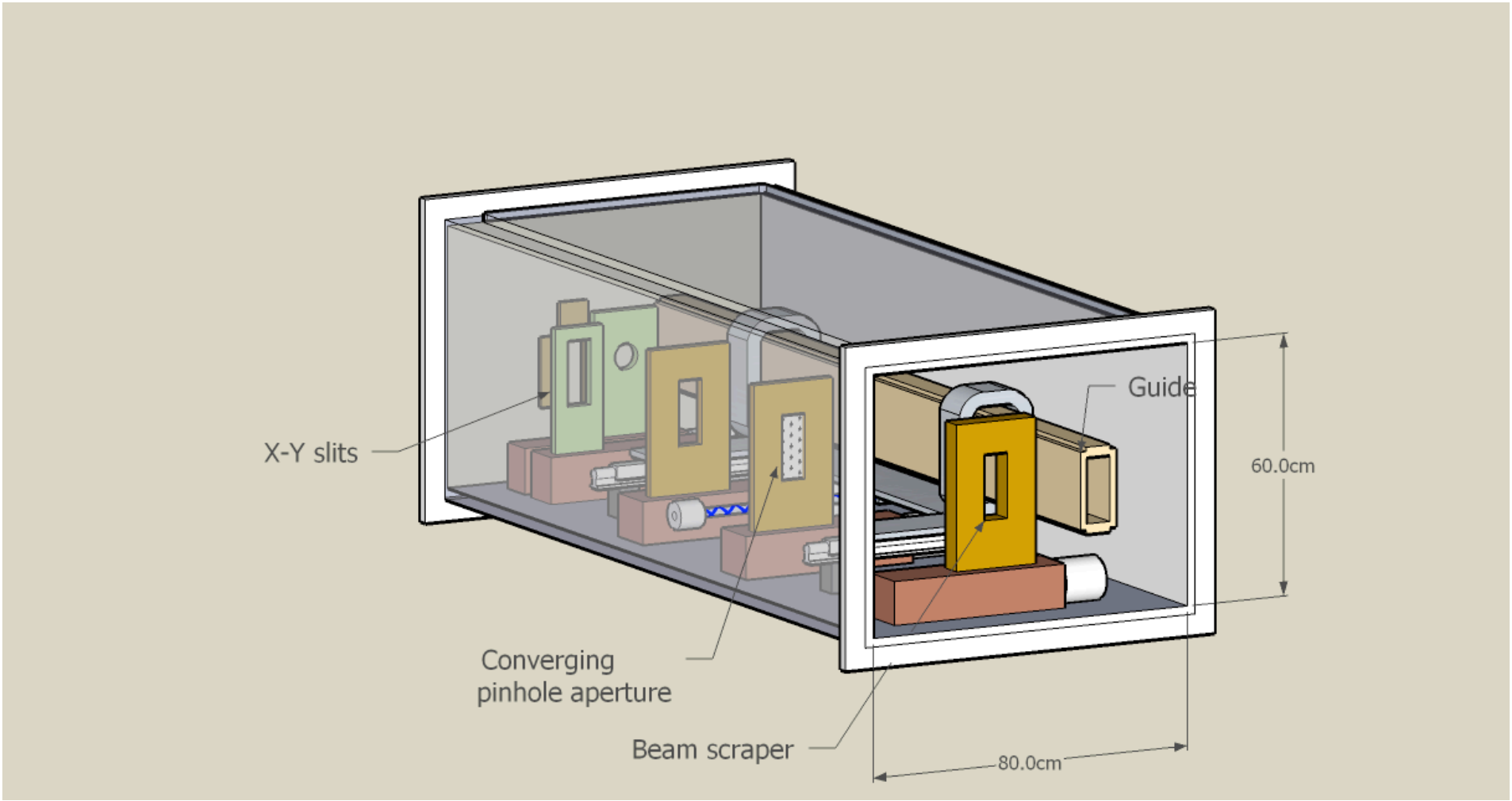





pump out port
typical cable passthrough
rail supports


USANS
VSANS
SANS
10-5
10-4
10-3
10-2
10-1
1
Q(Å-1)


mild steel
Guide
60.0cm
bar magnet
access port
beam scraper
80.0cm


X-Y slits
Guide
60.0cm
Converging
pinhole aperture
Beam scraper
80.0cm

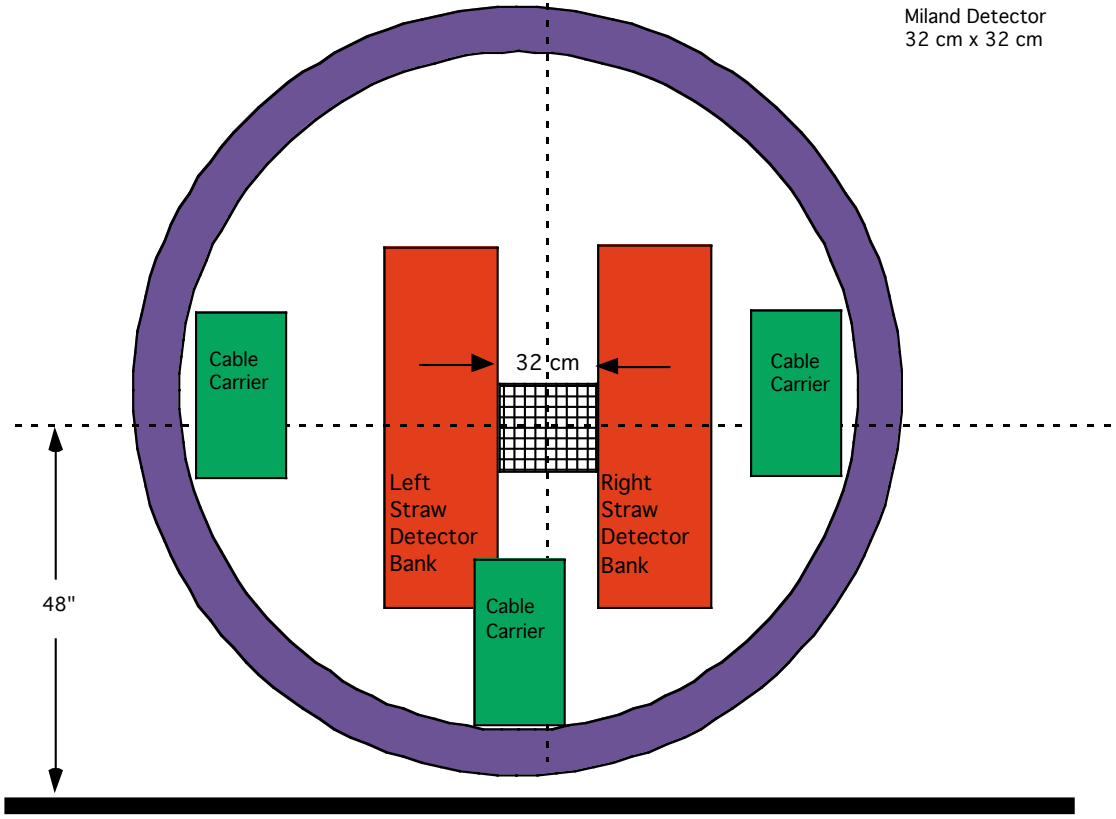
Tube detector banks opened at 32 cm to allow viewing of "Miland" Detector inside new 90" ID SANS tank

Detector tank, with 90" I.D., and 102" O.D.,with center shifted 5" up, and 4" to the left. Spacing between tank and floor is 2". Detector carriage can move to the left by 8" (20 cm).
Tube detector banks include additional length to accommodate wire connections (48" long.).

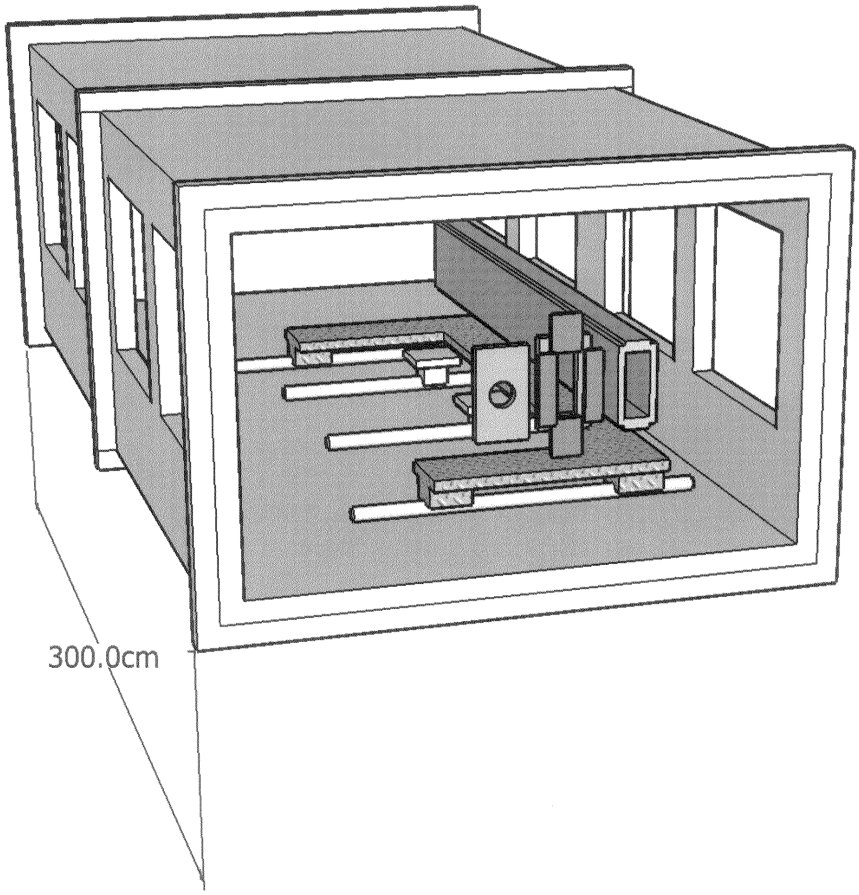
vsans_det3.cv5

Tank Center is 4" to the left and 5" up from beam center

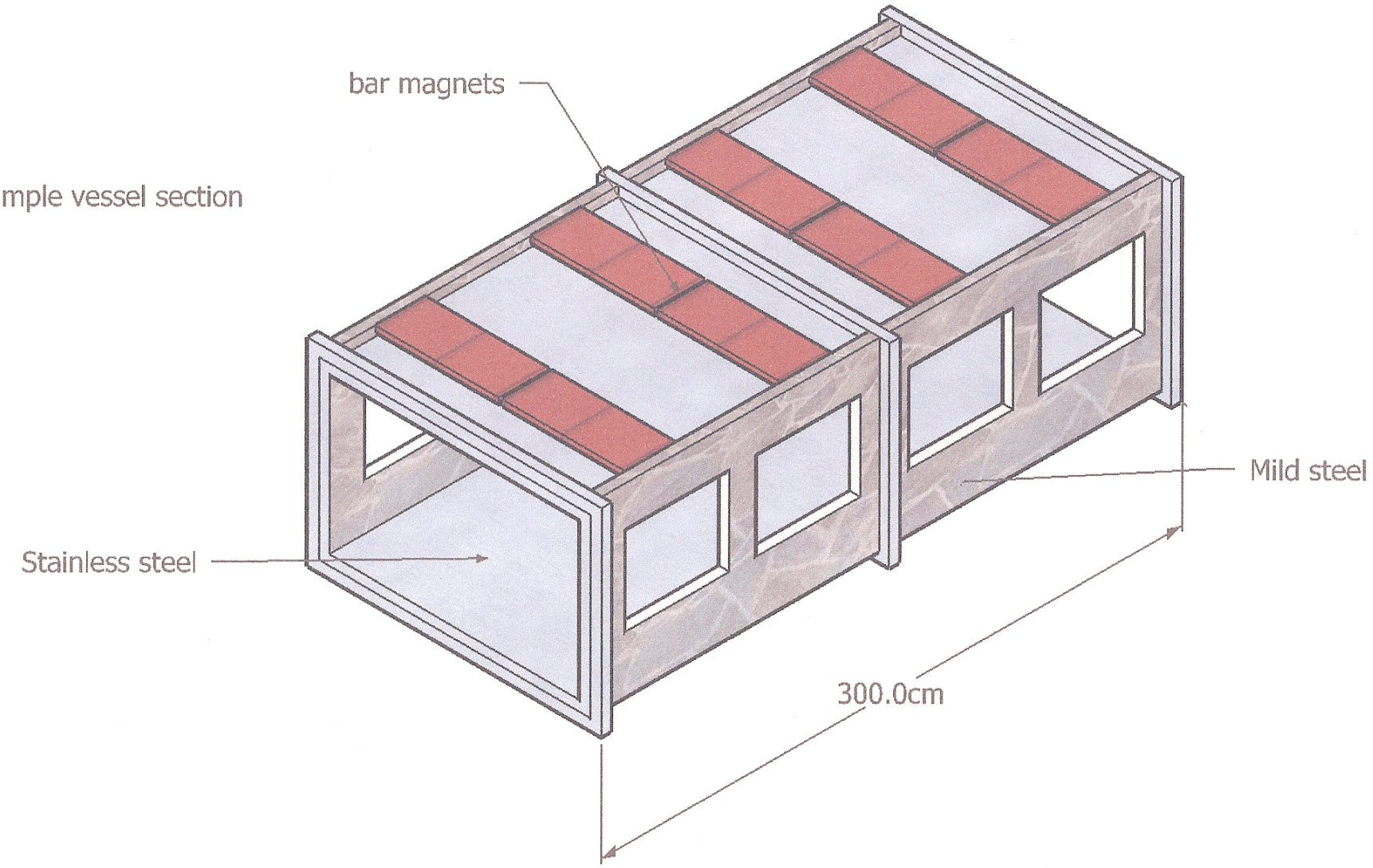
Miland Detector
32 cm x 32 cm

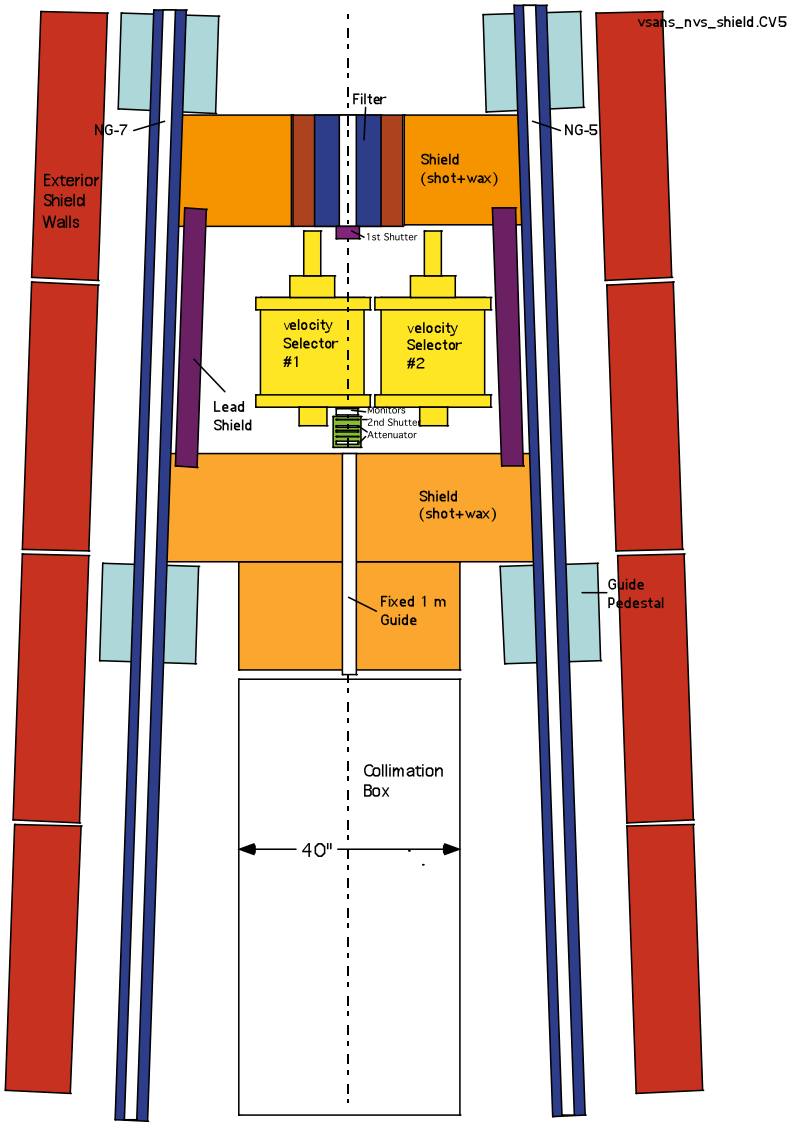


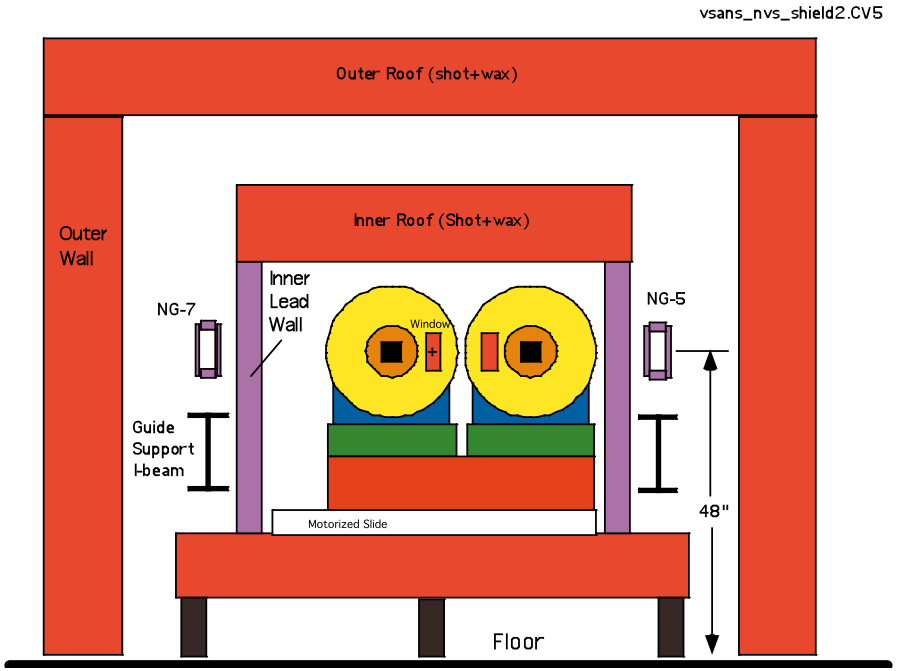
Pre-sample vessel section

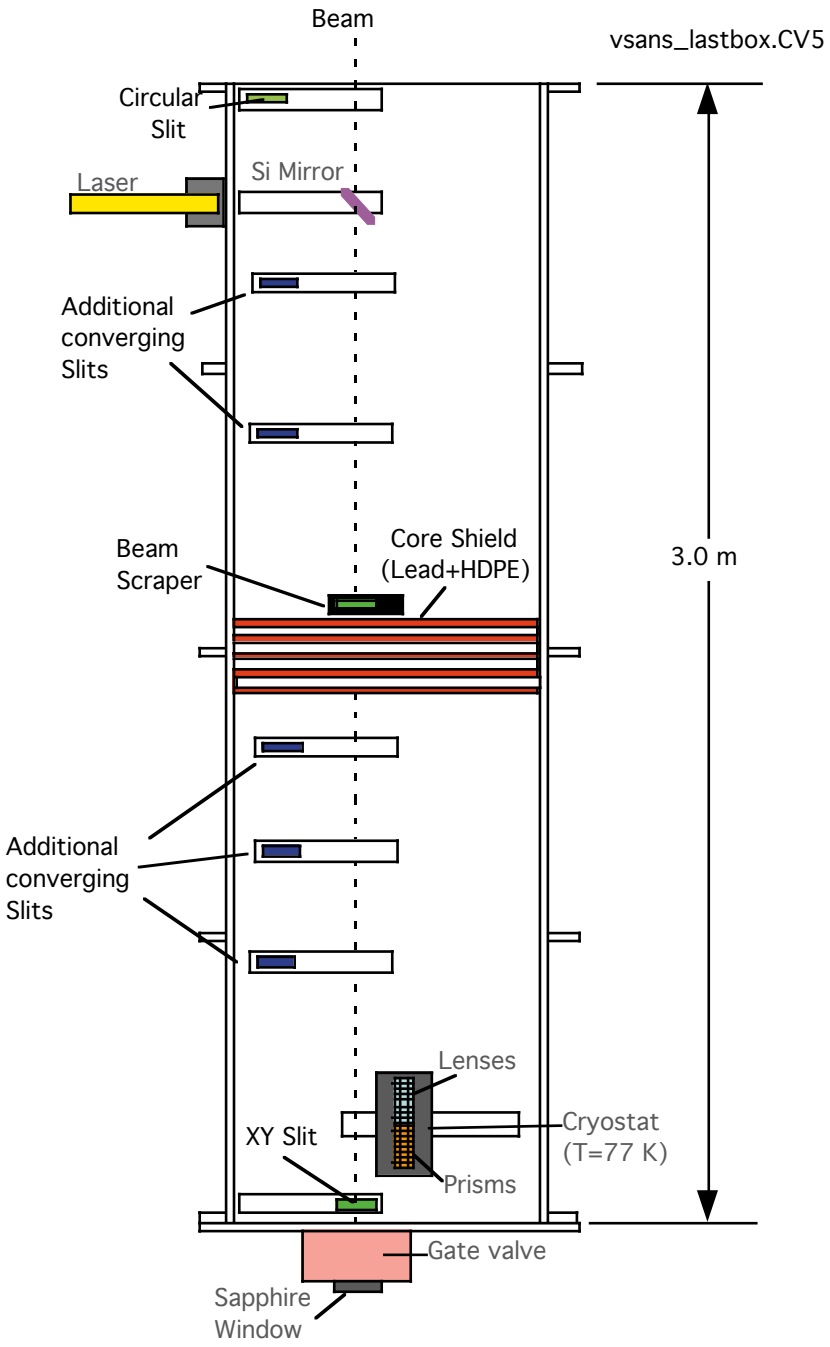


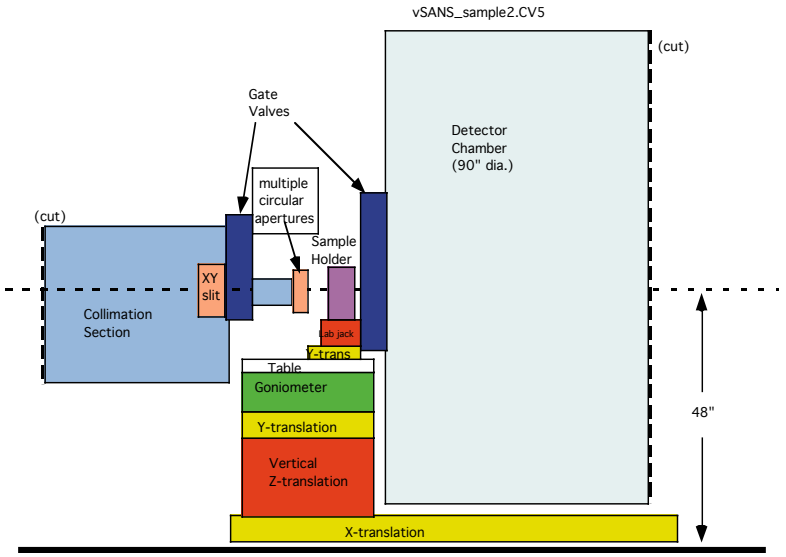
Pre-sample vessel section

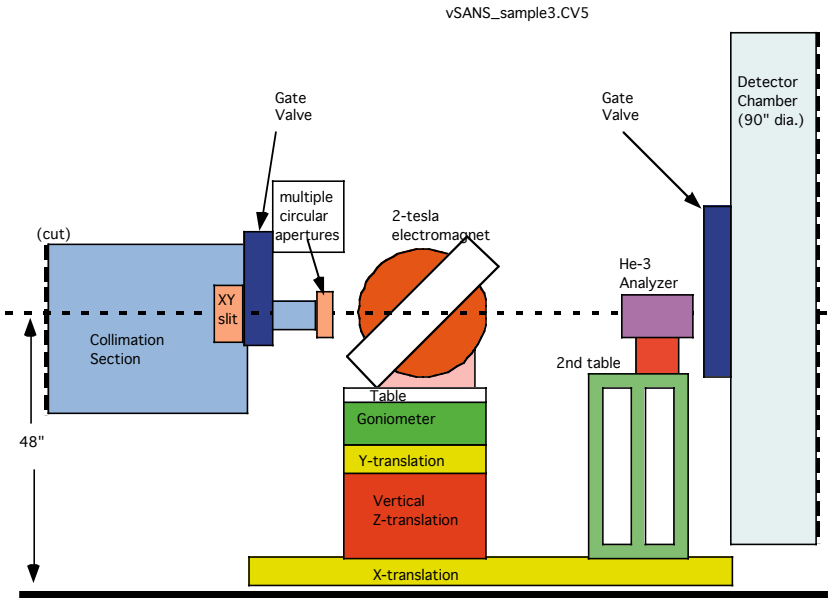



vsans_nvs_shield.CV5
Filter
NG-7
NG-5
Exterior
Shield
Walls
Shield
(shot+wax)
1st Shutter
velocity
Selector
#1
velocity
Selector
#2
Lead
Shield
Monitors
2nd Shutter
Attenuator
Shield
(shot+wax)
Fixed 1 m
Guide
Guide
Pedestal
Collimation
Box
40"


vsans_nvs_shield2.CV5
Outer Roof (shot+wax)
Outer
Wall
Inner Roof (Shot+wax)
Inner
Lead
Wall
NG-7
NG-5
Window
Guide
Support
I-beam
48"
Motorized Slide
Floor

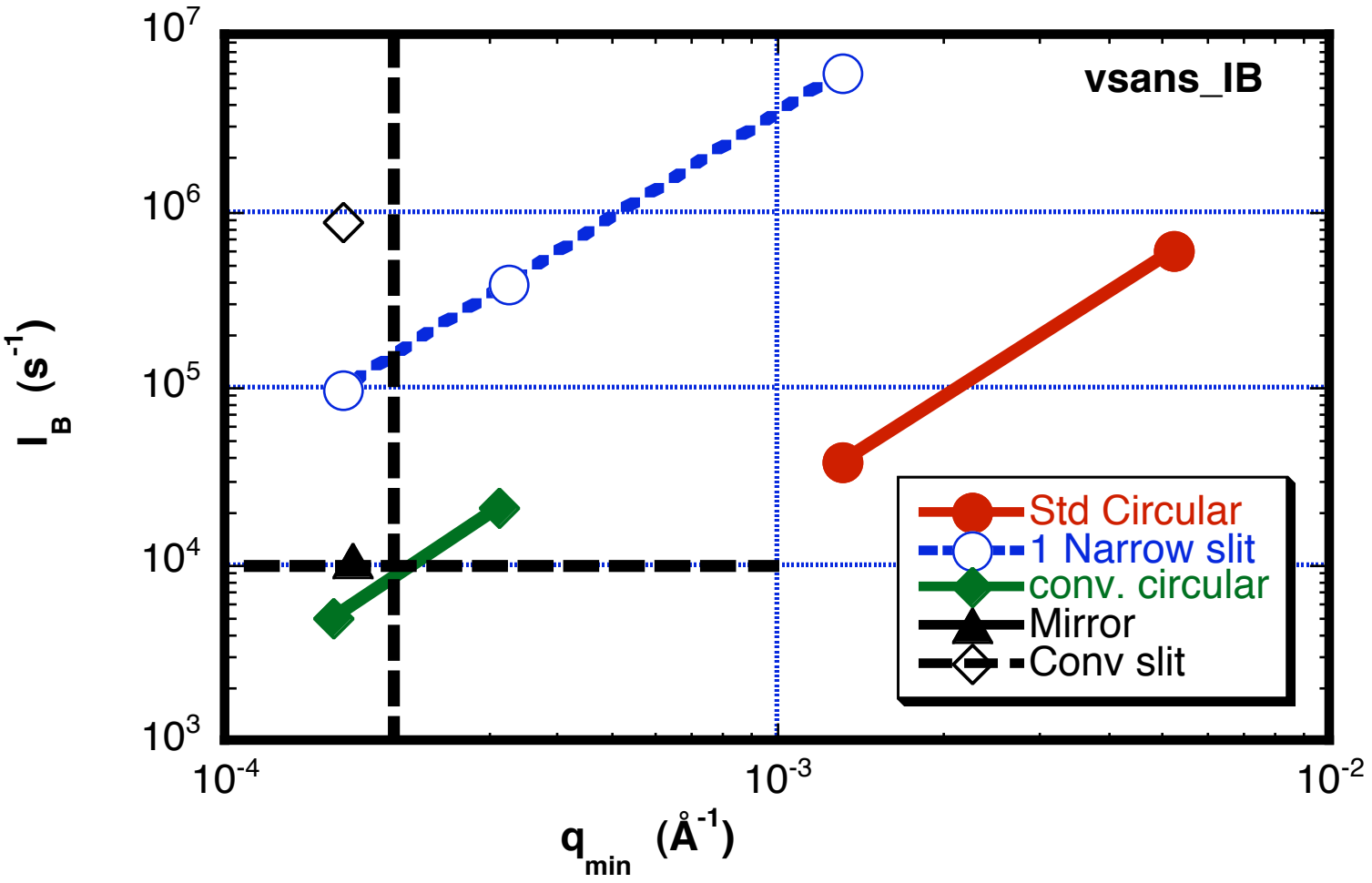

Beam
vsans_lastbox.CV5
Circular
Slit
Laser
Si Mirror
Additional
converging
Slits
Beam
Scraper
Core Shield
(Lead+HDPE)
3.0 m
Additional
converging
Slits
Lenses
Cryostat
(T=77 K)
XY Slit
Prisms
Gate valve
Sapphire
Window


vSANS_sample2.CV5
(cut)
Gate
Valves
Detector
Chamber
(90" dia.)
multiple
circular
apertures
(cut)
Sample
Holder
XY
slit
Collimation
Section
lab jack
Y-trans
Table
Goniometer
Y-translation
48"
Vertical
Z-translation
X-translation


vSANS_sample3.CV5
Gate
Valve
Gate
Valve
Detector
Chamber
(90" dia.)
multiple
circular
apertures
2-tesla
electromagnet
(cut)
He-3
Analyzer
XY
slit
Collimation
Section
2nd table
Table
Goniometer
48"
Y-translation
Vertical
Z-translation
X-translation

Instrument Characteristics

Source	Ni^{58} Guide 150 mm x 60 mm
Wavelength Range	4 to 20 A
Wavelength resolution	2% (graphite), 9 % and 25 % (separate selectors)
Source-to-sample distance	3.5 m to 21.5 m in 1.5 m steps
Sample-to-detector distance	0.6 m to 20 m continuous
Collimation	• Circular pinhole - several
	• Rectangular XY slits - continuous
	• Multiple (17) Converging circular beams + lens + prism
	• Multiple converging narrow rectangular beams
Sample Size	• Circular: 1 mm to 18 mm diameter
	• Rectangular width 1 to 18, height 1 to 75 mm
	• Converging beams: typically 30 mm x 75 mm
Q-range	**0.0002 A^{-1}** to 1.0 A^{-1}
Detectors	A1) **1 mm fwhm res., 2D 128 x 128, 128 mm x 128 mm**
	A2) 8 mm fwhm res. 2D (tubes), 1000 mm x 1000 mm
separate carriage	B) 8 mm fwhm res. 2D (tubes), 1000 mm x 1000 mm

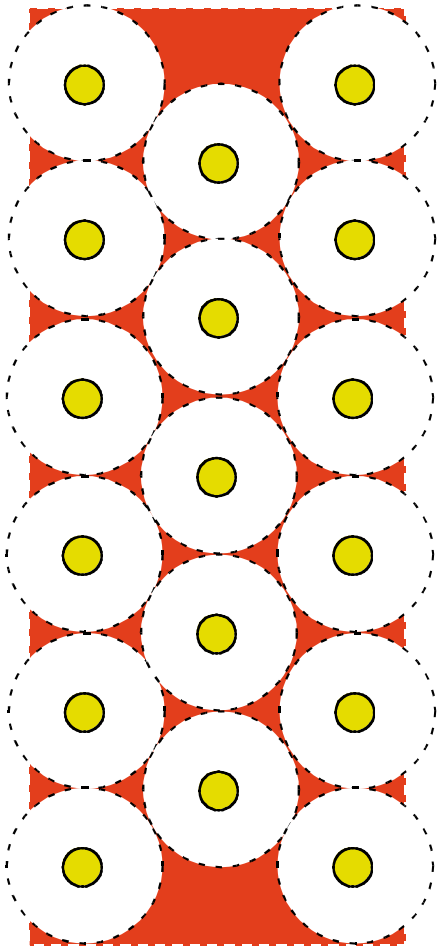

vsans_IB
10^7
10^6
10^5
10^4
10^3
I_B (s^{-1})
10^{-4}
10^{-3}
10^{-2}
q_{min} ($Å^{-1}$)
Std Circular
1 Narrow slit
conv. circular
Mirror
Conv slit

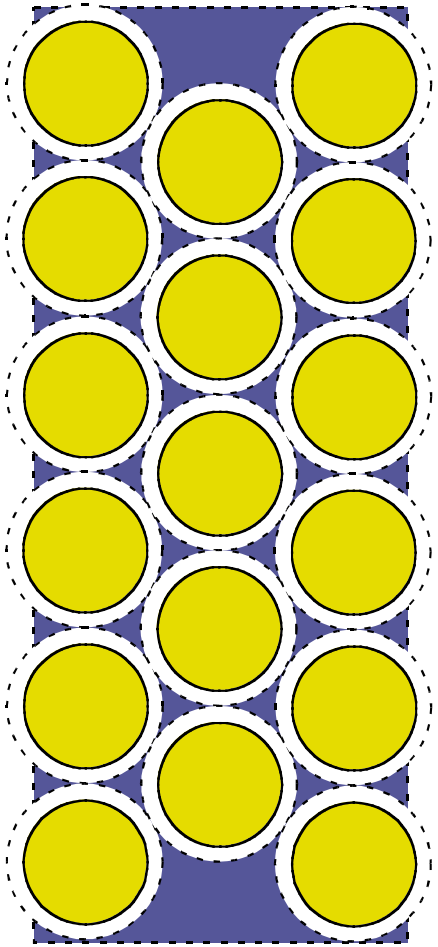
VSANS 2DCollimation System:

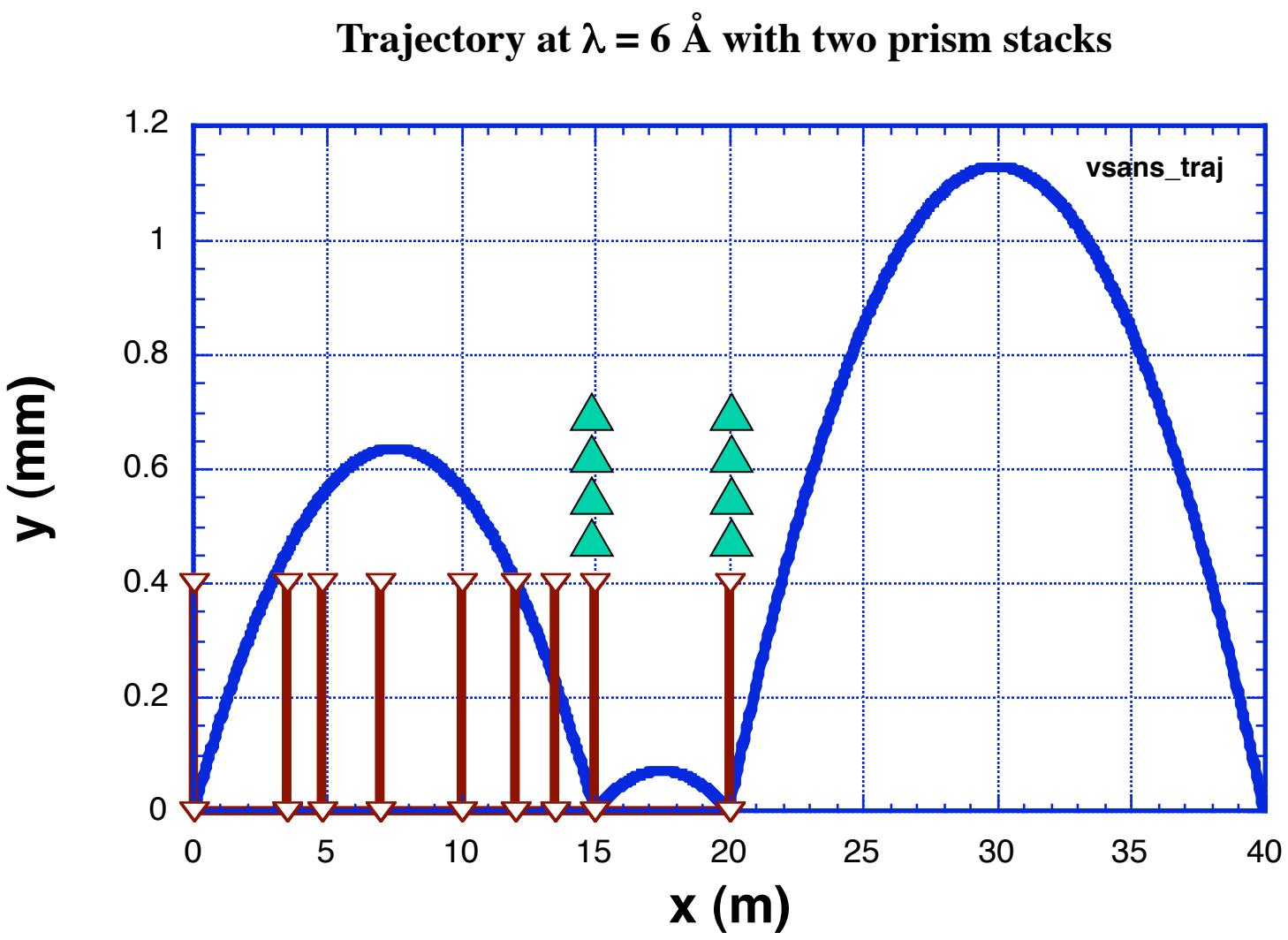
- Five intermediate masks
- Two stacks of prisms cooled w lN2
- 1 mm res. Detector: 320 mm x 320 mm

Source: Scale 1:1
R1= 3 mm
gap = 19 mm
A1= 60 mm x 150 mm

Sample: Scale 2:1
R2= 5 mm
gap = 2.5 mm
A1= 30 mm x 75 mm






Trajectory at λ = 6 Å with two prism stacks
vsans_traj
y (mm)
x (m)
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40

C. D. Dewhurst D33 instrument concept at ILL (2007)

2.4. Final specifications are yet to be defined but both ~1m² detectors could be built from either commercial individual tube elements, 8mm diameter and 1m length (128 – 256 pixels), or banks of square cross section tubes can be now be spark-cut from solid aluminium in a new process being developed at ILL.

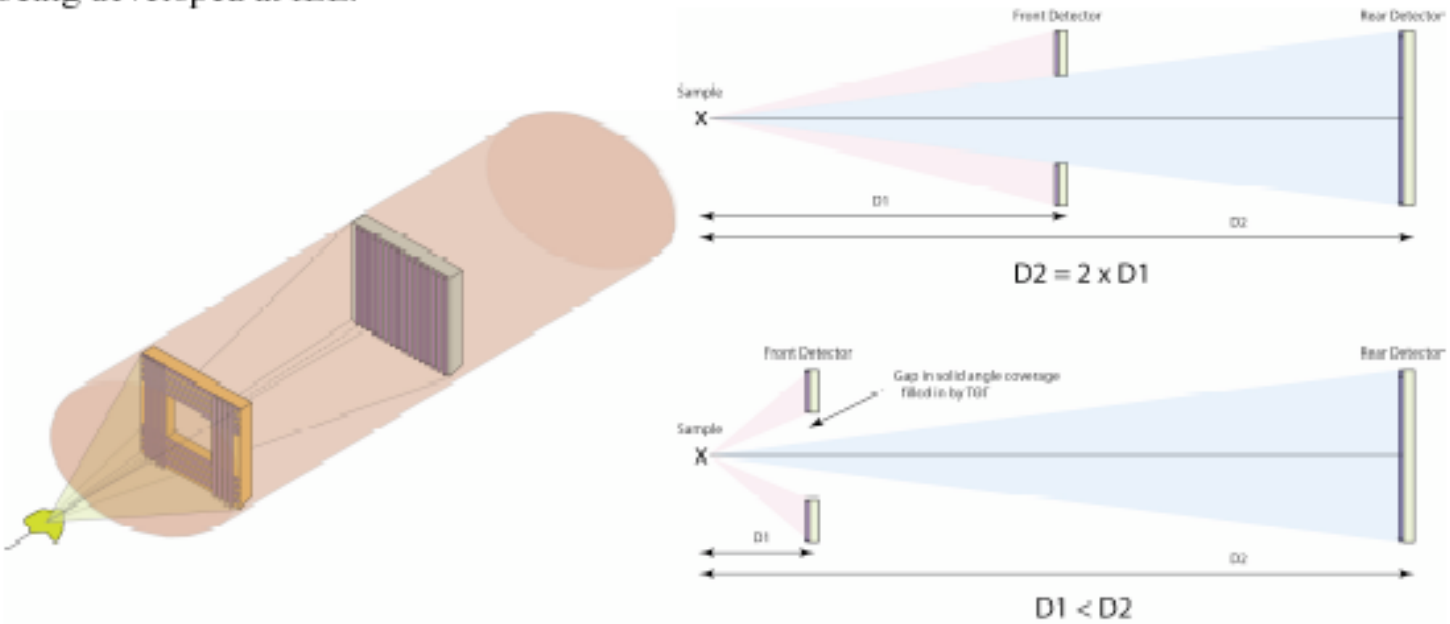


Figure 2. (a) D33 twin-detector configuration. (b) 'Standard' configuration with continuous solid-angle coverage between front and rear detectors for use in either monochromatic or TOF modes. (c) 'Extreme' configuration with a gap in solid angle coverage but continuous coverage in q-space in TOF mode.