S01020500-IS0023-R03

SECOND TARGET STATION (STS) PROJECT

Interface Sheet for Moderator Reflector Assembly and Instrument Systems

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8/7/2025

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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Date Published: 8/7/2025

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managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

Approvals

Interface Sheet for Moderator Reflector Assembly and Instrument Systems		ISSUE DATE: 8/7/2025
PREPARED BY Jim Janney	PROJECT Second Target Station	DOCUMENT NUMBER: S01020500-IS0023

	Signature / Date					
	Rev. 01	Date	Rev. 02	Date	Rev. 03	Date
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Revision	Description
00	Initial Release
01	QIKR moved to ST04, moderator vertical plane adjustment to reflect preliminary MRA engineering and current target assembly height, guide entrance distances updated
02	Reduced number of beamlines to 18, QIKR moved to ST02 and dimensions adjusted
03	ST 15 and 16 changed to dual beam ports, QIKR dimensions adjusted, moderator vertical plane adjusted to reflect final MRA and target assembly geometry, guide entrance distances updated

TABLE OF CONTENTS

1. PURPOSE

This document defines the Neutron Beam layout and characteristics of the interfaces between Moderator Reflector Assembly and Instrument Systems neutron scattering instruments and bunker. The interface described in this document will provide guidance to the designs of the Moderator Reflector Assembly, neutron scattering instruments and Bunker Systems. Moderator locations and neutronic characteristics are all key inputs into the design and optimization of the neutron scattering instruments.

2. SCOPE

The scope of this document is the Neutron Beam layout and characteristics interface between Moderator Reflector Assembly and Instrument Systems as identified in the parent Interface Control Document S01020500-IC0004 [1] between Target Systems and Instrument Systems. The scope of this document does not include the physical hardware connections such as the core vessel seal between Target Systems and Instrument Systems.

2.1 INTERFACING PARTS OR COMPONENTS

No.	Components (Moderator Reflector Assembly)		Components (Instrument Systems)	
	Name	Functional reference Number	Name	Functional reference Number
1	Moderator Reflector Assembly	S03040000-M8U-8800-A001	Instrument Systems	S04000000-M8U-8800-A10000

3. ACRONYMS AND DEFINITIONS

MRA Moderator Reflector Assembly
SSC Structure, System or Component
STS Second Target Station
WBS Work Breakdown Structure

4. REFERENCES

4.1 DOCUMENTS APPLICABLE TO THE INTERFACING SSCS

Ref	Document Titles	Document Control System Location
[1]	S01020500-IC0004	https://edrm.ornl.gov/federaldox/#/irl/0902f41f804c5af3?dataSourceId=ORNL_PRD&versionLabel=CURRENT
[2]	Second Target Station Conceptual Design Report	https://edrm.ornl.gov/federaldox/#/irl/0902f41f80099f74?dataSourceId=ORNL_PRD&versionLabel=CURRENT
[3]	Second Target Station Neutron Beam Size Report	To Be Released
[4]	Preliminary Moderator Optimization Report	https://edrm.ornl.gov/federaldox/#/irl/0902f41f8073505e?dataSourceId=ORNL_PRD&versionLabel=CURRENT
[5]	Moderator Selection Report	To Be Released
[6]	Final Moderator Optimization Report	To Be Released
[7]	Final MRA Neutronics Analysis	To Be Released

5. INTERFACE DEFINITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

In the STS design, a pulsed proton beam is converted to pulsed high brightness cold neutron beams optimized for neutron scattering experiments. The Target Systems group is responsible for designing a Target Assembly to produce neutrons from the pulsed proton beam and a Moderator Reflector Assembly to convert the neutrons emitted from the target to cold neutron beams useful for neutron scattering experiments on the instruments designed by Instrument Systems group. The Instruments Systems group is responsible for the design of the neutron optics modules within the target monolith and all beamline components outside the monolith.

The number of moderators, number of beamlines, and angular orientation of the beamlines to be included in the STS design were determined during the conceptual design phase of the project [2] and updated during preliminary design while the characteristics of those neutron beams such as the size of the viewed area of the moderator [3], the maximum acceptance aperture of the guide entrance, the distance of the guide entrance from the viewed face of the moderator, and the desired neutron beam characteristics have been determined by the Instrument Systems group in collaboration with the Target Systems group during early preliminary design.

The two moderator types under consideration provide opportunity to best match moderator neutronics performance to neutron instrument requirements. Relevant moderator figures-of-merit continue to be peak brightness, time-averaged brightness, and the time distribution of neutrons emitted from the moderator face typically provided as FWHM (neutron pulse widths) for initial evaluation. Optimizing each moderator for both peak and time-average brightness separately has established useful bounding performance values, while middle configurations balance performance between the two [4]. Optimizing moderator geometry for maximum time-average brightness comes at the expense of broader neutron time distributions and consequently lower wavelength resolution, while optimizing for peak brightness comes at the expense of flux on sample.

Early in preliminary design, the Neutronics Team completed a moderator optimization which determined optimal MRA configurations for peak brightness, time-average brightness, and a middle configuration between the two for each moderator [4]. Source files for all configurations for both moderators were supplied to the Instrument Systems group for further evaluation. After detailed analysis on representative instruments, the Instrument Systems group decided that the middle configuration yields the best instrument performance for both the upper, cylinder moderator and lower, tube moderator [5].

Now in final design, the Neutronics Team has completed another moderator optimization with an updated Target Assembly and more parameters for premoderator optimization [6]. Resulting optimum moderator geometry changed slightly from the preliminary optimization. The final MRA model was created using the results of the final moderator optimization, and final neutronics results [7] and geometry from the final MRA model are presented in this document.

5.2 INTERFACE DATA

5.2.1 Moderator Performance Parameters

The neutron beam characteristics of the chosen configuration are illustrated below as a series of emission time distributions (ETD), peak and time-averaged brightness, and ETD FWHM plots. Note, the plots shown in this section are from analysis of the final MRA geometry and no further updates are anticipated.

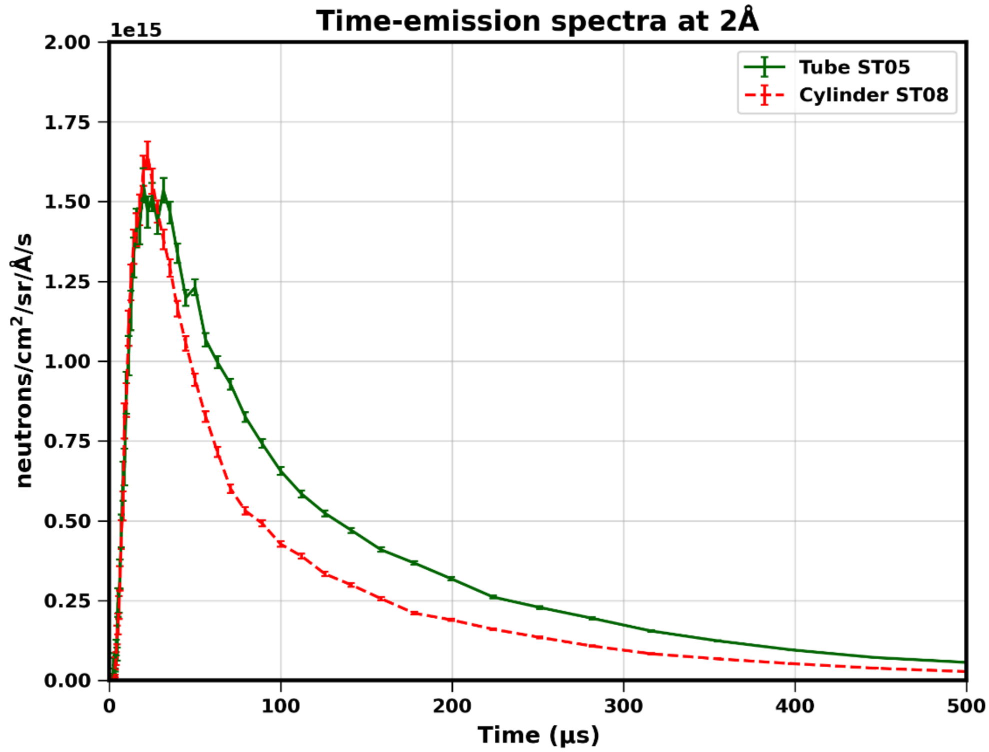

Figure 1. Emission time distribution for the chosen optimized configurations of the 2 moderators at 2Å.

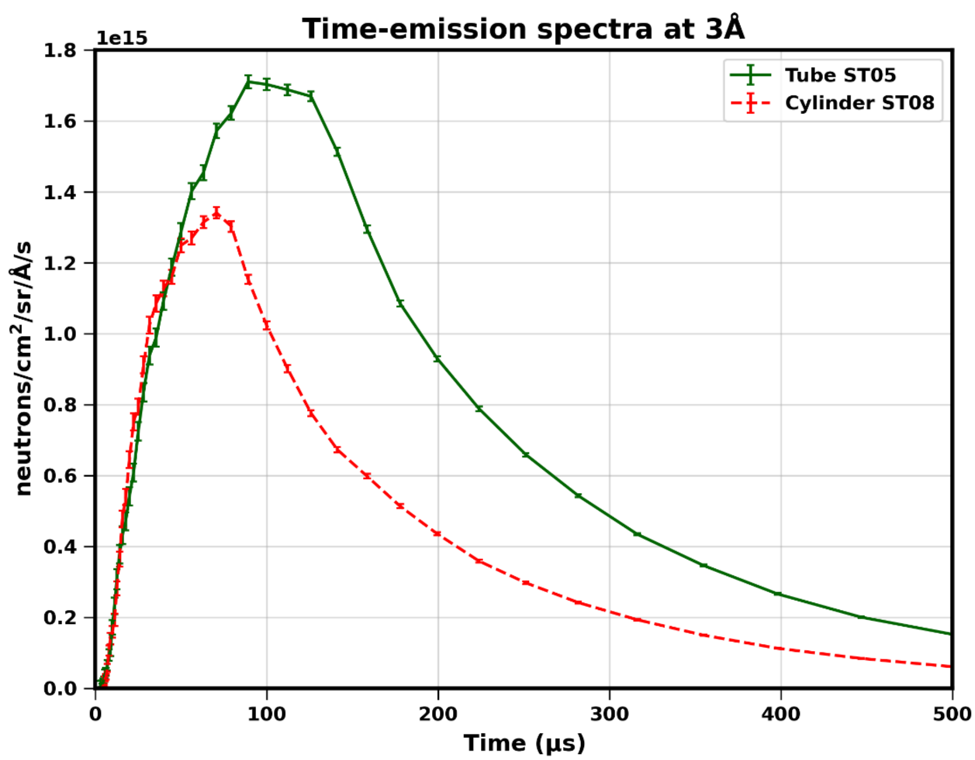

Figure 2. Emission time distribution for the chosen optimized configurations of the 2 moderators at 3Å.

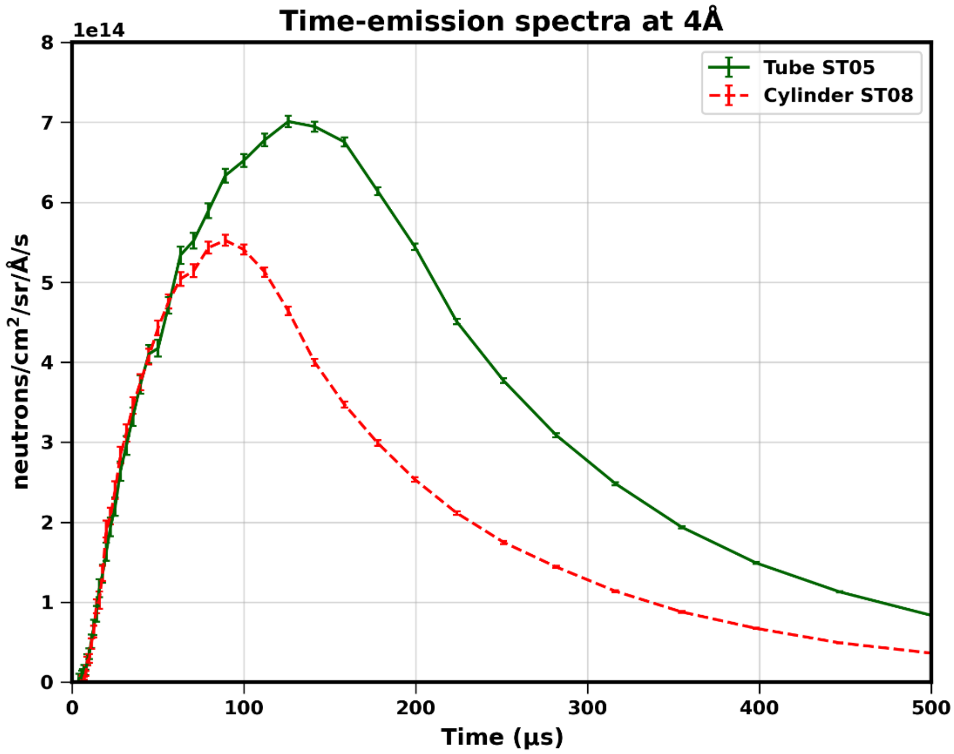

Figure 3. Emission time distribution for the chosen optimized configurations of the 2 moderators at 4Å.

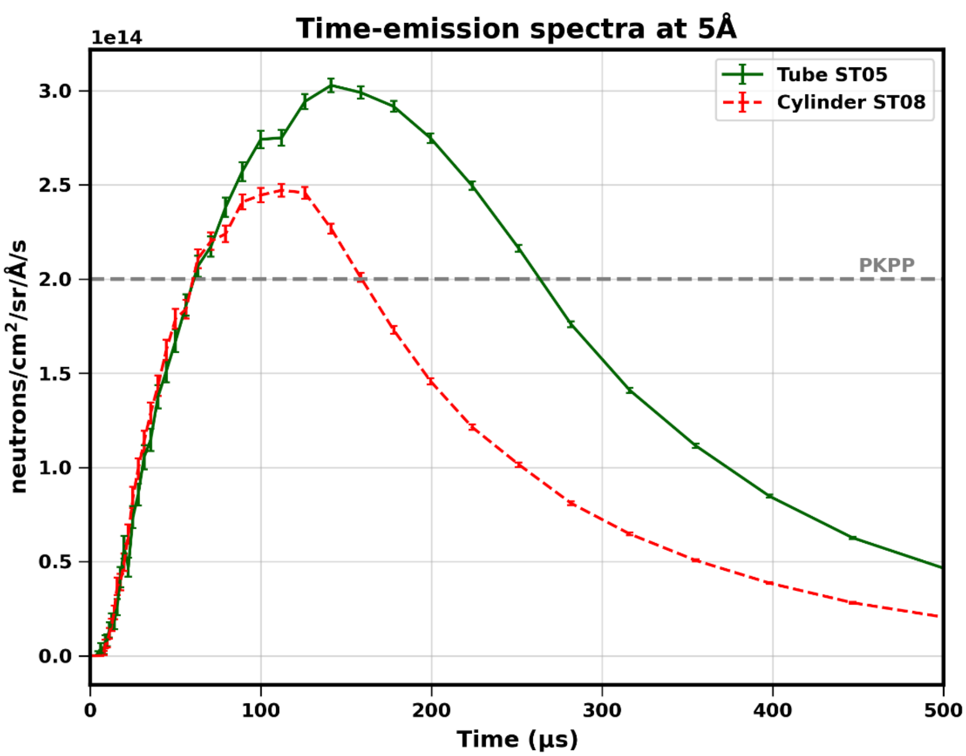

Figure 4. Emission time distribution for the chosen optimized configurations of the 2 moderators at 5Å.

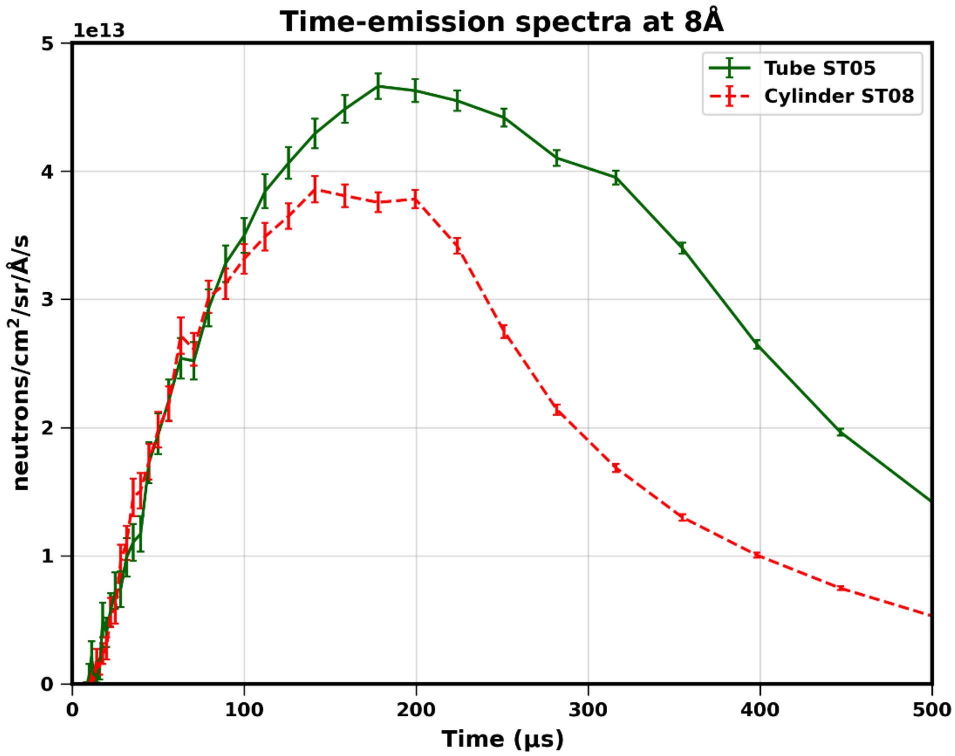

Figure 5. Emission time distribution for the chosen optimized configurations of the 2 moderators at 8Å.

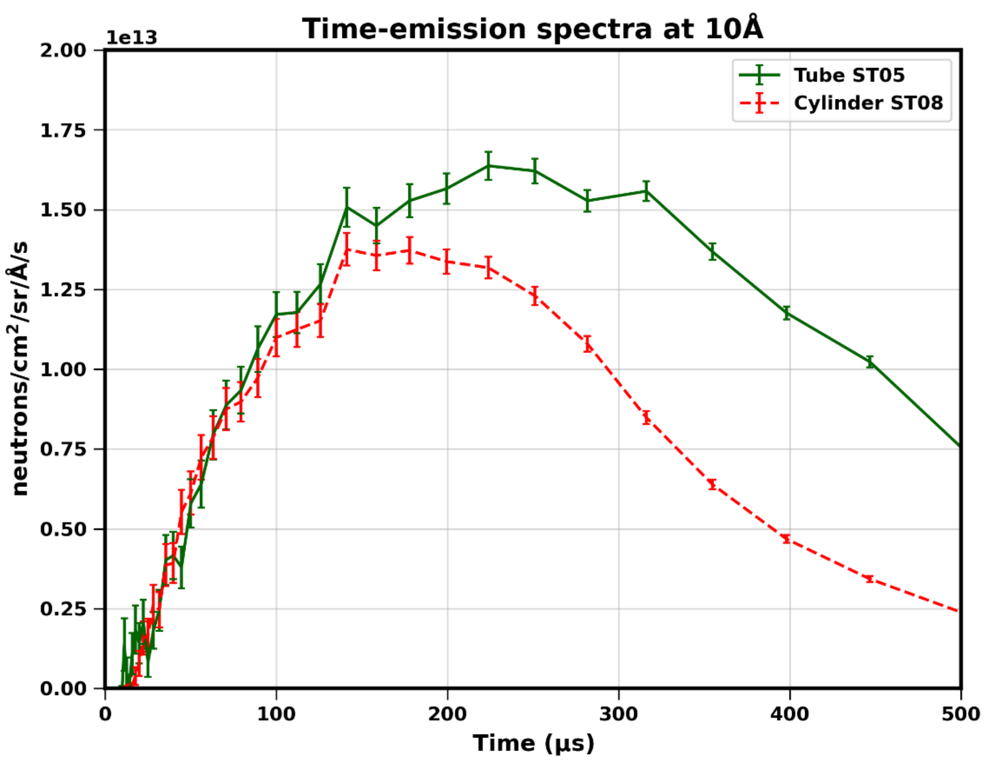

Figure 6. Emission time distribution for the chosen optimized configurations of the 2 moderators at 10Å.

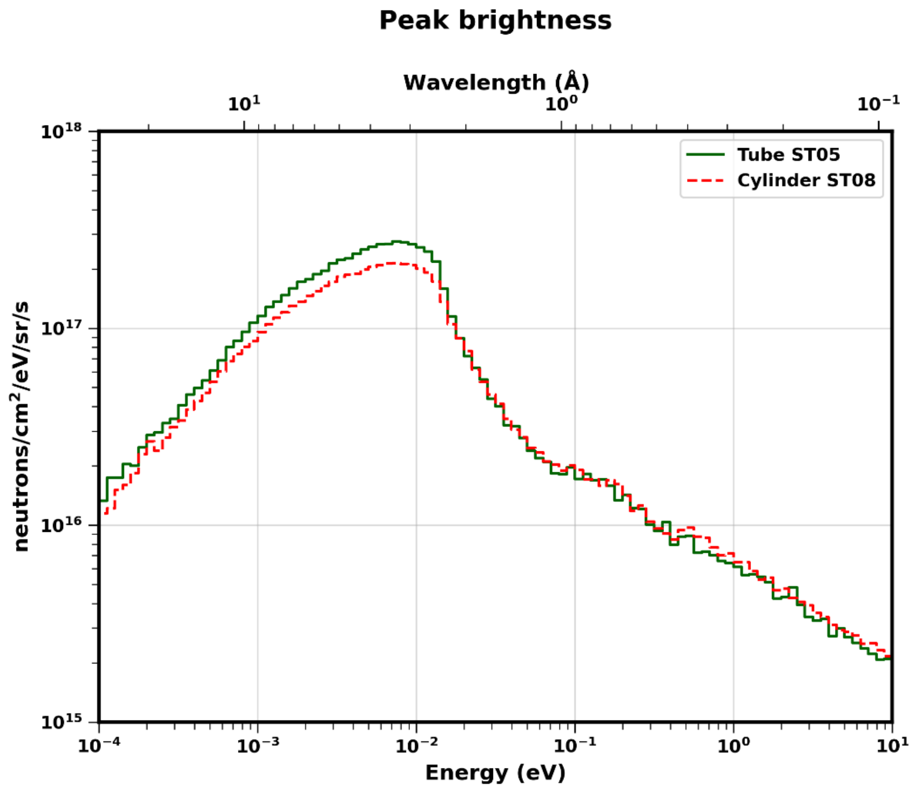

Figure 7. Peak brightness for the chosen optimized configurations of the 2 moderators (log scale).

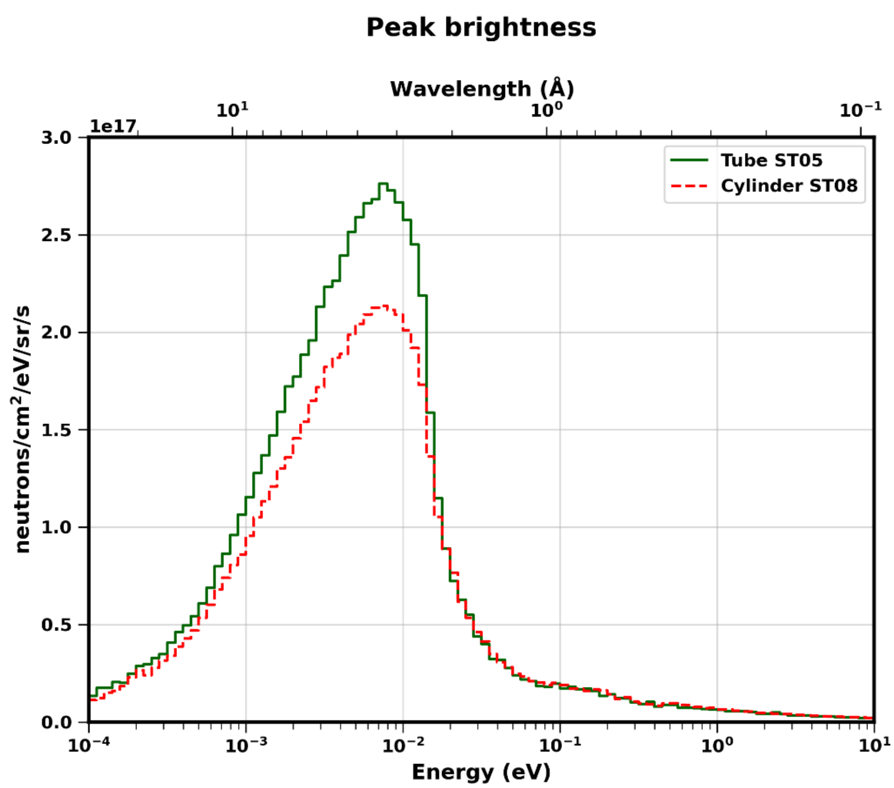

Figure 8. Peak brightness for the chosen optimized configurations of the 2 moderators (linear scale).

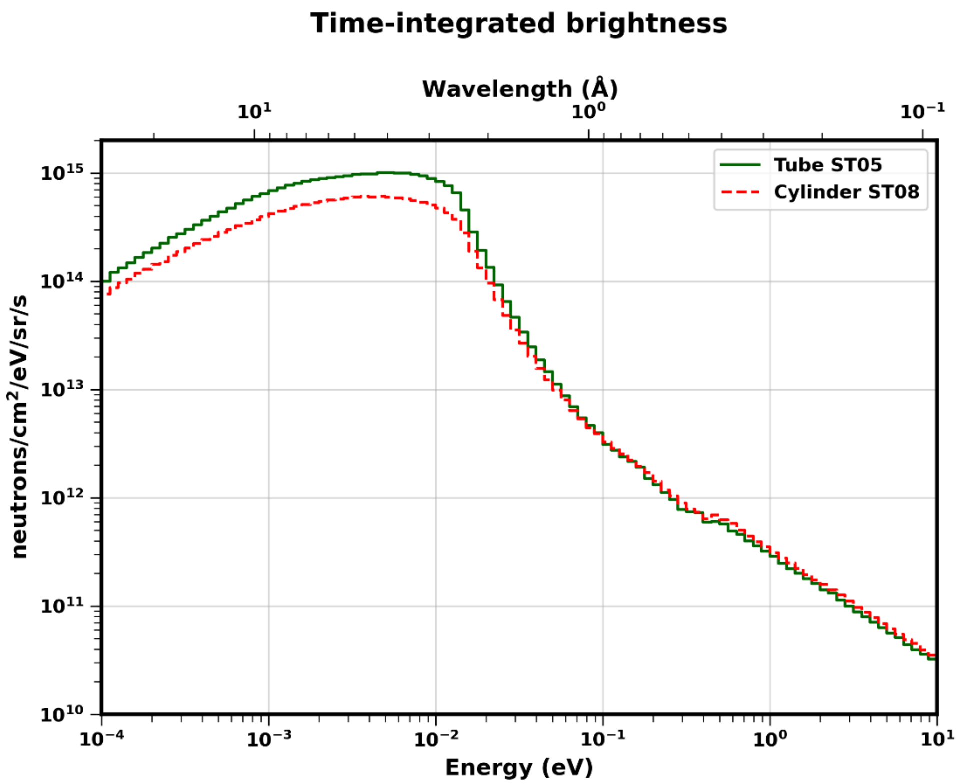

Figure 9. Time-average brightness for the chosen configurations of the 2 moderators (log scale).

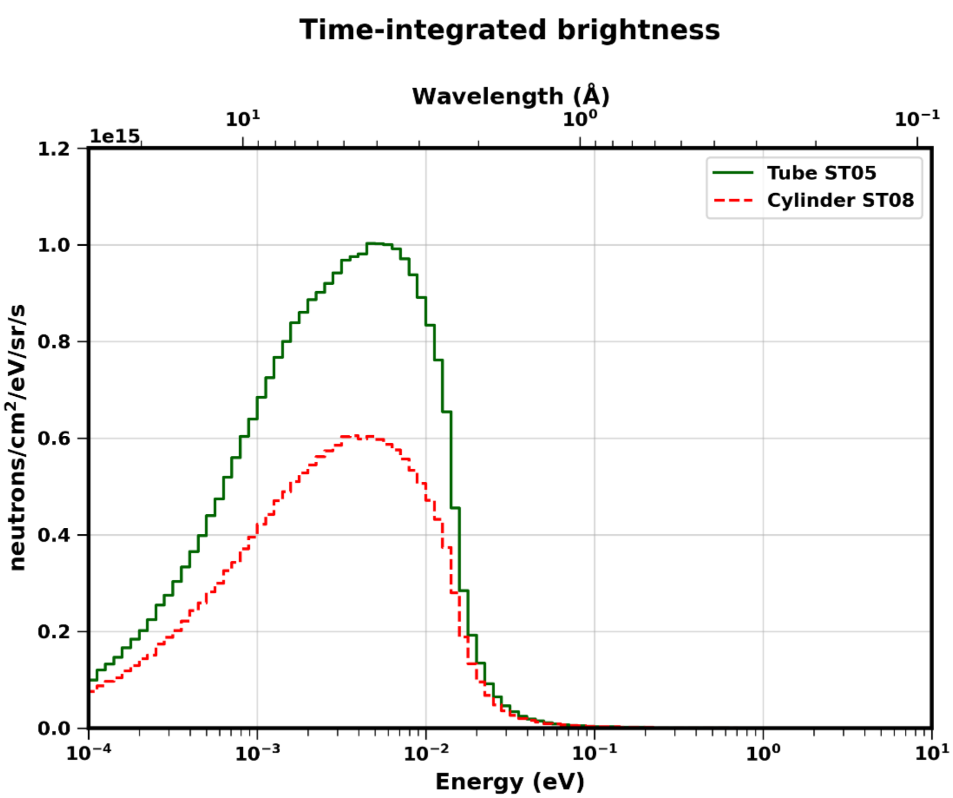

Figure 10. Time-average brightness for the chosen configurations of the 2 moderators (linear scale).

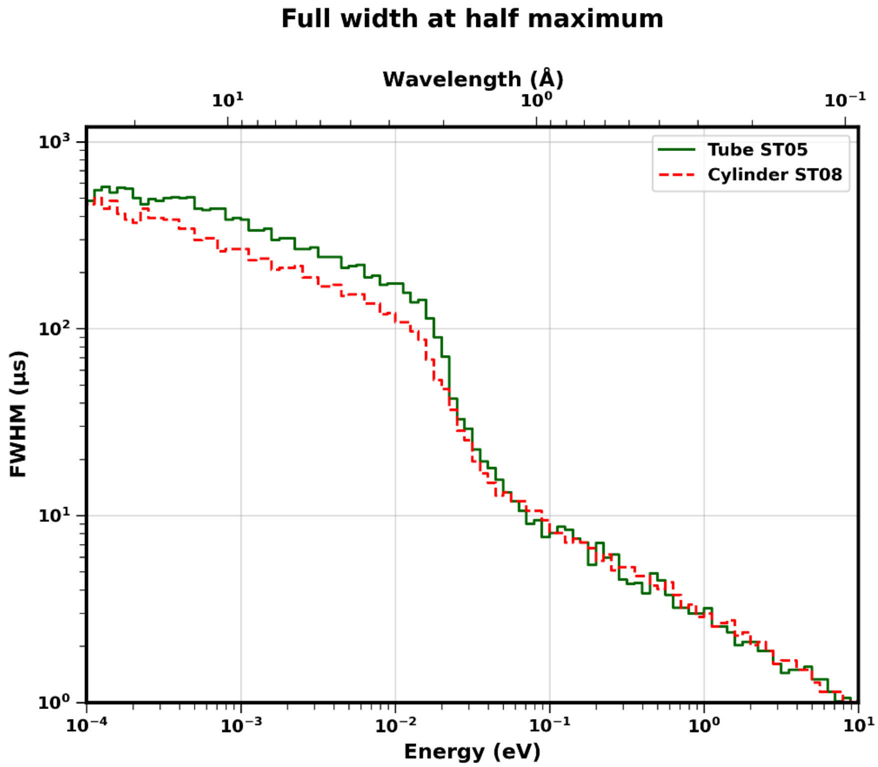

Figure 11. Full Width at Half Maximum for the chosen configurations of the 2 moderators (log scale).

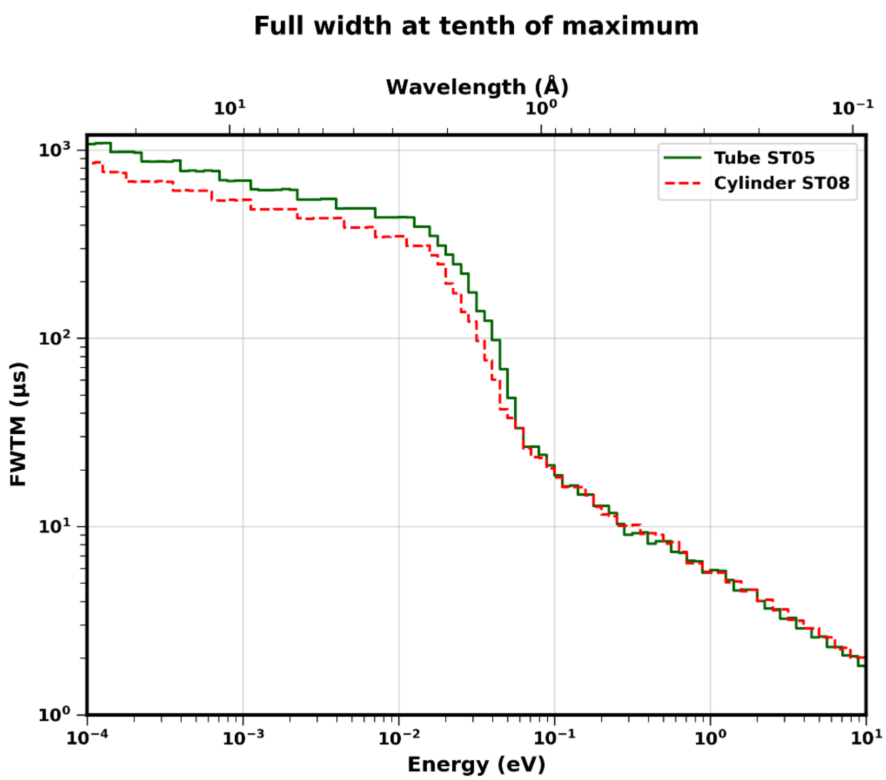

Figure 12. Full Width at 0.1 Maximum for the chosen configurations of the 2 moderators (log scale).

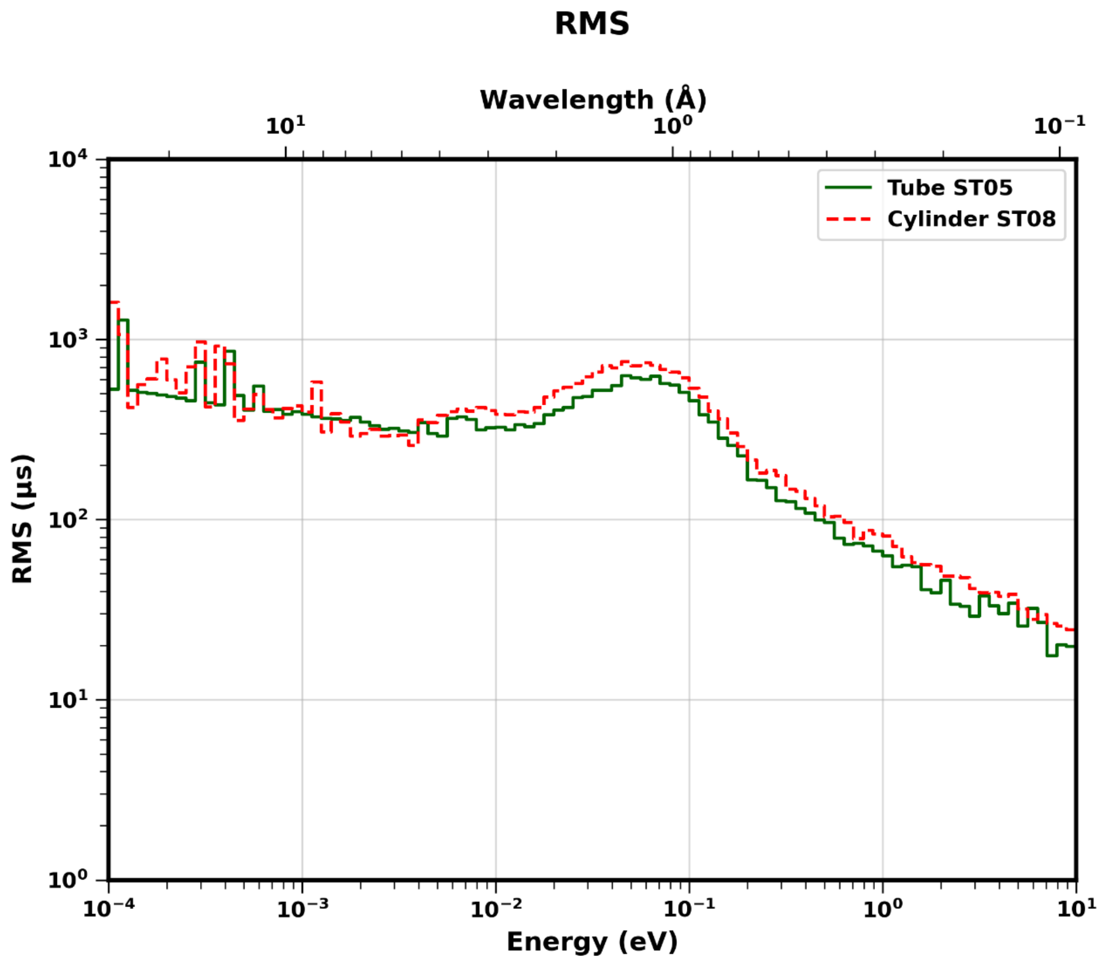

Figure 13. Root mean square for the chosen configurations of the 2 moderators (log scale).

5.2.2 Interface Geometry

During preliminary design, the STS design was changed to feature a total of 18 beamlines, reduced from the 22 beamlines described in the Conceptual Design Report [2]. The upper moderator, located just above the target, will be viewed by 12 of those beamlines, while the lower moderator, located just beneath the target, will be viewed by the remaining 6 beamlines. The angular orientation of each beamline and which moderator each beamline views is shown in Table 1 and Figure 14 below. The viewed area geometry, nominal guide entrance geometry, and nominal guide entrance distance from the beamline origin on the viewed surface of the hydrogen is also listed in Table 1. Note that the nominal guide entrance geometry and nominal guide entrance distance are included to describe the nominal open flight path between the moderator and the guide entrance and do not dictate the actual guide geometry used by the beamline. The characteristic size of the viewed face of the moderators will be 30 mm, as discussed in reference [3].

Table 1. STS Nominal Beamline Geometry

Beamline	Angle from Proton Beam	Moderator	Viewed Area Geometry	Nominal Guide Entrance Geometry	Nominal Guide Entrance Distance
ST01	-145°	Lower	Ø30mm Circle	50mm Square	805.6mm
ST02	-131.25°	Upper	30mm Square	See 5.2.2.1	2000mm
ST03	-117.5°	Upper	30mm Square	50mm Square	1018mm
ST04	-103.75°	Upper	30mm Square	50mm Square	1018mm
ST05	-90°	Lower	Ø30mm Circle	50mm Square	805.6mm
ST06	-76.25°	Upper	30mm Square	50mm Square	1018mm
ST07	-62.5°	Upper	30mm Square	50mm Square	1018mm
ST08	-48.75°	Upper	30mm Square	50mm Square	1018mm
ST09	-35°	Lower	Ø30mm Circle	50mm Square	1003mm
ST10	35°	Lower	Ø30mm Circle	50mm Square	1003mm
ST11	48.75°	Upper	30mm Square	50mm Square	1018mm
ST12	62.5°	Upper	30mm Square	50mm Square	1018mm
ST13	76.25°	Upper	30mm Square	50mm Square	1018mm
ST14	90°	Lower	Ø30mm Circle	50mm Square	805.6mm
ST15	103.75°	Upper	30mm Square	50mm Square	2000mm
ST16	117.5°	Upper	30mm Square	50mm Square	2000mm
ST17	131.25°	Upper	30mm Square	50mm Square	1018mm
ST18	145°	Lower	Ø30mm Circle	50mm Square	805.6mm

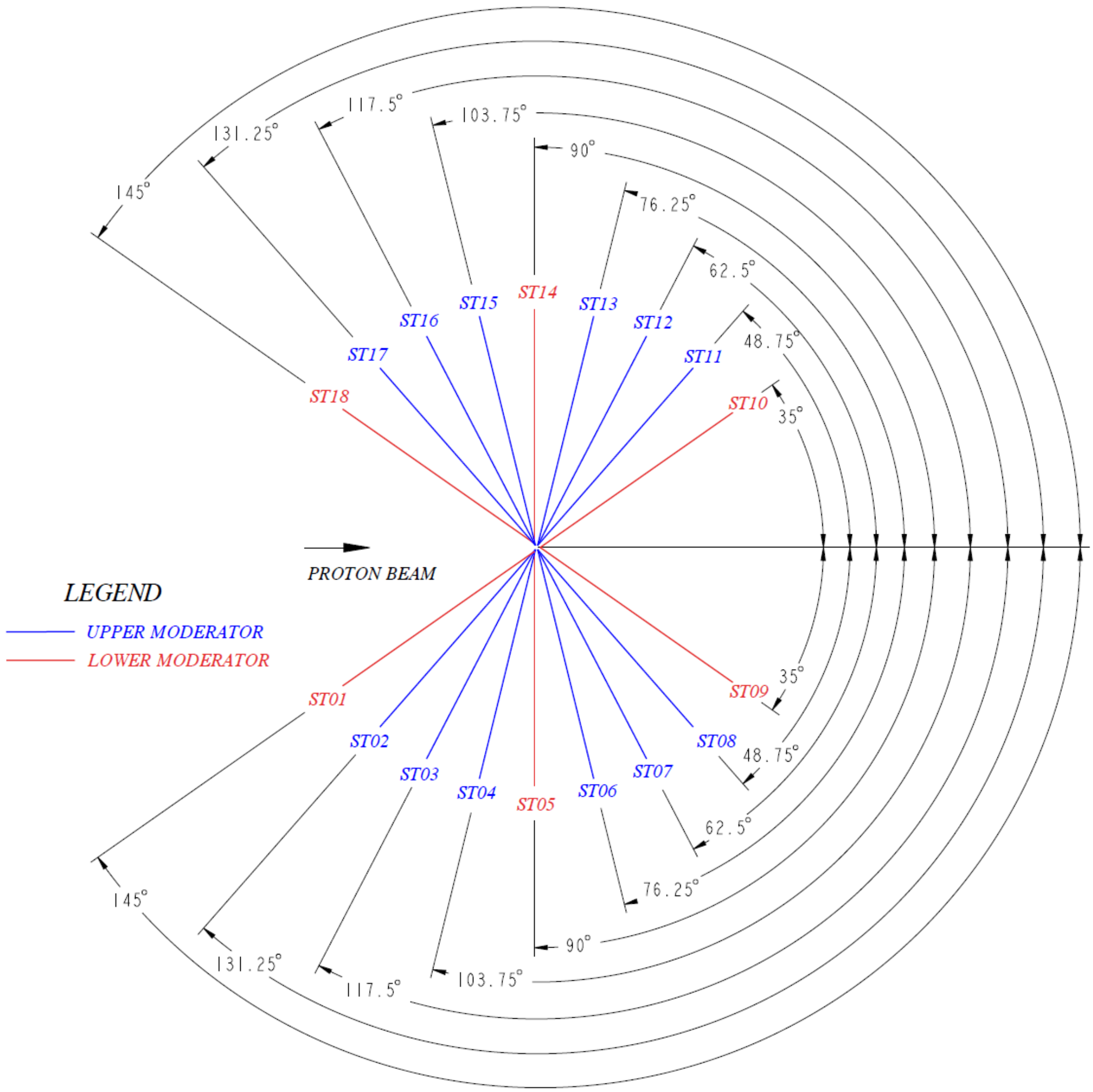

Figure 14. Overall Beamline Angle Layout Plan View. Angles Defined Relative to the Proton Beam Direction.

Figures 15,16, and 17 define the beamline origins on the viewed faces of the hydrogen moderators. The beamline origins are located on the outer surface of the hydrogen.

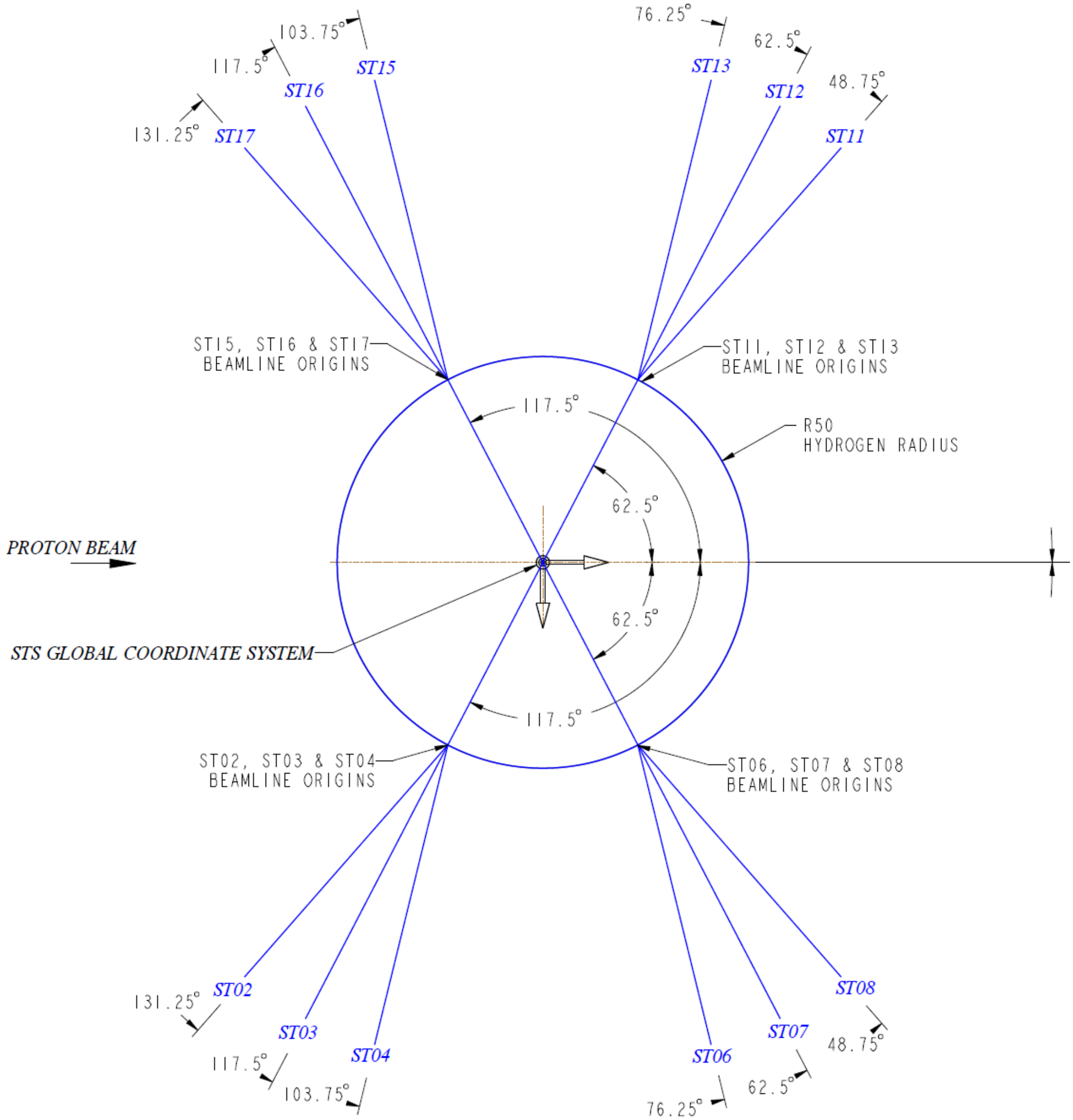

Figure 15. Cylinder Moderator Beamline Layout Plan View (dimensions in mm).
Cylinder Moderator Vertical Axis is Aligned with the STS Global Coordinate System Vertical Axis.
Hydrogen Boundary and Beamlines are Shown in Blue.

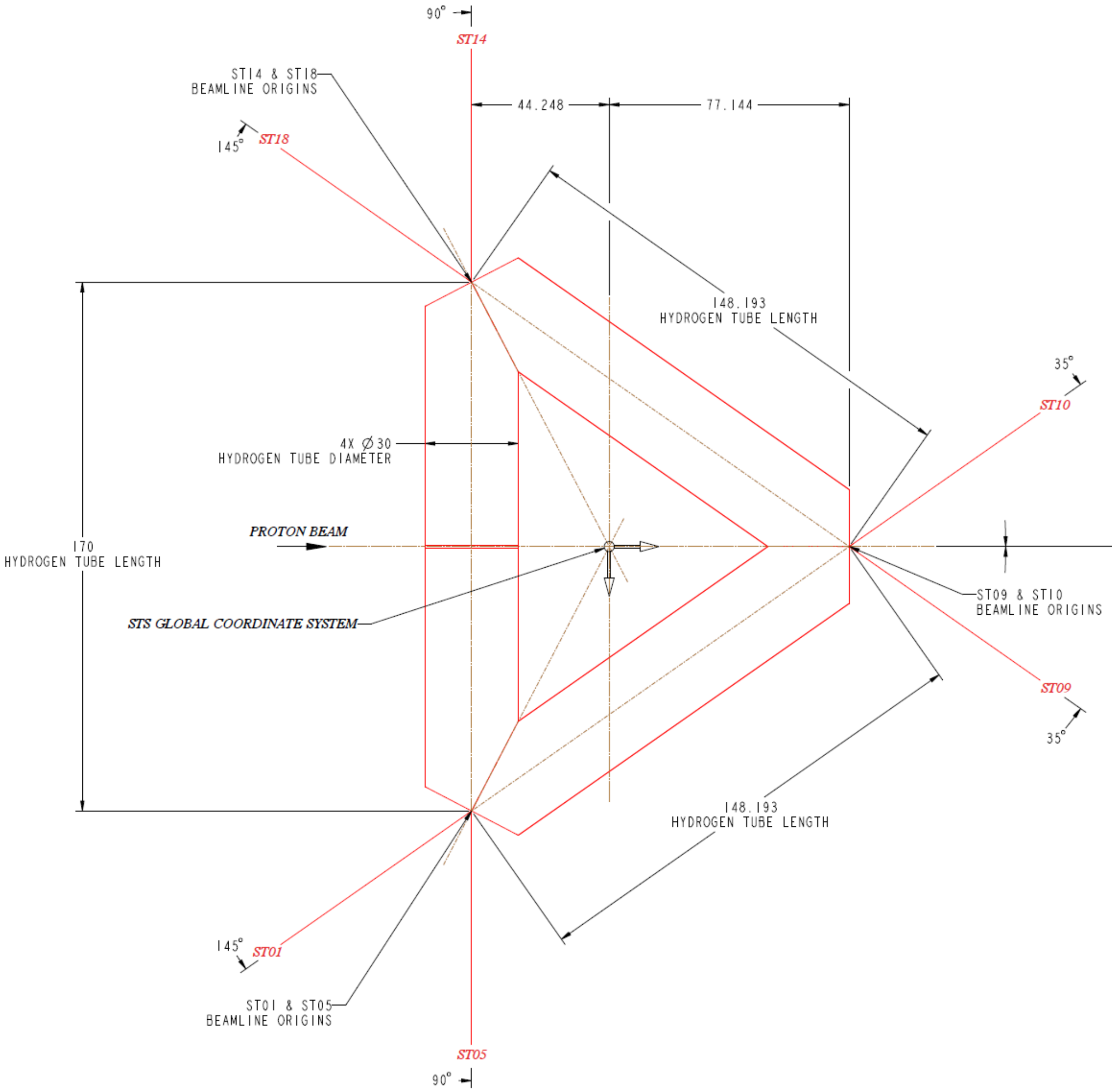

Figure 16. Tube Moderator Beamline Layout Plan View (dimensions in mm).
Tube Moderator Angular Bisector Intersection is Aligned with the STS Global Coordinate System Vertical Axis. Hydrogen Boundary and Beamlines are Shown in Red.

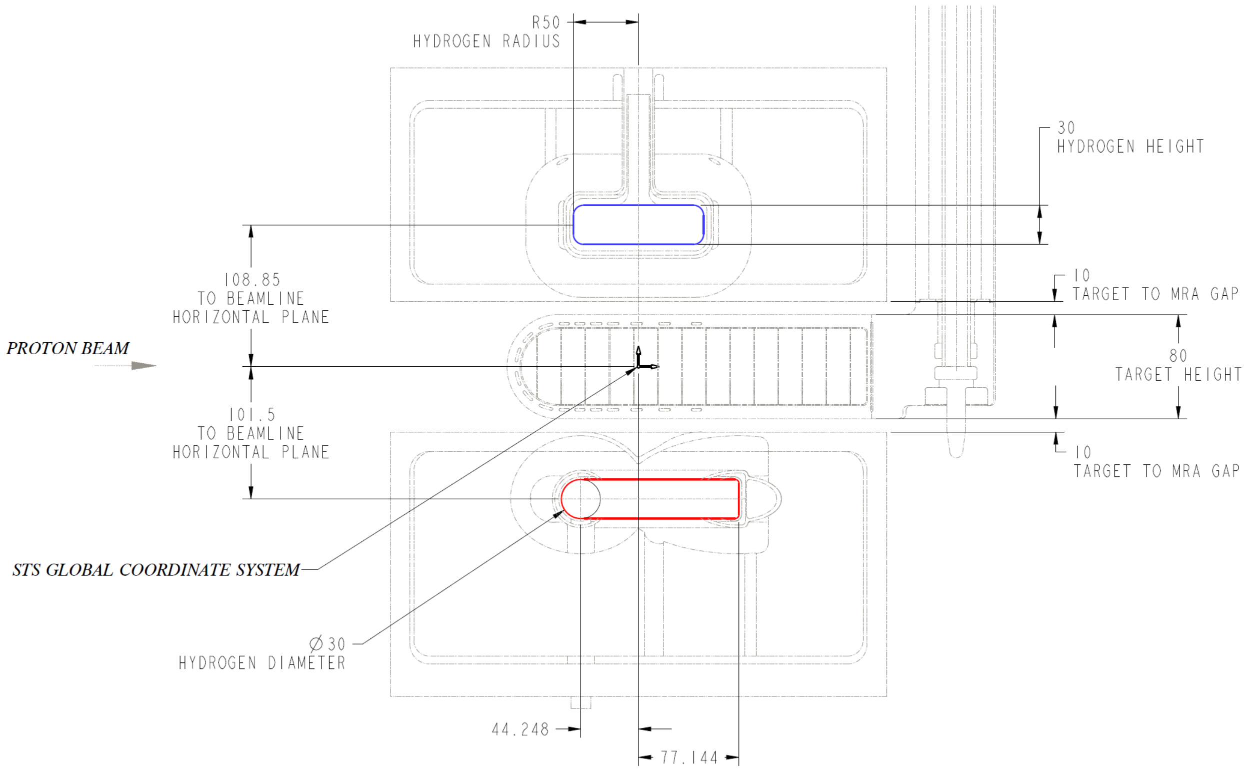

Figure 17. Moderator Vertical Cross-section Along Proton Beam Axis (dimensions in mm). Cylinder Moderator Hydrogen Boundary is Shown in Blue. Tube Moderator Hydrogen Boundary is Shown in Red.

5.2.2.1 Beamline ST02 Geometry

The ST02 beamline will house the QIKR instrument, a horizontal-sample-surface reflectometer, which will feature 2 independent beamlines offset 2.5 degrees from horizontal, one up and one down, as shown in Figure 18. Each beamline is also angled horizontally from the nominal beamline angle to allow space for the independent beamlines and sample locations as shown in Figure 19. The dimensions of the rectangular guide entrances at the distance given in Table 1 from the moderator viewed face are shown in Table 2.

Table 2. ST02 Rectangular Guide Entrance Geometry

Beamline	Guide Entrance Width	Guide Entrance Height
ST02-U	30mm	26.5mm
ST02-L	30mm	26.5mm

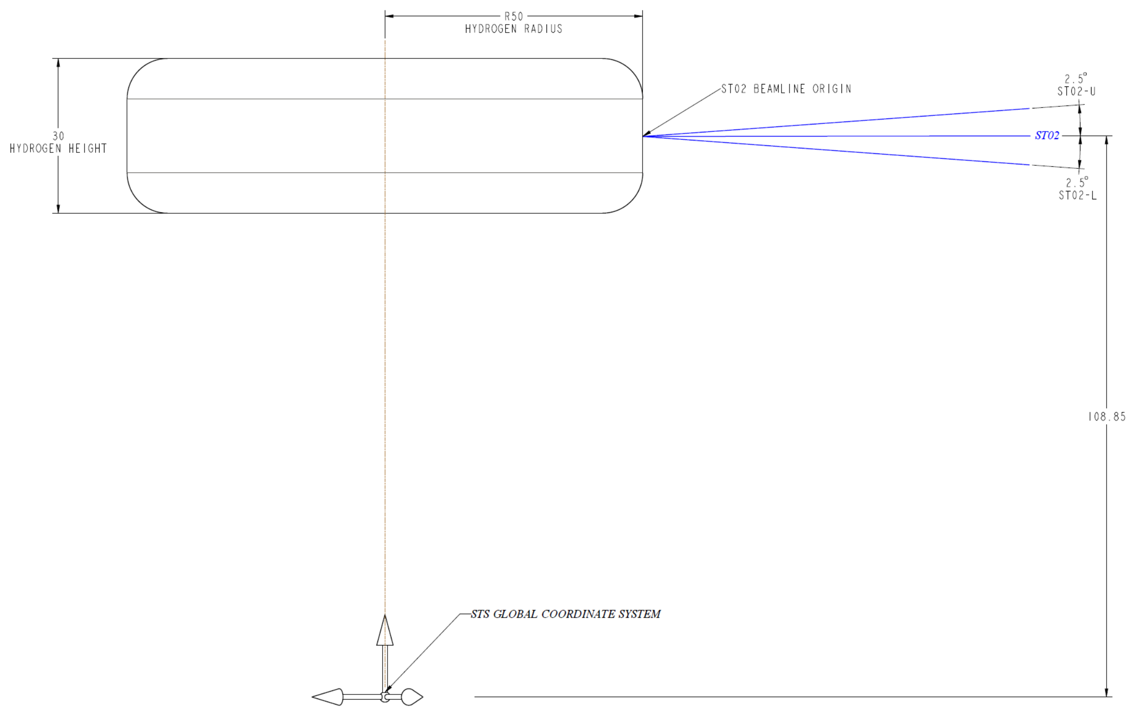

Figure 18. ST02-U and ST02-L Vertical Cross-section through ST02 Layout (dimensions in mm, angles are not to scale for clarity).

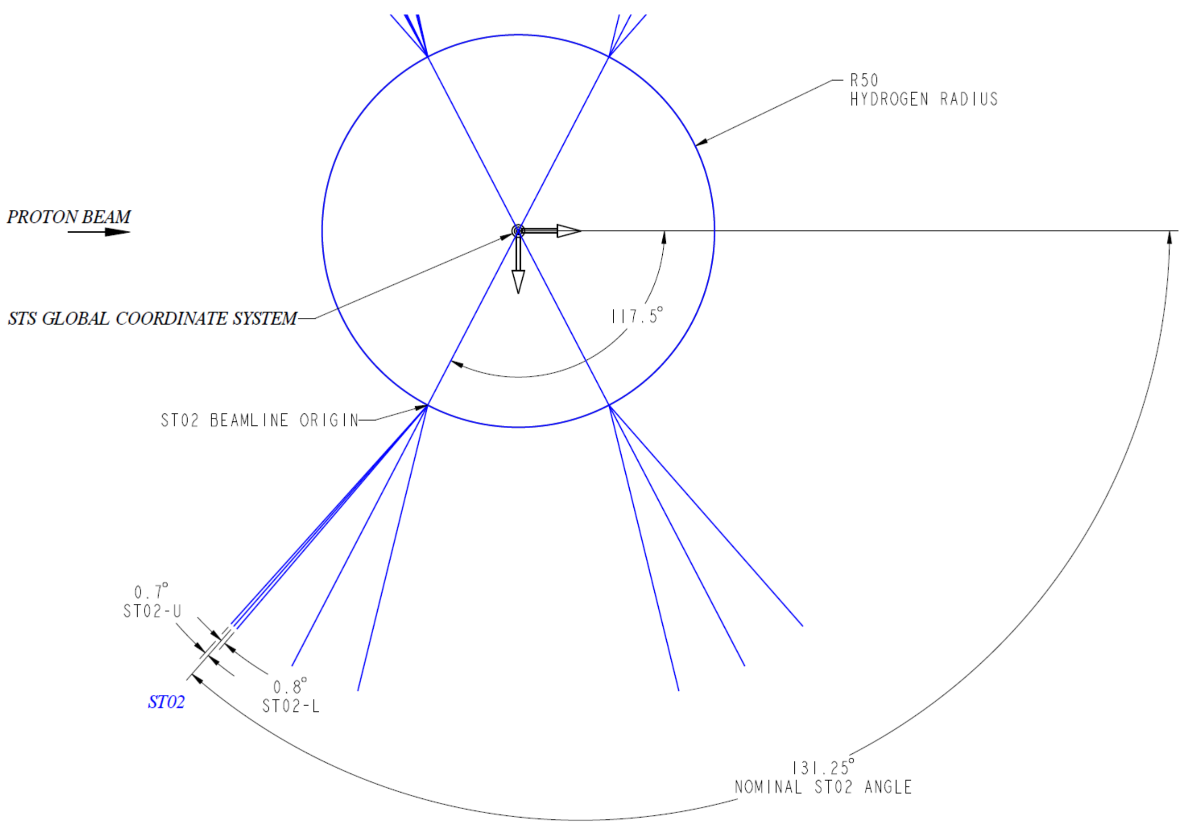

Figure 19. ST02-U and ST02-L Plan View (dimensions in mm).

5.2.2.2 Beamline ST15 and ST16 Geometry

Beam ports ST15 and ST16 will each accommodate two instruments, indicated as ST15-A, ST15-B, ST16-A, and ST16-B, from a single beam port. Each beamline is angled 1.3-degrees horizontally from the nominal beamline angle to allow space for the independent beamlines and sample locations as shown in Figure 20 and Figure 21. The dimensions of the square guide entrances and the distance viewed from the moderator face for each of the independent beamlines are listed in Table 1 as ST15 and ST16.

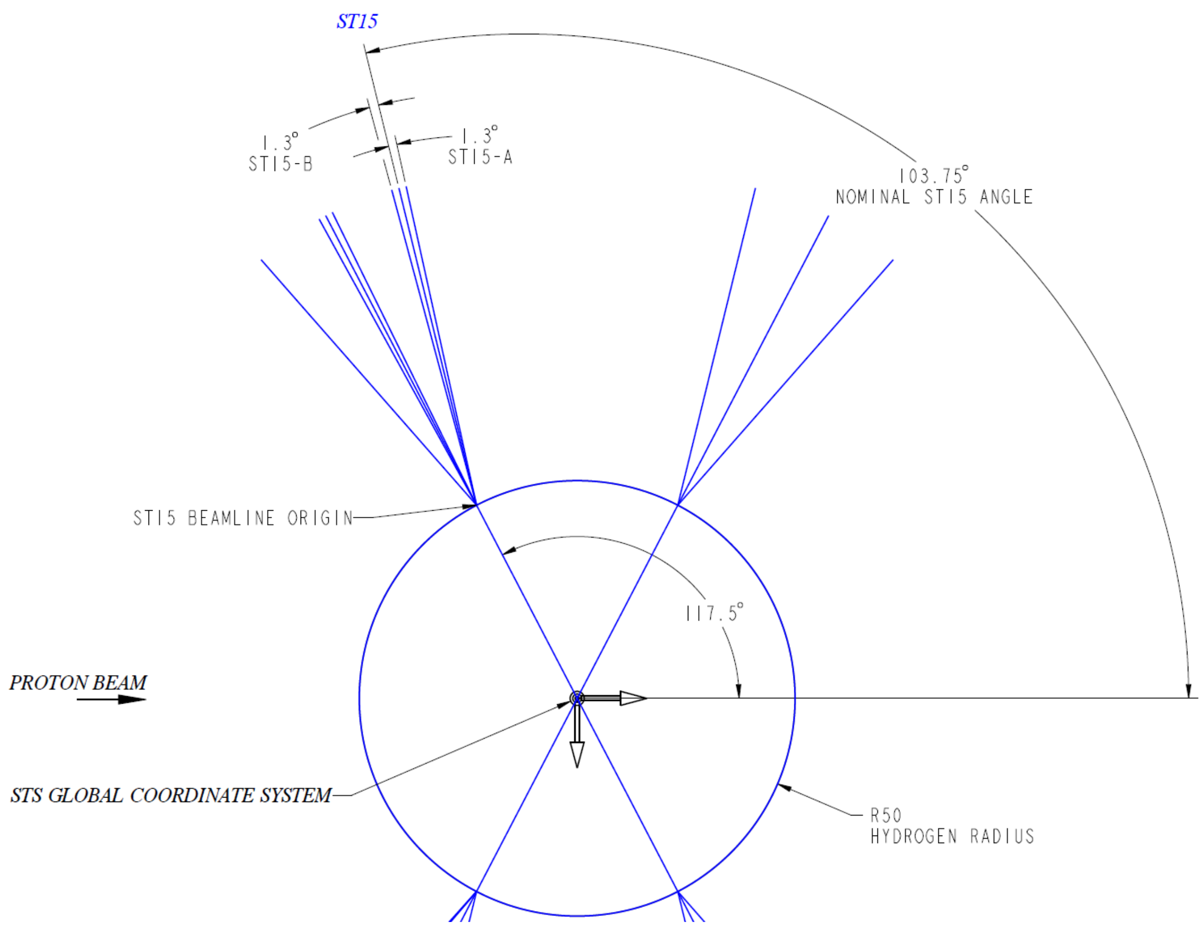

Figure 20. ST15-A and ST15-B Plan View (dimensions in mm).

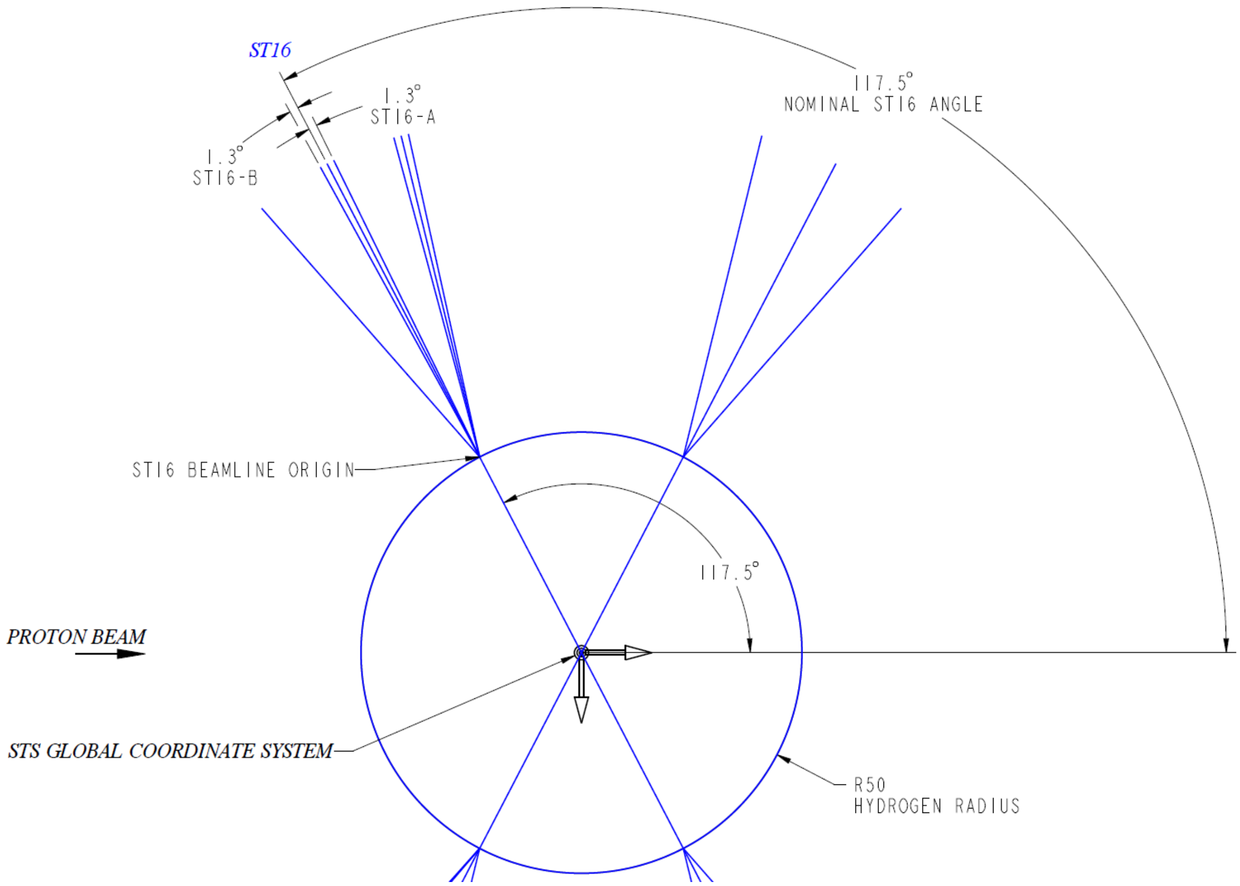

Figure 21. ST16-A and ST16-B Plan View (dimensions in mm).