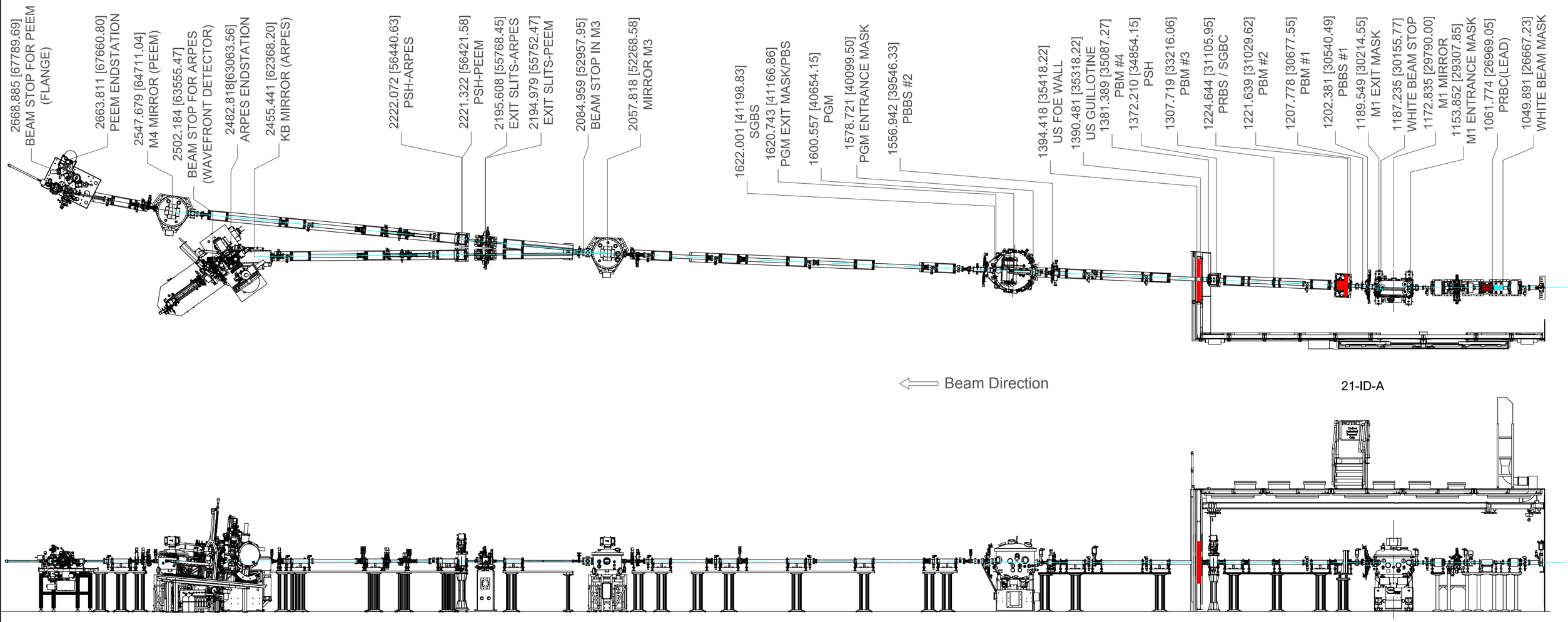
| REVISION HISTORY | | | | | |
|---|---|---|---|---|---|
| REV | DESCRIPTION | DATE | DESIGNER | CHECKED BY | ENGINEER |
| A | RELEASE PER ECO 003834 | 3/28/2016 | S. PJEROV | C. STELMACH | Y. ZHU |
| B | RELEASE PER ECO 005062 | 5/05/2017 | Y. ZHU / SP | C. STELMACH | Y. ZHU |

NOTES:
1. FE REFERENCE DRAWING SR-FE-EPU21-1001 REV. C
2. THE CENTER OF STRAIGHT IS THE ORIGIN FOR ALL DIMENSIONS UNLESS OTHERWISE NOTED.
3. BLUE AND MAGENTA COLORED RAYS ARE DETERMINED BY TOLERANCE APERTURES. GREEN COLORED RAYS ARE DETERMINED BY NOMINAL APERTURES.
4. DIMENSIONS PBM #1, #2, #3 AND #4 ARE TO GLIDCOP BLOCK FRONT SURFACE.
5. ALL DIMENSIONS ARE IN INCHES, IN BRACKETS [XX.XX] ARE MILLIMETERS AND ARE FOR REFERENCE ONLY.






| SPECIFICATIONS | | REFERENCE |
|---|---|---|
| Project | NEXT PROJECT | NX-C-XFD-RSI-001 |
| Source | EPU105, EPU 57 | NX-C-XFD-RSI-001 |
| Beam Line Name | ELECTRON SPECTRO-MICROSCOPY | NX-C-XFD-RSI-001 |
| Abbreviation | ESM | NX-C-XFD-RSI-001 |
| Period of insertion device | 105 mm, 57 mm | NX-C-XFD-RSI-001 |
| Long / Short Straight / Cell | SHORT/21-ID | NX-C-XFD-RSI-001 |
| Length of Source | 2800 mm, 1400 mm | NX-C-XFD-RSI-001 |
| Location of Center of Source (from Center of Straight) | +790 mm, -1492 mm | NX-C-XFD-RSI-001 |
| Ray Tracing Procedure | | PS-C-XFD-PRC-008 (Version 2) |
| Front End Ray Tracing Drawing | | SR-FE-EPU21-1001 (REV. C) |

# ESM BEAMLINE LAYOUT
## SCALE 1:30

**ABBREVIATIONS:**
ARPES - ANGLE - RESOLVED PHOTO EMISSION SPECTROSCOPY
DS - DOWNSTREAM
LCO - LEAD COLLIMATOR
PBBS - PINK BEAM BAFFLE SLITS
PBM - PINK BEAM MASK
PBS - PINK BEAM STOP
PEEM - PHOTON EMISSION ELECTRON MICROSCOPES
PGM - PLANE GRATING MONOCHROMATER
PRBC - PRIMARY BREMSSTRAHLUNG COLLIMATOR
PRBS - PRIMARY BREMSSTRAHLUNG STOP
PSH - PHOTON SHUTTER
SGBC - SECONDARY GAS BREMSSTRAHLUNG COLLIMATOR
SGBS - SECONDARY GAS BREMSSTRAHLUNG STOP
US - UPSTREAM
WBM - WHITE BEAM MASK
WBS - WHITE BEAM STOP

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
DIMENSIONS IN BRACKETS [xx.xx] (WHERE PRESENT) ARE MILLIMETERS AND ARE FOR REFERENCE ONLY
INTERPRET DRAWING AS PER ANSI Y14.5-1994 OR Y32.2-1975
DIMENSIONAL TOLERANCE: X ± 0.060, .X ± 0.030, .XX ± 0.015, .XXX ± 0.005
ANGULAR TOLERANCE ± .5
FINISH 125
BREAK EDGES & SHARP CORNERS 0.005 MIN. TO 0.030 MAX.

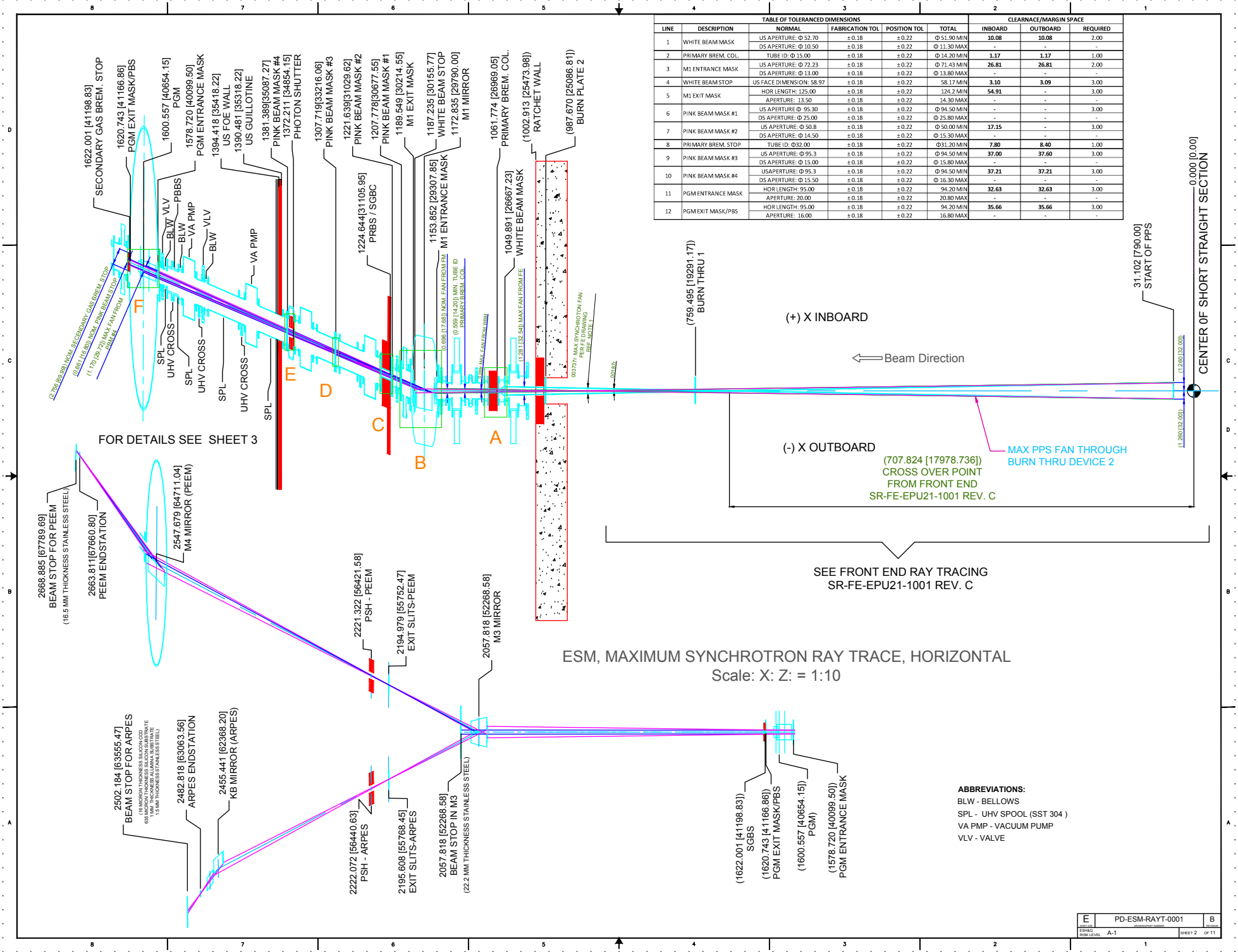
BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES
UPTON, NEW YORK 11973
*Exploring Life's Mysteries*
*Protecting its Future*

| | | |
|---|---|---|
| DRAWN BY | S. PJEROV | 3/2016 |
| CHECKED BY | C. STELMACH | 4/2016 |
| VACUUM APPROVAL | | |
| ENGINEER APPROVAL | Y. ZHU | 4/2016 |
| SUPERVISOR APPROVAL | E. VESCOVO | 4/2016 |
| ESH&H APPROVAL | L. STIEGLER | 4/2016 |
| QA APPROVAL | J. ZIPPER | 4/2016 |

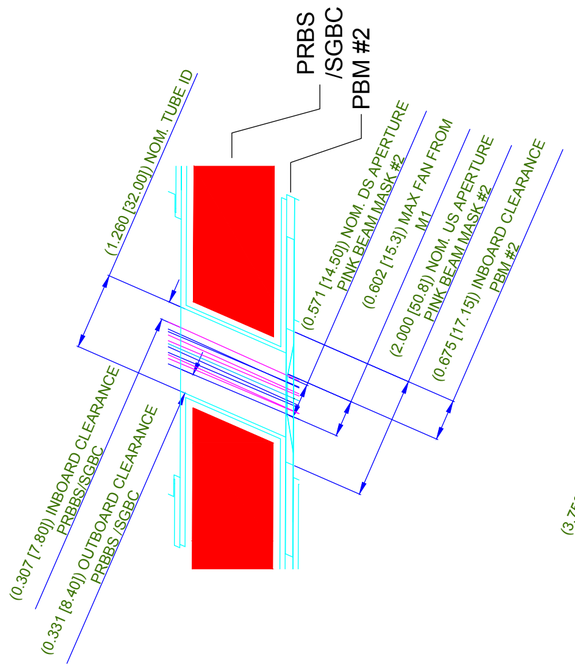
PHOTON DIVISION
ESM RAY TRACING
21 - ID, ESM BEAMLINE RAY TRACING

NEXT ASSY:
PROJECT: ESM BEAMLINES
THIRD ANGLE PROJECTION
SCALE: NOTED
WBS# 2,05.02.02
SHEET SIZE: E
DRAWING/PART NUMBER: PD-ESM-RAYT-0001
REVISION: B
ESH&Q RISK LEVEL: A-1
SHEET 1 OF 11

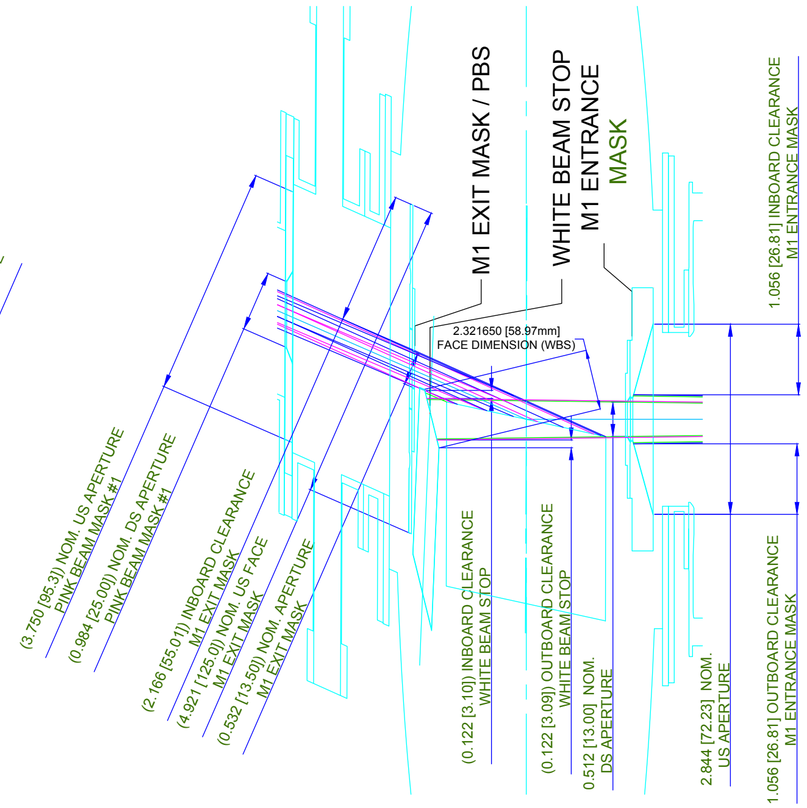
PD:ESM:RAYT:PD-CSX-RAYT-0001



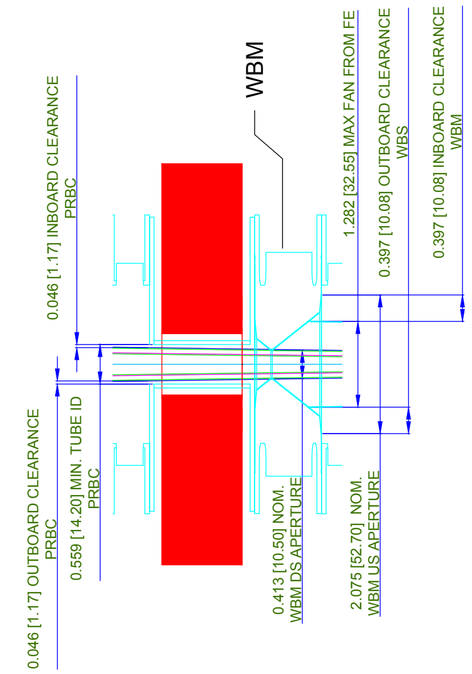

| TABLE OF TOLERANCED DIMENSIONS | | | | | | CLEARNACE/MARGIN SPACE | | |
|---|---|---|---|---|---|---|---|---|
| LINE | DESCRIPTION | NORMAL | FABRICATION TOL | POSITION TOL | TOTAL | INBOARD | OUTBOARD | REQUIRED |
| 1 | WHITE BEAM MASK | US APERTURE: Φ 52.70 | ± 0.18 | ± 0.22 | Φ 51.90 MIN | **10.08** | **10.08** | 2.00 |
| | | DS APERTURE: Φ 10.50 | ± 0.18 | ± 0.22 | Φ 11.30 MAX | - | - | - |
| 2 | PRIMARY BREM. COL. | TUBE ID: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 14.20 MIN | **1.17** | **1.17** | 1.00 |
| 3 | M1 ENTRANCE MASK | US APERTURE: Φ 72.23 | ± 0.18 | ± 0.22 | Φ 71.43 MIN | **26.81** | **26.81** | 2.00 |
| | | DS APERTURE: Φ 13.00 | ± 0.18 | ± 0.22 | Φ 13.80 MAX | - | - | - |
| 4 | WHITE BEAM STOP | US FACE DIMENSION: 58.97 | ± 0.18 | ± 0.22 | 58.17 MIN | **3.10** | **3.09** | 3.00 |
| 5 | M1 EXIT MASK | HOR LENGTH: 125.00 | ± 0.18 | ± 0.22 | 124.2 MIN | **54.91** | - | 3.00 |
| | | APERTURE: 13.50 | ± 0.18 | ± 0.22 | 14.30 MAX | - | - | - |
| 6 | PINK BEAM MASK #1 | US APERTURE Φ 95.30 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | - | - | 3.00 |
| | | DS APERTURE: Φ 25.00 | ± 0.18 | ± 0.22 | Φ 25.80 MAX | - | - | - |
| 7 | PINK BEAM MASK #2 | US APERTURE: Φ 50.8 | ± 0.18 | ± 0.22 | Φ 50.00 MIN | **17.15** | - | 3.00 |
| | | DS APERTURE: Φ 14.50 | ± 0.18 | ± 0.22 | Φ 15.30 MAX | - | - | - |
| 8 | PRIMARY BREM. STOP | TUBE ID:Φ32.00 | ± 0.18 | ± 0.22 | Φ31.20 MIN | **7.80** | **8.40** | 1.00 |
| 9 | PINK BEAM MASK #3 | US APERTURE: Φ 95.3 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | **37.00** | **37.60** | 3.00 |
| | | DS APERTURE: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 15.80 MAX | - | - | - |
| 10 | PINK BEAM MASK #4 | USAPERTURE: Φ 95.3 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | **37.21** | **37.21** | 3.00 |
| | | DS APERTURE: Φ 15.50 | ± 0.18 | ± 0.22 | Φ 16.30 MAX | - | - | - |
| 11 | PGM ENTRANCE MASK | HOR LENGTH: 95.00 | ± 0.18 | ± 0.22 | 94.20 MIN | **32.63** | **32.63** | 3.00 |
| | | APERTURE: 20.00 | ± 0.18 | ± 0.22 | 20.80 MAX | - | - | - |
| 12 | PGM EXIT MASK/PBS | HOR LENGTH: 95.00 | ± 0.18 | ± 0.22 | 94.20 MIN | **35.66** | **35.66** | 3.00 |
| | | APERTURE: 16.00 | ± 0.18 | ± 0.22 | 16.80 MAX | - | - | - |




DETAIL C
SCALE 4:1

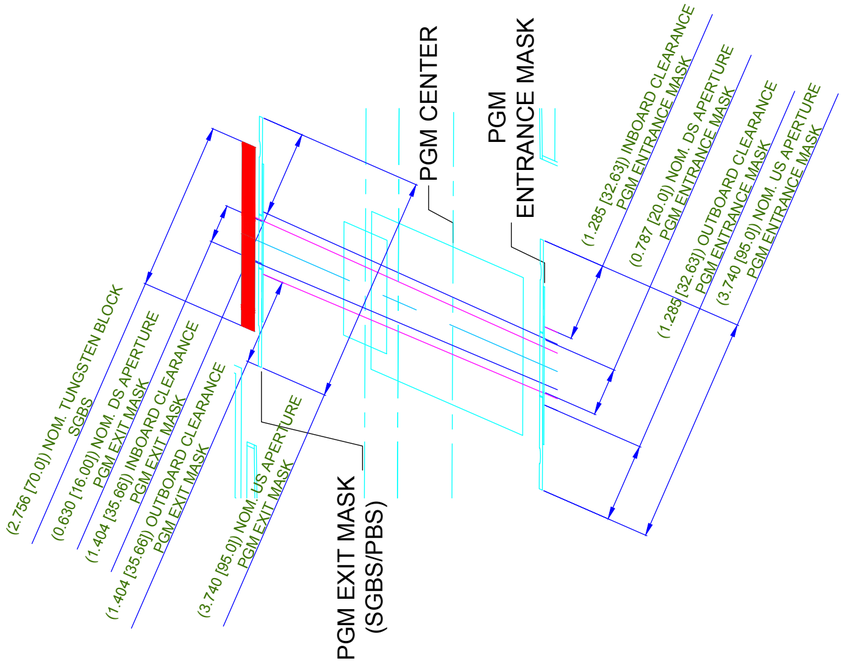



DETAIL B
SCALE 4:1

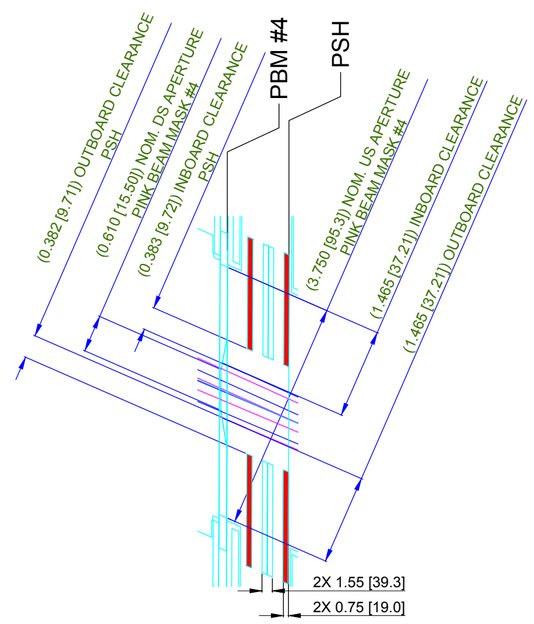



DETAIL A
SCALE 4:1

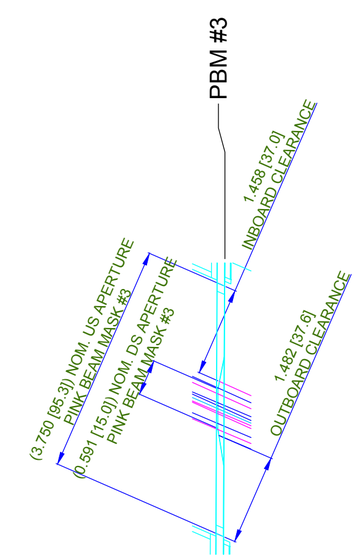
Beam Direction




DETAIL F
SCALE 4:1



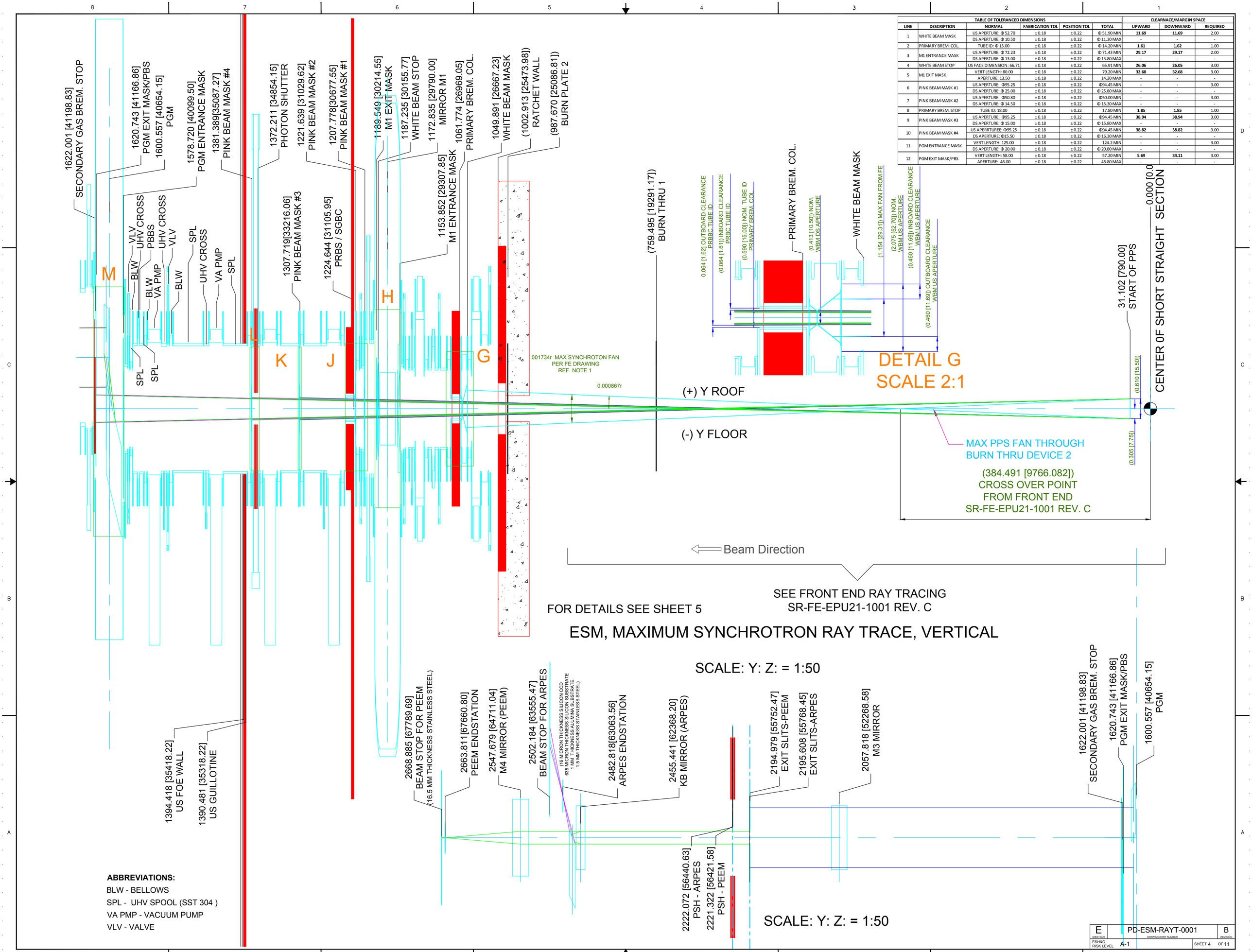

DETAIL E
SCALE 4:1




DETAIL D
SCALE 4:1

| | | |
|---|---|---|
| E | PD-ESM-RAYT-0001 | B |
| SHEET SIZE | DRAWING/PART NUMBER | REVISION |
| ESH&Q RISK LEVEL A-1 | | SHEET 3 OF 11 |

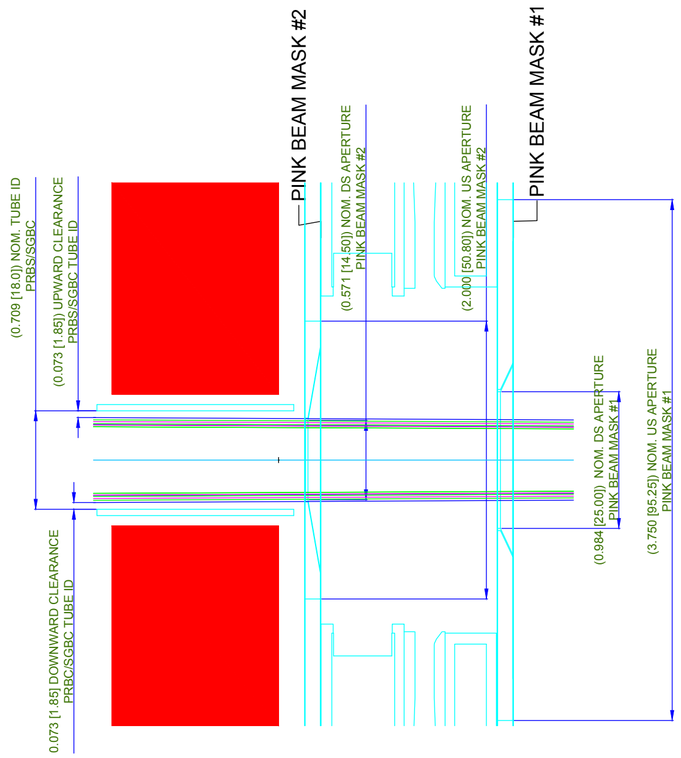
| TABLE OF TOLERANCED DIMENSIONS | | | | | | CLEARNACE/MARGIN SPACE | | |
|---|---|---|---|---|---|---|---|---|
| LINE | DESCRIPTION | NORMAL | FABRICATION TOL | POSITION TOL | TOTAL | UPWARD | DOWNWARD | REQUIRED |
| 1 | WHITE BEAM MASK | US APERTURE: Φ 52.70 | ± 0.18 | ± 0.22 | Φ 51.90 MIN | **11.69** | **11.69** | 2.00 |
| | | DS APERTURE: Φ 10.50 | ± 0.18 | ± 0.22 | Φ 11.30 MAX | - | - | - |
| 2 | PRIMARY BREM. COL. | TUBE ID: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 14.20 MIN | **1.61** | **1.62** | 1.00 |
| 3 | M1 ENTRANCE MASK | US APERTURE: Φ 72.23 | ± 0.18 | ± 0.22 | Φ 71.43 MIN | **29.17** | **29.17** | 2.00 |
| | | DS APERTURE: Φ 13.00 | ± 0.18 | ± 0.22 | Φ 13.80 MAX | - | - | - |
| 4 | WHITE BEAM STOP | US FACE DIMENSION: 66.71 | ± 0.18 | ± 0.22 | 65.91 MIN | **26.06** | **26.05** | 3.00 |
| 5 | M1 EXIT MASK | VERT LENGTH: 80.00 | ± 0.18 | ± 0.22 | 79.20 MIN | **32.68** | **32.68** | 3.00 |
| | | APERTURE: 13.50 | ± 0.18 | ± 0.22 | 14.30 MAX | - | - | - |
| 6 | PINK BEAM MASK #1 | US APERTURE: Φ95.25 | ± 0.18 | ± 0.22 | Φ94.45 MIN | - | - | 3.00 |
| | | DS APERTURE: Φ 25.00 | ± 0.18 | ± 0.22 | Φ 25.80 MAX | - | - | - |
| 7 | PINK BEAM MASK #2 | US APERTURE: Φ50.80 | ± 0.18 | ± 0.22 | Φ50.00 MIN | - | - | 3.00 |
| | | DS APERTURE: Φ 14.50 | ± 0.18 | ± 0.22 | Φ 15.30 MAX | - | - | - |
| 8 | PRIMARY BREM. STOP | TUBE ID: 18.00 | ± 0.18 | ± 0.22 | 17.80 MIN | **1.85** | **1.85** | 1.00 |
| 9 | PINK BEAM MASK #3 | US APERTURE: Φ95.25 | ± 0.18 | ± 0.22 | Φ94.45 MIN | **38.94** | **38.94** | 3.00 |
| | | DS APERTURE: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 15.80 MAX | - | - | - |
| 10 | PINK BEAM MASK #4 | US APERRTUREE: Φ95.25 | ± 0.18 | ± 0.22 | Φ94.45 MIN | **38.82** | **38.82** | 3.00 |
| | | DS APERTURE: Φ15.50 | ± 0.18 | ± 0.22 | Φ 16.30 MAX | - | - | - |
| 11 | PGM ENTRANCE MASK | VERT LENGTH: 125.00 | ± 0.18 | ± 0.22 | 124.2 MIN | - | - | 3.00 |
| | | DS APERTURE: Φ 20.00 | ± 0.18 | ± 0.22 | Φ 20.80 MAX | - | - | - |
| 12 | PGM EXIT MASK/PBS | VERT LENGTH: 58.00 | ± 0.18 | ± 0.22 | 57.20 MIN | **5.69** | **34.11** | 3.00 |
| | | APERTURE: 46.00 | ± 0.18 | ± 0.22 | 46.80 MAX | - | - | - |



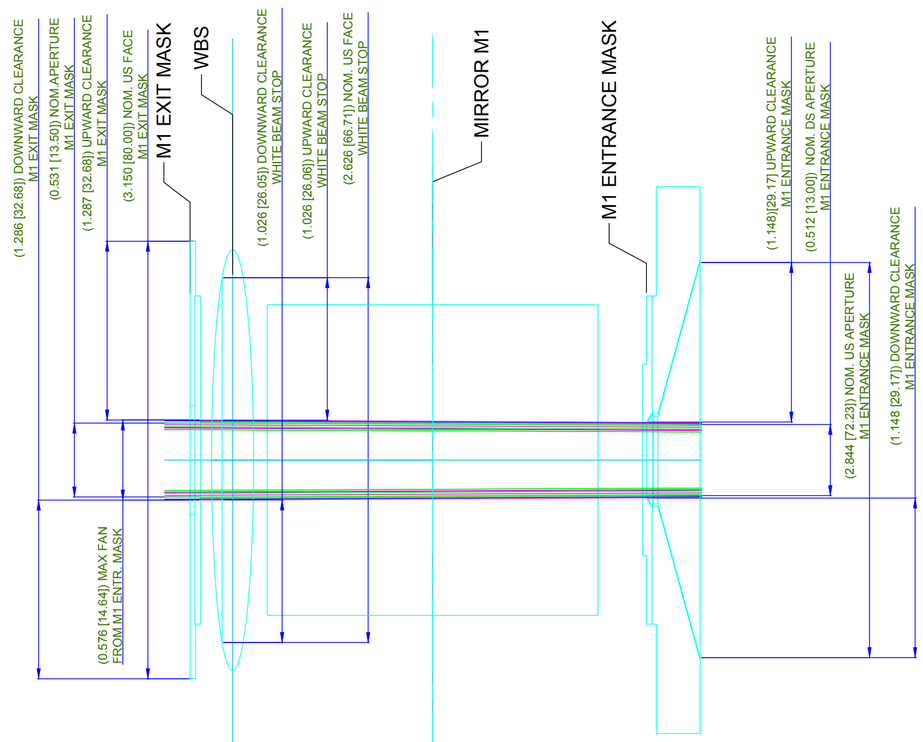

**ABBREVIATIONS:**

BLW - BELLOWS
SPL - UHV SPOOL (SST 304 )
VA PMP - VACUUM PUMP
VLV - VALVE

| | | |
|---|---|---|
| E (SHEET SIZE) | PD-ESM-RAYT-0001 (DRAWING/PART NUMBER) | B (REVISION) |
| ESH&Q RISK LEVEL A-1 | SHEET 4 OF 11 | |



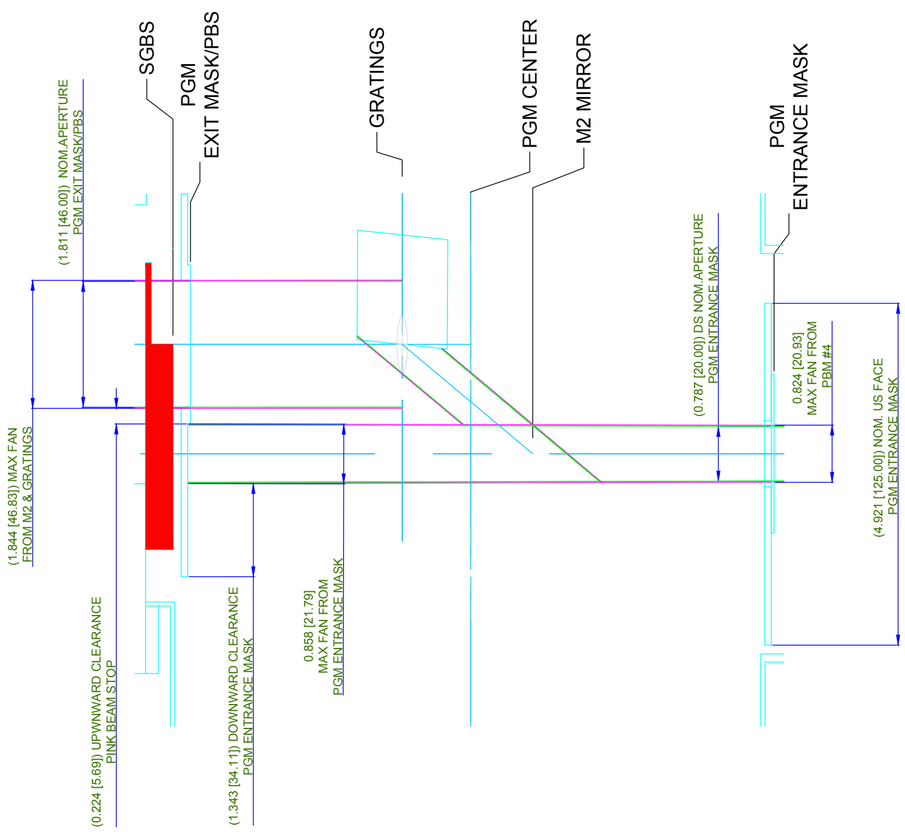

DETAIL J
SCALE 2:1



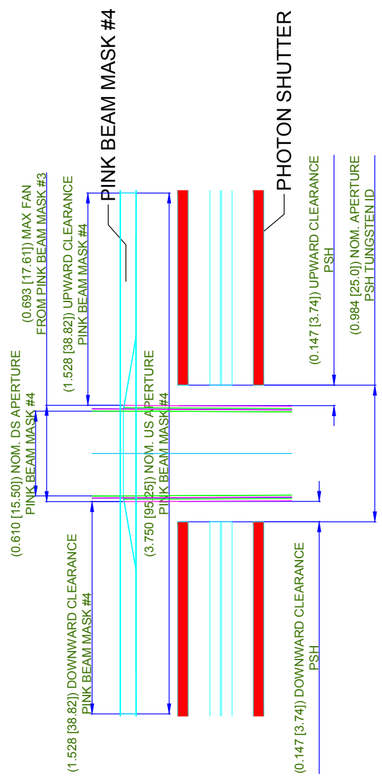

DETAIL H
SCALE 2:1

# ESM, COLLIMATORS AND MASKS DETAILS, VERTICAL

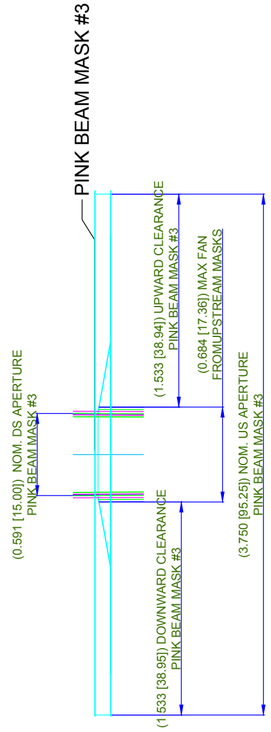
Beam Direction




DETAIL M
SCALE 2:1



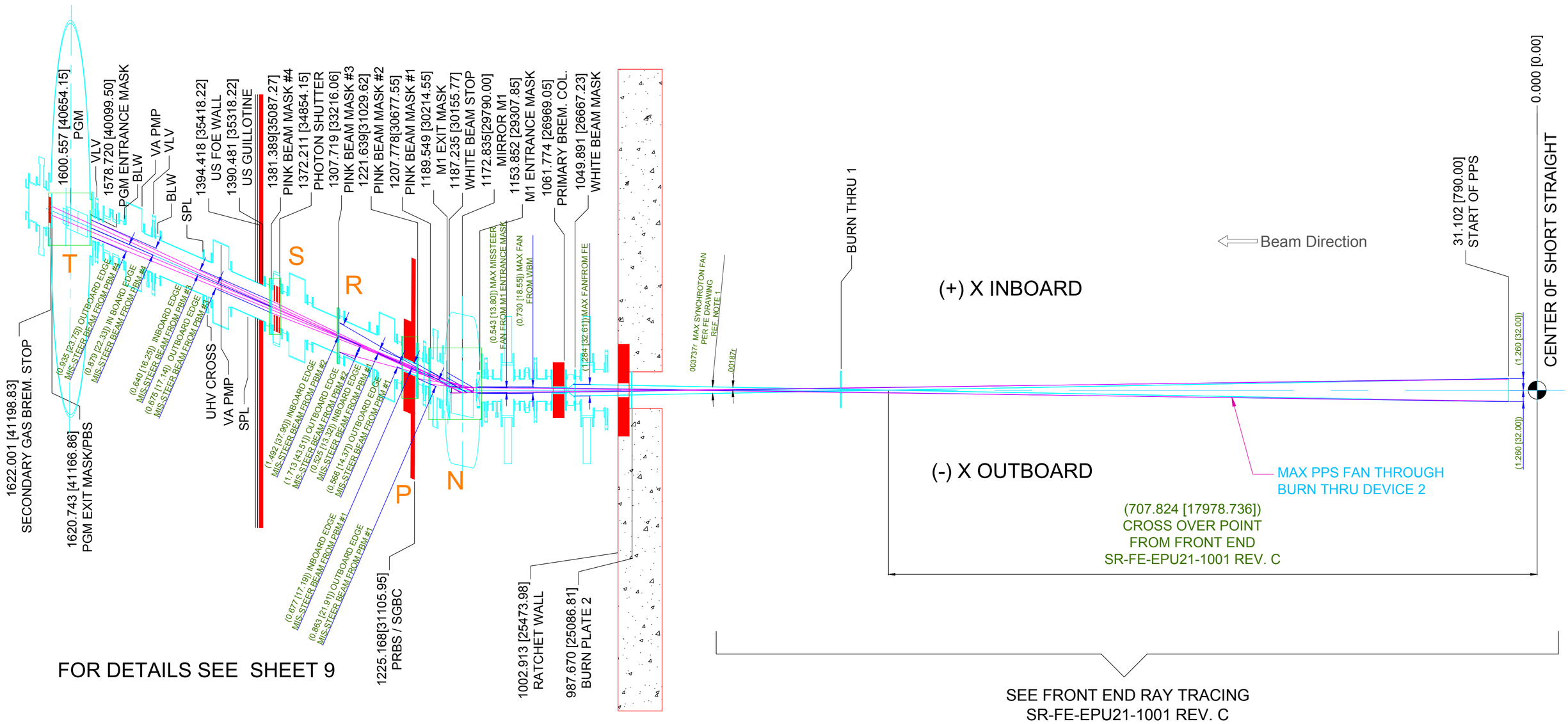

DETAIL L
SCALE 2:1




DETAIL K
SCALE 2:1

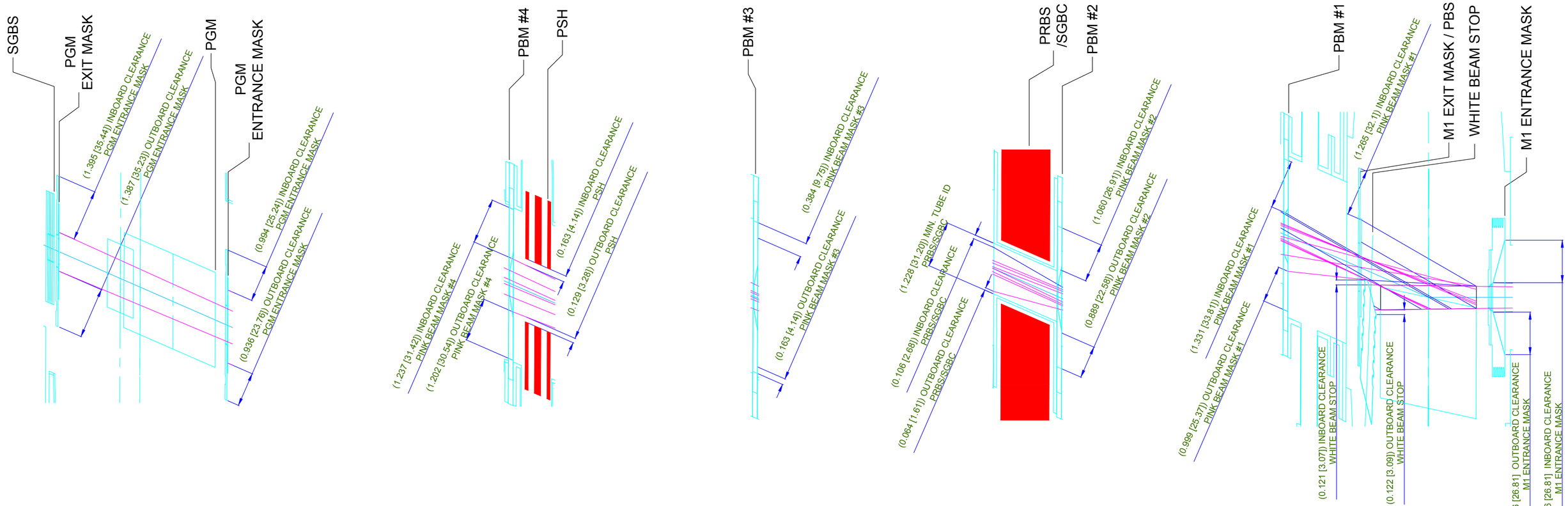
| | | |
|---|---|---|
| E (SHEET SIZE) | PD-ESM-RAYT-0001 (DRAWING/PART NUMBER) | B (REVISION) |
| ESH&Q RISK LEVEL A-1 | | SHEET 5 OF 11 |

| TABLE OF TOLERANCED DIMENSIONS | | | | | | CLEARNACE/MARGIN SPACE | | |
|---|---|---|---|---|---|---|---|---|
| LINE | DESCRIPTION | NORMAL | FABRICATION TOL | POSITION TOL | TOTAL | INBOARD | OUTBOARD | REQUIRED |
| 1 | WHITE BEAM MASK | US APERTURE: Φ 52.70 | ± 0.18 | ± 0.22 | Φ 51.90 MIN | **10.08** | **10.08** | 2.00 |
| | | DS APERTURE: Φ 10.50 | ± 0.18 | ± 0.22 | Φ 11.30 MAX | - | - | - |
| 2 | PRIMARY BREM. COL. | TUBE ID: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 14.20 MIN | **1.17** | **1.17** | 1.00 |
| 3 | M1 ENTRANCE MASK | US APERTURE: Φ 72.23 | ± 0.18 | ± 0.22 | Φ 71.43 MIN | **26.81** | **26.81** | 2.00 |
| | | DS APERTURE: Φ 13.00 | ± 0.18 | ± 0.22 | Φ 13.80 MAX | - | - | - |
| 4 | WHITE BEAM STOP | US FACE DIMENSION: 58.97 | ± 0.18 | ± 0.22 | 58.17 MIN | **3.07** | **3.09** | 3.00 |
| 5 | M1 EXIT MASK | HOR LENGTH: 125.00 | ± 0.18 | ± 0.22 | 124.20 MIN | **54.91** | - | 3.00 |
| | | APERTURE: 13.50 | ± 0.18 | ± 0.22 | 14.30 MAX | - | - | - |
| 6 | PINK BEAM MASK #1 | US APERTURE Φ 95.30 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | - | - | 3.00 |
| | | DS APERTURE: Φ 25.00 | ± 0.18 | ± 0.22 | Φ 25.80 MAX | - | - | - |
| 7 | PINK BEAM MASK #2 | US APERTURE: Φ 50.80 | ± 0.18 | ± 0.22 | Φ 50.00 MIN | **17.15** | - | 3.00 |
| | | DS APERTURE: Φ 14.50 | ± 0.18 | ± 0.22 | Φ 15.30 MAX | - | - | - |
| 8 | PRIMARY BREM. STOP | TUBE ID: Φ32.00 | ± 0.18 | ± 0.22 | Φ31.20 MIN | **7.80** | **8.40** | 1.00 |
| 9 | PINK BEAM MASK #3 | US APERTURE: Φ 95.30 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | **37.00** | **37.60** | 3.00 |
| | | DS APERTURE: Φ 15.00 | ± 0.18 | ± 0.22 | Φ 15.80 MAX | - | - | - |
| 10 | PINK BEAM MASK #4 | USAPERTURE: Φ 95.30 | ± 0.18 | ± 0.22 | Φ 94.50 MIN | **37.21** | **37.21** | 3.00 |
| | | DS APERTURE: Φ 15.50 | ± 0.18 | ± 0.22 | Φ 16.30 MAX | - | - | - |
| 11 | PGM ENTRANCE MASK | HOR LENGTH: 95.00 | ± 0.18 | ± 0.22 | 94.20 MIN | **32.63** | **32.63** | 3.00 |
| | | APERTURE: 20.00 | ± 0.18 | ± 0.22 | 20.80 MAX | - | - | - |
| 12 | PGM EXIT MASK/PBS | HOR LENGTH: 95.00 | ± 0.18 | ± 0.22 | 94.20 MIN | **35.66** | **35.66** | 3.00 |
| | | APERTURE: 16.00 | ± 0.18 | ± 0.22 | 16.80 MAX | - | - | - |




ESM, MIS-STEERED SYNCHROTRON RAY TRACE, HORIZONTAL
SCALE: X:Z=1:10

| E | PD-ESM-RAYT-0001 | B |
|---|---|---|
| SHEET SIZE | DRAWING/PART NUMBER | REVISION |
| ESH&Q RISK LEVEL A-1 | SHEET 8 OF 11 | |




DETAIL T
SCALE 4:1

DETAIL S
SCALE 4:1

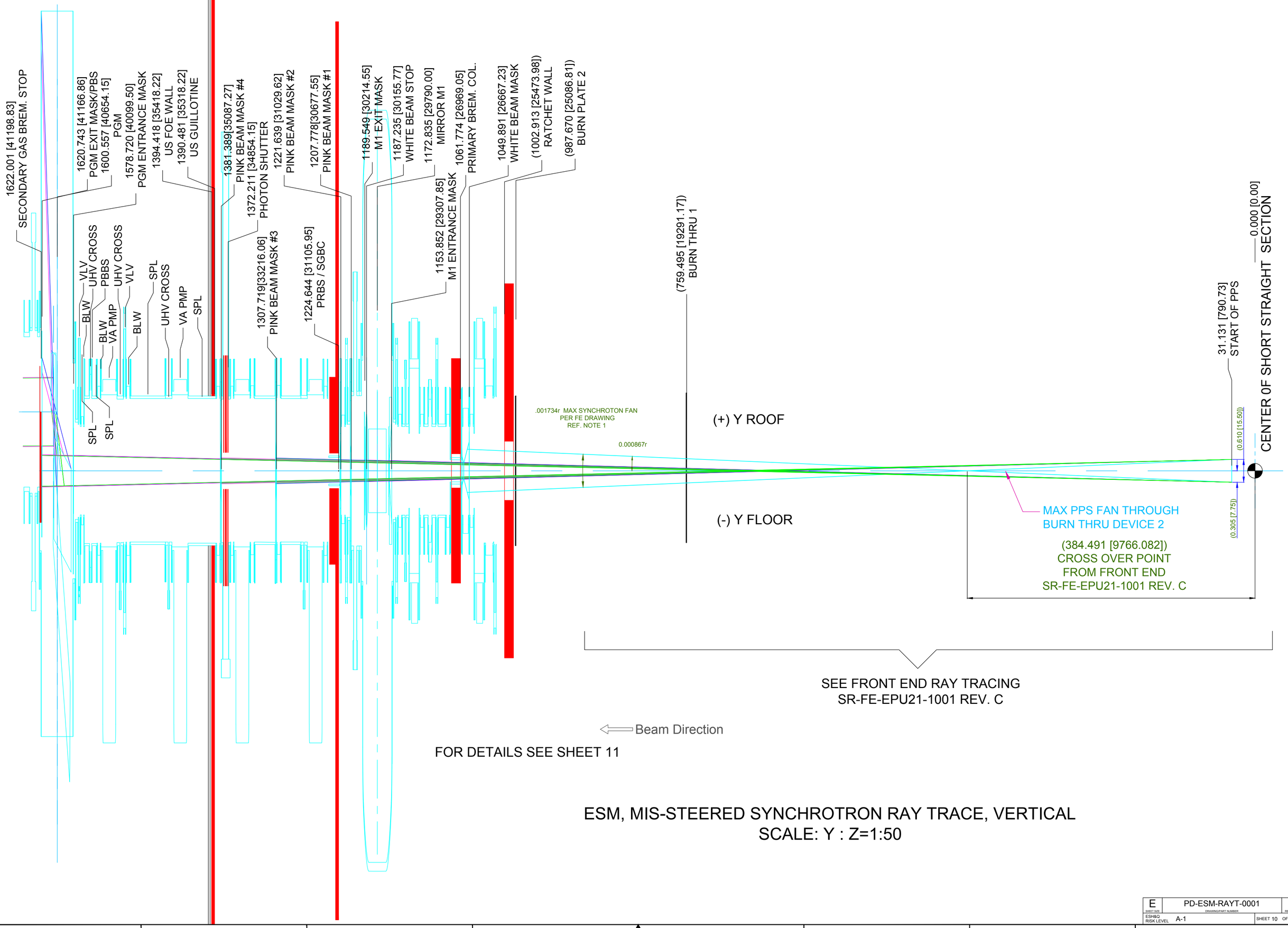
DETAIL R
SCALE 4:1

DETAIL P
SCALE 4:1

DETAIL N
SCALE 4:1

⇦ Beam Direction

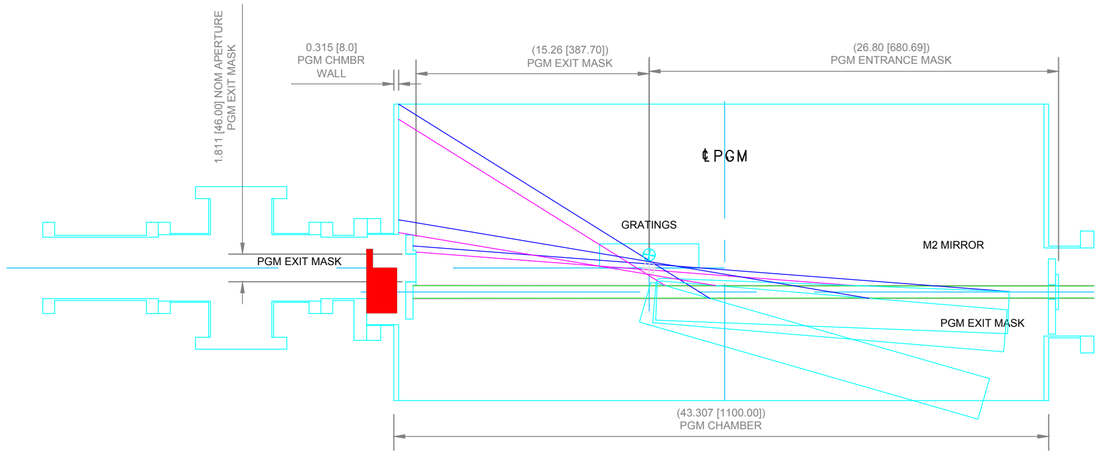
| | | |
|---|---|---|
| E (SHEET SIZE) | PD-ESM-RAYT-0001 (DRAWING/PART NUMBER) | B (REVISION) |
| ESH&Q RISK LEVEL A-1 | SHEET 9 OF 11 | |

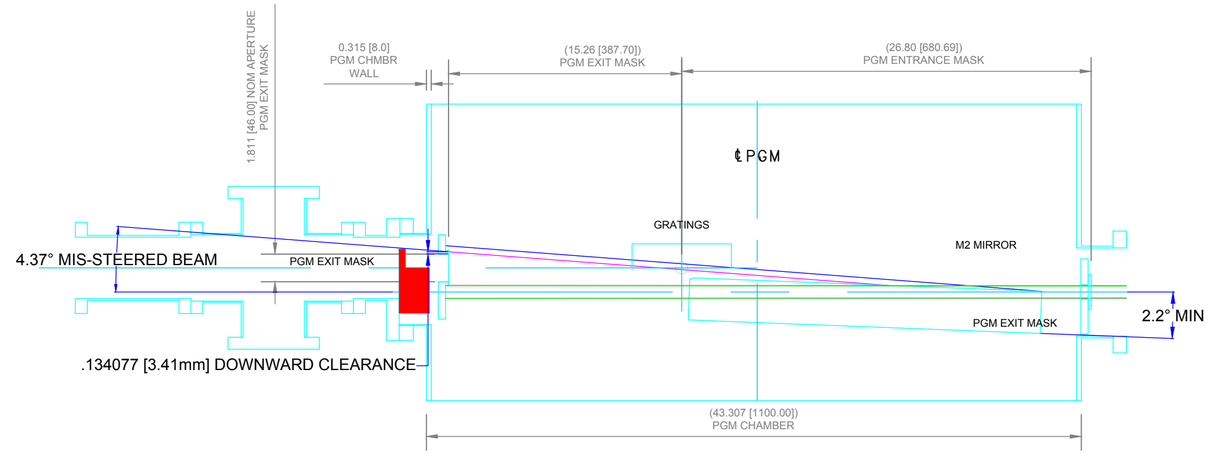



FOR DETAILS SEE SHEET 11

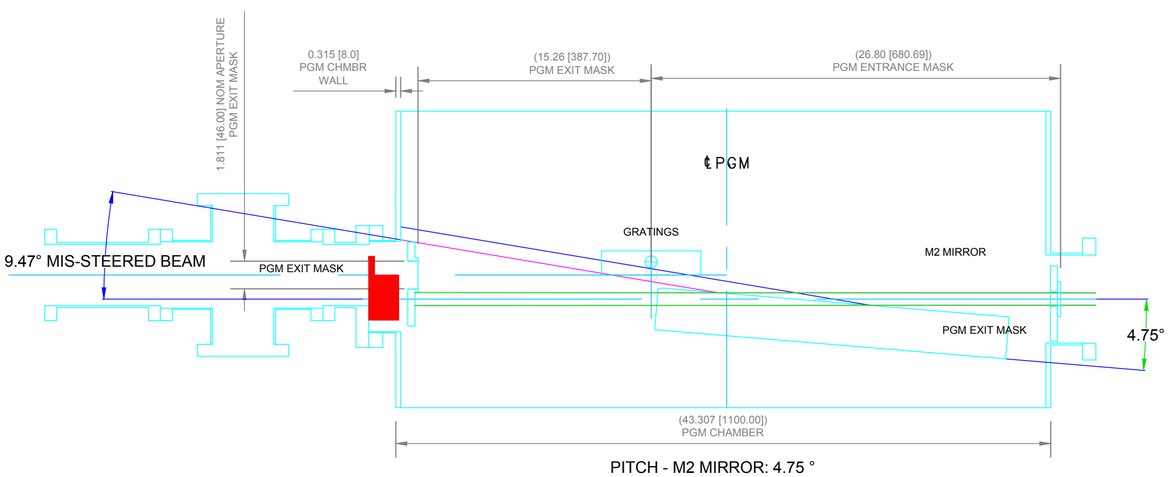
# ESM, MIS-STEERED SYNCHROTRON RAY TRACE, VERTICAL
SCALE: Y : Z=1:50

| | | |
|---|---|---|
| E (SHEET SIZE) | PD-ESM-RAYT-0001 (DRAWING/PART NUMBER) | B (REVISION) |
| ESH&Q RISK LEVEL A-1 | SHEET 10 OF 11 | |

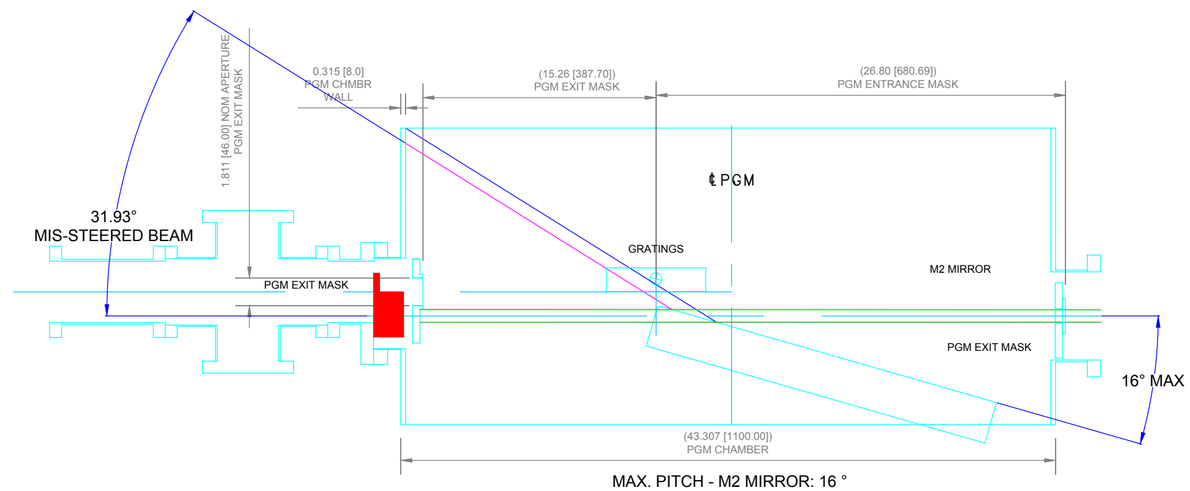



MINI. PITCH - M2 MIRROR: 2.2 °
MINI. DEFLECTION ANGLE - M2 MIRROR: 4.4 °




PITCH - M2 MIRROR: 4.75 °
DEFLECTION ANGLE - M2 MIRROR : 9.5 °




MAX. PITCH - M2 MIRROR: 16 °
MAX. DEFLECTION ANGLE - M2 MIRROR: 32 °

⇦ Beam Direction

# ESM, MIS-STEERED SYNCHROTRON RAY TRACE, VERTICAL
SCALE: Y : Z=1: 1

| | | |
|---|---|---|
| E (SHEET SIZE) | PD-ESM-RAYT-0001 (DRAWING/PART NUMBER) | B (REVISION) |
| ESH&Q RISK LEVEL A-1 | | SHEET 11 OF 11 |