MEBT Wire Scanner Mechanical Design Review - 2/13/01

LBNL Action Items and Milestones

1. Update interface drawing to show a dimension of 9.25", rather than 7.5", from the wire scanner mounting flange to the beamline bore of the beambox.
2. Determine probable surface finish in the slot in which the wire scanner fork slides.
3. Add a stay-clear envelope around the beambox windows for laser wire hardware access.

Schedule:
April 15, 2001 – First beambox fabrication completed.
May 31, 2001 – All beamboxes completed.

BNL Action Items and Milestones

CJ Liaw – Wire Heating

1. Check numbers used for emissivity, area factor
2. Investigate carbon wire survival above 2000 C (profile measurements become less reliable due to thermionic emission – investigate only wire survival)

Chau Lac – Mechanism

1. Mechanical stiffness of long cantilevered external portion of the actuator – This thing looks not too stiff, and is sticking out pretty far from the beambox. Does it require mechanical support against incidental damage that might occur for instance from people working nearby?
2. Rotate motor 90 degrees to minimize envelope along the beamline.
3. Modify detail drawings to incorporate length increase of beambox envelope from 7.5" to 9.25". This modification to be such as to permit fork to be fully extracted for Laser Wire operation.
4. Assure that the fork cannot move (gravity, vacuum loading on bellows) when power is off.
5. Refine design of carbon wire tensioning leaf spring. Calculate thermal lengthening of wire due to beam heating, stress induced in wire due to spring deflection.
6. Generate an estimate of absolute position accuracy.
7. Verify number of ground wires required with LANL.
8. Send a 3D cad file of the mechanism to LBNL for inclusion in their MEBT model.
9. Continue development of carbon wire attachment technique.
10. Do lifetime cycle testing under vacuum.

Roger Connolly – Laser Wire

1. Bask in the glow of having accomplished an important Proof-of-Principle experiment.
2. Collaborate with Chau Lac to define the envelope for the MEBT Laser Wire.

Schedule:
May 1, 2001 – LBNL to deliver beambox to BNL.
Aug 1, 2001 – BNL to deliver first mechanism to LBNL.
Oct 1, 2001 – BNL to deliver five additional mechanisms to LBNL.

Agenda
MEBT Wire Scanner Mechanical Final Design Review

February 13, 2001, 10:00 AM – 12:00 PM PST

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1. **MEBT Wire Scanner Requirements** (10 minutes) **D. Oshatz**
   - Beam parameters
   - Wire Scanner Locations

2. **Beambox Mechanical Design** (20 minutes) **A. Zachoszcz**
   - Mechanical design
   - MEBT beamline interfaces

3. **Wire Heating Calculations** (20 minutes) **C.J. Liaw**

4. **Wire Scanner Mechanical Design** (30 minutes) **Chau Lac**
   - Wire and frame assembly
   - Actuator / feedthrough assembly

5. **Schedule / Milestones** (10 minutes)
   - Beamboxes **D. Oshatz**
   - Wire scanner assemblies **BNL**

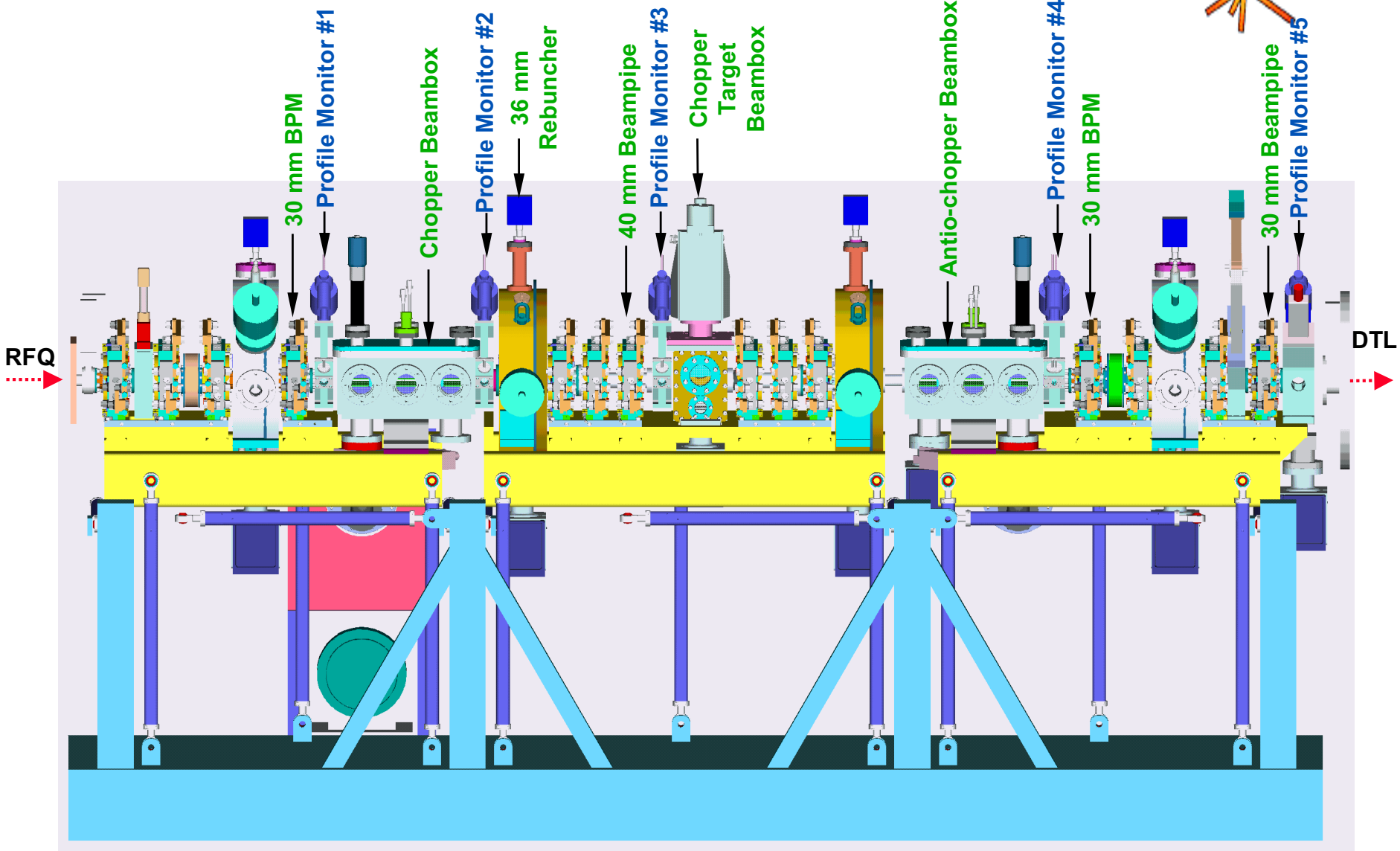
6. **Laser Wire Developments**(10 minutes)
   - Laser Wire POP experiment **R. Connolly**
   - Laser Wire interface requirements (stay-clears in MEBT)

MEBT Wire Scanner Requirements

Daryl Oshatz

February 13, 2001

MEBT Wire Scanner Locations



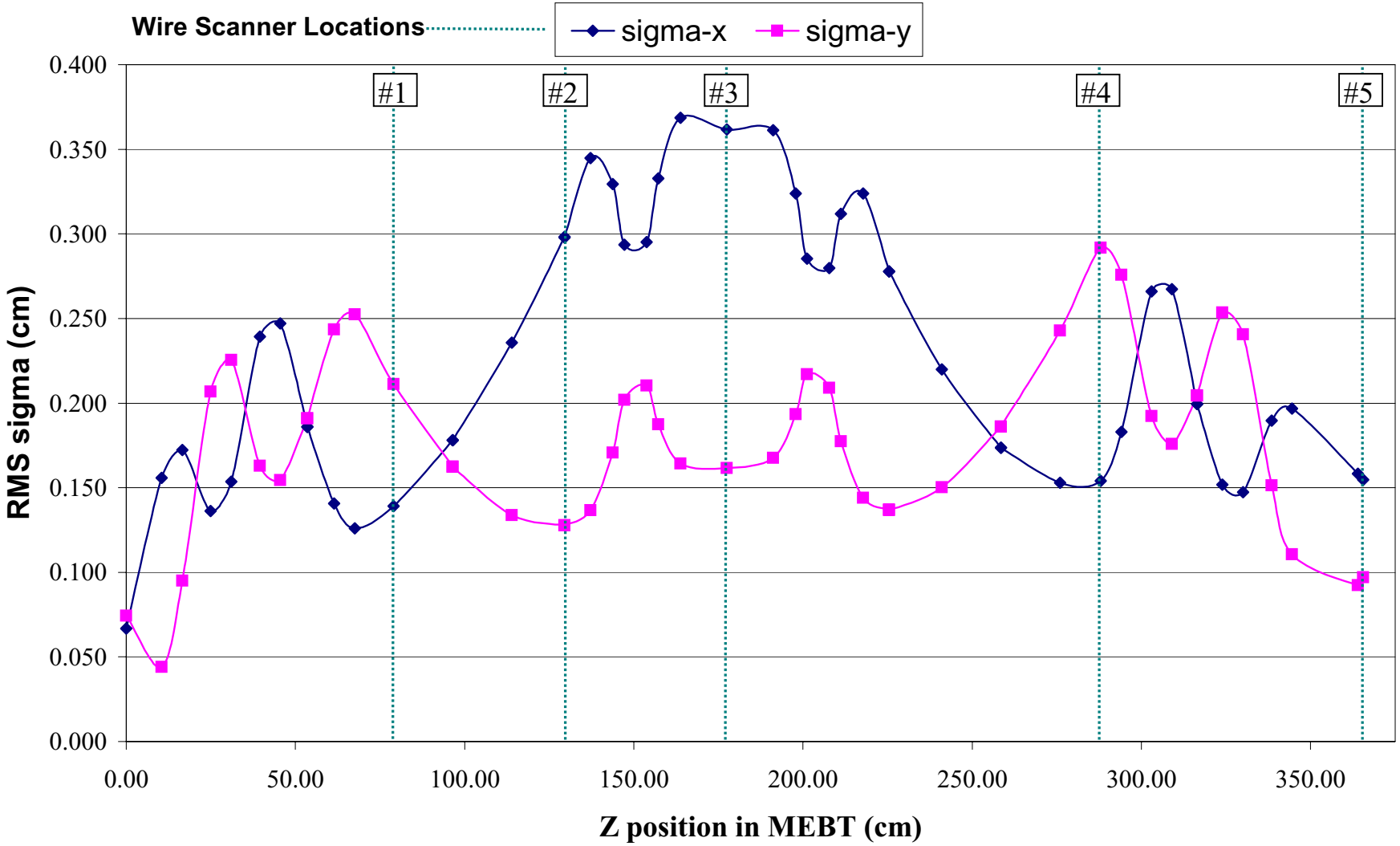
Wire Scanner Requirements

- Wire scanners will be provided in 5 locations to measure profile at low duty factor.
- Provisions will be made in the beamboxes to add on-line profile monitoring at ORNL.
- Wire scanners will be used during commissioning and for calibration of a future on-line monitoring system.

Beam Parameters at Wire Scanners

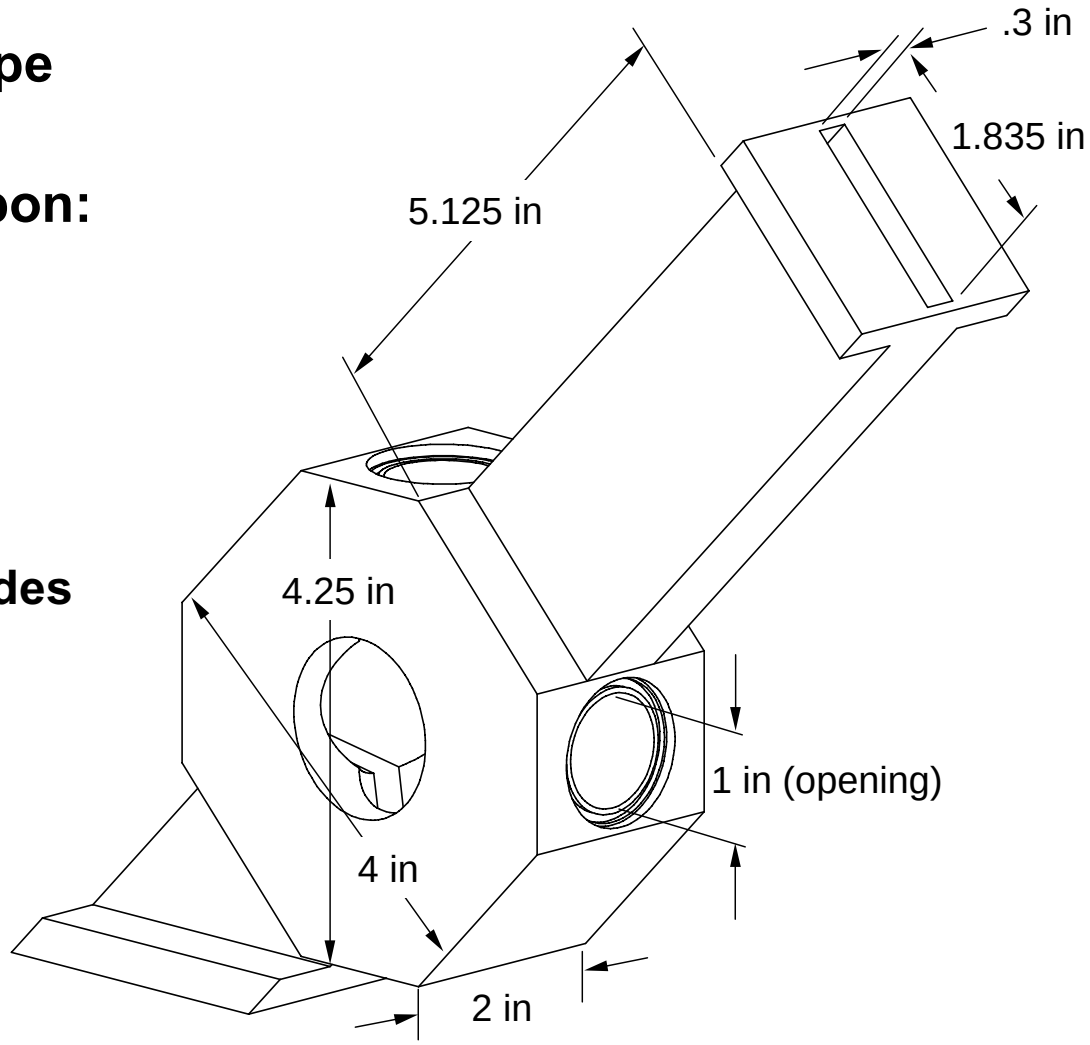
Beam Size vs. Z position

(Staples: MEBT into 7.5 MeV DTL, 10/25/00)

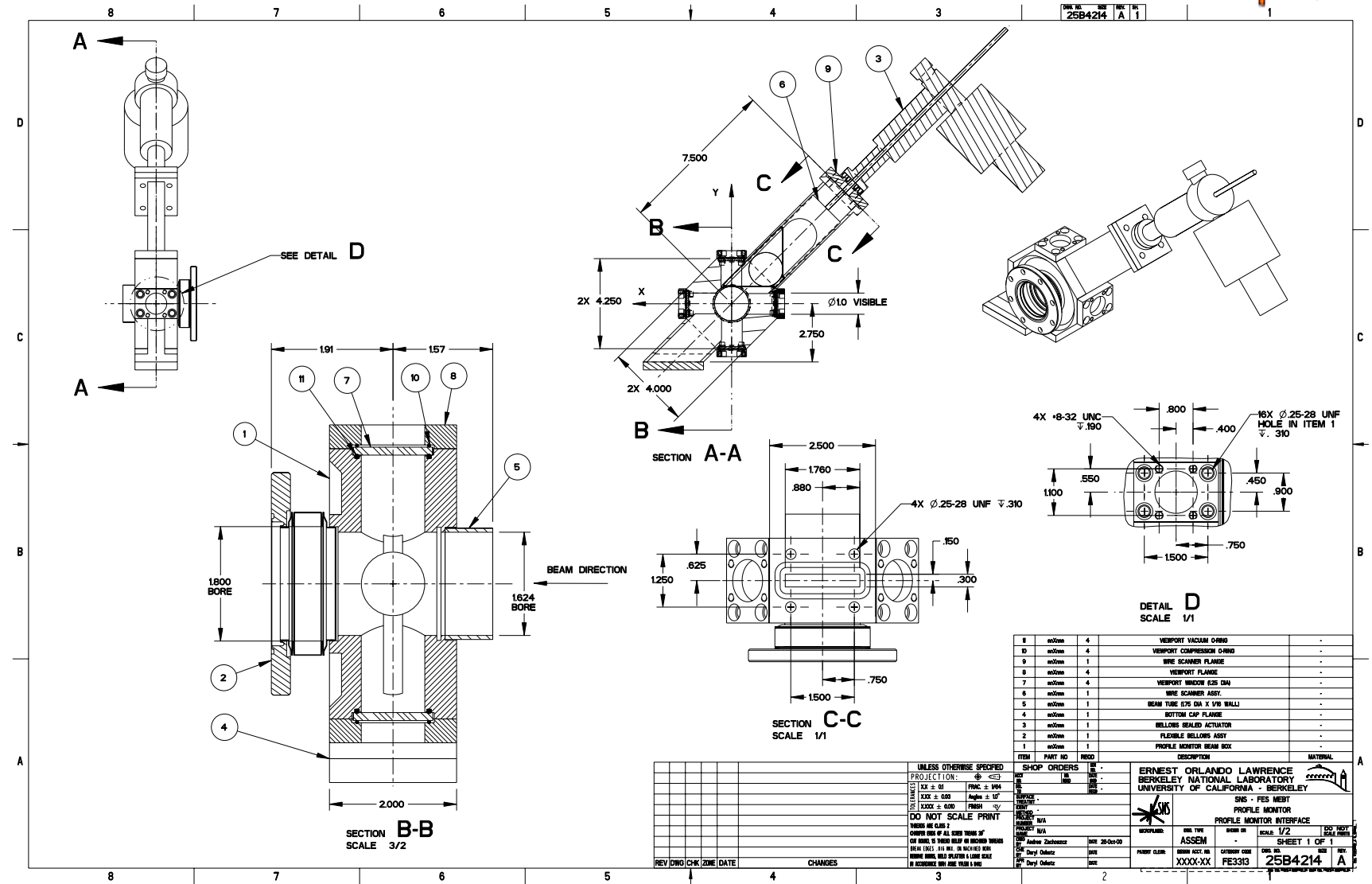


Beambox Envelope

- **A mechanical envelope has been defined.**
- **Envelope is based upon:**
  - **Space available between MEBT components.**
  - **4 cm bore wire assembly.**
  - **Windows on four sides (1 inch viewing diameter)**
  - **116 mm stroke.**



Interface Drawing October 2000

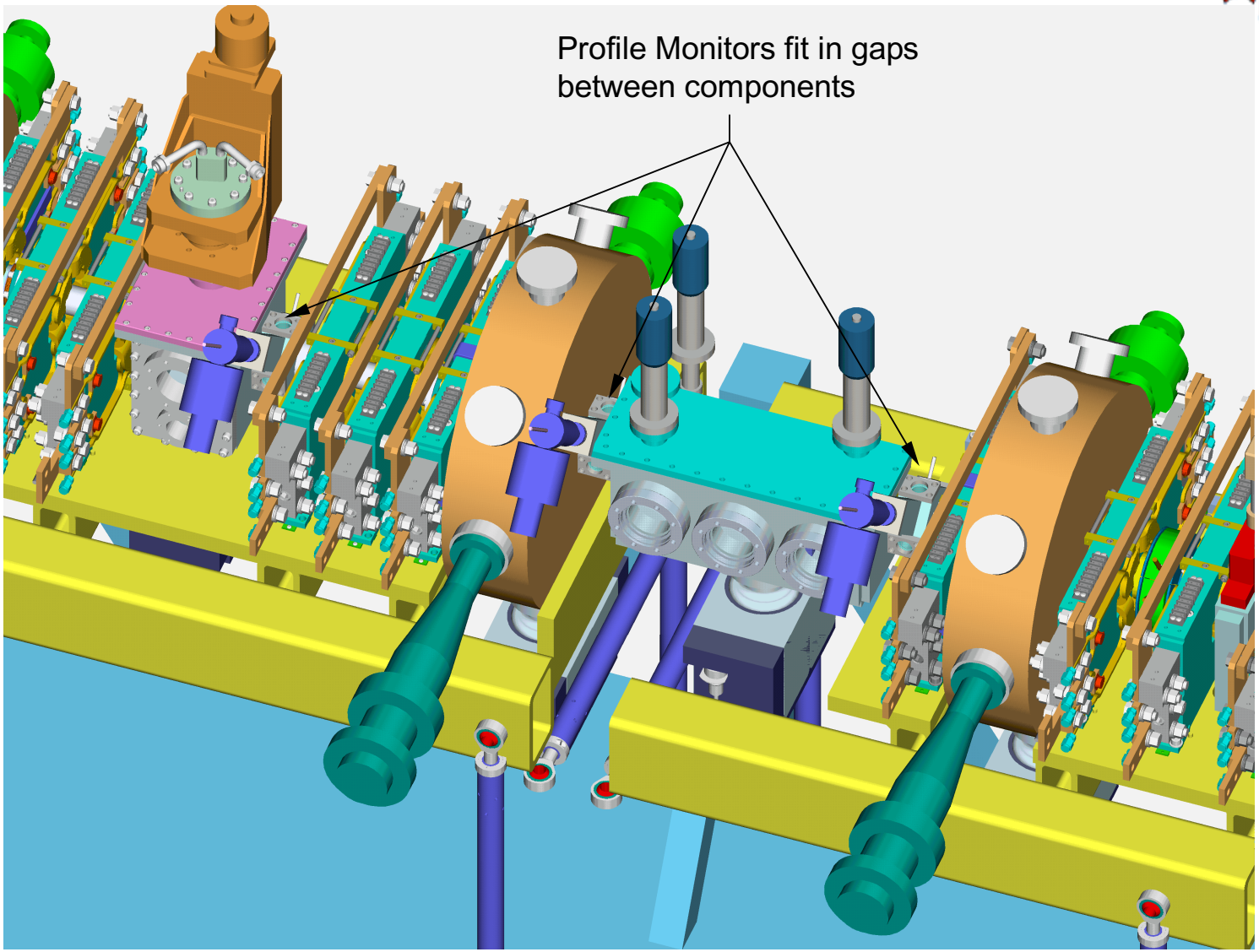


Beambox Mechanical Design

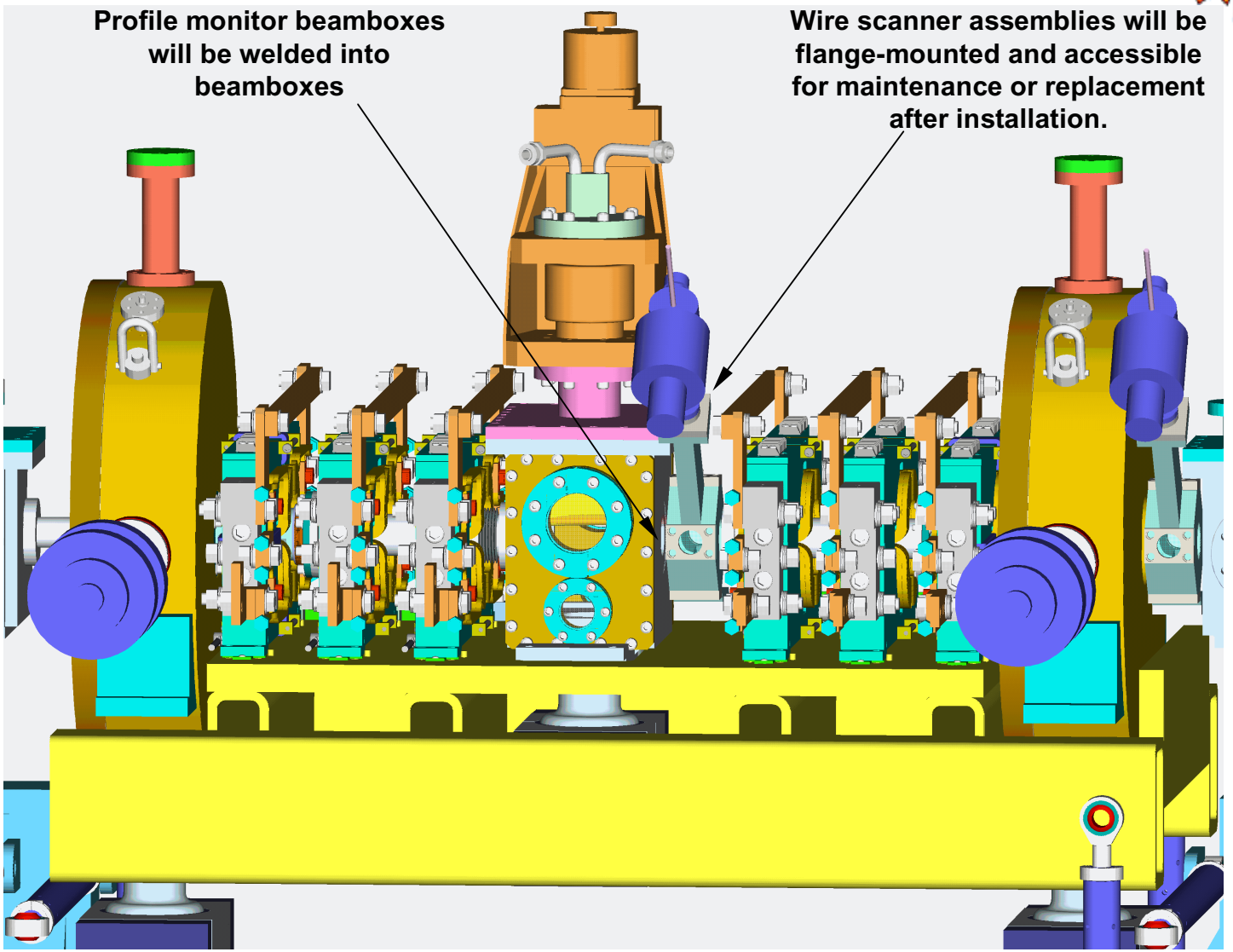
A. Zachoszcz

February 13, 2001

Profile Monitor Interfaces



Profile Monitor Accessibility



DWG. NO.	SIZE	REV.	SH.
25B4374	A	1	

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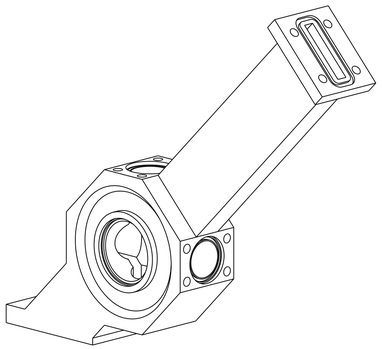
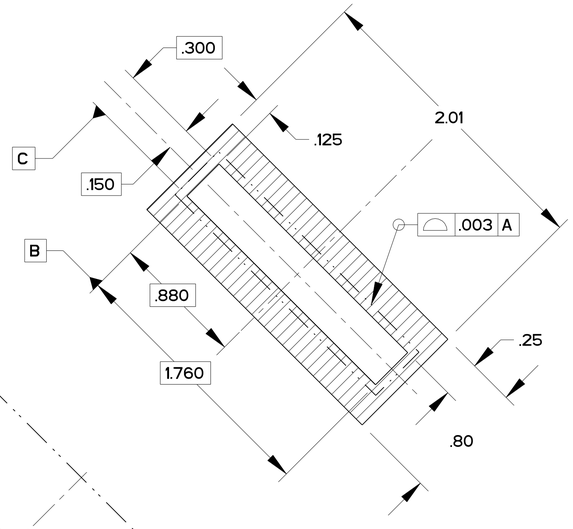
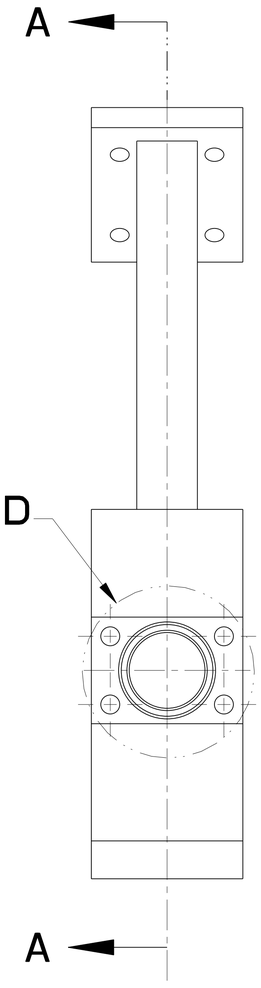
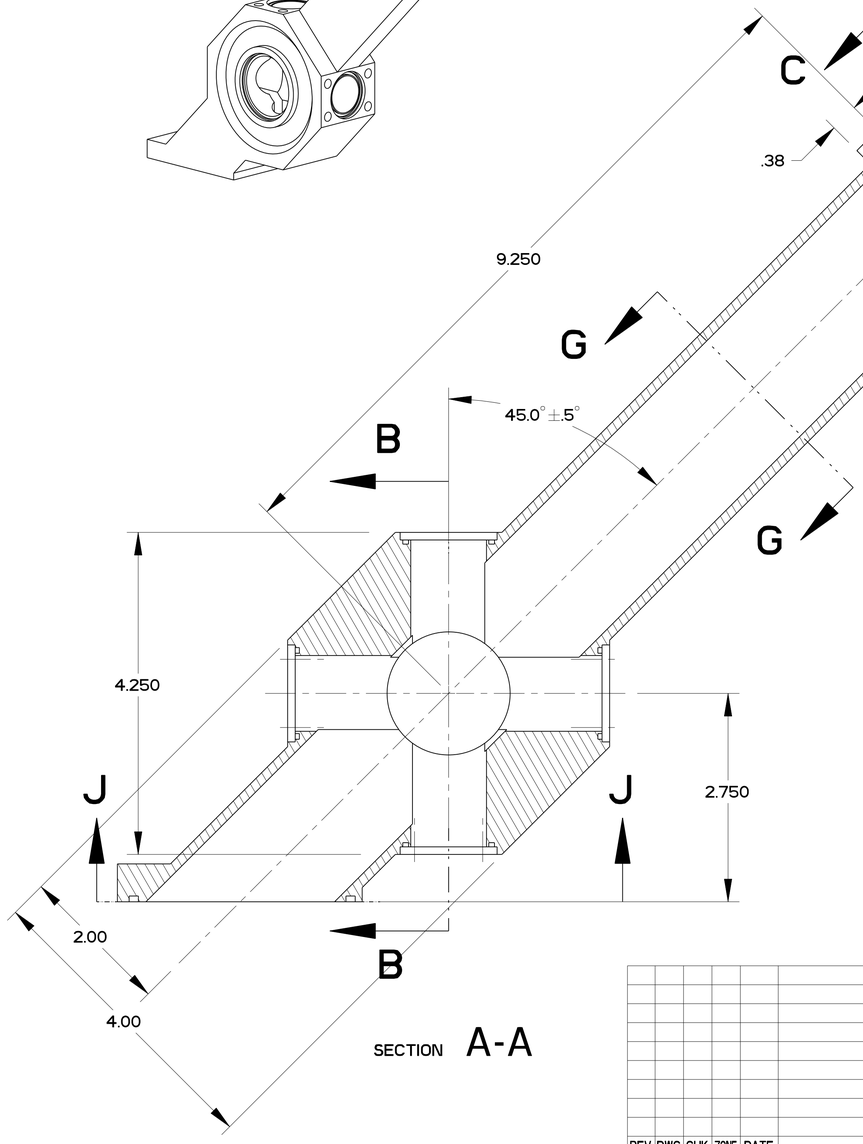


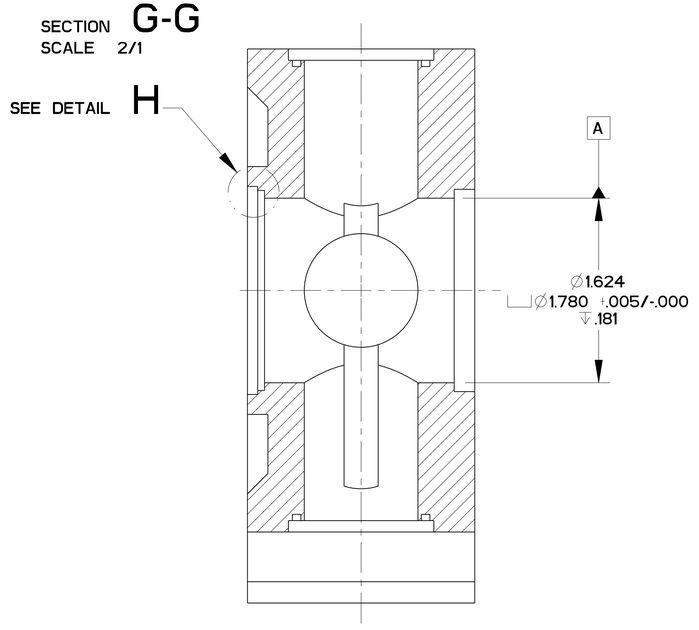






SECTION A-A

SECTION G-G
SCALE 2/1



SECTION B-B
SCALE 3/2

REV	DWG	CHK	ZONE	DATE	CHANGES

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PROJECTION:
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DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 15 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .06 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS
ACCT NO. | NO. REQD | SER NO. -
DEL TO | DATE ISSD - | DATE RECD -
SURFACE TREATMT -
IDENT METHOD TAG
PROJECT NUMBER N/A
PROJECT NAME N/A
DWG BY A. ZACHOSZCZ | DATE 29-Jan-01
CHK BY - | DATE
APR BY D. OSHATZ | DATE

2" PLATE	316L PRODEC	-
DESCRIPTION	MATERIAL	MAT. LOCATION

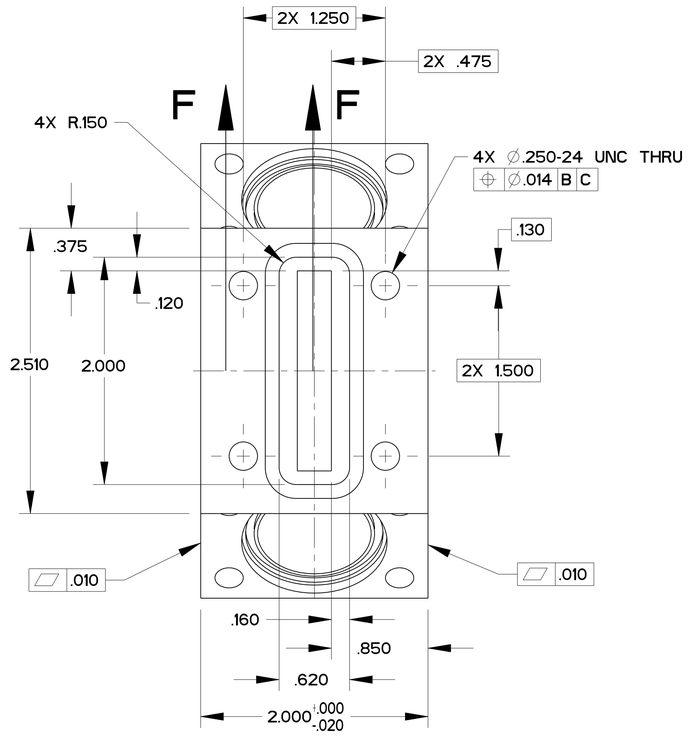
ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS - FES MEBT
BEAM TRANSPORT SYSTEMS
40 MM PROFILE MONITOR BEAMBOX

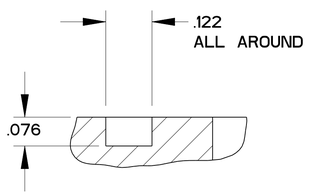
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 1/1	DO NOT SCALE PRINTS
	PART	-	SHEET 1 OF 2	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B4374	A

Dwg. File: PROFILE_MONITOR.FAB Model File: PROFILE_SCANNER

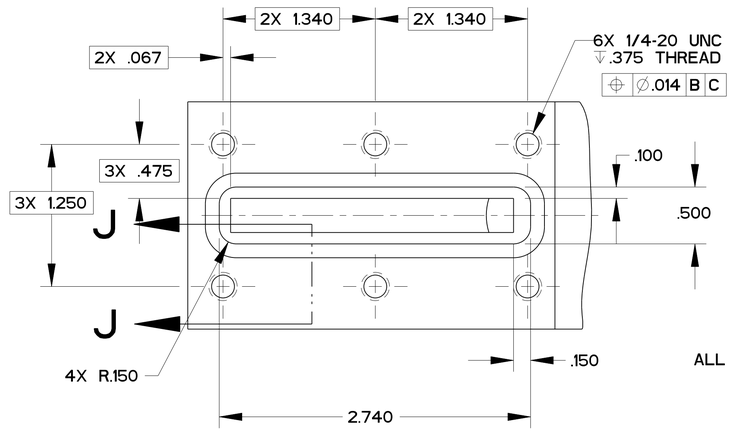
NOT RELEASED FOR FABRICATION



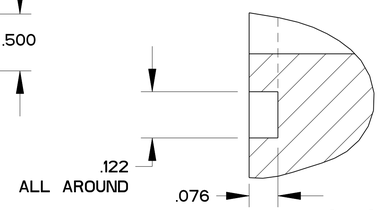
VIEW C-C
SCALE 3/2



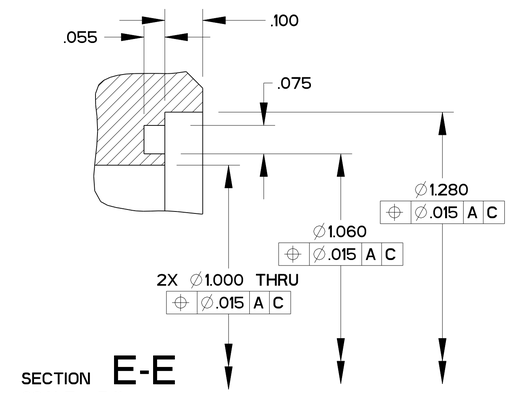
SECTION F-F
SCALE 5/1



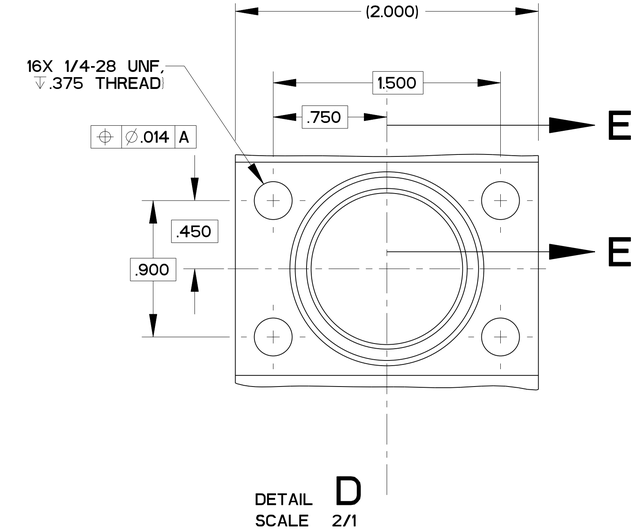
VIEW J-J
SCALE 3/2



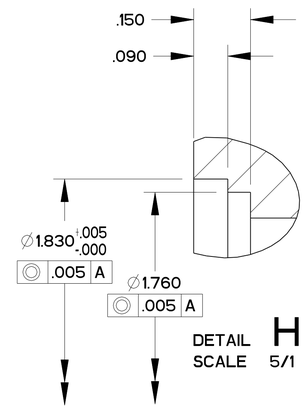
SECTION J-J
SCALE 5/1



SECTION E-E
SCALE 5/1



DETAIL D
SCALE 2/1



DETAIL H
SCALE 5/1

REV	DWG	CHK	ZONE	DATE	CHANGES

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 1.0° | X.XXX ± 0.005 | FINISH
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 15 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS
ACCT NO. | NO. | SER NO. -
REQD | DATE ISSD -
DEL TO | DATE REQD -
SURFACE TREATMT -
IDENT METHOD TAG
PROJECT NUMBER N/A
PROJECT NAME N/A
DWG BY A. ZACHOSZCZ | DATE 08-Feb-01
CHK BY - | DATE
APR BY D. OSHATZ | DATE

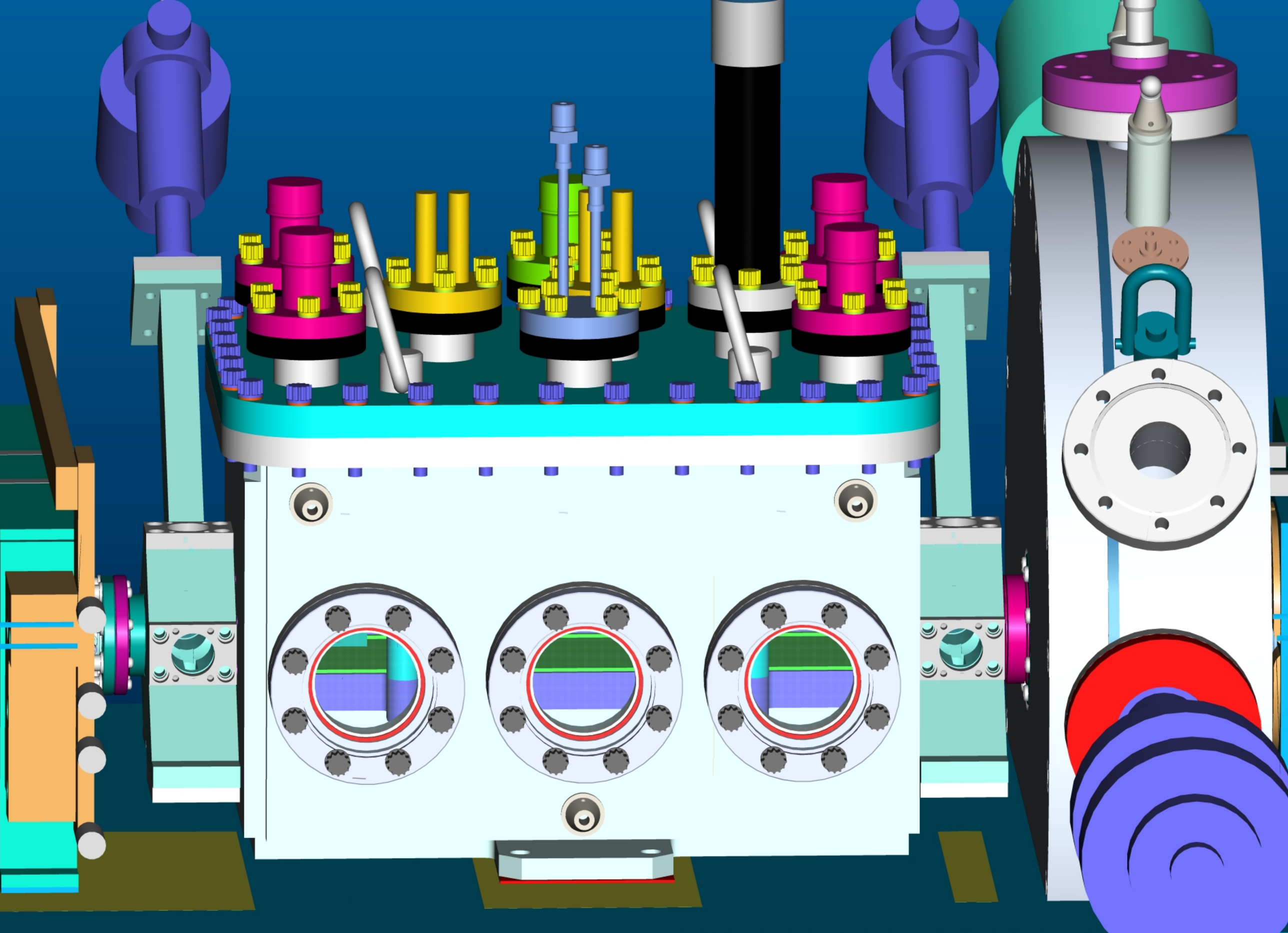
2" PLATE	316L PRODEC	-
DESCRIPTION	MATERIAL	MAT. LOCATION

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS - FES MEBT
BEAM TRANSPORT SYSTEMS
40 MM PROFILE MONITOR BEAMBOX

MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 3/4	DO NOT SCALE PRINTS
	PART	-	SHEET 2 OF 2	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B4374	A

Dwg. File: PROFILE MONITOR FAB Model File: PROFILE SCANNER



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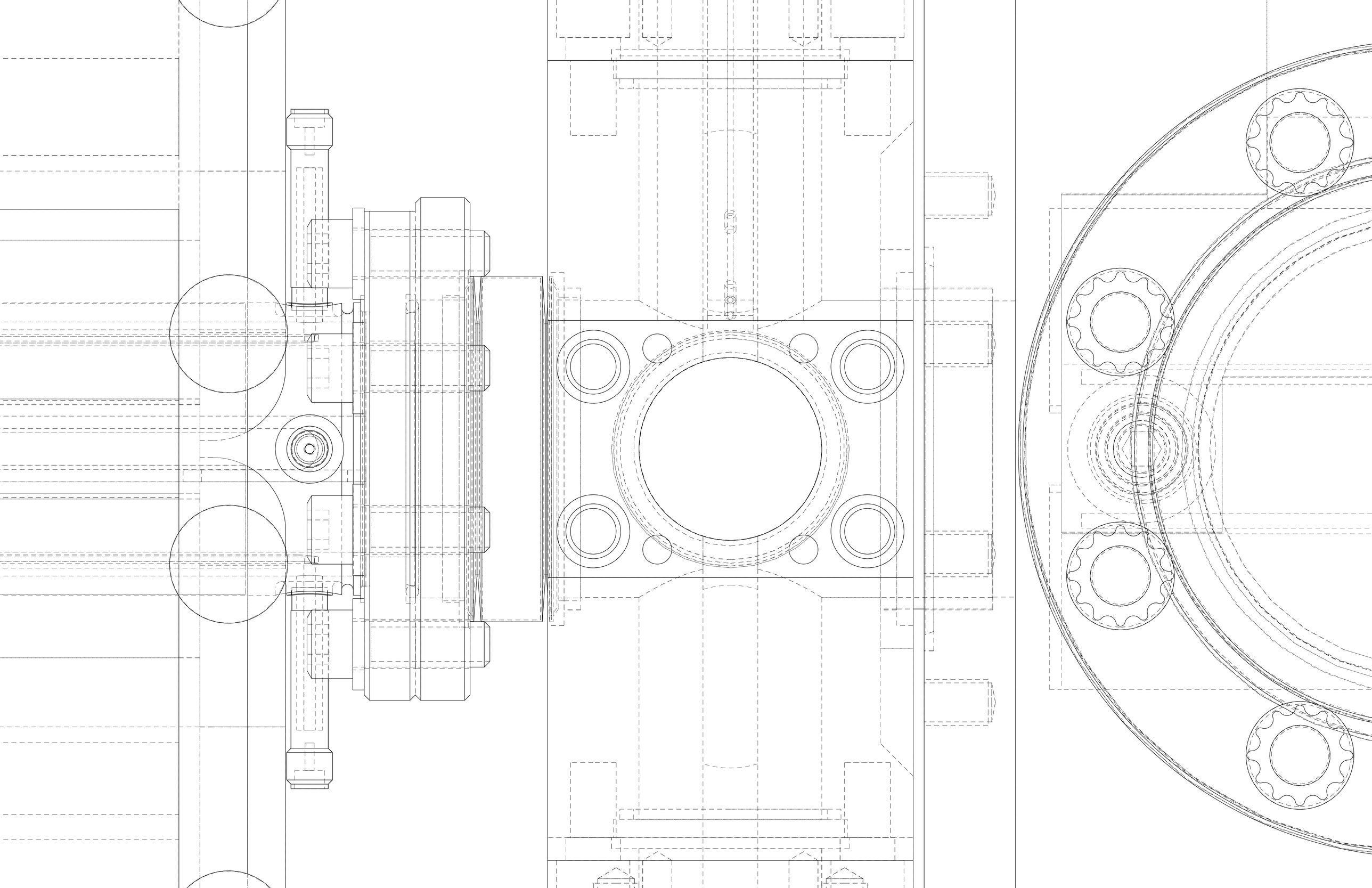
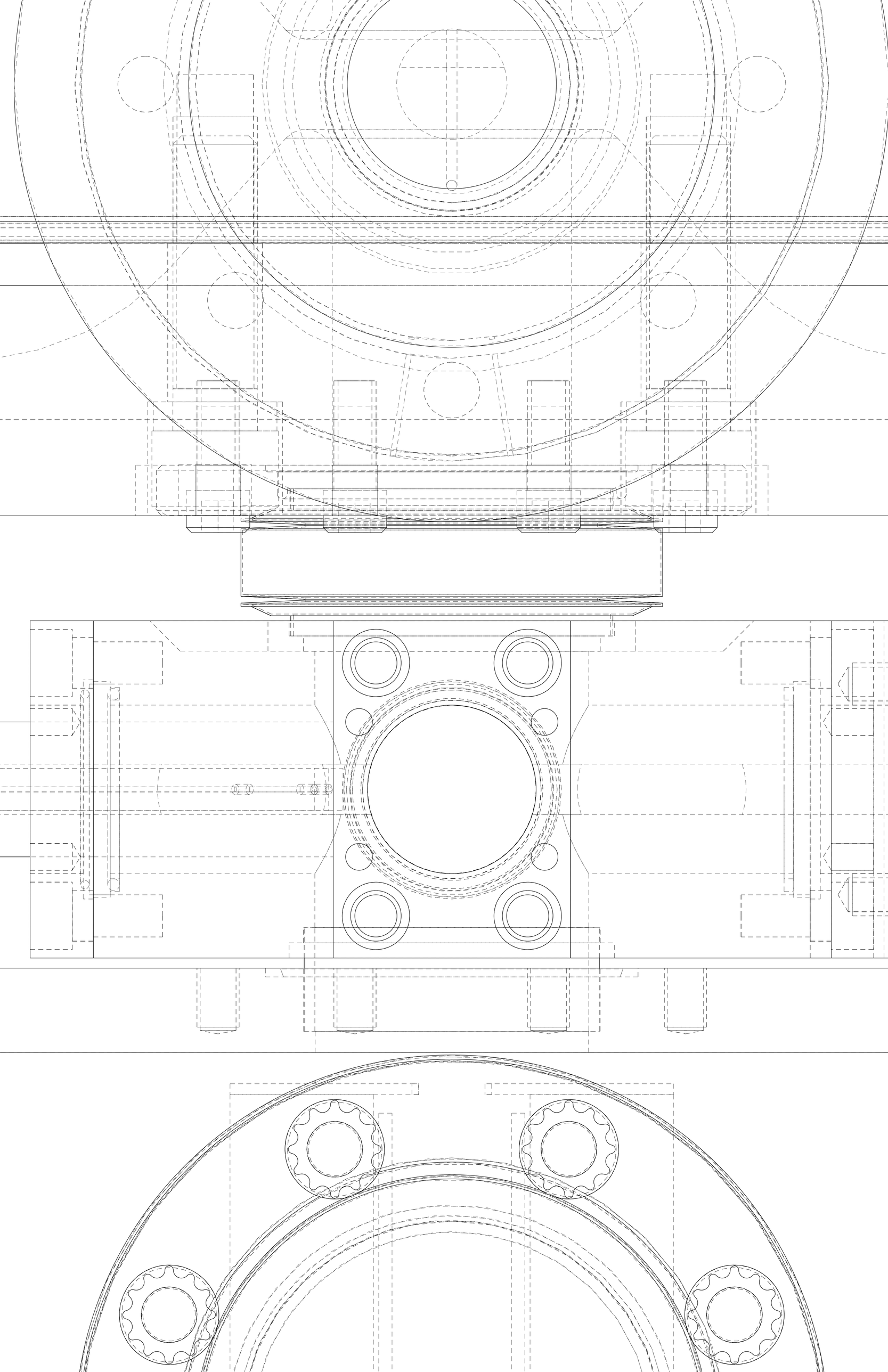
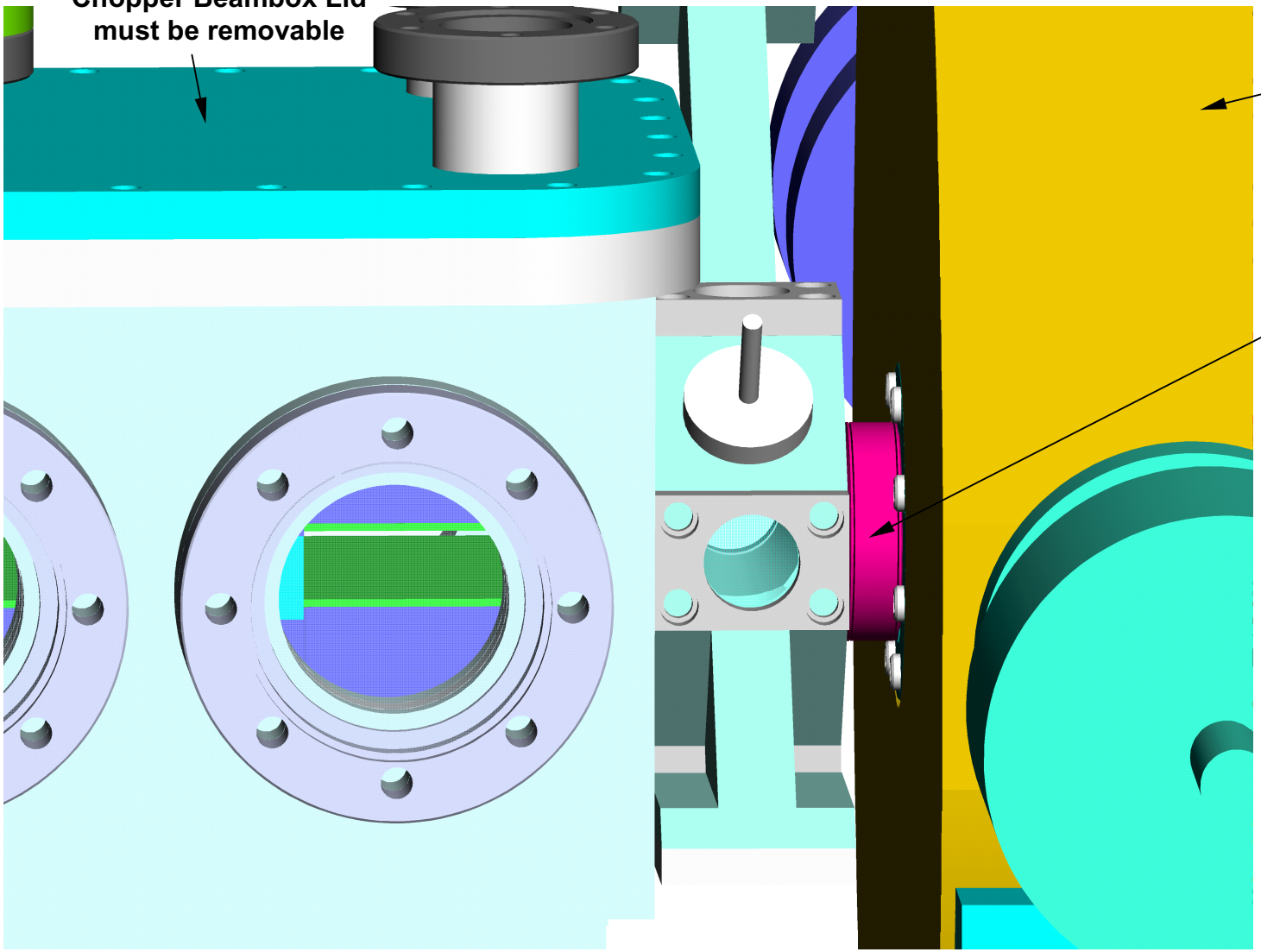
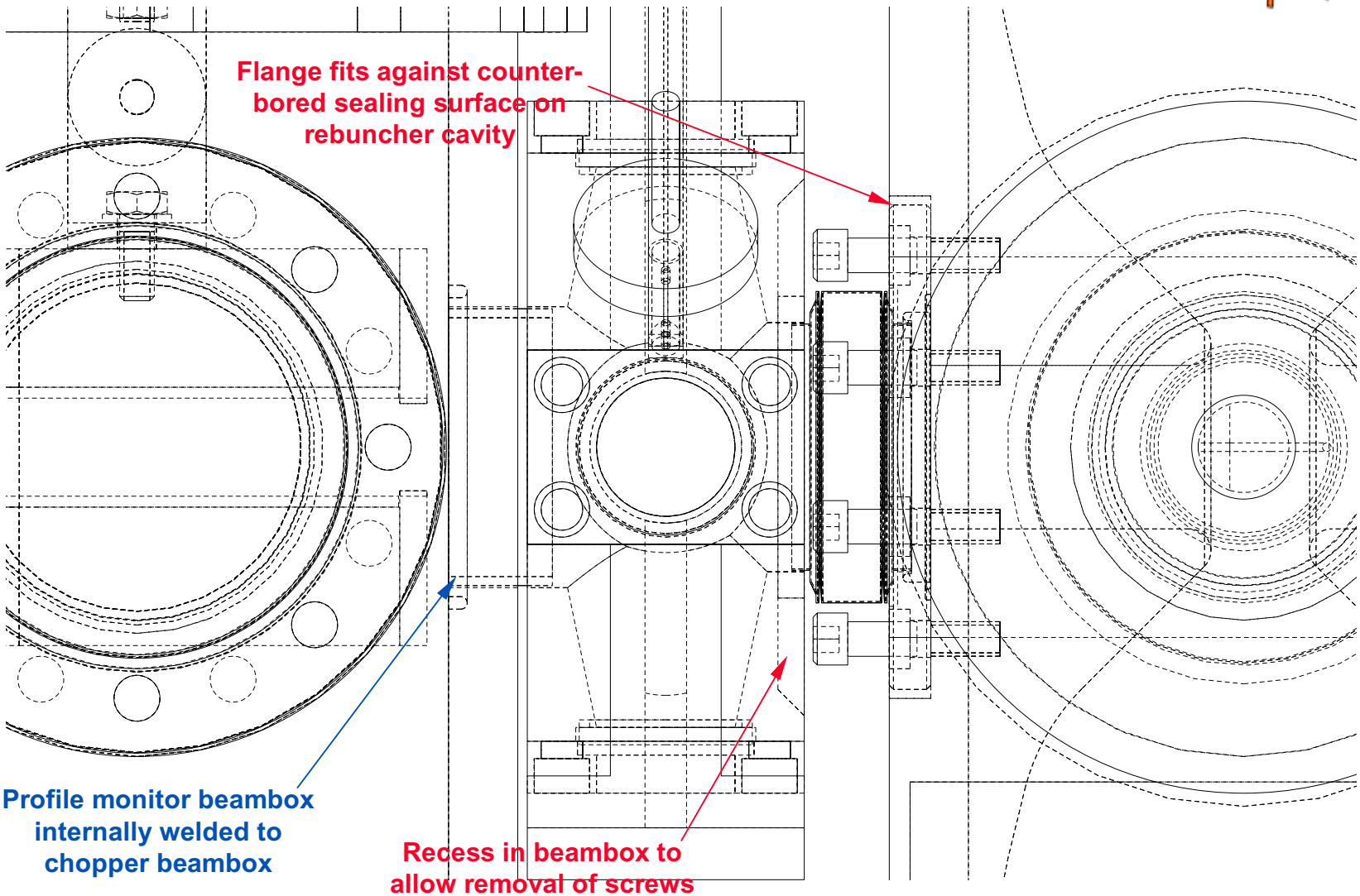


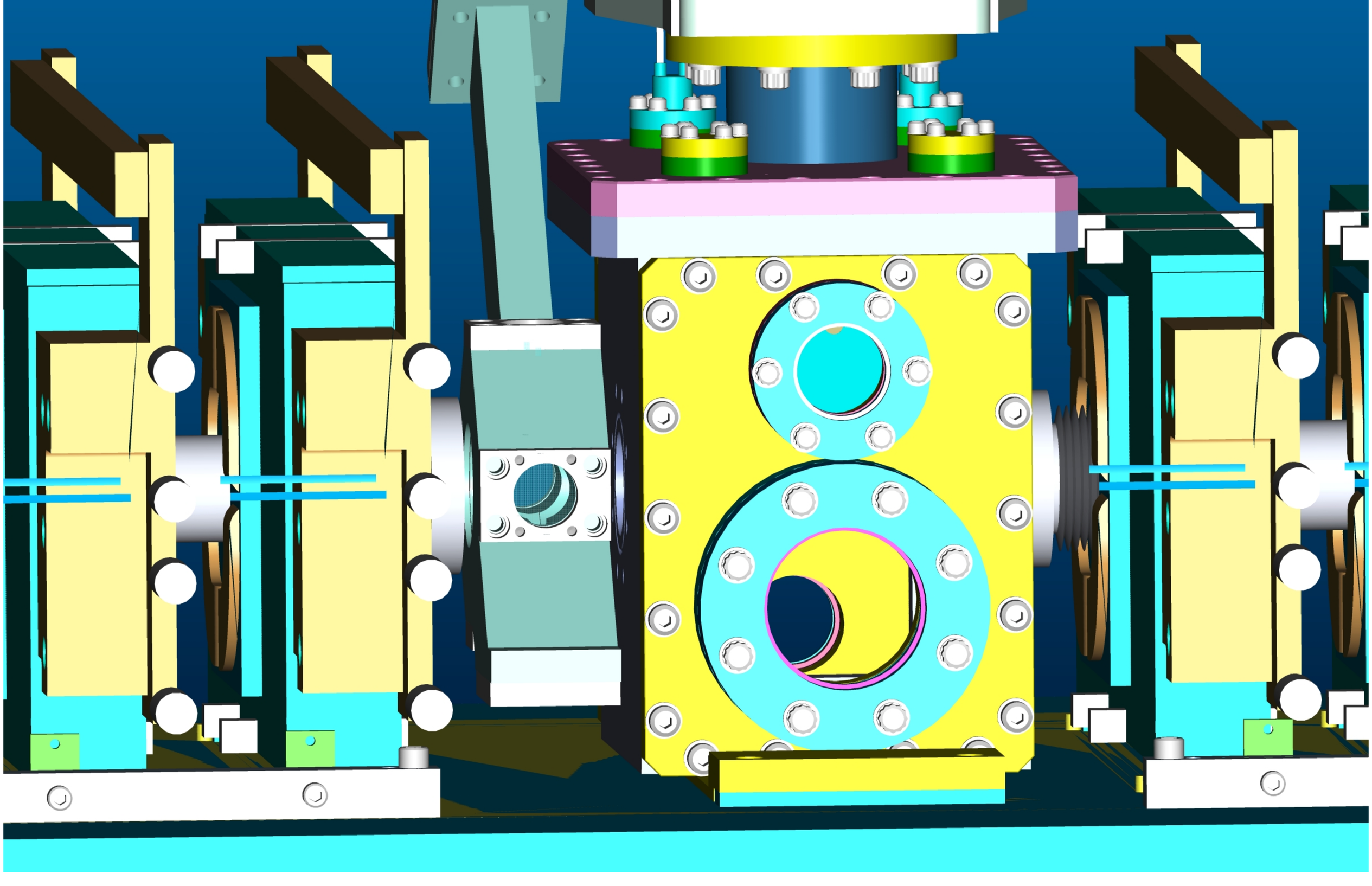


Profile Monitor #2 Interface



Detail of Flange Interface





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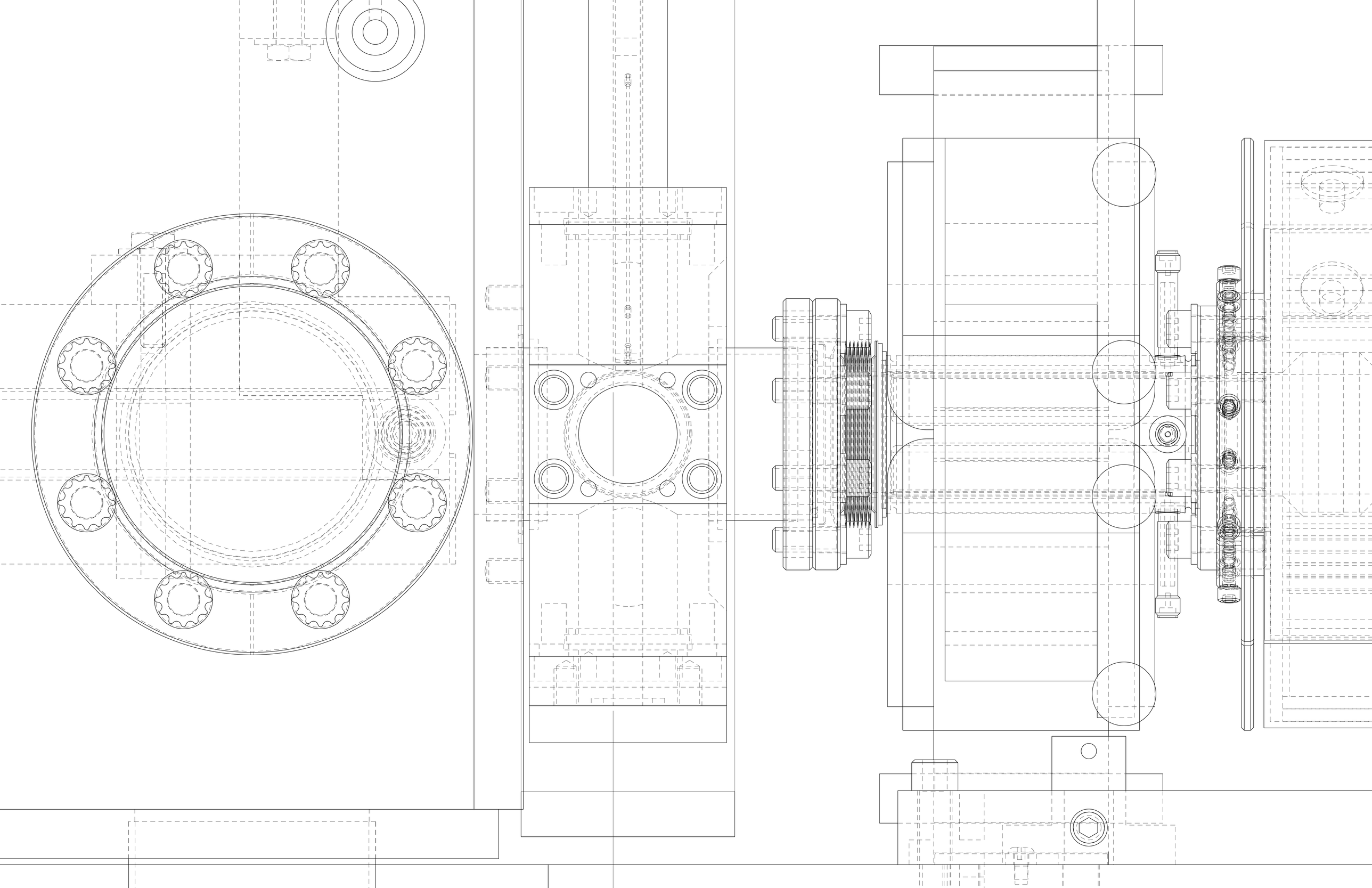


Carbon Wire Heating due to Scattering in the SNS Injection Line

By

C. J. Liaw, BNL

February 13, 2001

Assumptions

H^- beam

K.E.: 2.5 MeV (MEBT) ~ 1.3 GeV(HEBT)

Beam profile: 2-D Gaussian distributed

Assumptions

Carbon wire

Size: 33 μm dia.

Stationary at the center of the beam

Assumptions

Possible wire heating scenarios

Beam currents: 16 mA and 36 mA

Repetition rate and pulse length:

- 60 Hz,1 ms long
- 6 Hz, 1 ms long
- 6 Hz, 50 μs long

Assumptions

<u>Radiative cooling is the only cooling mechanism</u>.

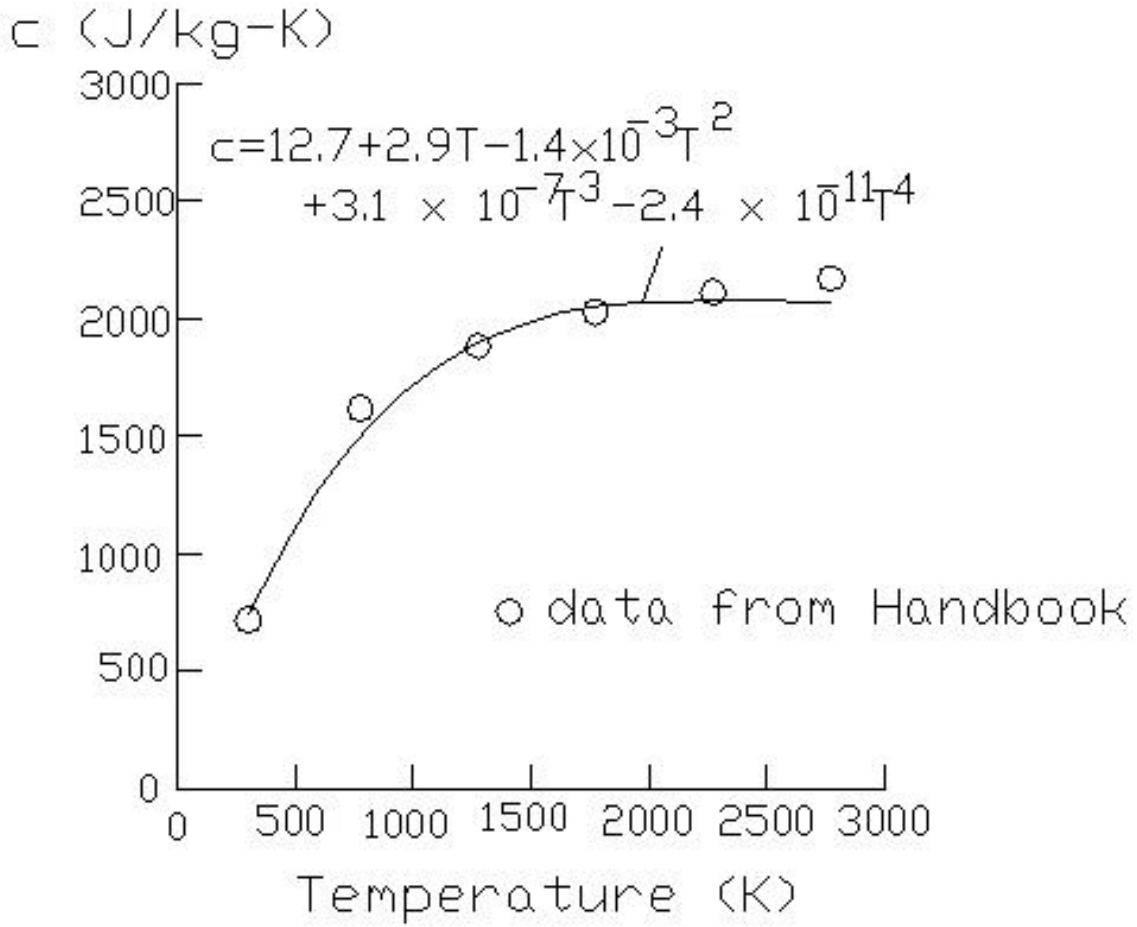
<u>Thermal properties of carbon</u>:

Density = 2000 kg/m^3

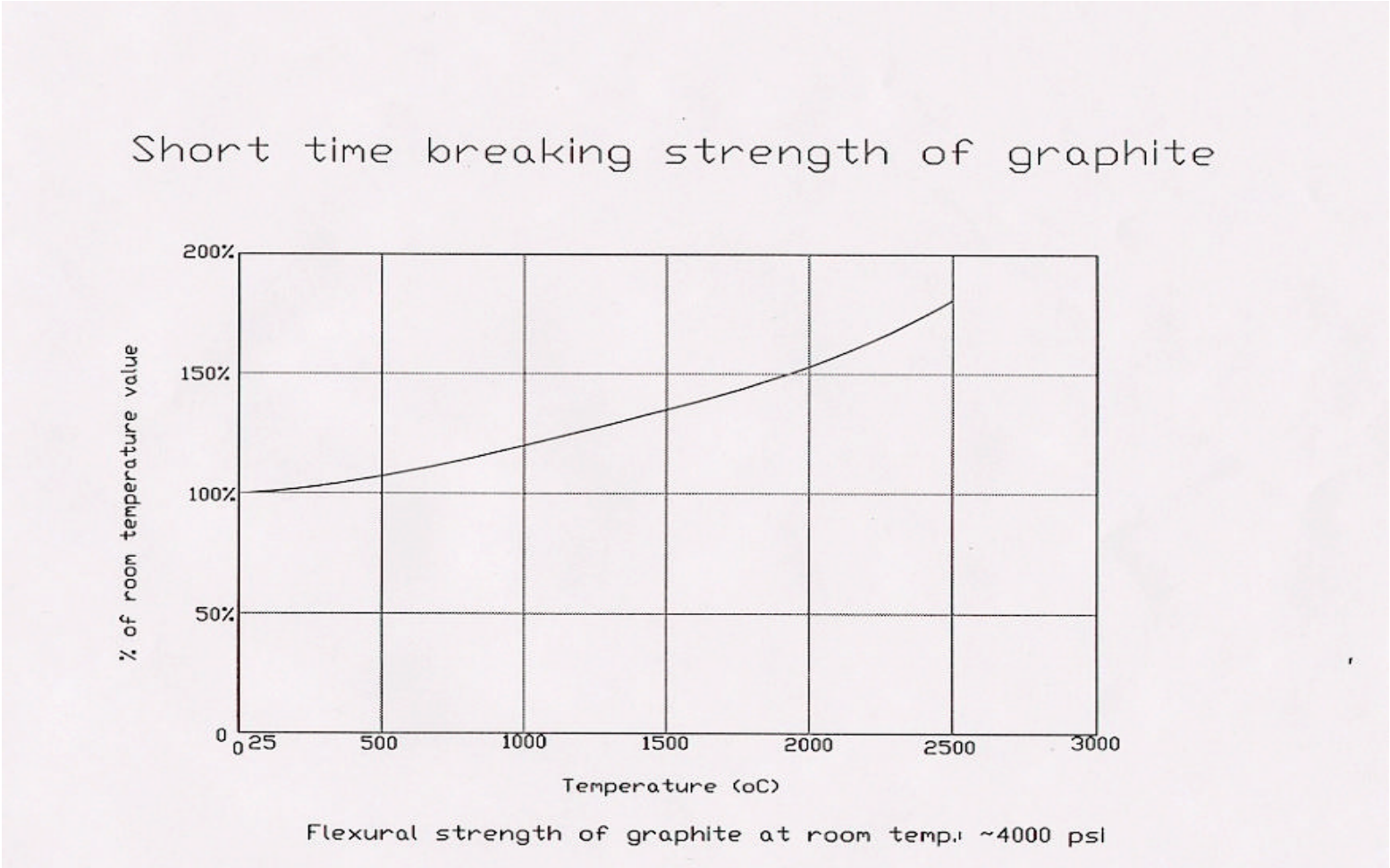
Radiant emissivity = 0.8

Heat capacity (temperature dependent)

Carbon Heat Capacity



Strength of Graphite (from Material Handbook)



Energy Loss due to Scattering of H- Beam through Carbon Wire

$$\mathbf{P = (1/\rho)(dE/dx)_{proton} I\ \rho x + P_{electron}[watts/m^2]}$$

where P = power/area [watts/m^2]

P_e = power to stop an electron beam [eV]

$P_{electron} = 2/\rho(dE/dx)_{electron} I\ \rho x \quad (1/\rho(dE/dx)_{electron} * x < P_e)$

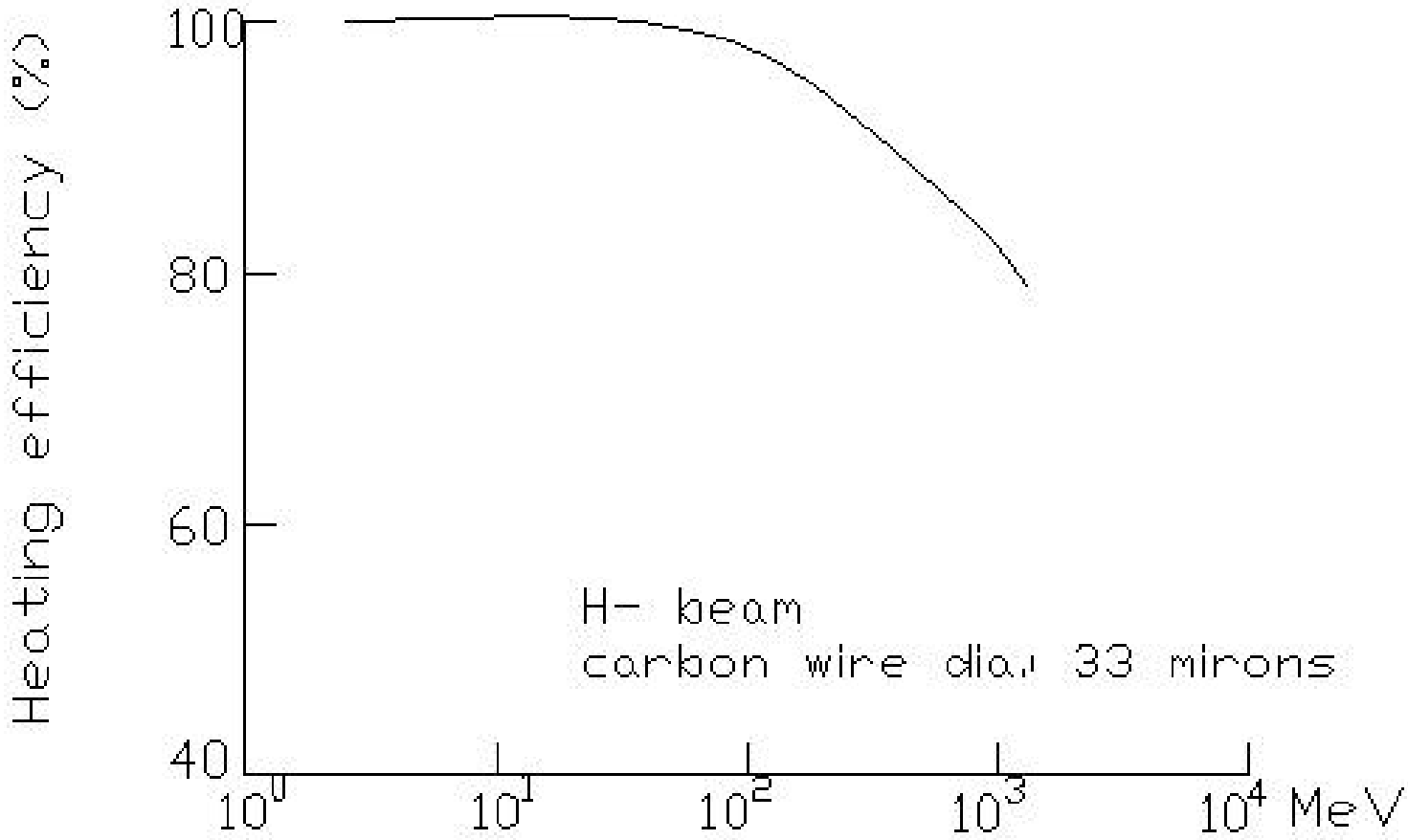
or $= 2\ P_e * I \quad (1/\rho(dE/dx)_{electron} * x > P_e)$

$(1/\rho)dE/dx$ = beam energy loss through the carbon wire [MeV/g/cm^2]

I = beam current density [A/m^2]

x = mean wire thickness [m] = $\pi d/4$

Heating Efficiency



Governing Equation

$$dT/dt = 4(\rho d c)(P_{h\text{-}p} s e)(T^4 - T_0^4))$$

where T = wire temperature [K]

T_o = beam pipe temperature = 297 [K]

d = diameter of the wire [m]

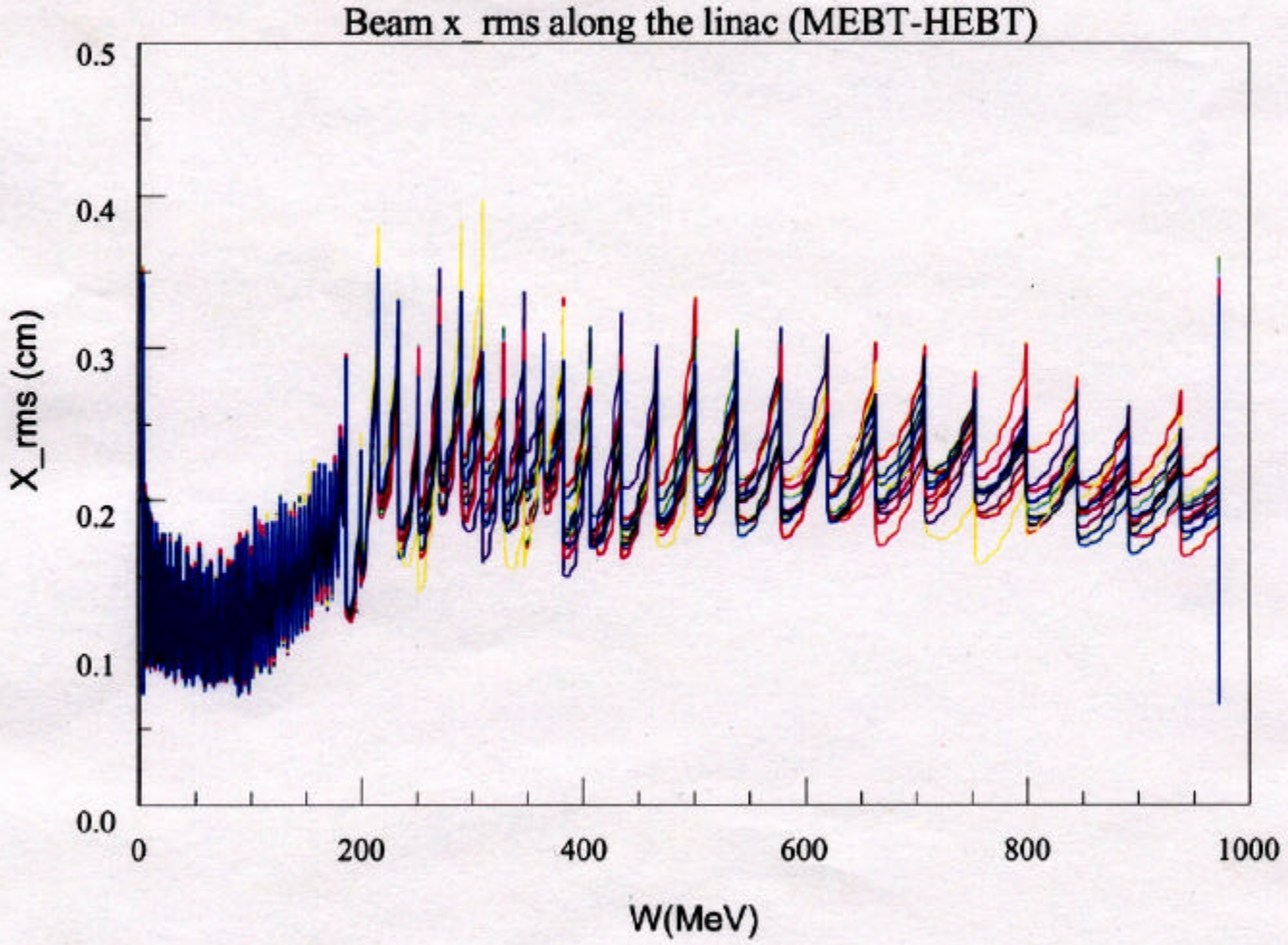
t = time [sec]

η = heating efficiency

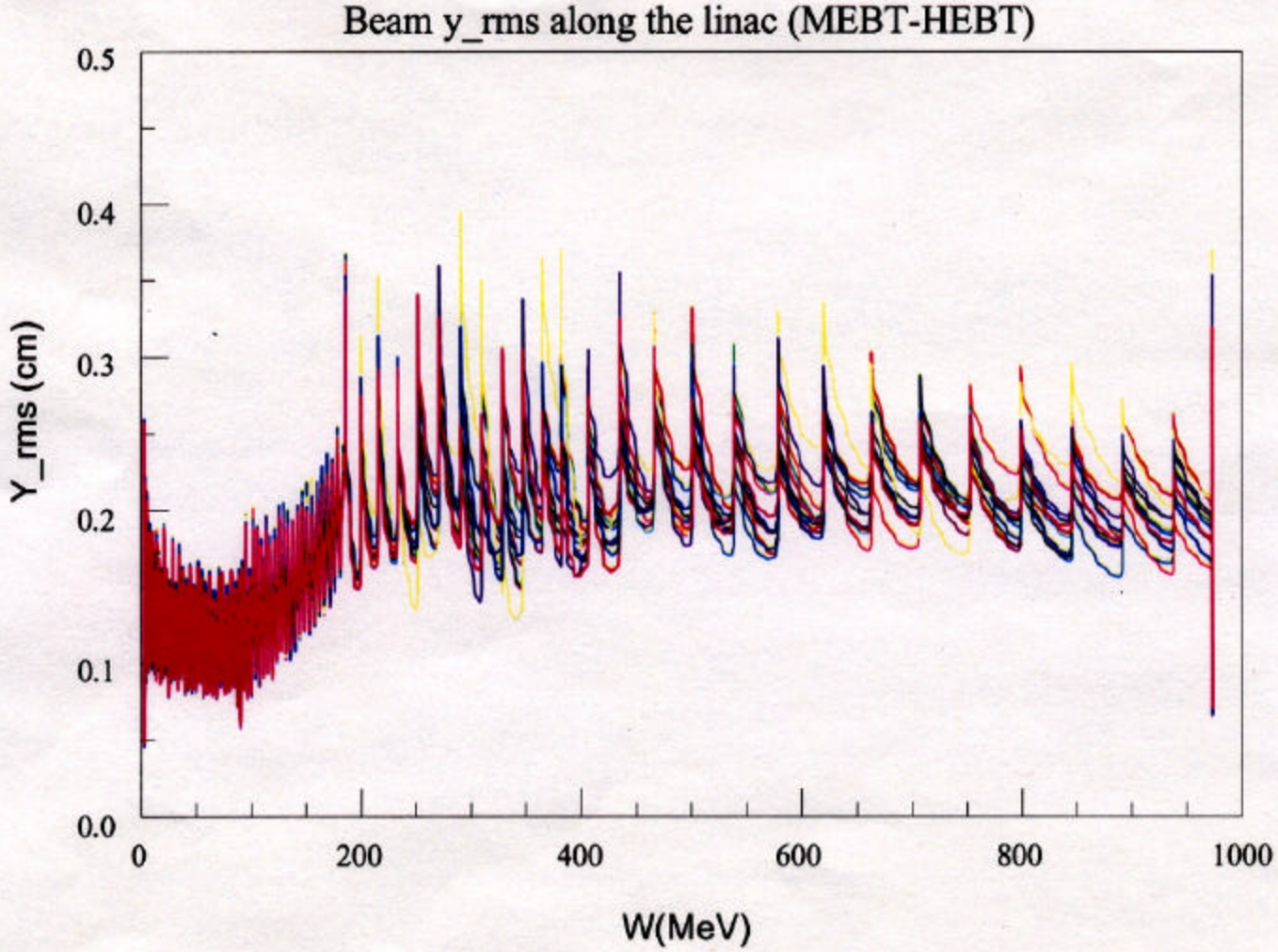
σ = Stefan Boltzmann constant = 5.67×10^{-8} [W/m^2K^4]

ρ, ε, c, and P are defined above.

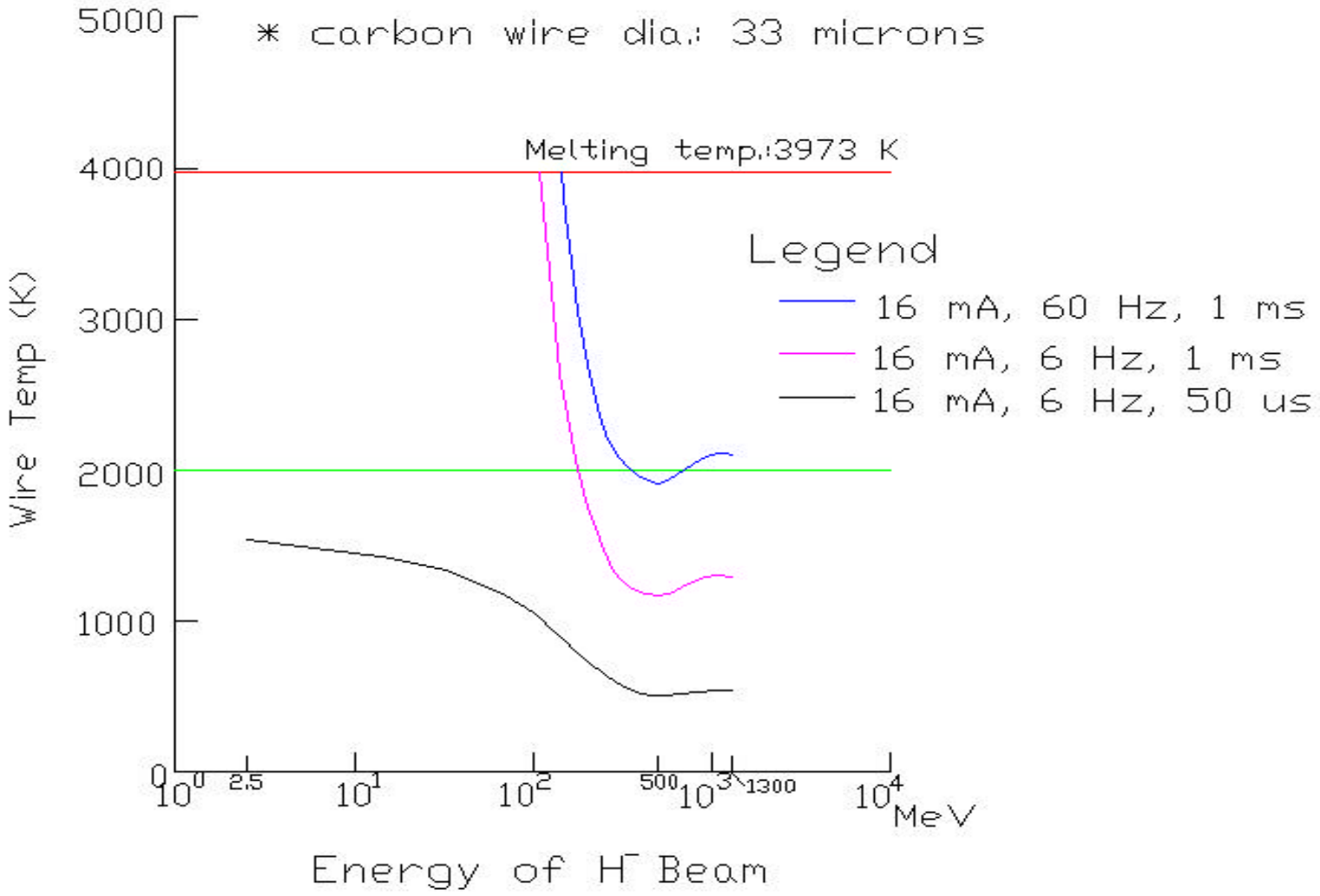
X_{rms} Profiles for 10 runs With Errors



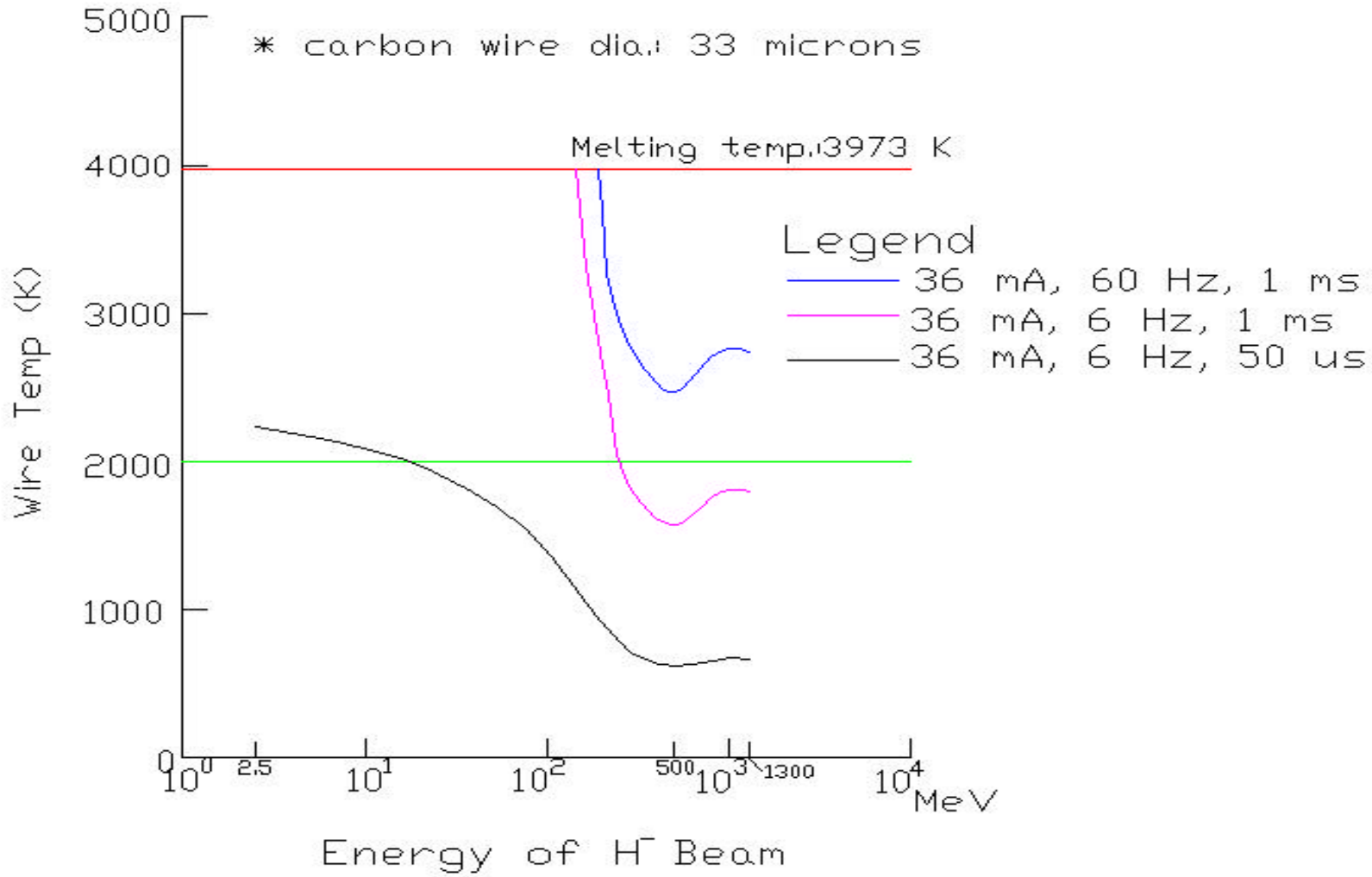
Y_{rms} Profiles for 10 runs With Errors



Wire Temperature vs. Beam Energy (1)



Wire Temperature vs. Beam Energy (2)

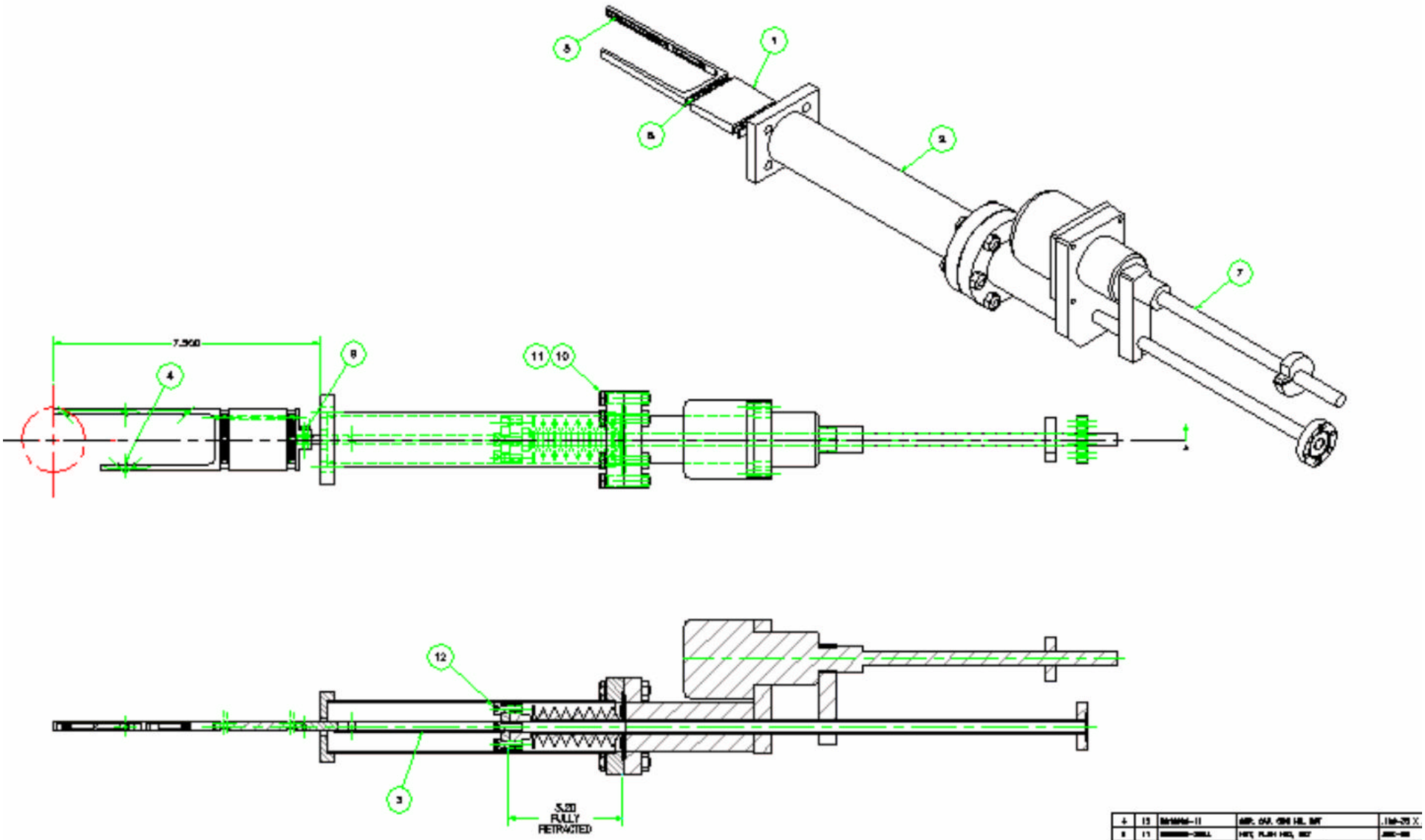


MEBT Wire Scanner Mechanical Design

By

Chau M. Lac, BNL

February 13, 2001

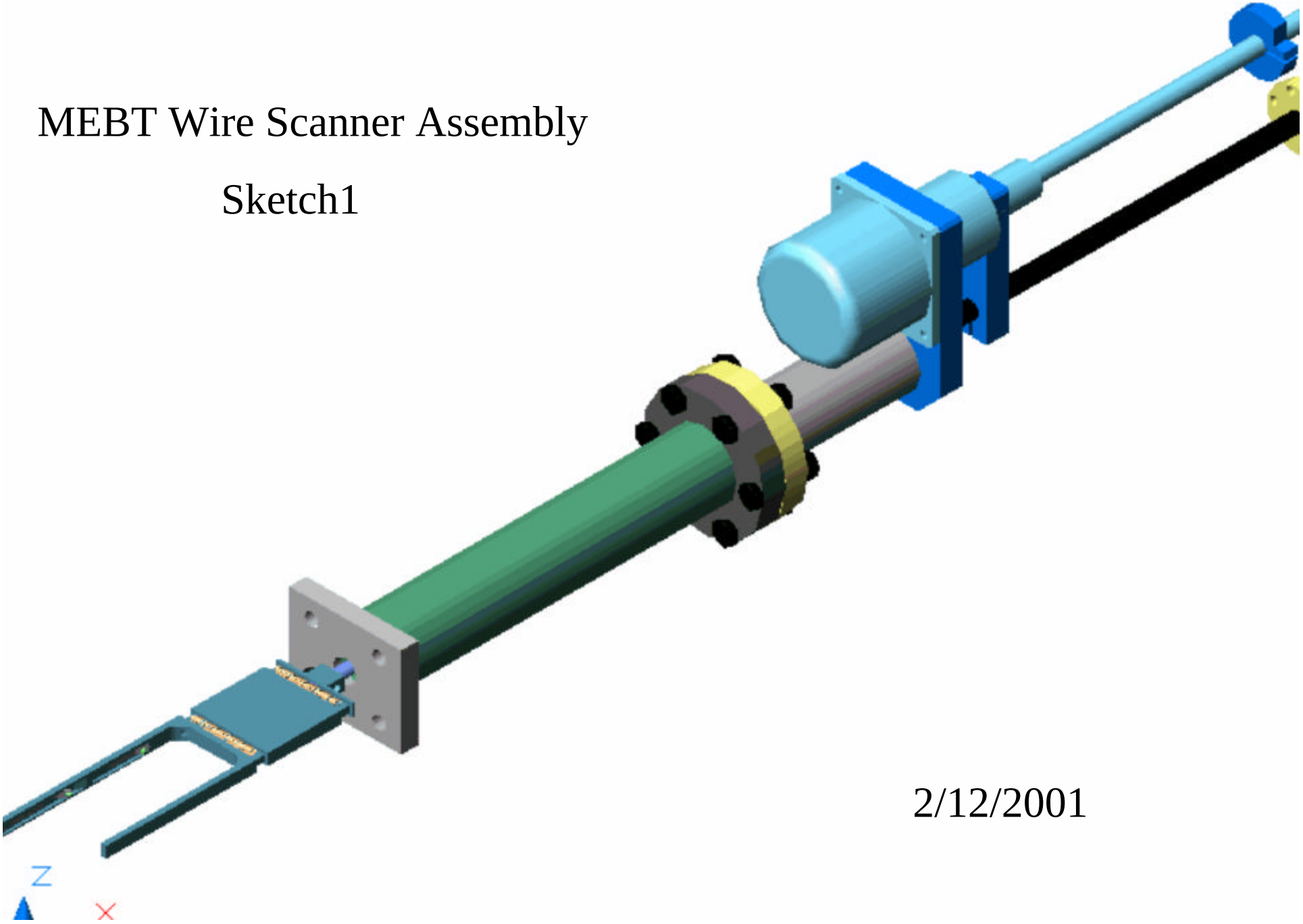


QTY	ITEM	PART NO.	DESCRIPTION	REMARKS
1	1		FORK	
1	2		YELLOWJET BRACKET	
1	3		YELLOWJET, EXT ROD	
1	4		PRESARS, TAPE	
3	5		PRESARS, TAPE	
1	6		PRESARS, TAPE	
1	7	L-2204-5-1	RECTANGULAR BOSSED	
1	8		SPACER	
1	9		SPACER	
1	10		SPACER	
1	11		HEX. SOC. HD. SET	
1	12		HEX. SOC. HD. SET	

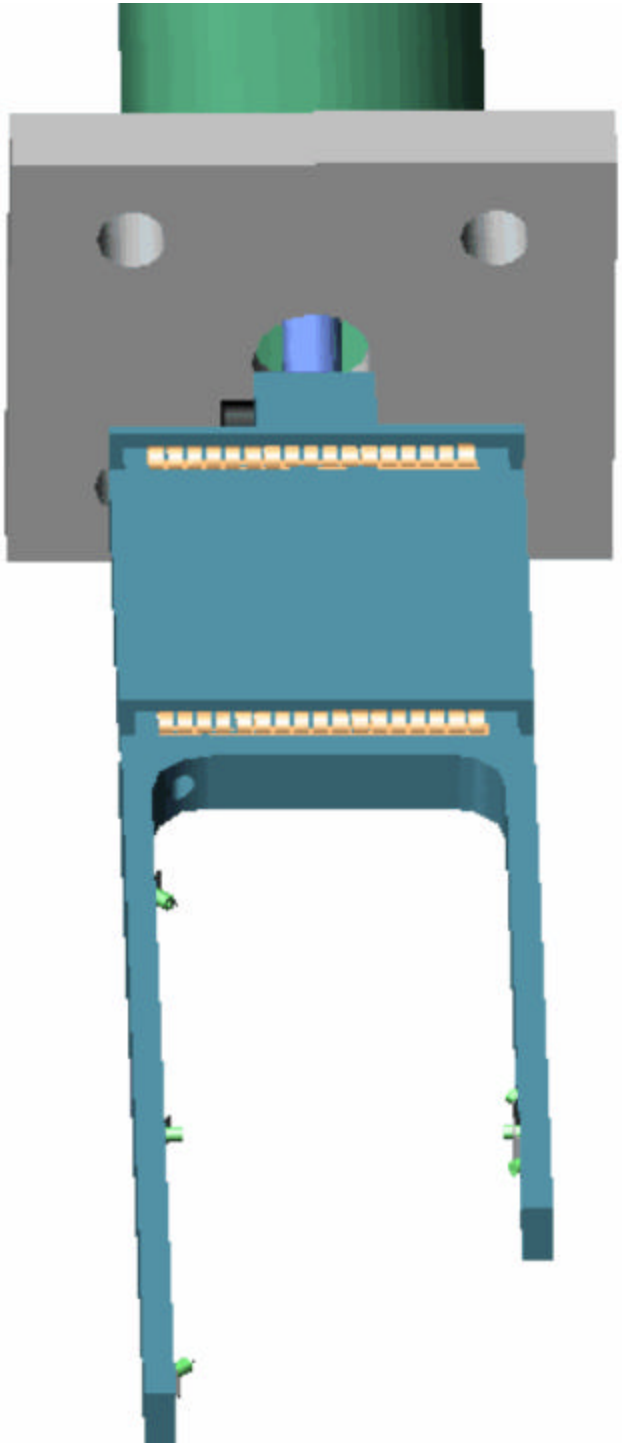
PARTS LIST

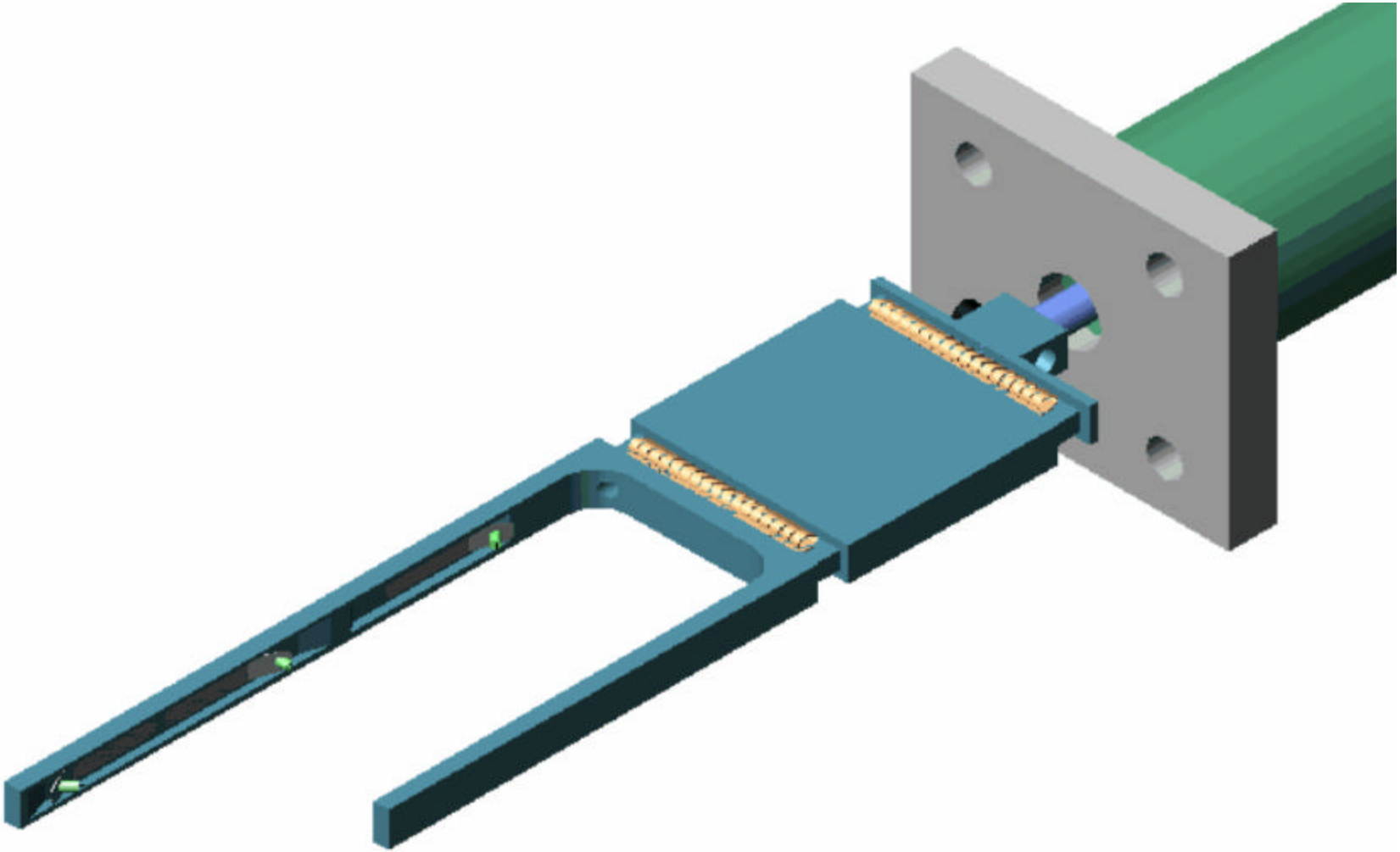
MEBT Wire Scanner Assembly

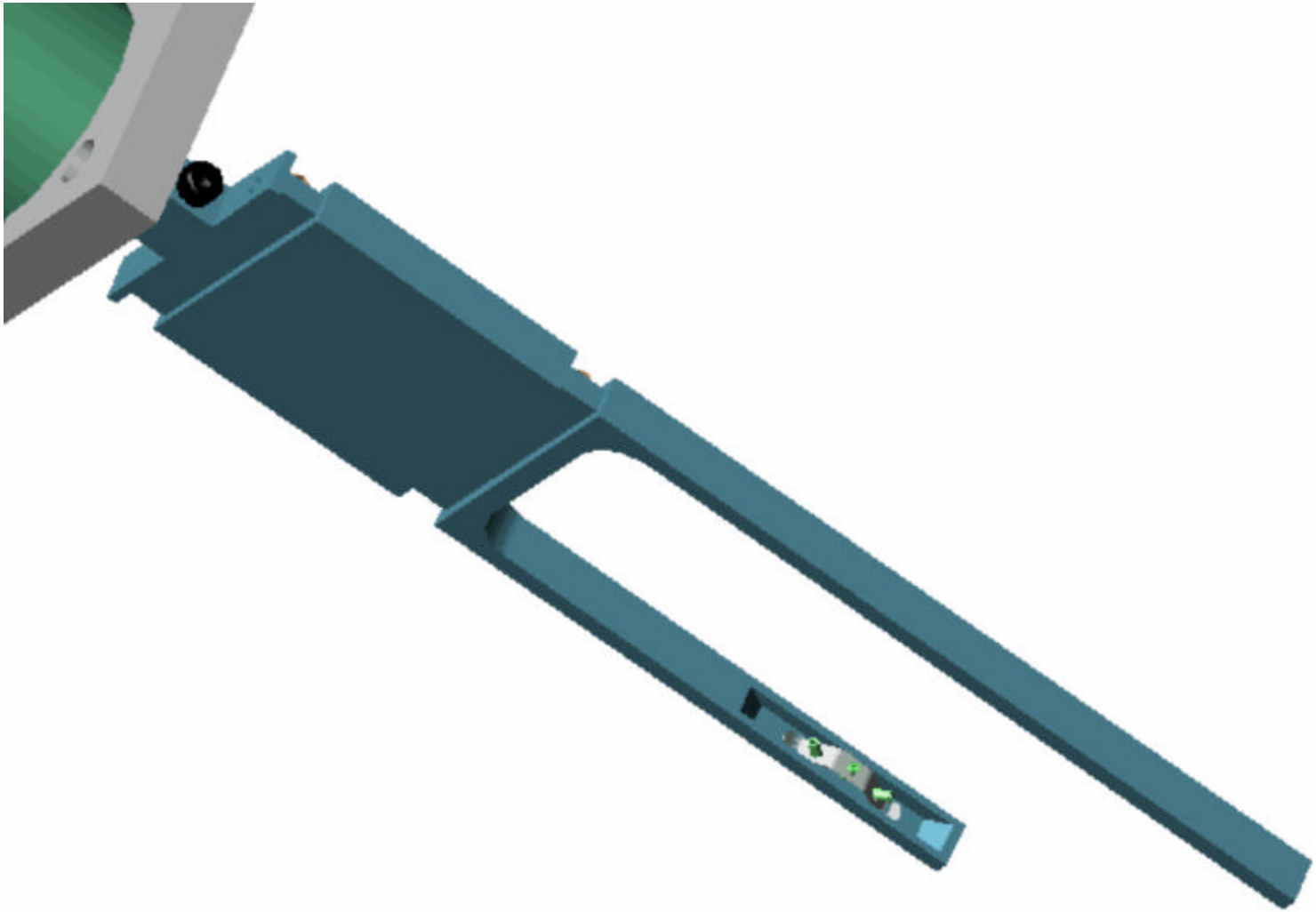
Sketch1



2/12/2001

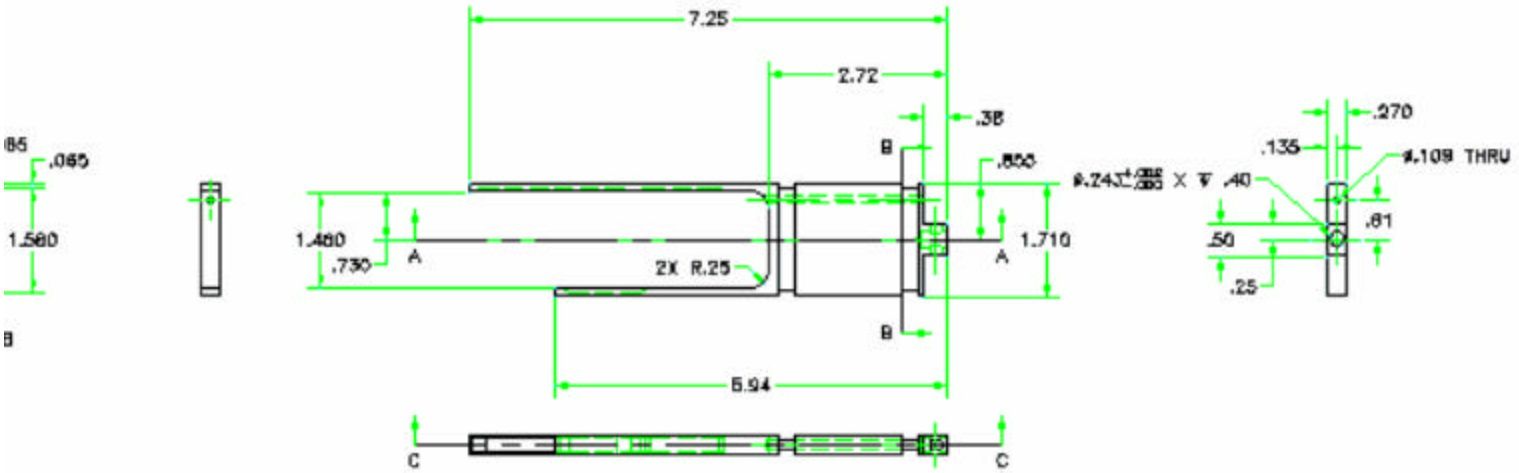


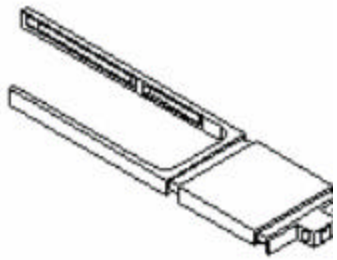


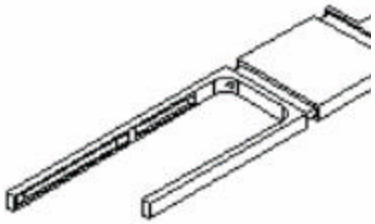


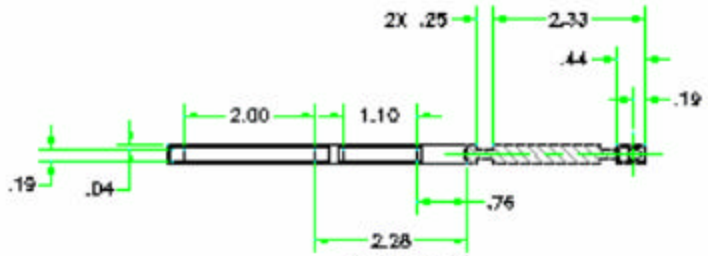
REVISIONS				
REV	ZONE	ECN NO.	DESCRIPTION	BY
A			INITIAL RELEASE	

5ST TYPE 304 PER ASTM A240.



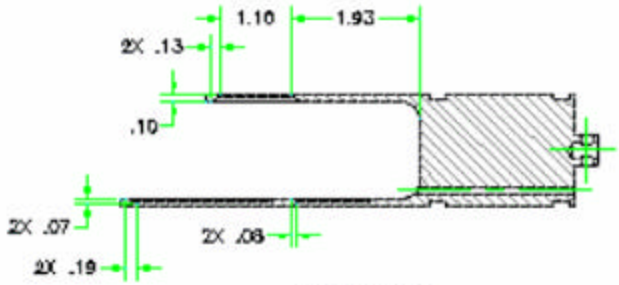






SECTION A–A

ISOMETRIC VIEWS
FOR REFERENCE



SECTION C–C

SNS

COLLIDER–ACCELERATOR DEPT.
BROOKHAVEN NATIONAL LABORATORY

SPALLATION NEUTRON SO
MEBT WIRE SCANNER
FORK

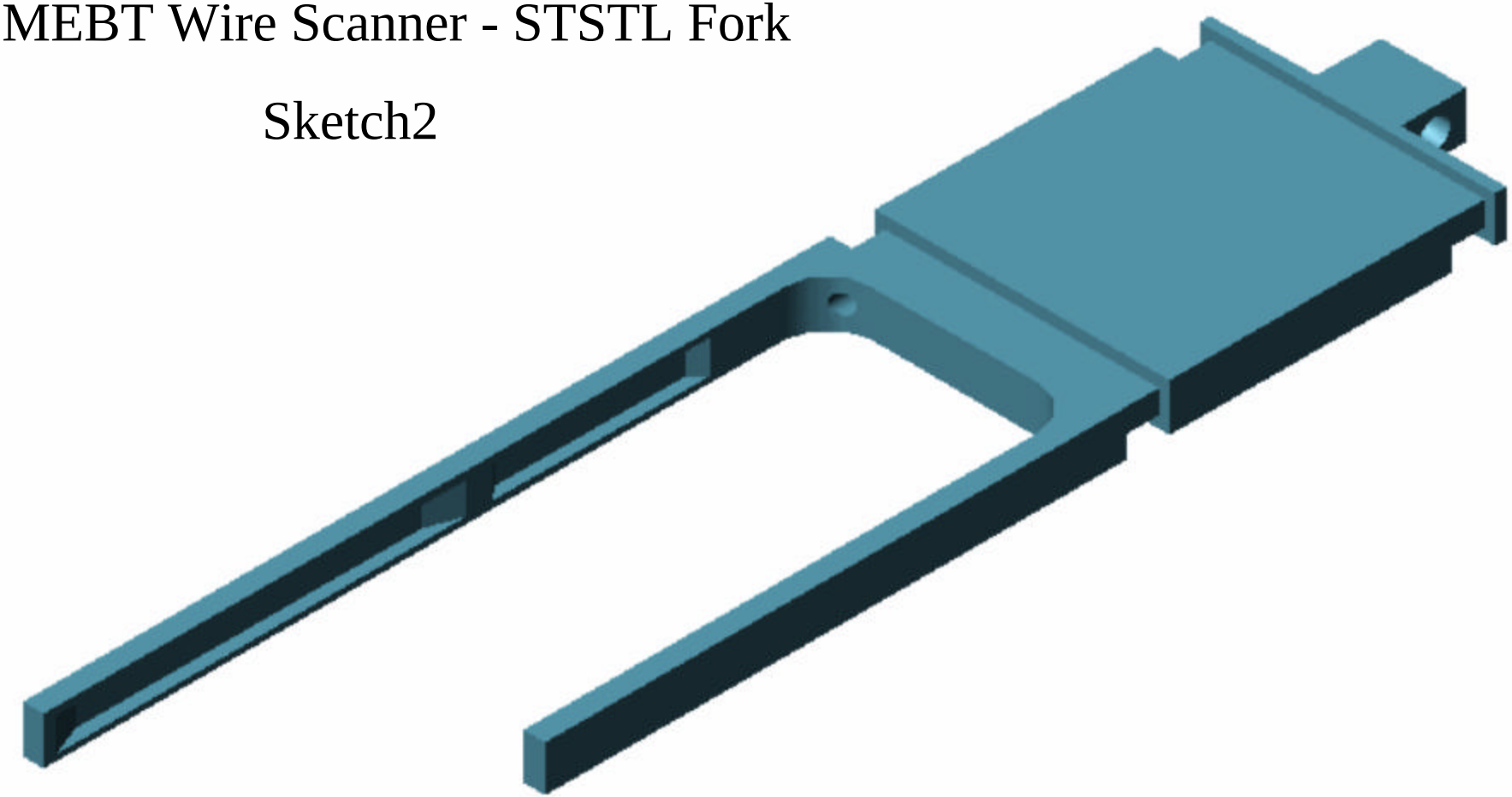
SIZE D | 5706002

SHEET 1/1

7 6 5 4 3 2 1

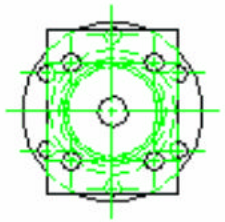
MEBT Wire Scanner - STSTL Fork

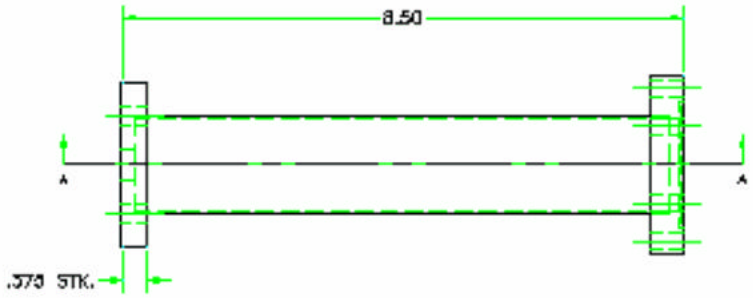
Sketch2

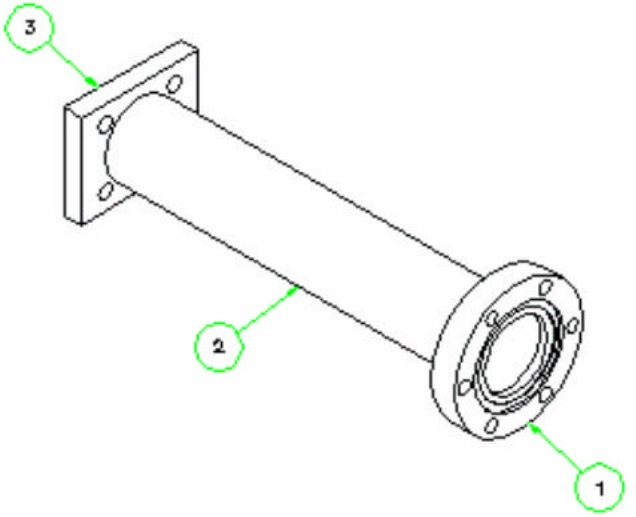


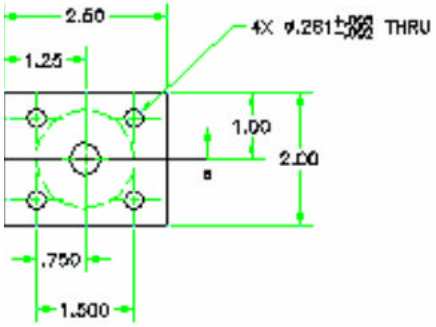
2/12/2001

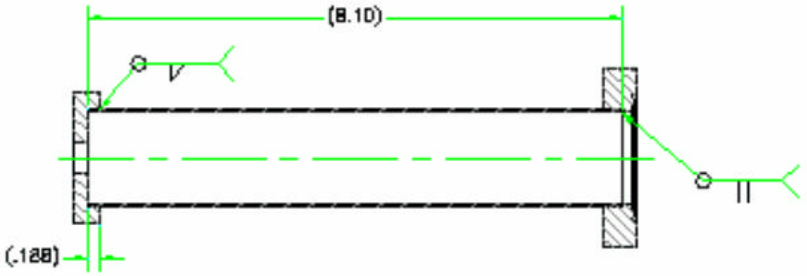
REVISIONS					
REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE
A			INITIAL RELEASE		



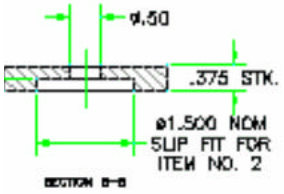








SECTION A-A



SECTION B-B

DETAIL – ITEM NO. 3

QTY	ITEM	PART NO.	DESCRIPTION	MATERIAL
1	3	FLANGE	PLATE, 8ST TYPE 304	ASTM A 240
1	2	TUBE	TUBE, 8ST TYPE 304, 1.500 OD X .065 WALL	ASTM A249
1	1	110014	FLANGE, ø2.75 KF	NDO OR EQ

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES PER ASME Y14.5M-1994

SNS

SPALLATION NEUTRON SOURCE
MEBT WIRE SCANNER
WELDMENT, CHAMBER

SIZE D

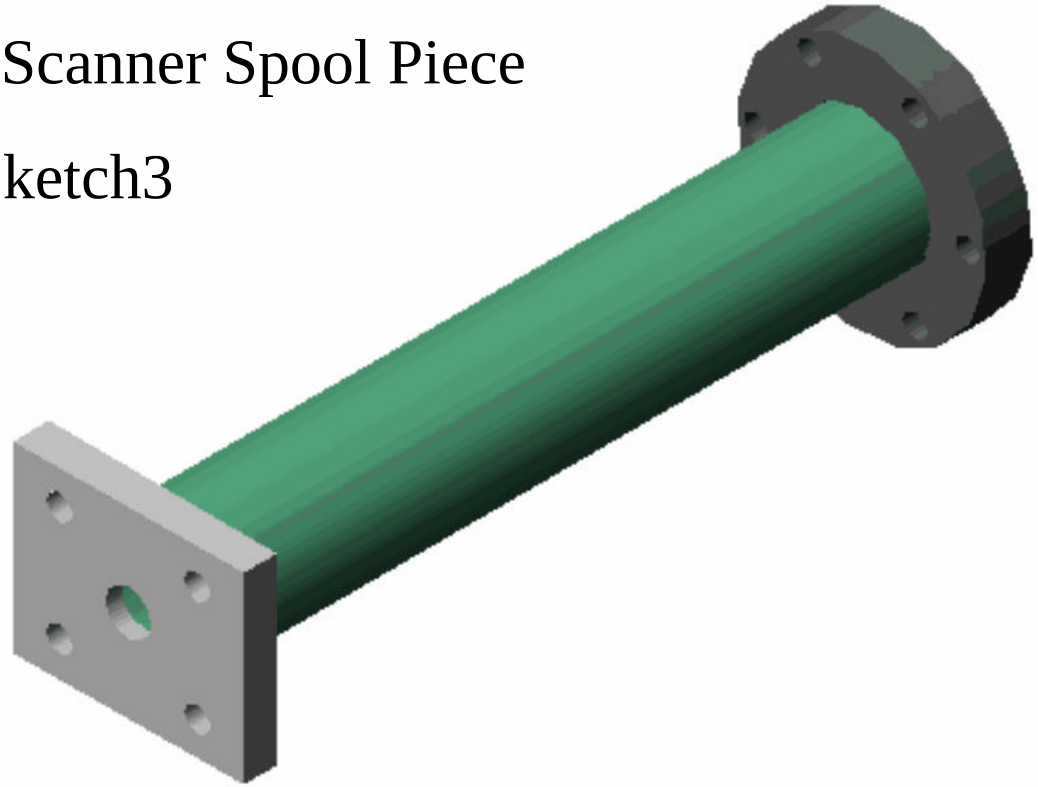
5706003

SCALE 1/1

7 6 5 4 3 2 1

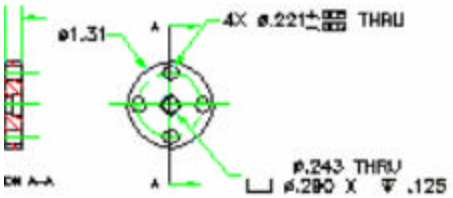
MEBT Wire Scanner Spool Piece

Sketch3

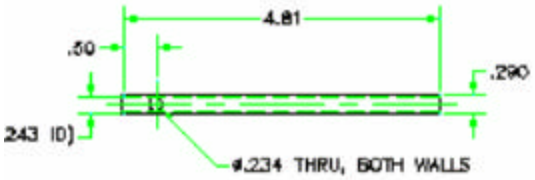


2/12/2001

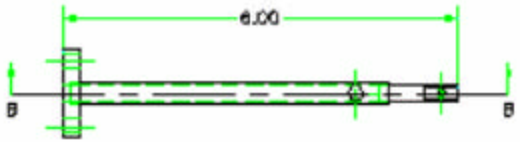
REVISIONS				
REV	ZONE	ECN NO.	DESCRIPTION	BY
A			INITIAL RELEASE	

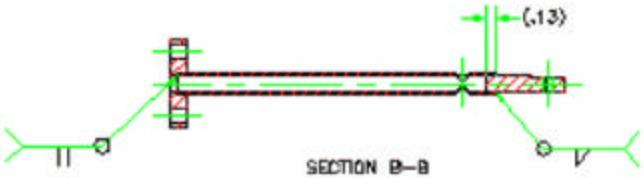


DETAIL – ITEM NO. 1

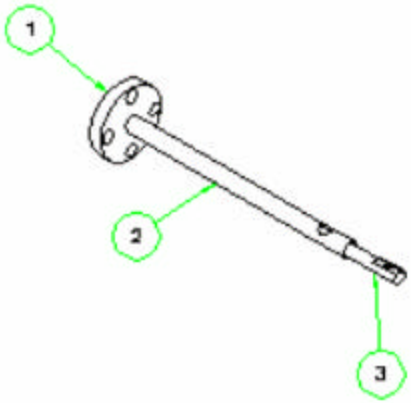


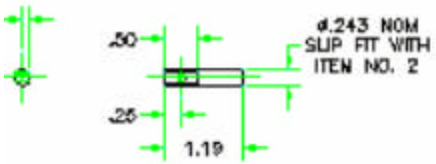
DETAIL – ITEM NO. 2





SECTION B–B





DETAIL – ITEM NO. 2

QTY	ITEM	PART NO.	DESCRIPTION
1	3	PART 3	PEDIND, SST TYPE 304
1	2	PART 2	TUBE, SST TYPE 304, .312 OD X .026 WALL
1	1	PART 1	PLATE, SST TYPE 304

PARTS LIST

SPALLATION NEUTRON SO
MEBT WIRE SCANNE
WELDMENT, EXTENTION

D 5706004

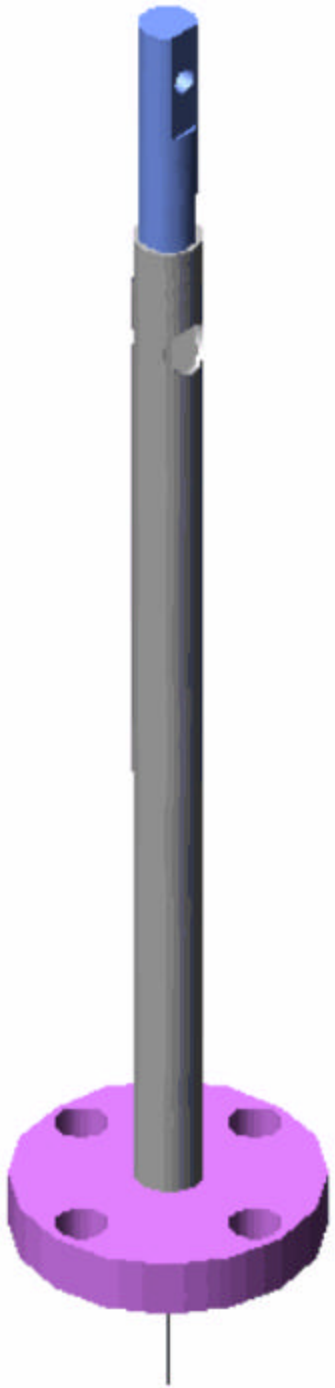
SCALE 1/1

7 6 5 4 3 2 1

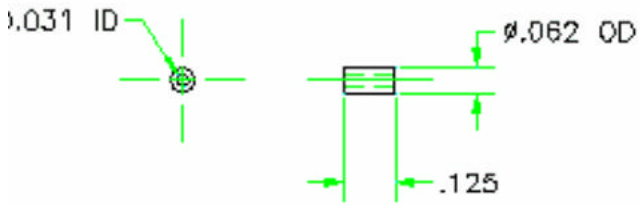
MEBT Wire Scanner

Extension Shaft

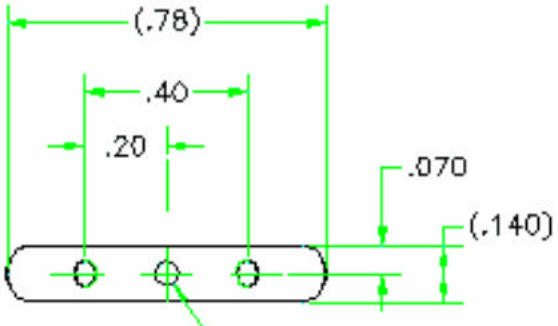
Sketch4

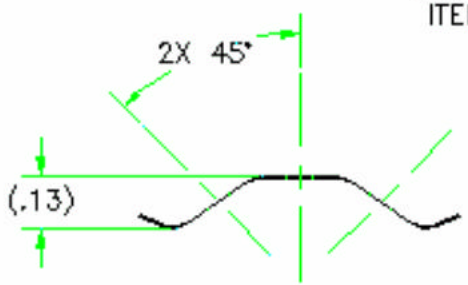


2/12/2001

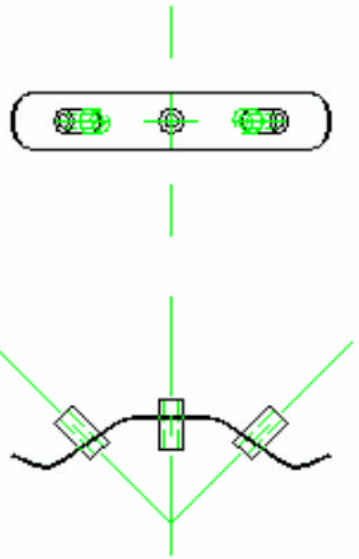


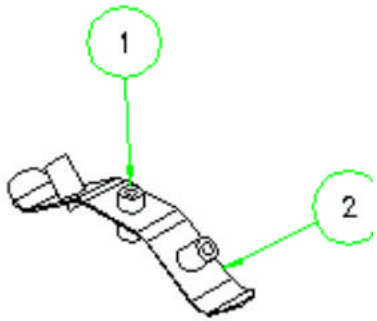
DETAIL – ITEM NO. 2





REWORK – ITEM NO. 1





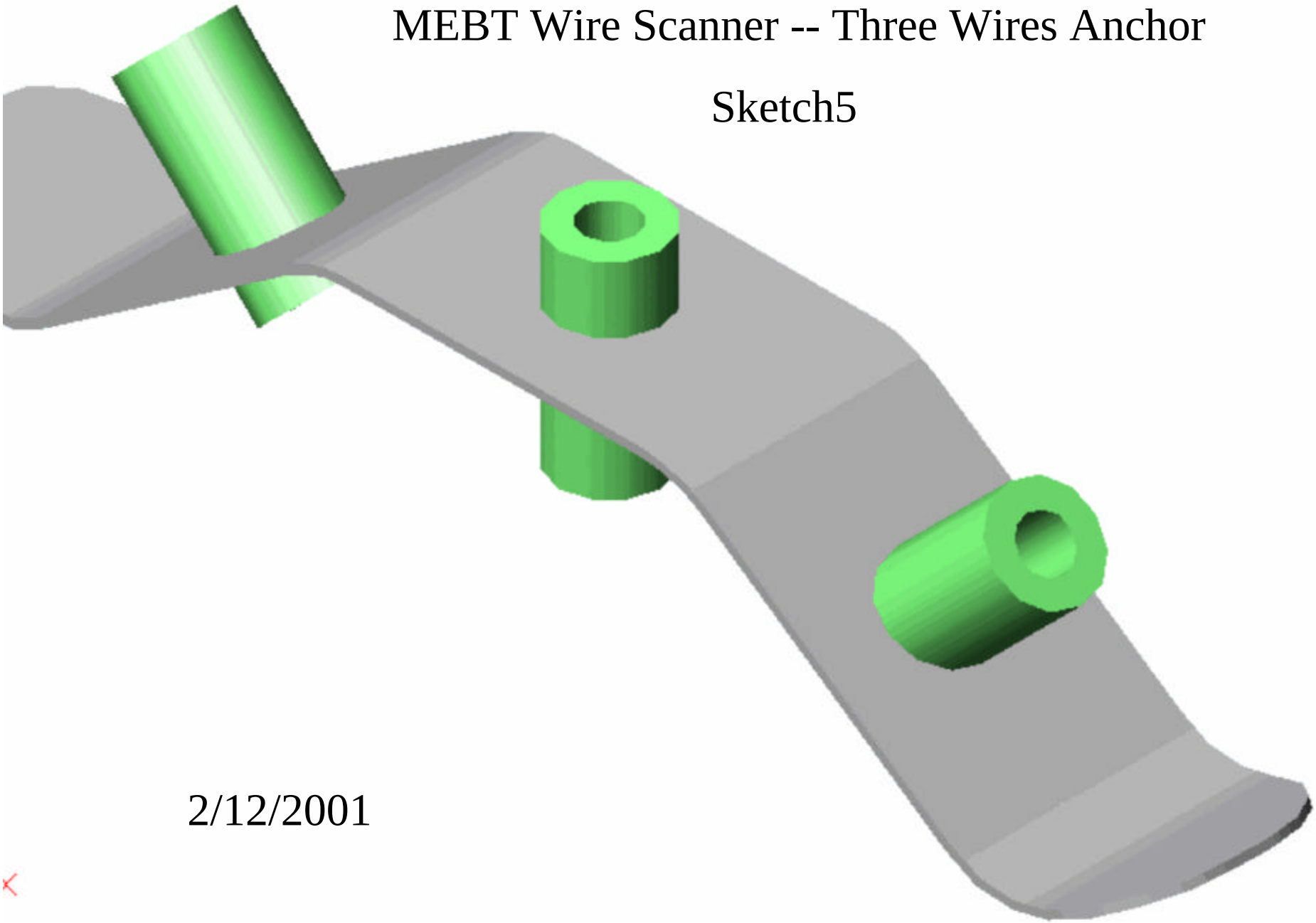
1	2	97–115	CONTIP – REWORK	INSTRUMENT SPE
3	1	PART 1	TUBE, CERAMIC	
QTY	ITEM	PART NO.	DESCRIPTION	REMARKS

PARTS LIST

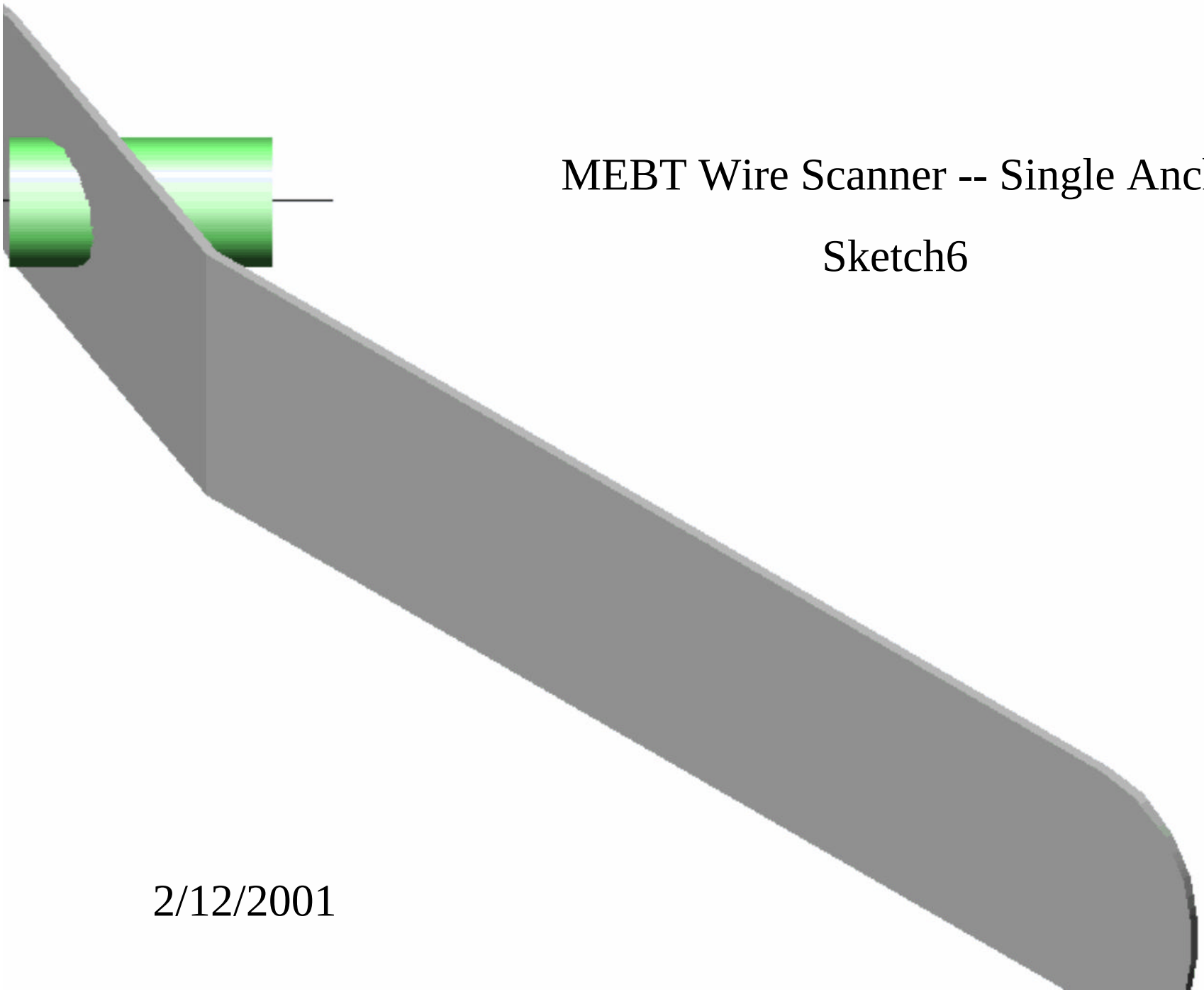
INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M–1989	SNS		COLLIDER–ACCELERATOR DEPARTM BROOKHAVEN NATIONAL LABORATORY UPTON, N.Y. 11973		
UNLESS OTHERWISE SPECIFIED	DRAWN BY	C. LONGO	1/28/01	TITLE	SPALLATION NEUTRON SOURC
DIMENSIONS ARE IN INCHES DECIMAL TOLERANCES .X ± .06 .XX ± .02 .XXX ± .005	DESIGN APPROVAL CHECKED BY				MEBT WIRE SCANNER STRIP, CERAMIC TUBE
	ENGINEER APPROVAL				

MEBT Wire Scanner -- Three Wires Anchor

Sketch5



2/12/2001



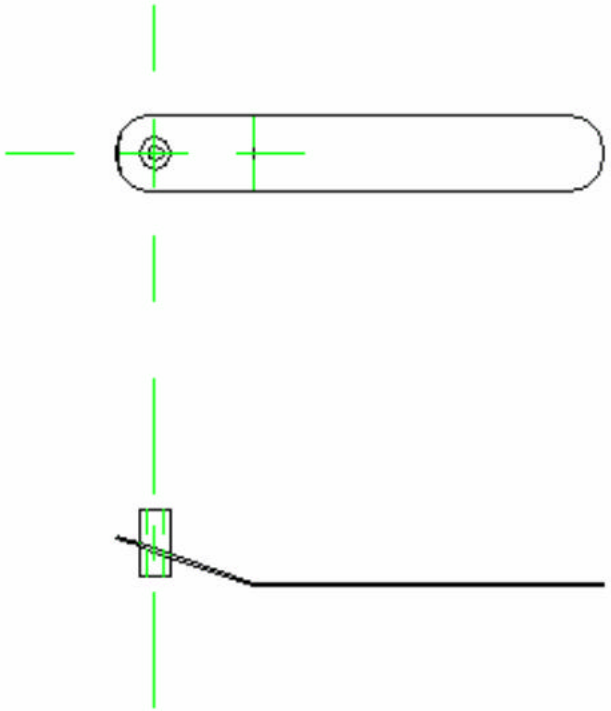
MEBT Wire Scanner -- Single Anchor

Sketch6

2/12/2001

REVISIONS

REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR
A			INITIAL RELEASE			



5706001	2
USED ON DRAWING NO.	QTY. PER ASS'Y.
APPLICATION	

OUTSTANDING ECN

INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M–1989

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES
DECIMAL TOLERANCES
.X ± .08
.XX ± .02
.XXX ± .005
ANGULAR TOLERANCE ± 1°

125 FINISH

BREAK SHARP EDGES MAX. .03 MIN. .015

SNS

DRAWN BY	C. LONGO	1/31/01
DESIGN APPROVAL		
CHECKED BY		
ENGINEER APPROVAL		
SUPERVISOR APPROVAL		

COLLIDER–ACCELERATOR DEPARTMENT
BROOKHAVEN NATIONAL LABORATORY
UPTON, N.Y. 11973

TITLE: SPALLATION NEUTRON SOURCE
MEBT WIRE SCANNER
RETAINER, WIRE

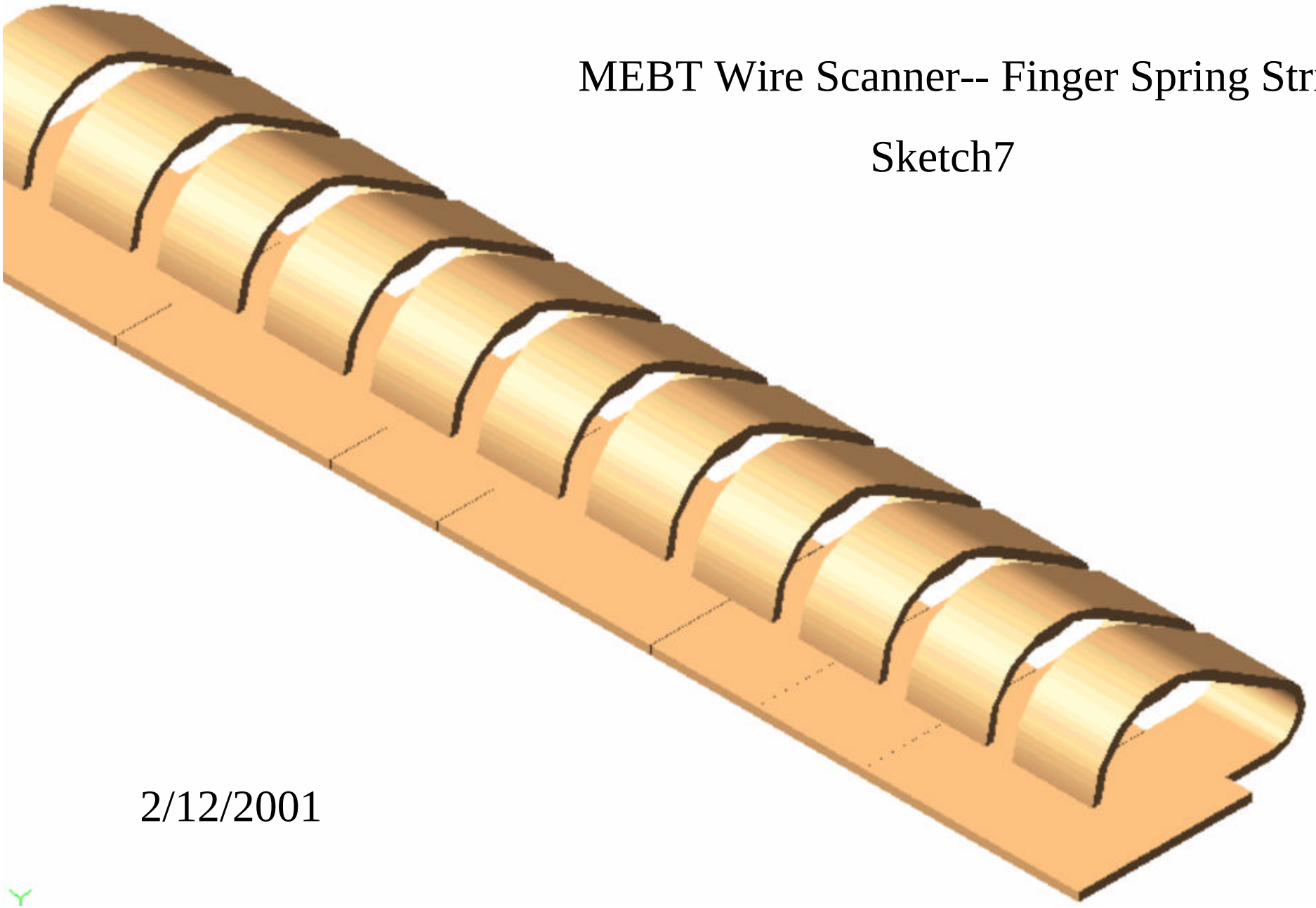
SIZE B | DRAWING NUMBER: 5706007

D.A. CATEGORY A-3 | SCALE: 4/1 | WEIGHT: — | SHEET 1 OF

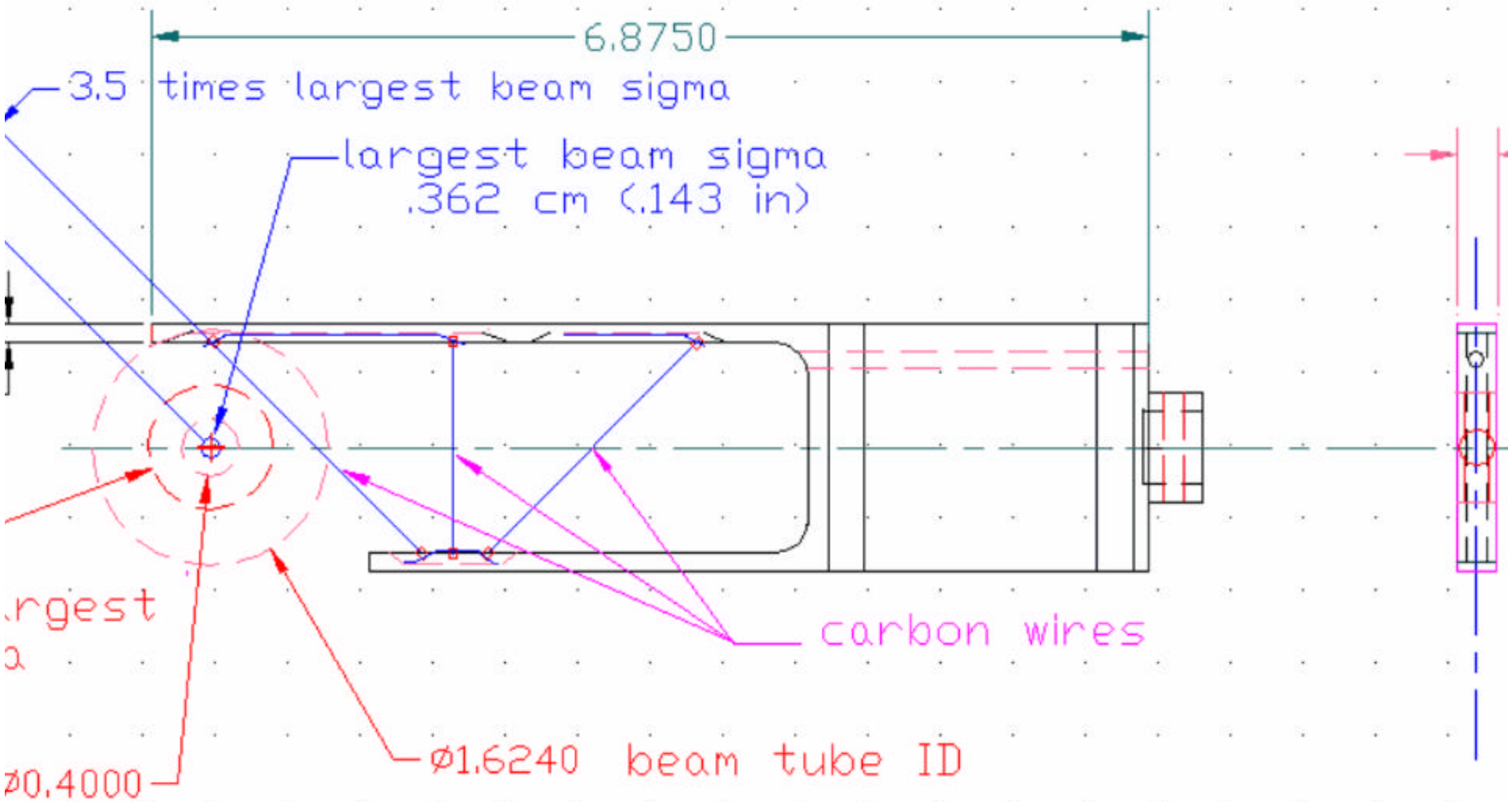
4 3 2 1 DESKTC

MEBT Wire Scanner-- Finger Spring Strip

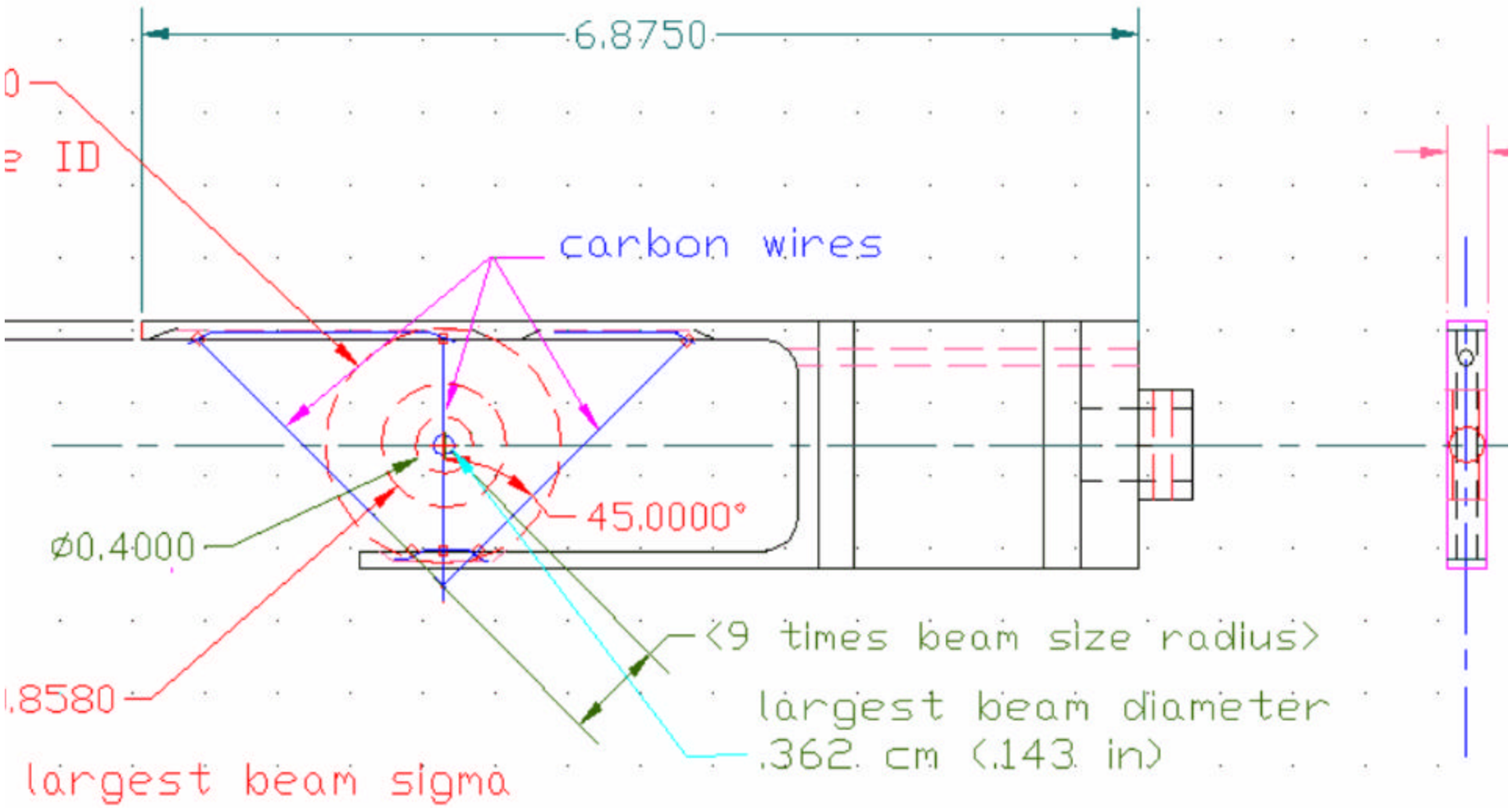
Sketch7



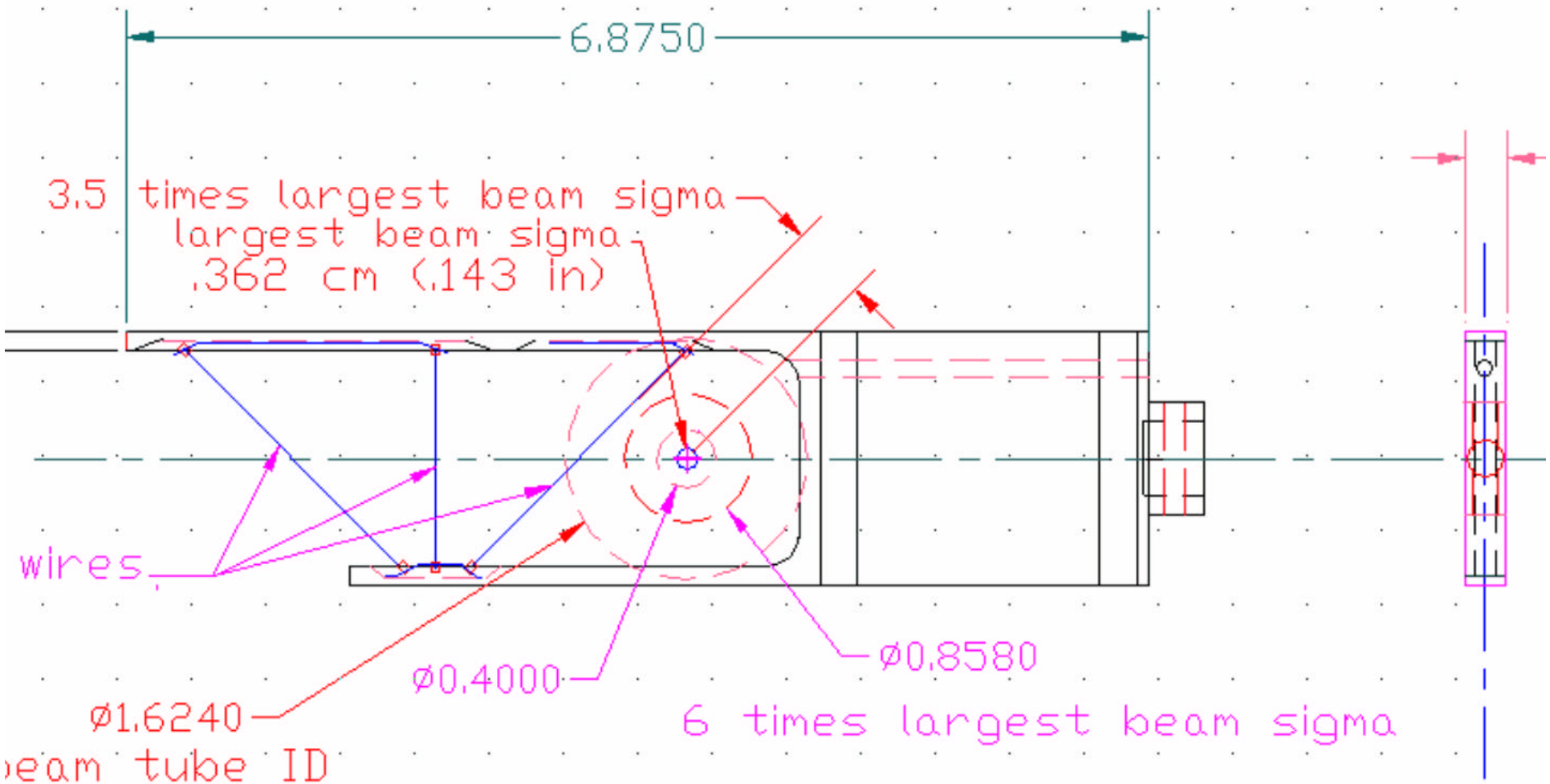
2/12/2001



(fork at fully retract position)



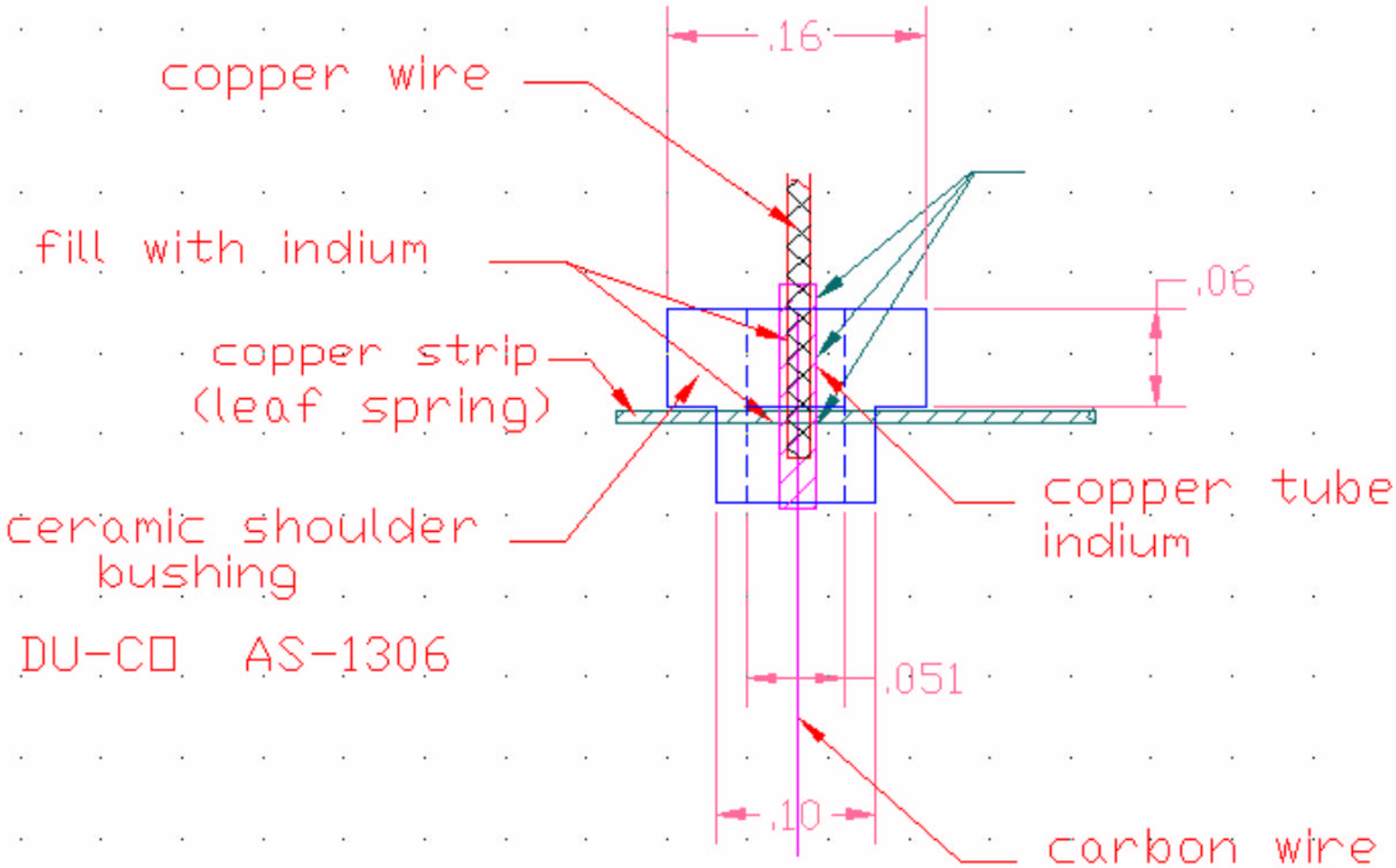
(fork at center beam tube position)



(fork at fully extent position)

wire scanner Attach carbon wire to copper wire

Sketch8



2/13/2001

MEBT Wire Scanner Schedule and Milestones

Daryl Oshatz

February 13, 2001

Profile Monitor Beambox Schedule

- **First Article Complete:** **4-15-01**
- **All Beamboxes Complete:** **5-31-01**
- **Raft Assembly Begins:** **6-1-01**
- **Raft Assembly Complete:** **10-31-01**
- **Wire Scanners Needed for:** **1-1-02**
  MEBT Commissioning