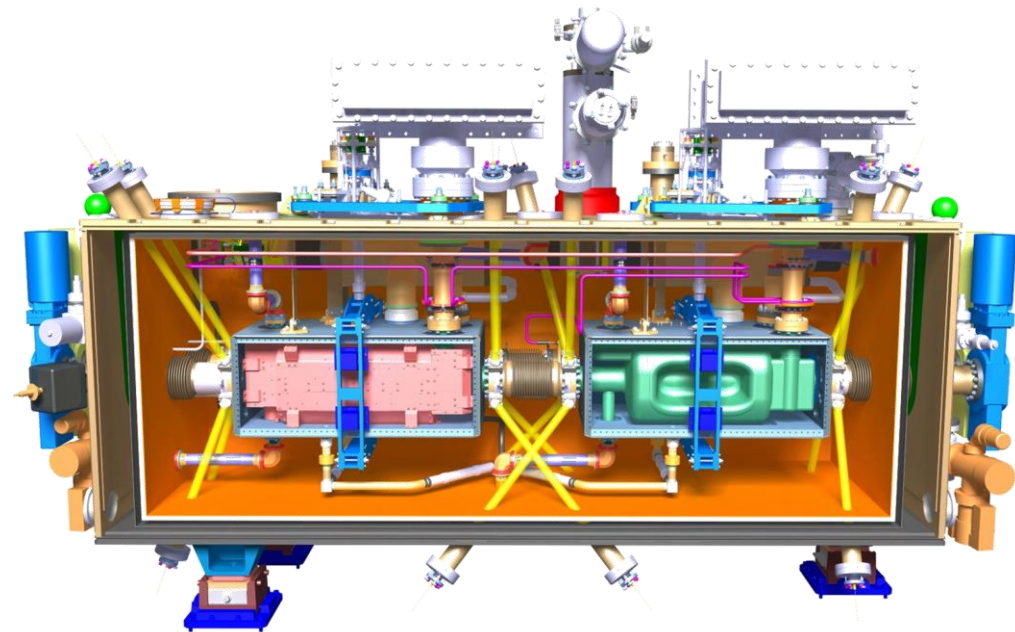


Engineering Issues TRIUMF RFD CM Production

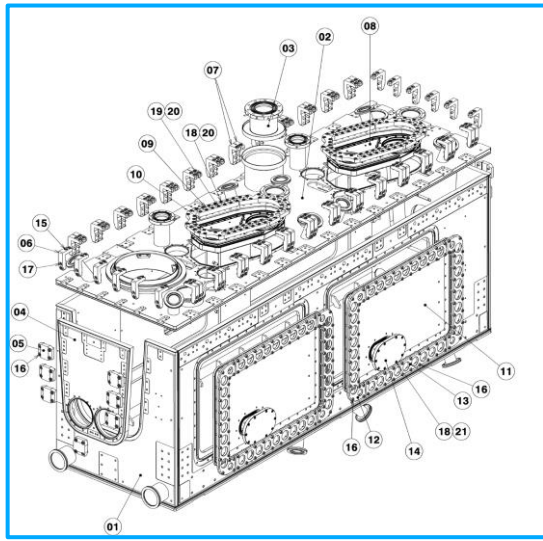
Oliver Law

Project Engineer – HL-LHC collaboration

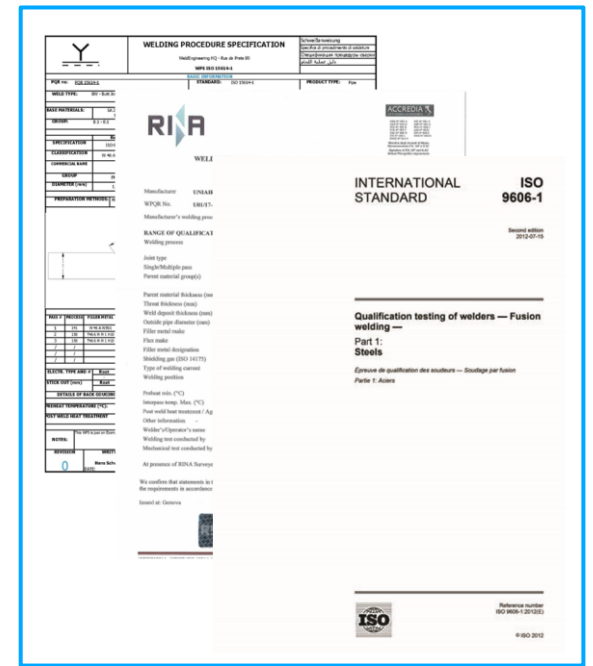
TRIUMF



Outline



OVC Progress



Welding Qualification



Material



Orbital Welding



Budget Deadline

OVC Status

Document Name	Action	Status 2023	Status 2024
3D Models	N/A	Completed	Completed
2D Drawings	N/A	Completed	Completed
Manufacturing drawings	TRIUMF	In Progress	Completed
Manufacturing and Inspection Plan (MIP)	Axton	In Progress	Completed
Welder Certification	Axton	In Progress	In Progress
Welding Procedure Specifications (WPS)	Axton	In Progress	In Progress
Welding Procedure Qualifications Records (WPQR)	Axton	In Progress	In Progress
Raw material certificates	TRIUMF	In Progress	Completed
Filler material certificates	CERN	In Progress	Completed
Material samples	TRIUMF	In Progress	In Progress
Scheduling (incl. preliminary dates)	Axton	In Progress	Completed
Traceability procedure	Axton	In Progress	Completed
Cleaning procedure	TRIUMF	In Progress	Completed
Leak test procedure	TRIUMF	In Progress	Completed

Weld Documentation and Qualification

Welding Procedure Specification (WPS)		ISO 15609-1:2019																															
WPS No: AX-GTAW-B1 R2	Date: Sept-25-2024	Parent Material designation: Group 8.1	Material thickness: 1.5 mm to 6 mm																														
WPR No(s): AX-GTAW-6G-3 R2	Manufacturer: AXTON Incorporated	Parent Material specification: All Group 8.1	Material thickness: 1.5 mm to 6 mm																														
441 Derwent Place, Delta BC V3M 5Y9																																	
Welding Procedure Specification (WPS)																																	
ISO 15609-1:2019																																	
WPS No: AX-GTAW-B2 R2	Date: Sept-25-2024	Parent Material designation: Group 8.1	Material thickness: 2 mm to 6 mm																														
WPR No(s): AX-GTAW-6G-3 R2	Manufacturer: AXTON Incorporated	Parent Material specification: All Group 8.1	Material thickness: 2 mm to 6 mm																														
441 Derwent Place, Delta BC V3M 5Y9																																	
Welding process: 141 (GTAW)	Mode of metal transfer: N/A	Joint Type and Weld: Partial Penetration Butt welds	Product forms: All positions (Upward)																														
Weld prep details: All surfaces shall be free from fins, tears, cracks or any other defects. All surfaces shall be wire brushed prior to welding.	Welding position: All positions (Upward)	Method of preparation and cleaning: Brushing, grinding	Weld joint area (25 mm both side) shall be cleaned by wire brushing. The grinding discs shall be kept exclusively for use on stainless steels.																														
Joint Design:	Welding Sequence: E = S	Welding position: All positions (Upward)	Product forms: All product forms (plate and pipes)																														
Welding Details	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Run</th> <th>Pass</th> <th>Welding process</th> <th>Size of filler metal (mm)</th> <th>Current [A]</th> <th>Voltage [V]</th> <th>Current type</th> <th>Wire feed speed m/min (ipm)</th> <th>Travel speed m/min (ipm)</th> <th>Heat input kJ/mm</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>141 (GTAW)</td> <td>1.6 (1/16)</td> <td>90 - 110</td> <td>11 - 16</td> <td>DC EN(SP)</td> <td>N/A</td> <td>75 - 120 (3-5)</td> <td>0.52 - 1.40</td> </tr> <tr> <td>2-n</td> <td>2-n</td> <td>141 (GTAW)</td> <td>1.6 (1/16)</td> <td>90 - 110</td> <td>11 - 16</td> <td>DC EN(SP)</td> <td>N/A</td> <td>75 - 120 (3-5)</td> <td>0.52 - 1.40</td> </tr> </tbody> </table>			Run	Pass	Welding process	Size of filler metal (mm)	Current [A]	Voltage [V]	Current type	Wire feed speed m/min (ipm)	Travel speed m/min (ipm)	Heat input kJ/mm	1	1	141 (GTAW)	1.6 (1/16)	90 - 110	11 - 16	DC EN(SP)	N/A	75 - 120 (3-5)	0.52 - 1.40	2-n	2-n	141 (GTAW)	1.6 (1/16)	90 - 110	11 - 16	DC EN(SP)	N/A	75 - 120 (3-5)	0.52 - 1.40
Run	Pass	Welding process	Size of filler metal (mm)	Current [A]	Voltage [V]	Current type	Wire feed speed m/min (ipm)	Travel speed m/min (ipm)	Heat input kJ/mm																								
1	1	141 (GTAW)	1.6 (1/16)	90 - 110	11 - 16	DC EN(SP)	N/A	75 - 120 (3-5)	0.52 - 1.40																								
2-n	2-n	141 (GTAW)	1.6 (1/16)	90 - 110	11 - 16	DC EN(SP)	N/A	75 - 120 (3-5)	0.52 - 1.40																								
Notes: All moisture, grease, contact with lead, zinc, or other foreign material that would prevent proper welding or produce objectionable fumes, shall be removed. The edges or surfaces of parts to be joined by welding shall be prepared by shear or plasma arc cutting. Where hand cutting is involved the edge will be ground to a smooth surface.																																	
Manufacturer: AXTON Incorporated																																	

Welding Procedure Qualification Record (WPQR)		as per ISO 15614-1:2017																																																			
Manufacturer's WPQR no: AX-GTAW-6G-3 R2	Manufacturer: AXTON Incorporated	Address: 441 Derwent Place, Delta BC V3M 5Y9	Date: Sept-25-2024																																																		
Code/Testing Standard: ISO-15614-1:2017	Examiner: SKC Engineering	Reference no.: W16170-D2																																																			
Level: 2																																																					
Date of welding: Feb-11	Welding Procedure Qualification Record (WPQR)																																																				
as per ISO 15614-1:2017																																																					
Product form: All prod	Manufacturer's WPQR no: AX-GTAW-1F-20 R1	Manufacturer: AXTON Incorporated	Examiner: SKC Engineering																																																		
Welding Process(es): 141 (GT)	Address: 441 Derwent Place, Delta BC V3M 5Y9	Date: Sept-25-2024	Reference no.: W16170-D2																																																		
Base material I - Group: 8	Code/Testing Standard: ISO-15614-1:2017	Level: 2																																																			
Base material II - Group: 8	Date of welding: Mar-20-2024																																																				
Throat thickness: No restr	Test Piece	Range of Qualification																																																			
Single layer / Multi run: Single	Product form: All product forms	Type of joint and weld: Multi Run	Filler metal: W Z 18 16 5 Mn N L																																																		
Filler metal designation: W Z 18 16 5 Mn N L	Welding Process(es): 141 (GTAW)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Filler metal make: Voestalpine Bohler	Base material I - Group: B	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Filler metal F No. / A No.: F6 / A8	Base material II - Group: B	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Filler metal size: Any	Throat thickness: No restriction	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Material transfer mode: N/A	Single layer / Multi run: Multi Run	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Welding position: All positi	Filler metal designation: W Z 18 16 5 Mn N L	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Preheat temperature [C]: 16°C (60)	Filler metal make: Voestalpine Bohler	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Interpass temperature [C]: 16°C (60)	Filler metal F No. / A No.: F6 / A8	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Filler metal size: Any	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Location / Manufacturer: Axon Inc	Material transfer mode: N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Manufacturer's WPQR No: AX-GTAW-6G-3 R2	Welding position: All positions (Uphill)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Welder's / operator's name: Nathaniel Printis	Preheat temperature [C]: 15°C (59°F)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Metal transfer mode: N/A	Interpass temperature [C]: 15°C (59°F) - 85°C (185°F)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Joint type and weld: Full Pen		Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Weld on one side: Weld from one side	Location / Manufacturer: Axon Incorporated shop	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Welding position: H-LO45	Manufacturer's WPQR No: AX-GTAW-1F-20 R1	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
G - Root opening, G = 0	Welder's / operator's name: Nathaniel Printis	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
RF - Root face, RF = 1.5 mm	Welding process: 141 (GTAW)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
2 NPS Pipe, OD = 60 mm	Metal transfer mode: N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
Wall thickness T = 3 mm	Joint type and weld: Filler Weld - Tee Joint	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Welding position: PB (Horizontal)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Welding sequence:	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Notes: Wire brushed between passes. Stainless steel brushes.	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Welding details	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
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Run	Welding Process	Filler metal size (mm)	Current A	Voltage V	Current Polarity	Wire feed speed (mm/min)	Travel speed (mm/min)	Heat input (kJ/mm)	Metal transfer																																												
1	141 (GTAW)	2.4	198	17	DC EN(SP)	-	100 (4.0)	2.02	N/A																																												
2	141 (GTAW)	2.4	211	18	DC EN(SP)	-	152 (6.0)	1.50																																													
3	141 (GTAW)	2.4	211	18	DC EN(SP)	-	168 (6.6)	1.36																																													
4	141 (GTAW)	2.4	211	18	DC EN(SP)	-	152-168 (6-6.6)	1.36-1.50																																													
	Notes: Any special baking or drying: None	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Shielding gas/flux: 100% Argon	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Flow rate (l/min): 14.2 (30 cfm)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Backing gas/flux: N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Flow rate (l/min): N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Back gouging/backing: N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Weaving (max. width of run): N/A	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Oscillation (amplitude, frequency, dwell time): None	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Pulse weld details: None	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Contact tube distance: 10 - 12 mm (3/8 - 1/2 in)	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Torch angle: 15° - 20° away from the direction of travel	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		
	Manufacturer: AXTON Incorporated	Subgroup: 8.1	Thickness: 3 mm to 40 mm (0.118 in to 1.574 in)																																																		

Weld Documentation and Qualification

SKC Engineering
 10165 94th Ave, Surrey, BC V4N 3J4
 Phone: (604) 882-1889
 Fax: (604) 882-1811
 Website: www.skcing.com

VISUAL INSPECTION REPORT

PROJECT / CLIENT INFORMATION		
CLIENT:	Axton Incorporated	
JOB LOCATION:	SKC shop	
PROJECT:	3 x welded coupons to be inspected	
NDE REQUEST NO.:	N/A	
AFE / NOT NO.:	N/A	
PO / WO NO.:	W16170-D2	

March 25, 2024
 Page 2 of 3

INSPECTION DETAILS - RESULTS (CONTINUED):

W16170-VTAM-02

Overview of Fillet weld coupons

1F-2-1

1F-2-2

Item ID	PQR No.
1F-2-1	PQR AX-GTAW-11
1F-2-2	PQR AX-GTAW-11
1F-20	PQR AX-GTAW-1F

Results: No rejectable indications were detected

TECHNICIAN:	NAME
TECHNICIAN:	Anca Mihailescu, CWB 9692
REVIEWER:	
CLIENT REP.:	

Applus[®]
 SKC ENGINEERING LTD.
 N/A

March 25, 2024
 Page 2 of 2

LIQUID PENETRANT EXAMINATION REPORT

INSPECTION DETAILS - RESULTS (CONT)

CERTIFICATE #5781.01

1. Overview pre inspection

3. Overview pre inspection

5. Overview post inspection

Macro-Etch

Test Method: ISO 15614-1
Test Procedure: SKC-MEC-MT-R1
Reagent ID: Kalling's No 2
Acceptance Criteria: ISO 15614-1 level 2, ISO 5817

Test Results

Specimen ID	Fusion/Penetration	Discontinuities	Leg Sizes (mm)	Throat Thickness (mm)	Result
1	Complete	No visible internal discontinuities	11.4mm, 11.1mm	7.4mm	Acceptable
2	Complete	Internal discontinuities within allowable limit	11.6mm, 11.3mm	6.8mm	Acceptable

1

2

Material

- 316LN procurement
 - Large mill runs from EU suppliers
 - Bi-Phase Support, Thermal Screen, Cavity Support Structure, Cryo Jumper Internal Support
 - **Status: CERN agreed to supply 316LN material**



316LN Material	Length (mm)	Width (mm)	Qty
Ø25mm Rod	1000	N/A	5
2mm Sheet	1100	1100	1
8mm Plate	1500	2200	1
8mm Plate	400	2200	1
10mm Plate	1500	2000	1
12mm Plate	1000	650	1
15mm Plate	1500	700	1
20mm Plate	1100	700	1
30mm Plate	800	600	1
40mm Plate	600	400	1
50mm Plate	500	500	1

Material

- EN 10204 type 3.1 inspection certificate requirement
 - **Mandatory! Use Harmonized Standards** for pressure equipment or welded components to a pressure equipment
 - Materials in question for CERN: Grade 5 & 23 Ti, 6061-T6 Al
 - Example: Thermal Screen
 - North American certificates satisfy requirements related to form, alloy designation, temper state, etc. except EN 10204 type 3.1
- Status:
 - North American material certificates must include material information required for specific component (chemical composition and mechanical properties)
 - Must be submitted for CERN review with a **Deviation Request** containing the list of components to be manufactured with material of concern

Orbital Welding

- AMI Model 217 (supersedes CERN: Model 207A)
- MIT Wolfram Tungsten electrode (equiv. Wolfram Orbistar)
- Modified weld head clamps (8mm/10mm)
- Goal: Familiarize TRIUMF team with equipment and joint prior to certification process and CERN demonstration



```

ARC MACHINES, INC          COPYRIGHT 2001
AMIWELD 207 STD 2.5      24-APR-2021
POWER SUPPLY SN: 38577   12/10/2022

OPERATOR: HEBERT_JEROME_1205
WELD ID: _____
WELD HEAD MODEL: 9-500
WELD HEAD SN: 38461

#   DE   PAROI  TYPE  MAT  QTE
080 10.00 1.00  SKT  INOX 0037

PRE--GAZ--POST MONTEE--DESCENTE ROT--DLY
20      20    0.5   5.0  CW  3.5

SECT. PULSE  ROT    HT---TPM--BAS
1     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      1     2.5  56.0  18.0  0.10  0.10

SECT. PULSE  ROT    HT---TPM--BAS
2     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      2     4.3  55.0  18.0  0.10  0.10

SECT. PULSE  ROT    HT---TPM--BAS
3     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      3     4.3  53.0  18.0  0.10  0.10

SECT. PULSE  ROT    HT---TPM--BAS
4     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      4     4.3  52.0  18.0  0.10  0.10

SECT. PULSE  ROT    HT---TPM--BAS
5     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      5     4.3  50.0  18.0  0.10  0.10

SECT. PULSE  ROT    HT---TPM--BAS
6     ON     CONT    3.50
      SEC HT---AMP--BAS HT--PULSE-BAS
      6     1.6  49.0  18.0  0.10  0.10

PARAMETRES EXECUTES SELON PROGRAMME

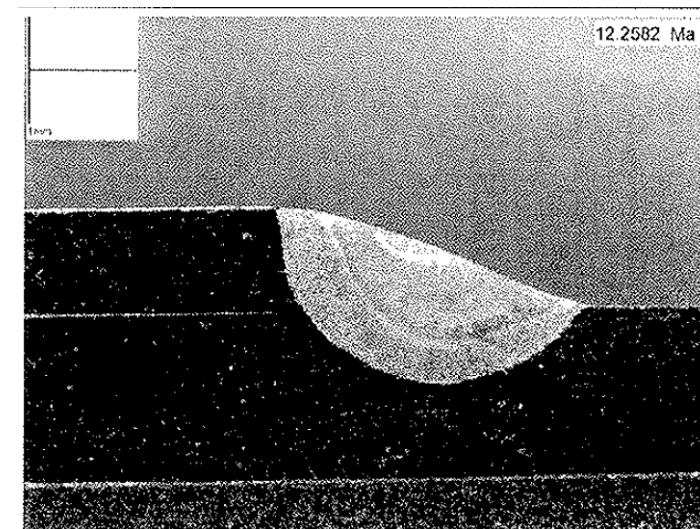
NOTES: _____

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Orbital Welding

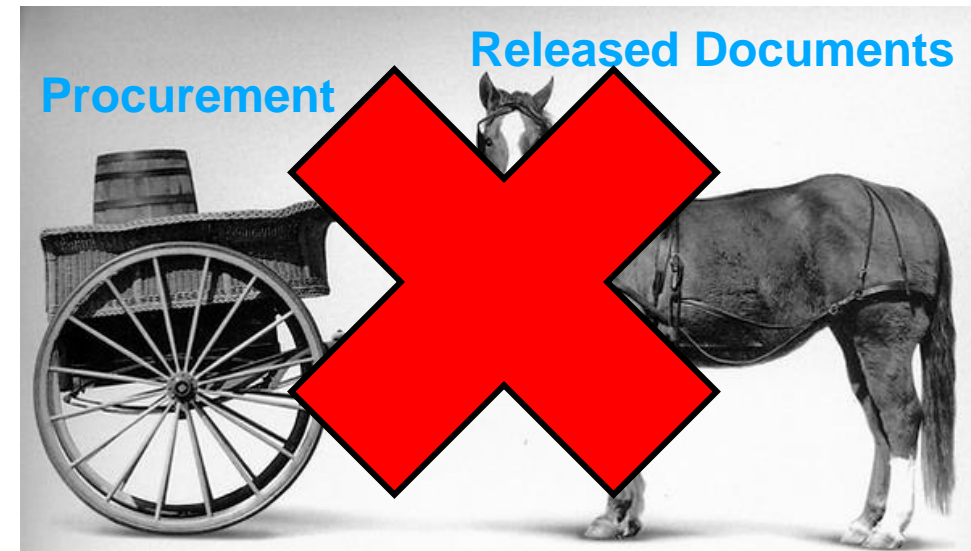
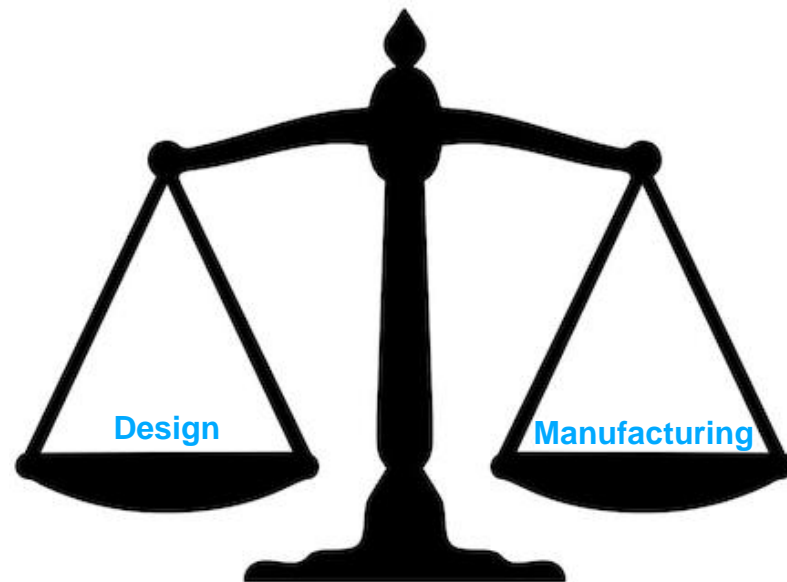


Orbital Welding



Budget Deadline

- **TRIUMF's fiscal year ends March 2025**
 - Ordered parts must be through the door for funds to be spent
- Unreleased drawings (ex. out of vacuum tuner)
- Hardware & Instrumentation lists of released assemblies
- Revisions to released drawings



Conclusion

- OVC Weld documentation qualification (Axton)
 - Expected to be approved this week (pending CERN action)
- Material procurement to EN/ISO standards
 - CERN's relaxation of requirements or supply of material
- Orbital welding
 - Demonstration at CERN
 - Further testing
- TRIUMF's end of fiscal year deadline – March 2025

Future Outlook

- OVC welding & dimensional checks
- Launching procurement of remaining assemblies/hardware/instrumentation
- Receiving parts @ TRIUMF
- TRIUMF welders' certifications



Thank you
Merci

www.triumf.ca

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