



Cavity Production Update

A. Ratti (LBNL)
for the CC collaboration

May. 11, 2015





Cavity Progress - Highlights



- Substantial progress since the last report at KEK
- Fabrication started and is well underway
- Current plan shows bare cavities ready to test by early fall
 - Coordinating delivery to CERN to minimize delays
- Cavity development in partnership with US industry at Niowave



Cavity Development in Industry



- Most but not all documents in the manufacturing readiness list were delivered and accepted
- Tested all forming steps in Copper
 - Similar behavior to Nb
- Formed nearly all Nb parts
- Built test beam pipe assembly
 - Measured and tested at CERN
 - Some non compliances (being addressed)
- Beam pipe assemblies fabrication started
 - Working on acceptance plan





Requirements for Manufacturing Readiness

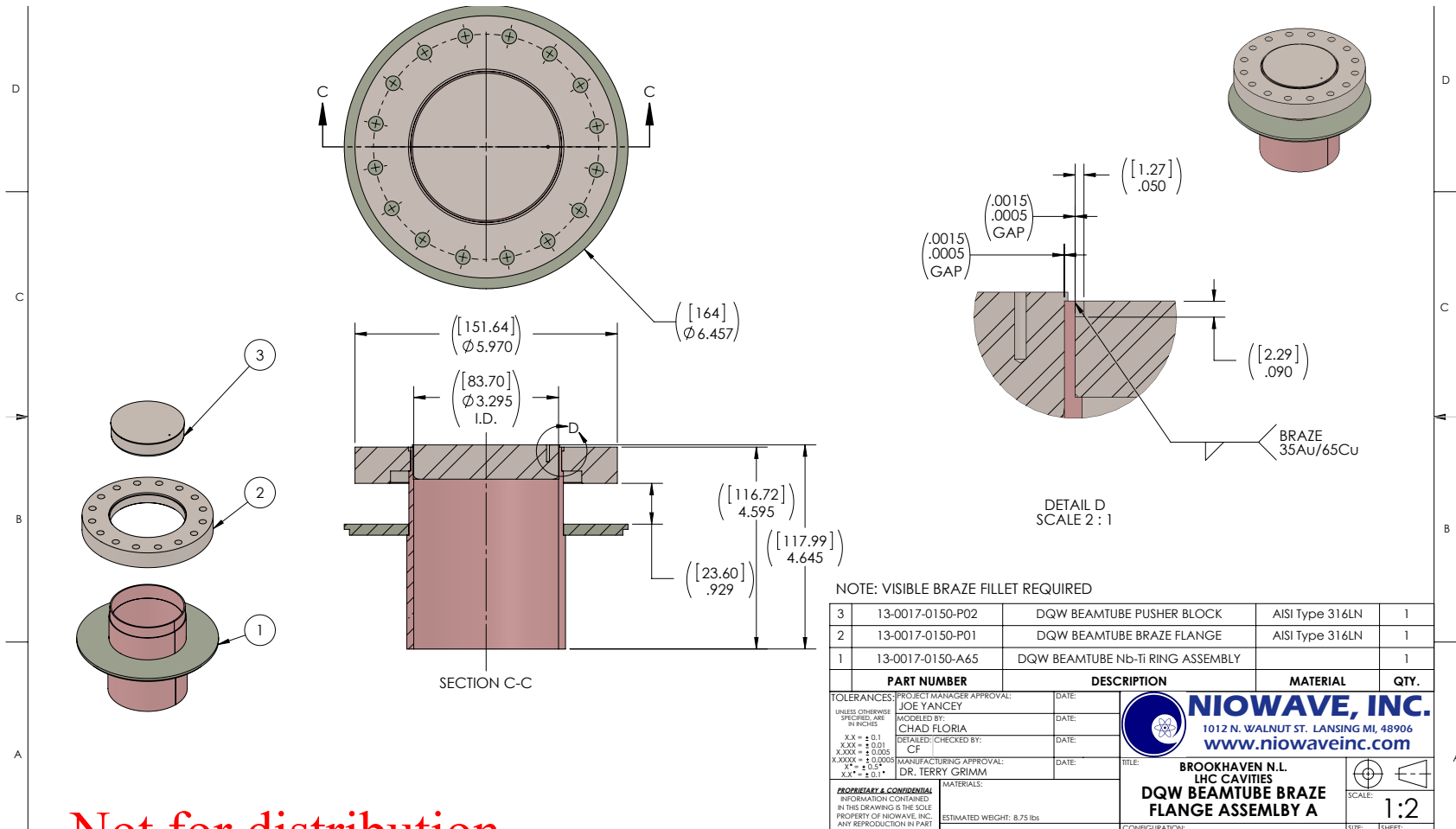


Due 1 month before start of manufacturing for CERN approval

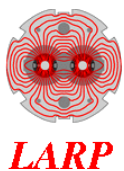
#	Requirements
1	Niobium material samples according to Section 3.2
2	Material certificates and quality control of raw materials (including RRR measurements)
3	Material certificates of welding consumables (whenever applicable)
4	Functional and manufacturing drawings (with tolerances)
5	Design reports demonstrating that welds are designed to withstand the specified load cases (refer to Section 3.6.1)
6	Welding plan including: <ul style="list-style-type: none">• Welding maps• Welding and brazing procedure qualification record including CERN acceptance criteria in Section 4.2 (WPQR and BPQR)• Welding and brazing procedure specification (WPS and BPS)• Welders performance qualification (GTAW), Welding and Brazing Operators Performance Qualifications (electron-beam welding and vacuum brazing) – WPQ, WOPQ and BOPQ
7	Manufacturing procedures (whenever required in Annex 6.3)
8	Test procedures (whenever required in Annex 6.3)
9	EB welded and vacuum brazed samples according to the requirements specified in Section 3.8.4
10	NDT personnel qualifications
11	Manufacturing and inspection plan (MIP) – list of all manufacturing and quality control operations.



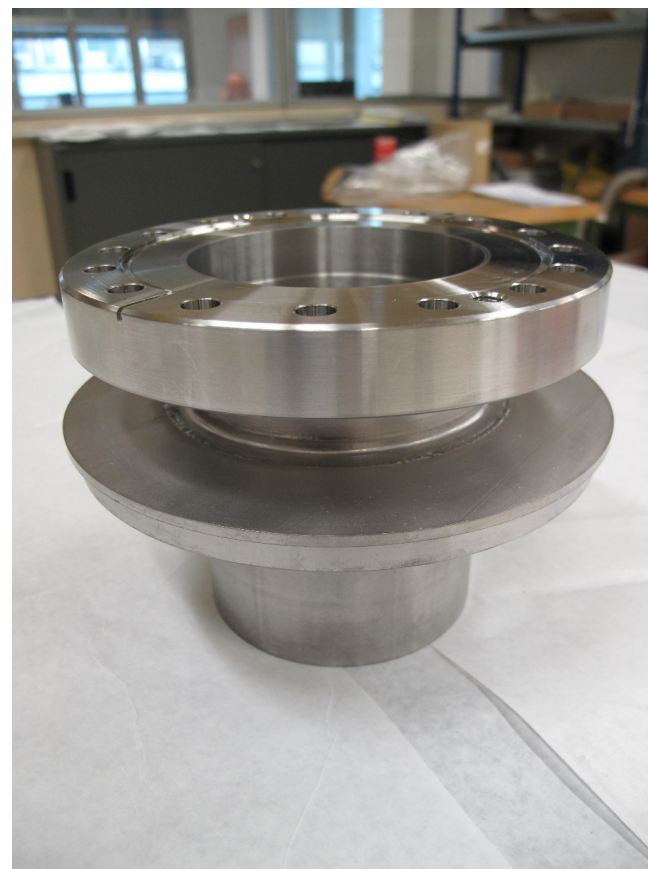
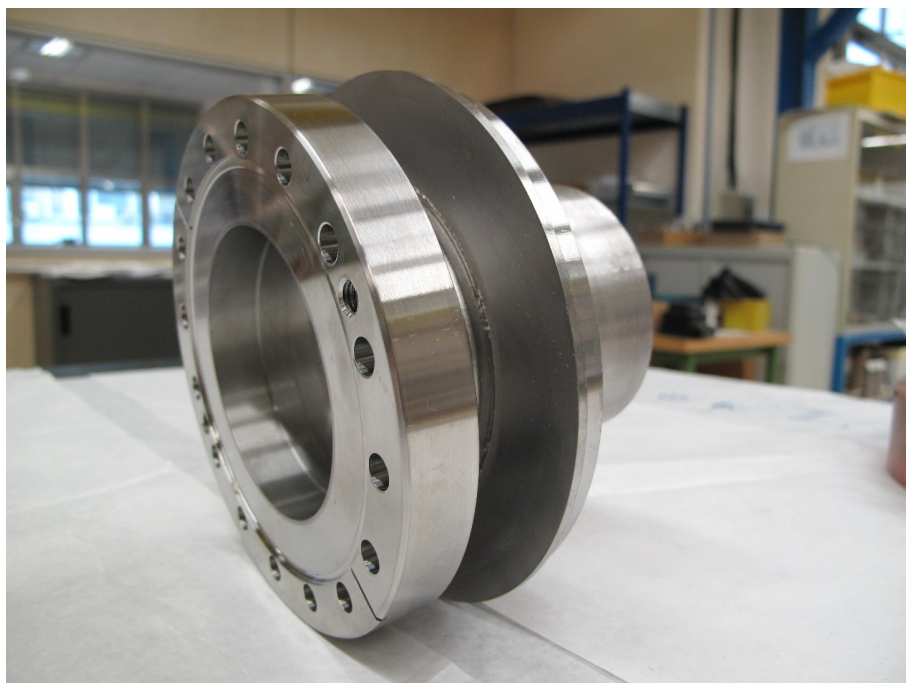
Beamtube Assembly

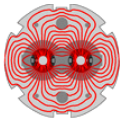


Not for distribution



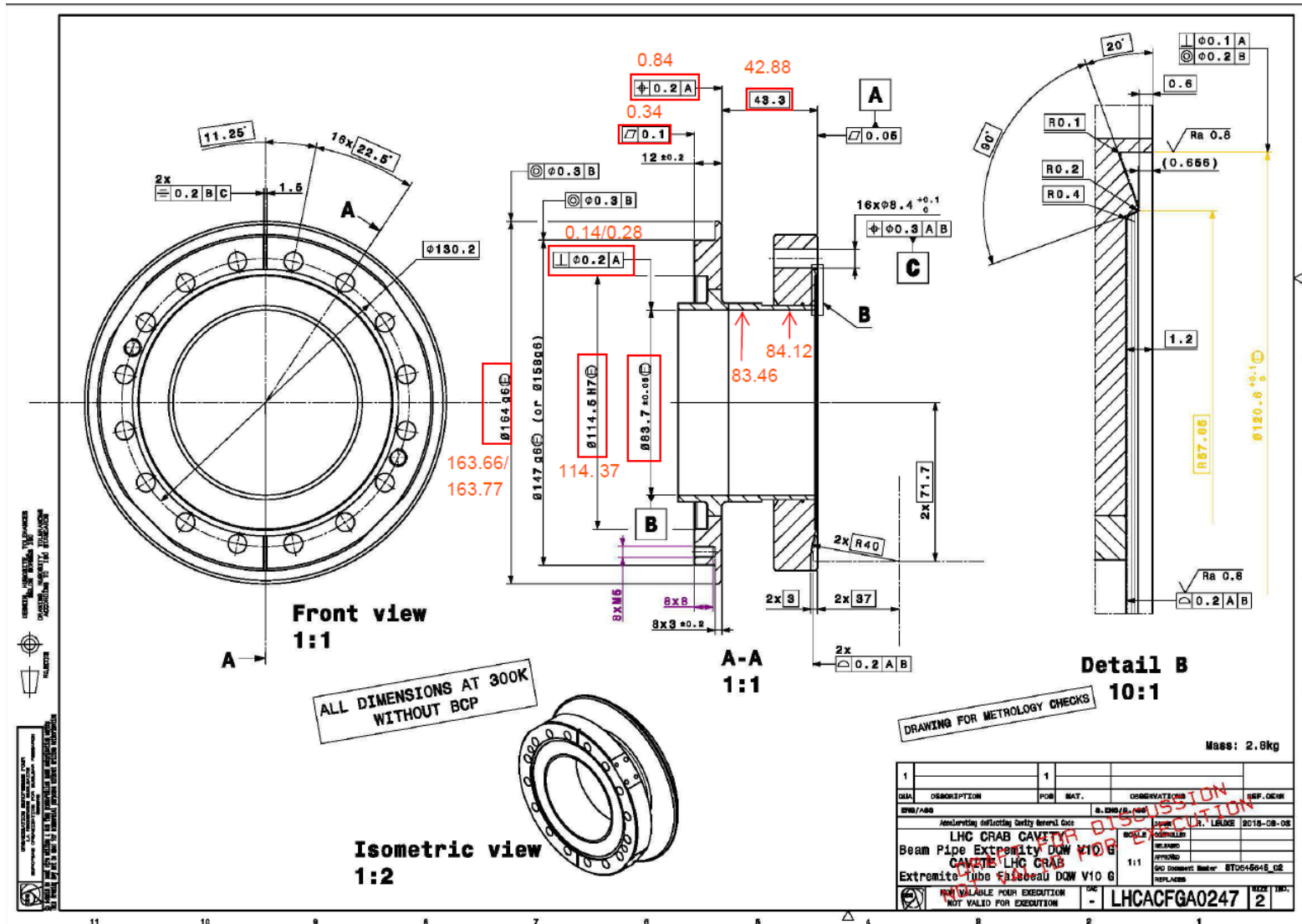
Beam tube testing at CERN





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Dimensional Control at CERN - some non compliance





Beam Pipe Testing Summary



Assembly and Dimensions:

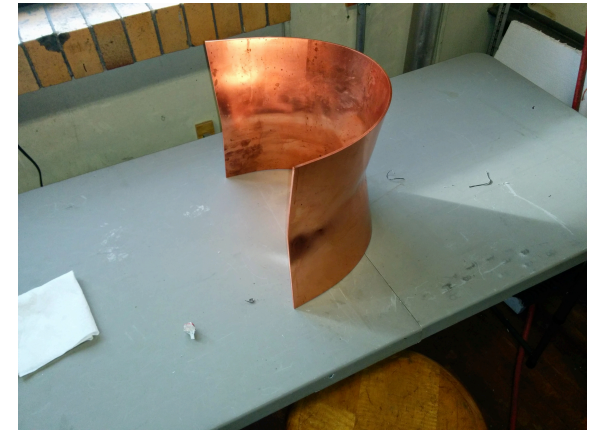
- Some dimensions are not compliant with spec. tolerances
 - The parallelism between the flange and the ring, and the diameter of the ring are the most relevant tolerances not achieved
- The knife edge is acceptable

Welding and brazing:

- Radiographic tests were acceptable
- Metallurgic tests were acceptable



Manufacturing Tooling and Testing

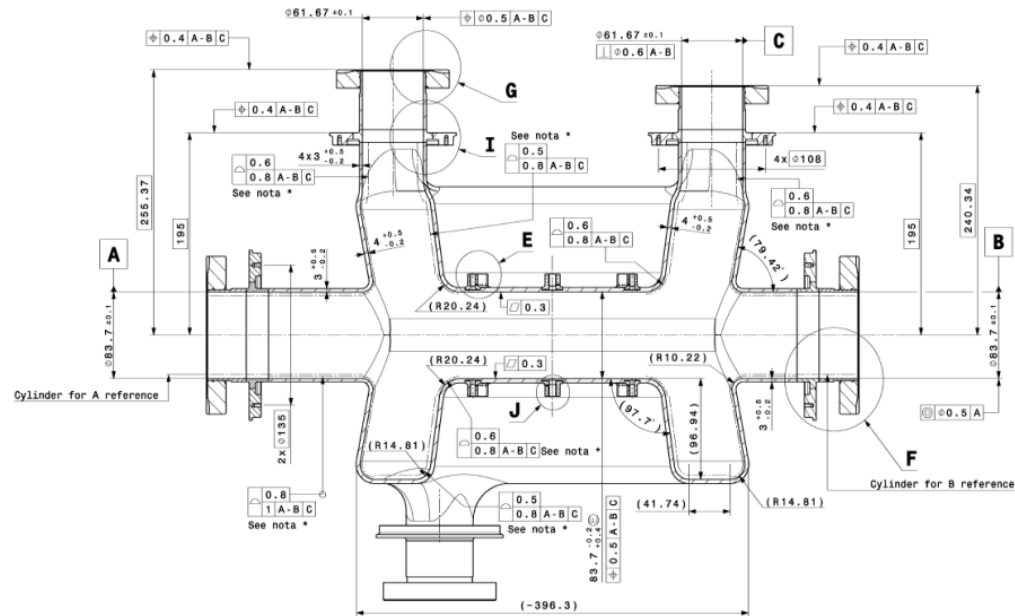
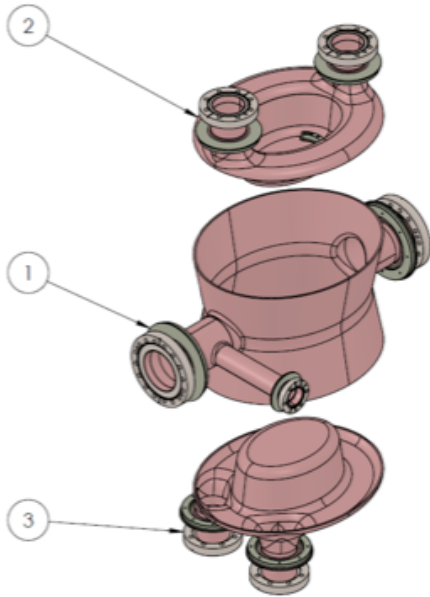
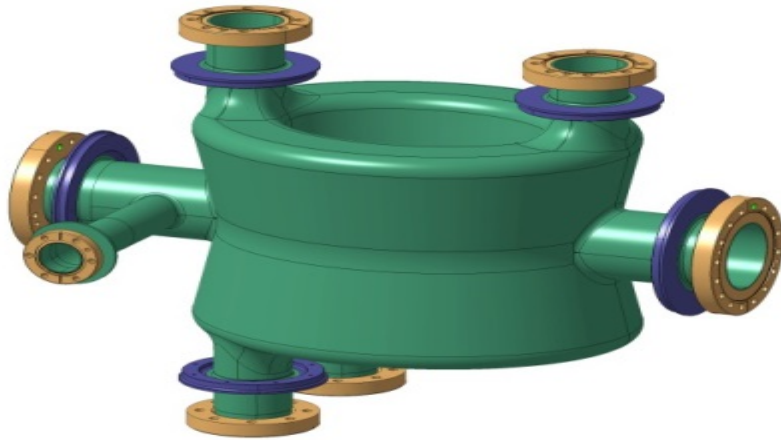


From Niowave





DQW – Assembly and Spec.



DQW – Outer Conductor

- Outer conductor halves
 - 4 halves etched, fixtured, and ready for weld

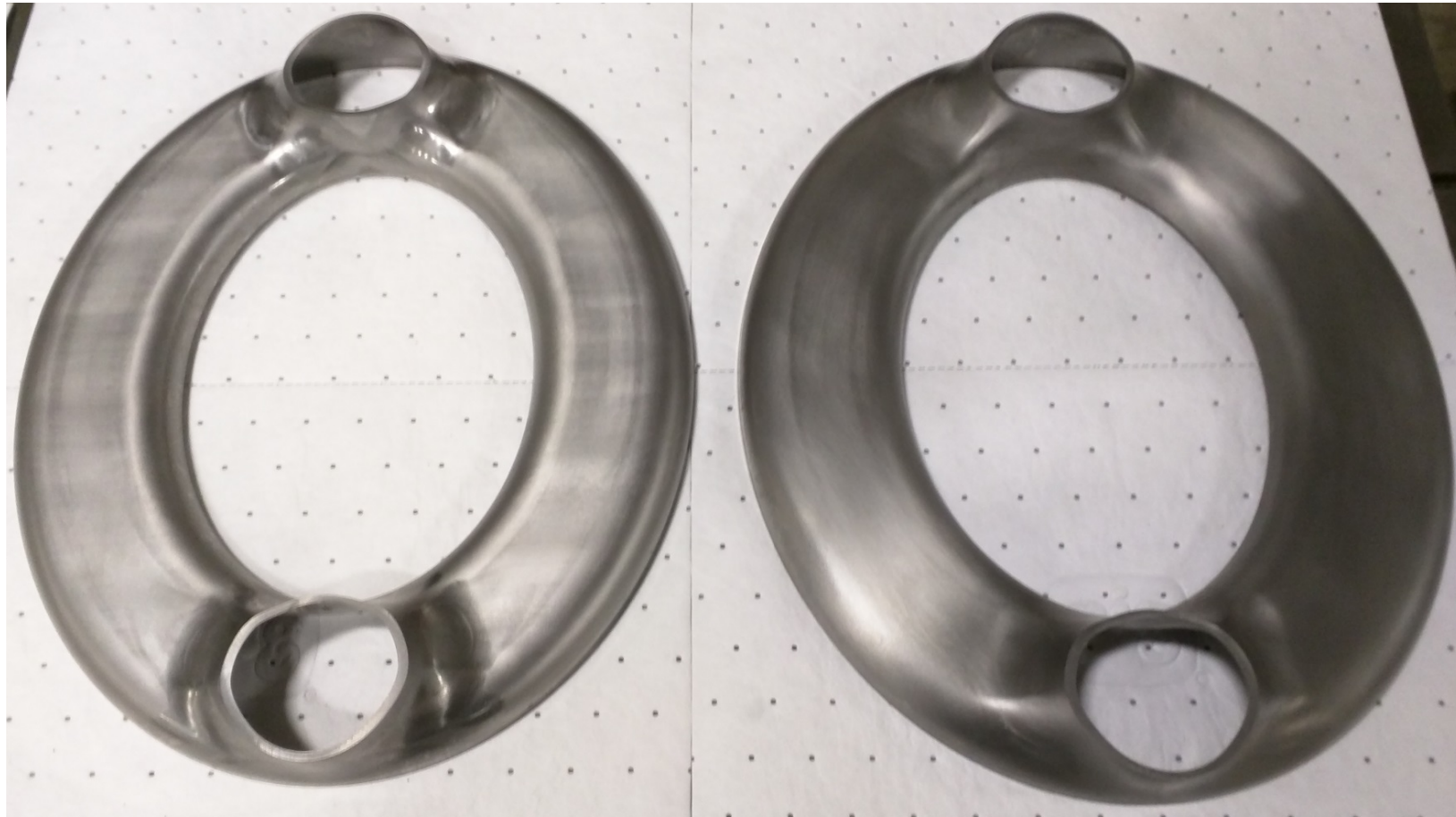




DQW – Cavity Lower End



- “Top cake pans”
 - 2 etched, and ready for weld





DQW – Cavity Upper Ends



- “Bottom cake pans”
 - 2 etched, and ready for weld





DQW - Cake pan assemblies



- Ready to weld



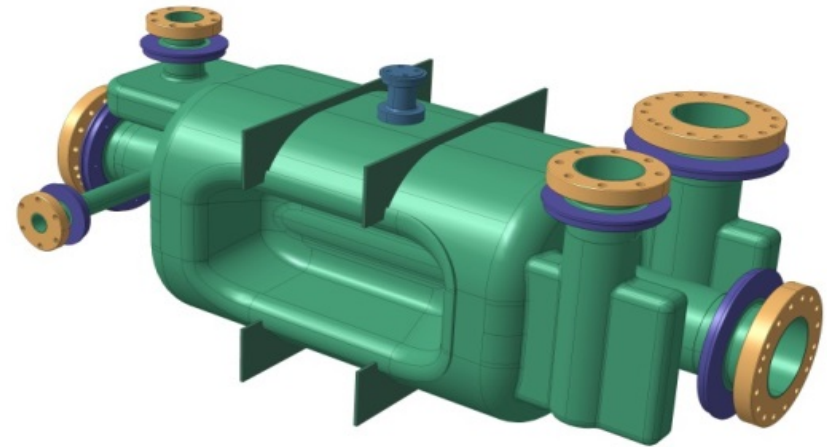
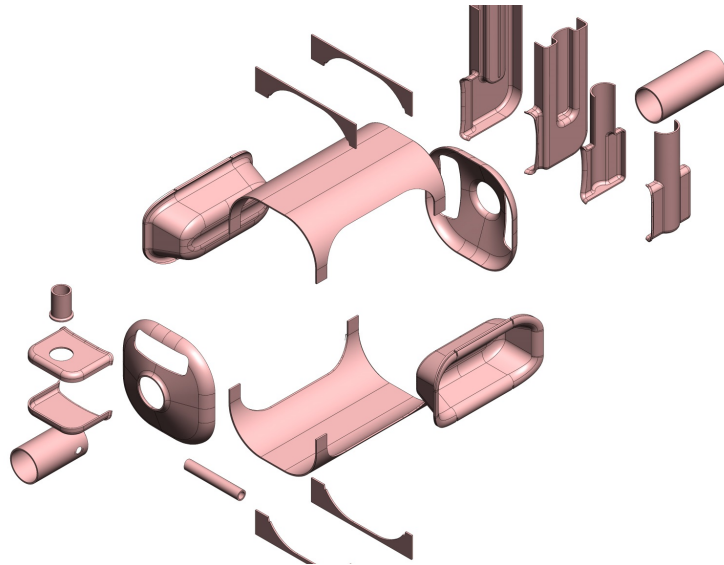
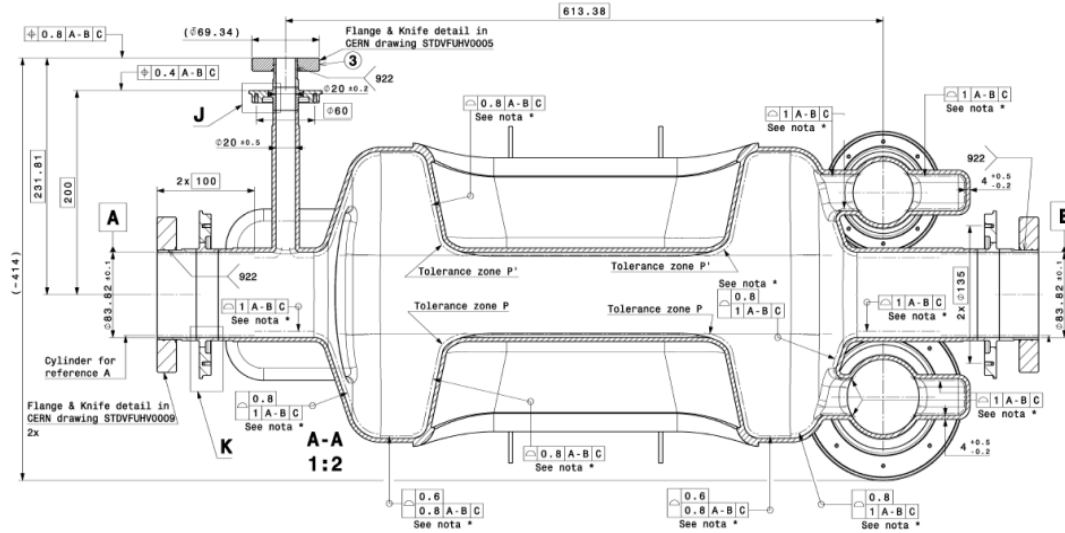
DQW – Inner Conductors

- “Bowls”
 - Complete
 - Etched, and ready for NbTi tuner attachment welds





RFD – Assembly and Spec.





RFD – Outer Conductor



- Outer conductor halves
 - Gages being fabricated for profile measurements





RFD — Inner Conductors



- Bowls: 2 Niobium stamped, 2 blanks cut
 - Expect stamping done this week





RFD - Stiffeners



- Stiffener: Niobium Stamped (yet to machine)





RFD – End Caps



- End cap: Niobium stamping in progress





RFD – HOM + FPC Ports



- Small HOM Box Side Port
 - 2 in QA (4 halves)





RFD — Power Couplers and HOM Ports



- FPC & HOM Box Port Halves
- Niobium blanks cut, ready to stamp





QA at the company



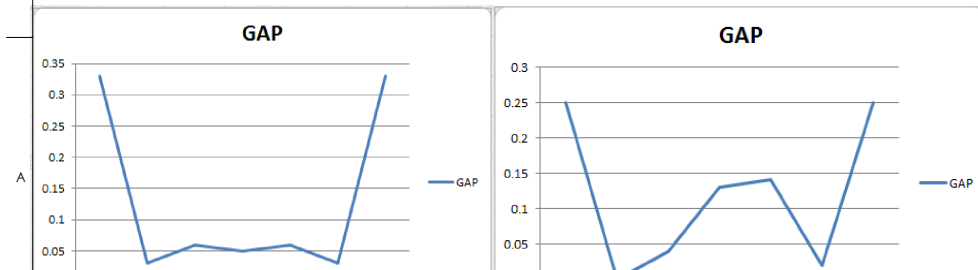
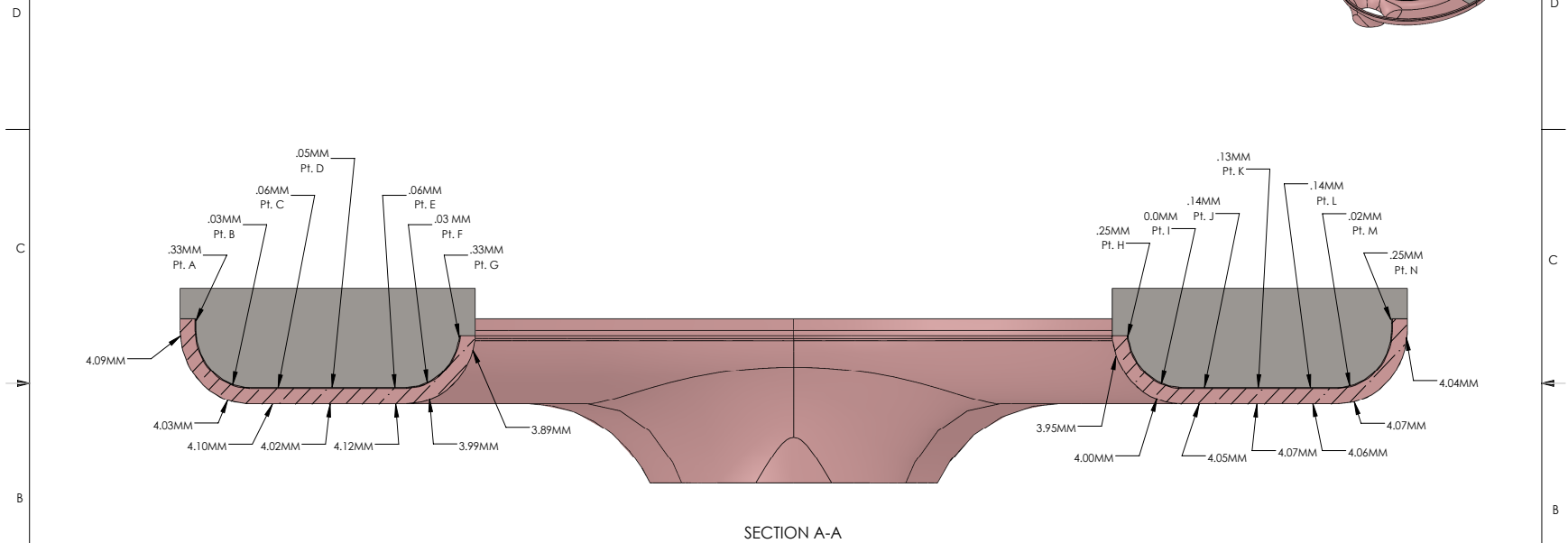
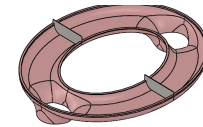
- Dimensions are checked against a reference and documented in Indico
 - Setting up EDMS folder
- About $\frac{1}{2}$ of the parts measured
 - A few variances, approved by the design teams



Nb Parts Measurements



- GREY AREA DEPICTS A CHECK FIXTURE ALLOWING FORM TO BE MEASURED. CHECK FIXTURE MADE WITH A .25MM GAP FROM THE NOMINAL CAKE PAN FORM.
- MATERIAL THICKNESS MEASUREMENTS WERE TAKEN WITH DIGITAL CALIPERS AT 12MM INCREMENTS.
- SHIM STOCK WAS USED ALONG THE FLAT GAUGE PINS IN RADIUS.



TOLERANCES: UNLESS OTHERWISE SPECIFIED, ARE IN INCHES. X.X = ± 0.1 X.XX = ± 0.01 X.XXX = ± 0.005 X.XXXX = ± 0.0005 X* = ± 0.5* X.X* = ± 0.1*	PROJECT MANAGER APPROVAL:	DATE:	NIOWAVE, INC. 1012 N. WALNUT ST. LANSING MI, 48906 www.niowaveinc.com
	MODELED BY:	DATE:	
PROPRIETARY & CONFIDENTIAL INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF NIOWAVE, INC. ANY REPRODUCTION IN PART	DETAILED, CHECKED BY:	DATE:	SCALE: 1:1 DATE: / /
	MANUFACTURING APPROVAL: DR. TERRY GRIMM	DATE:	
MATERIALS:		ESTIMATED WEIGHT: 6.66 lbs	



Summary from Niowave



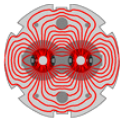
- Nearly all Nb parts are stamped
 - Waiting for 1/4" plates to finish stiffeners for one RFD
 - Due next week
- All parts are measured at the factory
 - Variances addressed on a case-by-case basis
- DQW bodies ready to weld
- RFD bodies will be ready to weld in about one month
- Beam pipe assemblies fabrication underway
 - First welding cycle this week
- CC team will visit Niowave on Thursday
 - Inspect all parts that are ready and available



Other CC Fabrication Activities



- HOM couplers and filters development
 - Finalized for SPS, presentation tomorrow
- Dressed Cavity integration and He Vessel Design
 - Review last week @ CERN, summary presentation tomorrow
- Cryomodule design and integration
 - Ongoing at CERN and the UK



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Short term plans

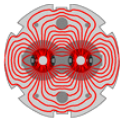
- Complete cavity fabrication
- Build two fully dressed cavities of each kind
 - Vertical test @ US lab before shipping
 - Ship at least two cavities of one kind by Dec. 2105
 - Ambitious but not impossible
 - Integrate cavities in cryomodule(s) for SPS test to begin in 2017



Conclusions



- Cavity production of both cavity designs is underway at our US industrial partner
- Finalizing dressed cavity design and its integration in cryomodule
- Schedule for SPS test remains very tight
- Active contributions from all collaborators



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Acknowledgments – The Team

- Contributions to this presentation came from the whole collaboration
 - BNL – S. Belomestnykh, S. Verdu-Andres, Q. Wu, B. Xiao
 - CERN – L. Alberty, R. Calaga, O. Capatina, T. Capelli, M. Garlasche, C. Zanoni (and more)
 - FNAL – T. Nicol
 - LBNL – A. Ratti
 - Niowave – J. Hollister, T. Grimm, S. Klass, E. Maddock, J. Yancey,
 - ODU – J. Delayen, H. Park, R. Olave, S. da Silva
 - LU/STFC – G. Burt, B. Hall, S. Pattalwar, N. Templeton
 - SLAC – Z. Li

And I'm sure there are more...



Questions





Production Plan from Eng. Spec.



BARE CAVITIES (WITH INTERFACES)

MANUFACTURING PROCESS

Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications
Niobium sheets	Supplier	Supplier	Supplier	Drawn Niobium parts	Supplier	Supplier	Supplier	SS flanges/Niobium parts	Supplier	Supplier	Supplier	SS Flanges - Niobium tube	Supplier	Supplier	Supplier	Brazed joints	Supplier	Supplier	Supplier
BC-1-QA				BC-2-QC				BC-3-QA				BC-4-QA				BC-5-QC			
Shaping and machining				Dimensional control				Cleaning and chemical polishing				Vacuum brazing				Visual examination			
Section 3.8.2 & 3.8.3				Section 4.1 - to be defined by supplier				Section 3.8.5 (Annex 6.5 and 6.6) - to be defined by supplier				Section 3.8.6 & 3.8.7 (ASME BPVC Section IX, part QB)				ASME BPVC Section V			
N/A				Functional drawings approved by CERN				N/A				N/A				ASME BPVC Section VIII Div. 1			
Report: N/A	Record: MIP	CERN control: N/A		Report: Yes	Record: MIP	CERN control: NP		Report: N/A	Record: MIP	CERN control: N/A		Report: N/A	Record: MIP	CERN control: N/A		Report: Yes	Record: MIP	CERN control: NP	

Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications
Brazed joints	Supplier	Supplier	EN ISO 9712 or SNT-TC-1A (ASNT) minimum level 2	Brazed assembly	Supplier	Supplier	N/A	EB assemblies	Supplier	Supplier	ASME BPVC Section IX, part QW	EB welded joints	Supplier	Supplier	EN ISO 9712 or SNT-TC-1A (ASNT) minimum level 2	EB welded joints	Supplier	Supplier	EN ISO 9712 or SNT-TC-1A (ASNT) minimum level 2
BC-8-QC				BC-9-QA				BC-10-QA				BC-11-QC				BC-12-QC			
Ultrasonic examination				Chemical polishing				Electron-beam (EB) welding				Visual examination				Radiographic examination			
ASTM E 1301				Section 3.8.5 (Annex 6.6) - to be defined by supplier				Section 3.8.7 & WPS (ASME BPVC Section IX, part QW)				ASME BPVC Section V				ASME BPVC Section V			
Section 4.2.2 Table 7				N/A				N/A				ISO 13919-2 & Table 6 of Section 4.2.1				ISO 12919-2 & Table 6 of Section 4.2.1			
Report: Yes	Record: WIR	CERN control: NP		Report: No	Record: MIP	CERN control: N/A		Report: N/A	Record: MIP	CERN control: N/A		Report: Yes	Record: WIR	CERN control: NP		Report: Yes	Record: WIR	CERN control: NP	

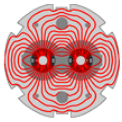
Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications
Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	ISO 3530 or ASME BPVC Section V	Cavity	Supplier	Supplier	EN ISO 9712 or SNT-TC-1A (ASNT) minimum level 2	Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	Supplier
BC-15-QC				BC-16-QC				BC-17-QA				BC-18-QC				BC-19-QA			
Dimensional control				Helium leak tightness test				Packaging & shipping											
Section 4.3 - to be defined by supplier				EN 13385 or ASME BPVC Section V				Section 3.9 - to be defined by supplier											
Functional drawings approved by CERN				Section 4.4				N/A											
Report: Yes	Record: MIP	CERN control: NP		Report: Yes	Record: MIP	CERN control: NP		Report: No	Record: MIP	CERN control: NP									

MIP Manufacturing and Inspection Plan
 WIR Welding Inspection Record
 N/A Not applicable
 NP Hold Point
 NP Notification Point

FINALIZATION OF MANUFACTURING PROCESS

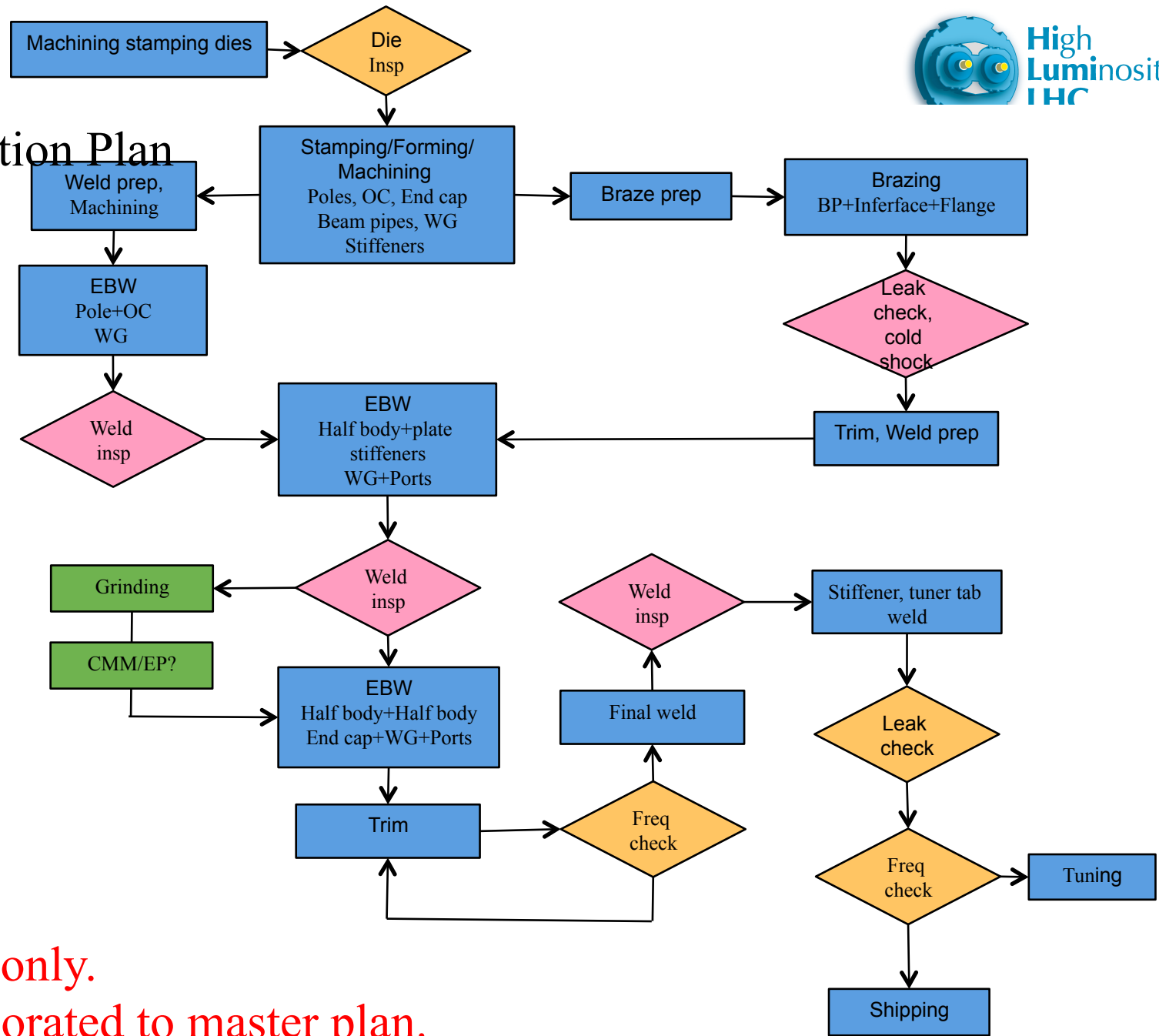
Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications	Materials	Equipment	Tools	Training/qualifications
Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	Supplier	Cavity	Supplier	Supplier	Supplier
BC-18-QA				BC-19-QA				BC-20-QA				BC-21-QA				BC-22-QC			
Bulk chemical polishing				Heat treatment				Light chemical polishing				High pressure water rinse				RF acceptance tests at cold temperature			
Section 3.8.5 (Annex 6.6) and Section 3.10 - to be defined by supplier				Section 3.10.1 - to be defined by supplier				Section 3.8.5 (Annex 6.4) and Section 3.10 - to be defined by supplier				Section 3.10.2 - to be defined by the supplier				To be defined by supplier			
N/A				N/A				N/A				N/A				Section 4.6			
Report: No	Record: MIP	CERN control: N/A		Report: No	Record: MIP	CERN control: N/A		Report: No	Record: MIP	CERN control: N/A		Report: No	Record: MIP	CERN control: N/A		Report: Yes	Record: MIP	CERN control: NP	





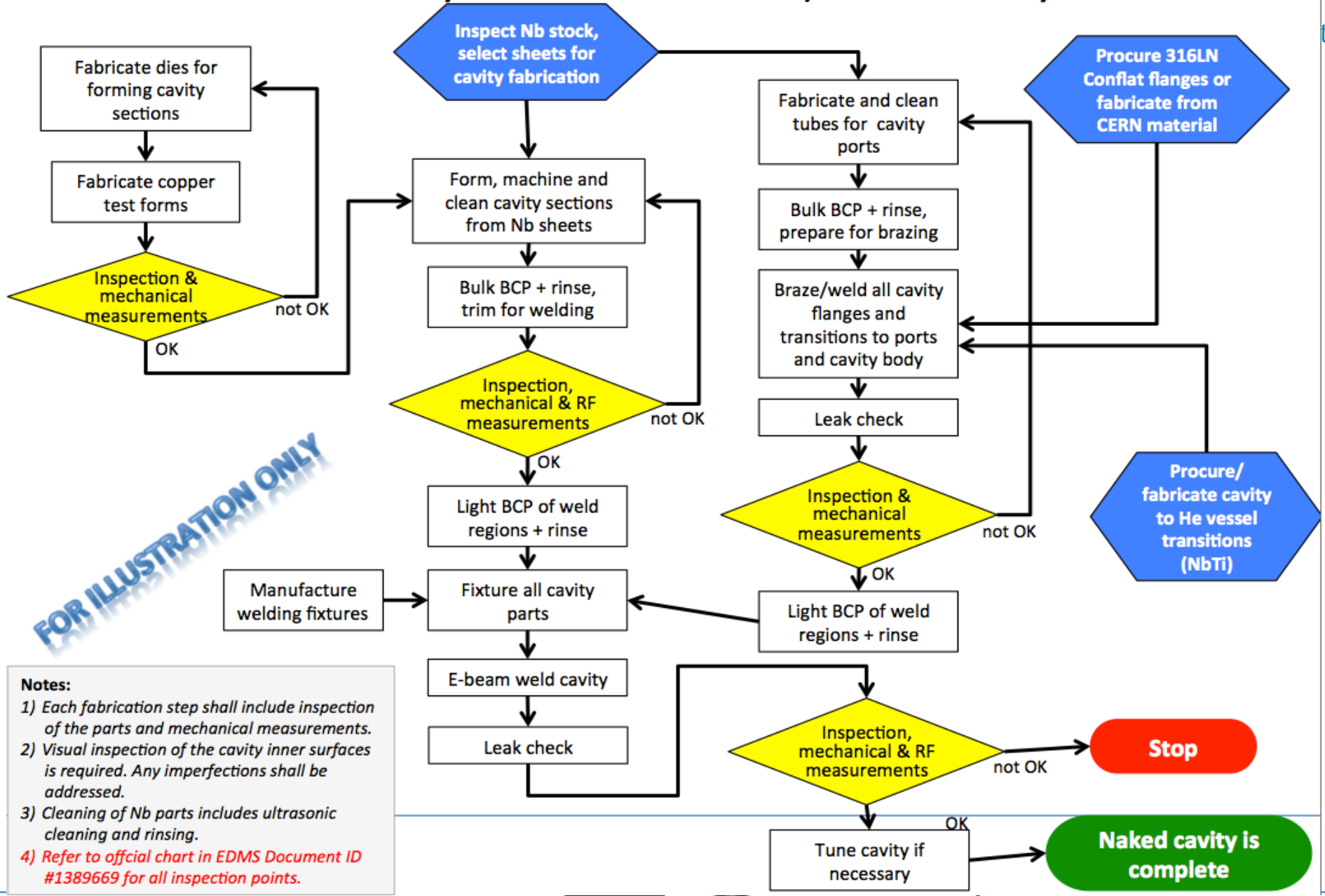
RFD Fabrication Plan

- Niowave
- Niowave+ODU
- ODU
- LARP+ODU



Information only.
To be incorporated to master plan.

DQWCC Cavity Fabrication Plan: 1) Naked cavity



FOR ILLUSTRATION ONLY

- Notes:**
- 1) Each fabrication step shall include inspection of the parts and mechanical measurements.
 - 2) Visual inspection of the cavity inner surfaces is required. Any imperfections shall be addressed.
 - 3) Cleaning of Nb parts includes ultrasonic cleaning and rinsing.
 - 4) Refer to official chart in EDMS Document ID #1389669 for all inspection points.