Development and Production of NSLS II by AES MOM Vacuum Group

An overview of the role that the AES-MOM vacuum group contributed to the NSLS II project. A 6-year project (2006 – 2012) started with contributing to final designs focused to weld joints and vacuum certification. Our group then focused on automated weld development, pre-production welding, Q/A measurement, cleaning and testing. After several full size pre-production vacuum chambers we completed and vacuum certified, the group then went into full production of NSLS II completing an average of 8 chambers a month on time and under budget while supporting APS. NSLS II on track to be ready for operation in 2015.

AES-MOM Vacuum Group - Who we are

Staff

- **George Goeppner** – Group Leader
- **Joe Gagliano** – Section Leader
- **John Hoyt** - Engineer
- **Try Leng Kruy** – Engineer
- **Mark Martens** – Chief Technician
- **John Zientek** - Engineer

Technicians

- **Scott Abbeduto**
- **Jack Burke**
- **Cheri Giacomi**
- **Guy Harris**
- **Kevin Knoerzer**
- **Aaron Lopez**
- **Raul Mascote**
- **Wayne Michalek**
- **Russ Otto**
- **Cristen Sarne (CJ)**
- **Robert Wilson**

AES-MOM Vacuum Group – What we do

- **Provide support for all APS vacuum related equipment**
  - Linac, Par, Booster, Storage Ring and Front Ends
- **Provide support for all pneumatic related systems**
  - Gate valves, safety shutters, photon shutters and beamline pneumatic doors
- **Provide support to the USER community**
  - USER Beamlines (vacuum and pneumatic systems)
- **Unique fabrication capabilities in building 382**
  - Aqueous cleaning, robotic welding, inspection of components, vacuum leak checking, high temperature vacuum oven, assembly of critical components, vacuum testing and vacuum certification
- **Services available to all of ANL and DOE laboratories**

Building a Storage Ring

- Contribution
- Development
- Production
  - Inventory
  - Q/A
  - Cleaning
  - Assembly
  - Certification

NSLS II Specifications

- Nominal Energy 3 GeV
- Nominal Current 500 ma

Building 382 – "UHV Vacuum Factory"

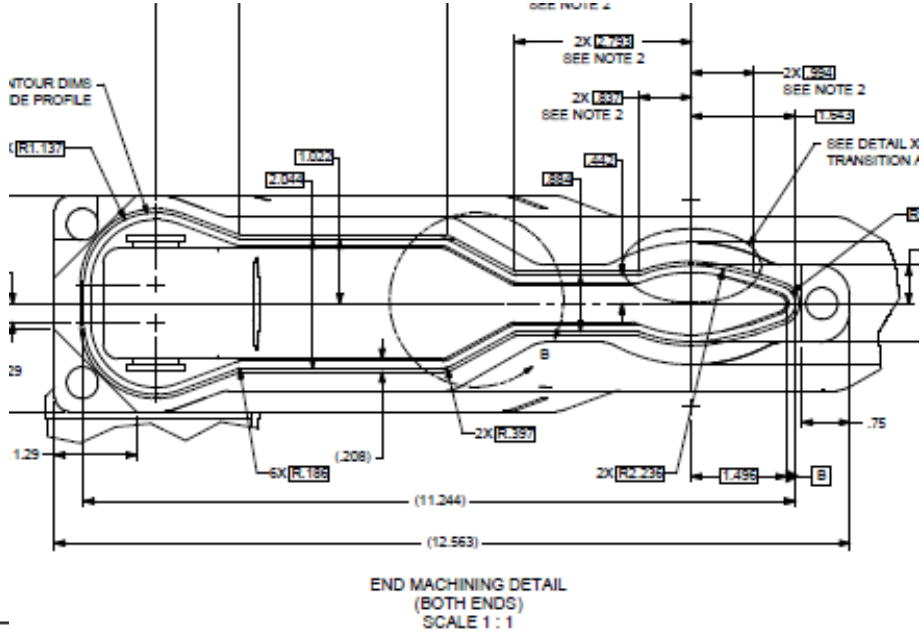
- **Complete fabrication facility**
  - Traveler and associated documentation to accompany each component
  - Inspection
  - Aqueous cleaning
  - Baking of vacuum components
  - Welding
  - Assembly and testing

- **Precision advanced arc welding systems**
  - Multi-axis contouring, integrating all welding parameters for a given weld path

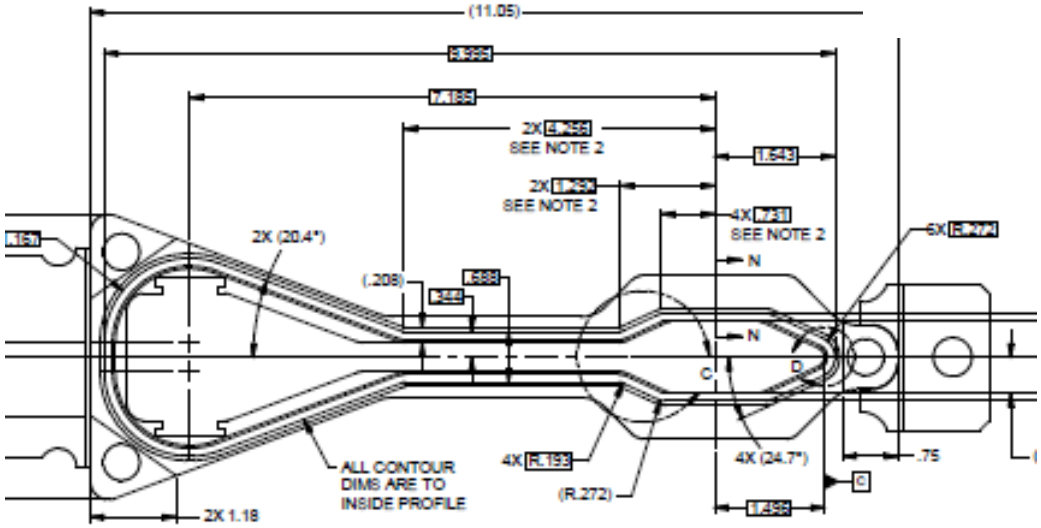
Contribution

- Similar step joint profile to APS

Dipole



END MACHINING DETAIL
(BOTH ENDS)
SCALE 1 : 1



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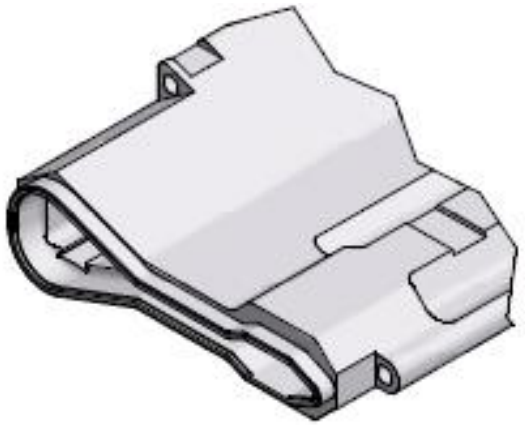
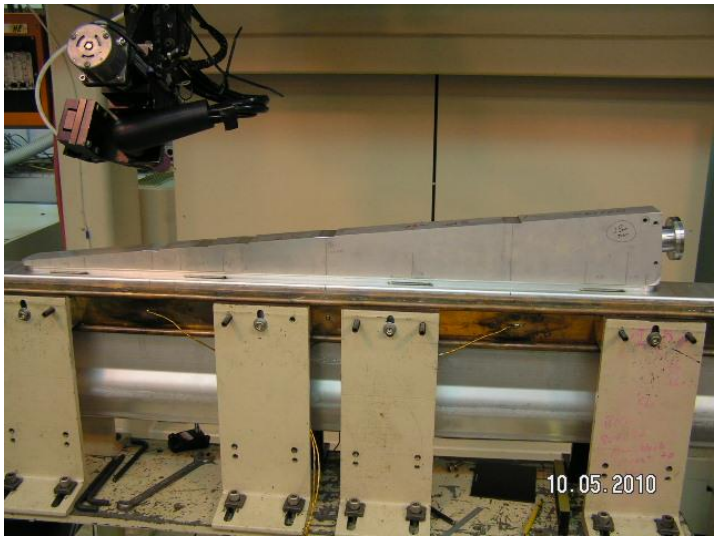


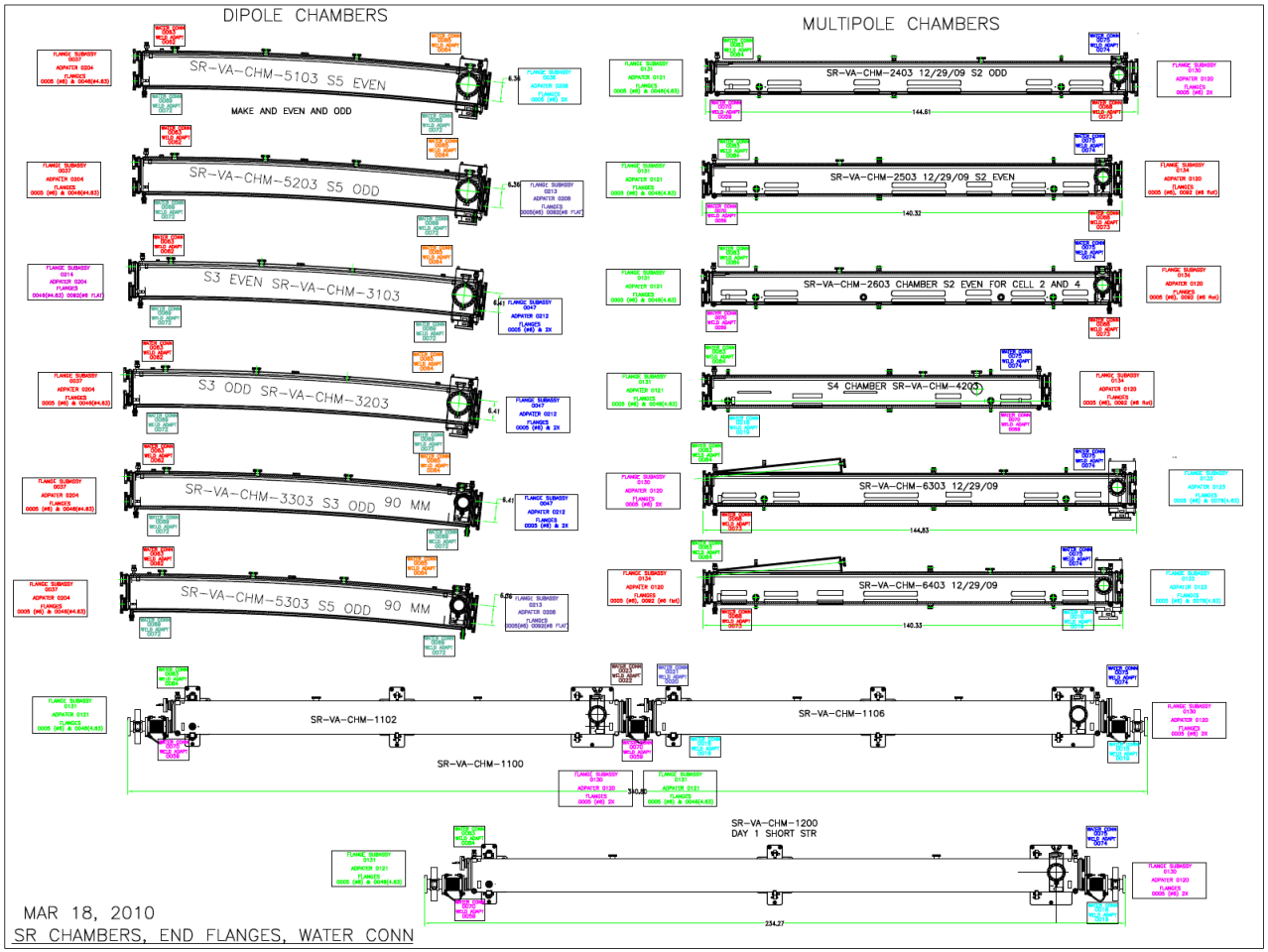
Multipole

Development

- Vacuum chamber material
  - Chamber 6063
  - Transition and Exit port 2219
  - Flange 6061 explosion bond to Stainless steel
- Flange issues during inspection
  - Leaking bi-metal joint
  - Wrong grade of aluminum
  - Porosity
  - Resulted in over 100 flanges recalled



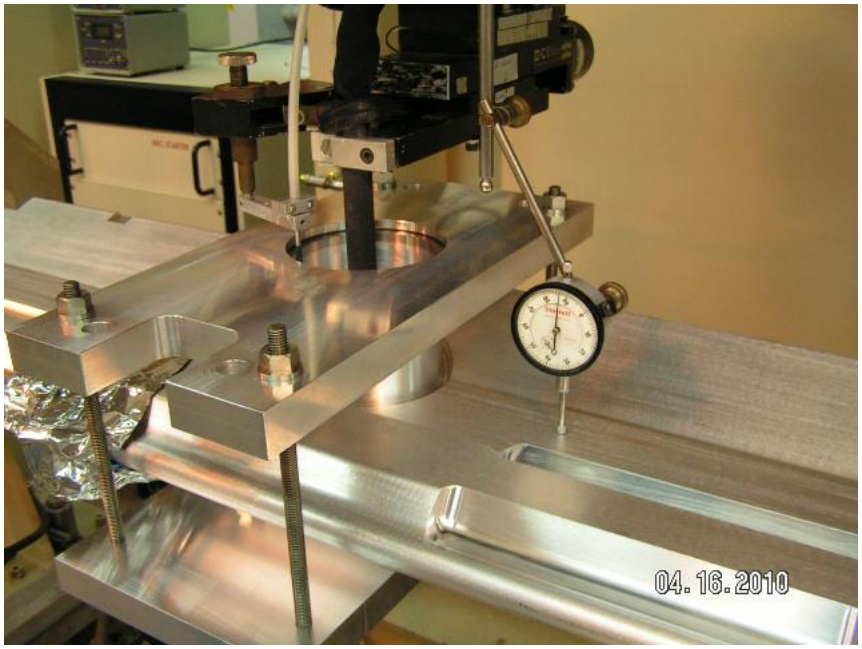
Development

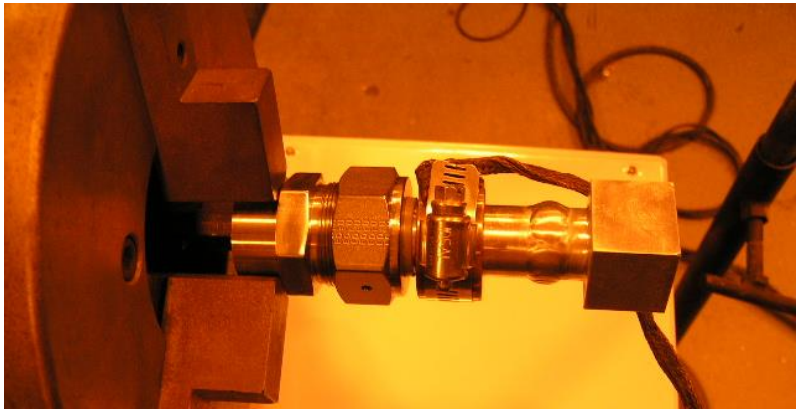


- 8 unique di-pole chamber designs
- 8 unique multi-pole chamber designs
- 3 straight sections to fill in for future ID chambers
- 218 vacuum chambers built

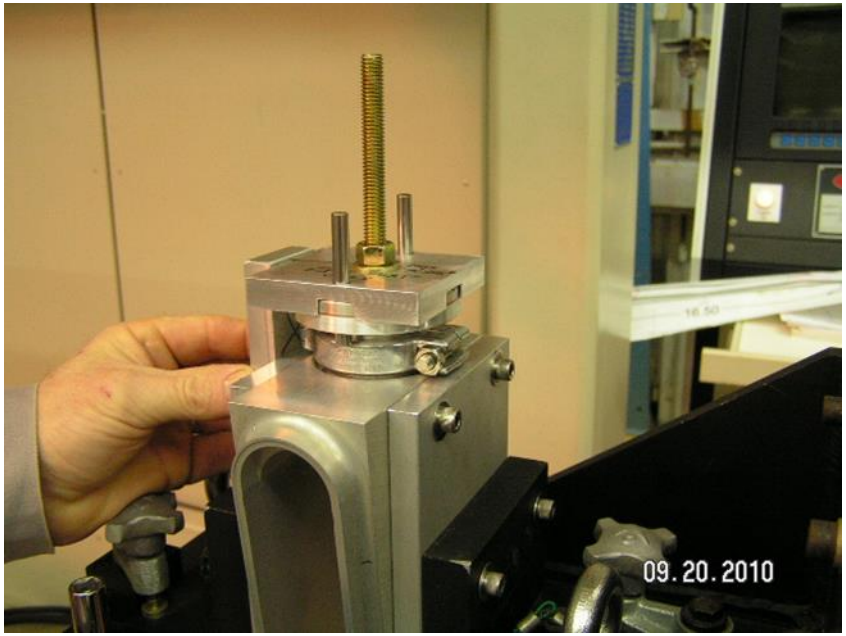
Development - Tooling

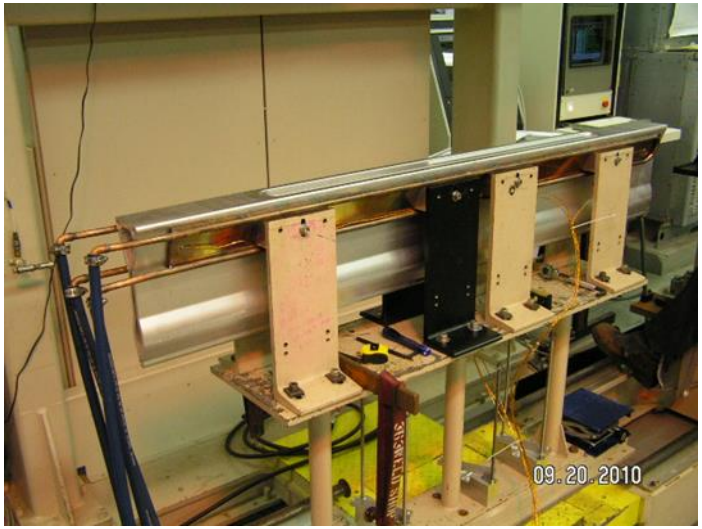
- All new tooling was developed by MOM – Vacuum group and fabricated in Central Shops

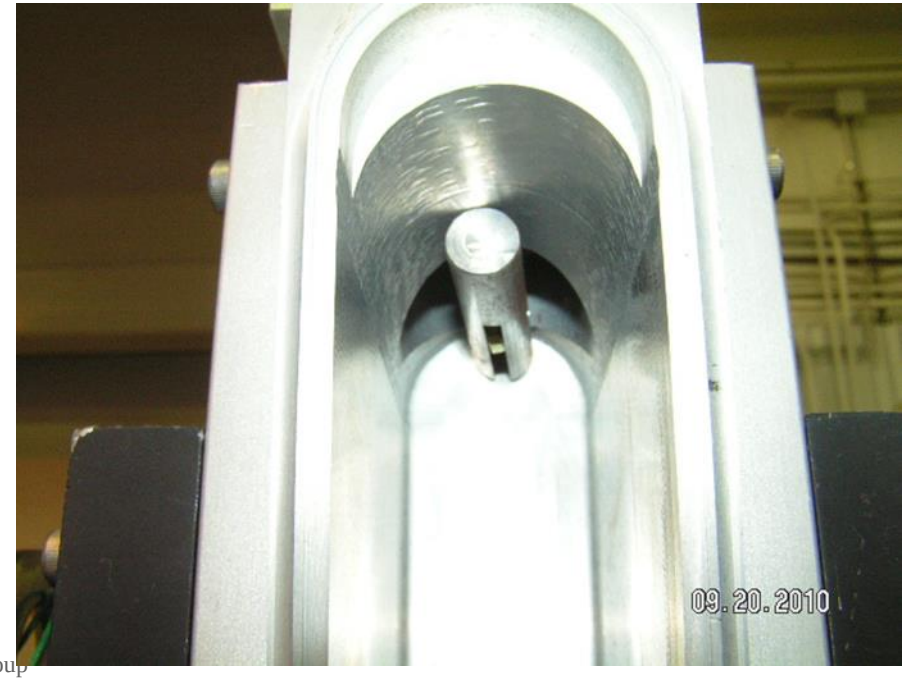




Development - Tooling



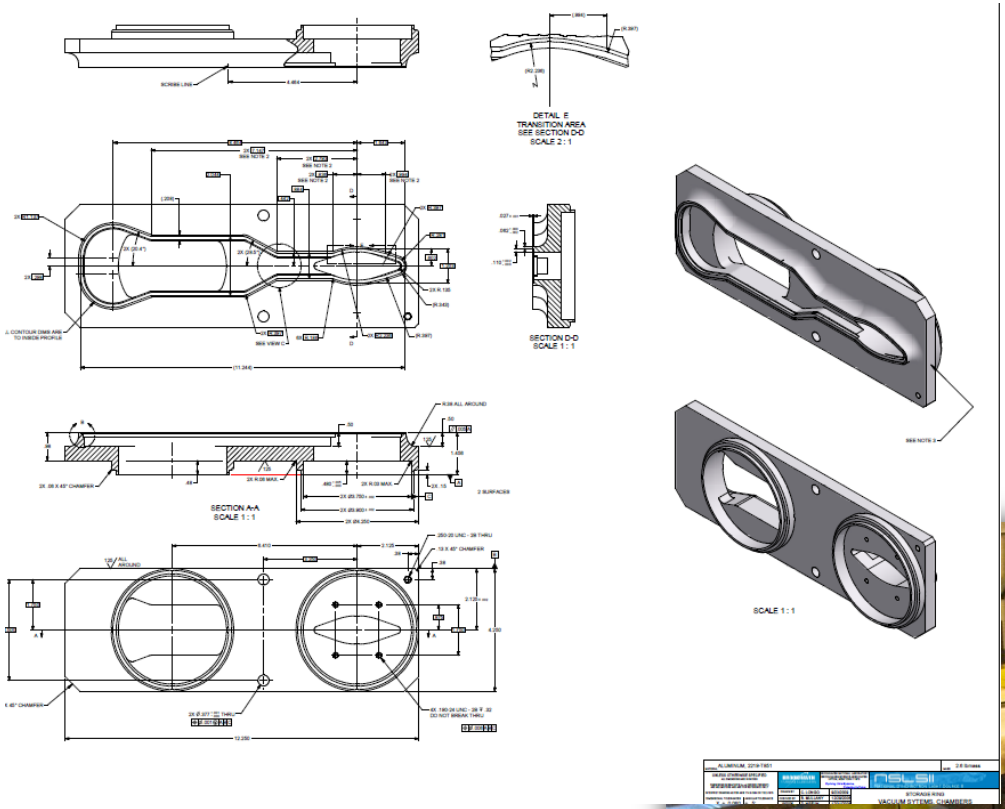




Production - Inventory

- 6 to 8 weeks of parts
- Average 8 chambers a month

Production - Q/A



- Random selection of each part for dimension check
- Go no-go gauge
- Pre weld leak check of Bi-metal flange

Production – Aqueous Cleaning

Production - Traveler

- Every part has documentation to follow it through to final production
- The complete multipage document is scanned to a pdf and filed for future reference

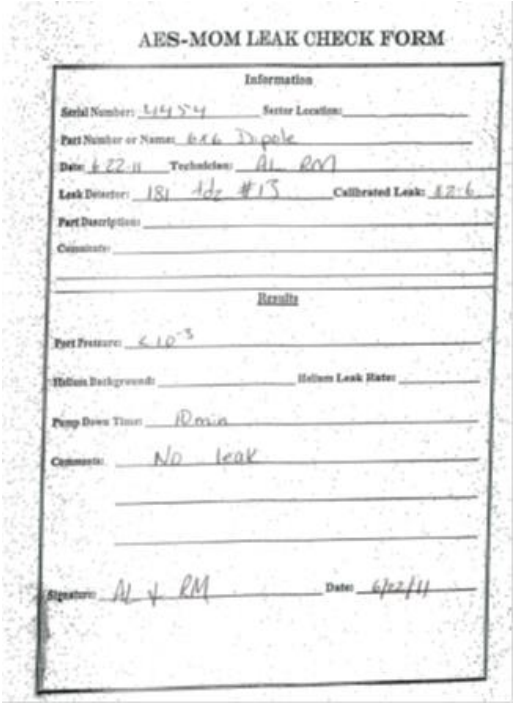
BNL PRODUCTION TRAVELER

Assembly No. 6303 56 Euro

Serial No. 0616

	INITIAL DATE IN	INITIAL DATE OUT	COMMENTS
Chamber Received	SZ 5/1/11	SZ 5/1/11	
Chamber Inspected	22 10/26/11	23 10/26/11	
Chamber Pwr Wash Ridoline 18	BF/SA 10/27/11	BF/SA 10/27/11	
Chamber Cleaned Citronox Ultrasonic	BF/SA 10/27/11	BF/SA 10/27/11	
Chamber Welded Water fitting, RF block, Router	DVL 11-2-11	RR 11-14-11	
Check 3 3/8 port with gauge	DVL 11-11-11	DVL 11-11-11	
Chamber Leak Tested	11-14-11 AL GH	11-14-11 GH AL	Found Leak 3 3/8 Repair Leak
BPM Polish	11-14-11 SY	11-14-11 SY	
Chamber Post-cleaned Citronox No Untrasonic	BF/SA 11/15/11	BF/SA 11/15/11	
Chamber Assembly		11/17/11 AL/GH/RM	
Chamber Bakeout	12/2 GH/AL/RM	12/3/11 AH/RM	
Chamber Final Leak Check		12/5/11 GH/AL	
Prepare For Shipping		12/5/11 GH/AL/RM	

Production - Traveler



AES-MOM LEAK CHECK FORM

Information

Serial Number: 11454 Sector Location:

Part Number or Name: 6x6 Dipole

Date: 6-22-11 Technician: AL RM

Leak Detector: 181 1d2 #13 Calibrated Leak: 2.2-6

Part Description:

Comments:

Results

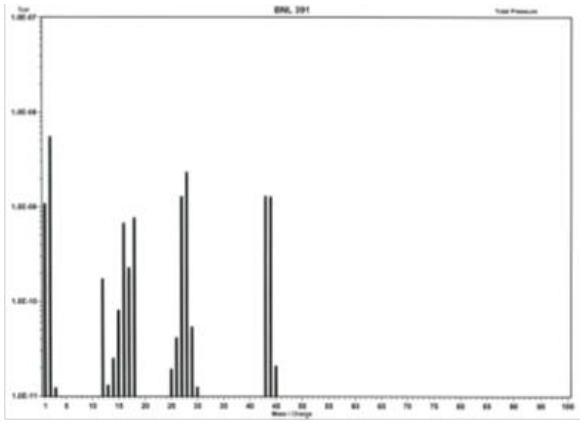
Part Pressure: < 10^-3

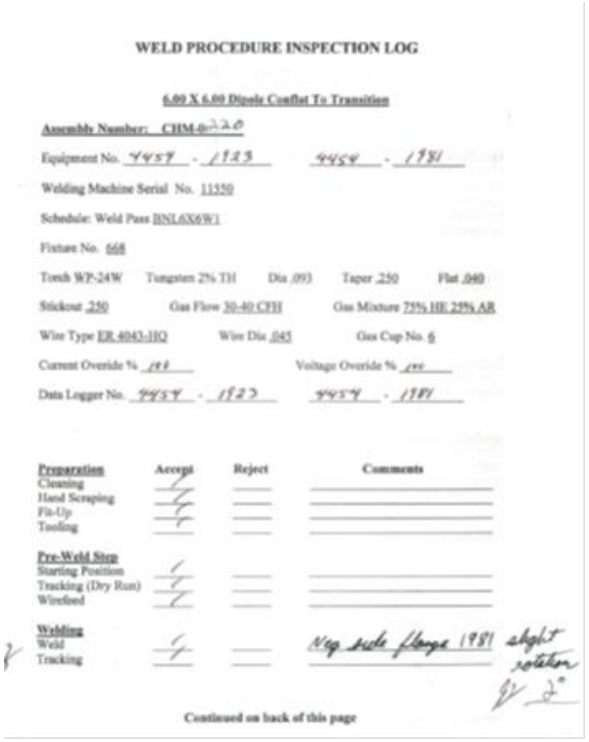
Helium Background: Helium Leak Rate:

Pump Down Time: 10min

Comments: NO leak

Signature: AL & RM Date: 6/22/11





WELD PROCEDURE INSPECTION LOG

6.00 X 6.00 Dipole Conflat To Transition

Assembly Number: CHM-0220

Equipment No. 9459 - 1825 9459 - 1981

Welding Machine Serial No. 11550

Schedule: Weld Pass BNL6X6W1

Fixture No. 668

Torch WP-24W Tungsten 2% TH Dia .093 Taper .250 Flat .040

Stickout .250 Gas Flow 30-40 CFH Gas Mixture 75% HE 25% AR

Wire Type ER 4043-HQ Wire Dia .045 Gas Cup No. 6

Current Override % 98 Voltage Override % 100

Data Logger No. 9459 - 1825 9459 - 1981

Preparation	Accept	Reject	Comments
Cleaning	✓		
Hand Scraping	✓		
Fit-Up	✓		
Tooling	✓		
Pre-Weld Step			
Starting Position	✓		
Tracking (Dry Run)	✓		
Wirefeed	✓		
Welding			
Weld	✓		Neg side flange 1981 slight rotation
Tracking	✓		

Continued on back of this page

BNL TEST LOG

Chamber No. 591

Assembly

	Accept	Reject	Comments
Post weld leak check	✓		
Inspect chamber for contamination	✓		
Inspect upstream flanges	✓		
Inspect downstream flanges	✓		
Inspect pump out flange	✓		
Inspect instrumentation flanges	✓		
Inspect absorber flange	✓		
Inspect BPM finish	N/A		
Inspect exit port flange	✓		

Bakeout

18 degree per hour ramp	Chamber Temperature	Chamber Pressure	Date / Time	Comments
Initial temperature	23°C	7.1e-8	7/18/11	
Ramp up to 135 C	135°C	9.3e-9	7/20/11	
Hold @ 135 for 16 hours	135°C	9.3e-9	7/21/11	
Isolate chamber	87°C	1.2e-7	7/21/11	
Ramp down to Initial temperature	135°C	9.3e-9	7/21/11	
RGA scan	25°C	1.0e-9	7/29/11	

Final Leak Check and Prepare For Shipping

	Accept	Reject	Comments
Final leak check	✓		
Pressure test water channel with He @ 30 PSI			

Tested By AL GH & RM Date 7-20-11

Approved By [signature] Date 7/25/11

- Inspection
- Leak Check
- Certification test log
- RGA

Precision Advanced Arc Welding Systems

- **Manual and Automated welding services**
  - Provide weld development
  - Provide welded components that meet or exceed Mil Spec requirements

- **Components fabricated using automated welding equipment**
  - All aluminum vacuum chambers for APS
  - All aluminum ID vacuum chambers for APS

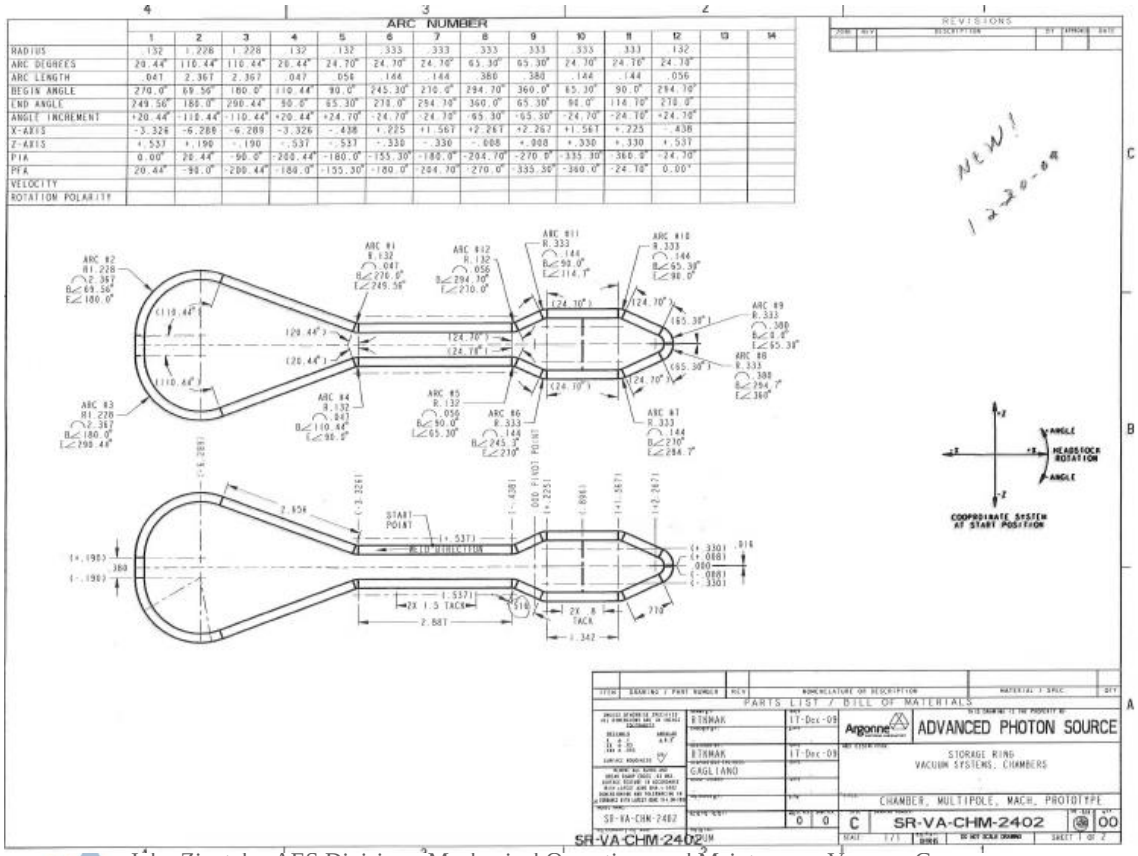
Components Fabricated at APS

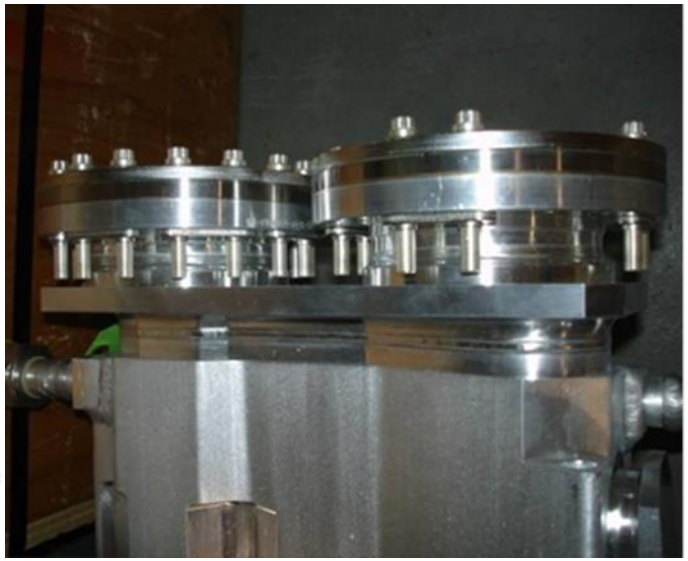
- APS Storage Ring
- BESSY II chambers
- DESY FEL chambers
- SLS chambers
- ESRF chamber
- CLS chambers
- LBL chambers
- KEK chambers
- NSLSII storage ring chambers
- LCLS chambers

Fermi Numi Horn fabricated at Argonne using innovative welding methods to assemble and straighten the Numi Horn for Fermi lab Neutrino Experiment

Production - welding

- Part drawings are used to create programs for the automated welding system
- The process involves several months of development

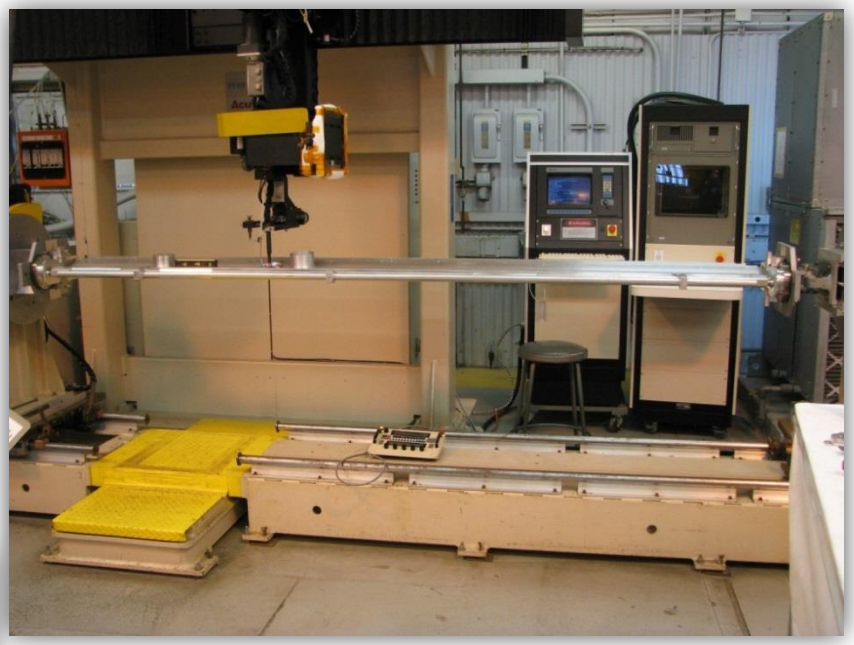


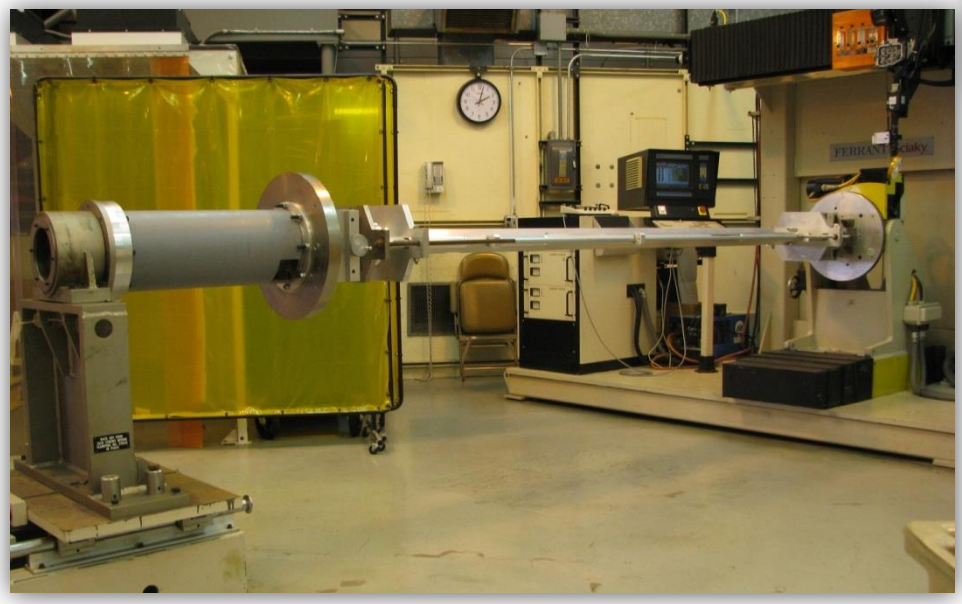


Final A-joint weld

Production - Assembly

NSLS II Chamber





Video
weld
bend

Production - Certification

Vacuum Oven

Vacuum Chamber Testing and Certification

Thank you

- George Goeppner
- Joe Gagliano
- Charles Hetzel - BNL
- Nick Sereno
- MOM Vacuum Group