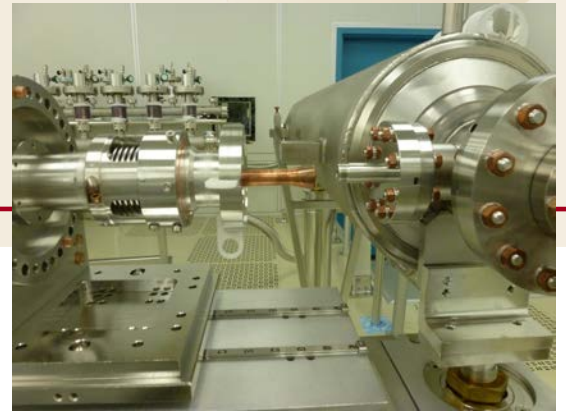
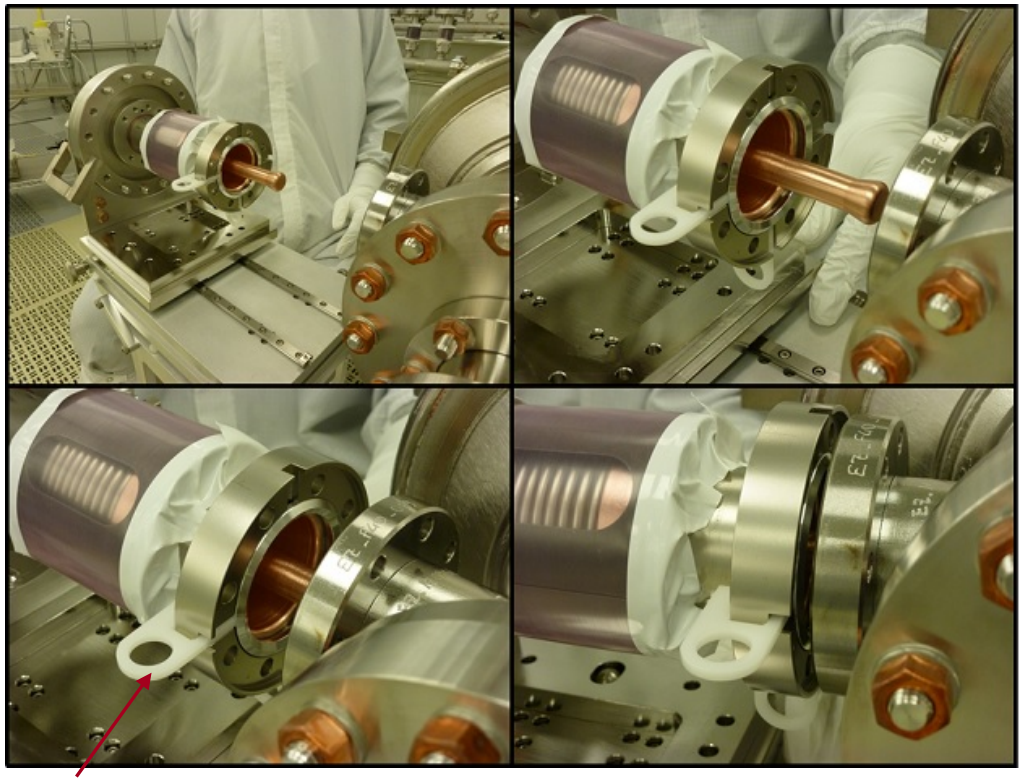
Cold End Coupler Assembly (WS0)



- Verify torque and tighten as needed all the fasteners for the cavity beamline(under vacuum) as received ***(starting from CM07)***
- Assemble pump/backfill/purge flex hose to the cavity
- Record as received vacuum levels
- Leak check, RGA
- Backfill the cavity
- Remove a cold end coupler from the storage manifold
- Assemble cold end coupler to the cavity using particle free flange assembly (PFFA) procedures
- Pump down, leak check, RGA
- Backfill



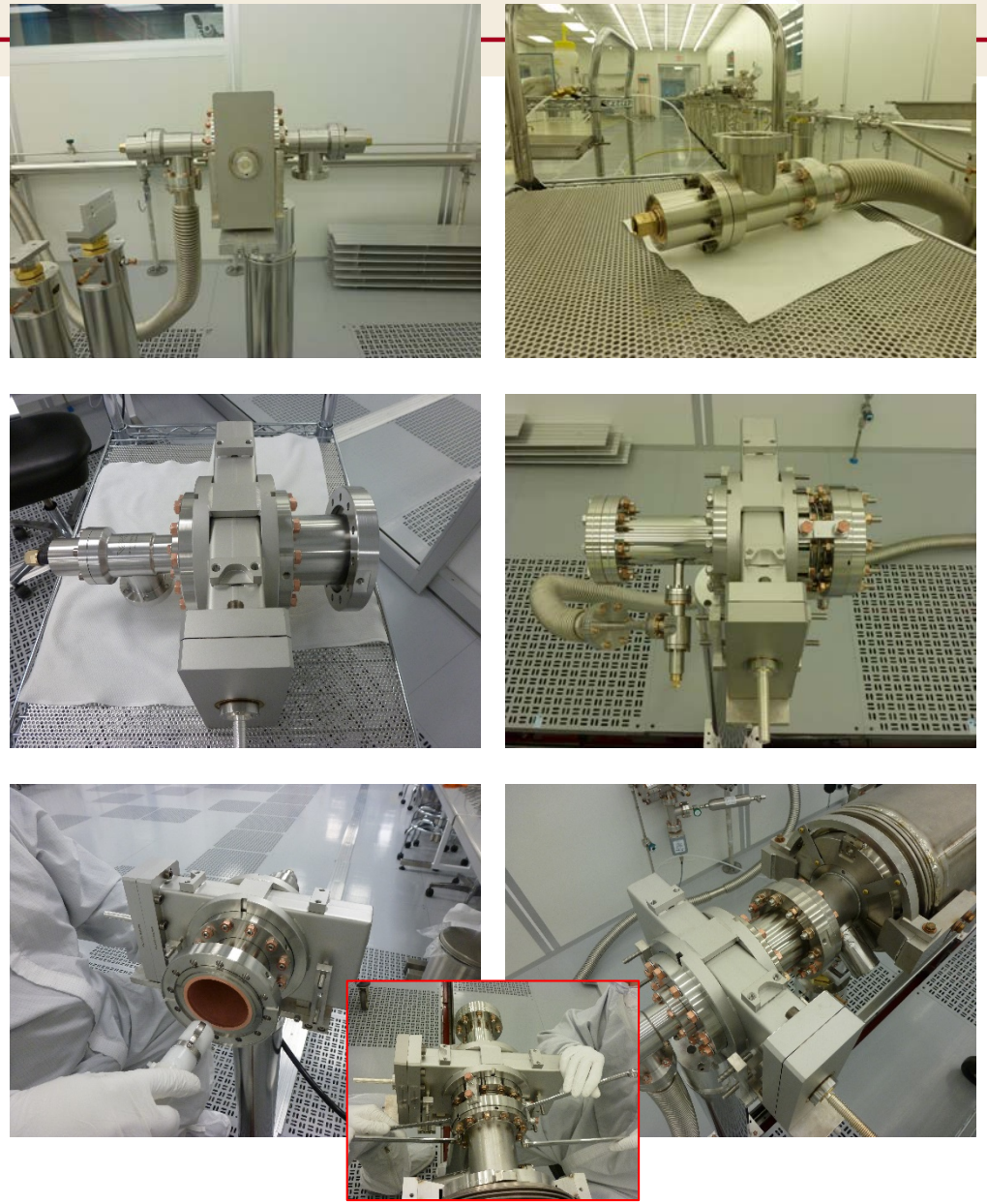
Starting from CM07, we introduced gasket holder (JLab design)

FPC Cold Ends

- Contrast to XFEL CMs production module, FPC are fabricated, cleaned, baked and sent directly to Labs. No RF processing before assembly to the cavities
- Incoming QC is limited to visual QC
- Due to parts in circulation shortage, extra handling of the cold end couplers: Remove from shipping stands and install on storage stands (stored under vacuum)

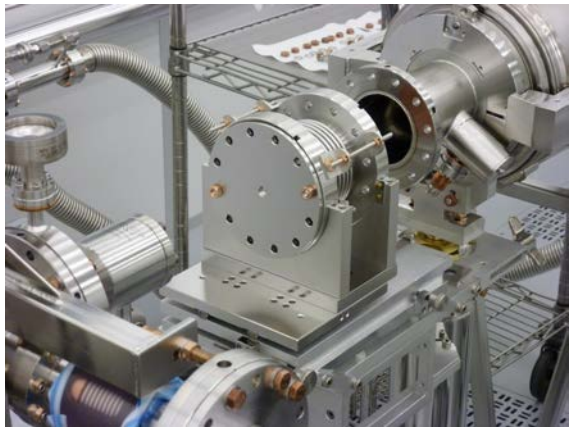
String Assembly-I (WS1)

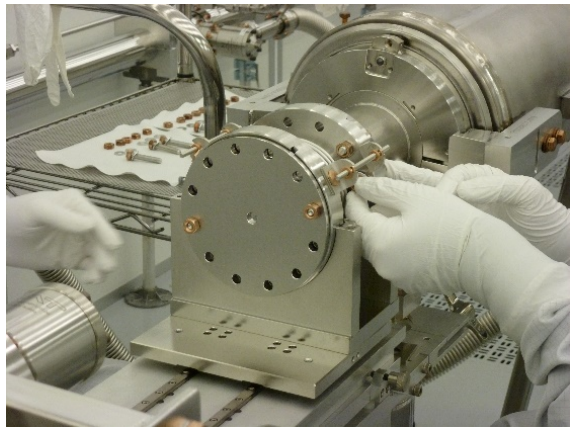
- Leak check gate valves and right angles valves before string assembly ***(started with CM05)***
- Align 8 cavities for string assembly
- Gate Valve (GV1) to Cavity #1 Assembly:
  - Check the particle free cleanliness of the GV and clean as needed
  - Sub-assembly of the GV peripherals
    - *Short spool for F1.3-1 through F1.3-5*
    - *Short bellows for F1.3-6 and forward*
  - Installation to the cleanroom post and flex hose assembly
  - Alignment to the cavity beam line flange
  - Assemble the gate valve to the cavity

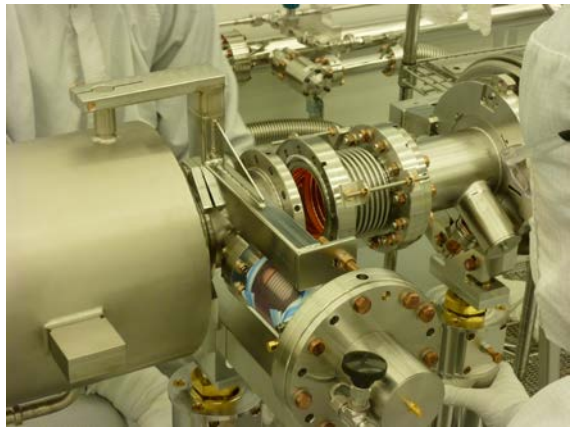


String Assembly-II (WS1)

Cavity to Cavity Assembly with the interconnect bellows

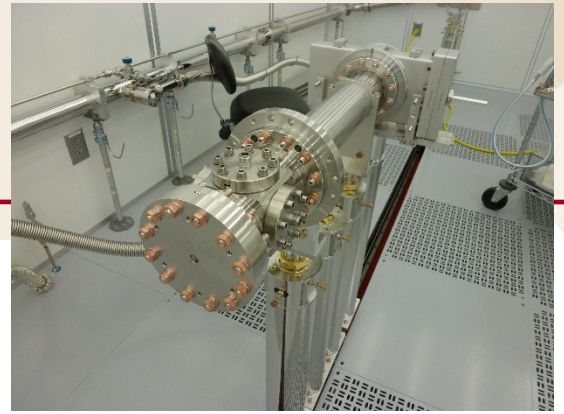


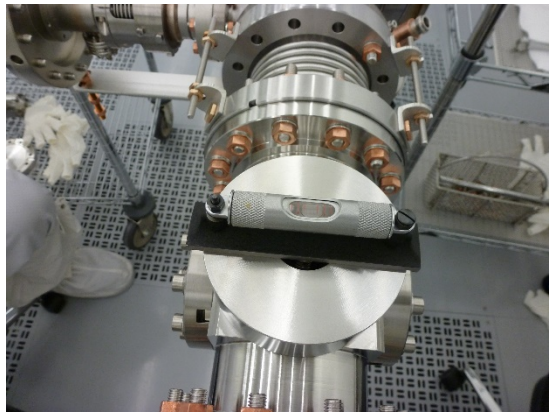




String Assembly-III (WS1)

- BPM sub-assemblies with feedthroughs ***(titanium bolts; increased torque from 12 N-m to 16 N-m starting from CM07)***
- BPM + Magnet Spool Tube + GV2 assembly and leak check
- BPM/Magnet package subassembly to the 8 cavities string
- Pump down the fully assembled cavity string, bag and conduct final leak check. Backfill
- Roll out of the cleanroom to WS2
- (socks to protect the cleanroom tooling better at WS2)





Field Emission Issue-I

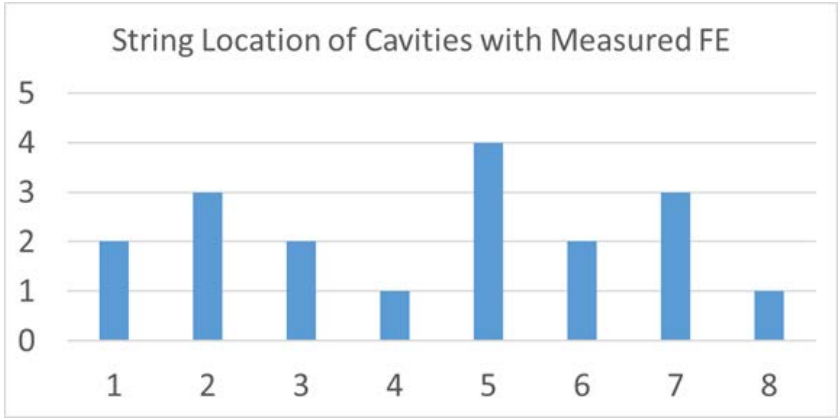
- After CM03 results, we have performed an unofficial internal review of the particle free UHV assemblies during CM07 assembly in the CAF cleanroom. CM08 assembly is being observed by Olivier Napoly.
- FE sources:
  - Process:
    - Human factors:
      - Contract technicians are trained but do not have years of experience
      - Core technicians are very well trained but do not have experience in mass production
    - Infrastructure
      - CAF cleanroom, WS5 (softwall cleanroom), CMTS (softwall cleanroom)
  - Product:
    - Copper plated beamline components (Copper plating quality assessment is very subjective, JLab is currently planning to conduct further tests to assess the effects on the cavity performance
    - Fundamental power coupler (FPC) cold end (Assembled at vendors premises, no RF power processing, extra handling in the cleanroom due to parts in circulation shortage

Field Emission Issue-II

- F1.3-1 (pCM):
  - Assembled by core cleanroom technicians
- F1-3-2:
  - Assembled mostly by core technicians while contract techs observed.
  - Difficulties during strings assembly at WS1 due to hardware configuration; leaking through gate valves discovered at WS5
- F1.3-3:
  - Assembled together with core and contract technicians (hands-on)
  - Discovered beamline leak at CMTS during warm-up
- F1.3-4:
  - Assembled together with core and contract technicians (hands-on)

Onset of measurable field FE Eacc>=14 MV/m, each cavity:

- F1.3-01: One cavity FE onset 12.7 MV/m, one at 13.6 MV/m; 6 acceptable
- F1.3-02: One cavity FE onset 12.5 MV/m; 7 acceptable
- F1.3-03: One cavity FE onset 9.2 MV/m, one at 11 MV/m; 6 acceptable
- F1.3-04:One cavity FE onset 12.0 MV/m, one at 13.9 MV/m; 6 acceptable



Torqueing the fasteners at CAF cleanroom

- Torque wrenches are intrinsically dirty. We did not use them in he CAF cleanroom.
- We do not know yet the root cause of the beamline leak for CM03
- ***Starting from CM07, torque wrenches are cleaned as good as possible, wrapped in bag and used regularly in the cleanroom***

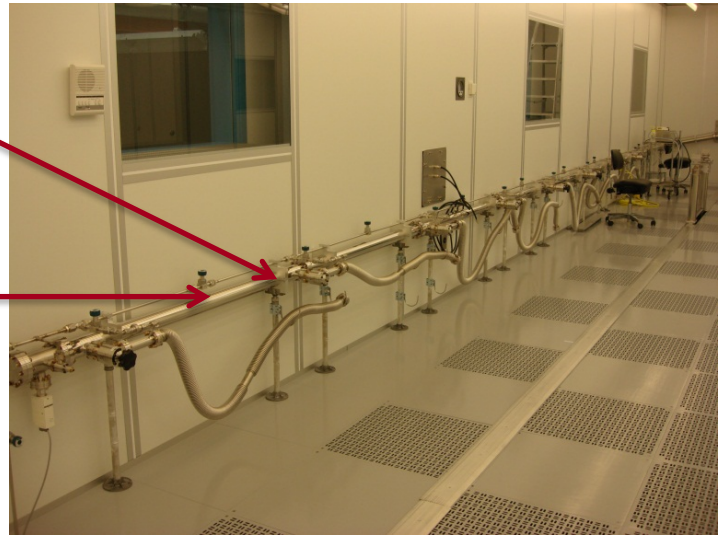
TORQUE VALUES

	Seal Type	Torque		
		in-lbs.	N-m	ft-lbs.
	13/16" Diamond Seal - 1.3 GHz (NW12)	45	5	4
	2-1/8" Diamond Seal - 1.3 GHz (NW40)	180	20	15
	4-3/8" Diamond Seal - 1.3 GHz (NW78)	340	38	28

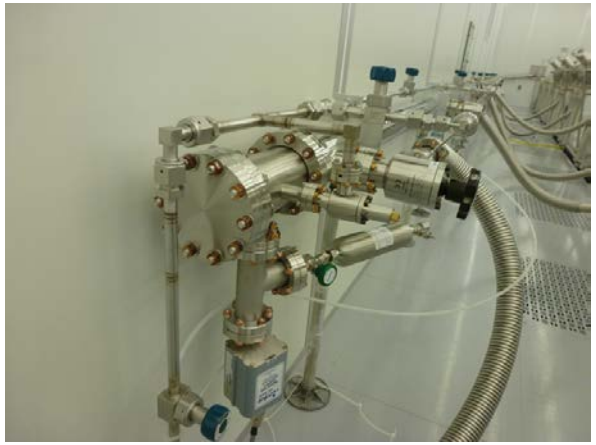
Fermilab CAF cleanroom Vacuum / Purge / Backfill Manifold

3 inches diameter
304 electro-polished
SS vacuum header

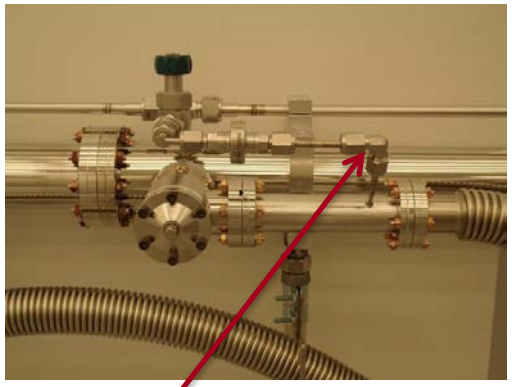
1/2 inches diameter 304 electro-polished SS backfill/purge line which also goes under the raised floor



Manifold with 8 pump/backfill/purge stations



Swagelok backfill/purge start valves



Nitrogen in-line and point of use filter: Mott Defender series sintered all metal (0.03 micron)

Changes done for CM07 string assembly: [to reduce delta(P)]

1. *Use the Swagelok valve as throttle valve to start the backfill/purge*
2. *Backfill whole manifold to atmospheric pressure before opening a station valve to a cavity which is at atmospheric pressure*