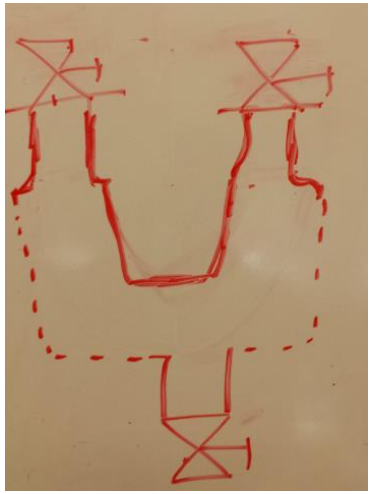
DISCUSSION

BCP in subassemblies or in fully assembled cavity?

Thanks to Mike Kelly (ANL) for a lot of input

BCP in subassemblies or in fully assembled cavity

	Advantages	Disadvantages
SUBASSEMBLIES (METHOD 2 – BUCKET)	• Reduce thickness removal deviation. (The variation of thickness removal in full assembled cavity can be up to 20% between most and least etched regions. The thickness removal deviation can be diminished by performing light BCP of about 50 um in the three subassemblies followed by bulk BPC for 100 um removal in assembled body, instead of performing 150 um bulk BCP in assembled body.) [Assumption: surface removal can be very well controlled.] • Reveal features in surface. • Easy access for optical inspection. • Monitor frequency shift prior to EBW → get first prediction of frequency shift due to BCP (50 um removal will already provide a non-negligible frequency shift). • Flow control. Temperature control from outside. • Reduced acid volume.	• Additional tooling / fixtures. 
FULLY ASSEMBLED CAVITY		• Non-uniform thickness removal for different cavity regions.

- Smooth down of weld features.

* *Fluid simulations?*

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(email exchange 12/4/2015)

Some detailed comments:

- **20% variability actually seems quite low** already…I'm fairly sure it is easy to get a factor of 2 variability. **Acid flow** rate at the niobium surface is the other **critical parameter besides temperature.**
- Based on the numbers you mention (**20% variability out of 100 or 150 microns**), then you must be concerned with tolerances of ~25 microns. **Are your cavity fabrication dimensions controlled at that level?** In our case we typically 'tune' accurately (say 1 kHz out of 100 MHz), but our fabrication tolerances are much larger i.e. 100 microns or more.
- […] **masking "rubber paint"** commercially available to cover NbTi surfaces…I've tried it and it seems to **work well** for BCP.
- The **EM frequency simulations are very accurate and reliable** I think, provided you give the **right input** (i.e. do you really know the removal profile) and you don't fool yourself with **mesh effects**. This might be a **time consuming** effort with only **modest benefit**.

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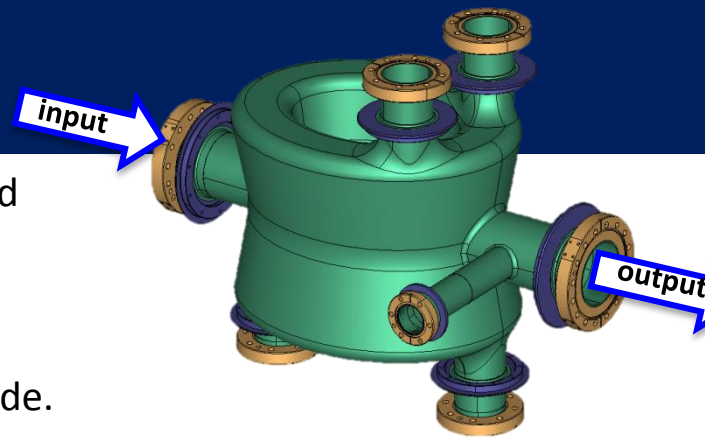
Overall:

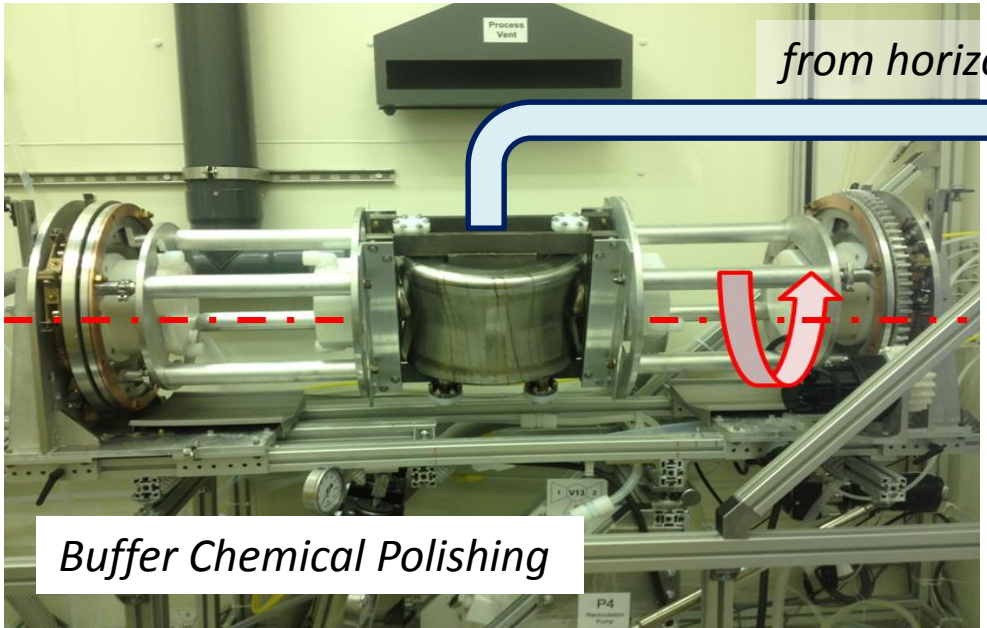
- **BCPing the subassemblies** does **not** sound too **difficult** and your **fixturing** sounds **reasonable.**
- I'm not fully convinced of the **effectiveness of the proposed procedure to meaningfully reduce nonuniformity**. In the best case, you'll still have to live with ~2/3 of the nonuniformity that you'd have if you just BCP'd the final assembly.
- Consider two things:
  - Can the quality (uniformity) of the final heavy BCP be improved (such as by rotating the cavity during BCP and using external water cooling rather than the more typical fill, recirculate and dump)?
  - Are there regions inside the cavity (such as in between the QWR stubs) where you really need 25 micron accuracy and other regions where you care less (the base of the QWR's or the ID of the ports)? If so, maybe you can focus on getting the BCP to produce reliable uniform results in the region you care about most.

Example: rotating BCP bench (ANL)



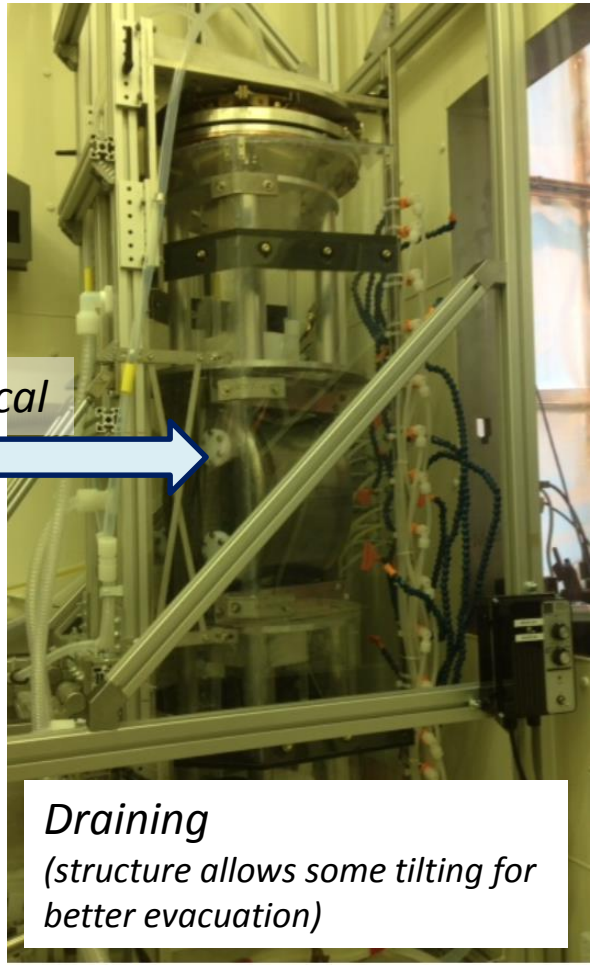
- Rotating BCP system for uniform etching also allows enhanced acid evacuation;
- 1/3 cavity volume filled with acid;
- Cavity rotating around beam axis
- Cavity cooled down to about 13°C with a water curtain from outside.
- About 1 um Nb-removal per minute for T_{acid} ~ 13°C (temperature control of about 1-2 degrees achieved).
- Uses rotation speed such that sheer velocity at the cavity surface of ~1 cm/s (as for EP)
- Acid flow rate?
- Satisfactory experience with PoP DQW CC

  However, cavity thickness was not controlled before / after procedure



Buffer Chemical Polishing

from horizontal to vertical



Draining

(structure allows some tilting for better evacuation)

Rotating BCP bench (JLab)

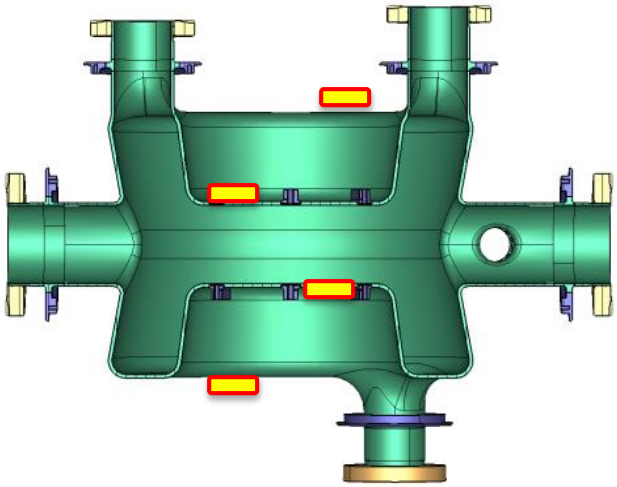
- Jlab will use EP bench to perform rotating BCP on DQW CC
- Cavity completely filled with acid to avoid fumes reacting with freshly polished niobium
- Status?

Monitoring thickness removal

1) *Four gauges to monitor thickness removal during BCP:*

(on high freq sensitivity regions)

- *one on each inductive plate*
- *one on each capacitive plate*



= thickness gauge

2) *Use witness sample?*

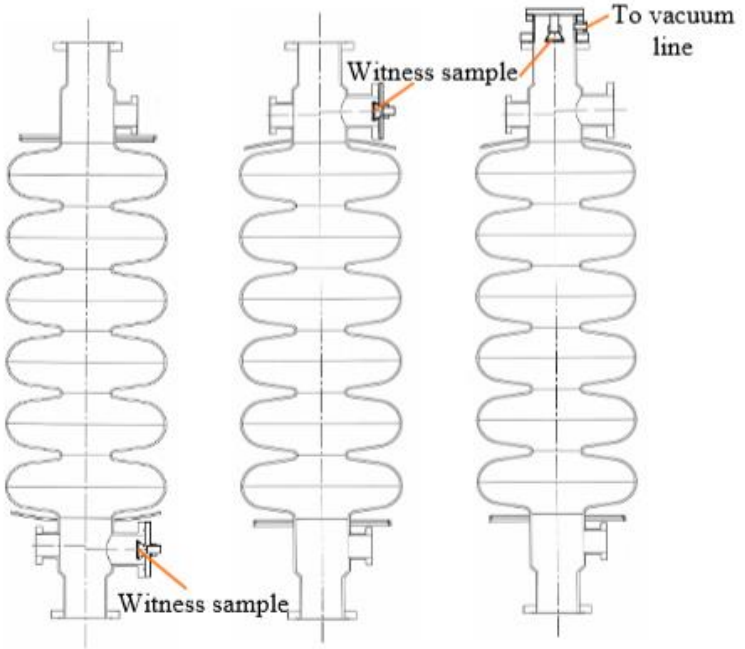
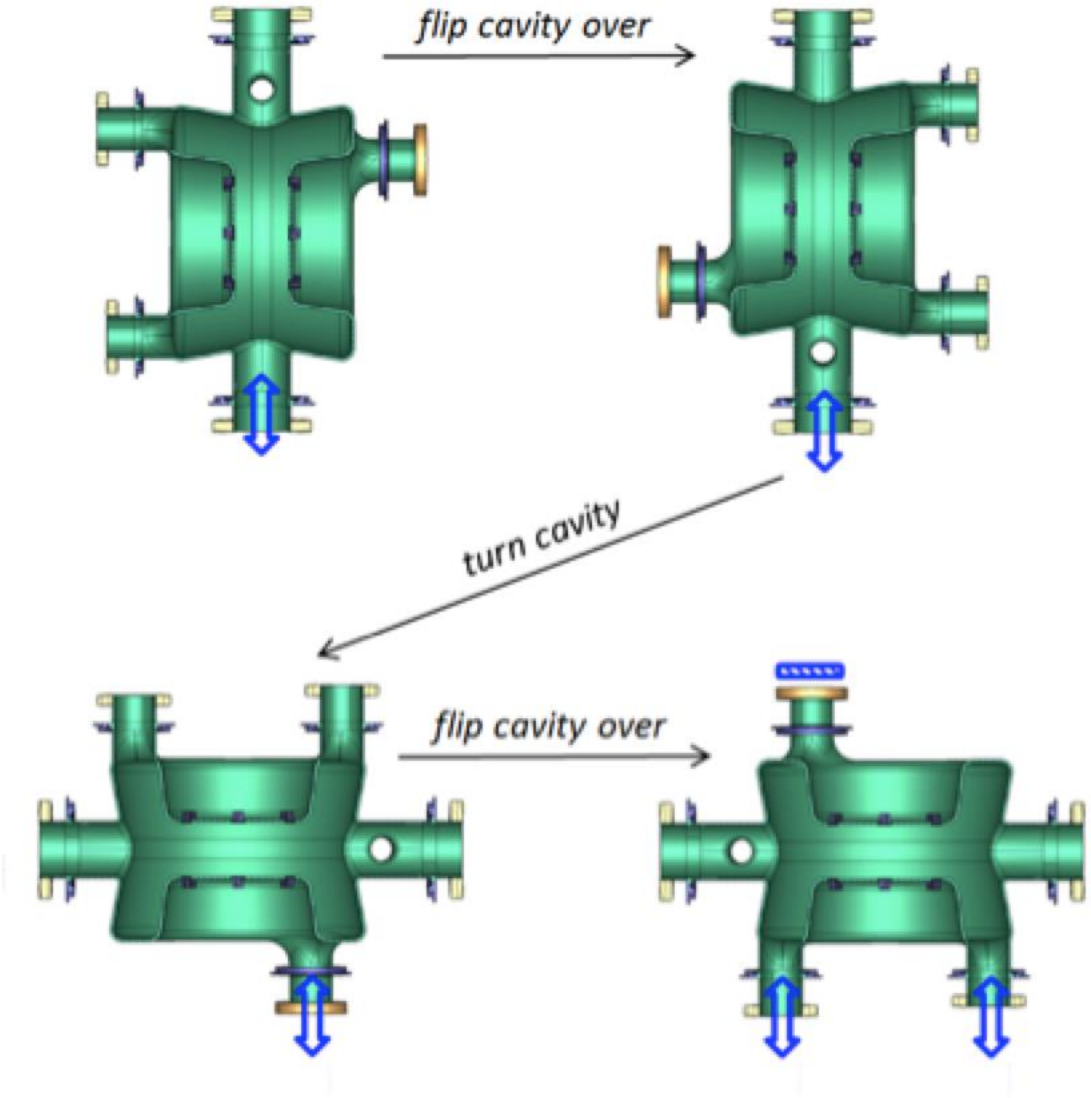


Figure 1: Witness sample setup for SNS production cavities: for BCP etching process (left), for HPR process (middle), and for combined HPR, evacuation plus RF vertical test process (right).

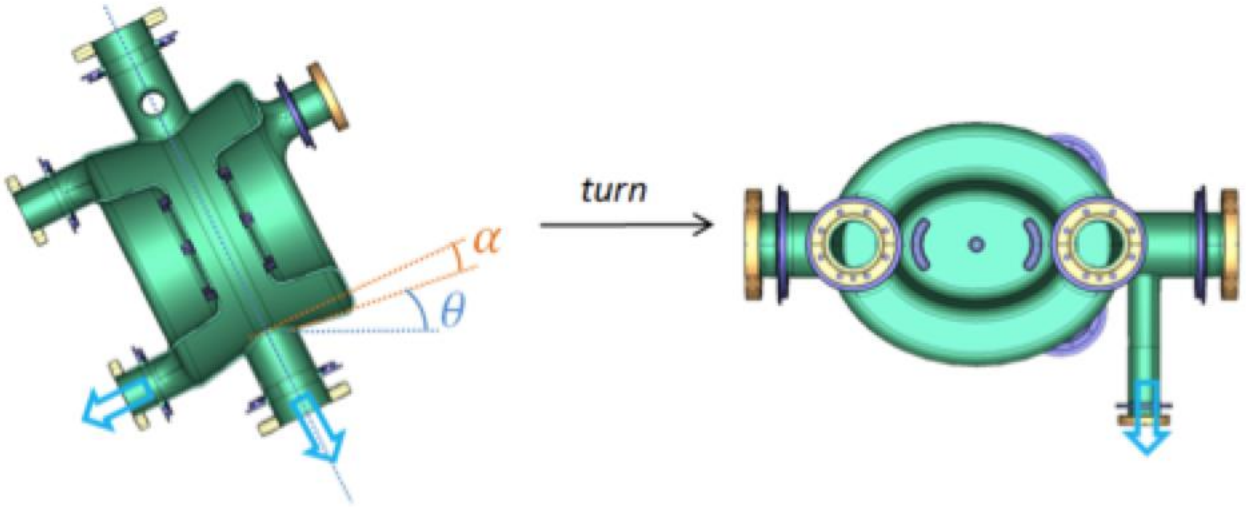
BCP & HPR procedure #2 – JLab facility

HPR CONFIGURATION



BCP & HPR procedure #2 – JLab facility

DRAINING & DRYING CONFIGURATION



- Angle α is 10.6 degrees → tilting needed to avoid stagnation in high H-field region
- Finish dry-out of cavity with warm N_2??? → email exchange