

# **REPORT OF WG2**

## **ION ACCELERATING STRUCTURES**

### **INTERMEDIATE VELOCITY CAVITIES**

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The discussions were organized around 6 topics with about 15mn allotted to each topic.

Three of the topics dealt with applications and systems:

- Low current applications
- High current cw applications
- High current pulsed applications

Three of the topics dealt with components and tools:

- Tuning mechanisms, frequency control, microphonics
- Ancillary systems, cryostats, couplers
- Design codes

For each of the topics the following generic questions were addressed:

- What is the status? Where do we stand?
- What are the issues?
  - For existing applications
  - To enable new applications
- What would we like to see happen?
  - R&D
  - New tools

### **LOW CURRENT APPLICATIONS**

Questions asked:

- What is available?
  - Are there still outstanding issues?
  - Do we need new structures?
  - What improvements would we like to see?
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- Superconducting RFQs:
    - Are being developed, but still are a new technology.
    - They are more compact than existing structures .
    - Still require additional bunching. 30% beam loss.
    - Pressure fluctuations in the cryogenic system are an issue.
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- Experience from operating machines: what would we do differently?
    - Get rid of split-rings and replace by quarter-waves (single or multi-stem).
    - Explosively bonded Cu/Nb expensive and difficult. Move away from it.
    - Use separate vacuum for the cryostat and the cavities.
    - Nb sputtered on Cu has shown good results but still needs development.

## HIGH CURRENT CW APPLICATIONS (Ex: APT, RIA)

Questions asked:

- Beam loading issues
- Beam loss issues
- Impact on cavity design
  - Geometry
  - Frequency
  
- At front end, normal conducting 4-vane RFQ is the only option for >10s of mA.
- SC has little advantage at high current in terms of real estate. Still an operating cost advantage.
- Because of NC RFQ at front end, frequency > 350 MHz.
  - Rules out QW because of steering effects.
  - IFMIF is planning for a 175 MHz NC RFQ.
- High power properties of  $\lambda/2$  structures still needs to be demonstrated.
- Number of gaps in SC sections must be determined by beam dynamics.
  - Current and ion species dependent.
- Couplers are still an issue.
  - Still prone to multipacting.
  - Need to be made cheaper.
  - Cavity/coupler integration needs to be addressed from the start and not as an afterthought.
- HOM properties of  $\lambda/2$  structures need to be investigated.
- Range of applicability of TM and TEM structures in the intermediate velocity region still under discussion.

## HIGH CURRENT PULSED APPLICATIONS (Ex: SNS)

Questions asked:

- Beam loading issues
- Beam loss issues
- Impact on cavity design
  - Geometry
  - Frequency
  
- Microphonics are not an issue but dynamics Lorentz detuning is
  - $\beta \sim 0.5$  TM structures have their lowest frequency at 30-40Hz.
  - $\beta \sim 0.5$  TEM structures have their lowest frequency at < 200 Hz.
- Use of piezo tuner compensation seems to be effective.
- TEM  $\lambda/2$  structures will operate at lower frequency and probably higher temperature than TM structures.
  - HOM properties of  $\lambda/2$  structures need to be investigated.
  - High power properties of  $\lambda/2$  structures still needs to be demonstrated.
- Needed cavity aperture is related to the lattice and cavity length.
  - Beam loss issue is similar between NC and SC structures.
  - Criteria is activation, not thermal stability.
- Range of applicability of TM and TEM structures in the intermediate velocity region still under discussion.
- Fault-tolerant designs are important feature.
  - Cannot afford to lose a cavity immediately after the RFQ.

## TUNING – FREQUENCY CONTROL – MICROPHONICS

Subjects for discussion

- Slow tuners
  - Fast tuners
  - Negative phase feedback
  - VCX
  - Piezo, magnetostrictive
  - Other
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- Pneumatic systems have been reliable with no backlash and high resolution. 50-300 Hz /sec slew rate.
  - Mechanical systems can have backlash and hysteresis.
  - TM-class structures have a complex mechanical mode and microphonics spectrum starting at low frequency.
  - TEM-class structures have simple mechanical mode and microphonics spectrum starting at high frequency.
  - VCX may be possible at 350 MHz but probably not higher. Development is needed.
  - Piezo compensation of microphonics would be helpful.
    - Probably easier on TEM than TM structures.
    - Would require sophisticated system for the latter. Simple feedback has not been successful so far.
    - Low frequency mechanical modes might make it difficult.
  - Magnetostrictive tuners should be given a real chance.
  - Negative phase feedback is always an option.
    - All it takes is rf power.
    - Electronic damping may reduce the power reduce the rf power requirement. Needs development

## ANCILLARY SYSTEMS

Subjects for discussion

- Cryostats
    - Design concepts
    - Common or separate vacuum
  - Couplers
    - Fixed or variable
    - Electric or magnetic coupling
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- Trend is away from common vacuum to separate vacuum.
  - Communication with cryogenic engineers needs to take place at an early stage of the design
    - Make system more stable.
    - Reduce fluctuations.
  - Alignment is an important issue that needs to be addressed from the beginning.
  - Variable couplers are convenient but more complex.
  - E field coupler can be biased. Useful to deal with multipacting.
  - Need to do more coupler development. Existing high-power designs are expensive.
  - Think of cavity/coupler as an integrated system.

## **DESIGN CODES**

Subjects for discussion

- 3D electromagnetic
  - Multipacting
  - How reliable/accurate are they?
  - Experience
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- Available 3D codes are quite good, especially for frequency .
  - Integrated mechanical/electrical/thermal codes exist.
    - COSMOS/M-MICAV used at LANL.
    - ANSYS used at AES and LBNL.
  - Need to be a little careful with surface fields but there are ways of dealing with that issue.
  - There are no proven 3D multipacting codes.
    - So far not an issue.
  - HOM calculations in 3D structures need to be done.
    - Existing codes are adequate.

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