REPORT OF WG2
ION ACCELERATING STRUCTURES
INTERMEDIATE VELOCITY CAVITIES

Chair : Jean Delayen, Thomas Jefferson National Accelerator Facility

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?

- 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.

- 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
    - β~0.5 TM structures have their lowest frequency at 30-40Hz.
    - β~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

- 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

- 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

- 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.

ACKNOWLEDGEMENTS

Many thanks to all the participants for a fruitful exchange of ideas and opinions.
Special thanks to Frank Krawczyk and Walter Hartung for taking notes during the discussions and providing them.