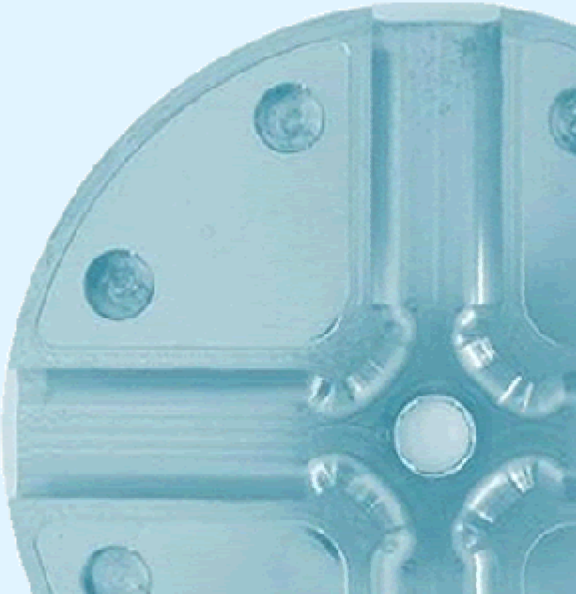
RF system requirements - Critical issues relevant for the module working group

W. Wuensch

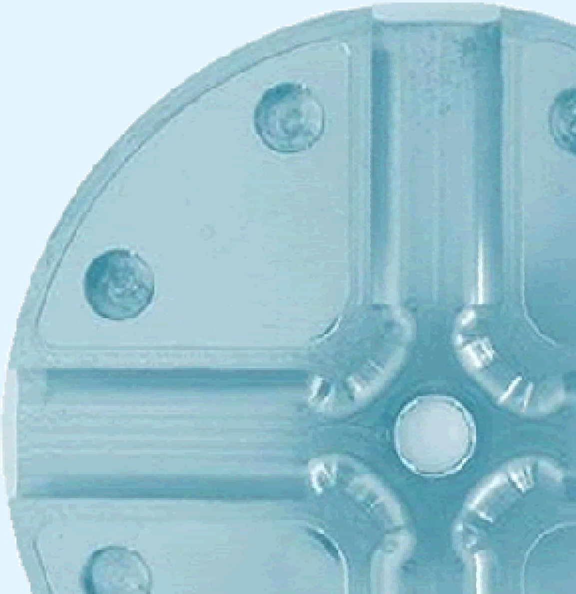
Module Review

15 September 2009



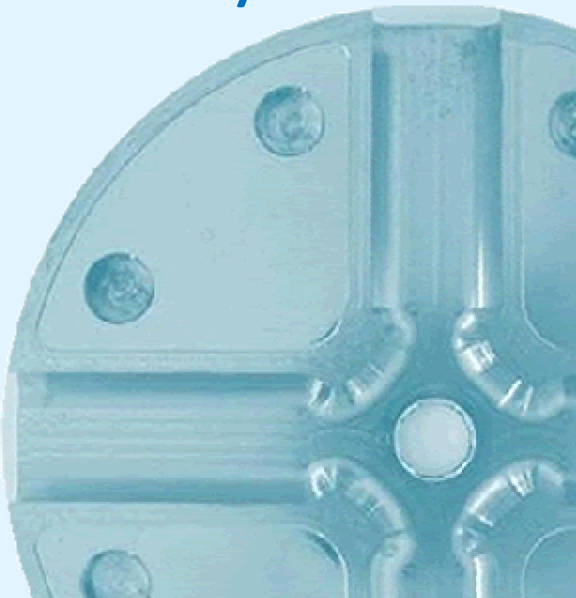
Outline

- Fundamental mode properties
- Higher-order modes
- High-power operation
- Subsystems – vacuum and cooling
- Technology



Fundamental mode operation

- Main linac filling factor – We fight for a structure active length (including couplers) gradient of 100 MV/m, but our real-estate gradient is closer to 80 MV/m. Every mm/module of longitudinal compactness gives gradient and efficiency.



Fundamental mode operation

- Phasing- The phase required reproducibility among individual rf network will be larger than the overall phase tolerance of a sector.
  - We will use mechanical tolerances plus rf final checks to achieve the required phase tolerance in the rf system. A rigid drive to main linac rf waveguide network would be enormously helpful.
  - If we adjust drive to main beam rf phase using beam-loading phase, we need either many measurements or a tighter tolerance on the individual networks.

Higher-order modes

- Transverse alignment is micron level to limit excitation of higher-order modes.
- Wakefield monitors – to whatever extent they are incorporated in the final modules, they remain a crucial tool to determine the accuracy we can actually install structures on modules. They will be present in test set-ups.
- Incorporating damping will be mechanically complex and will require transverse space.

Higher order modes continued

- Interconnects
  - Main beam – Non-contacting interconnects acceptable. Short range wakefields essentially equal to an iris. Long range wakefields however need damping, so imposes careful design.
  - Drive beam – Contacting interconnect necessary for baseline design due to the high drive beam current.

High-power operation

- Unless we are <u>very</u> lucky, no ‘spitfests’ in any components, we must be able to determine on every pulse exactly which accelerating structure, PETS or waveguide system has broken down. This means an rf measurement after every PETS and accelerating structure and dedicated instrumentation like pick-up coils between structures, plus vacuum as a backup.
- Reconditioning of sectors, after initial installation or after vacuum interventions, will be necessary.

High-power operation

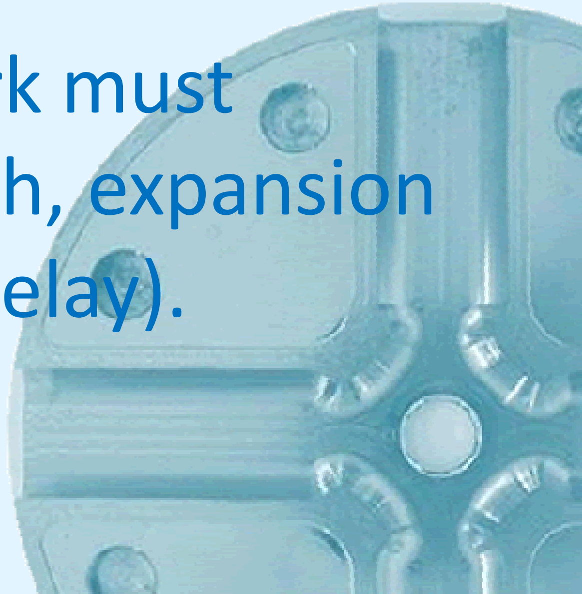
- On/off mechanism – Essential component to control breakdown by suppressing power production in the PETS. High-power, mechanically driven, vacuum rf component so really tough problem.
- We may need to *ramp* structures on over a number of pulses after breakdown.

Subsystems

- Vacuum – We deal with four pressures **inside** the PETS and accelerating structure:
  - Quasi-static – average pressure with machine pulsing
  - Dynamic – during rf pulse with no breakdown.
  - Dynamic – during breakdown
  - Quasi-dynamic – during pulses after breakdown with rf either off, ramping or on.

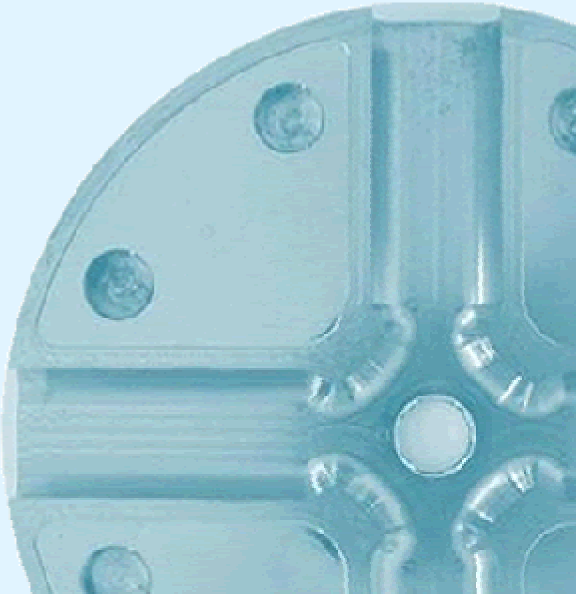
Subsystems

- Accelerating structure cooling – The structure must maintain its longitudinal and transverse tolerances during operation with varying beam-loading conditions. Power factors of roughly two in the downstream end of structure.
- RF network cooling - The rf network must maintain its correct electrical length, expansion is 0.2° phase/(°C*meter of group delay).



Subsystems

- PETS cooling – Dimensioned for steady state beam loss. Excessive heat rise causes phase slip and vacuum degradation. Asymmetrical heating can bend PETS and supporting system.



Technology

- Disk or quadrant accelerating structures? That is the question. Whether 'tis nobler in the mind to suffer the extra complication of feasibility demonstration structures (disks) or to take arms with a technology which promises significant savings (quadrants)?

Technology

- Tank or sealed (or hybrid): Plausible argument can be made that tank units run at lower gradient – without a good explanation or definitive proof. All PETS in our program have tanks and heavy damping makes tank-like features inevitable. Sealed better for alignment and cooling. Tank better isolated from mechanical constraints of vacuum system.