Optimization of 650 MHz 5–cell cavities with β=1.0

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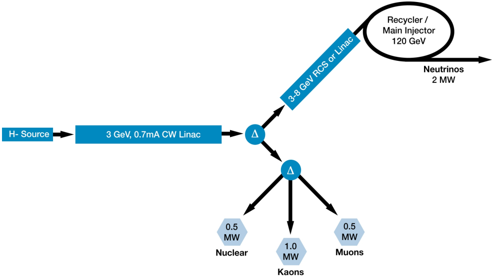
Project X concept



Multiexperemental facility. Based on an H^- linear accelerator using superconducting rf technology. Will provide opportunities at the intensity frontier.

CW mode, up to 3 GeV

- 0.5 MW muons
- 1.0 MW kaons
- 0.5 MW nuclear

LINAC, pulse mode, 3→8 GeV

- neutrinos experiments

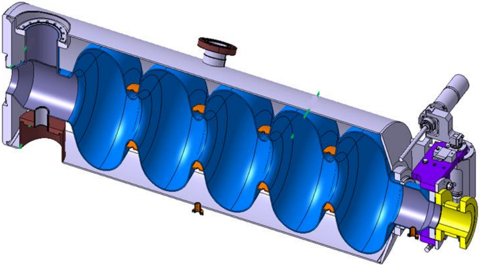
Cavities for recirculator for future μ–collider

Suggestion to use 3-8 GeV LINAC for recirculator for μ–collider

- lower frequency is needed for μ–collider $\rightarrow$ 650 MHz cavities were chosen
- less radiation

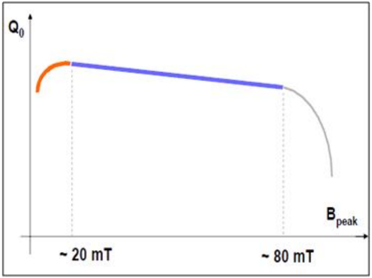
What was suggested?

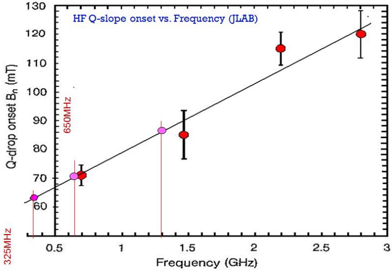
5–cell cavities with f=650 MHz and β=1.0



Limitations

- field flatness
- field emission
- high-field Q-slope
- mechanical stability
- surface processing





Working assumptions

Field enhancement factors (FEF) – as small as possible $\rightarrow$ higher gradient

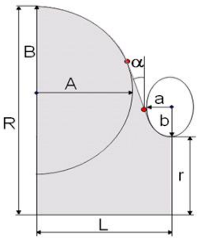
		limitations
surface fields chosen $B_{pk} < 70\mathrm{mT}$ $E_{pk} < 40\mathrm{MV/m}$		high field Q-slope field-emission
coupling coefficient chosen $\geq 0.75\%$	smaller k $\downarrow$ smaller FEF	field flatness
aperture chosen ≈ 110 mm	smaller aperture $\downarrow$ smaller FEF	beam losses field flatness mechanical stability
cavity wall slope chosen 7^o	smaller slope $\downarrow$ smaller FEF	mechanical stability surface processing

Understanding of the optimization process

3 steps

- Regular cell optimization
  Variying geometrical parameters to get as small as possible FEF ($FEF_E = \frac{E_{peak}}{E_{acc}}$, $FEF_H = \frac{H_{peak}}{E_{acc}}$)
- End cell optimization
  FEF should not be greater then in regular cell. Coincidence of the geometric parameters in the places of connection.
- Complete 5-cell cavity optimization.
  Using parameters of inner and end cells. Field should not be locked in the inner cells (no trapped modes).

Optimized cells' parameters



R	199.786 mm
r	55 mm
A	92.5 mm
B	84 mm
a	20 mm
b	28 mm
L	115.378 mm

Table: Inner cell

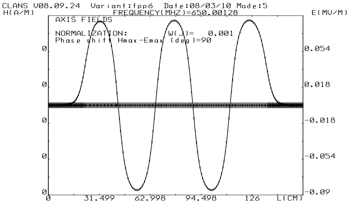
	Left	Right
R	199.786 mm	199.786 mm
r	55 mm	55 mm
A	72.5 mm	85 mm
B	70 mm	60 mm
a	18 mm	15 mm
b	28 mm	50 mm
L	97.053 mm	114.868 mm

Table: Left and right cell

Complete cell

Parameter	Magnitude	Units
Transit time factor	0.324	
Coupling coefficient	0.867	%
R/Q	700	Ohm
E_{peak}/E_{acc}	1.97	
H_{peak}/E_{acc}	3.65	mT/(MV/m)
Wall angle	4.5	degree
Beam pipe dia	0.11	m
Active length	1.135	m

Table: RF parameters for fundamental mode



Study of higher order modes

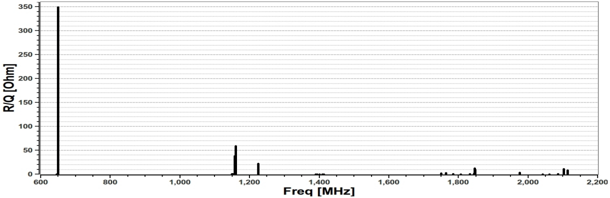


Figure: Distribution of longitudinal HOM

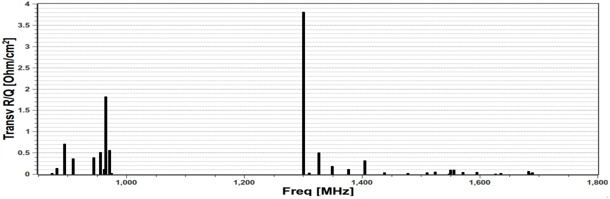


Figure: Distribution of transverse HOM

Conclusions

- 650 MHz 5-cell beta 1.0 cavity optimized
  - Inner cell geometry optimized
  - End (left, right) cell geometry optimized
- Longitudinal and transverse higher order modes are studied
  - All trapped modes are eliminated
- Design limitations are disscussed