HOM damping for future 3-section 200MHz TWCs

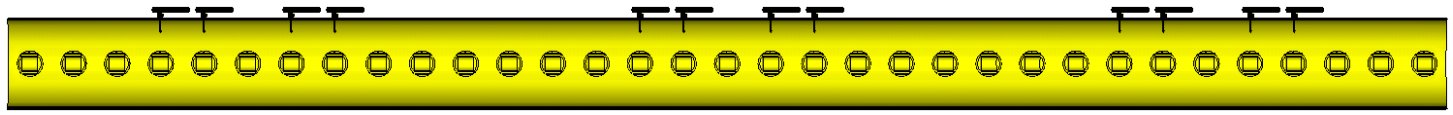
P. Kramer

Content

- Damping performance with todays damping scheme
- Effects of adding additional HOM-couplers
  - Increase in impedance of 17π/33 split-mode
- Possible mitigations of 17π/33 split-mode
- Proposals for new HOM-damping schemes
- Conclusions & Outlook

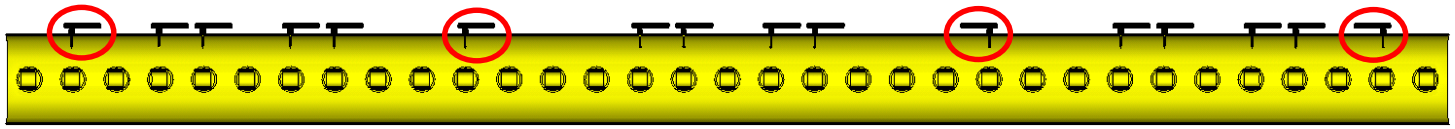
Improvement of present damping scheme

- The present damping scheme is insufficient



3-sections + present HOM damping				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.7	5600	5.9	33	17π/33
629.2	445	92	41	23π/33
630.3	394	137	54	14π/33

- Effect of additional couplers in E-field maxima of HOMs

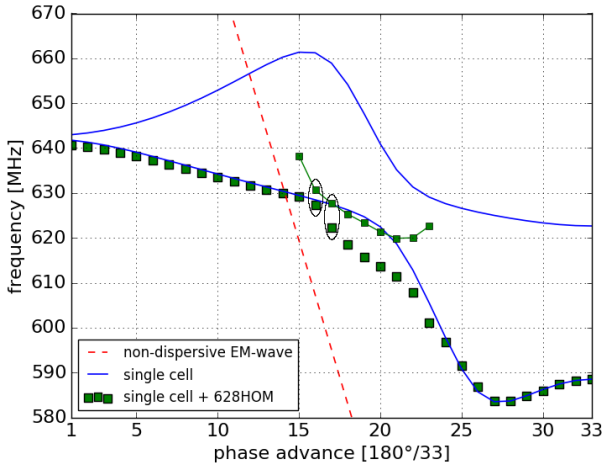


3-sections + additional couplers				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.7	6952	6.8	47	17π/33
629.2	296	89	26.1	23π/33
630.3	224	127	28.5	14π/33

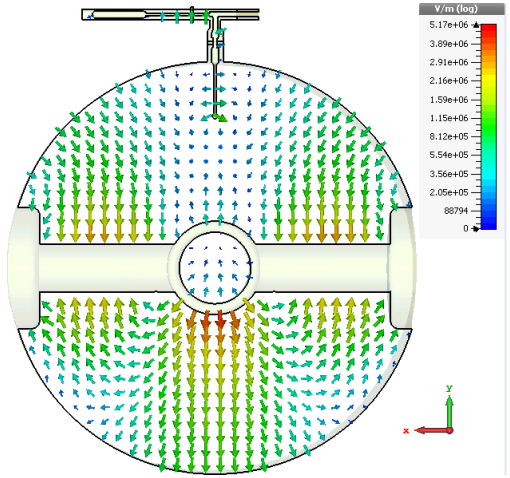
Increase in impedance of 17π/33-mode

Effects of adding HOM-couplers

- Additional modes are created in the dangerous 600MHz cavity passband
- 17π/33 split-mode is particularly detrimental
  - The EM-fields are pushed into the less accessible lower half of the cavity
  - The field strength in the coupler area and the Q are fairly low
- Sufficient damping is very difficult from the top-ports
  - One example: Fork-coupler



Q=8400



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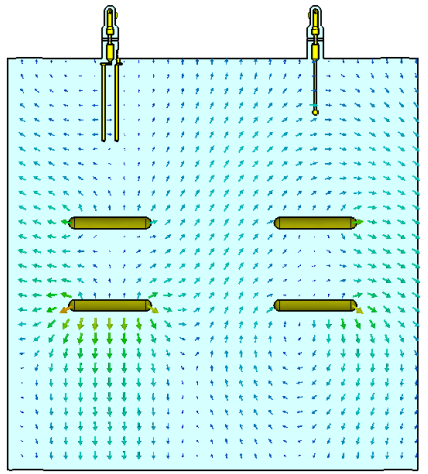
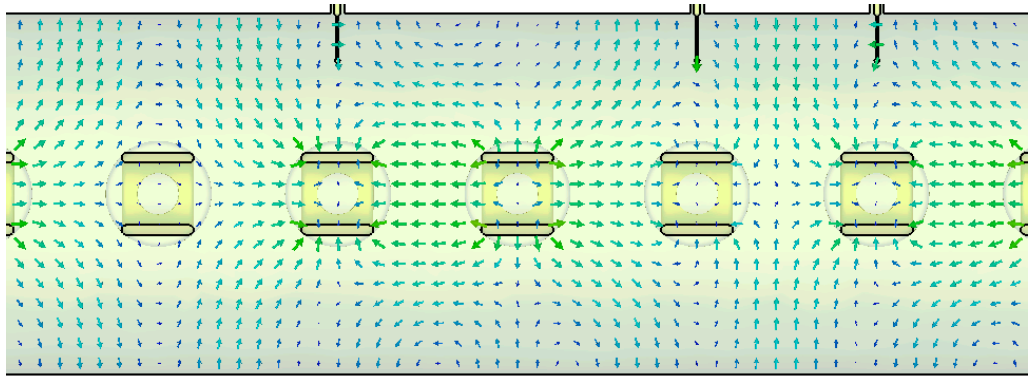


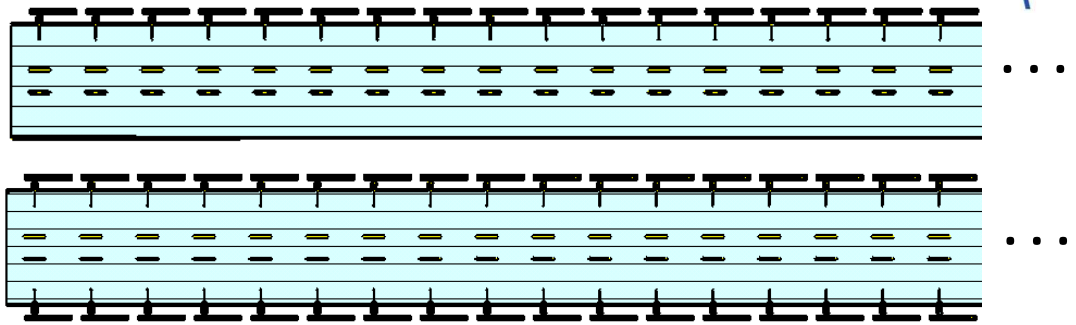
Remember:
Q_0=35000 to Q_d=3000
for 30π/44-mode

Q is not sufficiently well damped (even in the periodic 2-single-cell approach).

Better understanding of previous efforts

- EM-fields are pushed into lower part of cavity or in-between drift tubes





Courtesy Y. Shashkov

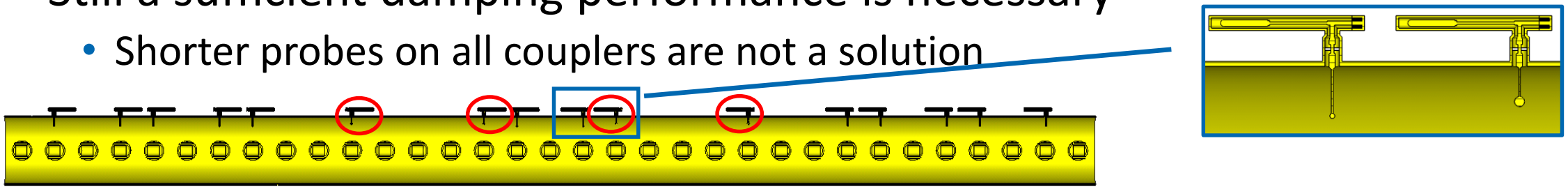
- A sufficient damping solution can not simply be improved by adding additional couplers
  - Especially (already damped) low-Q modes are susceptible to shifts of their EM-fields
  - The damping performance will therefore often even be deteriorated

Options for mitigation of 17π/33-mode

1) Avoid 17π/33-mode impedance to become pronounced
   - Essentially by using less invasive, shorter probes
2) Damp 17π/33-mode in the lower half of the cavity
   - Three proposals will be given

Avoid 17π/33-mode to become pronounced

- Use shorter probes on HOM-ports where 17π/33-mode is most susceptible
- Still a sufficient damping performance is necessary
  - Shorter probes on all couplers are not a solution



- This trade-off leads to a balancing of the 3 HOM impedances

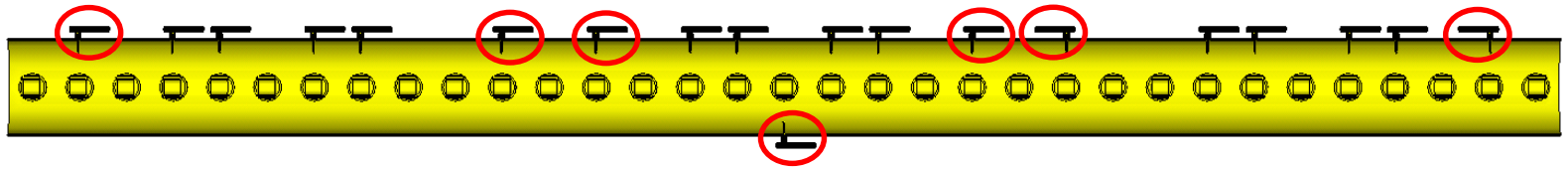
Impedance is reduced by factor 2.2
(with regard to impedance model)

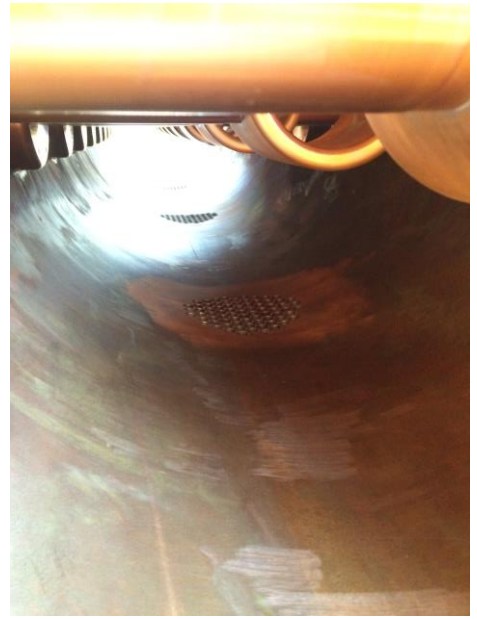
No room for further damping improvement

3-sections + HOM trade-off				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.6	5172	5.8	30.0	17π/33
629.2	325	90	29.3	23π/33
630.2	245	126	30.5	14π/33

Damping via vacuum pumping ports

- All sections have vacuum pumping ports in positions 3, 6, 9
  - Today and in the future not all of them are/ will be used





- Sections would most likely need to be machined

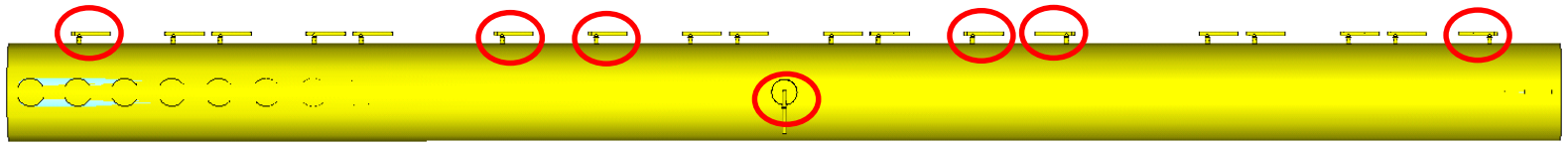
3-sections + vacPort17				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.6	3642	3.0	5.5	17π/33
629.3	262	79	20.8	23π/33
630.3	194	123	23.9	14π/33

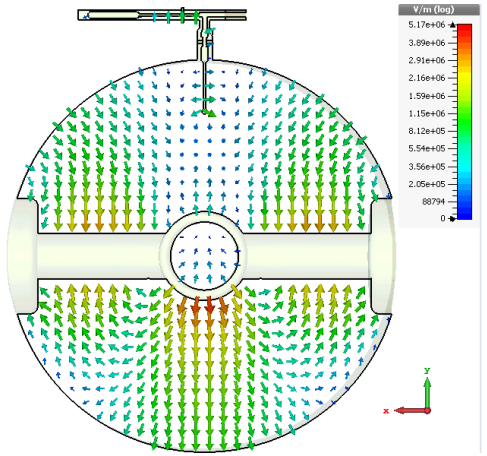
R/Q is reduced by probe alone

Impedance is reduced by factor 2.8
(with regard to impedance model)
Factor 3.1 using two vac-ports

Damping via pedestal

- Only one additional pedestal-coupler is considered
  - New drift-tube would have to be machined & assembled

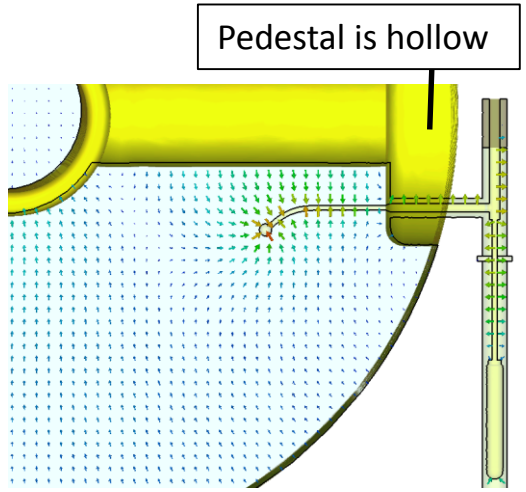




- Influence on FPB is investigated later in this presentation

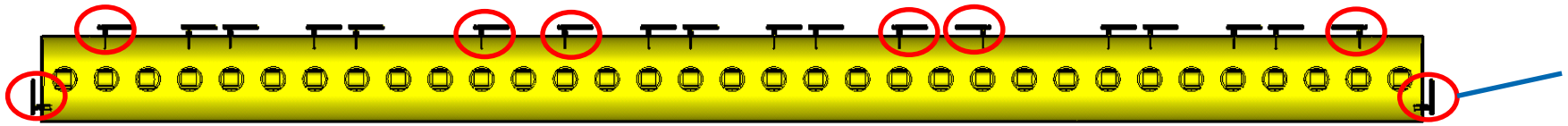
3-sections + pedestal coupler				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.6	2070	10.4	21.5	17π/33
629.3	250	86	21.6	23π/33
630.3	194	123	24.0	14π/33

Impedance is reduced by factor 2.8



Damping via endplate HOM-ports

- Ports are currently occupied by 460MHz transverse HOM-couplers
  - Use the lower ports for damping of 17π/33-mode



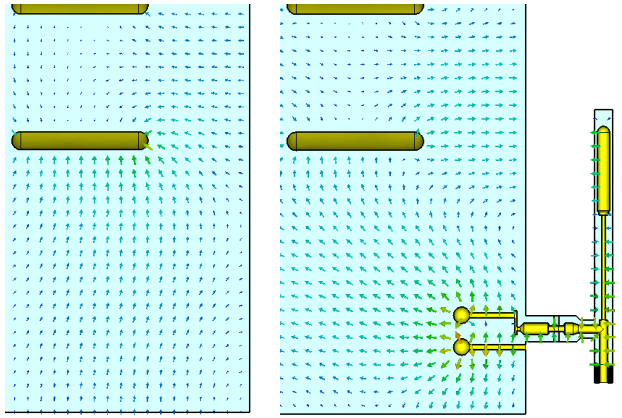
- Influence on FPB is investigated on next slide

3-sections + pedestal coupler				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.6	2550	9.4	23.9	17π/33
629.5	318	80	25.4	23π/33
630.4	197	116	22.9	14π/33

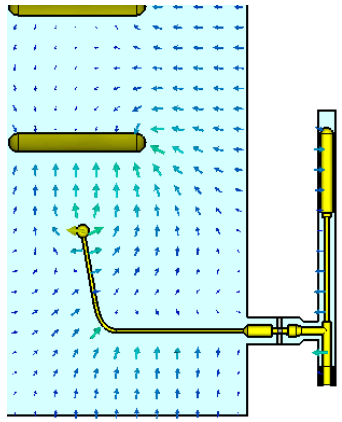
Impedance is reduced by factor 2.6
(with regard to impedance model)

- Damping is also still limited by 17π/33-mode
- Work ongoing

17π/33-mode



Factor >2.8 (so far not considered du to high EM-fields of FPB)



Influence on the fundamental passband (FPB)

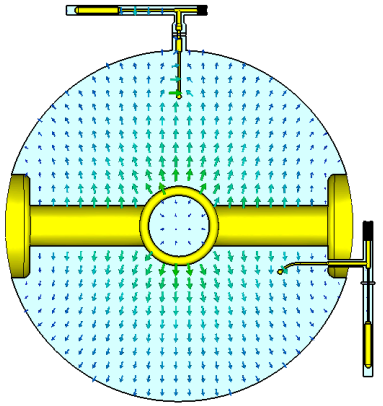
- Vacuum-port-couplers will not have an increased impact on FPB
- Influence of a single pedestal-coupler is negligible
  - Coupling of the probe to the FPB is not strong

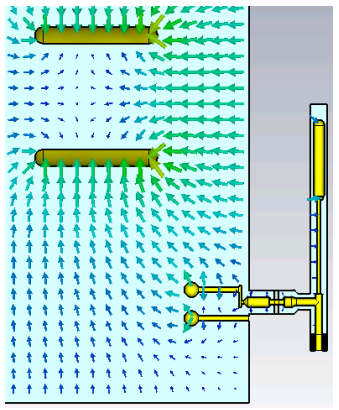
	f	Q
sC+628HOM	200.2	22710
sC+628HOM+pedestalHOM	200.2	22706

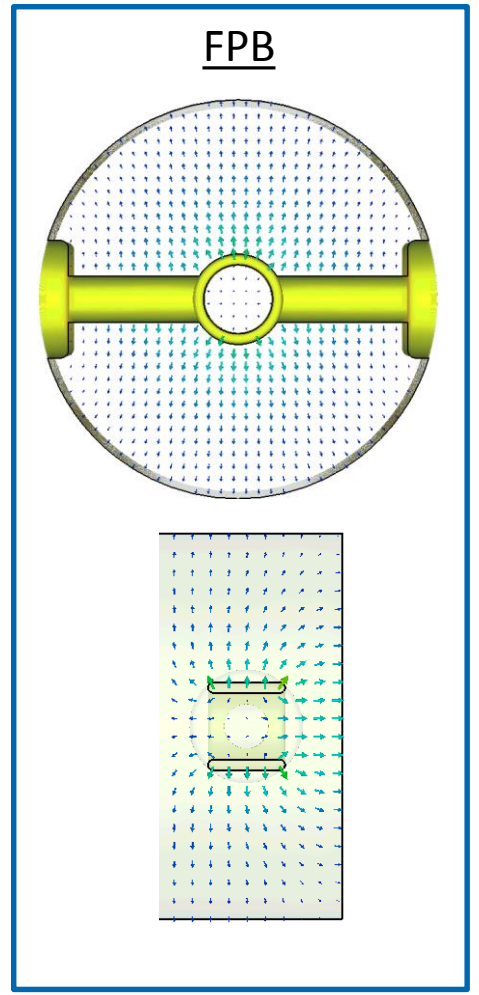
- Endplate-coupler can couple to FPB

	f	Q
3section+628HOM	200.1	22146
3sec+628HOM+endplateHOM	201.2	22565

➡ More in-depth analysis needed







Conclusions

- Conclusion on endplate-coupler will be given soon
  - Improve damping (on-going simulations, no single-cell approach possible)
  - Investigate impact on 460MHz transverse damping
  - Investigate impact on FPB further
- Mechanical feasibility of vac-port- and pedestal-coupler should be studied (Eric)
- Decision should be made if a slightly less damping would be preferred over cavity machining