HOM damping for future 3-section 200MHz TWCs

Update

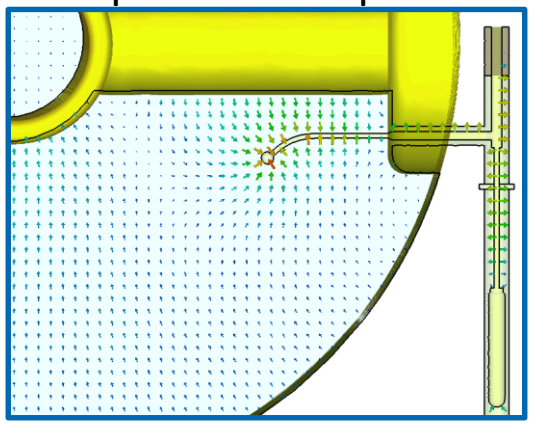
P. Kramer

Acknowledgements: C. Vollinger, A. Farricker

3-section damping

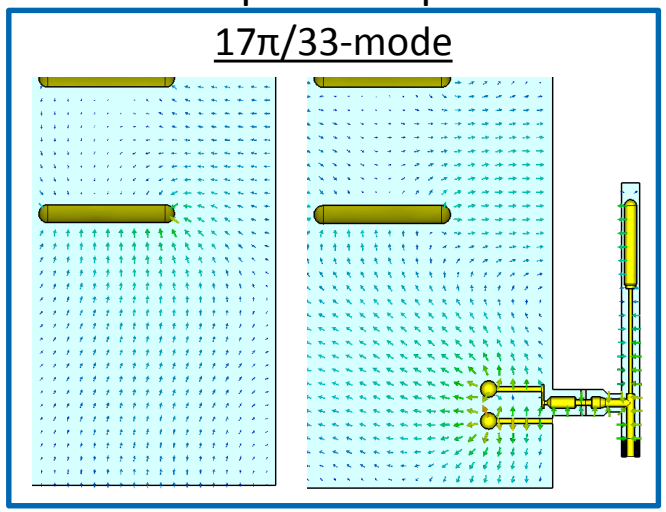
- Damping schemes must fulfill several requirements:
  1) Sufficient damping of 17π/33-mode in lower part of cavity
  2) Sufficient damping of other HOMs
  3) Acceptable influence on FPB
  4) Leave sufficient number of access ports for transverse HOM-damping

pedestal coupler



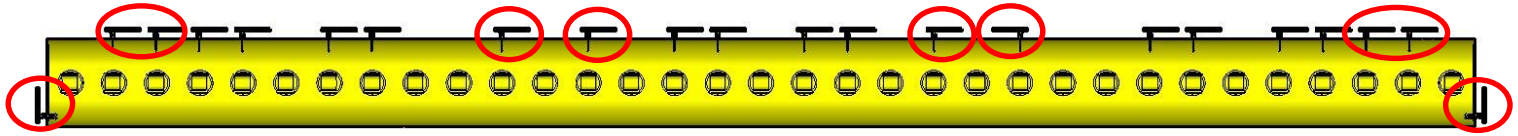
endplate coupler

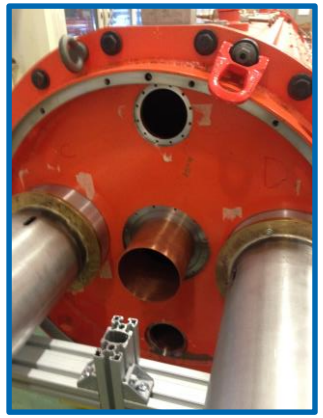
17π/33-mode



mitigation via pumping ports

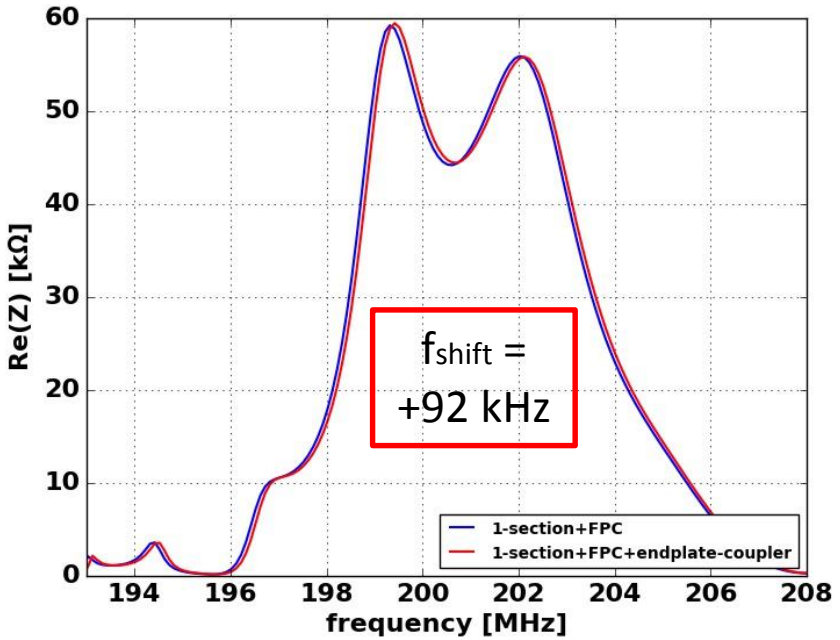
Damping via endplate HOM-ports

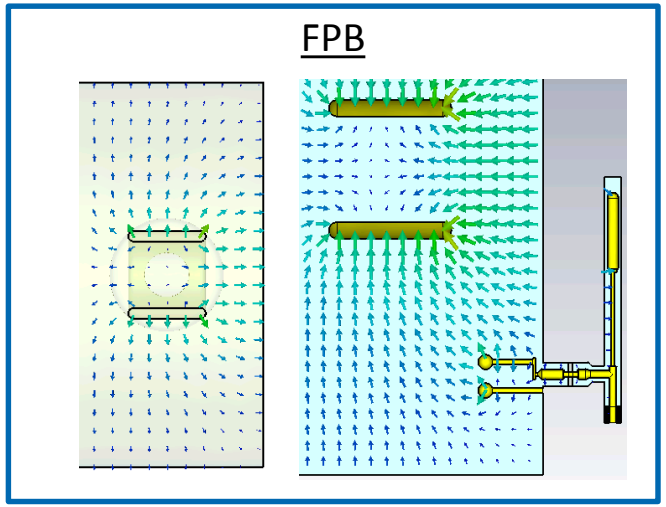




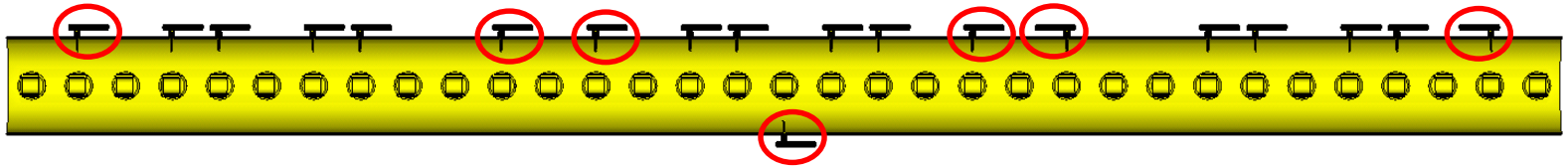
Impedance is reduced by factor 3.0
(with regard to impedance model)

- Influence of endplate-coupler on FPB:
  - Is this an acceptable frequency shift?
  - What is the maximum frequency shift allowed?





HOM-mitigation via vacuum pumping ports



Impedance is reduced by factor 2.8

(Factor 3.1 using two vacuum-ports)

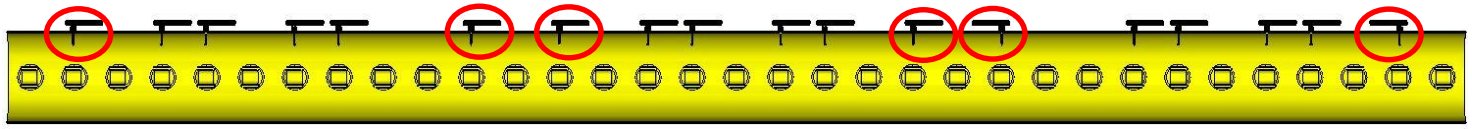
vacPort 17 coupler	f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
no	627.7	8500	7.4	62.5	17π/33
yes	627.7	3642	3.0	5.5	17π/33

- HOM-coupler in (one) pumping port can reduce both Q and R/Q
  - Machining of at least four sections would be necessary to obtain

→ Is it possible to reduce the impedance of the 17π/33-mode by only putting a perturbation in some vacuum pumping ports?

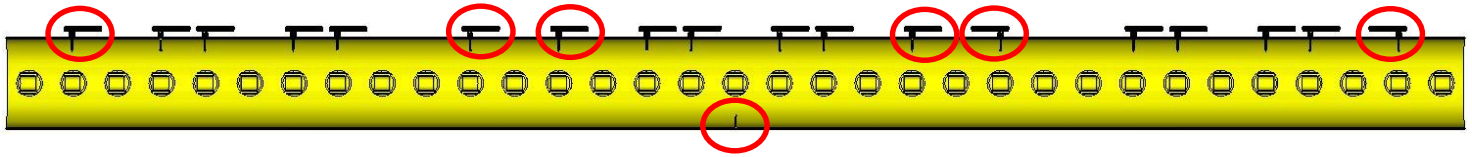
HOM-mitigation via vacuum pumping ports

- Configuration with additional couplers on top

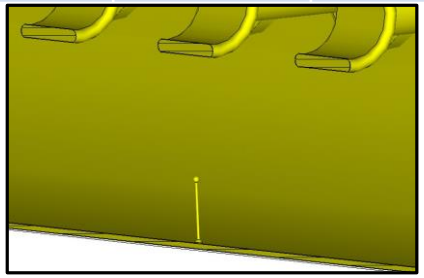


additional couplers				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.7	8500	7.4	62.5	17π/33

- Perturbation is placed in field maxima of 17π/33-mode



additional couplers + perturbation				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
-	-	-	-	-
629.0	15000	2.6	39.5	

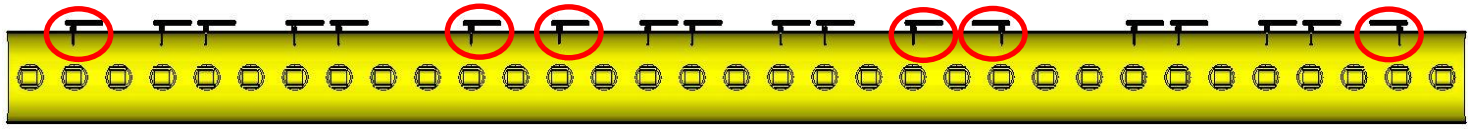


- 17π/33-mode does not exist anymore in the frequency range
- Impedance of another mode is increased as well

-> trade-off by using other vacuum pumping ports

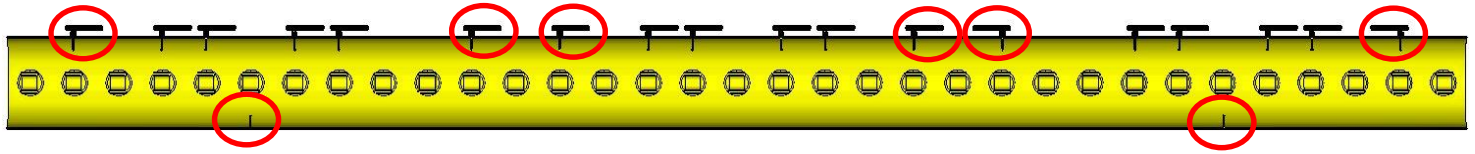
HOM-mitigation via vacuum pumping ports

- Configuration with additional couplers on top



additional couplers				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.7	8500	7.4	62.5	17π/33

- Perturbation placement: Trade-off by looking at field profiles
  - Vacuum ports 6



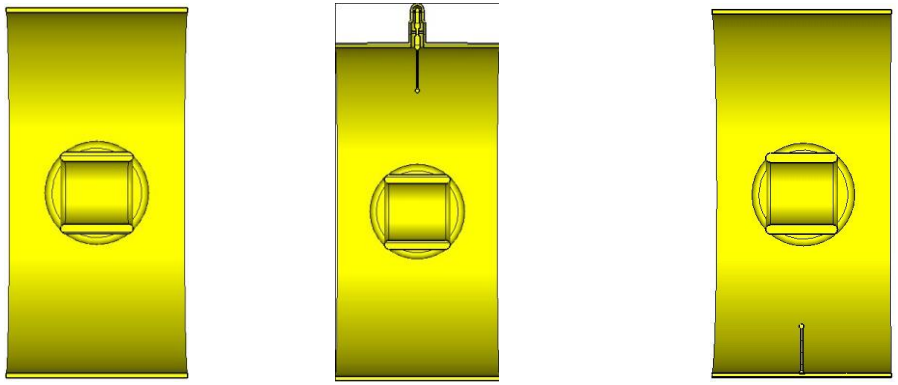
additional couplers + perturbation				
f [MHz]	Q	R/Q [Ω]	R [kΩ]	pA
627.6	3683	1.5	5.4	17π/33

  - Also R/Q of other high impedance modes is reduced
  - Results confirmed by ACE3P

Impedance of 3-section cavity is reduced by factor 3.0
(with regard to impedance model)

HOM-mitigation via vacuum pumping ports

- Influence of perturbation on FPB
  - Infinite periodic single-cell approach
  - 18 couplers and 2 perturbations are used on a 3-section cavity

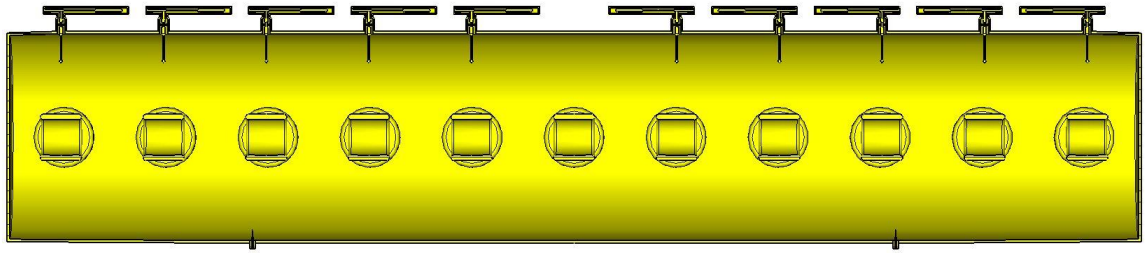


	sC	sC + 628-coupler	sC + perturbation
f [MHz]	200.51	200.57	200.31
Δf [kHz]	-	+60	-200

Next step: Proof of principle by measurement

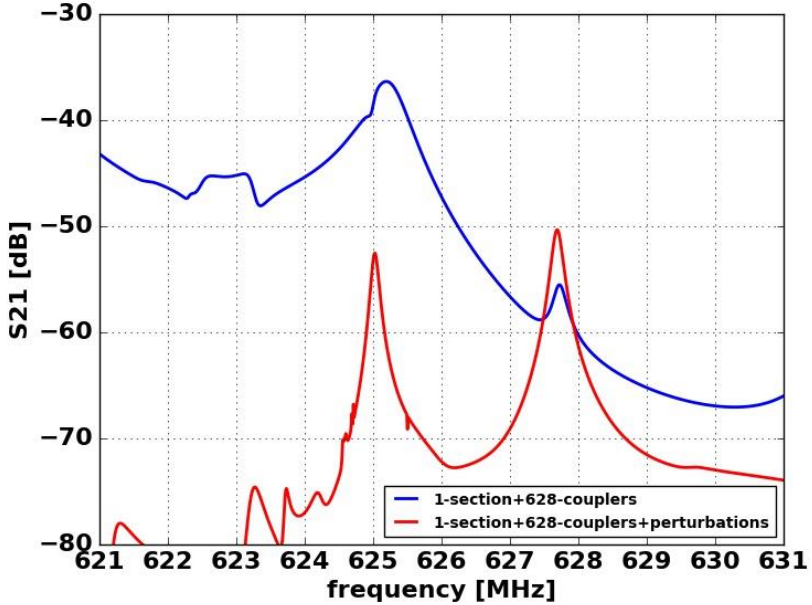
- Perturbation measurements on 3-section cavity are cumbersome
- A mode with similar behavior as 17π/33 was found on a 1-section cavity (6π/11)
- Show two effects of the perturbing probes:
  1) 6 π /11-mode does not exist anymore in 630MHz frequency range (S-Parameters)
  2) The R/Q of other modes is vastly influenced (Perturbation measurements)
- Measure also the influence on the FPB
- If simulation and measurements agree for 1-section, results for 3-section cavity can be considered reliable

Proof of principle by measurement

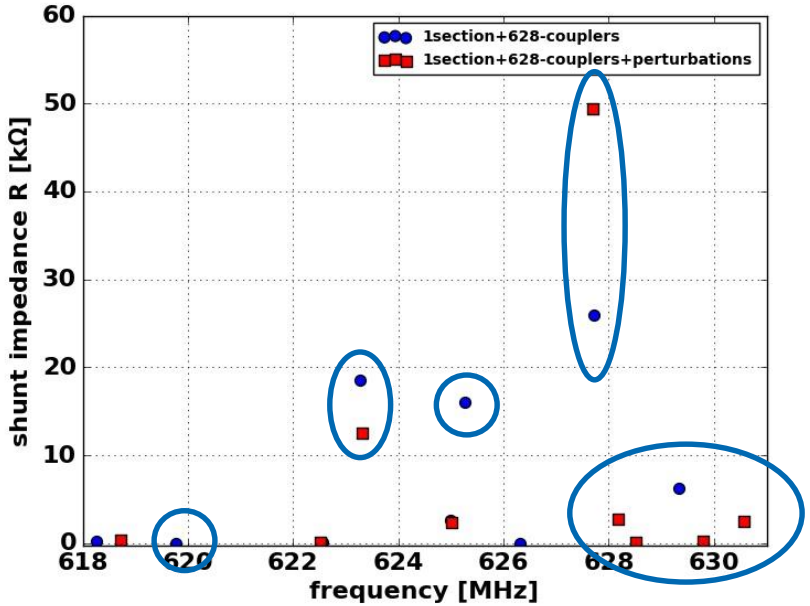


1-section + 628-couplers		
f [MHz]	Q	pA
625.0	5200	
625.27	1057	6π/11

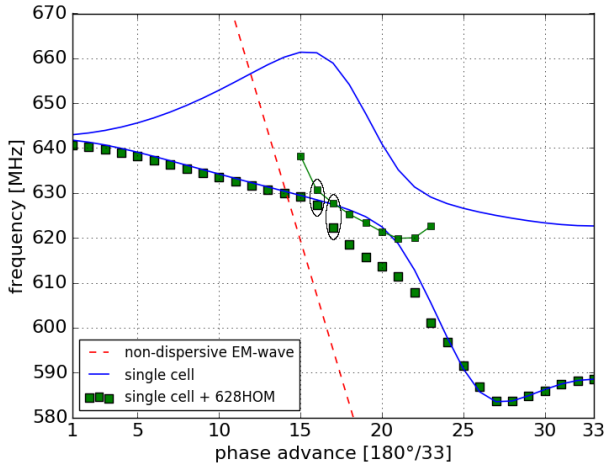
1) 6π/11 is eliminated



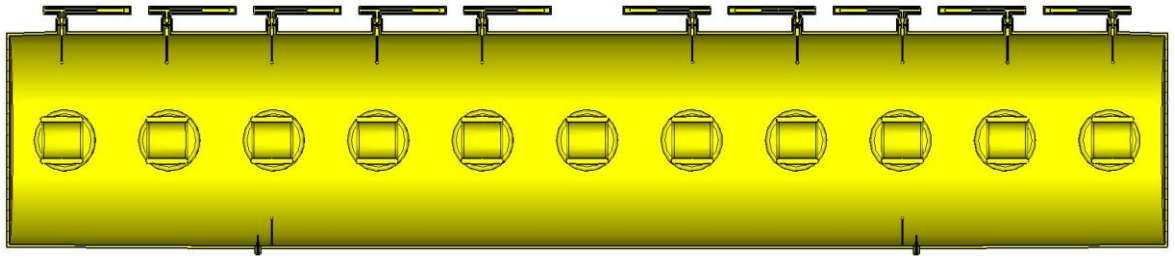
2) Impedance of other modes influenced



Modes are shifted towards their original passband



Proof of principle by measurement



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f [MHz]	Q	pA
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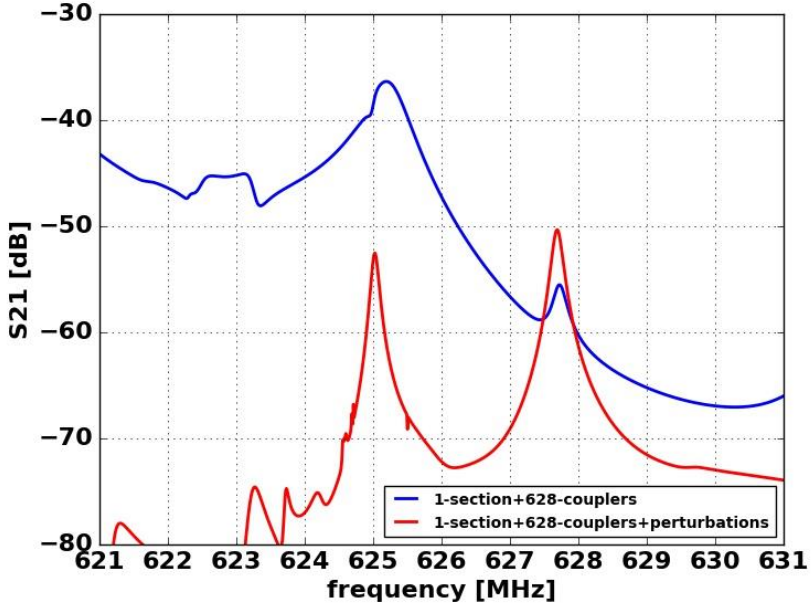

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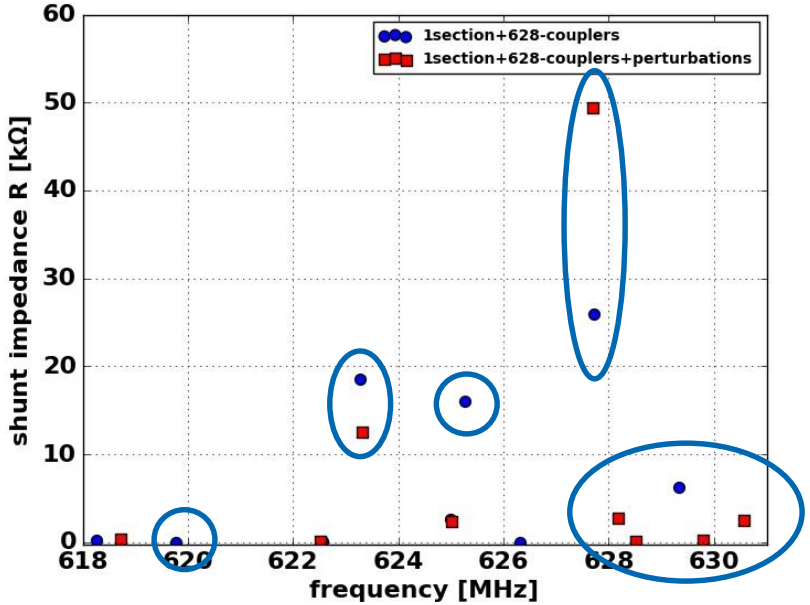
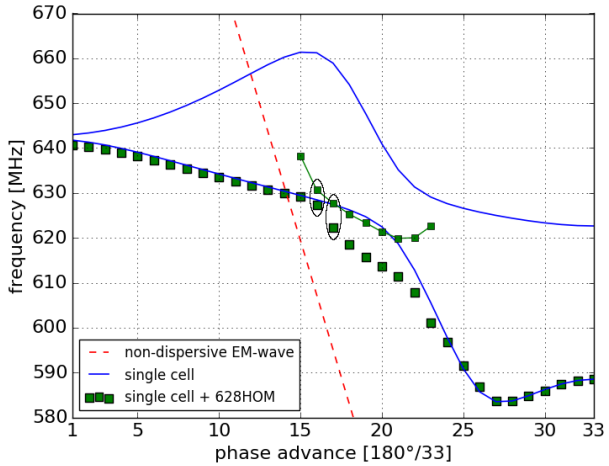


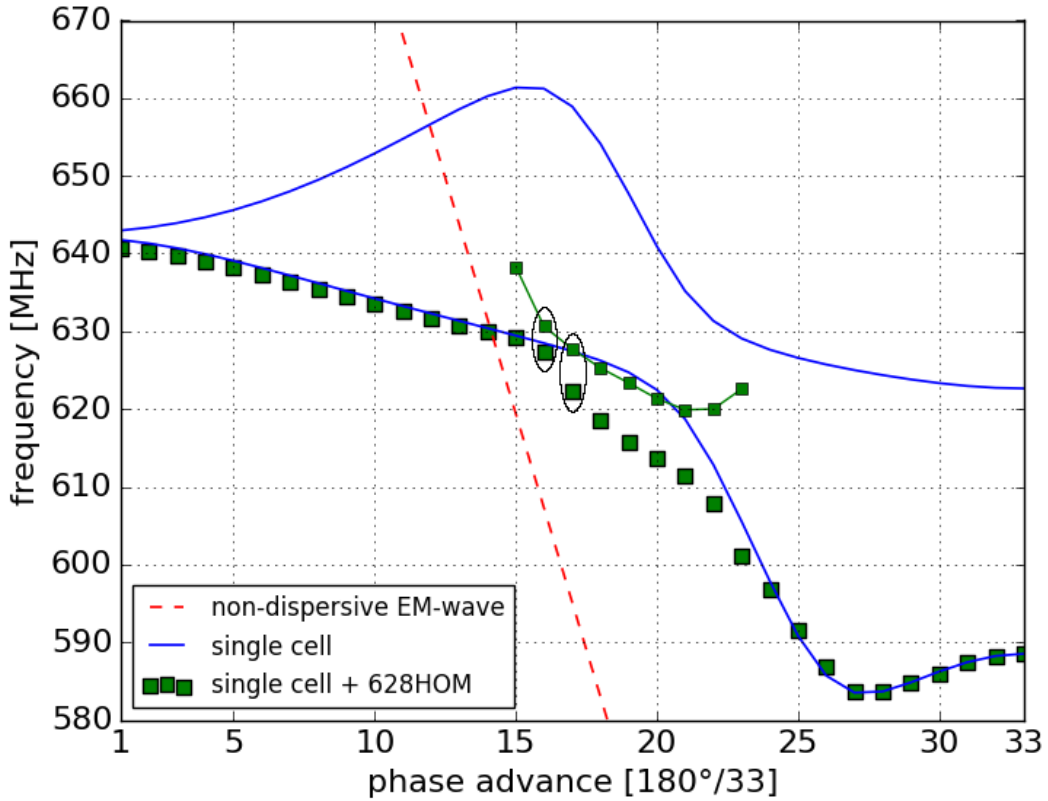
Modes are shifted towards their original passband



Conclusions

- Two damping solutions are found: both achieving factor 3.0 reduction
- Acceptable influence on FPB to be proven (work on-going)
  - Cavity tuning is studied
  - Maximal allowed frequency shift in FPB (due to HOM-mitigation) must be provided
- Once confirmed by measurements, the perturbation approach to decrease R/Qs could be generalized/ extended

Thanks


670
660
650
640
630
620
610
600
590
580
frequency [MHz]
1
5
10
15
20
25
30
33
phase advance [180°/33]
non-dispersive EM-wave
single cell
single cell + 628HOM