Revision of Accelerating and Damping Structures for KEK STF 45 MV/m Accelerator Modules

Revision of Accelerating and Damping Structures for KEK STF 45 MV/m Accelerator Modules

Morozumi Yuichi
for
High Gradient SRF Group
KEK, Tsukuba, Japan

STF

STF

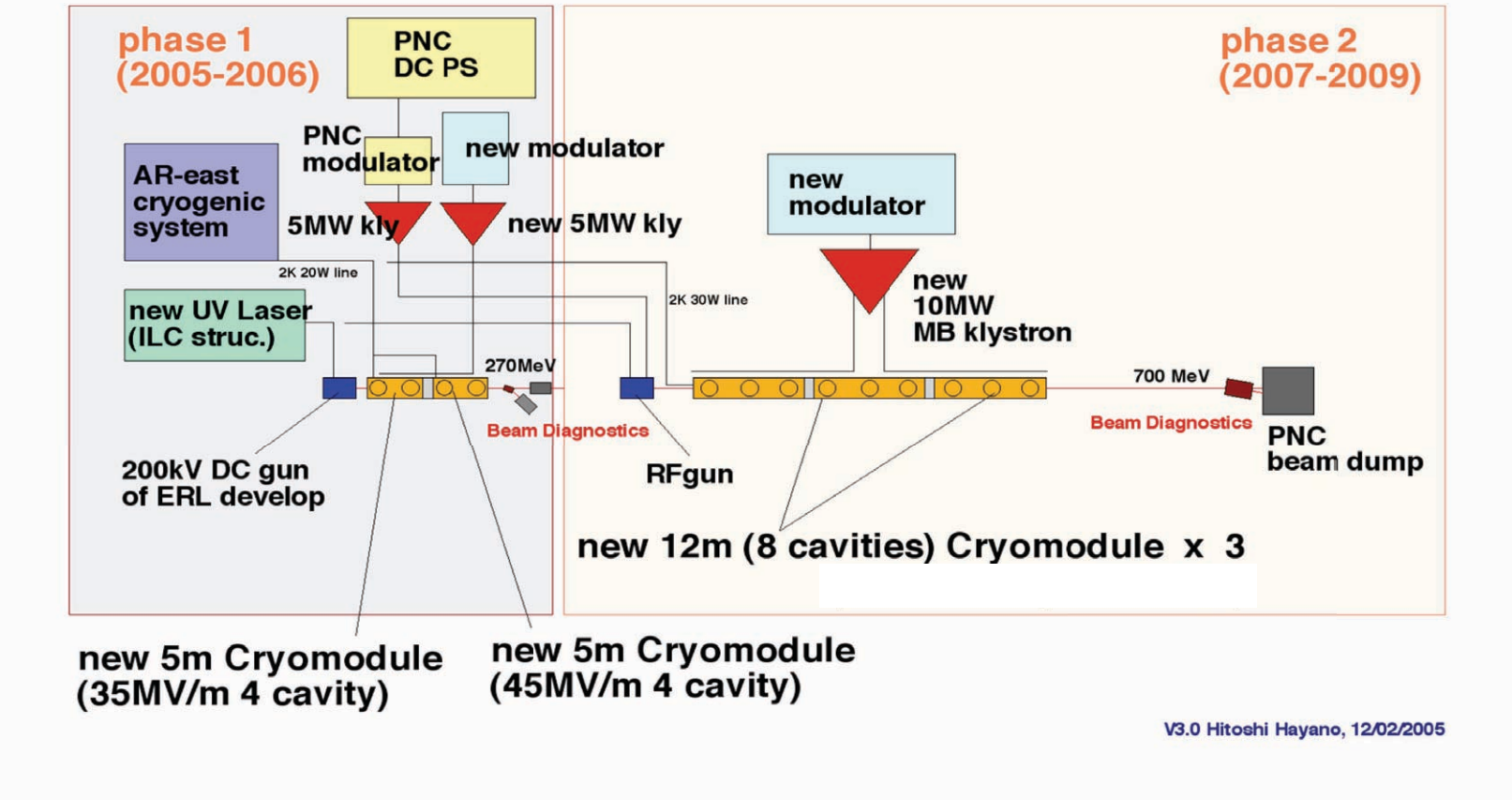
SRF Test Facility

to Develop Cryogenic Accelerator Modules for ILC

STF

SRF Test Facility

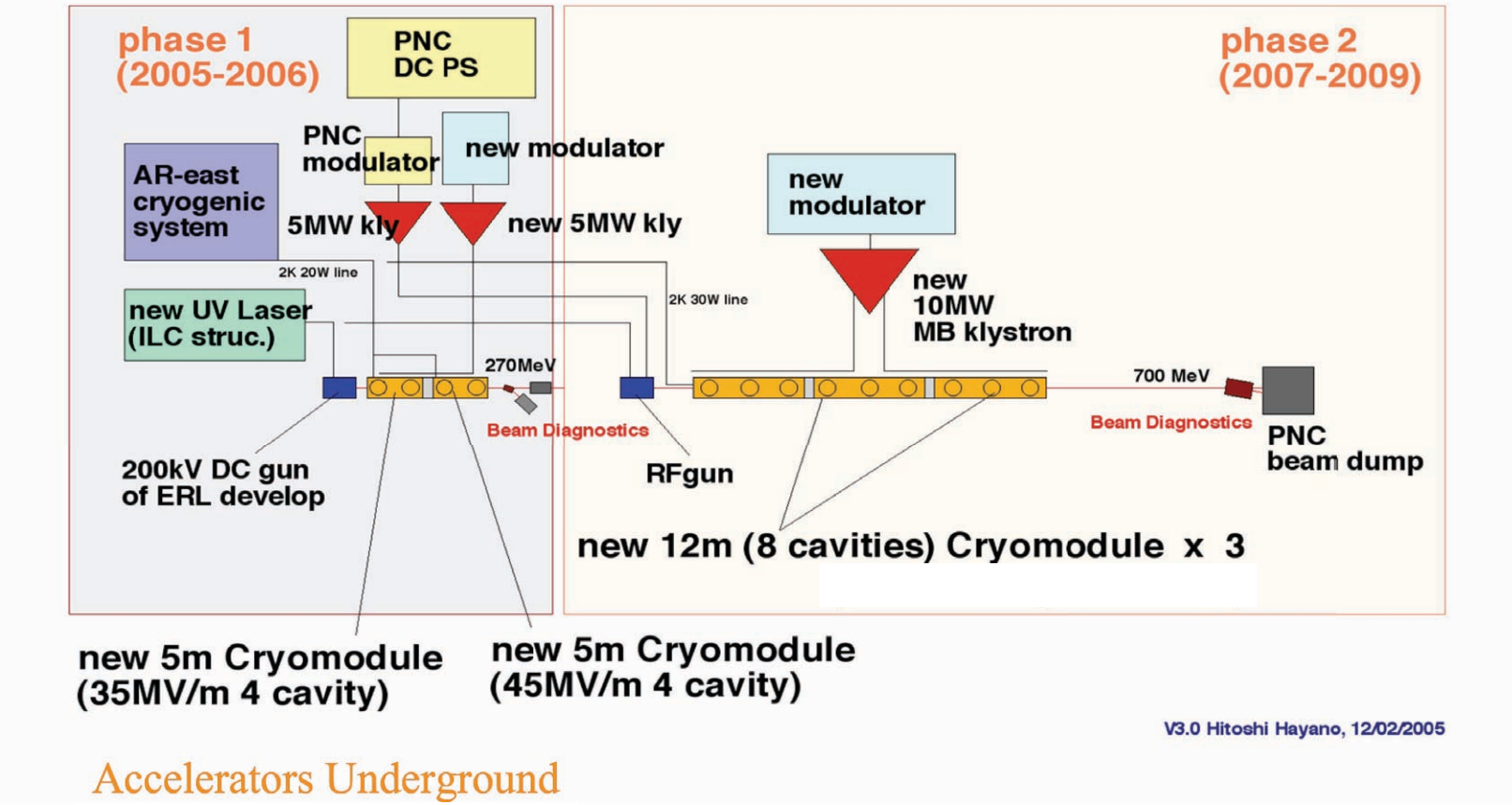
to Develop Cryogenic Accelerator Modules for ILC



STF

SRF Test Facility

to Develop Cryogenic Accelerator Modules for ILC

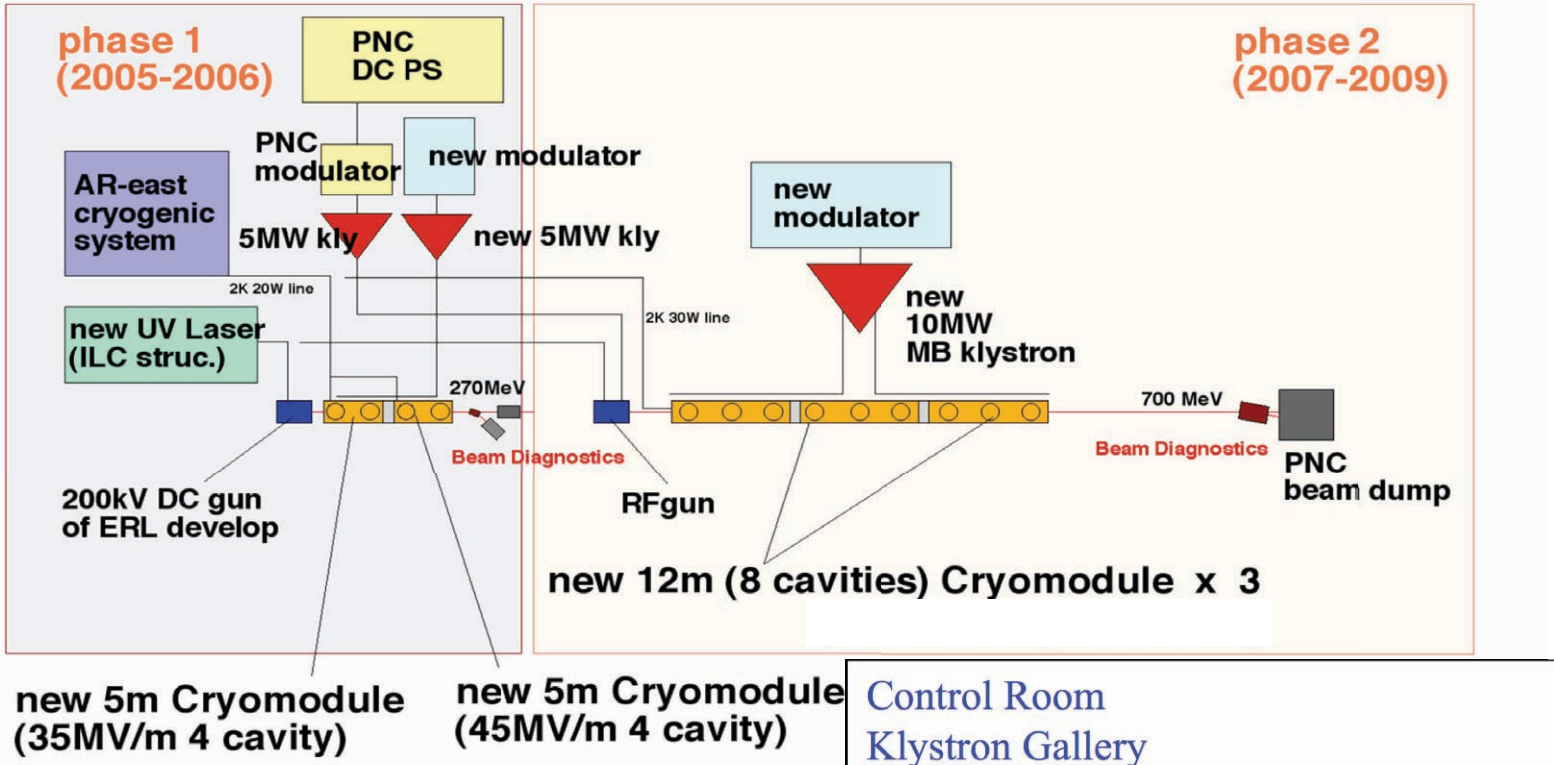


Accelerators Underground

STF

SRF Test Facility

to Develop Cryogenic Accelerator Modules for ILC



Accelerators Underground

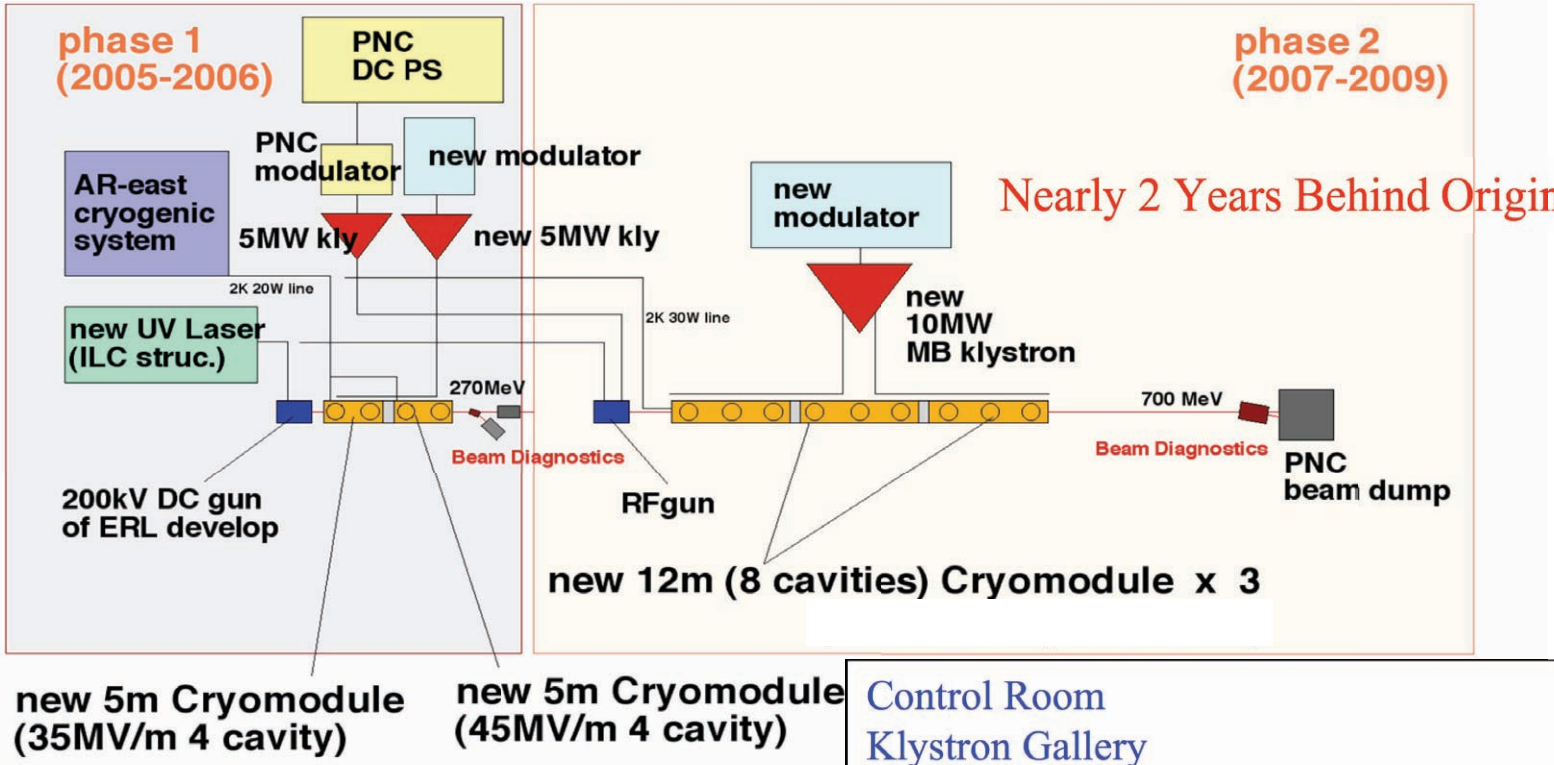
Control Room
Klystron Gallery
Clean Room
Assembly Hall
Surface Processing Shops

On Ground Floor

STF

SRF Test Facility

to Develop Cryogenic Accelerator Modules for ILC



Nearly 2 Years Behind Original Schedule

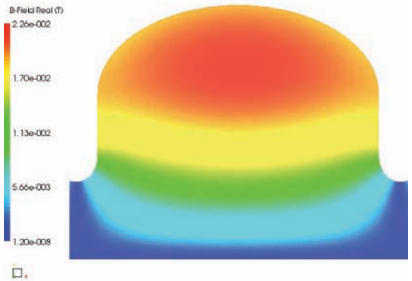
Accelerators Underground

Control Room
Klystron Gallery
Clean Room
Assembly Hall
Surface Processing Shops

On Ground Floor

High Gradient Efforts

High Gradient Efforts



Cavity Geometry Chosen for Gradient Efficiency

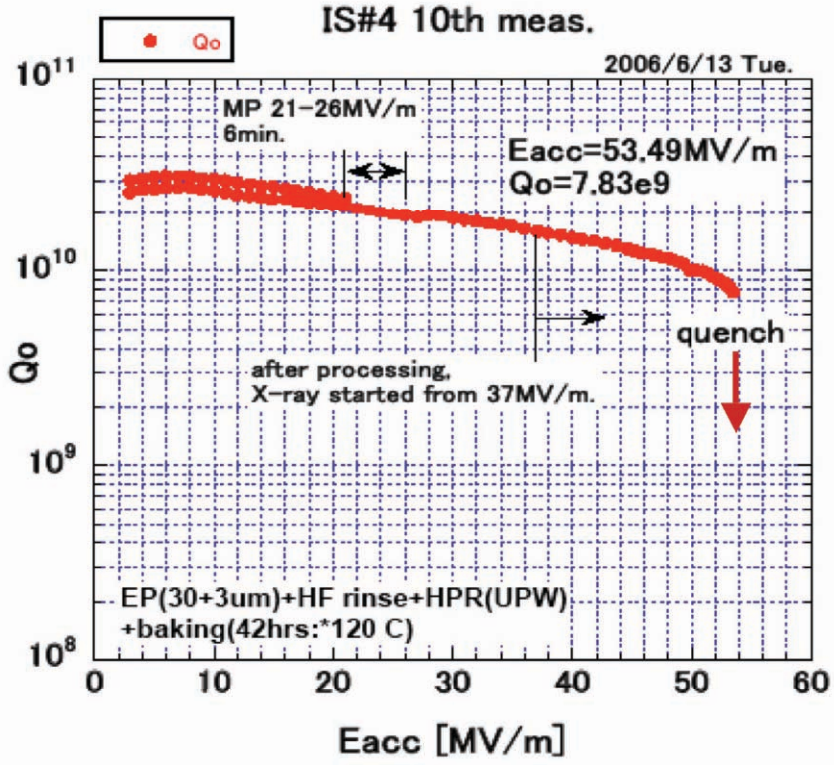
High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)

Surface Processing Technology Explored for High Performance and Reproducibility

High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)



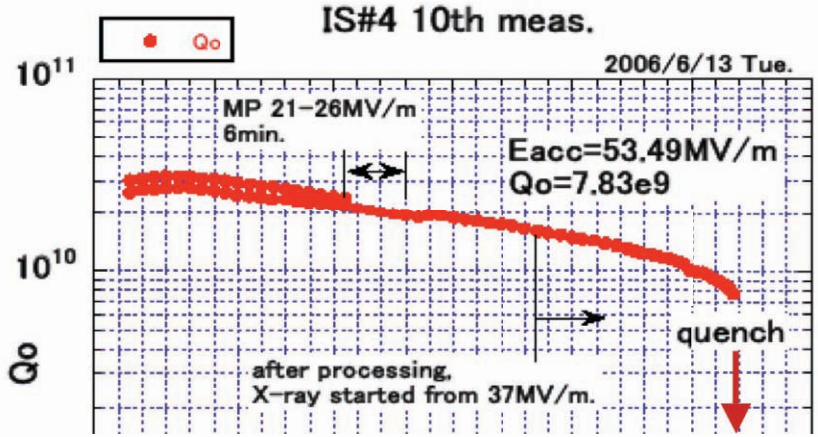
New record!

By.Furuta, Hong, Iwai

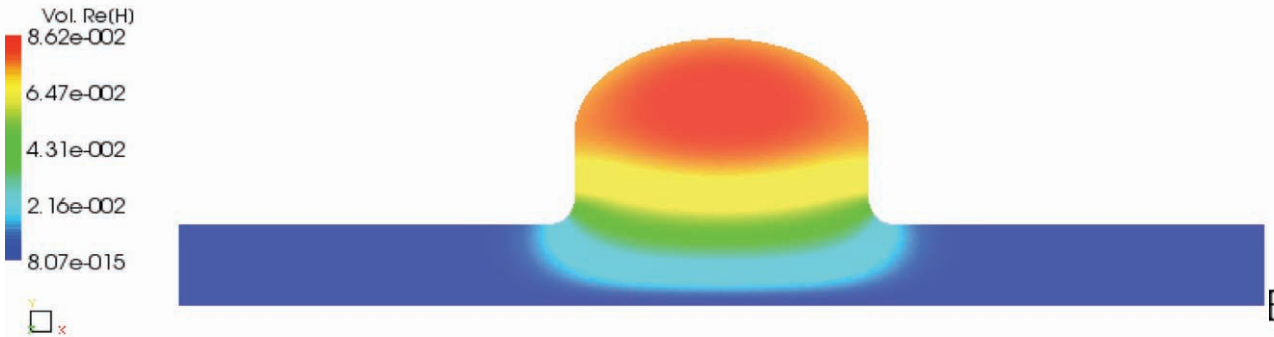
High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)

Single-Cell Cavity
Hsp/Eacc = 35.5 Oe/(MV/m)



New record!

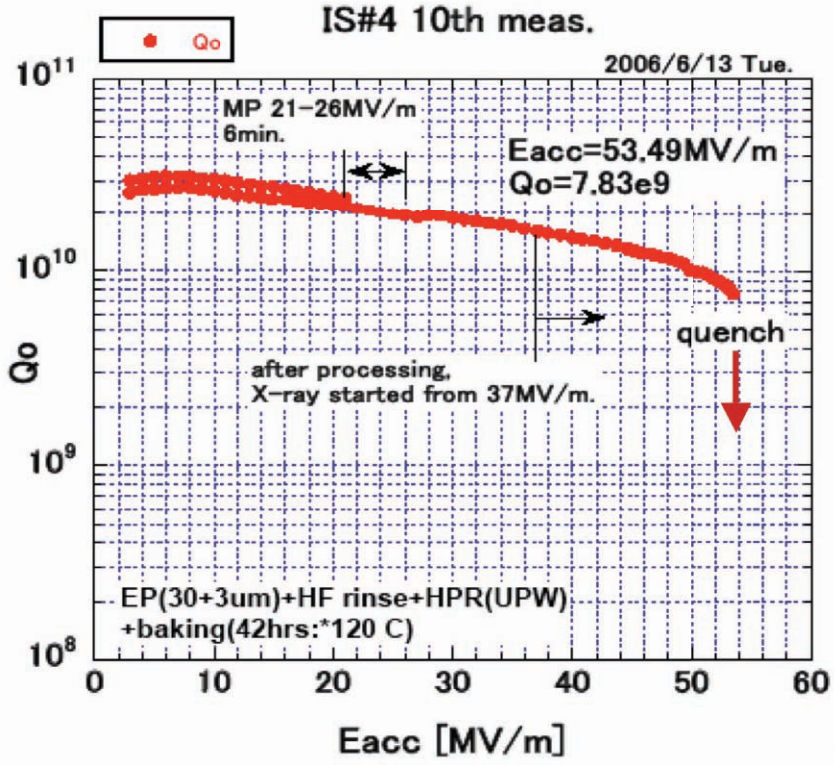


Hong, Iwai

High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)

Single-Cell Cavity
Hsp/Eacc = 35.5 Oe/(MV/m)



⇒ Critical Field ≅ 1900 Oe

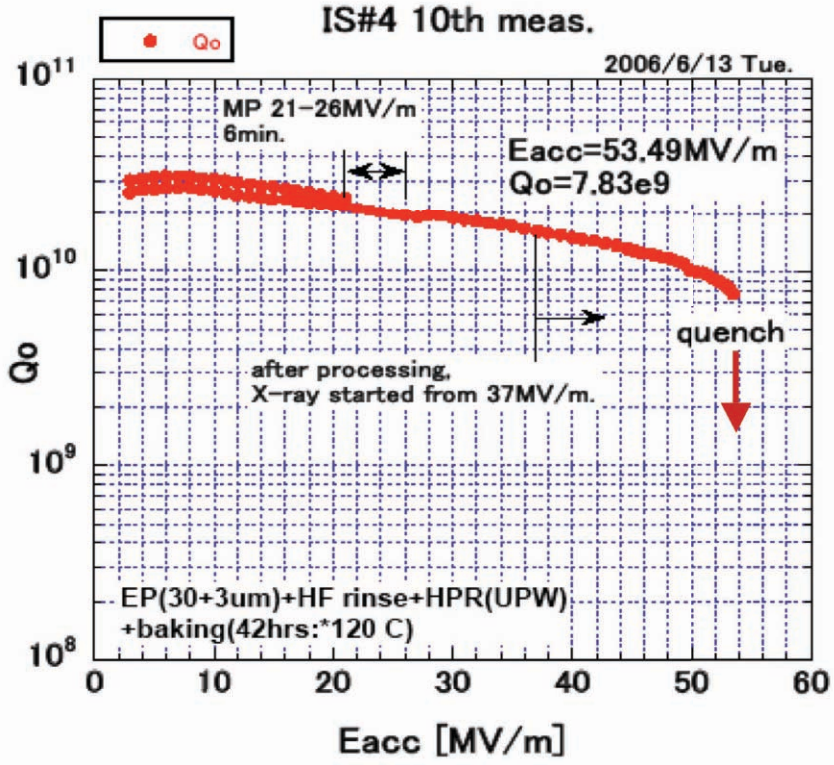
New record!

By.Furuta, Hong, Iwai

High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)

Single-Cell Cavity
Hsp/Eacc = 35.5 Oe/(MV/m)



⇒ Critical Field ≅ 1900 Oe

New record!

9-Cell Structure
Hsp/Eacc = 37 Oe/(MV/m)

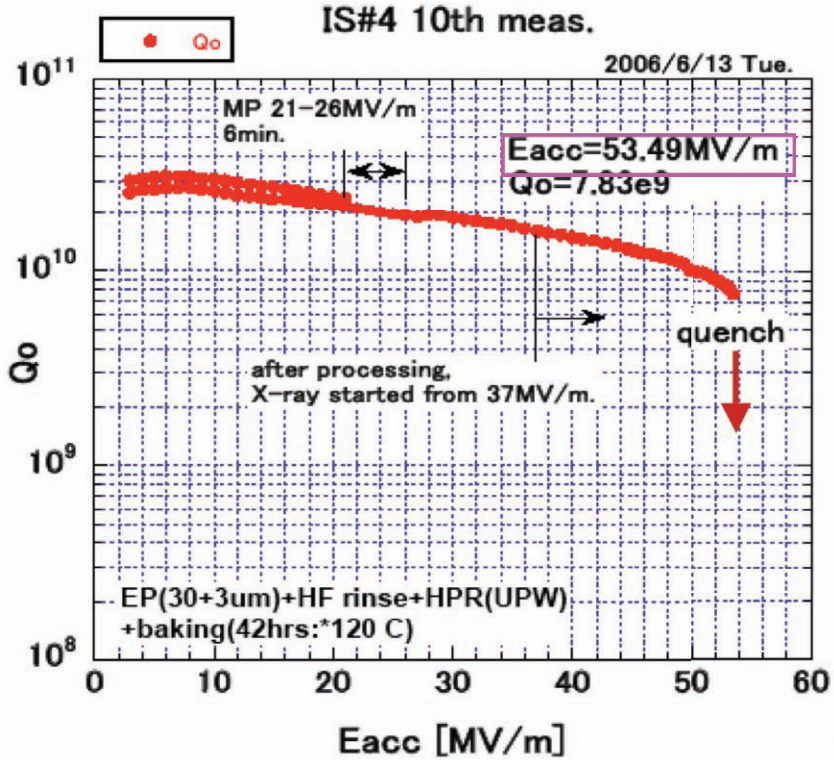
Eacc ≅ 51 MV/m Reachable

By.Furuta, Hong, Iwai

High Gradient Efforts

EP(20um)+EP(3um, closed, new acid)+HF rinse
+HPR(UPW)+Baking(120C*42-hrs)

Single-Cell Cavity
Hsp/Eacc = 35.5 Oe/(MV/m)



⇒ Critical Field ≅ 1900 Oe

New record!

9-Cell Structure
Hsp/Eacc = 37 Oe/(MV/m)

Eacc ≅ 51 MV/m Reachable

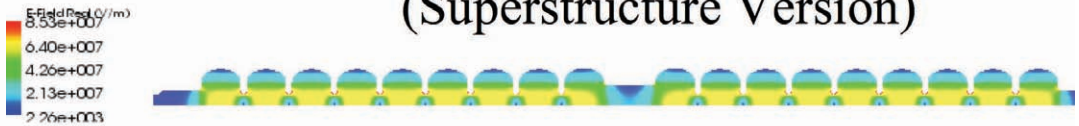
World Record
until Broken by Cornell
March 2007

By.Furuta, Hong, Iwai

Limitation of Gradient in Old 9-Cell Structures

Limitation of Gradient in Old 9-Cell Structures

(Superstructure Version)



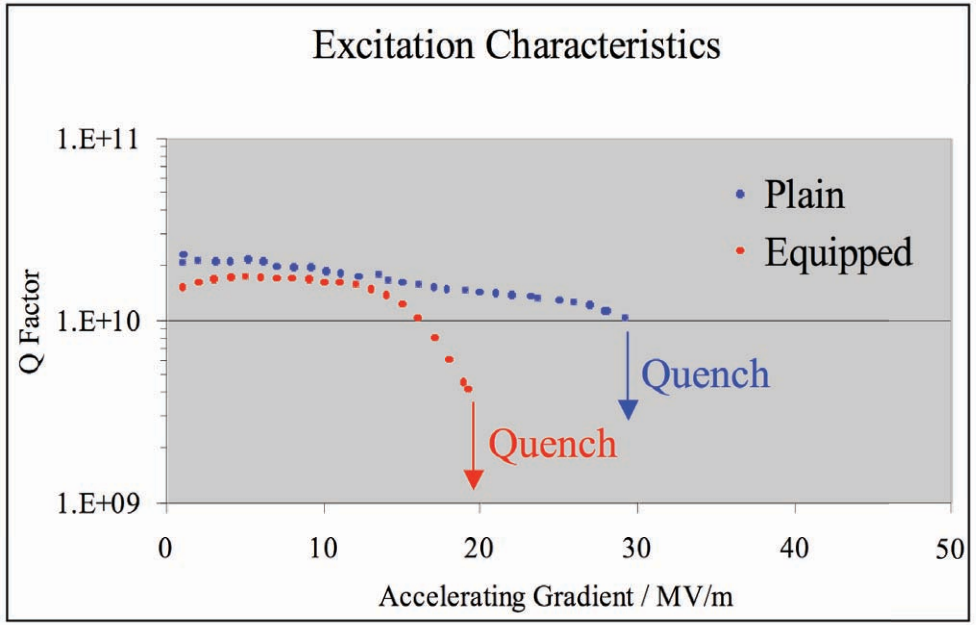
Limitation of Gradient in Old 9-Cell Structures

Equipped

Plain

Limitation of Gradient in Old 9-Cell Structures

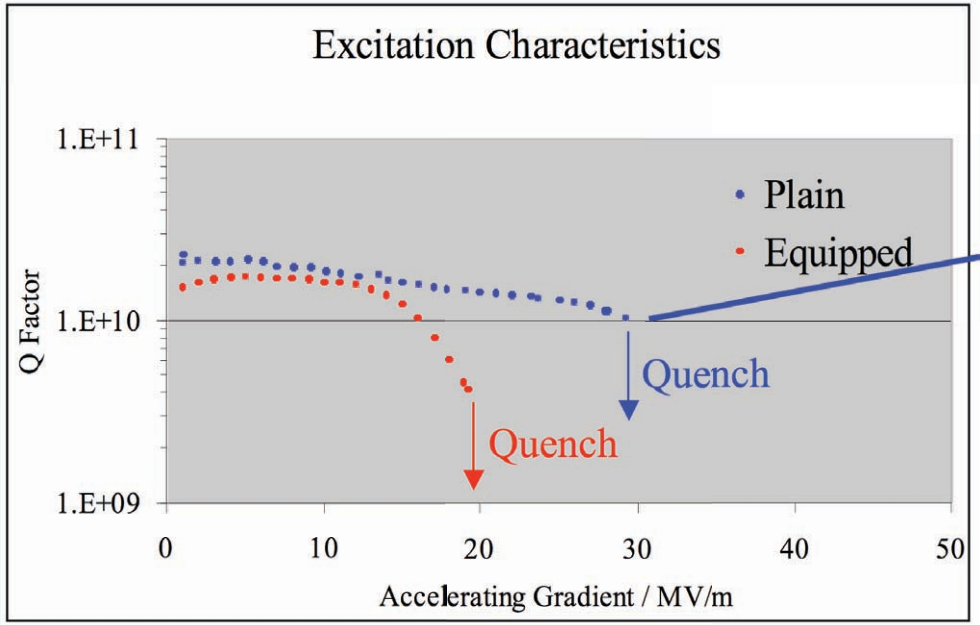
Equipped



Plain

Limitation of Gradient in Old 9-Cell Structures

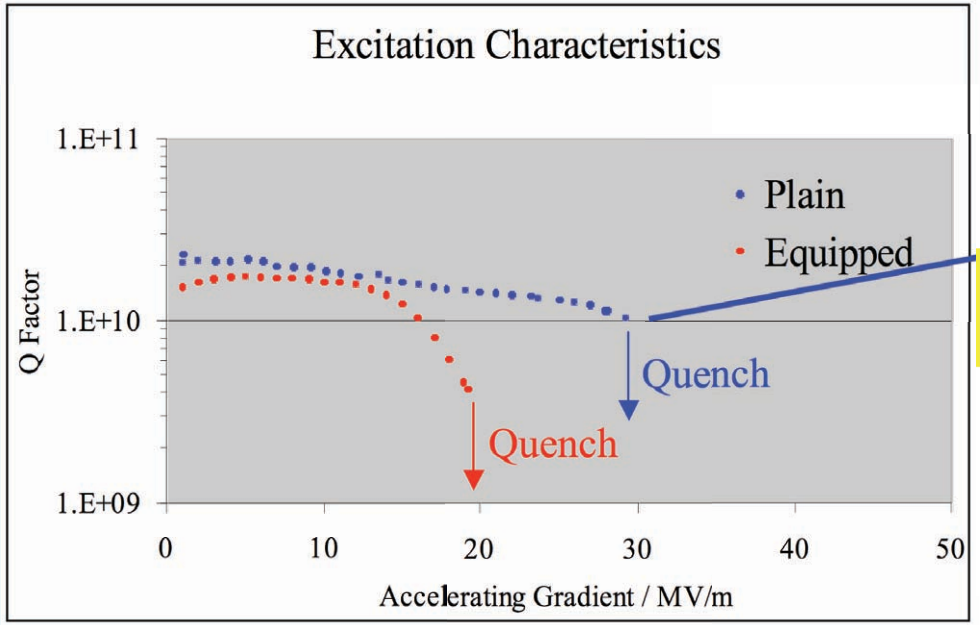
Equipped



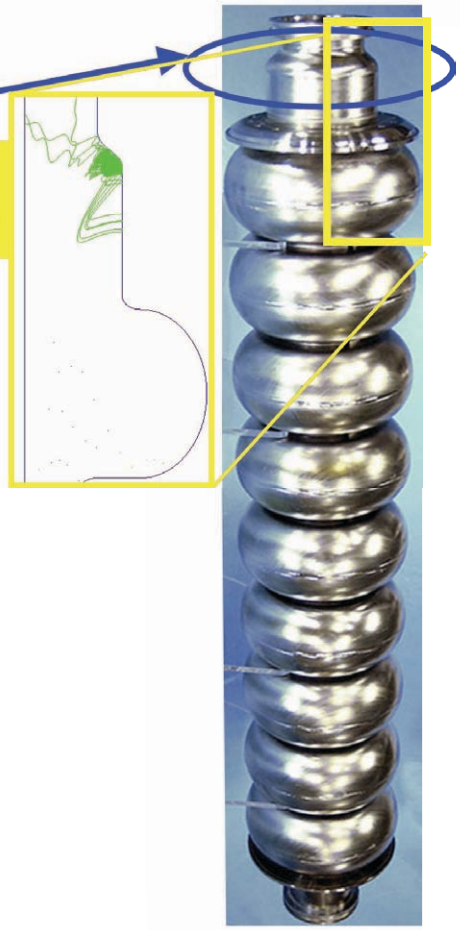
Plain

Limitation of Gradient in Old 9-Cell Structures

Equipped



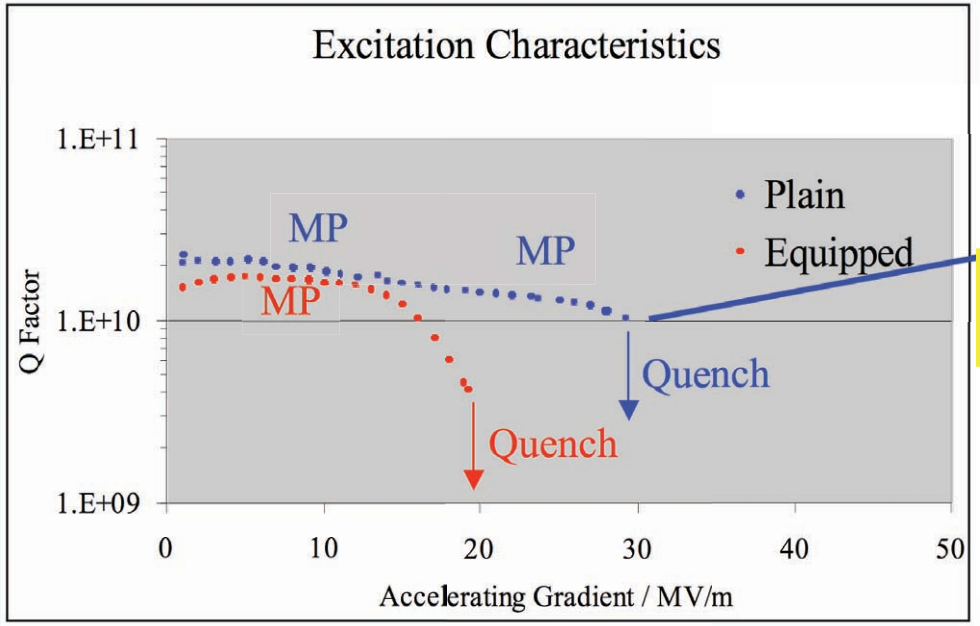
Multipacting at End Port Taper

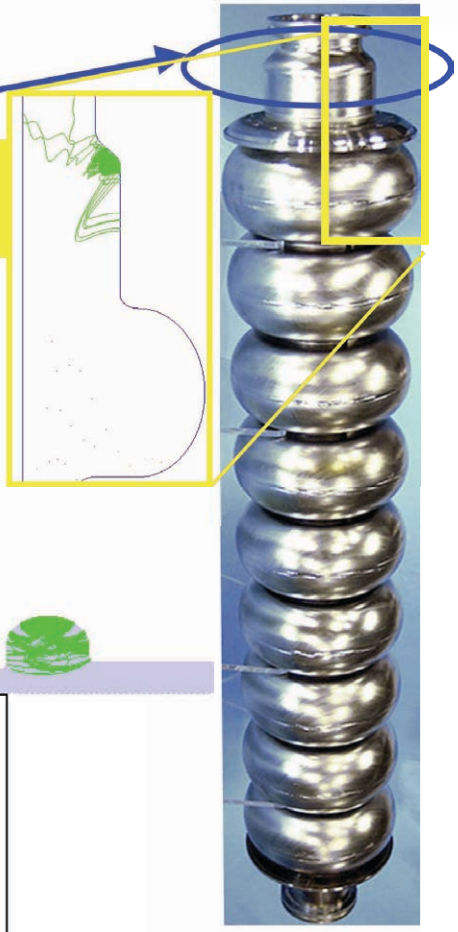


Plain

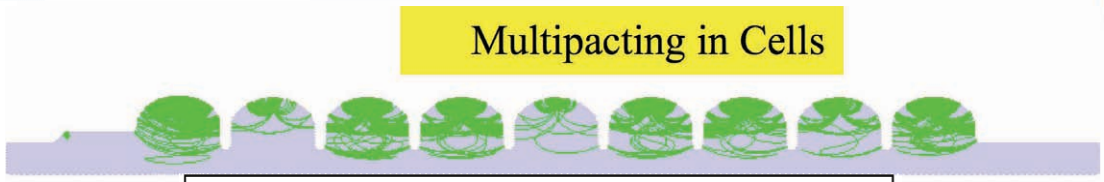
Limitation of Gradient in Old 9-Cell Structures

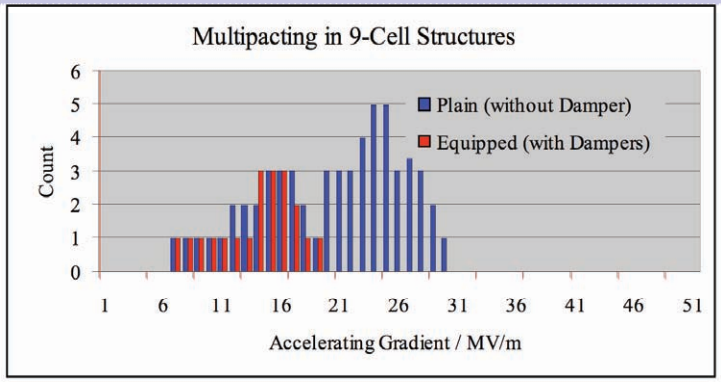
Equipped



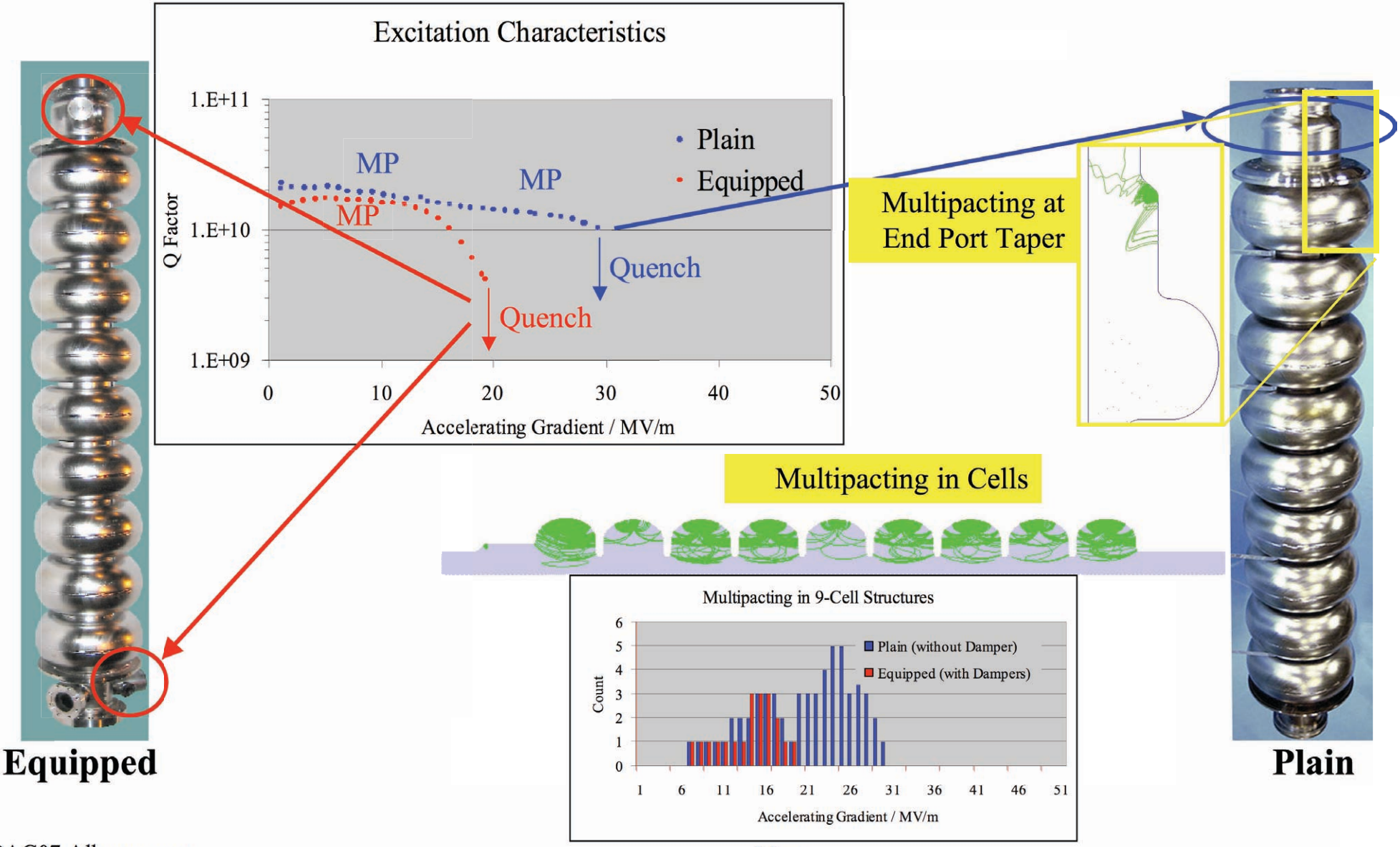


Plain

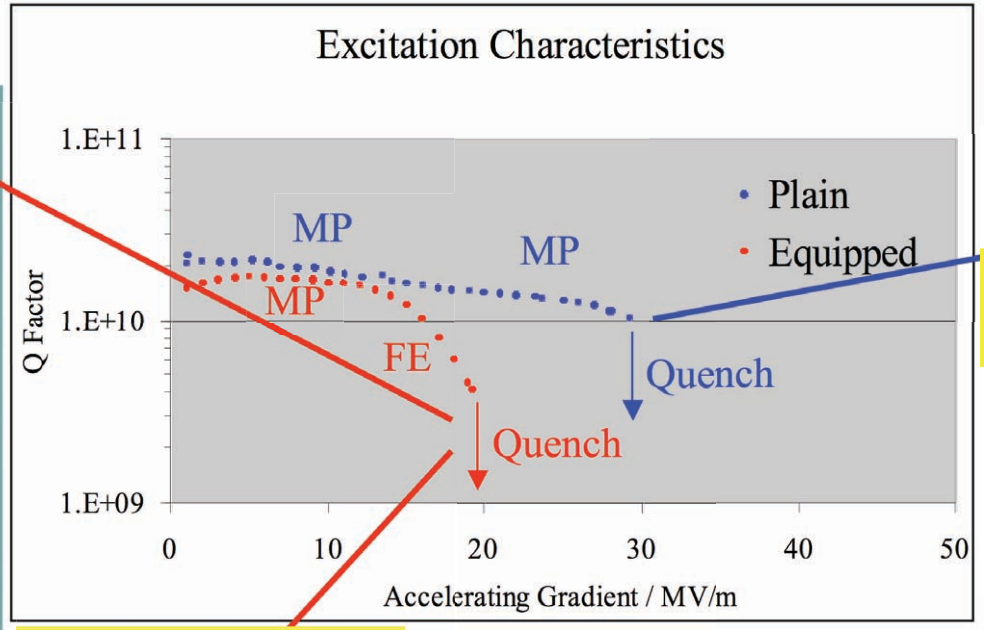




Limitation of Gradient in Old 9-Cell Structures

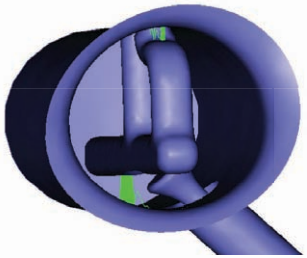


Limitation of Gradient in Old 9-Cell Structures

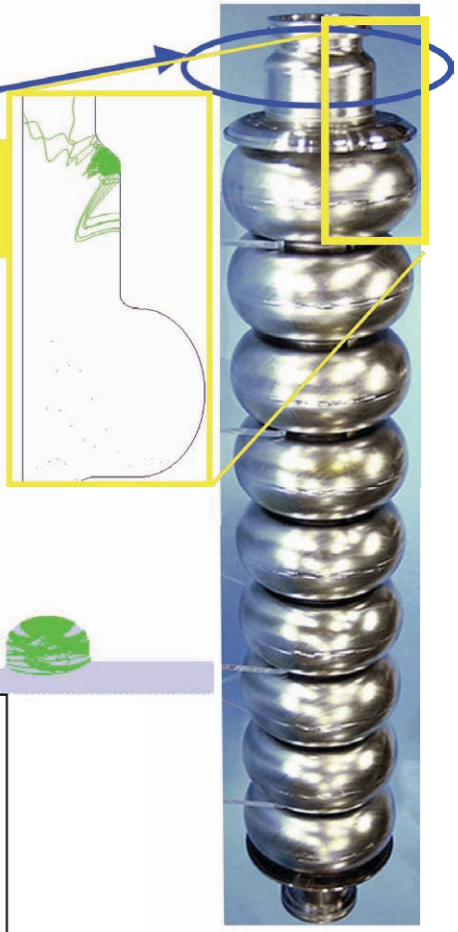


Equipped

Multipacting and Field Emission in Dampers

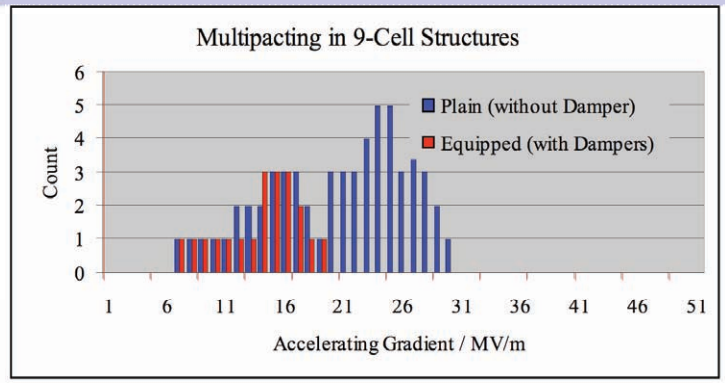


Multipacting at End Port Taper



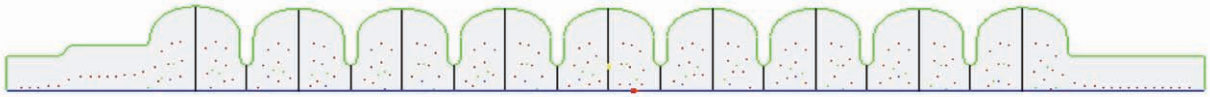
Plain

Multipacting in Cells

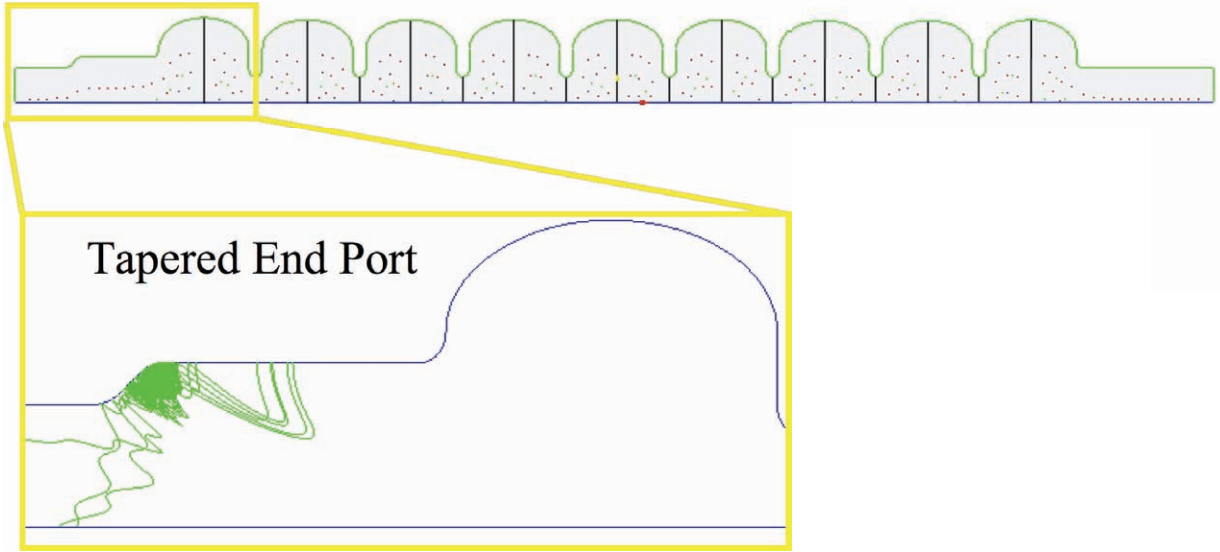


Multipacting in Old End Structure

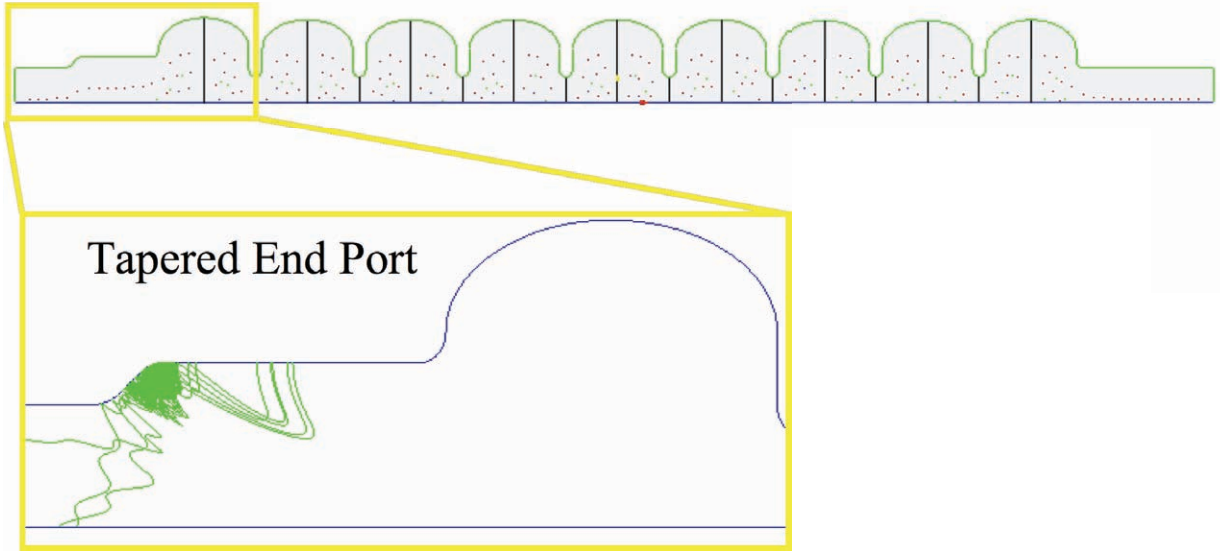
Multipacting in Old End Structure

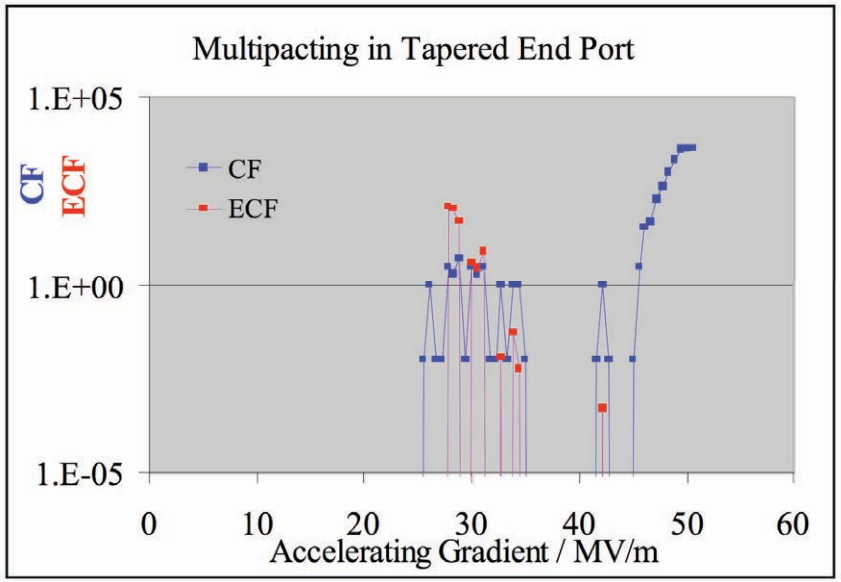


Multipacting in Old End Structure

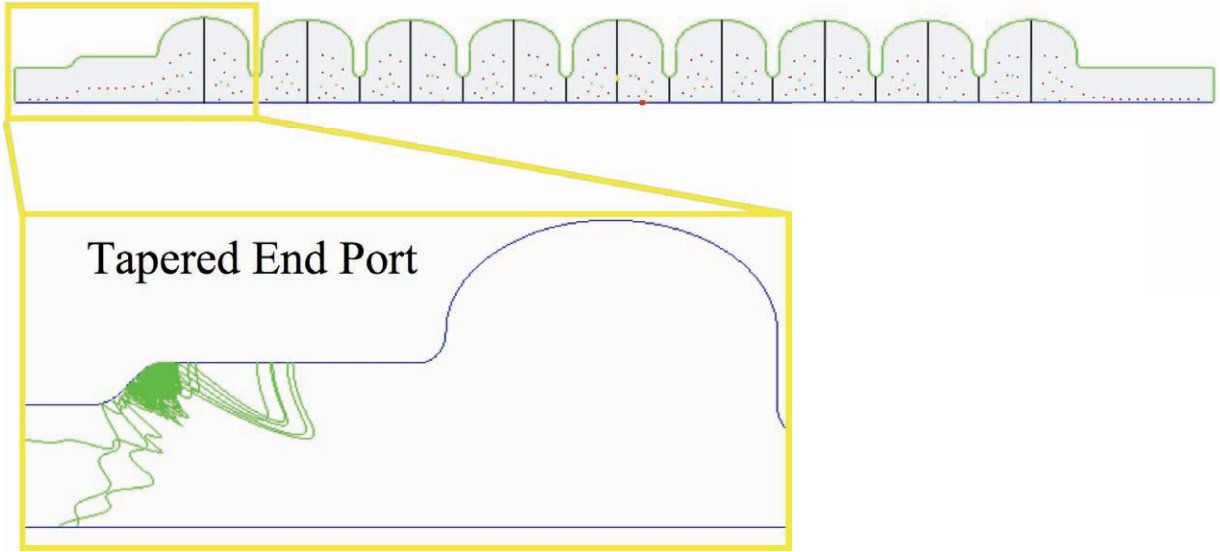


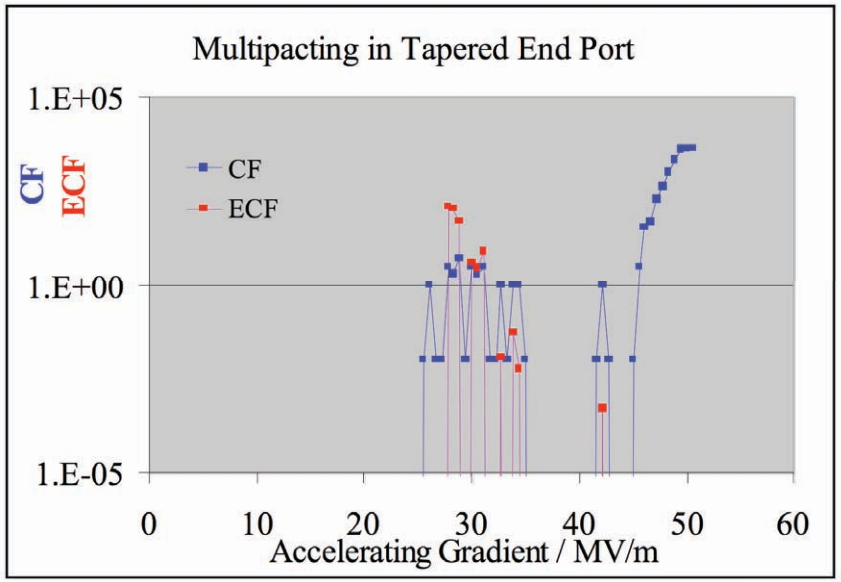
Multipacting in Old End Structure

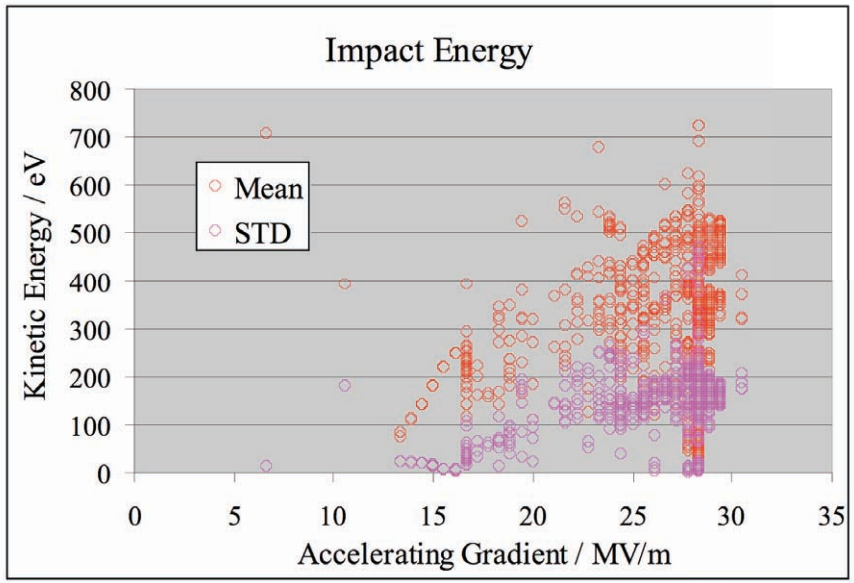




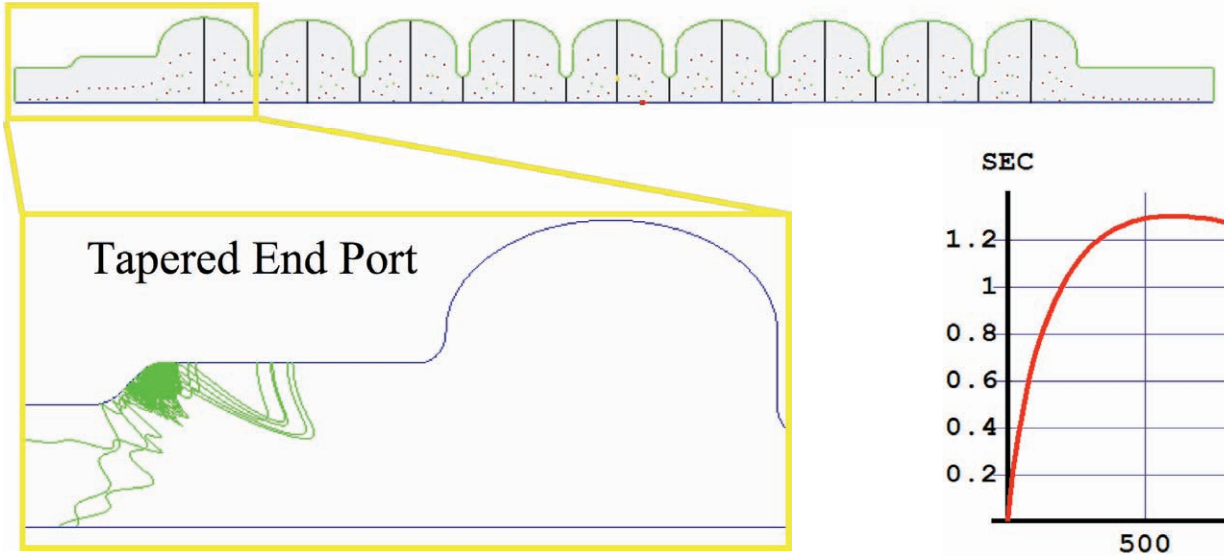
Multipacting in Old End Structure



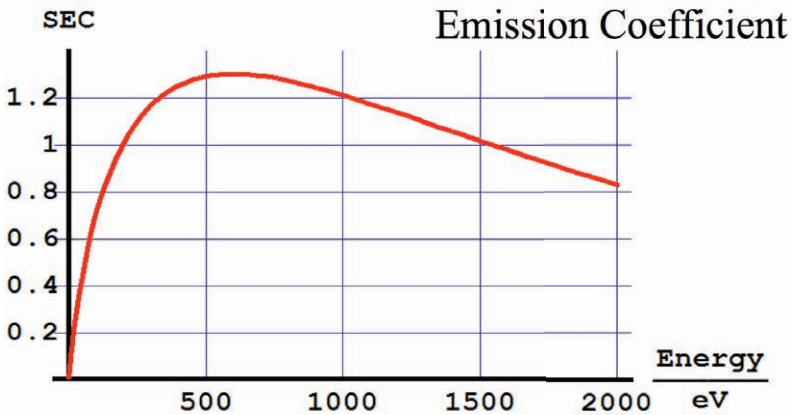


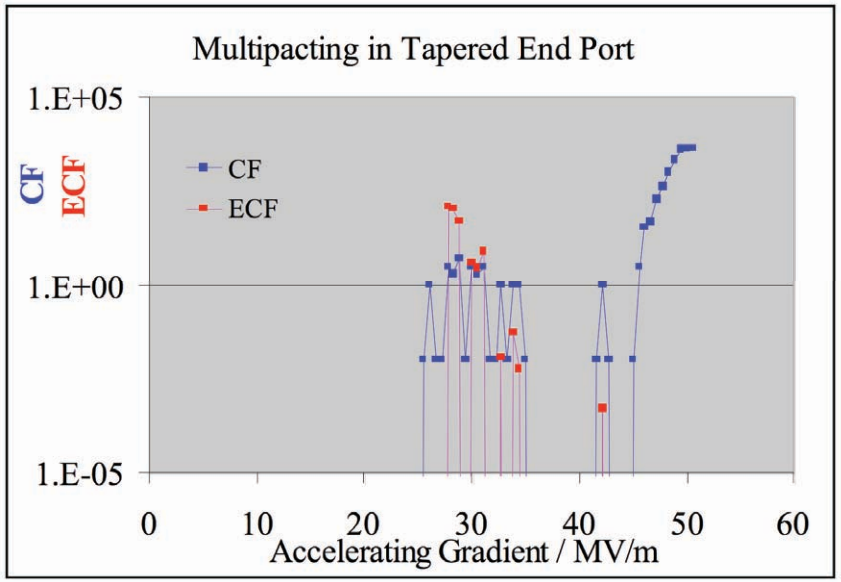


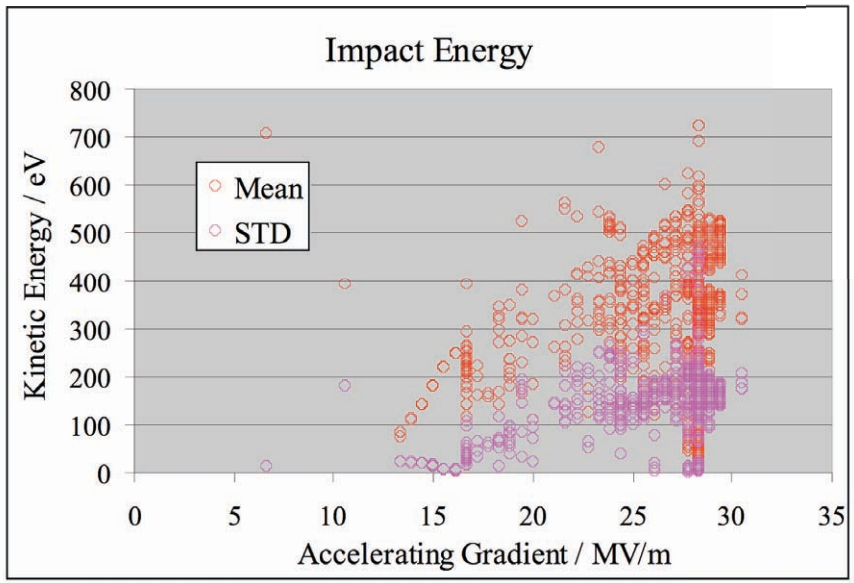
Multipacting in Old End Structure



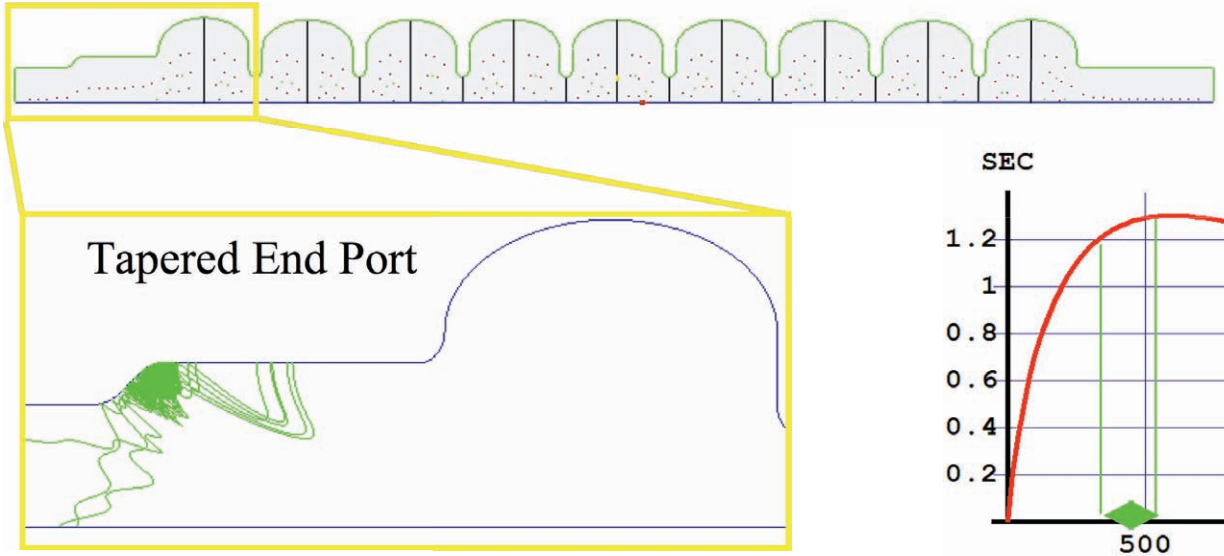
Assumed Secondary Emission Coefficient

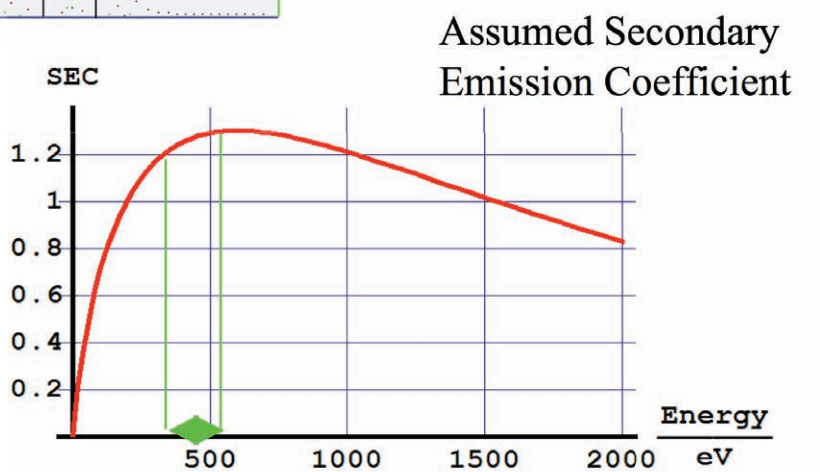


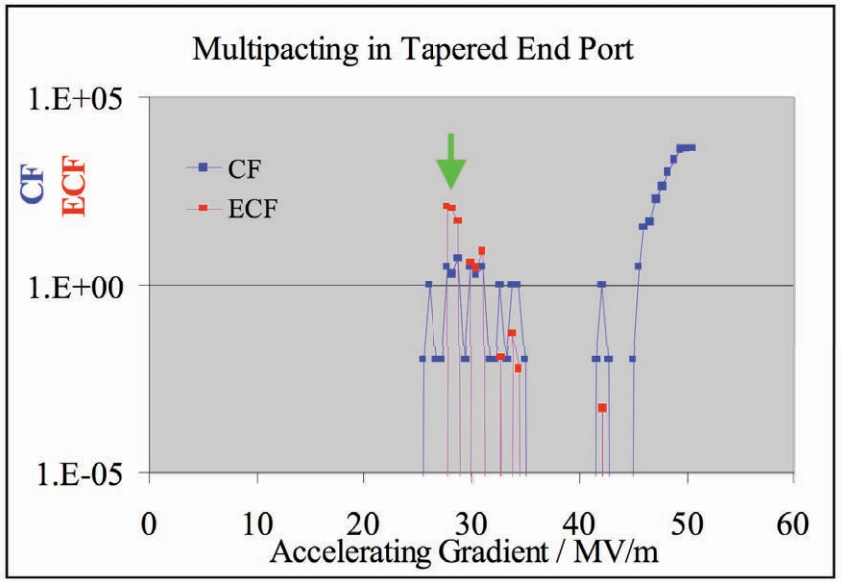


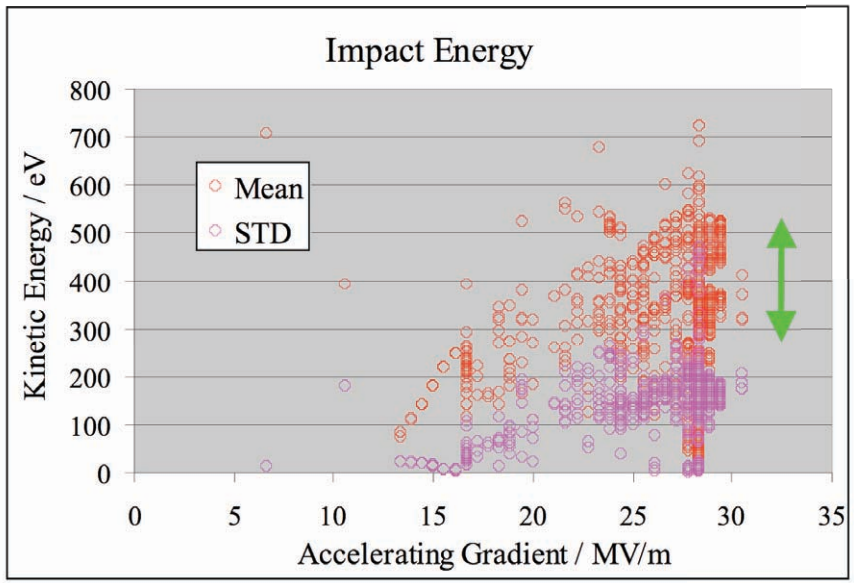


Multipacting in Old End Structure

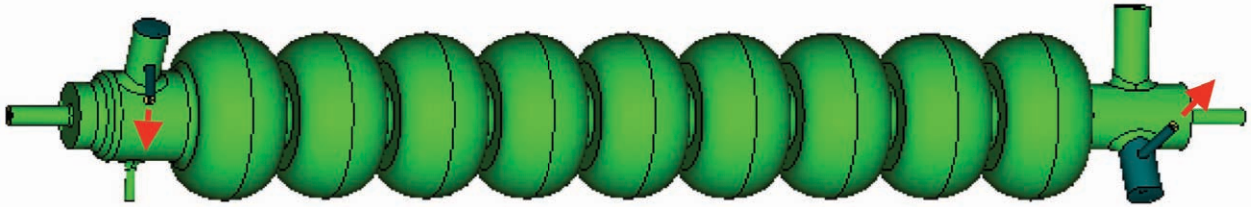


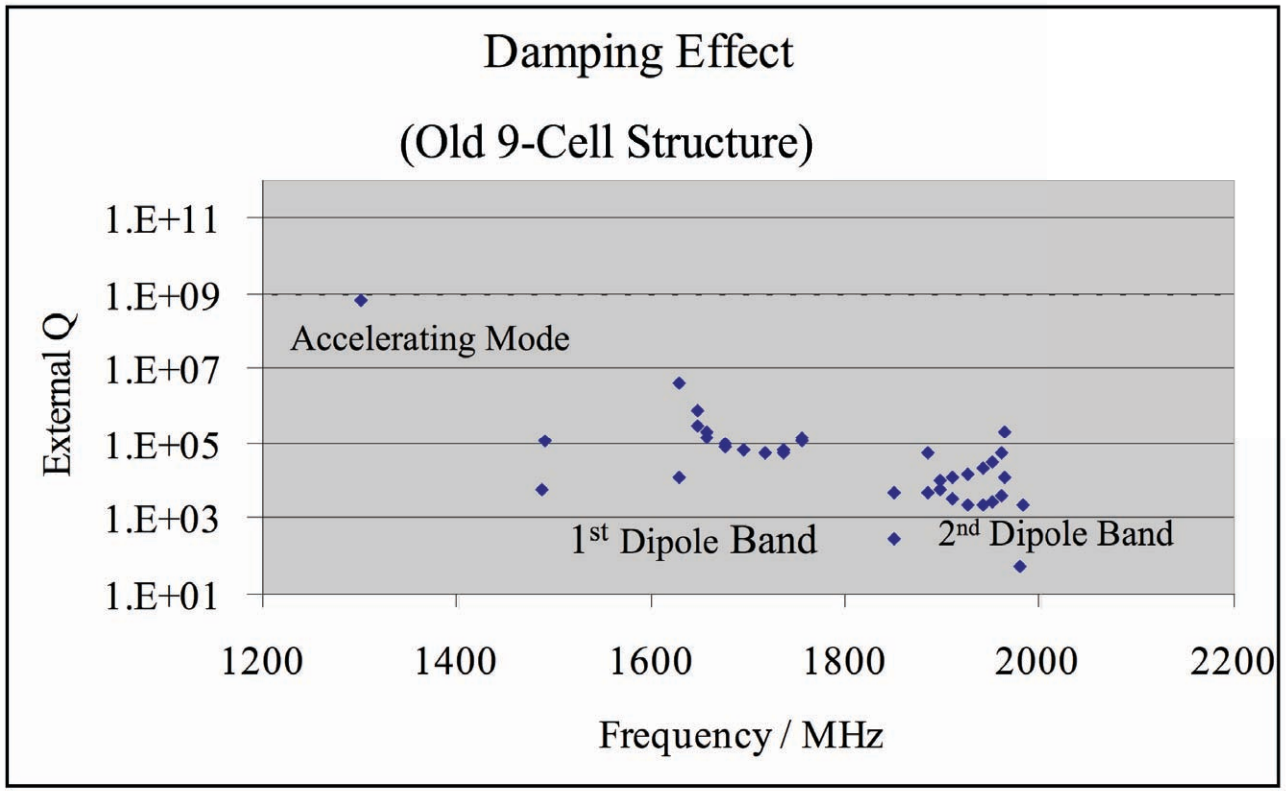




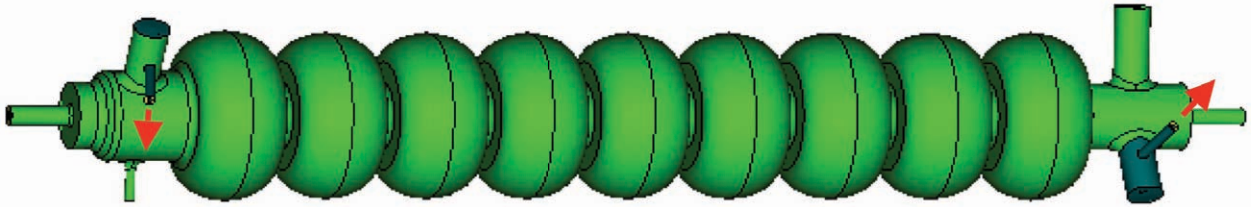


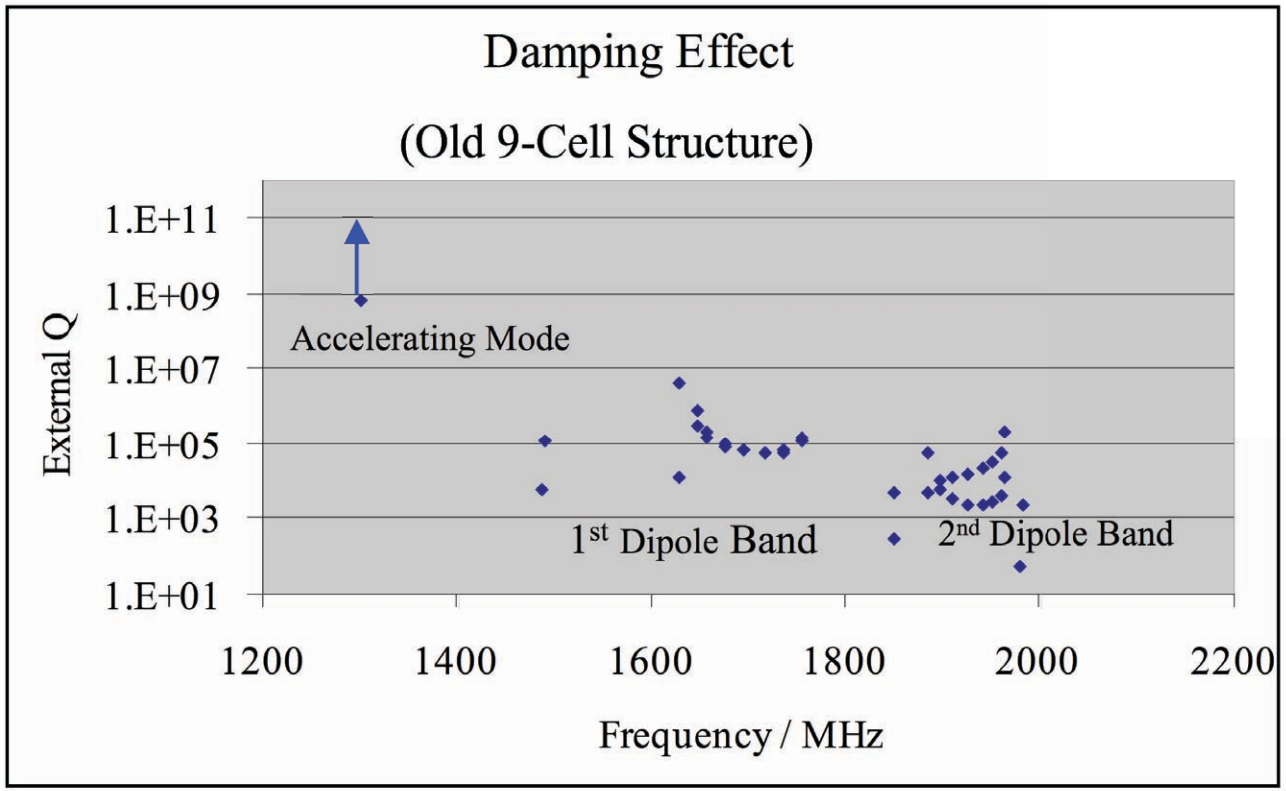
Power Leakage and Insufficient Damping



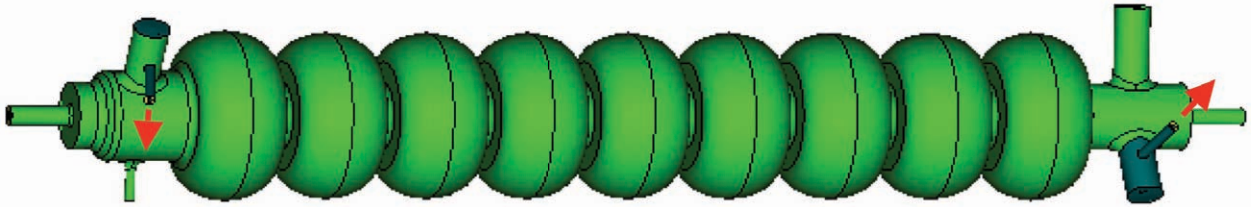


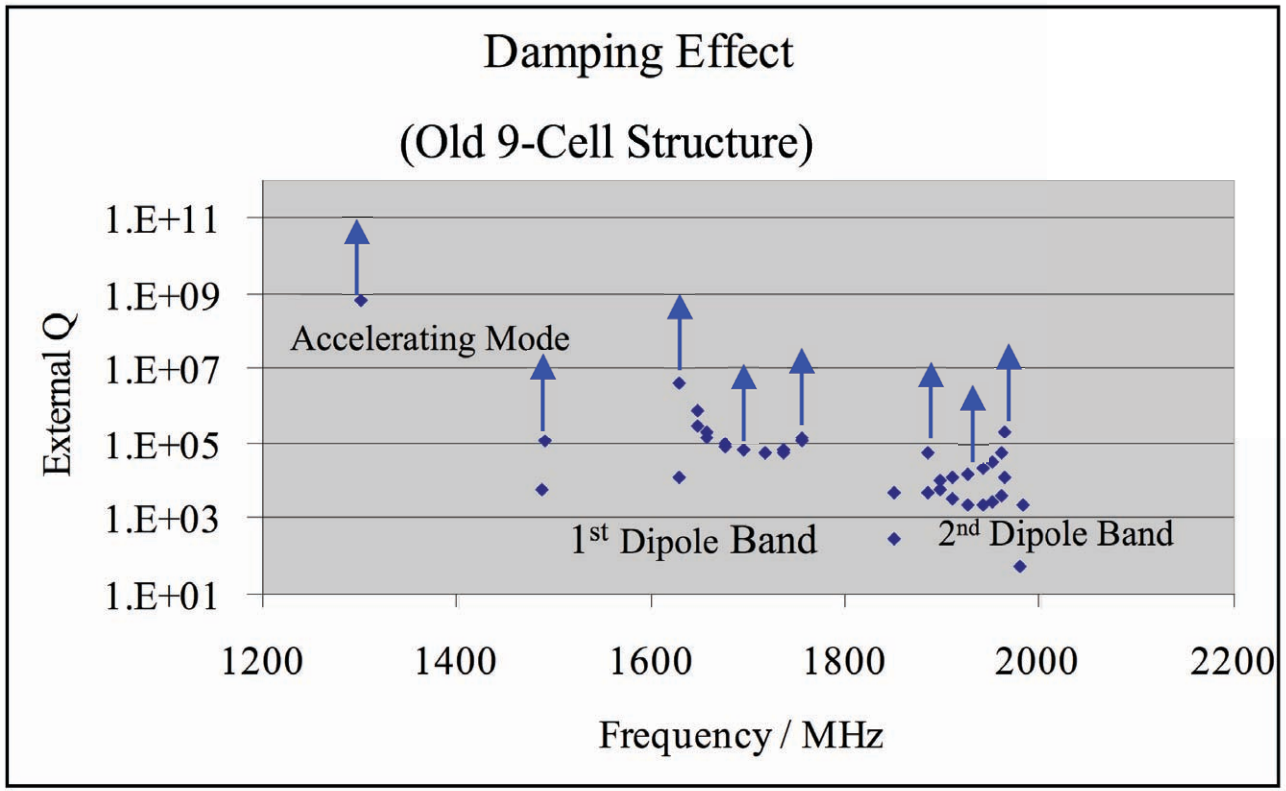
Power Leakage and Insufficient Damping





Power Leakage and Insufficient Damping





Revision of End Structure

- Toward STF Phase 1 -

<u>Realization of High Gradients ~ 51 MV/m</u> – 1st Priority

{ Suppression of Multipacting
(End Ports and Dampers)

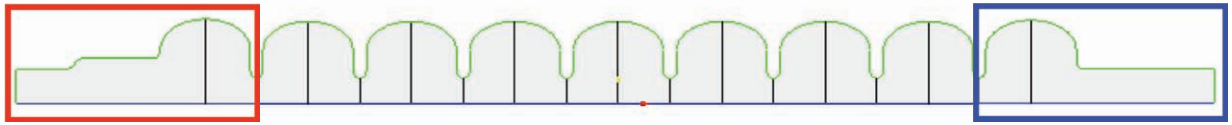
Decoupling from Accelerating Mode
(Notch Filters of Dampers)

<u>Damping of HOM</u> – 2nd Priority
(Lowest Two Dipole Bands under Cut-off Frequency)

Remodeled 9-Cell Structure

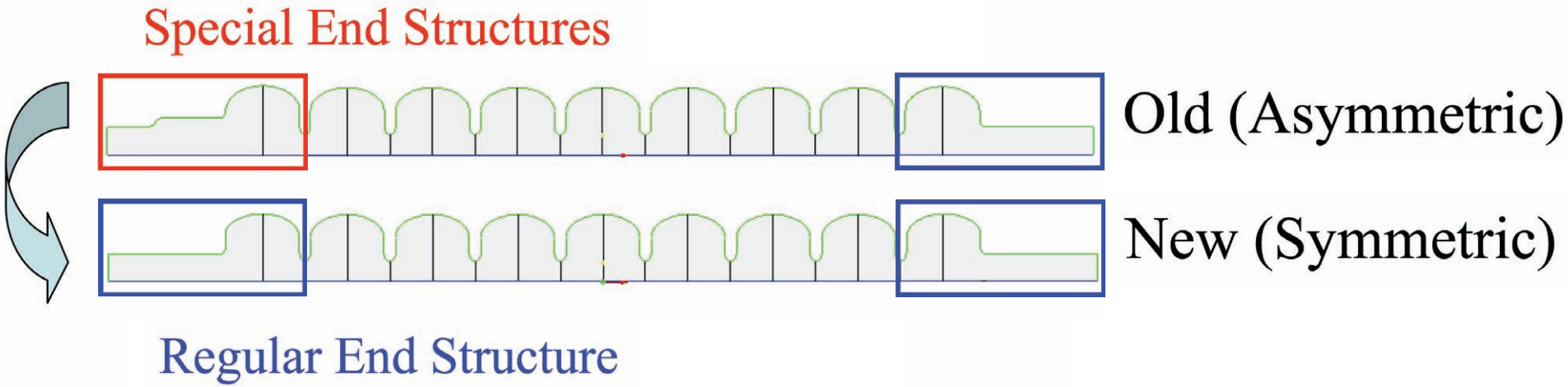
Remodeled 9-Cell Structure

Special End Structures

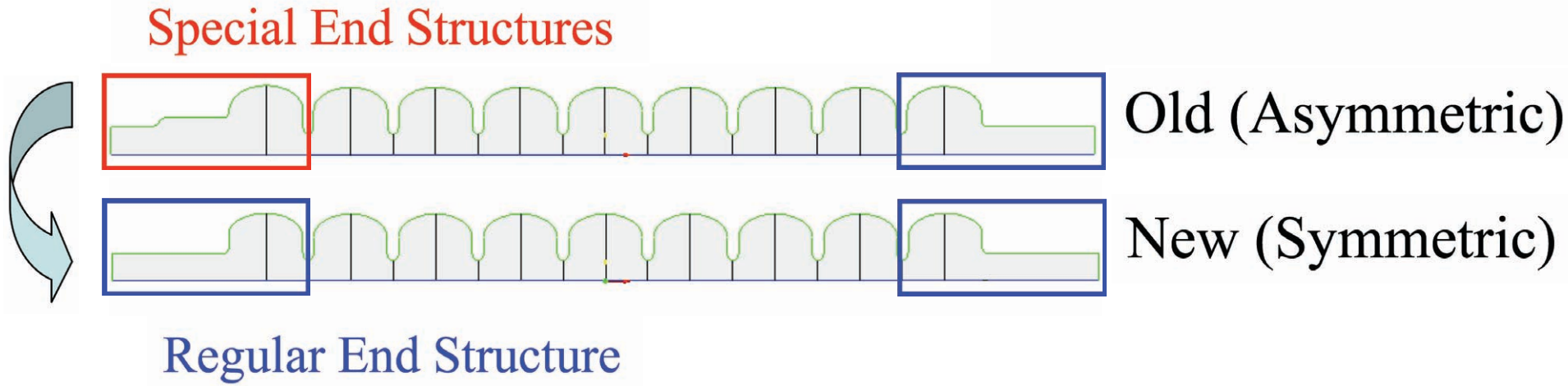


Old (Asymmetric)

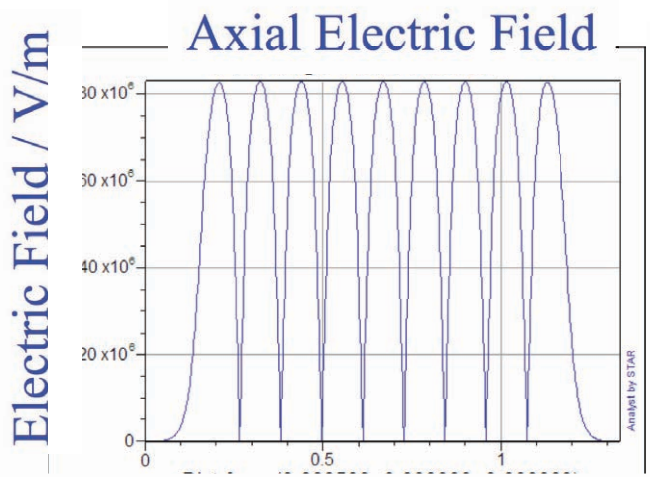
Remodeled 9-Cell Structure

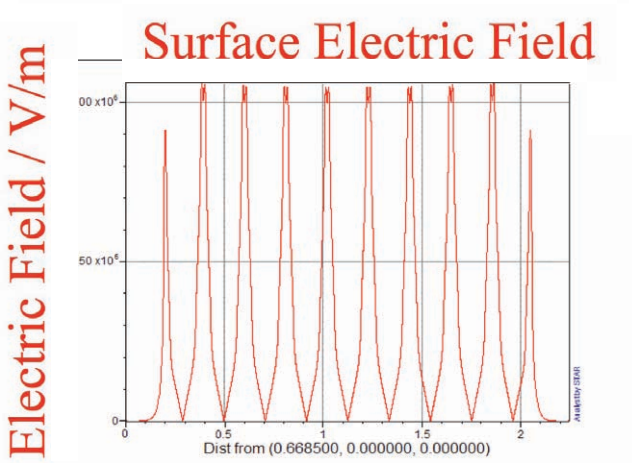


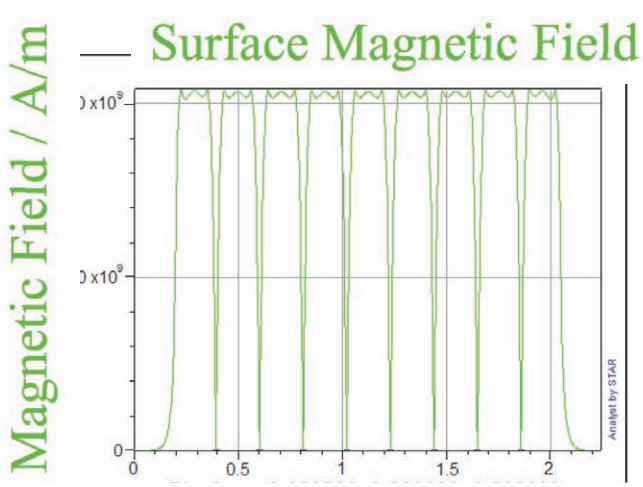
Remodeled 9-Cell Structure



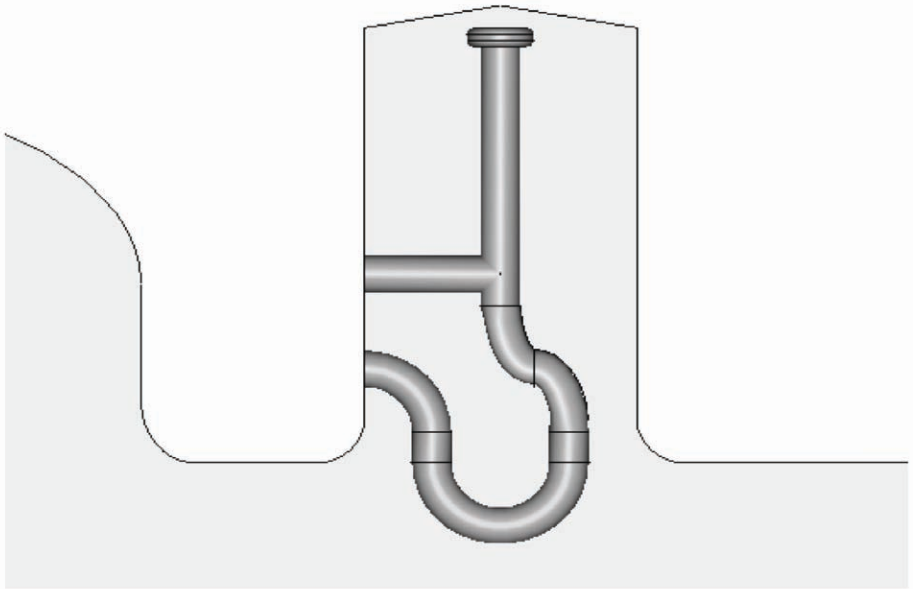
Flat Field Mapping

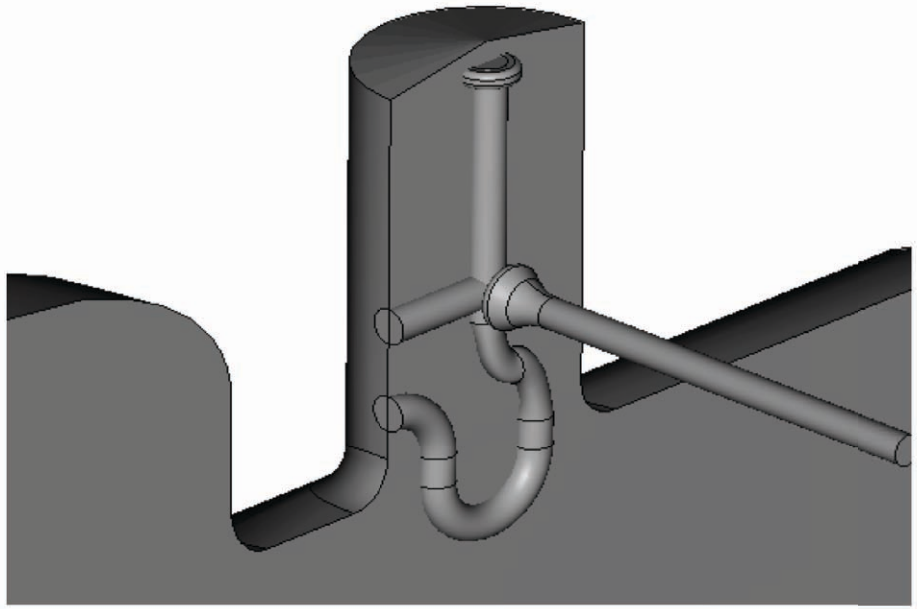






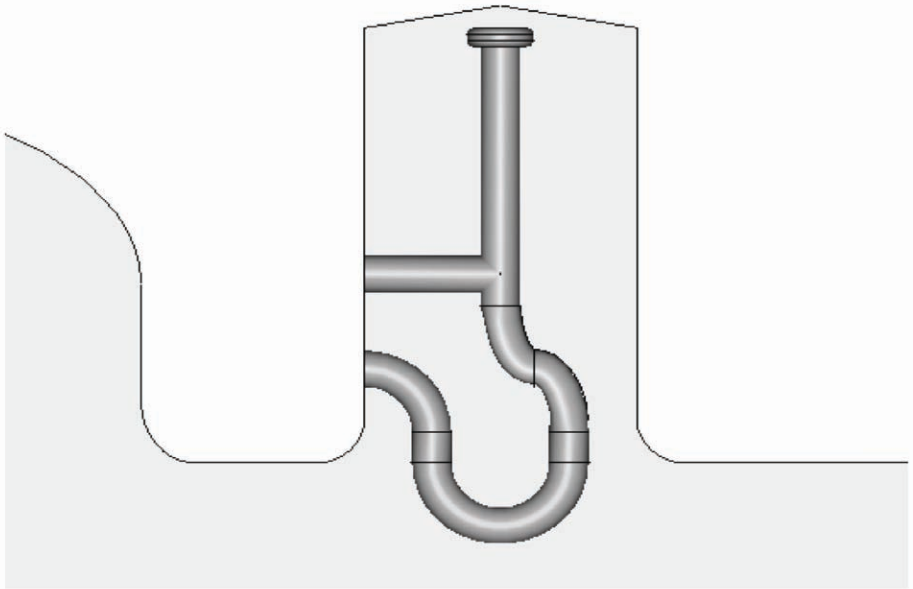
New HOM Damper

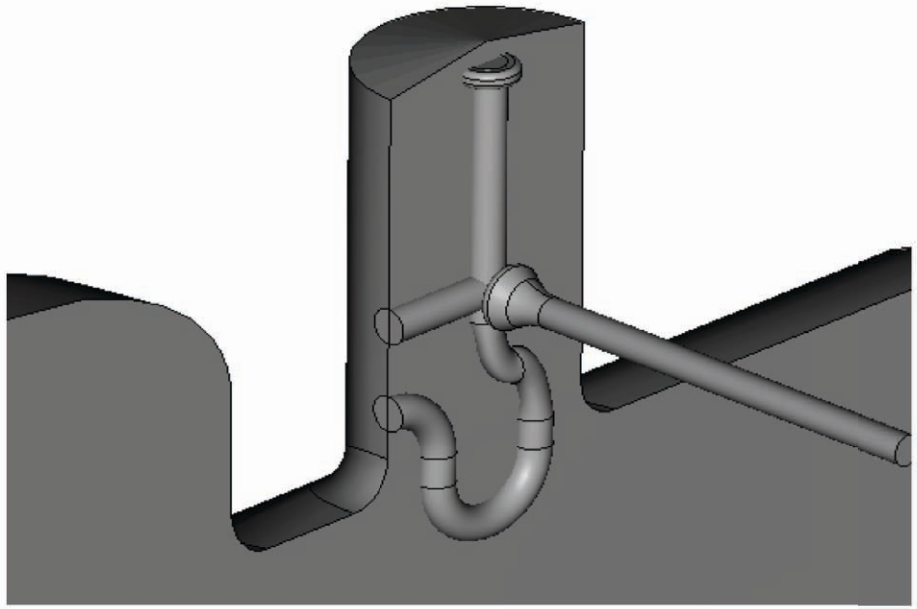




New HOM Damper

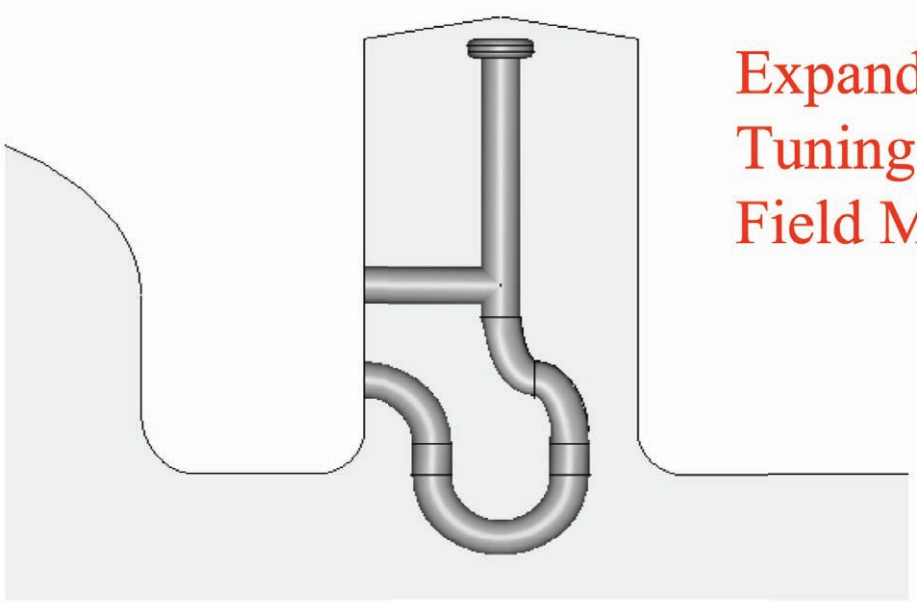
- Major Features -



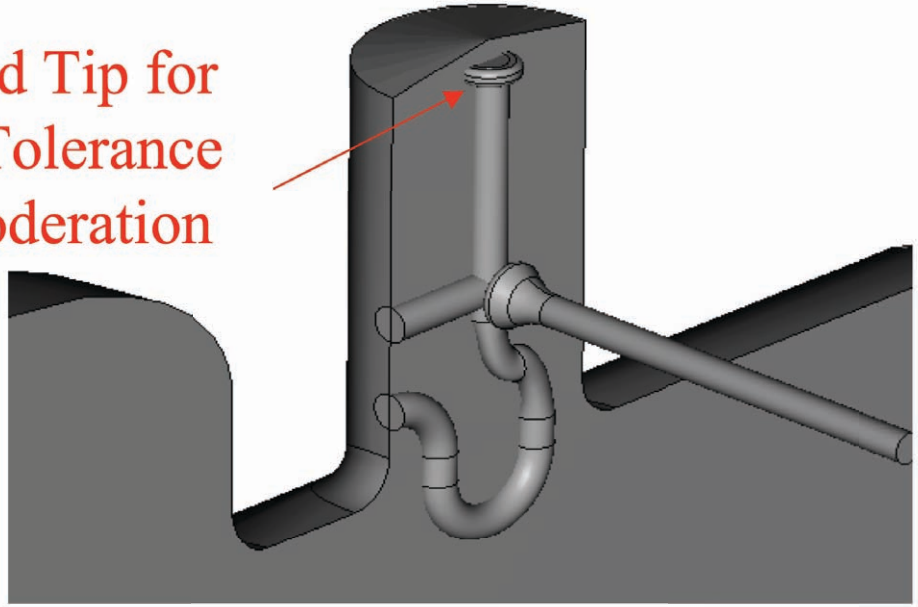


New HOM Damper

- Major Features -

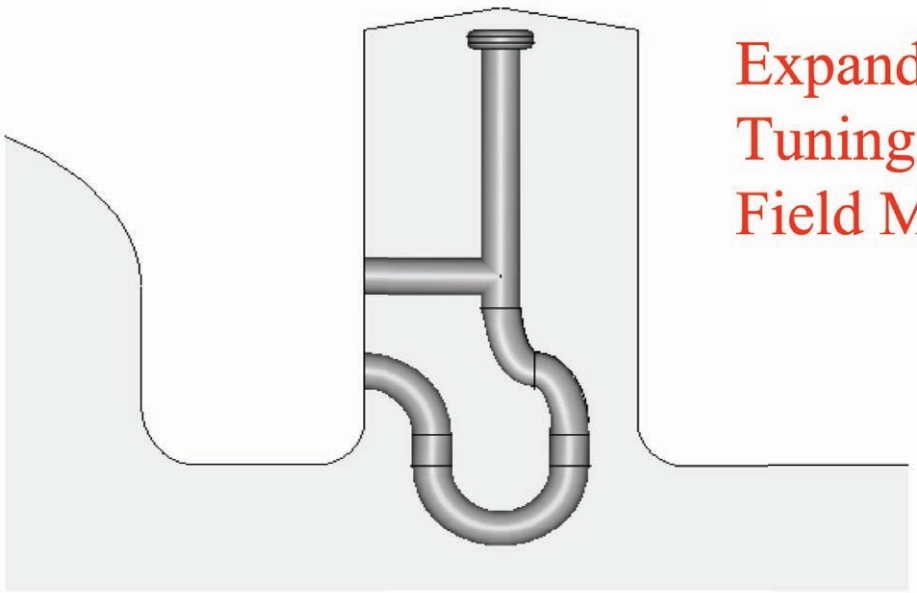


Expanded Tip for
Tuning Tolerance
Field Moderation



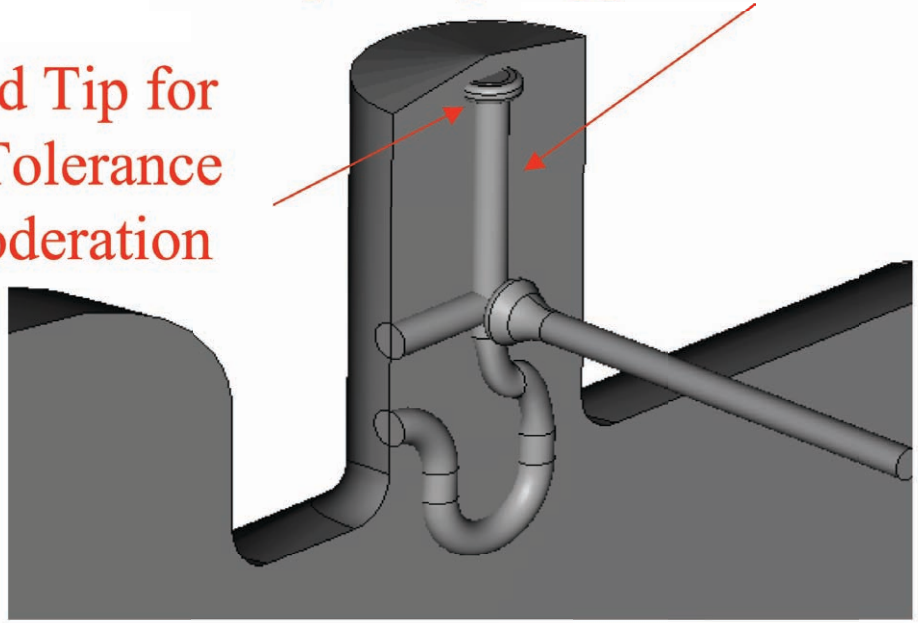
New HOM Damper

- Major Features -



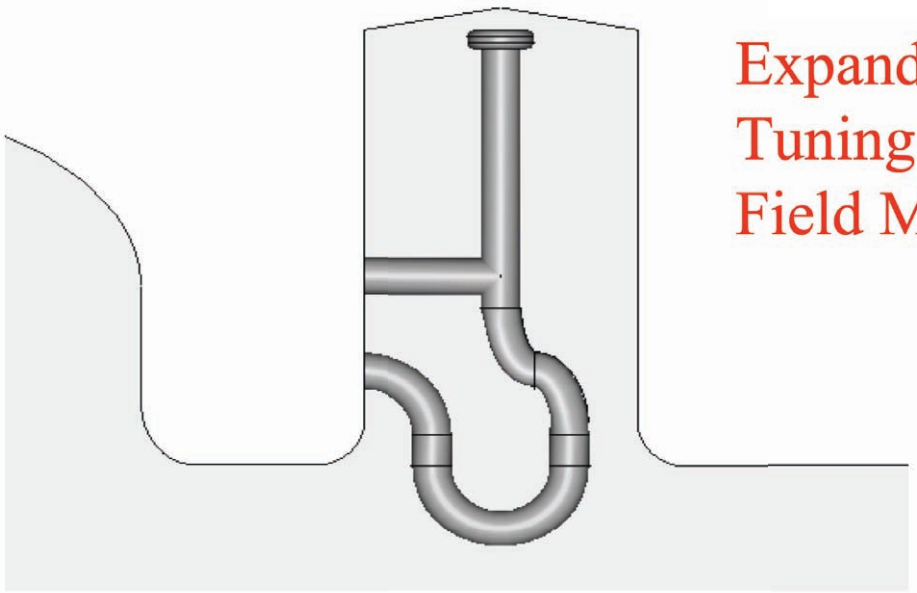
On-Center Stem for
Multipacting Suppression

Expanded Tip for
Tuning Tolerance
Field Moderation



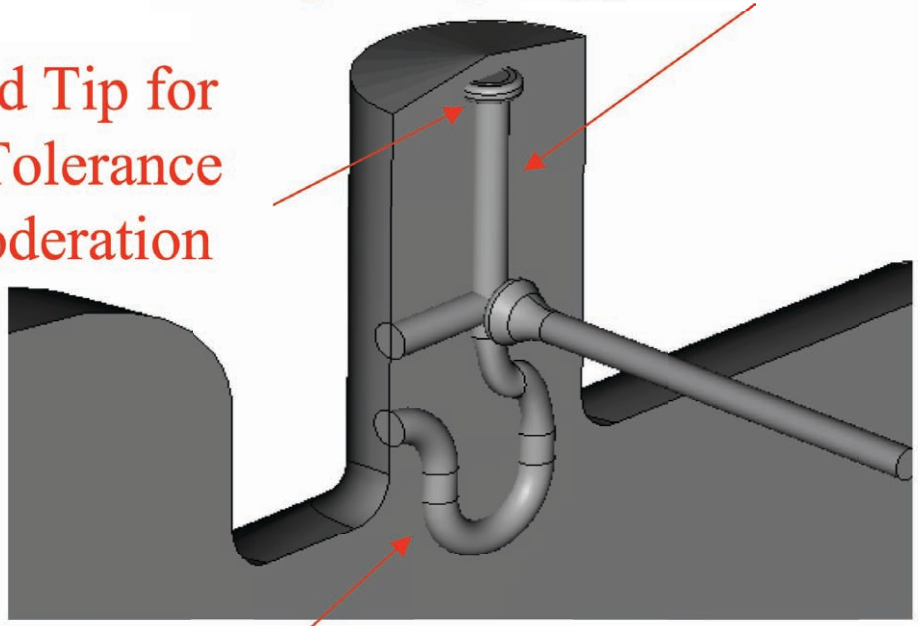
New HOM Damper

- Major Features -



On-Center Stem for
Multipacting Suppression

Expanded Tip for
Tuning Tolerance
Field Moderation



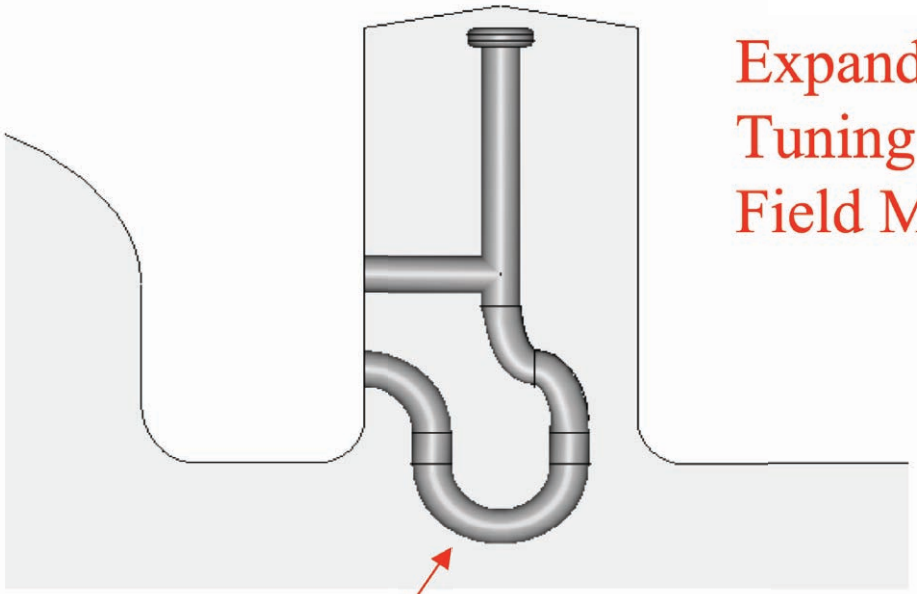
Axially Oriented Loop
for Efficient Coupling

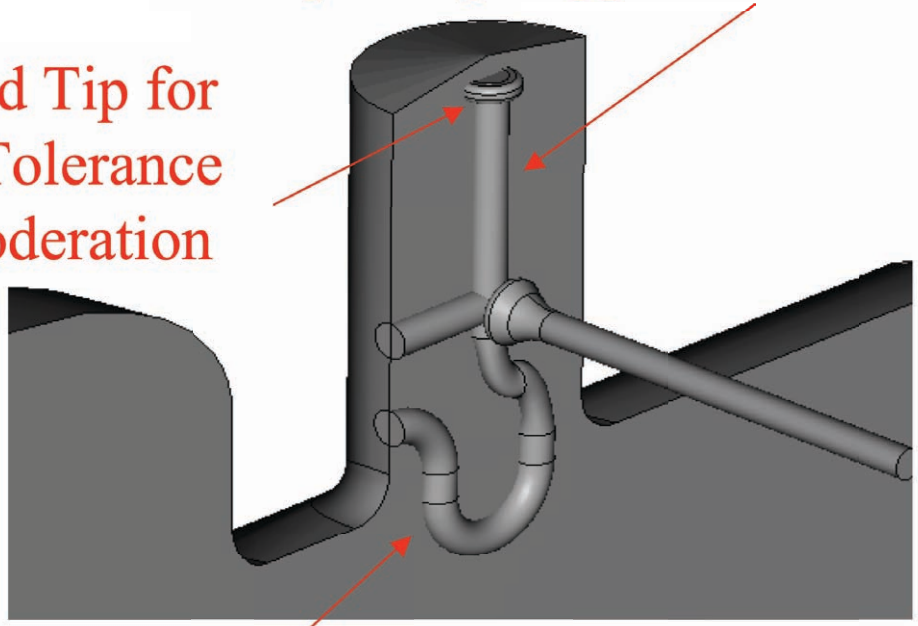
New HOM Damper

- Major Features -

On-Center Stem for
Multipacting Suppression

Expanded Tip for
Tuning Tolerance
Field Moderation





Simple Oval Loop

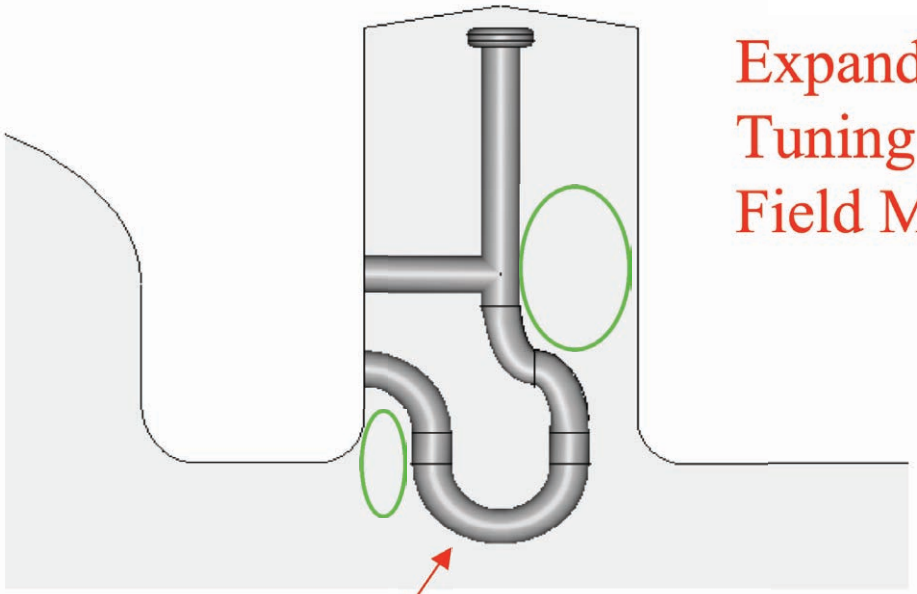
Axially Oriented Loop
for Efficient Coupling

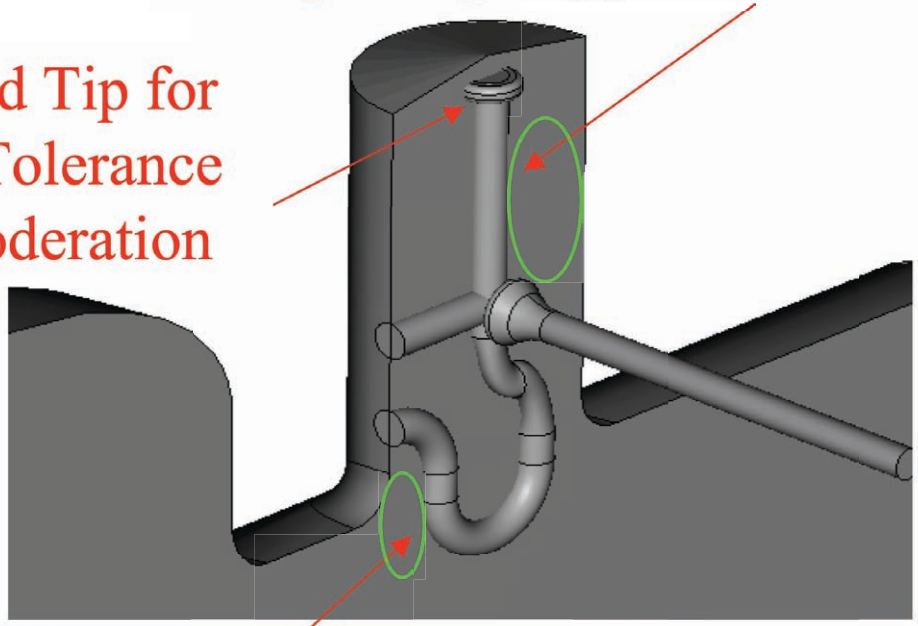
New HOM Damper

- Major Features -

On-Center Stem for
Multipacting Suppression

Expanded Tip for
Tuning Tolerance
Field Moderation



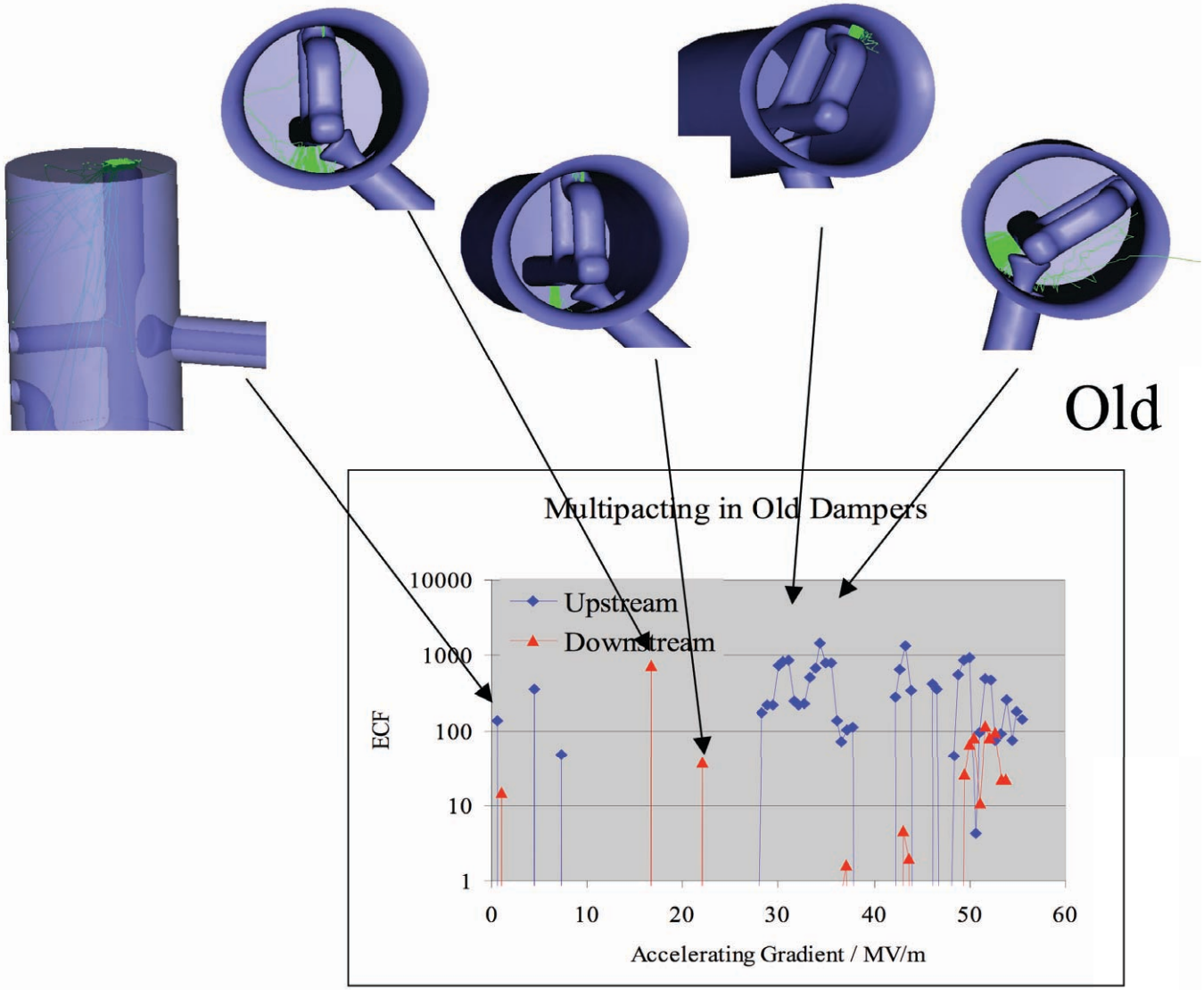


Simple Oval Loop

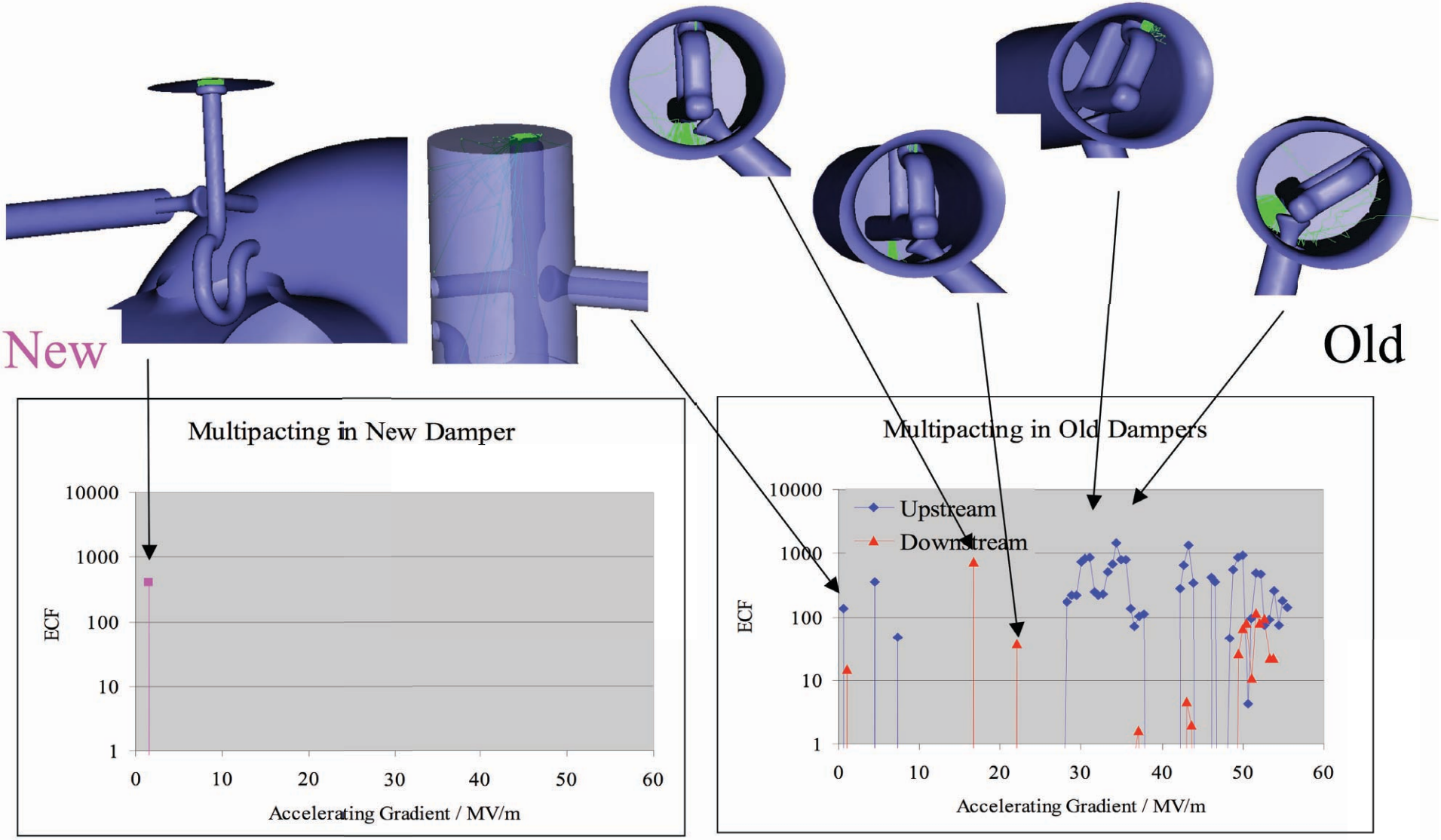
Axially Oriented Loop
for Efficient Coupling

Suppression of Multipacting in HOM Damper

Suppression of Multipacting in HOM Damper

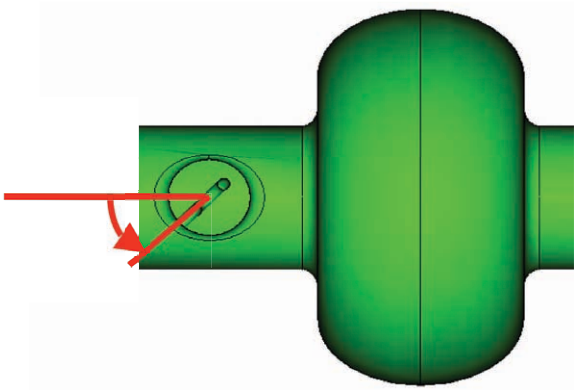


Suppression of Multipacting in HOM Damper

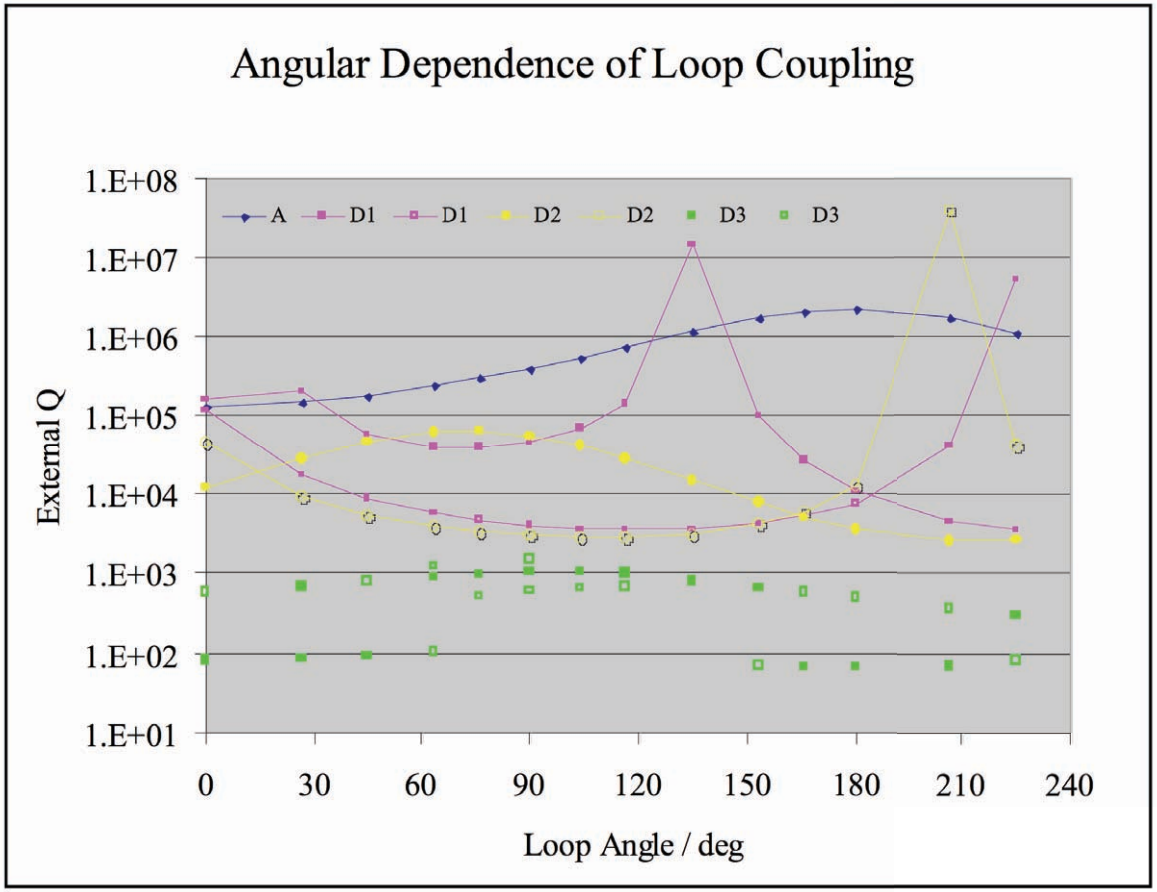


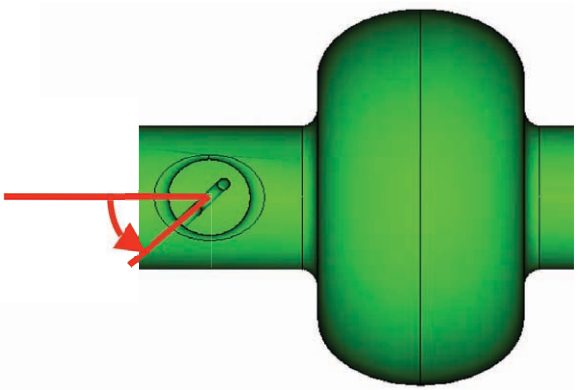
Angular Dependence of HOM Coupling

Angular Dependence of HOM Coupling

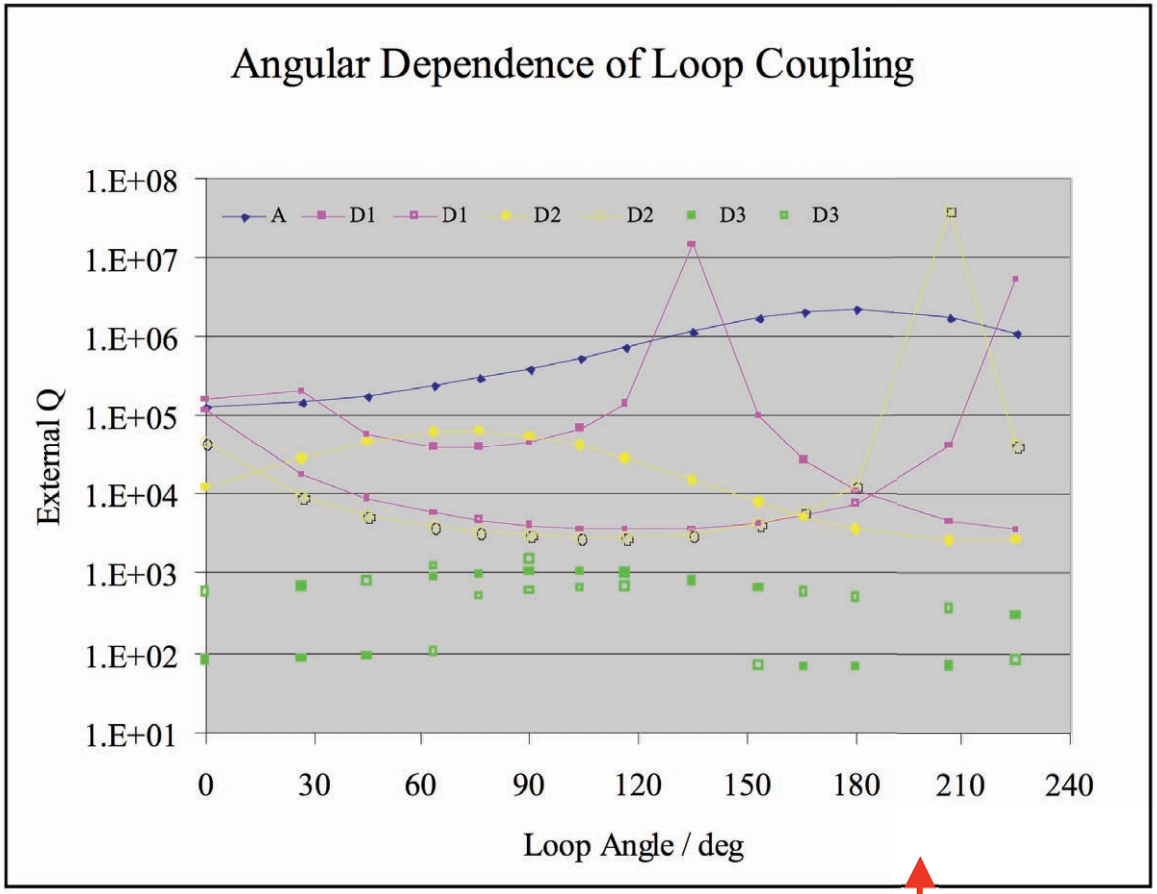


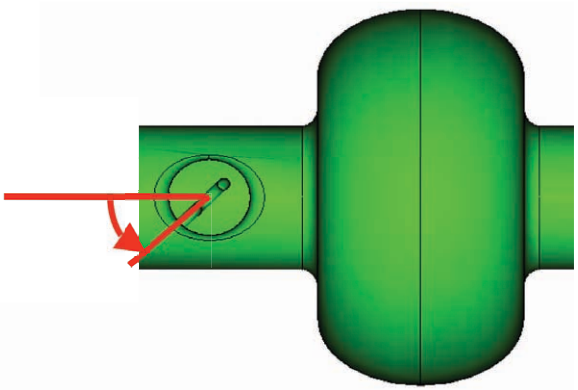
Angular Dependence of HOM Coupling





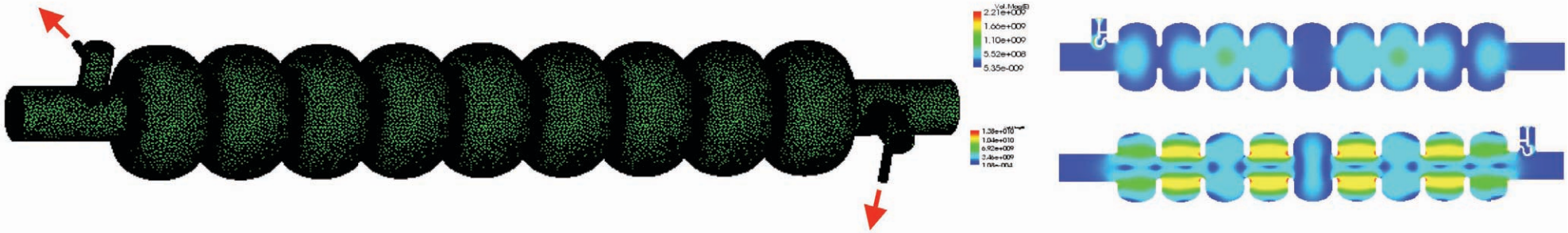
Angular Dependence of HOM Coupling

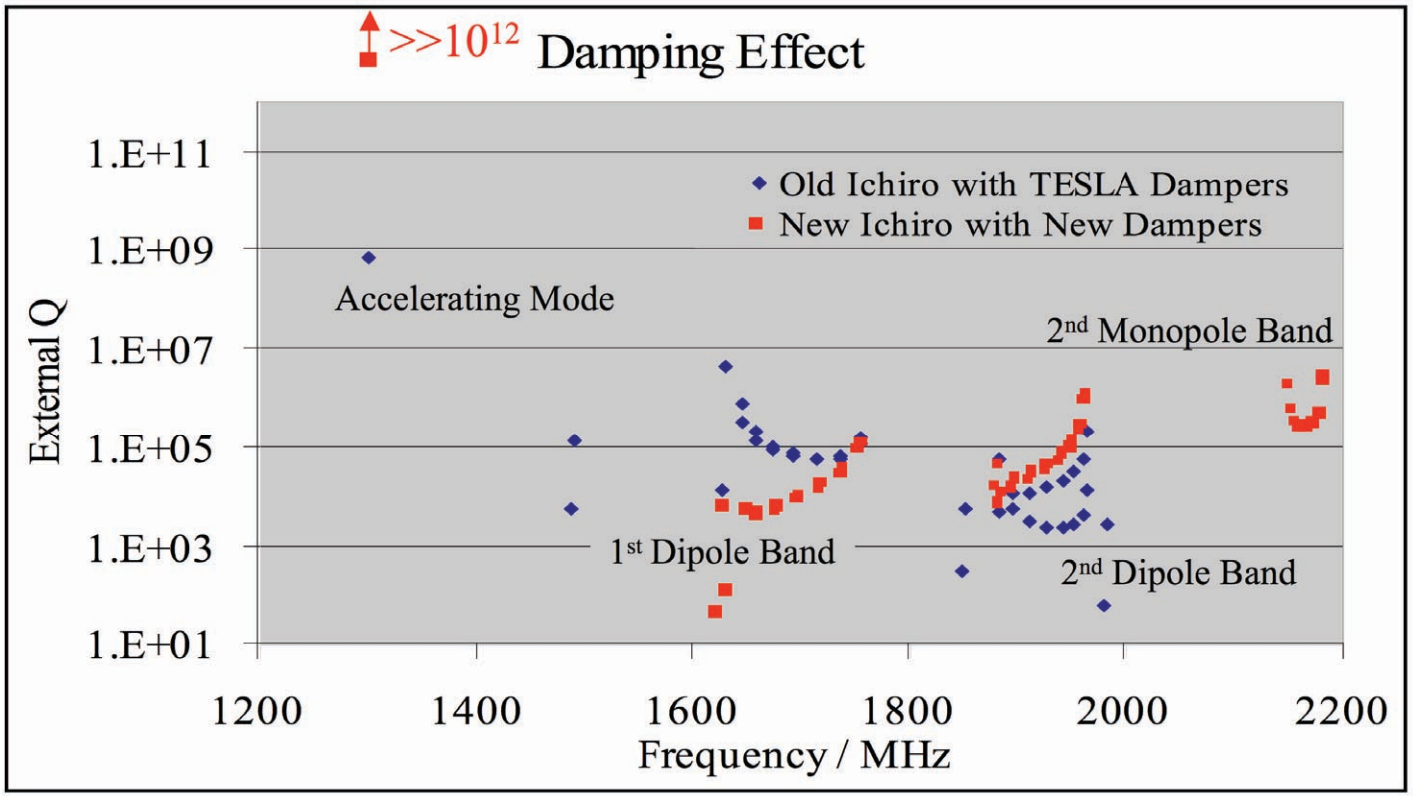




Optimum

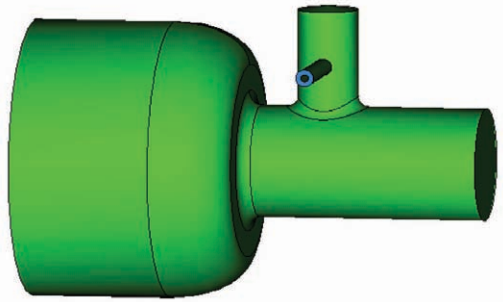
Damping Performance



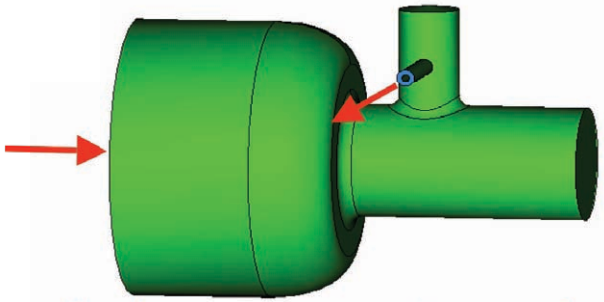


Tuning Characteristics

Tuning Characteristics

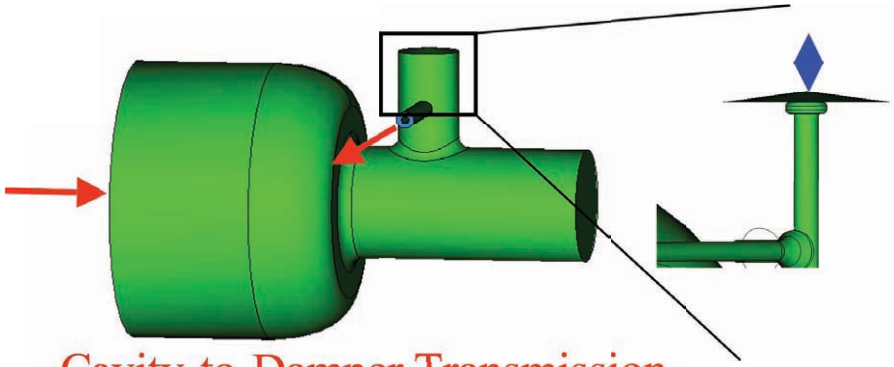


Tuning Characteristics



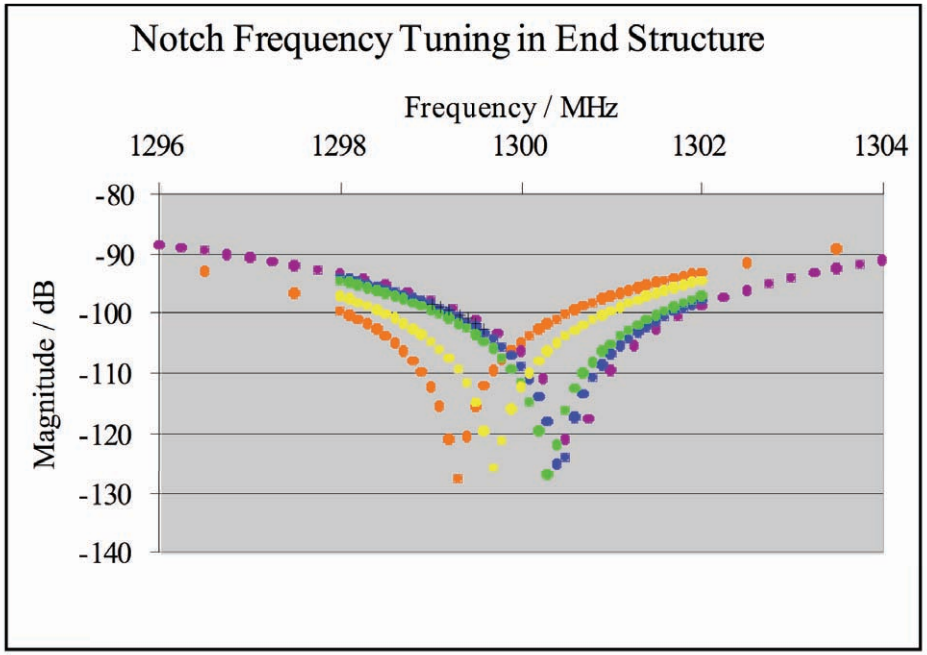
Cavity-to-Damper Transmission

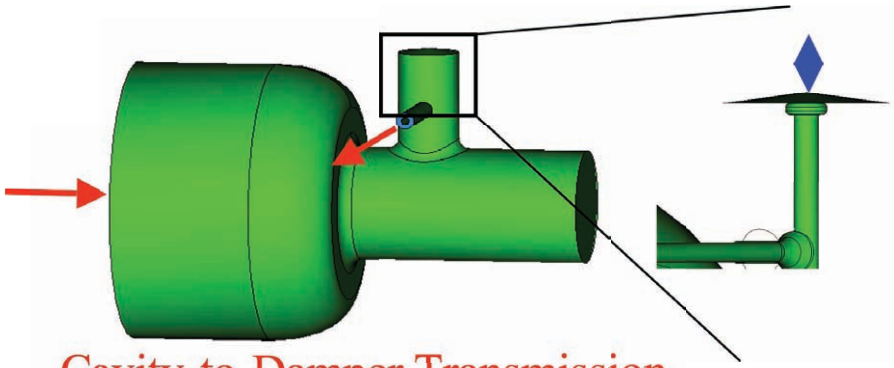
Tuning Characteristics



Cavity-to-Damper Transmission

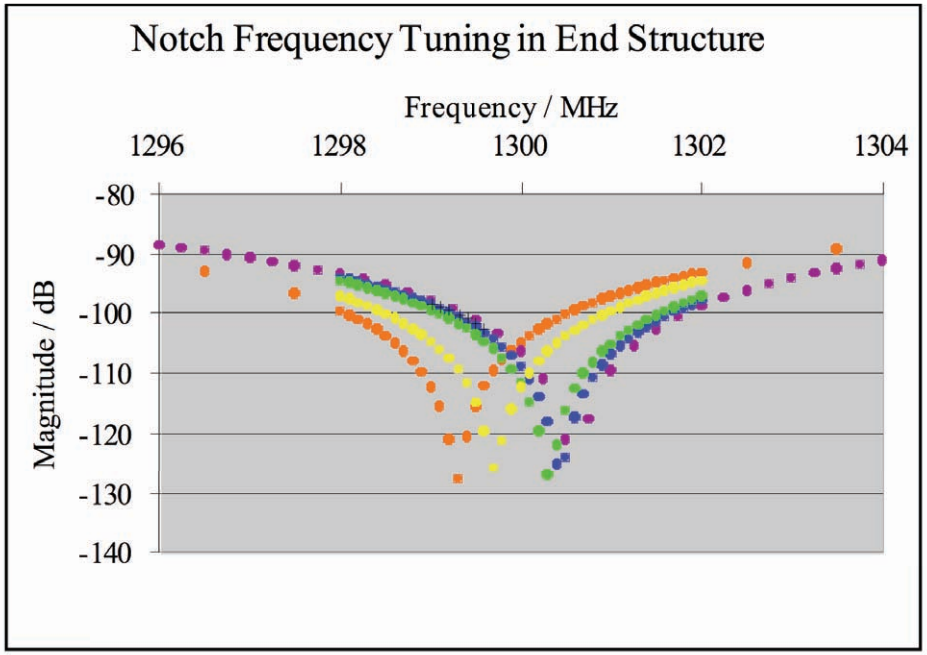
Tuning Characteristics

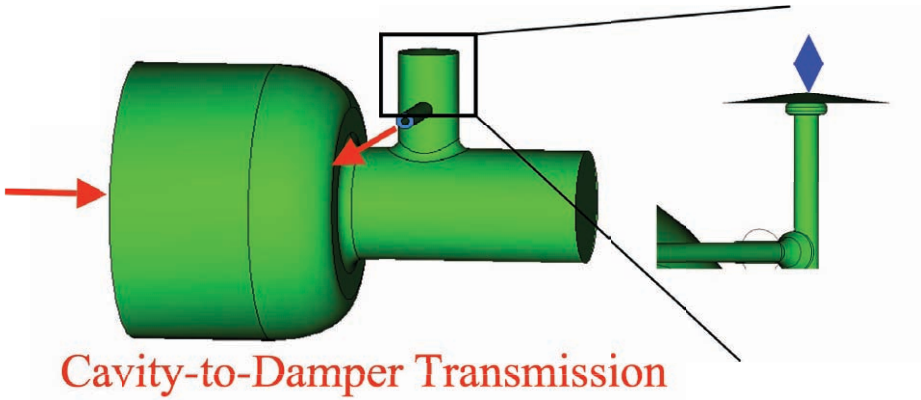




Cavity-to-Damper Transmission

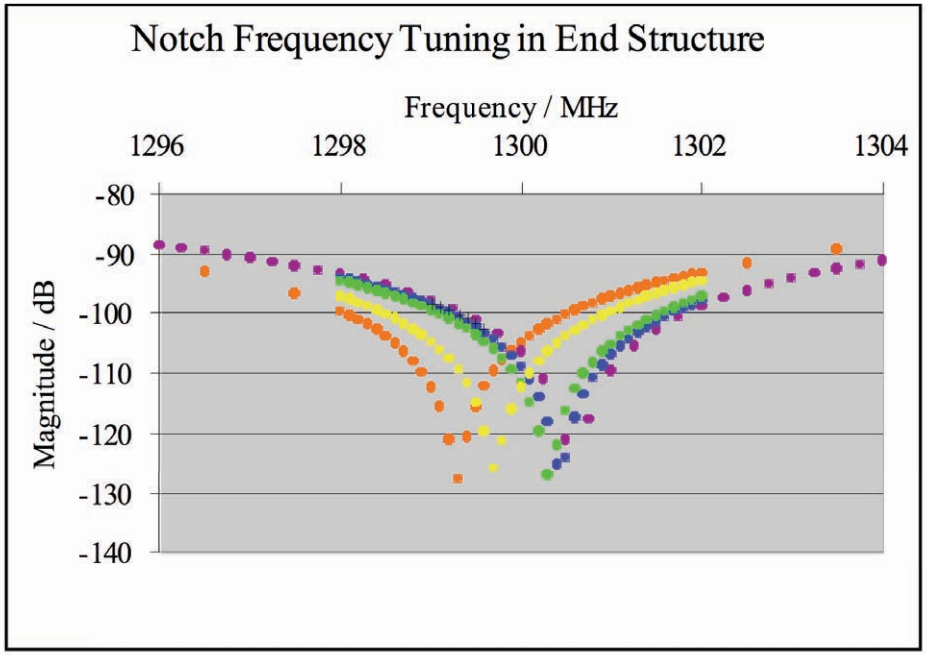
Tuning Characteristics

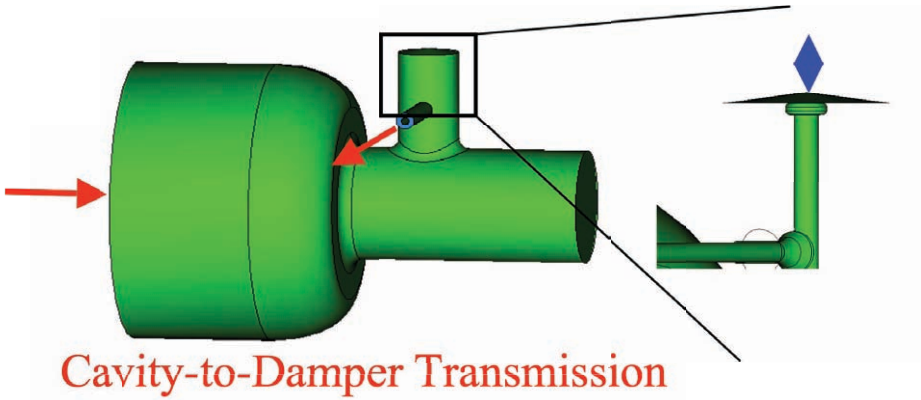




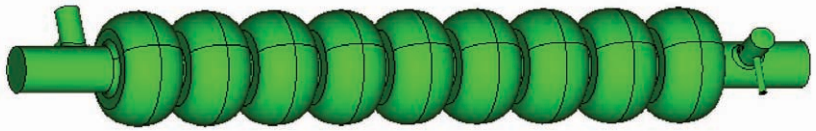
Tuning Sensitivity ~ 78 MHz/mm

Tuning Characteristics

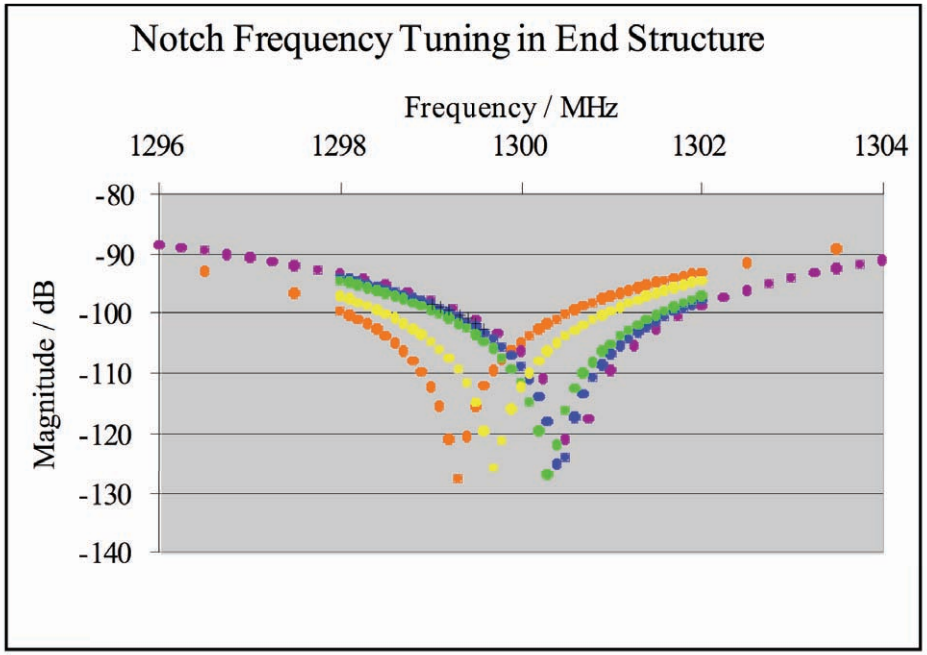


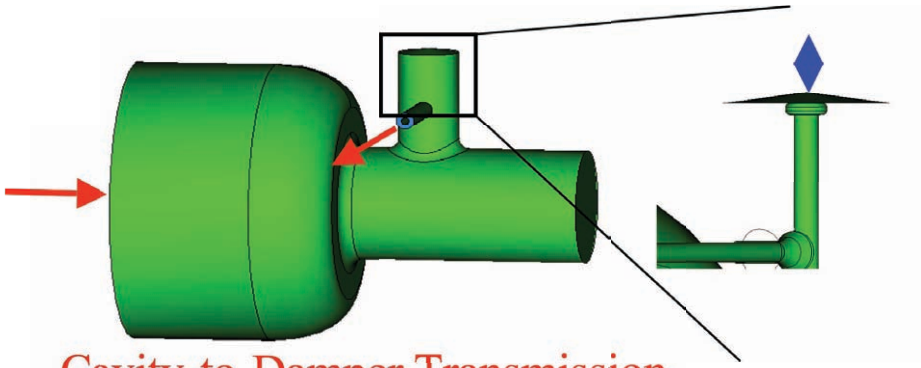


Tuning Sensitivity ~ 78 MHz/mm



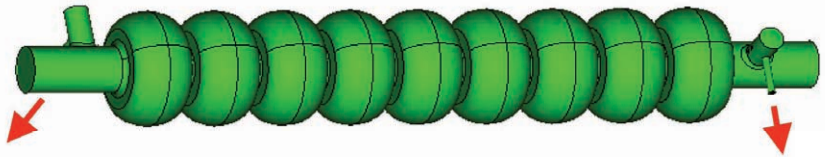
Tuning Characteristics





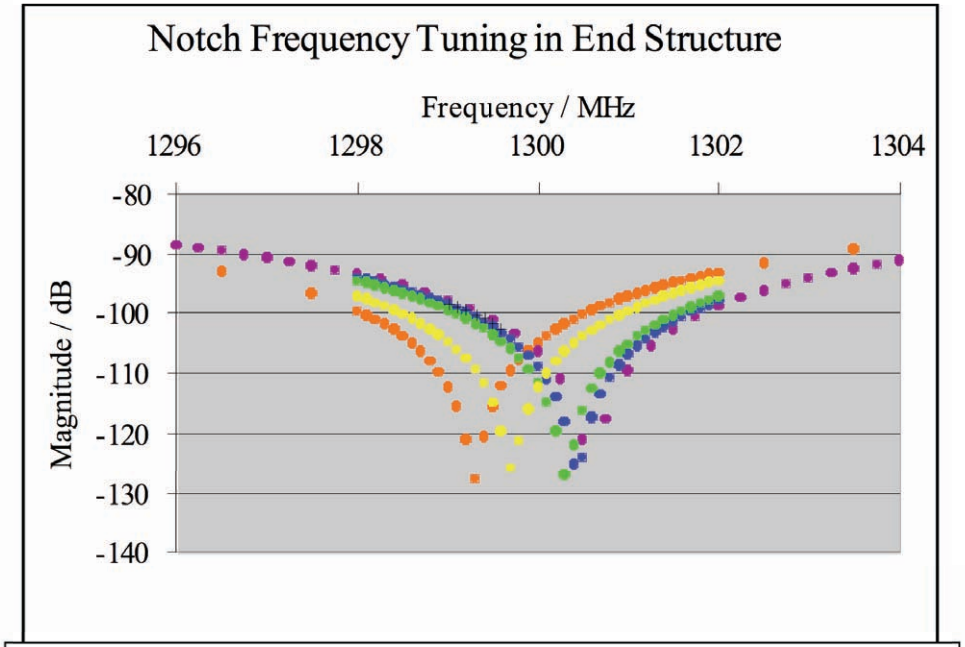
Cavity-to-Damper Transmission

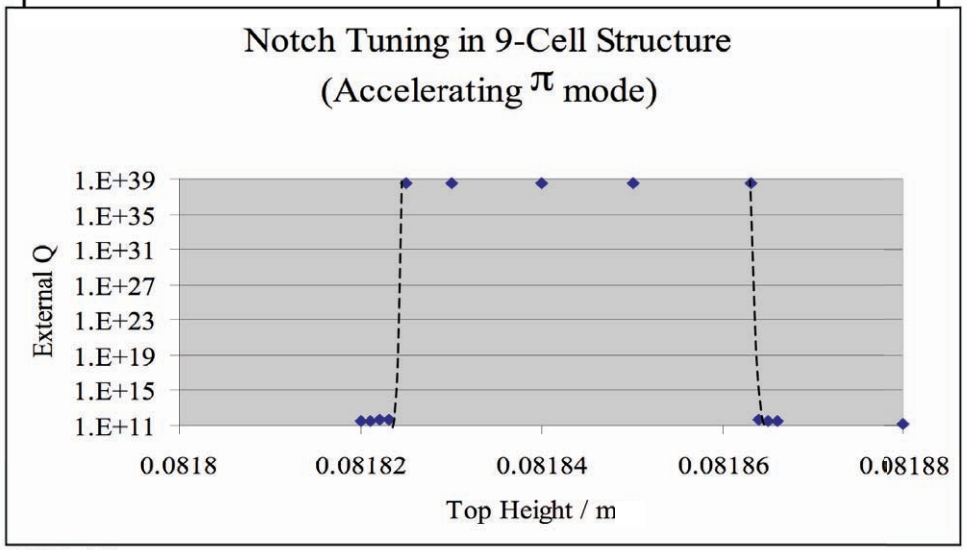
Tuning Sensitivity ~ 78 MHz/mm

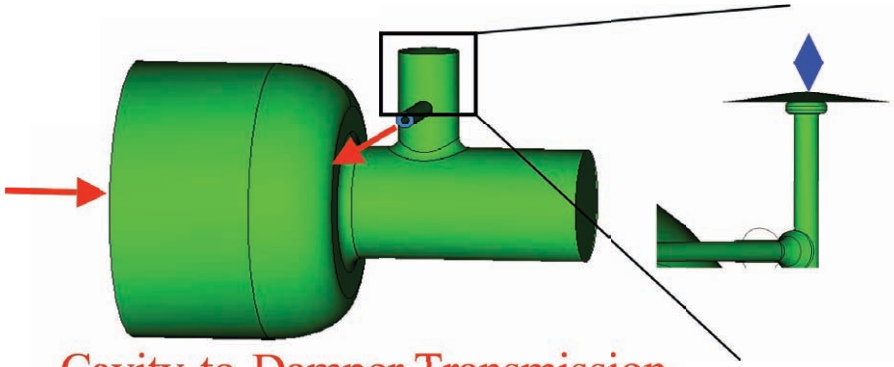


Power Loss from Dampers

Tuning Characteristics

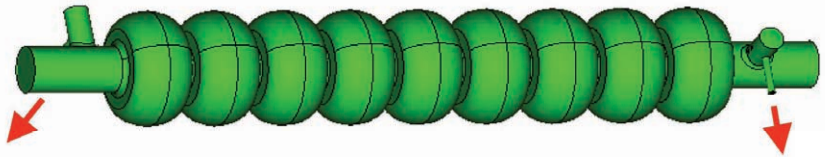






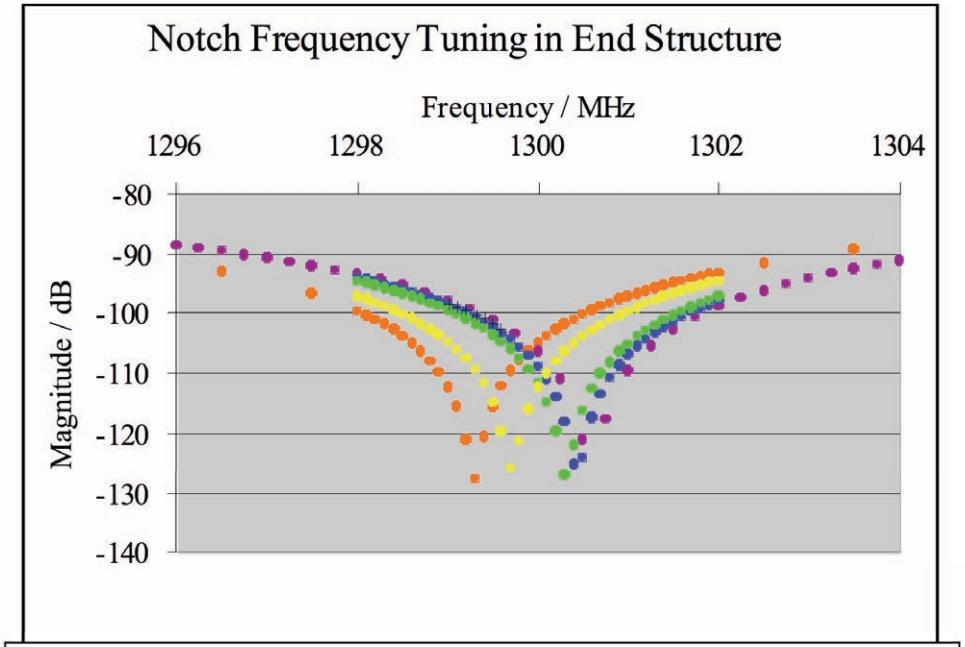
Cavity-to-Damper Transmission

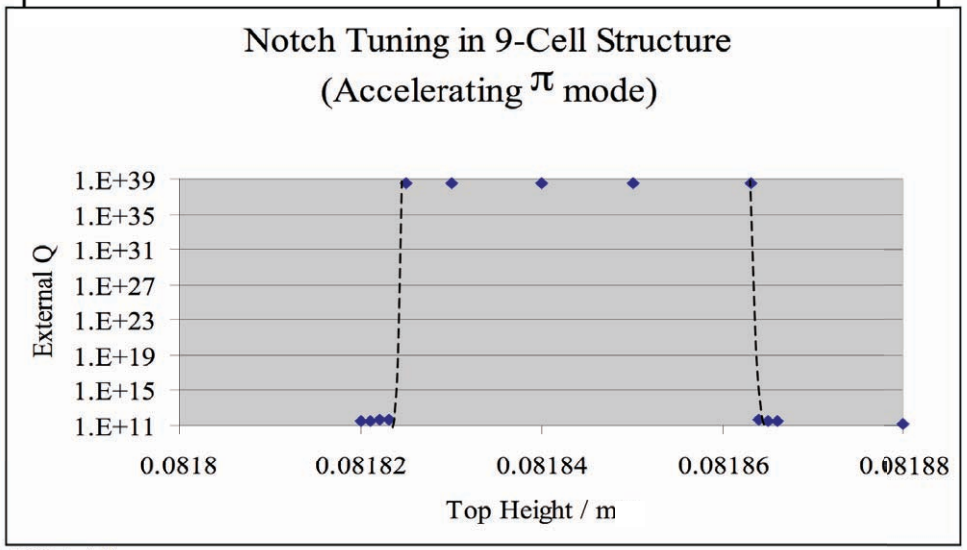
Tuning Sensitivity ~ 78 MHz/mm

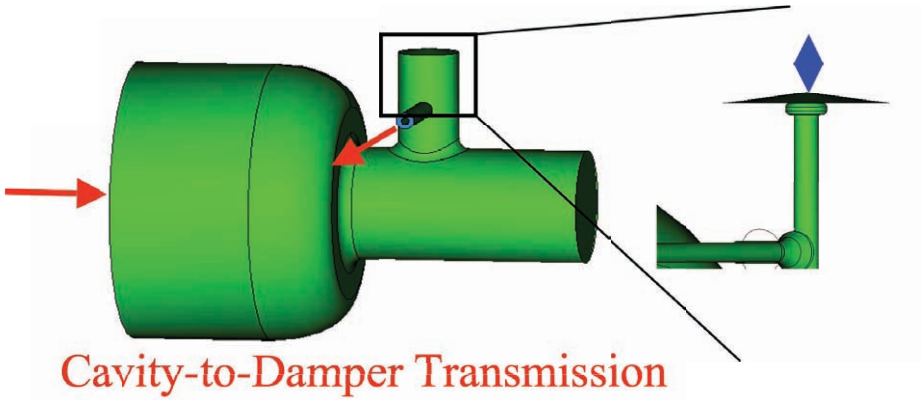


Power Loss from Dampers

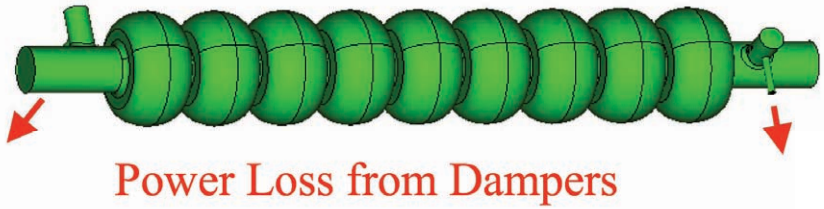
Tuning Characteristics





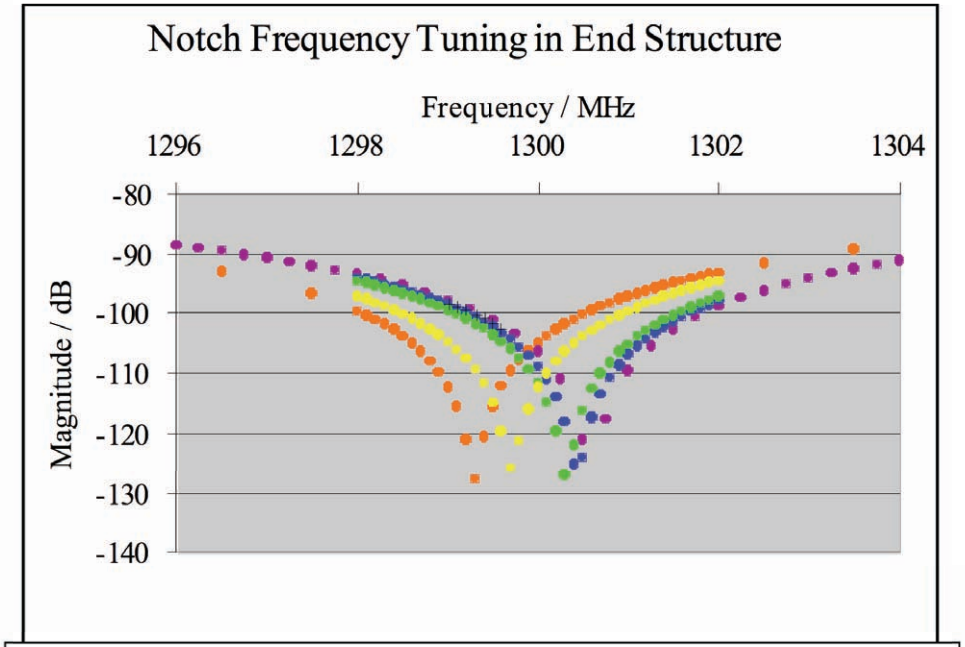


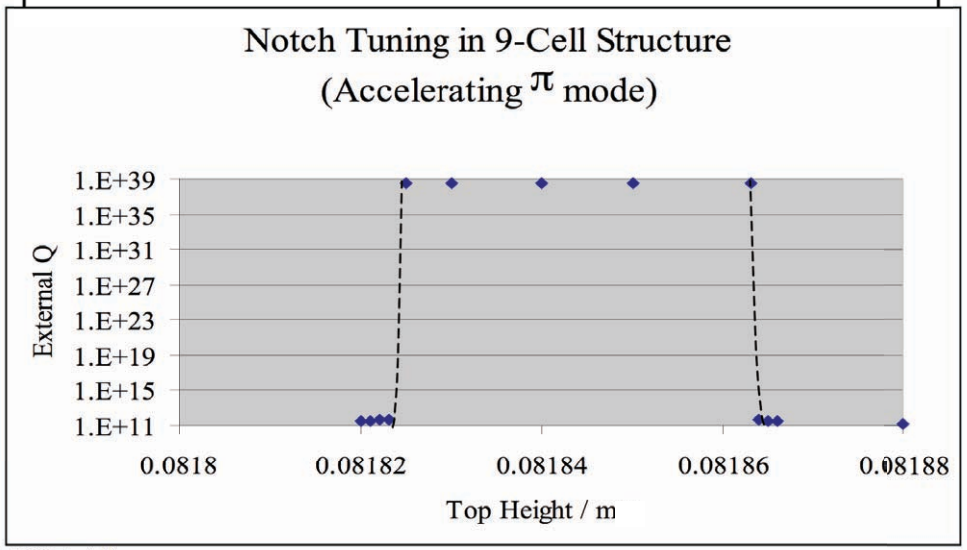
Tuning Sensitivity ~ 78 MHz/mm

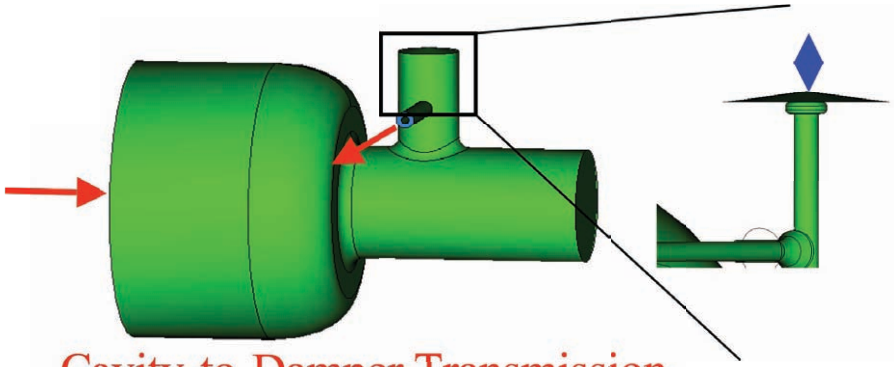


Notch Width (for Qext > 10^{12}) ~ 3 MHz

Tuning Characteristics

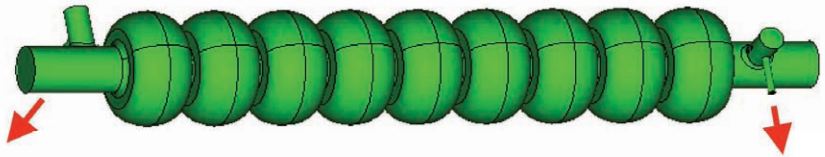






Cavity-to-Damper Transmission

Tuning Sensitivity ~ 78 MHz/mm



Power Loss from Dampers

Notch Width (for Qext > 10^{12}) ~ 3 MHz

>> Thermal Detuning (sub MHz)

Structure Parameters

	New Ichiro	Old Ichiro	TESLA
Aperture Diameter / mm	60	60	70
End Port Diameter / mm	80	80 (/108)	78
Regular Cavity Radius / mm	98.151	98.151	103.3
Coupling Coefficient	0.0155	0.0155	0.0187
Esp/Eacc	**2.36**	2.38	2.0
Hsp/Eacc / Oe/(MV/m)	**36.7**	37.5	42.6
Eacc max (Hc=1900 Oe) / MV/m	**51.8**	50.7	43.4
Geometric Impedance (R/Q) / Ω	**1170**	1144	1036
Geometric Factor / Ω	284	286	271

Summary

Accelerating and Damping Structures
– Resigned for Improvement

Multipacting – Eliminated in End Port
– Drastically Reduced in Damper

Decoupling from Accelerating Mode – Addressed

Damping of Higher Order Modes – Confirmed