

Progress on SSC Simulations in FLASH and XFEL Cavities

Thomas Flisgen, Johann Heller, and Ursula van Rienen

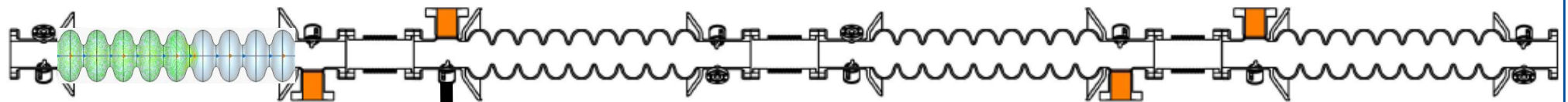
Eucard² 3rd Annual WP 12 Review Meeting 2016

STFC Daresbury Laboratory, Daresbury, UK, 4th – 5th of April 2016

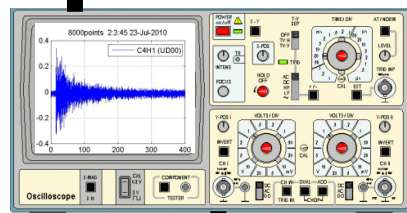


Introduction and Motivation

Overall Goal: „Parasitical“ use of HOM couplers: Diagnostic System based on HOM port signals*



String of 3rd harmonic cavities in FLASH**



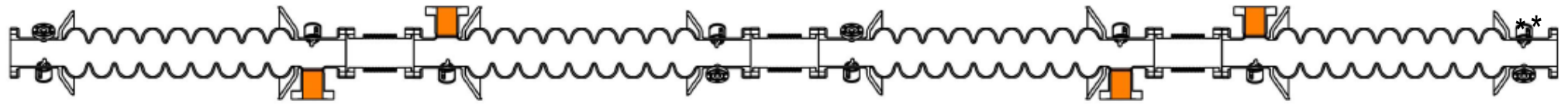
Information about:

- Transversal momentum and offset of bunch
- Perturbances of cavity
- Total charge of bunch

*Principle according to S. Molloy et al.: "High precision superconducting cavity diagnostics with higher order mode measurements", Phys. Rev. Spec. Top. Accel. Beams 9 (2006) 112802, 2006

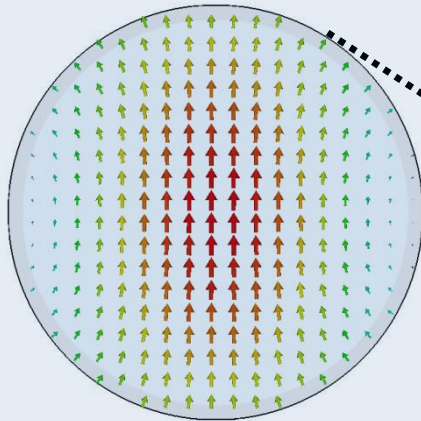
**Picture taken from: E. Vogel et al.: "Status of the 3rd harmonic systems for FLASH and XFEL in summer 2008", Proc. LINAC 2008

RF Properties of Chain of 3.9 GHz Resonators in FLASH and the European XFEL



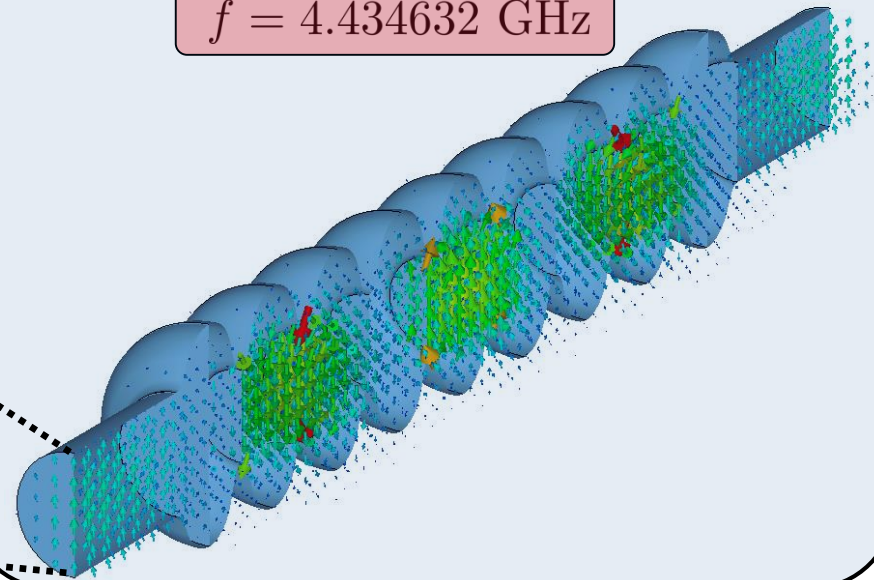
fundamental waveguide mode

$$f_{\text{co,TE}_{11}} = 4.39246 \text{ GHz}$$



electric field of third dipole mode in resonator

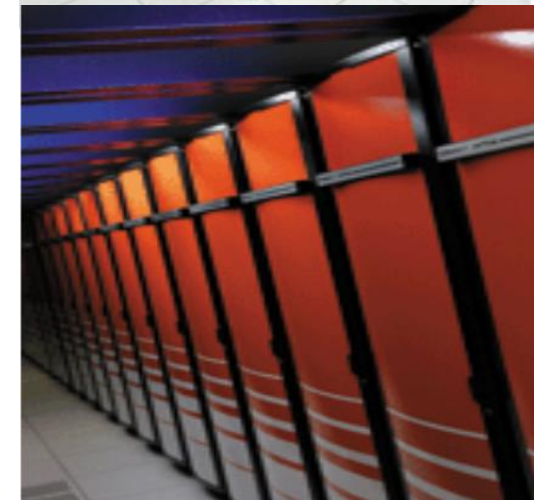
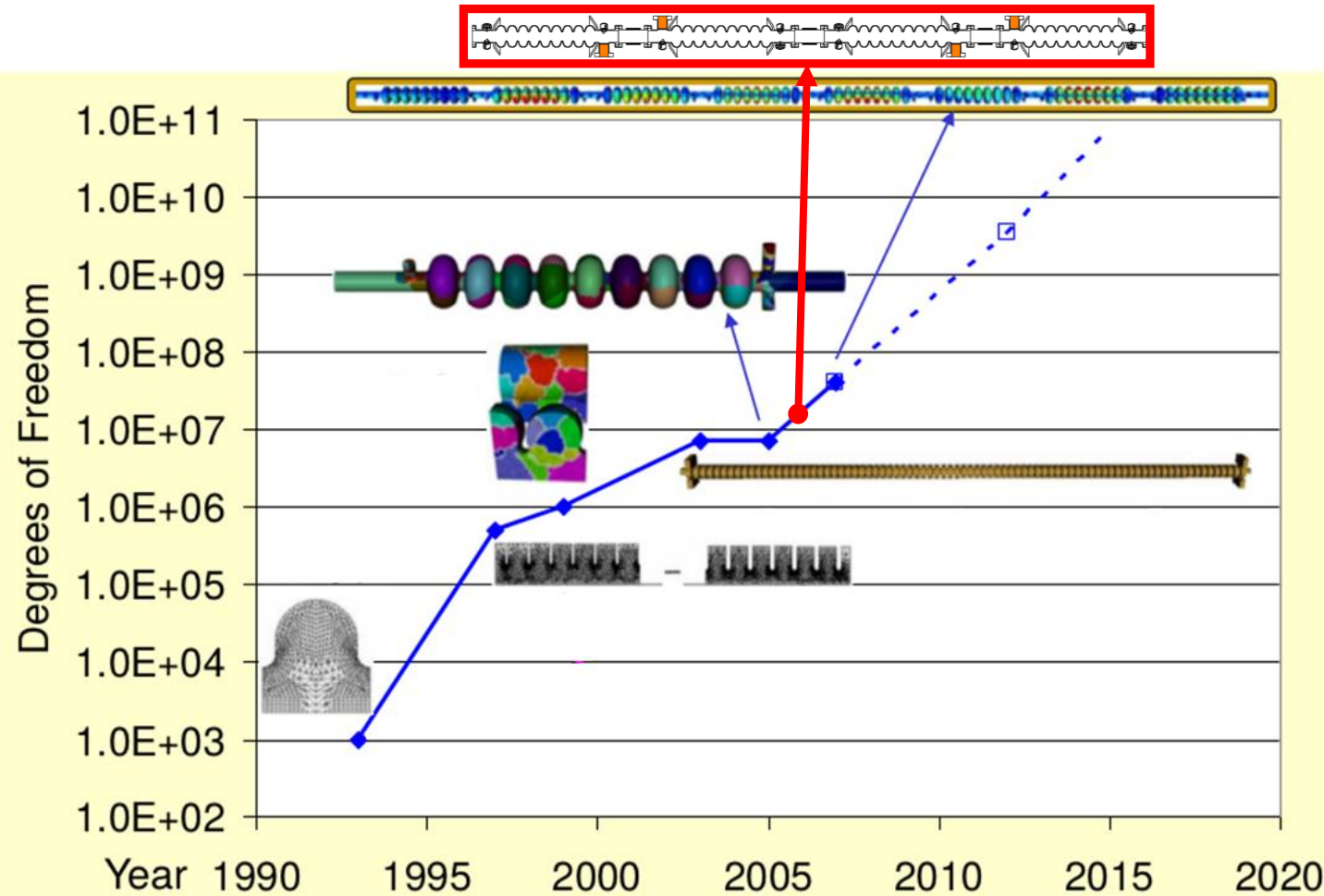
$$f = 4.434632 \text{ GHz}$$



- higher order modes are not required to be necessarily confined in the individual resonators
- consideration of entire cavity chain for a reasonable RF analysis is needed

*E. Vogel et al.: "Status of the 3rd harmonic systems for FLASH and XFEL in summer 2008", Proc. LINAC 2008

Problem Complexity of Direct Computations



Liling Xiao, Lixin Ge, Kwok Ko, Kihwan Lee, Zenghai Li, Cho-Kuen Ng: "Superconducting Cavity Imperfection Study for Projekt X Linac Using ACE3P", ComPASS All-Hands Meeting LBNL, Sept. 27 -28, 2012 und Kwok Ko et. al: "Advances in Parallel Electromagnetic Code for Accelerator Science and Development", Proceedings of the Linear Accelerator Conference 2010, pp. 1028 - 1032, Tsukuba, Japan 2010

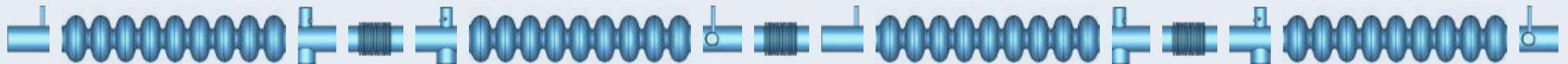


Are we able to avoid the need of
supercomputers?

Alternative approach:
State-Space Concatenations

State-Space Concatenations (SSC)

1. Decomposition of the Structure at Regions of Constant Cross Section

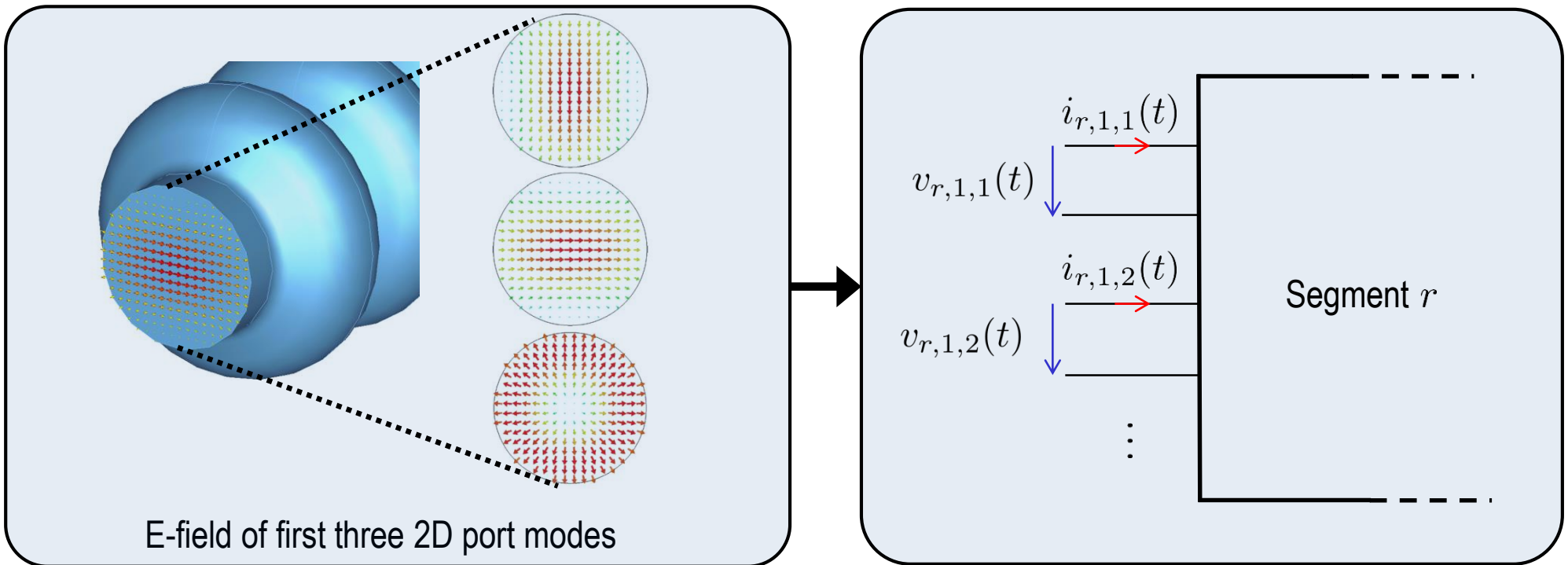


Important properties:

- (numerical) treatment of segments is computationally less demanding
- single treatment of identical segments
- segments with simple geometry can be treated semi-analytically, which is very fast
- employment of symmetry of segments is feasible

State-Space Concatenations (SSC)

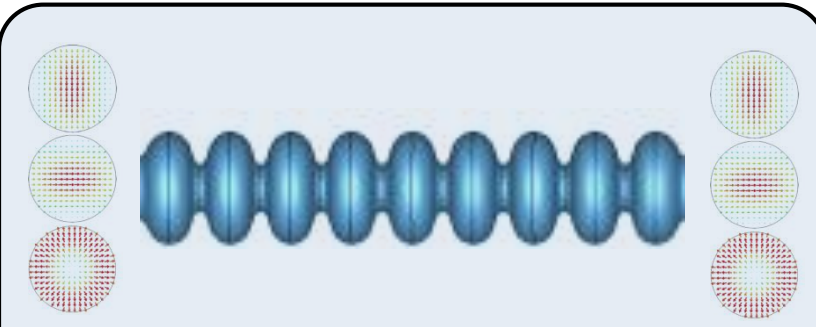
2. Consideration of Segments as Blocks with Terminals



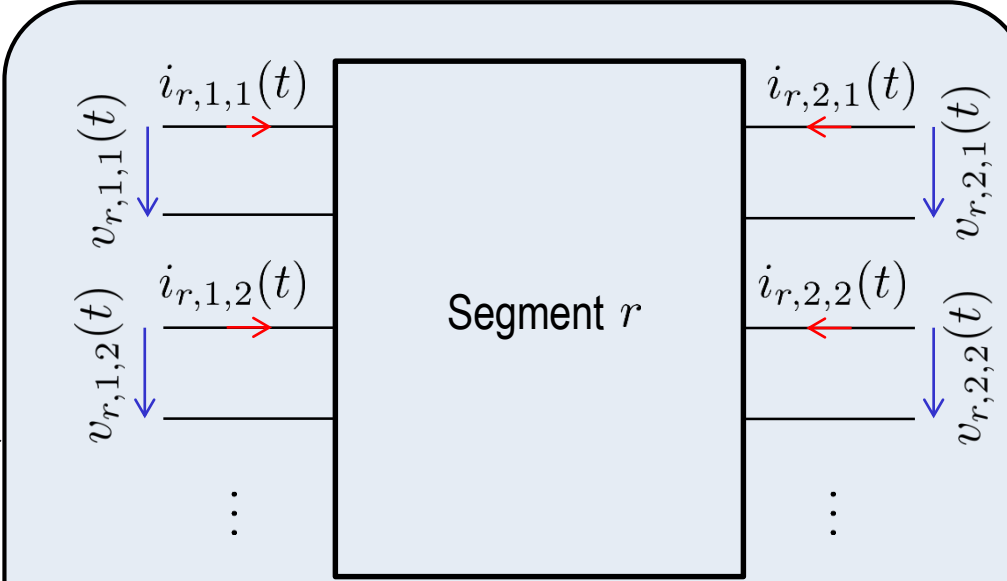
- Modal voltages $v_{r,p,m}(t)$ correspond to tangential electric fields of 2D port modes
- Modal currents $i_{r,p,m}(t)$ correspond to tangential magnetic fields of 2D port modes

State-Space Concatenations (SSC)

3. Generation of Second-Order State-Space Equations for Segments



wave equation (PDE):

$$\Delta \mathbf{E}(\mathbf{r}, t) = \varepsilon \mu \frac{\partial^2}{\partial t^2} \mathbf{E}(\mathbf{r}, t) + \mu \frac{\partial}{\partial t} \mathbf{J}(\mathbf{r}, t)$$


state-space system (ODE):

$$\frac{d^2}{dt^2} \mathbf{x}_r(t) = \mathbf{A}_r \mathbf{x}_r(t) + \mathbf{B}_r \frac{d}{dt} \mathbf{i}_r(t)$$

$$\mathbf{v}_r(t) = \mathbf{B}_r^T \mathbf{x}_r(t)$$

State-Space Concatenations (SSC)

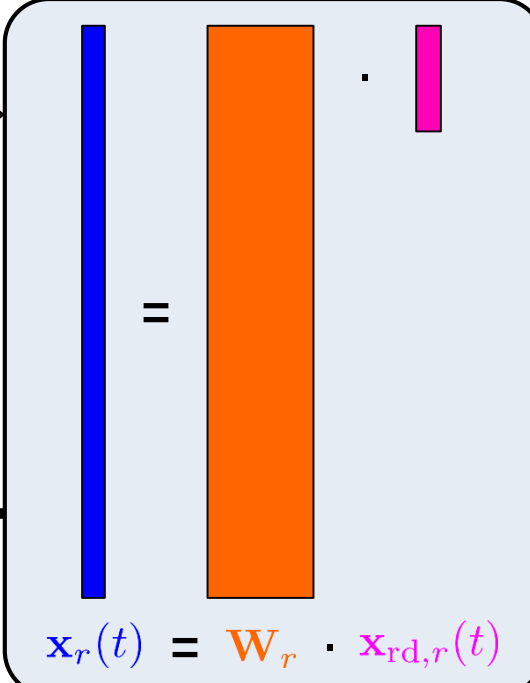
4. Model-Order Reduction for State-Space Systems

$$\frac{d^2}{dt^2} \mathbf{x}_r(t) = \mathbf{A}_r \mathbf{x}_r(t) + \mathbf{B}_r \frac{d}{dt} \mathbf{i}_r(t)$$

$$\mathbf{v}_r(t) = \mathbf{B}_r^T \mathbf{x}_r(t)$$

$$\frac{d^2}{dt^2} \mathbf{x}_{rd,r}(t) = \underbrace{\mathbf{W}_r^T \mathbf{A}_r \mathbf{W}_r}_{\mathbf{A}_{rd,r}} \mathbf{x}_{rd,r}(t) + \underbrace{\mathbf{W}_r^T \mathbf{B}_r}_{\mathbf{B}_{rd,r}} \frac{d}{dt} \mathbf{i}_r(t)$$

$$\mathbf{v}_r(t) = \underbrace{\mathbf{B}_r^T \mathbf{W}_r}_{\mathbf{B}_{rd,r}^T} \mathbf{x}_{rd,r}(t)$$



$$\mathbf{x}_r(t) = \mathbf{W}_r \cdot \mathbf{x}_{rd,r}(t)$$

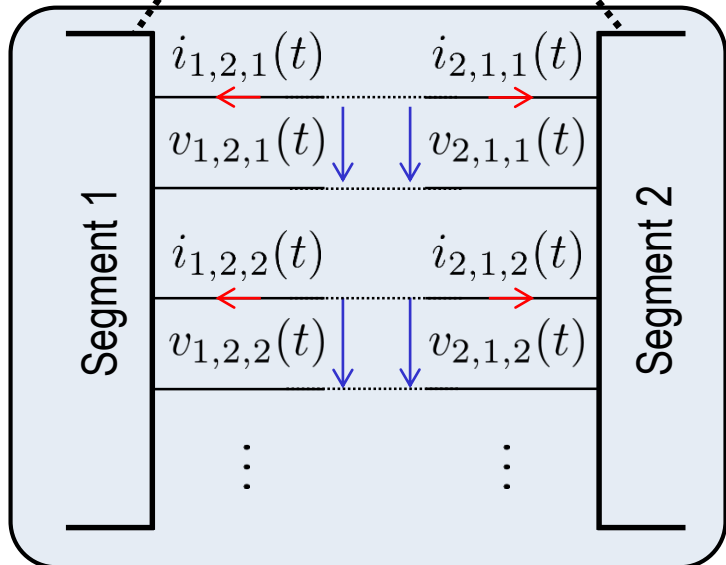
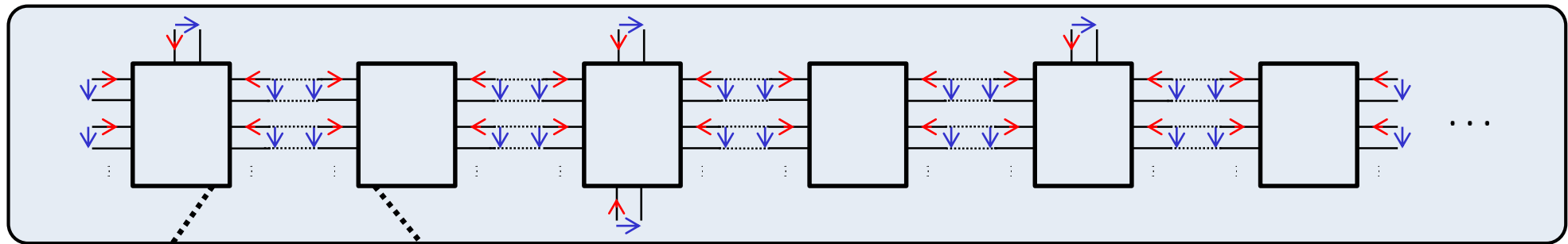
state vector: $\mathbf{x}_r(t) \in \mathbb{R}^{N_s}$, $N_s \approx 10^5$

orthogonal projection matrix: $\mathbf{W}_r \in \mathbb{R}^{N_s \times N_{srd}}$, $\mathbf{W}_r^T \mathbf{W}_r = \mathbf{I}$

reduced state vector: $\mathbf{x}_{rd,r}(t) \in \mathbb{R}^{N_{srd}}$, $N_{srd} < 10^2$

State-Space Concatenations (SSC)

5. Concatenation of Reduced-Order State-Space System



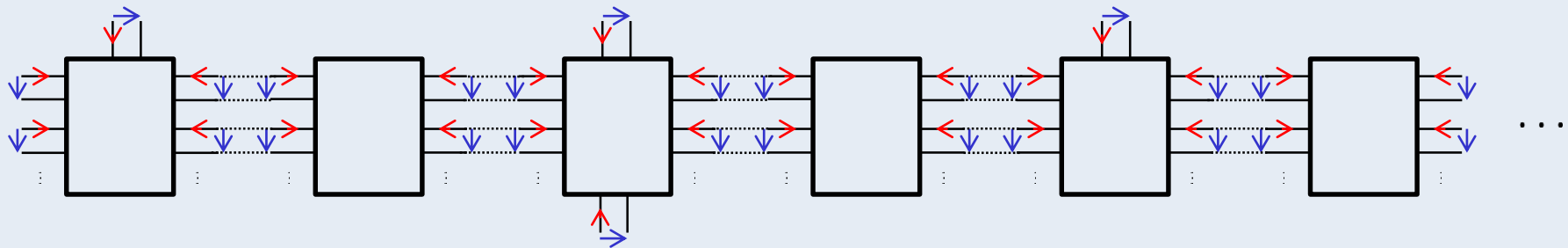
$$\frac{d^2}{dt^2} \mathbf{x}_{\text{rdc}}(t) = \mathbf{A}_{\text{rdc}} \mathbf{x}_{\text{rdc}}(t) + \mathbf{B}_{\text{rdc}} \frac{d}{dt} \mathbf{i}(t)$$

$$\mathbf{v}(t) = \mathbf{B}_{\text{rdc}}^T \mathbf{x}_{\text{rdc}}(t)$$

- Coupling constraints according to Kirchhoff's laws
- Arbitrary topologies and number of 2D port modes supported

State-Space Concatenations (SSC)

6. Computation of RF Properties by Means of the Reduced-Order Model



$$\frac{d^2}{dt^2} \mathbf{x}_{\text{rdc}}(t) = \mathbf{A}_{\text{rdc}} \mathbf{x}_{\text{rdc}}(t) + \mathbf{B}_{\text{rdc}} \frac{d}{dt} \mathbf{i}(t)$$

$$\mathbf{v}(t) = \mathbf{B}_{\text{rdc}}^T \mathbf{x}_{\text{rdc}}(t)$$

impedance- and
scattering parameters

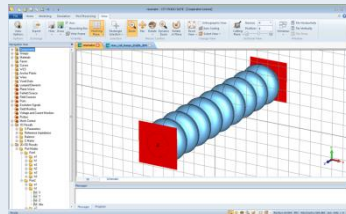
frequencies and field distributions
of eigenmodes

3D field distribution due to
port excitations

external quality factors

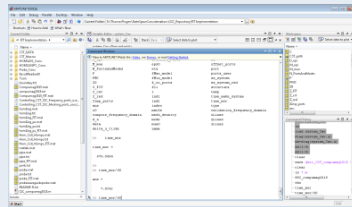
Implementation of SSC

CST Microwave Studio®



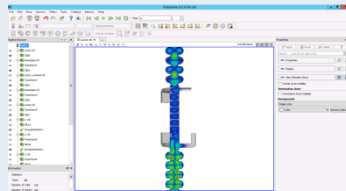
- geometrical modelling
- discretization

Matlab®



- model-order reduction
- concatenation
- computation of derived quantities

ParaView

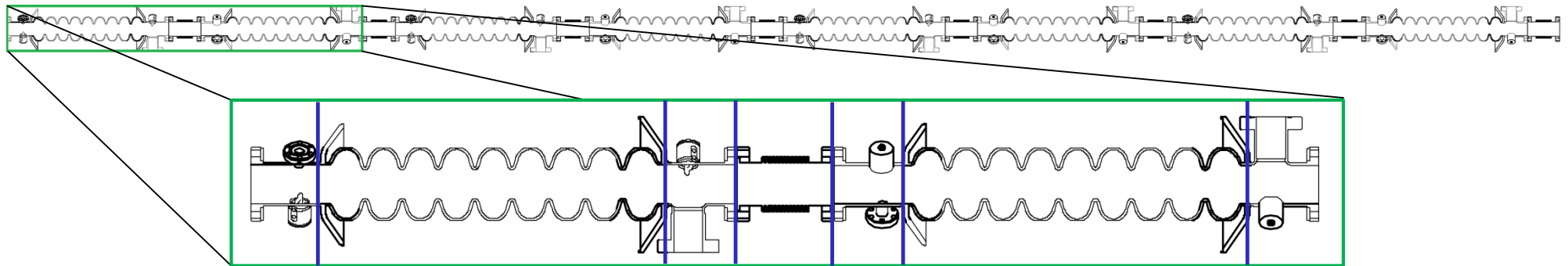


- visualization of field distributions



Full Analysis of Eigenmodes up to 8 GHz in Chain of Eight 3rd Harmonic Cavities for the European XFEL

Chain of Eight Superconducting 3rd Harmonic Cavities in XFEL



	HOM Coupler	Cavity	HOM Coupler with Power Coupler	Bellow	HOM Coupler (rotated)	HOM Coupler with Power Coupler (rotated)
N_{dof}	411,015	1,119,963	585,915	427,119	411,015	585,915
$N_{\text{dof,red}}$	138	258	164	145	138	164

- Full model of eight cavity chain is estimated to have $N_{\text{dof}} = 20,239,977$ degrees of freedom
- Reduced-order models of segments concatenated to reduced-order model of full chain with $N_{\text{dof,red}} = 2,931$ degrees of freedom

Figures of cavities E. Vogel et al.: "Status of the 3rd harmonic systems for FLASH and XFEL in summer 2008", Proc. LINAC 2008

Computation of Eigenmodes based on Reduced-Order Model

Nr.	f_r (GHz)	Deg.	R_r/Q_r (Ω)
419	5.29620e+000	2.01770e+000	8.89265e-002
420	5.39250e+000	3.47200e+005	5.83226e-001
421	5.39314e+000	2.01770e+000	8.34606e-001
422	5.39555e+000	8.01800e+005	1.42224e-001
423	5.39610e+000	7.95200e+005	1.68882e-002
424	5.39665e+000	1.87920e+000	3.16501e-001
425	5.39866e+000	6.93300e+005	2.63697e-002
426	5.39927e+000	1.86010e+000	1.11795e+001
427	5.40121e+000	1.54520e+000	6.13410e-001
428	5.40279e+000	1.47030e+007	4.54930e-001
429	5.41722e+000	1.8270e+000	7.04884e-001
430	5.41927e+000	2.97200e+005	8.09410e-001
431	5.41927e+000	2.2960e+000	7.99056e-001
432	5.42181e+000	8.5090e+005	1.27970e-002
433	5.42247e+000	1.0200e+000	2.32417e-001
434	5.42474e+000	5.0200e+004	1.02848e-001
435	5.43479e+000	2.3730e+000	1.66530e-001
436	5.42710e+000	6.0390e+005	1.33942e-001
437	5.42771e+000	1.9775e+000	6.64693e-001
438	5.42978e+000	9.4980e+005	3.01202e-001
439	5.42980e+000	1.5620e+000	2.01105e-001
440	5.43226e+000	1.0540e+000	9.99550e-001

Nr.	f_r (GHz)	Deg.	R_r/Q_r (Ω)
441	5.43331e+000	1.12250e+000	8.09626e-001
442	5.43444e+000	9.2400e+004	1.69851e-001
443	5.43452e+000	1.38200e+000	1.03714e-001
444	5.43593e+000	5.8510e+000	7.54958e-001
445	5.44170e+000	2.4130e+000	2.56226e-001
446	5.44184e+000	5.6180e+005	1.14234e-001
447	5.44176e+000	2.0848e+000	8.42748e-001
448	5.44664e+000	1.61410e+000	3.17296e-001
449	5.44821e+000	1.0343e+000	1.13965e-001
450	5.44944e+000	7.2300e+005	4.72692e-001
451	5.45012e+000	1.8190e+000	1.43972e-001
452	5.45190e+000	2.2190e+005	1.29539e-001
453	5.45221e+000	2.1170e+000	2.72421e-001
454	5.45428e+000	1.2490e+005	3.53428e-002
455	5.45453e+000	1.92410e+000	2.86249e-001
456	5.45627e+000	4.3030e+005	3.87567e-001
457	5.45687e+000	1.4910e+000	3.42705e-001
458	5.45828e+000	9.7920e+005	9.24915e-001
459	5.45928e+000	4.0930e+005	6.36074e-001
460	5.45961e+000	1.6690e+000	4.69826e-001
461	5.46125e+000	2.0634e+000	2.42203e-001
462	5.46331e+000	6.9000e+005	1.12131e-001

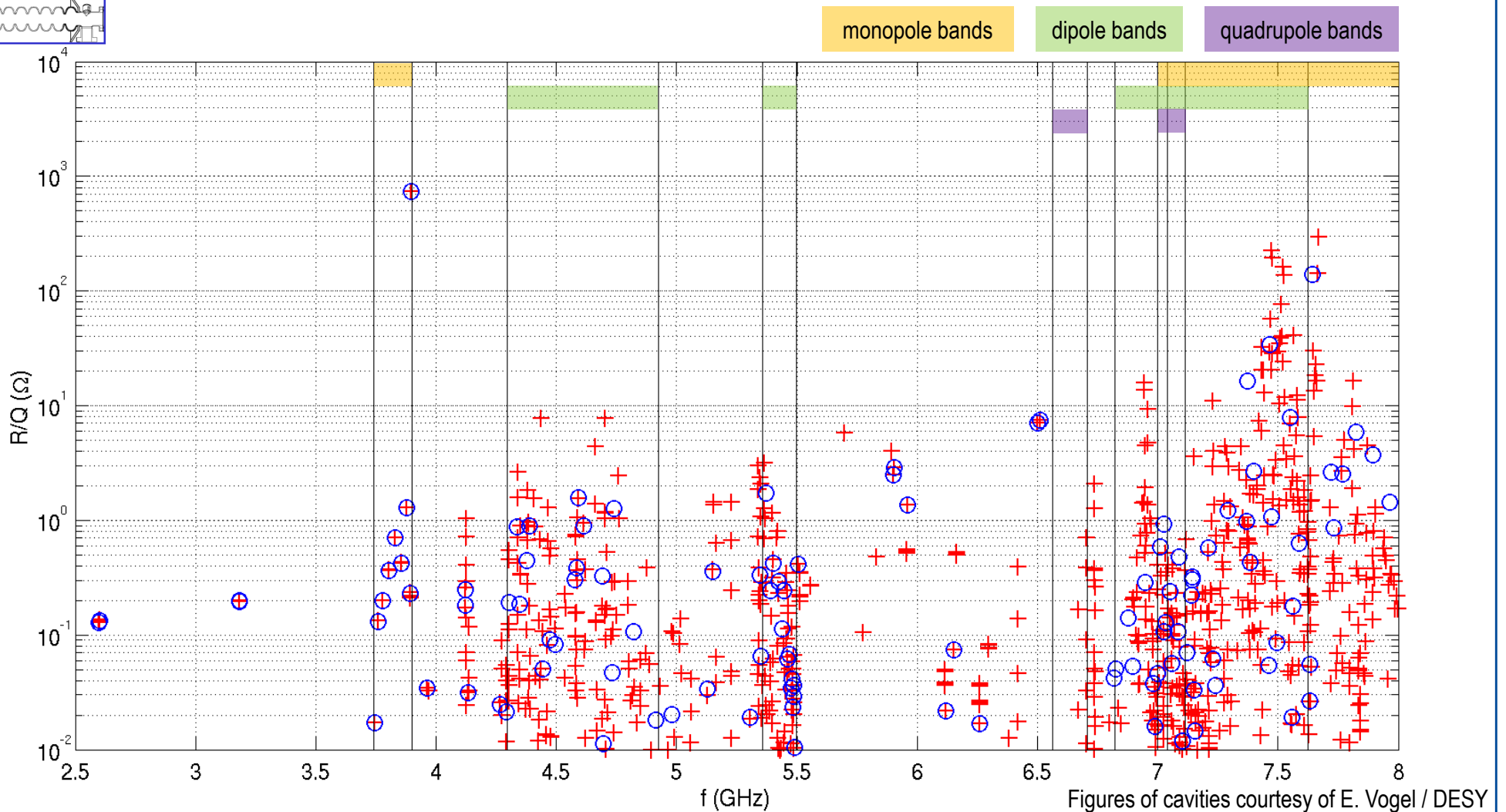
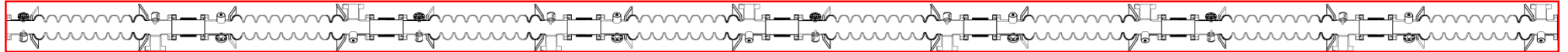
Nr.	f_r (GHz)	Deg.	R_r/Q_r (Ω)
463	5.46491e+000	1.23030e+000	1.77984e-001
464	5.46528e+000	7.0900e+005	2.18529e-001
465	5.46592e+000	1.11200e+000	1.53641e-001
466	5.46798e+000	3.2600e+005	4.78266e-001
467	5.46798e+000	1.3760e+000	3.64276e-001
468	5.46875e+000	1.4180e+005	1.94276e-001
469	5.46917e+000	1.4410e+000	3.79652e-001
470	5.47051e+000	3.1180e+004	8.11378e-001
471	5.47042e+000	1.37010e+000	2.30257e-001
472	5.47121e+000	7.2300e+005	1.31868e-001
473	5.47184e+000	1.2700e+000	7.40797e-001
474	5.47307e+000	9.6900e+005	9.70417e-001
475	5.47402e+000	2.5300e+005	5.21675e-001
476	5.47424e+000	8.2700e+005	8.52062e-001
477	5.47512e+000	1.12010e+000	4.27918e-001
478	5.47622e+000	2.8300e+005	1.14439e-001
479	5.47648e+000	8.3100e+005	3.75766e-001
480	5.47718e+000	4.2000e+004	3.88960e-001
481	5.47780e+000	9.0100e+005	1.12838e-001
482	5.47820e+000	1.4780e+005	5.14258e-001
483	5.47840e+000	7.8200e+005	1.48722e-001
484	5.47944e+000	1.7800e+005	7.50944e-001

Nr.	f_r (GHz)	Deg.	R_r/Q_r (Ω)
485	5.48028e+000	1.12250e+000	8.09626e-001
486	5.48144e+000	9.2400e+004	1.69851e-001
487	5.48152e+000	1.38200e+000	1.03714e-001
488	5.48293e+000	5.8510e+000	7.54958e-001
489	5.48867e+000	2.4130e+000	2.56226e-001
490	5.48884e+000	5.6180e+005	1.14234e-001
491	5.48876e+000	2.0848e+000	8.42748e-001
492	5.49364e+000	1.61410e+000	3.17296e-001
493	5.49521e+000	1.0343e+000	1.13965e-001
494	5.49644e+000	7.2300e+005	4.72692e-001
495	5.49712e+000	1.8190e+000	1.43972e-001
496	5.49890e+000	2.2190e+005	1.29539e-001
497	5.49921e+000	2.1170e+000	2.72421e-001
498	5.50128e+000	1.2490e+005	3.53428e-002
499	5.50153e+000	1.92410e+000	2.86249e-001
500	5.50327e+000	4.3030e+005	3.87567e-001
501	5.50387e+000	1.4910e+000	3.42705e-001
502	5.50528e+000	9.7920e+005	9.24915e-001
503	5.50628e+000	4.0930e+005	6.36074e-001
504	5.50661e+000	1.6690e+000	4.69826e-001
505	5.50825e+000	2.0634e+000	2.42203e-001
506	5.51031e+000	6.9000e+005	1.12131e-001

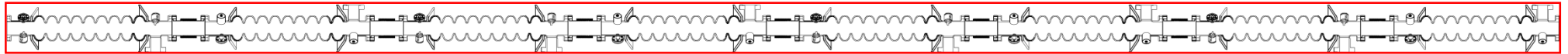
- Computed 1,479 eigenmodes in the interval 1 GHz to 8 GHz of the chain by means of a standard workstation computer
- Assembled a modal compendium for the chain with resonant frequency, external quality factor, R/Q, and electric field distribution of each mode
- In total, the compendium consists of 137 pages



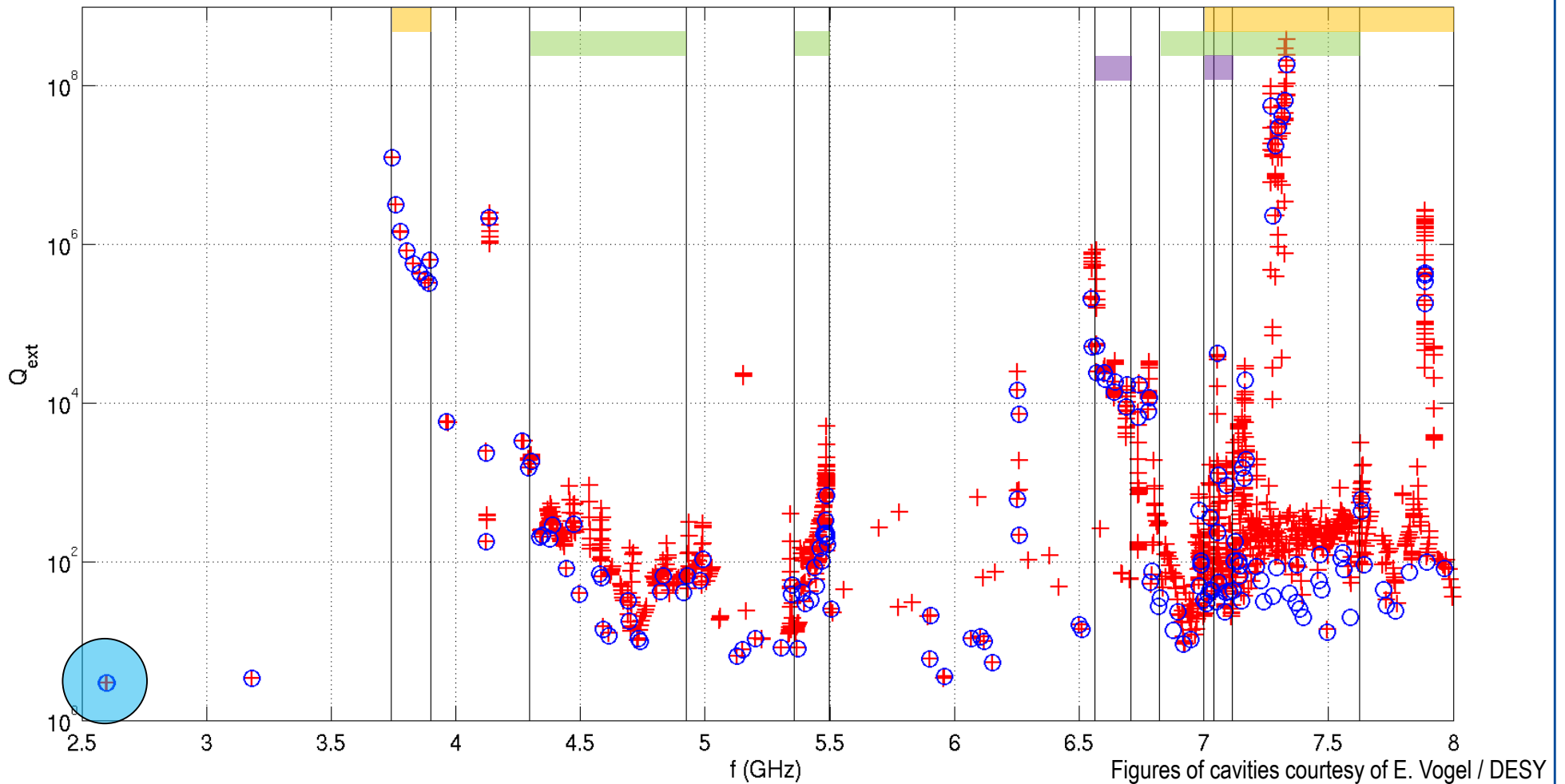
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



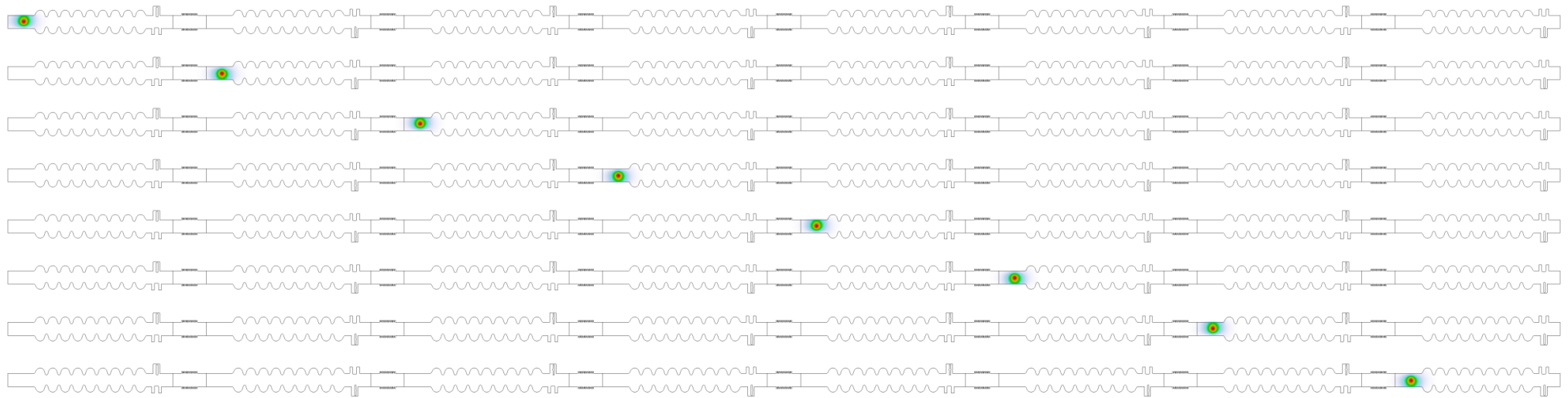
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



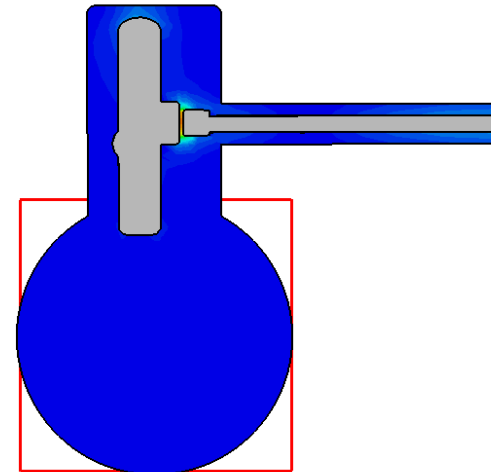
monopole bands dipole bands quadrupole bands



Modes Localized in HOM Couplers (I/II)

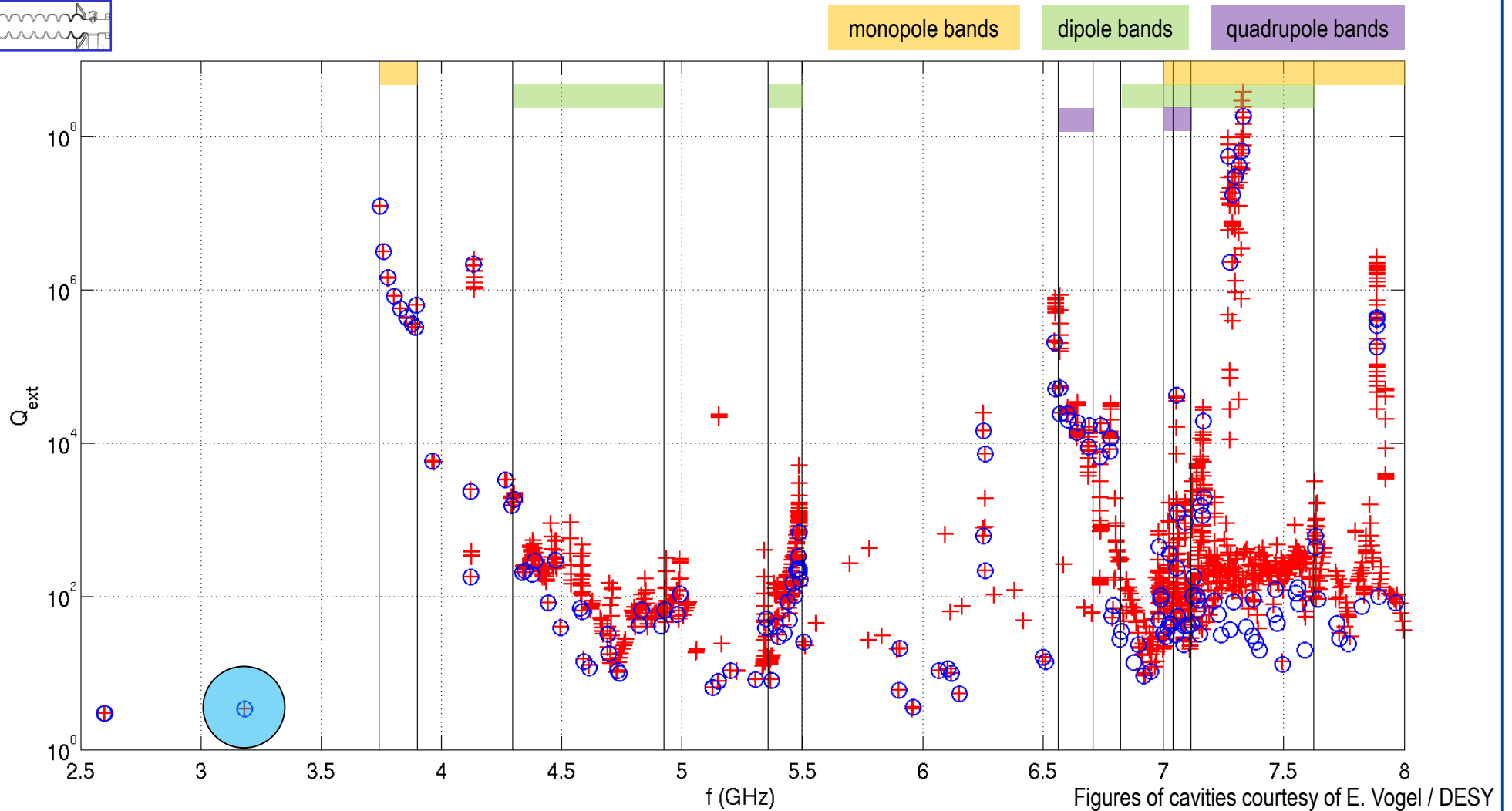
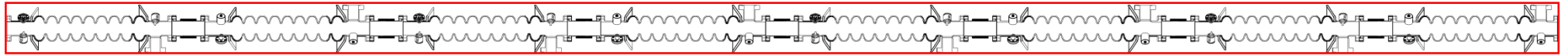


Index	f (GHz)	R/Q (Ω)	Q_{ext}
1 – 8	2.5987	$1.2829 \cdot 10^{-1}$	2.9707

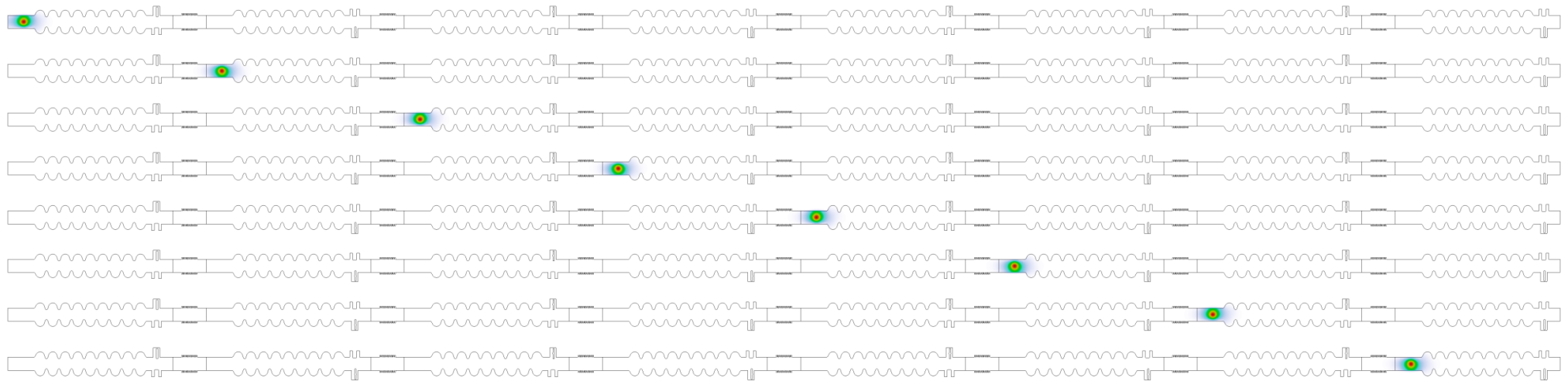


The plots show the absolute value of the electric field.

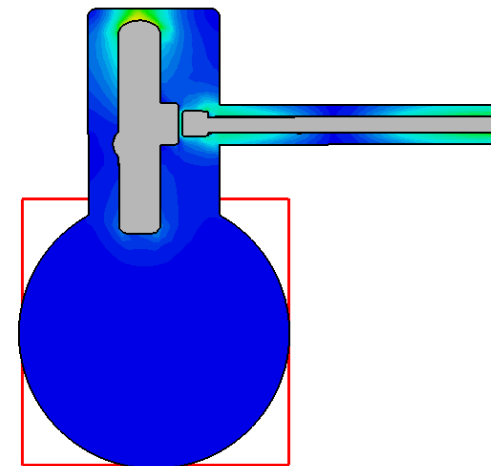
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



Modes Localized in HOM Couplers (II/II)

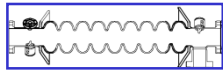
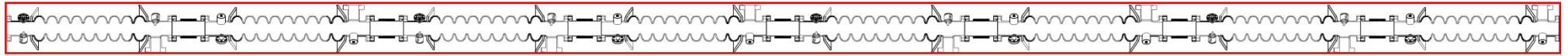


Index	f (GHz)	R/Q (Ω)	Q_{ext}
17 – 24	3.1828	$1.9402 \cdot 10^{-1}$	3.395



The plots show the absolute value of the electric field.

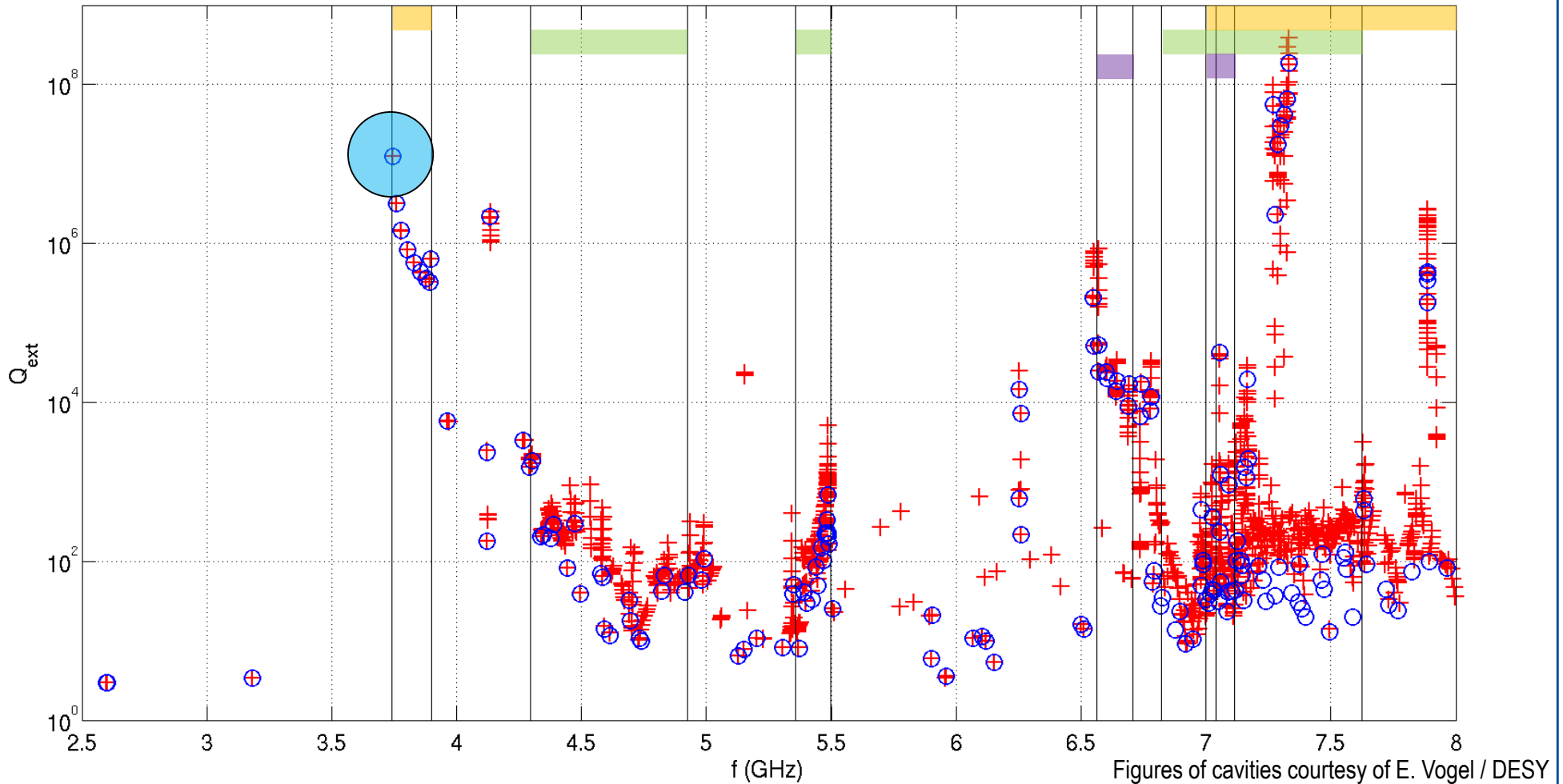
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



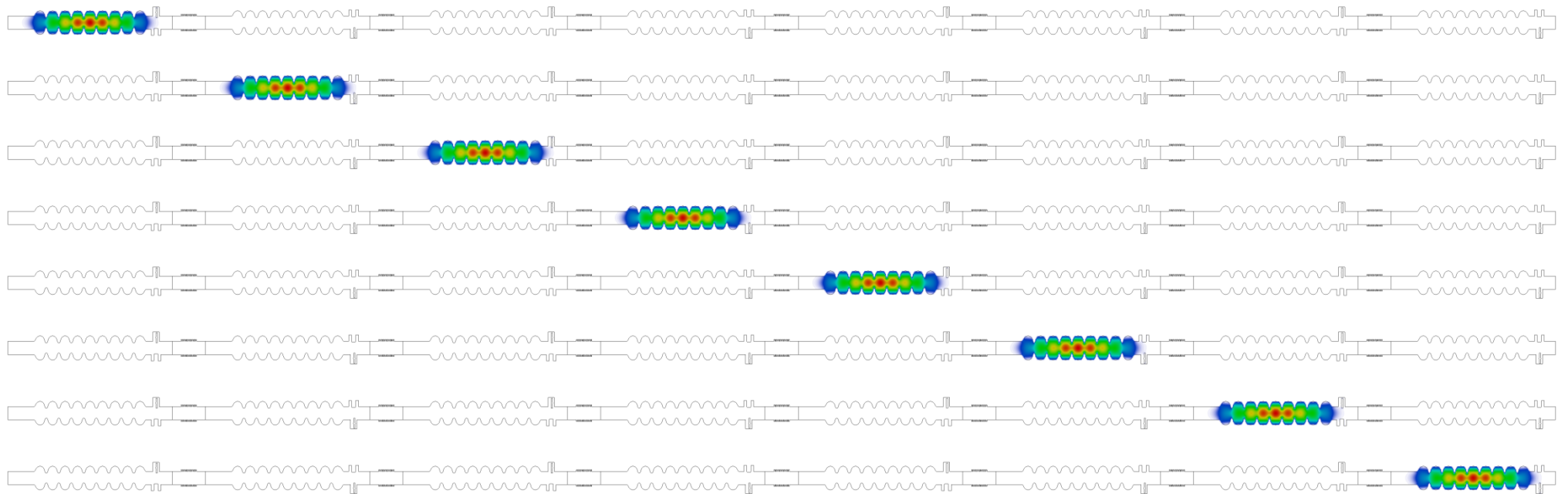
monopole bands

dipole bands

quadrupole bands



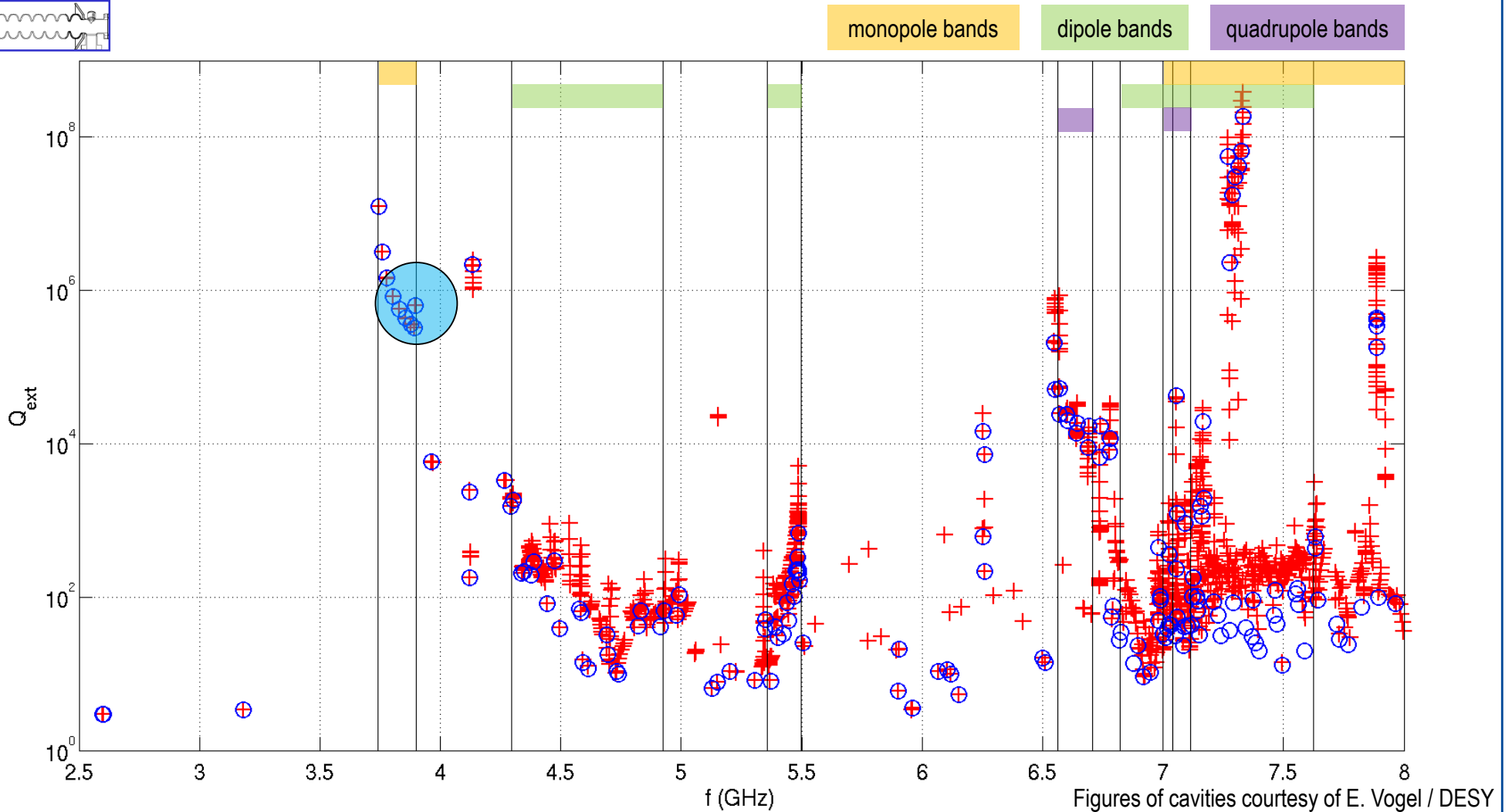
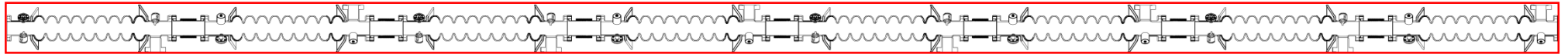
TM₀₁-n/9-Modes Localized in Cavities (I/II)



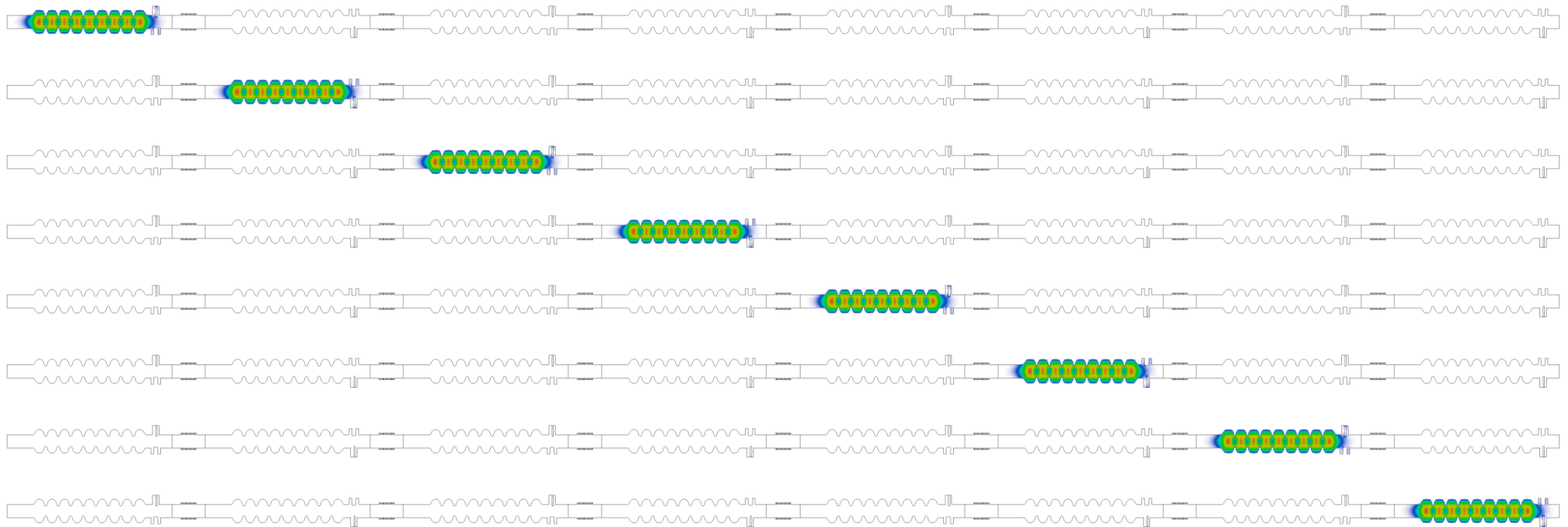
Index	f (GHz)	R/Q (Ω)	Q _{ext}
33 – 40	3.7442	1.7069 · 10 ⁻²	1.2539 · 10 ⁷

The plots show the absolute value of the electric field.

External Quality Factors in Chain of Eight 3rd Harmonic Cavities



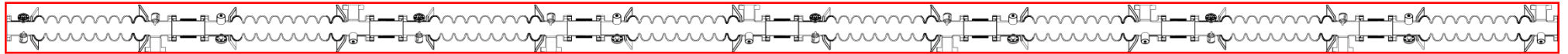
TM₀₁-n-Modes Localized in Cavities (II/II)



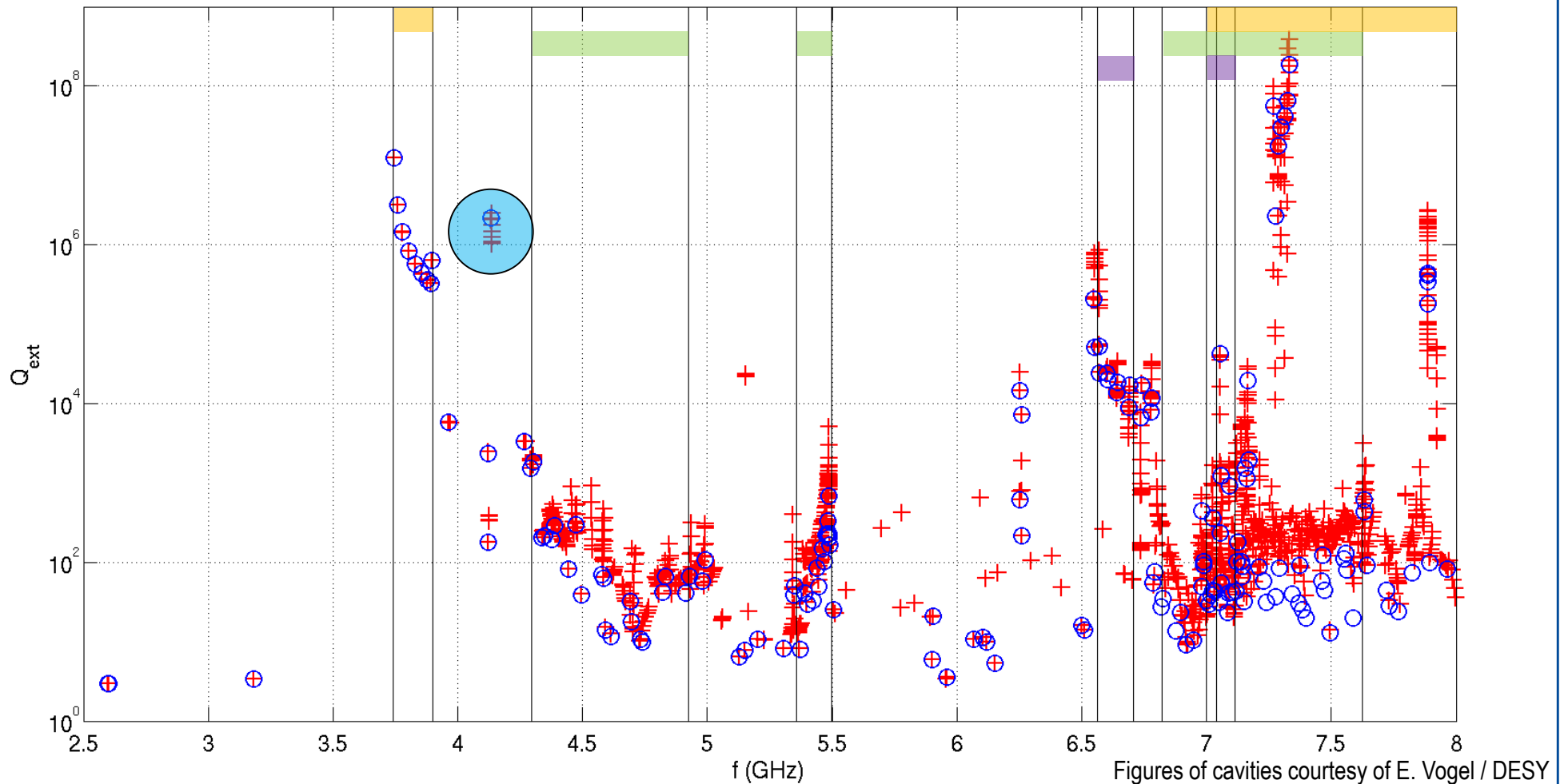
Index	f (GHz)	R/Q (Ω)	Q _{ext}
97 – 104	3.8976	$7.4322 \cdot 10^2$	$6.3826 \cdot 10^5$

The plots show the absolute value of the electric field.

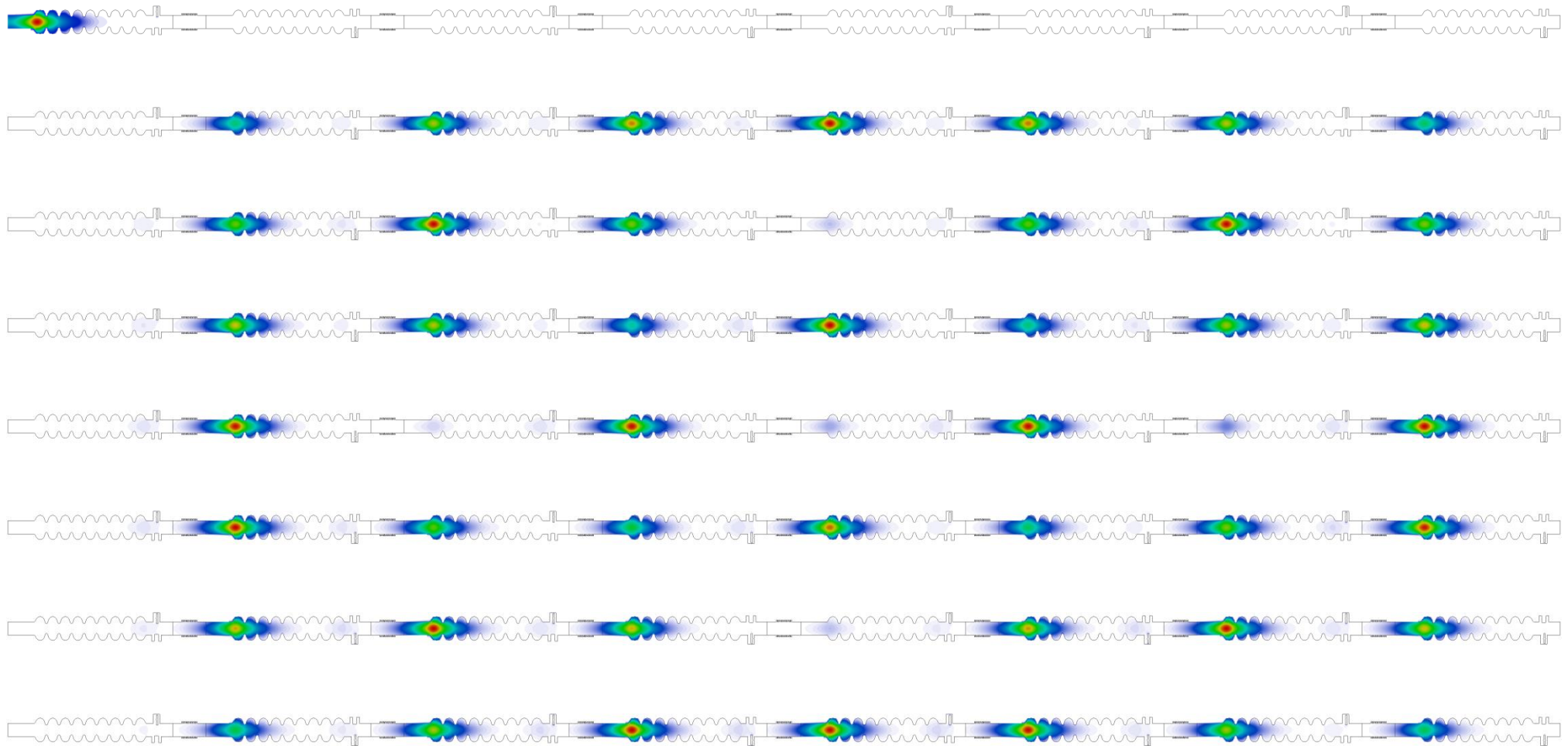
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



monopole bands dipole bands quadrupole bands

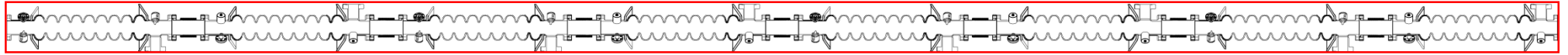


Beam-Pipe Modes from 4.1329 GHz to 4.1354 GHz

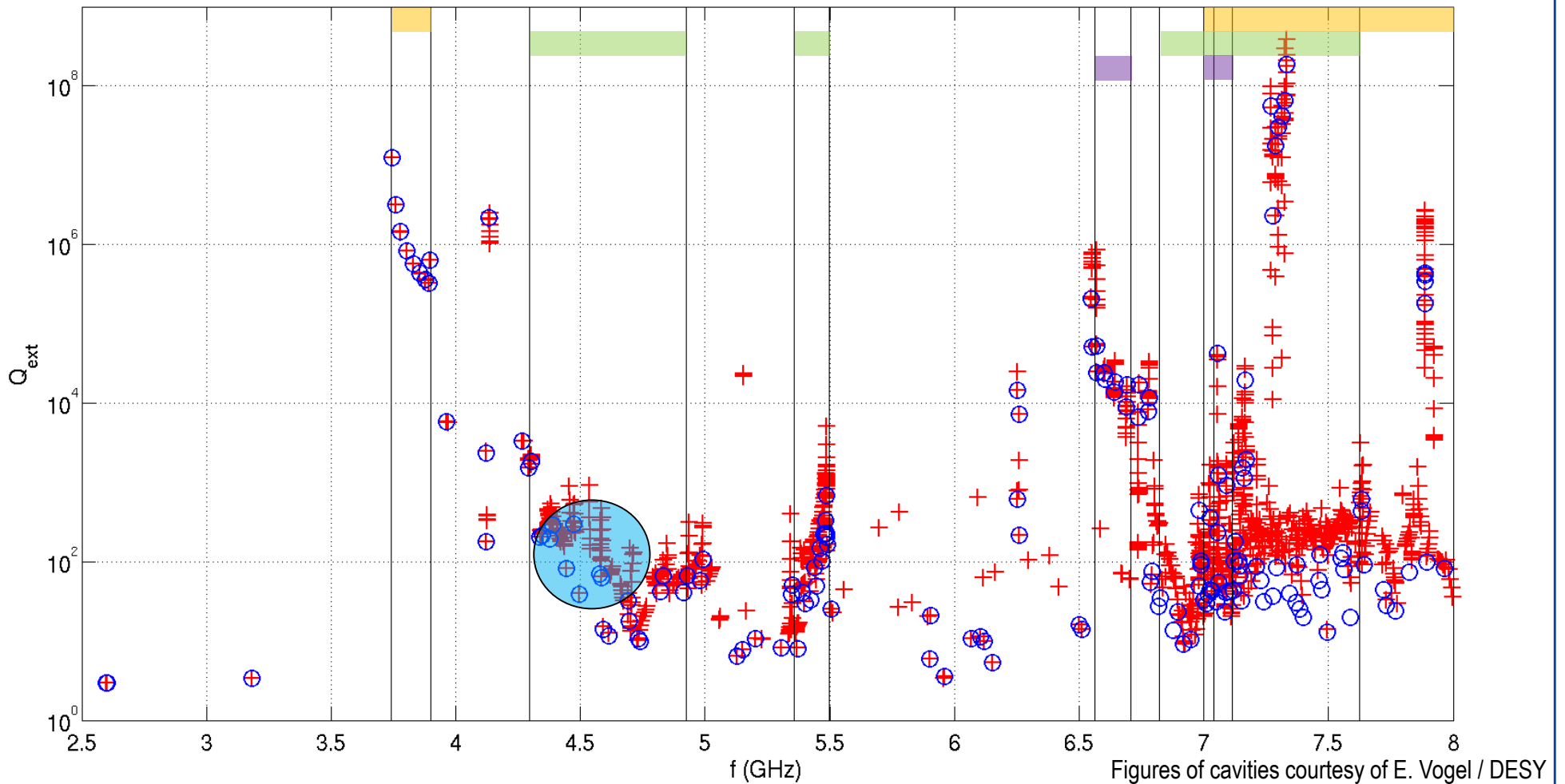


The plots show the absolute value of the electric field.

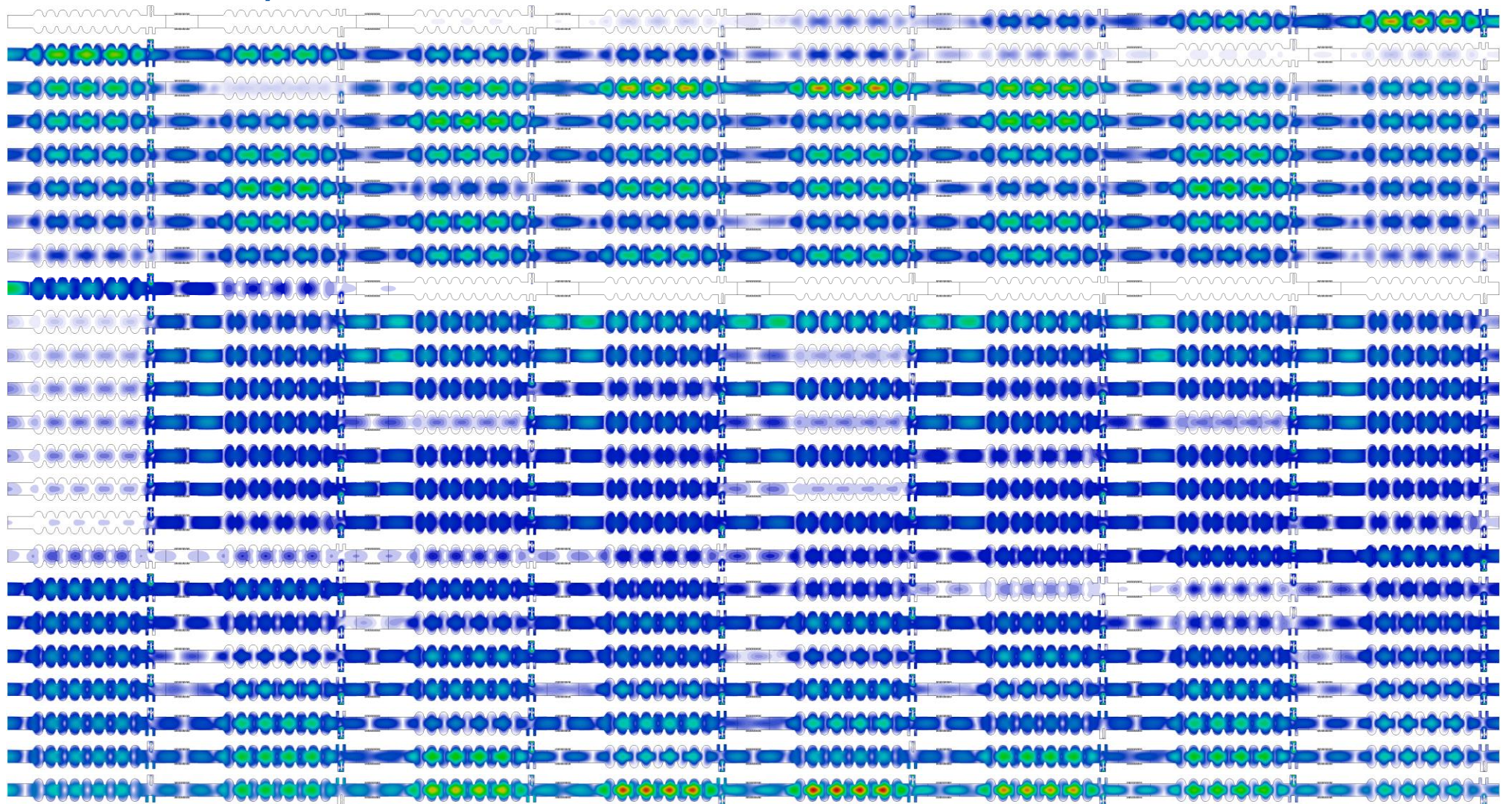
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



monopole bands dipole bands quadrupole bands

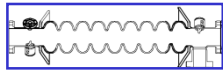
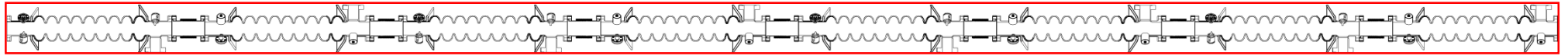


Multi-Cavity Modes from 4.4746 GHz to 4.5829 GHz



The plots show the absolute value of the electric field.

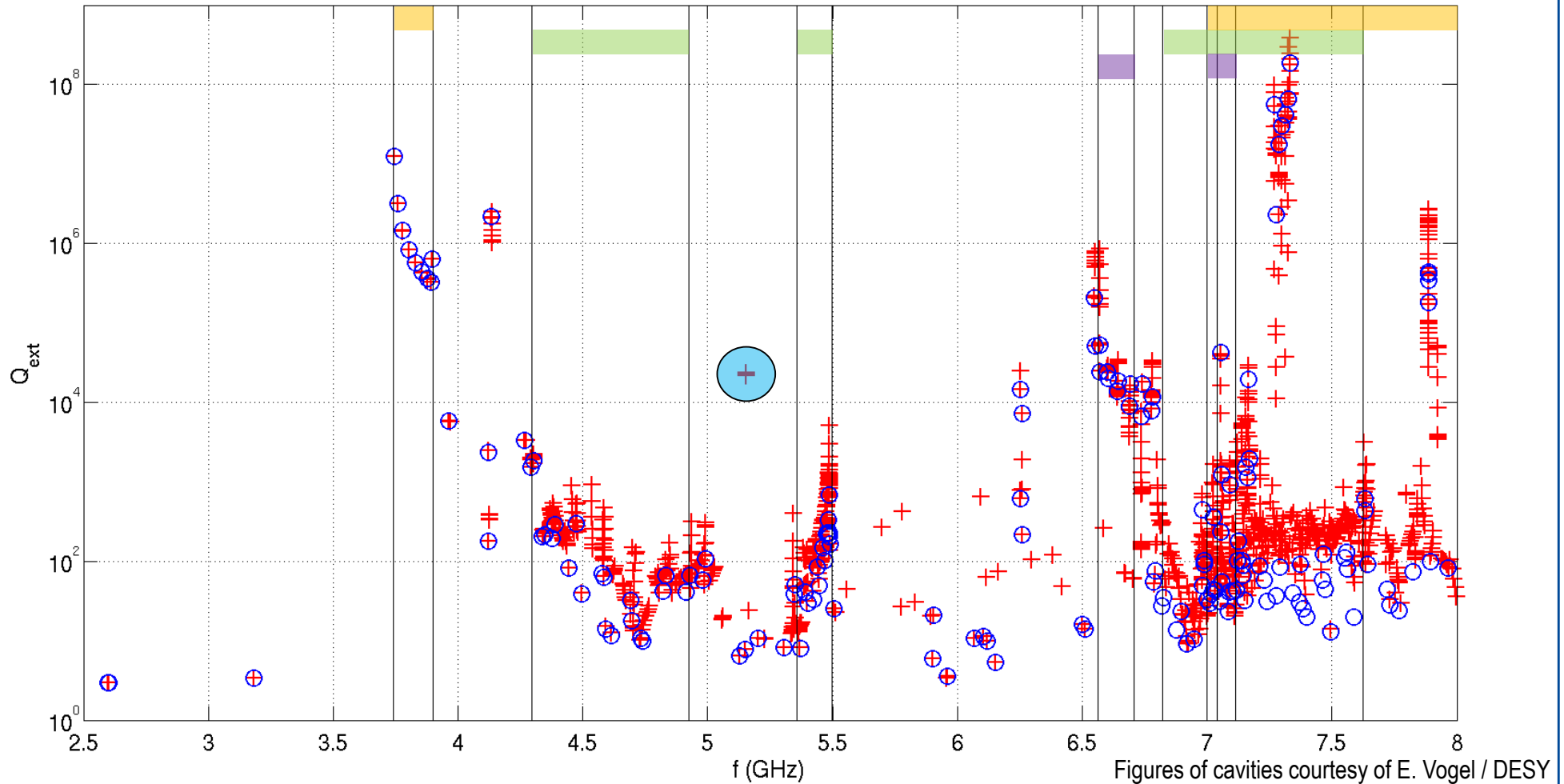
External Quality Factors in Chain of Eight 3rd Harmonic Cavities



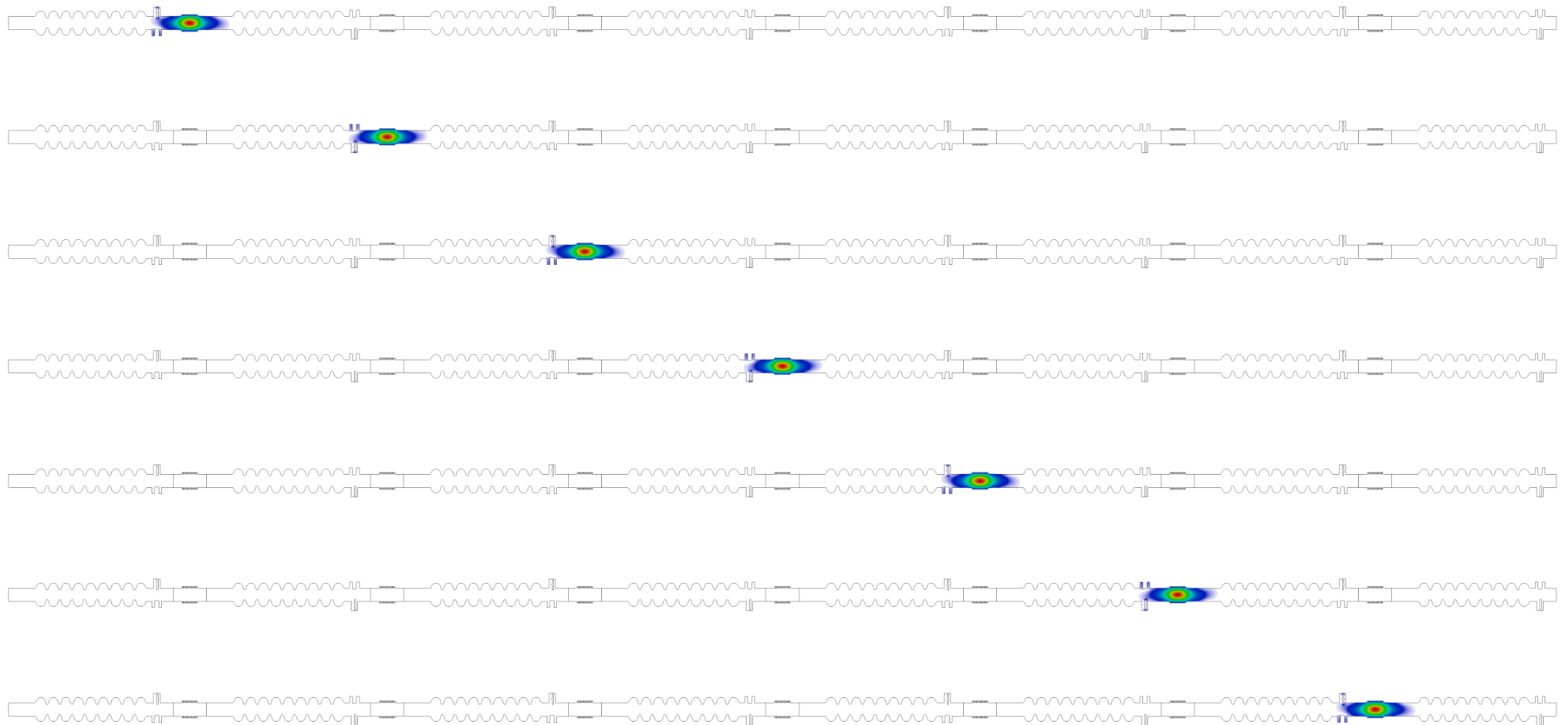
monopole bands

dipole bands

quadrupole bands

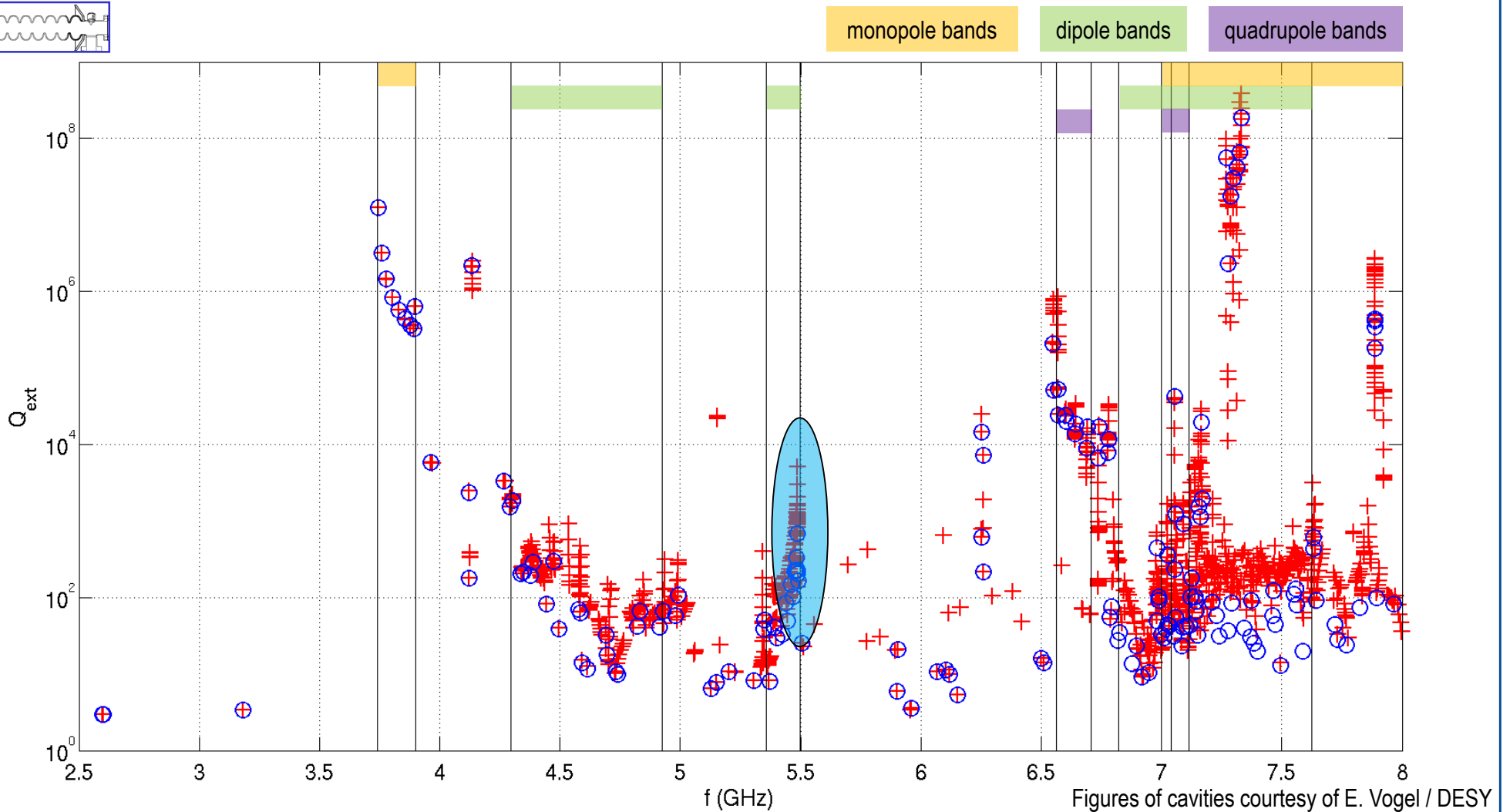
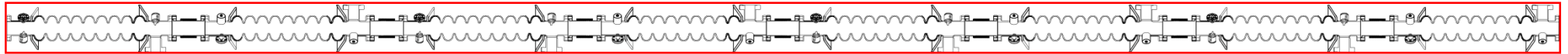


Pure Bellow Modes at 5.1524 GHz

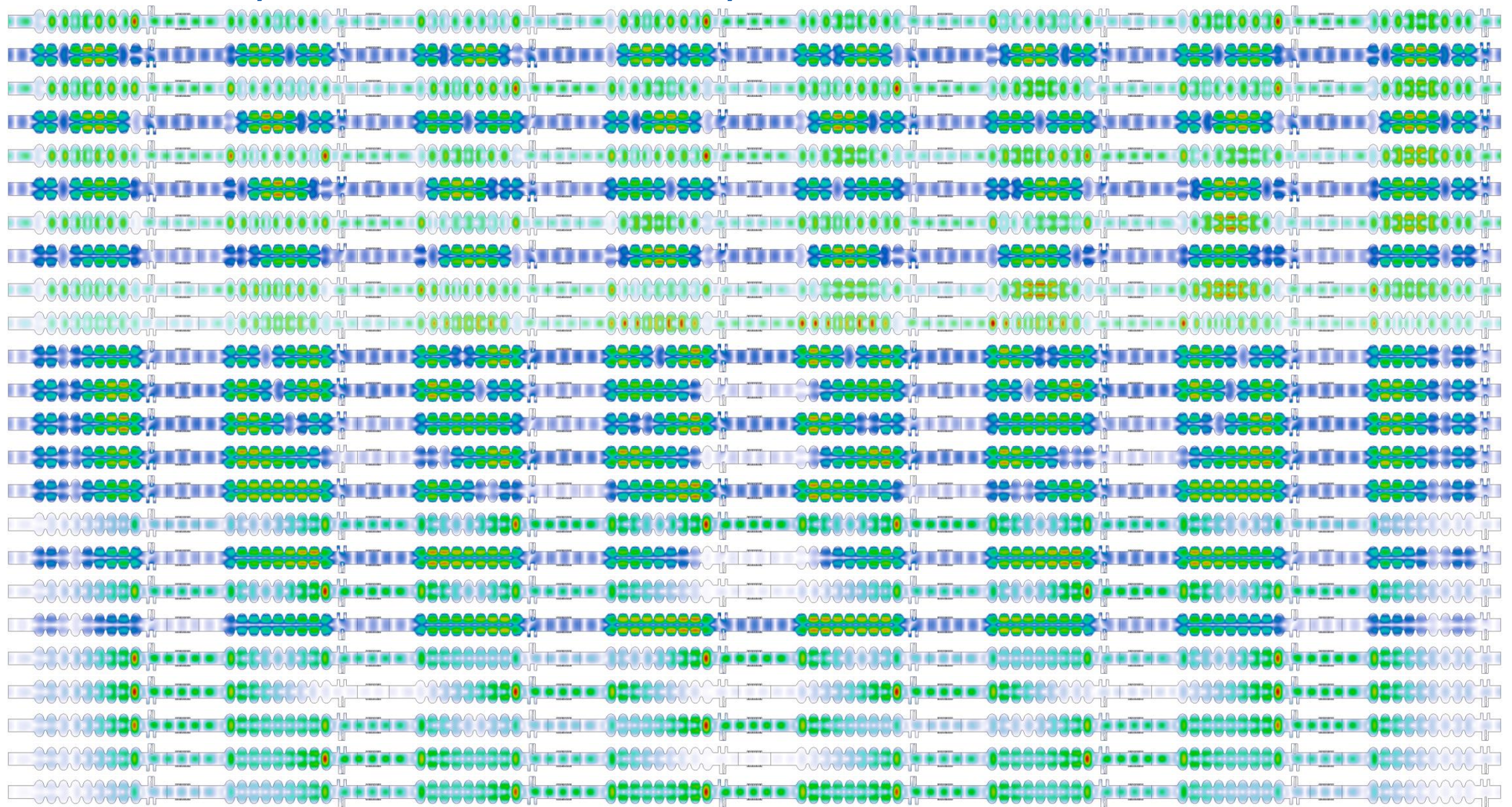


The plots show the absolute value of the electric field.

External Quality Factors in Chain of Eight 3rd Harmonic Cavities

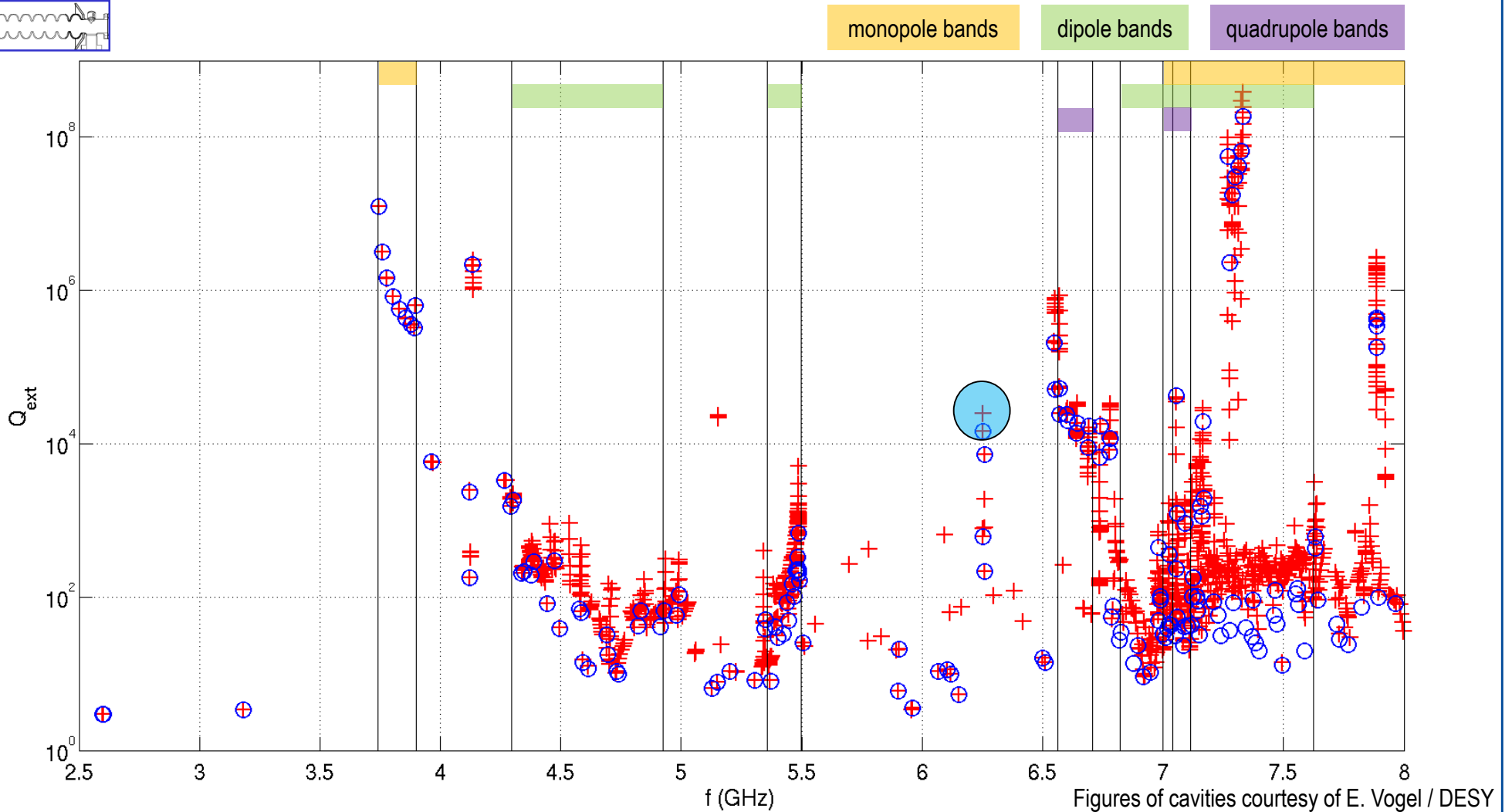
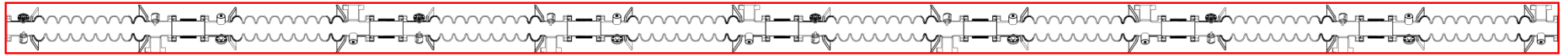


Multi-cavity Modes in the Vicinity of 5.5 GHz

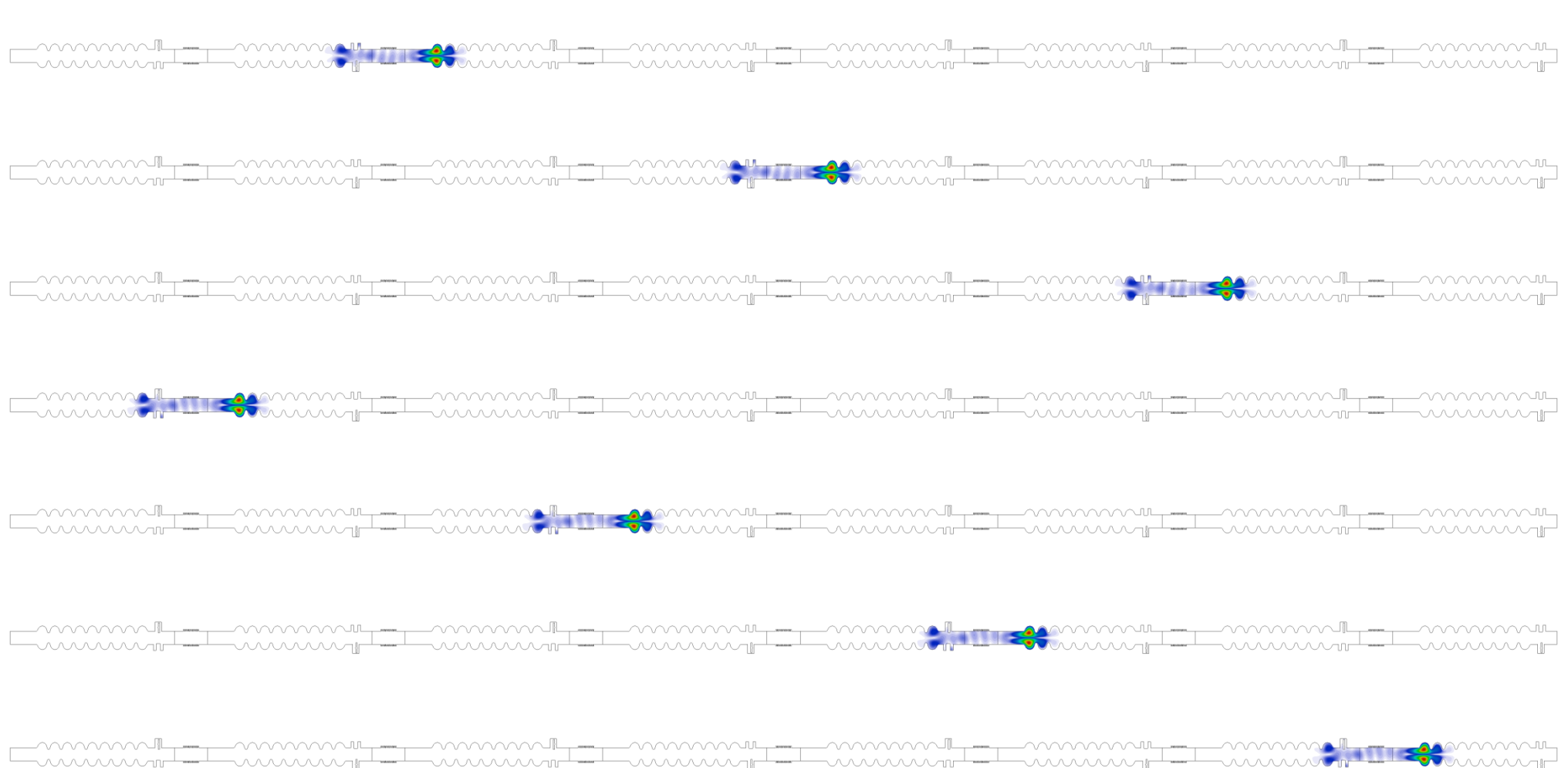


The plots show the absolute value of the electric field.

External Quality Factors in Chain of Eight 3rd Harmonic Cavities

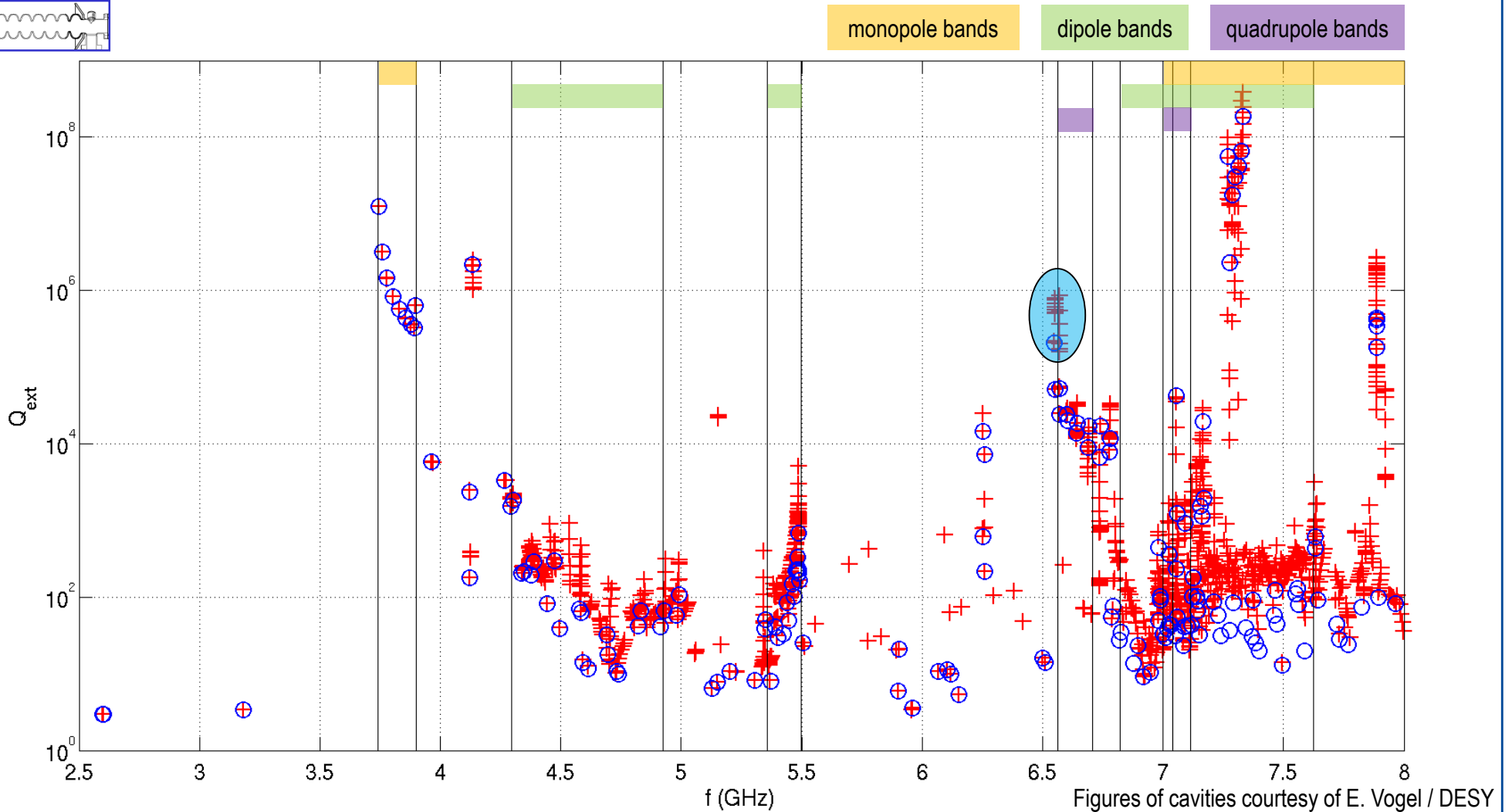
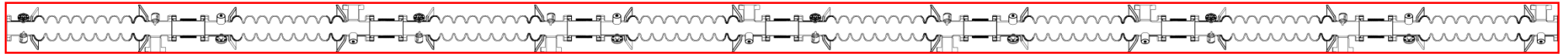


Bellow-Coupler-Endcell Modes at 6.2514 GHz



The plots show the absolute value of the electric field.

External Quality Factors in Chain of Eight 3rd Harmonic Cavities

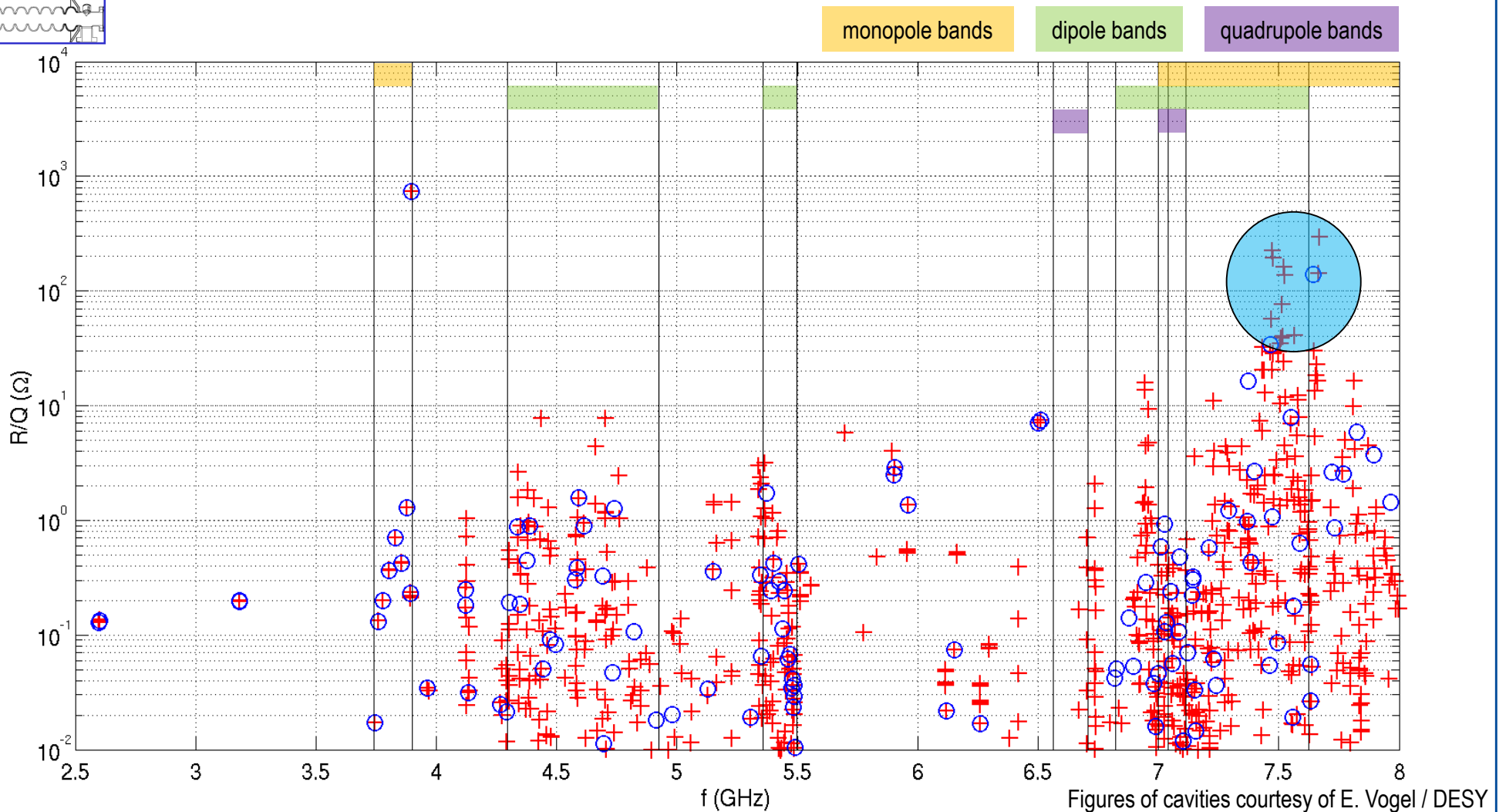
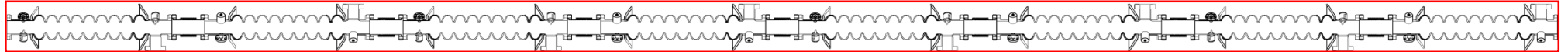


Quadrupole Modes at 6.5487 GHz

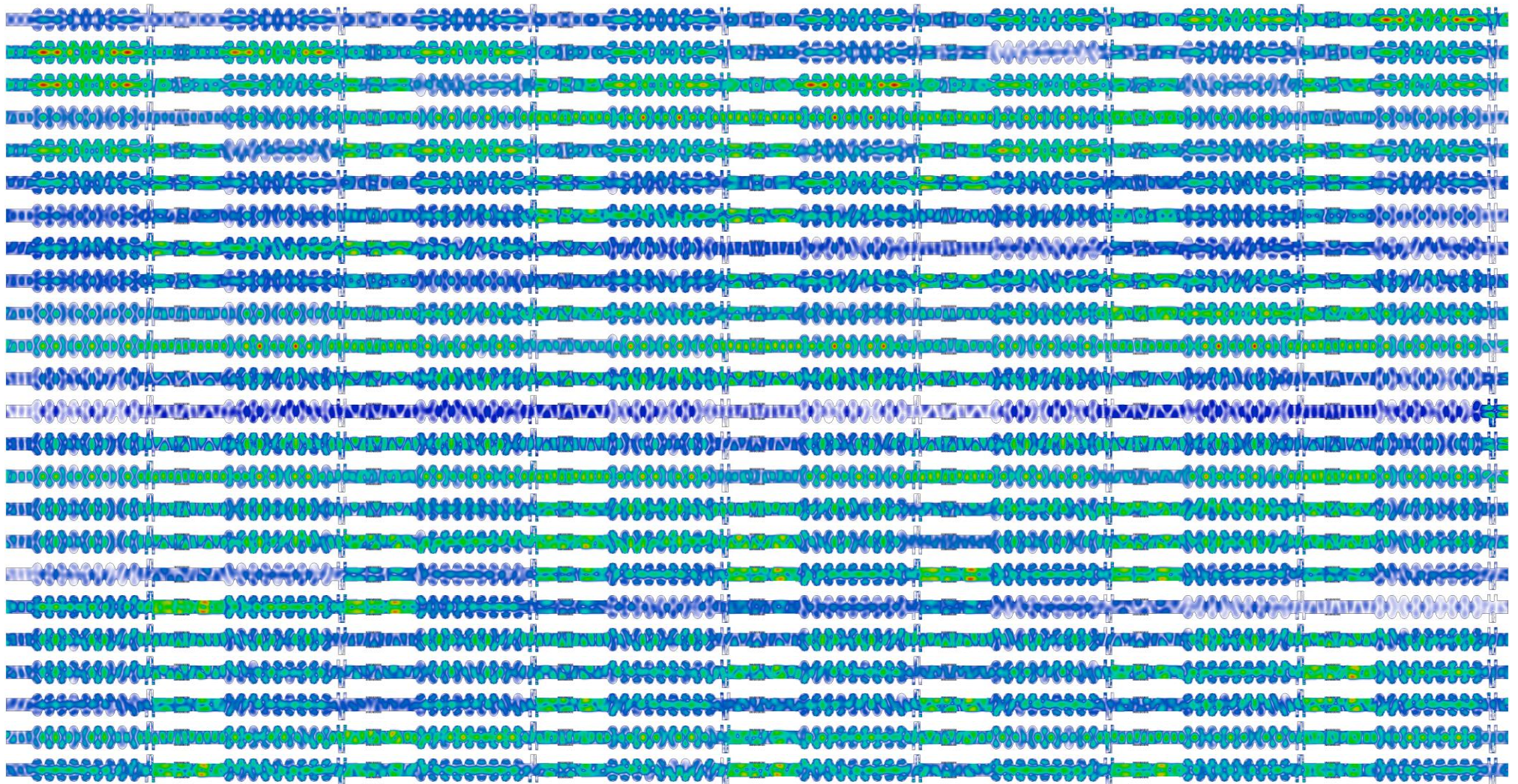


The plots show the absolute value of the electric field.

External Quality Factors in Chain of Eight 3rd Harmonic Cavities



Modes with a Large R/Q in the Vicinity of 7.5 GHz



The plots show the absolute value of the electric field.



Conclusions and Future Plans

Conclusions

- Example for solution of large scale problems without using high performance computers by a priori reducing the complexity of the field problem
- As far as the authors can determine, a complete eigenmode computation of such a complex structure on such a wide band has never been done before (?)
- Results show that not restricting on single cavities but considering the entire cavity chain gives a more complete description of the spectrum of the structure (multi-cavity modes, bellow modes etc.)
- Bands are more densely populated with eigenmodes in the chain of cavities
- R/Q and Q_{ext} have the tendency to be larger in the chain of cavities

Future Plans – Assembly of PRSTAB Paper

Compendium of Resonant Modes in the Chain of Third Harmonic TES for the European XFEL.

Thomas Flisgen,^{1,2} Johann Heller,³ Thomas Galk,⁴ Longsheng He,^{5,6,7} Steve Babel,⁸ Steffen Babel,⁹ Roger M. Jones,^{10,11} and Udo van Rienen¹

¹University of Rostock, Institute for Applied Electrodynamics, Albert-Ludwigs-Str. 2, D-18059 Rostock, Germany

²The Cockcroft Institute, Daresbury, Warrington, Cheshire WA4 2AD, United Kingdom

³School of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom

⁴Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, D-22607 Hamburg, Germany (E-mail: flisgen@desy.de)

I. INTRODUCTION

Linear sparsely doped (LSD) resonant undulating cells, and their necessary steering magnets to achieve a desired magnetic alignment, and their alignment, are used to accelerate or pre-bunch electrons in a FEL. Linear sparsely doped (LSD) resonant undulating cells, and their necessary steering magnets to achieve a desired magnetic alignment, and their alignment, are used to accelerate or pre-bunch electrons in a FEL. Linear sparsely doped (LSD) resonant undulating cells, and their necessary steering magnets to achieve a desired magnetic alignment, and their alignment, are used to accelerate or pre-bunch electrons in a FEL.

FIG. 1. (a) Chain of eight superconducting third harmonic cavities. Each cavity is equipped with an H-land side and a HOM coupler with a power coupler on the right hand side. Couplers of cavities are rotated by an angle of 180° along the longitudinal axis. Below are mounted in between the cavity-sets Magnification of the end rectangle in Figure 1(a), i.e. magnification of the first two cavities with rough HOM couplers are attached on the left hand side and HOM couplers with power couplers are mounted HOM couplers are based on the existing design (see Figure 1(a) in [1]). The length L_{cav} of the cavity with whereas the length of the below is HOM. Both figures (a) and (b) are modifications of Figure 4 in [2]

FIG. 2. Segments considered in the framework of this paper: (a) beampipe with HOM coupler and power coupler, (b) beampipe with HOM coupler and power coupler (90° rotated), (c) beampipe with HOM coupler, (d) beampipe with HOM coupler (90° rotated), (e) below, (f) single-cell third harmonic cavity, and (g) nine-cell third harmonic cavity. The segments (a) - (c) and (g) arise from the decomposition of the chain of cavities (refer to Figure) whereas the segment (f) is required for validation purposes (refer to Section V).

TABLE I

Segment	Length [m]	Frequency [GHz]	Q-factor
(a)	0.15	1.3	1000
(b)	0.15	1.3	1000
(c)	0.15	1.3	1000
(d)	0.15	1.3	1000
(e)	0.15	1.3	1000
(f)	0.15	1.3	1000
(g)	1.35	1.3	1000

Appendix A: List of Eigenmodes

IV. NUMERICAL APPROXIMATION

A. Decomposition of the Chain

Table with segments and their properties

B. Generation of Resonant Modes

V. VALIDATION

VI. RESULT

VII. SUMMARY

ACKNOWLEDGMENTS

The authors wish to thank H. Enckelmann for kindly providing the used Schwab ZNAS vector network measurements described above. Further W.-D. Müller and E. Vogel from DESY and T. Khachatryan from FNAL to the technical drawings of ACCU

FIG. 3. Segments considered in the framework of this paper: (a) beampipe with HOM coupler and power coupler, (b) beampipe with HOM coupler and power coupler (90° rotated), (c) beampipe with HOM coupler, (d) beampipe with HOM coupler (90° rotated), (e) below, (f) single-cell third harmonic cavity, and (g) nine-cell third harmonic cavity. The segments (a) - (c) and (g) arise from the decomposition of the chain of cavities (refer to Figure) whereas the segment (f) is required for validation purposes (refer to Section V).

TABLE I

Segment	Length [m]	Frequency [GHz]	Q-factor
(a)	0.15	1.3	1000
(b)	0.15	1.3	1000
(c)	0.15	1.3	1000
(d)	0.15	1.3	1000
(e)	0.15	1.3	1000
(f)	0.15	1.3	1000
(g)	1.35	1.3	1000

Appendix A: List of Eigenmodes

IV. NUMERICAL APPROXIMATION

A. Decomposition of the Chain

Table with segments and their properties

B. Generation of Resonant Modes

V. VALIDATION

VI. RESULT

VII. SUMMARY

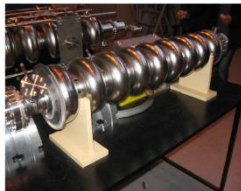
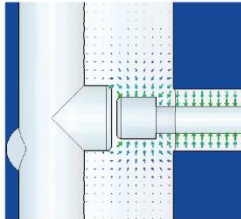
ACKNOWLEDGMENTS

The authors wish to thank H. Enckelmann for kindly providing the used Schwab ZNAS vector network measurements described above. Further W.-D. Müller and E. Vogel from DESY and T. Khachatryan from FNAL to the technical drawings of ACCU

International ICFA Mini-Workshop on

High Order Modes in SC Cavities

Rostock-Warnemünde (Germany) at the Baltic Sea coast | August 22 - 24, 2016



General Information and Objectives

The workshop High Order Modes in Superconducting Cavities 2016 (HOMSC16) will be held on August 22 - 24, 2016 in Rostock-Warnemünde at the Baltic Sea. The conference venue will be "Technologiezentrum Warnemünde". The object of the workshop is to bring together researchers studying high order mode suppression in superconducting cavities. The workshop will discuss the current status of both experimental and theoretical work. HOMSC16 follows HOMSC12 at the Cockcroft Institute and ASTeC, Daresbury, UK, and HOMSC14 at Fermilab, Batavia, USA.

Scientific Programme Committee (SPC)

Carsten Welsch / Cockcroft Institute
 Erk Jensen / CERN
 Georg Hoffstaetter / Cornell University
 Jacek Sekutowicz / SLAC
 Jean Delayen / Old Dominion University
 Jens Knobloch / Helmholtz Zentrum Berlin
 John Corlett / Lawrence Berkeley National Laboratory
 Matthias Liepe / Cornell University
 Nicoleta Baboi / DESY
 Nikolay Solyak / Fermilab
 Olivier Napoly / CEA Saclay
 Roger Jones / University of Manchester
 Ursula van Rienen (Chair) / Universität of Rostock
 Vyacheslav Yakovlev / Fermilab

Local Organising Committee (LOC)

Ursula van Rienen (Chair) / Universität of Rostock
 Thomas Flisgen / Universität of Rostock
 Dirk Hecht / Universität of Rostock

Further Information and Registration

Early Bird Deadline: 25/06/2016

<http://indico.cern.ch/event/465683>

For further information contact:
 Thomas Flisgen
 Universität Rostock, Institut für Allgemeine Elektrotechnik
 Albert-Einstein-Str. 2, 18059 Rostock, Germany
 Phone: +49 - 381 - 498 - 7044
 Email: thomas.flisgen@uni-rostock.de

