International Workshop on Higher Order Mode Diagnostics & Suppression in SC Cavities

COCKCROFT INSTITUTE, DARESBURY, UK 25 - 27 June 2012

Overview by Nicoleta Baboi,

Roger Jones, Jacek Sekutowicz and Pei Zhang

RFTech Workshop, Annecy, 26 March 2013

http://www.cockcroft.ac.uk/events/HOMSC12/index.html



IOP Institute of Physics

Workshop Overview

- Born from the collaboration within CEUCARD on HOM-BPMs in 3.9GHz Cavities at FLASH: DESY, Uni Manchester/Cockcroft Inst., Uni Rostock
- > HOMSC12 follows two previous workshops
 - HOM Measurements in SC Accelerating Cavities, DESY, Jan 2007
 - HOM Damping in SCRF Cavities, Cornell, Oct 2010
- > 58 participants registered: 26 UK, 14 Europe, 11 USA, 3 Asia



Nicholas Valles' & Jean Delayen's participation supported by RFTech

Topics covered at HOMSC12

- Various issues related to beam-excited wakefields in SC cavities were discussed
 - HOM absorbers, damping requirements, beam dynamics, simulations
 - Also HOM-based beam diagnostics (not all wakes are un-wanted)
 - in energy recovery linacs, light sources, linear colliders
 - at electron and proton accelerators
- (not only) HOMs! Also:
 - LOM = Lower Order Mode
 - SOM = Same Order Mode
 - Wakefields = Sum of (HOM + LOM + SOM)

HOMSC12 Workshop

≻HOM BPM diagnostics and measurement methods

>HOM couplers and influence of FP

couplers

>Novel HOM suppression in TEM and other cavity shapes

>Special considerations in third harmonic,

deflecting and crab cavities

>RF absorbing materials

>Antenna HOM absorbers

>Beam-pipe HOM absorbers

➤Waveguide HOM absorbers

>HOM simulation tools and models















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Scientific Programm

R.M. Jones N. Baboi S. Chattopadhyay J. Corlett J.R. Delayen G. Hoffstaetter J. Knobloch M. Liepe S. Molloy O. Napoly U. van Rienen J. Sekutowicz N.A. Solyak C.P. Welsch V.P. Yakovlev (Chair) (Cl/University of Manchester) (Doutsches Elektronen-Synchrotron) (Cockcroft Institute) (Lawrence Berksley National Laboratory) (Old Dominion University/Jefferson Lab) (Cornell University) (Helmholtz Zentrum Berlin) (Cornell University) (European Spallation Source/University of Lund) (CEA Sacley) (University of Roetock) (Dautsches Elektronen-Synchrotron) (Fermi National Accelerator Laboratory) (Cl/University of Liverpool) (Fermi National Accelerator Laboratory)

Local Organising Committe

- S. Buckley R. Carter R.M. Jones P. McIntoeh I. Neemiyan S. Waller
- (Chair) (CI/ASTeC) (Lancaster University) (CI/University of Manchester) (CI/ASTeC) (CI/University of Manchester) (CI/ASTeC)

Information and registration:

Early Registration Deadline: 14/5/2012

www.cockcroft.ac.uk/events/HOMSC12

For further Information please contact Sus Waller, Conference Administrator Cockcroft Institute, Dereabury Science and Innovation Campus, Keckwick Lane Dareabury, Warrington, Cheshire WA4 4AD, UK

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HOMSC12, ICFA Mini Workshop, Cockcroft Institute, 25th-27th June 2012

Agenda: Plenary Talks

Agenda Day 1 - 25/06/2012

0800 - 0830	Transport from Doubletree Hotel to Cockcroft Institute	0815 - 0900	Transpor
0830 - 0900	Registration	0900 - 0900	Plenary
0900 - 0910	Logistics and Introduction to the Workshop <u>Roger Jones</u> - University of Manchester/Cockcroft Inst. <u>mjones-intro-homsc12.pptx</u>	0900 - 0915	Diagnost Roger Jo
0910 - 0925	Welcome to Cockcroft Institute Swapan Chattopadhyay - Cockcroft Institute	0915 - 0940	A study o
0925 - 0940	Welcome to ASTeC Susan Smith - STFC Welcome to ASTeC		Pei Zhan
0940 - 0940	Plenary Session - Chaired by Vyacheslav Yakovlev	0940 - 1020	HOMs in
0940 - 1020	Higher Order Modes in the Project-X Linac Vyacheslav Yakovlev - Fermilab Higher Order Modes in the Project-X		HON Cavities
	Linac	1020 - 1040	Refresh
1020 - 1040	Refreshment break	1040 - 1120	Unwante
1040 - 1050	HOM Damping Requirements for the Cornell ERL <u>Matthias Liepe</u> - Cornell University <u>HOM Damping Requirements for</u> the Cornell SD	1120 1200	Graeme hom sum
1050 - 1120	HOM damping in the ERL main linac: Cavity design through first horizontal test Nicholas Valles - Cornell University	1120 - 1200	Peter Mo
	vallescerlmainlinac- developmentoptimization.pdf		
1120 - 1200	HOM Modes in Parallel-bar Deflecting /Crabbing Cavities Jean Delayen - Old Dominion University Higher-Order Modes in Parallel-Bar DC Cavity and High-Velocity Spoke	Invited a	

Cavities

Agenda Day 2 - 26/06/2012

0815 - 0900	Transport from Doubletree Hotel to Cockcroft Institute			
0900 - 0900	Plenary Session - Chaired by Ulla van Rienen			
0900 - 0915	Diagnostics based on HOMs in Superconducting Cavities at FLASH/XFEL <u>Roger Jones</u> - University of Manchester/Cockcroft Inst. <u>mihomsc12.pptx</u>			
0915 - 0940	A study of beam position diagnostics with HOM in the 3.9GHz cavities at FLASH <u>Pei Zhang</u> - The University of Manchester / DESY <u>pei-homsc12-2012-06-26.pptx</u>			
0940 - 1020	HOMs in the BNL ERL SC Five-cell Cavities Harald Hahn - BNL HOMs in the BNL ERL SC five-cell cavities			
1020 - 1040	Refreshment break & Group Photograph			
1040 - 1120	Unwanted Mode Damping in SRF Deflecting/Crabbing Cavities <u>Graeme Burt</u> - Lancaster University <u>homscburt.pptx</u> <u>summary-d.pptx</u>			
1120 - 1200	SRF Cryomodule Development for ERL Applications Peter McIntosh - STFC SRF Cryomodule Developmenet for FRL Applications			

Invited and contributed talks

Agenda: Plenary Talks (cont.)

Agenda Day 3 - 27/06/2012

Transport from Doubletree Hotel to Cockcroft Institute		
Plenary Session - Chaired by John Corlett		
Recent Experiences with XFEL-like Cryomodules		
Jacek Sekutowicz - DESY		
🔁 XFEL-like Cryomodules		
HOM Damping for the Next Generation Light Source		
John Byrd - LBNL		
Byrd NGLSHOMDampers		
Refreshment break		
Working Group A summary		
Jacek Sekutowicz - DESY		
Working Group A summary		
Working Group B&E summary		
Nicoleta Baboi - DESY		
Working Group B&E summary		
Working Group E summary		
Tom Powers - Jefferson Lab		
Working Group E summary		
Working Group C summary		
Matthias Liepe - Cornell University		
Working Group C summary		
Working Group D summary		
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Graeme Burt - Lancaster University		
Graeme Burt - Lancaster University Working Group D summary		
Graeme Burt - Lancaster University Summary Closeout		

RMJ Closing Remarks

Tutorials (during lunch):

1230 - 1250	Tutorial - The Use of HFSS for the Design and Analysis of HOM's in SCRF Accelerating Structures Ian Shinton <u>HFSS Tutorial</u>
1250 - 1310	Tutorial - The GdfidL Electromagnetic Fields Simulator Inna Nesmiyan - University of Manchester/Cl
1310 - 1330	Tutorial - The ACE3P Suite of high Performance Parallel EM Codes for the Design and Analysis of HOM's in SCRF Accelerating Structures Ian Shinton ACE3P Tutorial
1230 - 1300	Tutorial - Introduction to computations using the code VORPAL Jonathan Smith - Tech-X UK Ltd
1230 - 1300	Tutorial - Advanced computations using the code VORPAL Jonathan Smith - Tech-X UK Ltd

WG-A: HOM Damping Requirements on a Project Basis

A. Neumann	HZB	Cavity and HOM design for the BERLinPro ERL project
Ken Wanatabe	KEK	Development of the HOM coupler and the rf feedthrough for cERL injector at KEK
Ali Nassiri	ANL	Status of SiC-Based High-Power Waveguide Dampers R&D for the Short –Pulse X-Ray Project at the Advanced Photon Source
Philippe Kolb	Triumf	HOM considerations for the TRIUMF eLINAC
Lee Hammons	BNL	Development of SRF gun and HOM consideration at BNL
Nicoleta Baboi	DESY	HOM Damping Requirements at the European XFEL
Matthias Liepe	Cornell	HOM damping in the Cornell ERL SRF injector module: HOM measurements and high current beam operation
Rob Ainsworth	RHUL	HOM damping requirements and accelerating structure design for ESS

Summary of WG-A (web)

WG-C: RF Simulations and Beam Dynamics

- RF simulation codes used at Cornell University
 - Nicholas Valles Cornell University
- State space model to compute external quality factors of accelerating structures
 - Thomas Flisgen University of Rostock
- Simplified mathematical model for cavity-cavity coupling
 - Stephen Molloy ESS
- Studies of electron emission and multipacting in HOM couplers
 - Stephen Molloy ESS
- Status of the design and HOM calculations for the BERLinPro main linac cavity
 - Bernard Riemann Center for Synchrotron Radiation / TU Dortmund University
- Particle Trajectories in 4 Rod Crab Cavities
 - David Brett University of Manchester/Cockcroft

Summary of WG-C (web)

WG-D: HOM Damping Couplers and Loads

- Cornell HOM load Research and Development
 - Nicholas Valles Cornell University
- Demountable Damped Cavity using a Coaxial Line and Choke Filter
 - **Taro Konomi** Institute for Molecular Science
- > HOM damping schemes for the parallel-bar cavity
 - Jean Delayen Old Dominion University

Summary of WG-D (web)

WG-B: HOM-based Diagnostics (Joint with WG-E)

- Overview of HOM-based Diagnostics at FLASH and the European XFEL
 - Nicoleta Baboi DESY
- Techniques for the Measurement and Analysis of HOM Signals for Diagnostics
 - Stephen Molloy ESS
- HOM-BPMs and Phase Stability
 - Nathan Eddy Fermilab
- HOM BPM Study at KEK-STF
 - Ken Watanabe KEK
- Simulations in the 3rd Harmonic ACC39 FLASH Module Focussed on Diagnostic Applications
 - Ian Shinton

Summary of WG-B (web)

WG-E: Low-level RF, Controls and System Integration (joint with WG-B)

- LLRF System Requirements for SRF Driven Accelerators
 - Tom Powers Jefferson Lab
- Discussion Using electronic feedback for HOM suppression
- Discussion RF receiver technology needs for HOM diagnostics
 - John Byrd LBNL
- > Beneficial Presence of LLRF Experts for work on HOMBPM
 - Discussed the concept of using a frequency agile local oscillator so that the same hardware could be used as a phase and amplitude detector for HOMs
 - Discussed ways of dealing with 'bad' modes during operation

Summary of WG-E (web)

HOM Damping



Some Facilities Will Have NO HOM Damping!

Project-X

- At least the low-β cavities have no dampers planned
- But they will build in flanges, to add HOM-couplers later, if needed

> ESS

Fear of multi-pacting

But Damping is Planned for Crabbing/Deflecting Cavities



Simulations of Cavities with Misaligned Cells



In both cases the operating mode is tuned to correct frequency and field flatness.

Yakovlev, FNAL

Multi-Cavity Simulations



Shinton



Trapped 5th dipole band mode at 9.061GHz

Also cascading methods: e.g. GSM, CSC

Change in HOM Spectrum Observed at Fermilab

Detuned 1.3 GHz 9-cell ILC cavity by 90 kHz, then back

- \rightarrow HOMs moved by 100-500 Hz!
- Plan to use this in case of HOM is close to beam spectrum line at Project X and at ESS
- Changes in HOM spectrum also observed (after the workshop) in 3.9 GHz cavities at FLASH



Yakovlev, FNAL

Zhang

Nicoleta Baboi | Overview of HOMSC12 Workshop | RFTech Workshop, Annecy, France | 26 March 2013 | Page 17

More from the Workshop

- Student poster prize
 - Nicholas Valles



Runner up prize

Pei Zhang



- Proceedings to be published in NIMA
- Proposal to make a regular workshop, every two years or even yearly