Report on the Broadband Impedance Measurements and Modeling Workshop

SLAC

February 28 - March 2, 2000

John Corlett

LBNL

Workshop goals

- First, examine the accuracy of the impedance models by comparing calculations, bench measurements, and beam measurements for recently commissioned rings
- Second, discuss techniques of quantifying the impedance models that are relevant for estimating the instability thresholds but are still useful to compare to bench and beam measurements
- Finally, consider instability mechanisms and components of the impedance that may limit the performance of future storage rings as the vacuum chamber impedance is further reduced.

Agenda

Broadband Impedance Measurements and Modelling Workshop
Stanford Linear Accelerator Center **February 28 - March 2, 2000**

AGENDA Revision 1 (Feb 28)

Monday: Plenary Sessions: 9:00 AM - 12:00 - Orange Room			2.28.00
0800 - 0900	Registration – Orange Room	Robbin Nixon	
0900 - 0915	Introduction	M. Ross	
0915 -1000	**Single Bunch Instabilities**	**S. Heifets, SLAC**	
		1000 - 1030	Coffee Break
1030 - 1115	**Impedance Measurements & Models**	**B. Podobedov, BNL**	
1115 - 1145	**Parameters of Future Rings**	**J. Corlett, LBNL**	
1145 - 1200	Tentative Working Group Programs		
		1200 - 1300	Lunch
Monday: Working Group Sessions: 13:00 -16:00 - Orange Room- split in two			
1300 - 1600	Afternoon Working Group Sessions	1530 – 1600	Coffee
Tuesday: Working Group Sessions - Orange Room - split in two			2.29.00
0830 - 0900	Review of previous day & Schedules		
0900 - 1200	Morning working Group Sessions	1015 – 1045	Coffee
		1200 – 1300	Lunch
1330 – 1600	Afternoon Working Group Sessions	1445 – 1515	Coffee
1600 – 1700	**Broadband Impedance – Historical view**	**Guest Speaker - Bruno Zotter**	
18:00	*Banquet - Fanny and Alexander, 412 Emerson, Palo Alto*		
Wednesday: Working Group Sessions - Orange Room - split in two			3.1.00
0830 - 0900	Review of previous day & Schedules		
0900 - 1200	Morning working Group Sessions	1015 – 1045	Coffee
		1200 – 1300	Lunch
1330 – 1600	Afternoon Working Group Sessions	1445 – 1515	Coffee
1600 – 1700	**ALS Broadband Impedance**	**Guest Speaker – John Byrd, LBNL**	
Thursday: Summary Plenary Sesssion - Orange Room			3.2.00
0900 - 1100	Working Group Closeout		

Broadband Impedance Measurements and Modelling Workshop **February 28 - March 2, 2000**

Stanford Linear Accelerator Center

Name	E-Mail Address	Institution	Notes	Presentation(s)
Kwang-Je Kim	kwangje@aps.anl.gov	ANL		
Boris Podobedov	borisp@bnl.gov	BNL	*Plenary speaker*	'Impedance Measurements and Models'
Fritz Caspers	fritz.caspers@cern.ch	CERN	**Working Group Leader - Measurements and Calculations Comparisons**	
Albert Hofmann		CERN		
Bruno Zotter		CERN	*Guest speaker - Tuesday*	Historical perspective
Alexandre Novokhatski	novok@temf.tu-darmstadt.de	Darmstadt		Inductive Impedance and Saw Tooth Instability
R. Nagaoka	nagaoka@esrf.fr	ESRF		(1) Estimate of the impedance budget of the ESRF machine made at the design stage using TBCI. (2) Calculation of taper impedance of insertion device low gap chambers using NOVO and ABCI, and some comparison with analytical methods. (3) Use of a 3-dimensional code GdfidL for taper calculations, and comparison to 2-dimensional results. (4) Study of transverse collective effects and beam based impedance modelling at the ESRF.
L. Farvacque	farvacque@esrf.fr	ESRF		
K-Y Ng	ng@fnal.gov	FNAL		Compensation of space charge force
Fernando Sannibale	fernando.sannibale@lnf.infn.it	INFN Frascati		
Luigi Palumbo	lpalumbo@lnf.infn.it	INFN Frascati	**Working Group Leader - Instabilities**	
Fabio Marcellini	Fabio.Marcellini@lnf.infn.it	INFN Frascati		Longitudinal and transverse impedance measurements of the DAFNE injection kickers
Andrea Chigo	CHIGO@lnf.infn.it	INFN Frascati		
Nobuhiro Terunuma	terunuma@post.kek.jp	KEK		
John Byrd	JMByrd@lbl.gov	LBNL	*Guest speaker - Wednesday*	ALS broad band impedance
John Corlett	JNCorlett@lbl.gov	LBNL	*Organizing Committee/Plenary speaker*	'Parameters of Future Rings'
Glen Lambertson	GRLambertson@lbl.gov	LBNL		
Swapan Chattopadhyay	S_Chattopadhyay@lbl.gov	LBNL		
Derun Li	DLi@lbl.gov	LBNL		
Bob Rimmer	RARimmer@lbl.gob	LBNL		
Sam Heifets	heifets@slac.stanford.edu	SLAC	*Plenary speaker*	'Single Bunch Instabilities'
Gennady Stupakov	stupakov@slac.stanford.edu	SLAC		
Cho Ng	cho@slac.stanford.edu	SLAC		Numerical Calculations of NLC Damping Ring Impedance
Karl Bane	kbane@slac.stanford.edu	SLAC		Impedance estimates of the ATF Damping Ring; Impedance calculations for the SLC Damping Rings
John Seeman	seeman@slac.stanford.edu	SLAC		
John Sheppard	jcs@slac.stanford.edu	SLAC		
Robert Warnock	warnock@slac.stanford.edu	SLAC		A Simulation of the Bursting Mode in the SLAC Damping Rings by Solution of the Vlasov-Fokker-Planck Equation
Patrick Krejcik	pkr@slac.stanford.edu	SLAC		SLC Damping Ring bunch length instabilities
R. Keith Jobe	keith.jobe@slac.stanford.edu	SLAC		
James Sebek	sebek@slac.stanford.edu	SLAC		
Cecile Limborg	limborg@slac.stanford.edu	SLAC		Measurements at SPEAR
Heino Henke	henke@tu-berlin.de	TUB Berlin		
Mauro Migliorati	migliorati@axrma.uniroma1.it	U di Roma		
Heinz-Dieter Nuhn	nuhn@slac.stanford.edu	SLAC		Stimulated emission in the NLC Damping Ring Wigglers

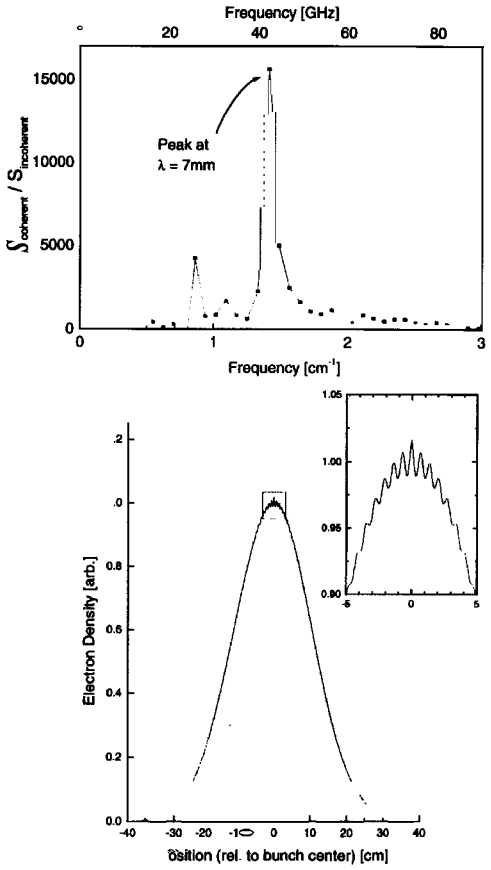
Observations summary

- Single-bunch instability behavior observed in many rings
  - Transverse and longitudinal
    - Quadrupole, sextupole, higher modes observed
      - SLAC SLC damping rings, NSLS VUV ring, APS, ESRF, ALS, etc...
    - Transient behavior seen in many rings
      - "sawtooth" instabilites
      - Coherent radiation bursts at NSLS
        - » 40 GHz radiation peak, 7 mm structure on beam

- Need further experimental study
  - High frequency signals generated by the beam
  - Detailed bunch structure measurements
  - Insert known impedance into a machine?

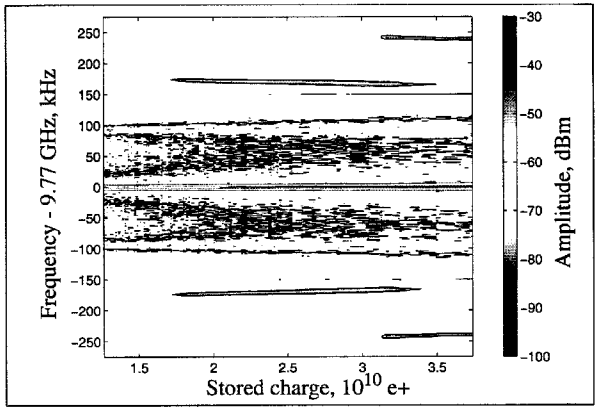
Observations summary

- NSLS (*J. Murphy*)

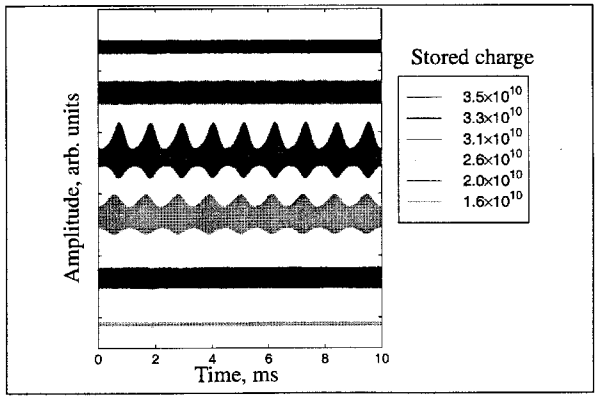


- SLC (*B. Podobedov*)

Spectrum Analyzer Data



Scope Traces for Different Stored Charge

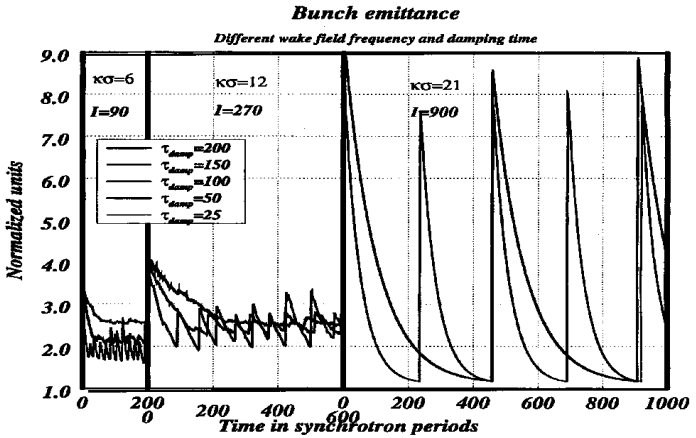


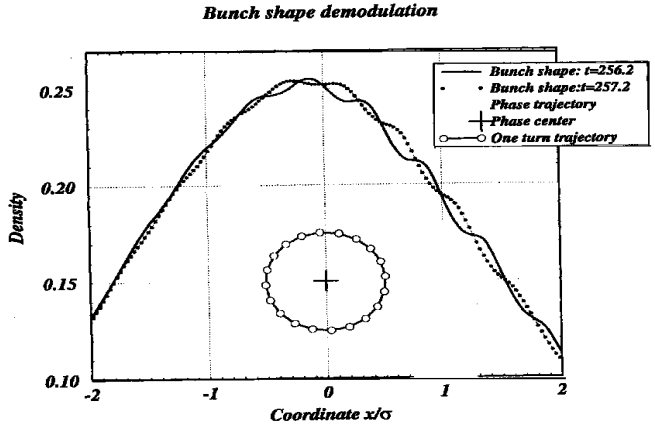
Simulations summary

- *Some* good agreement between calculated and observed behavior
  - Complex bunch distributions and dynamics
    - Use detailed impedance calculations
      - Use MAFIA / GDFIDL / ABCI / etc … generate wakes of all components and structures
    - Self-consistent single-bunch effects use Green's function
      - Need accurate modeling of high-frequency impedance otherwise termed "inductive"
- Transient or "sawtooth" behavior observed in some models
- No consistent well understood modeling
  - Need different simulation models to be compared, running identical problems

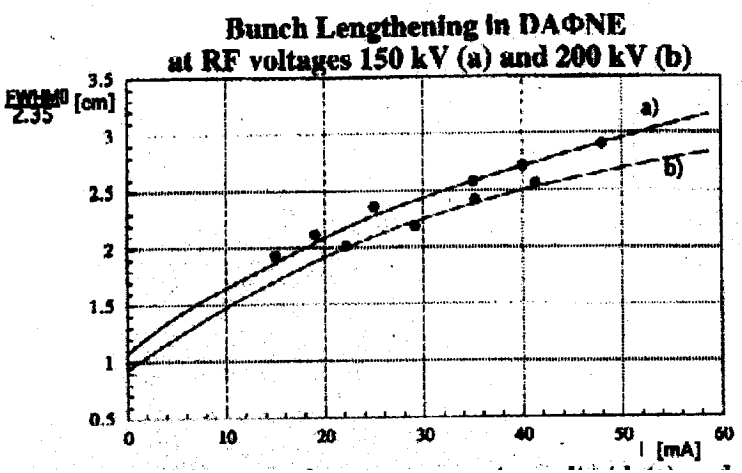
Simulation summary

- A. Novokhatski





- A. Ghigo



  - Good agreement with measurement

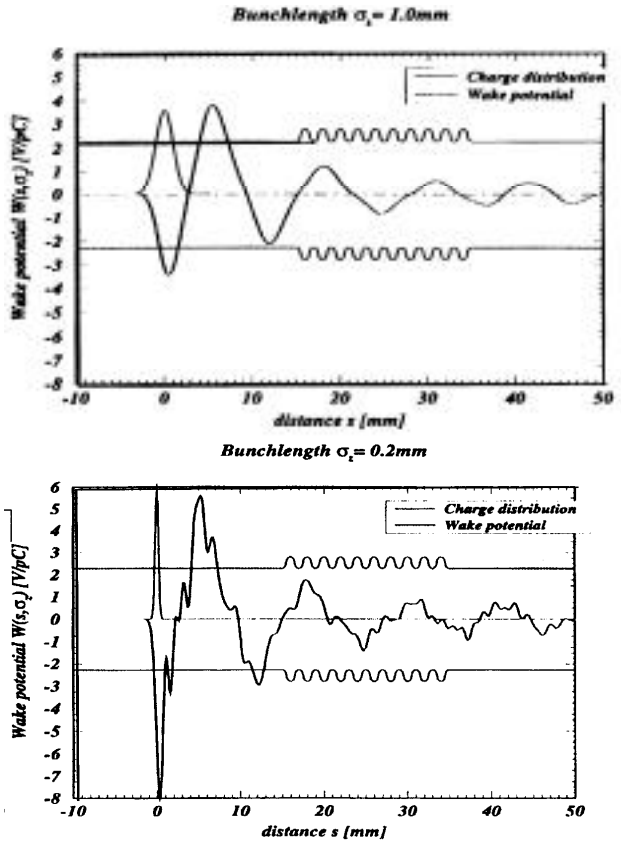
Impedance summary

- High-frequency impedance drives within-bunch motion
  - Coherent radiation? Small perturbations in vacuum chamber?
- Need detailed impedance model with high-frequency components
  - Small gaps, bellows, tapers, etc …
    - Dense meshes in computer models
- Measurements above 10 GHz become very difficult
  - Travelling waves
    - Need to develop techniques for measuring beam impedance well above cut-off

- Website
  - http://www-project.slac.stanford.edu/lc/wkshp/Impedance_Wrkshop.htm

Impedance summary

- A. Novokhatski



- C. Ng