



10th Anniversary of CWRF

Looking Back and to the Future



A. Nassiri on behalf of Organizing and Program Committees
June 29, 2018



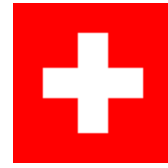
Workshop Goal

The goal of this workshop is to share the experience and ideas on applications which utilize high-power klystrons, gridded tubes, combined solid-state architectures, high-voltage power supplies, high-voltage modulators, high-power combiners, circulators, cavities, power couplers and tuners. New ideas on upgrading the high-power RF systems and novel ways of the RF power generation and distribution will also be discussed.

Venues



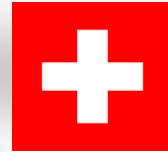
ANL – 2000, 2002, 2006



SLS-PSI - 2004



CERN -2008



Venues

ALBA - 2010



BNL - 2012



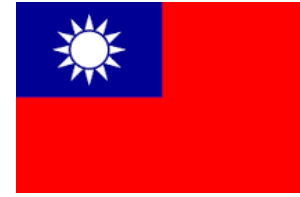
Elettra - 2014



Venues



ESRF - 2016

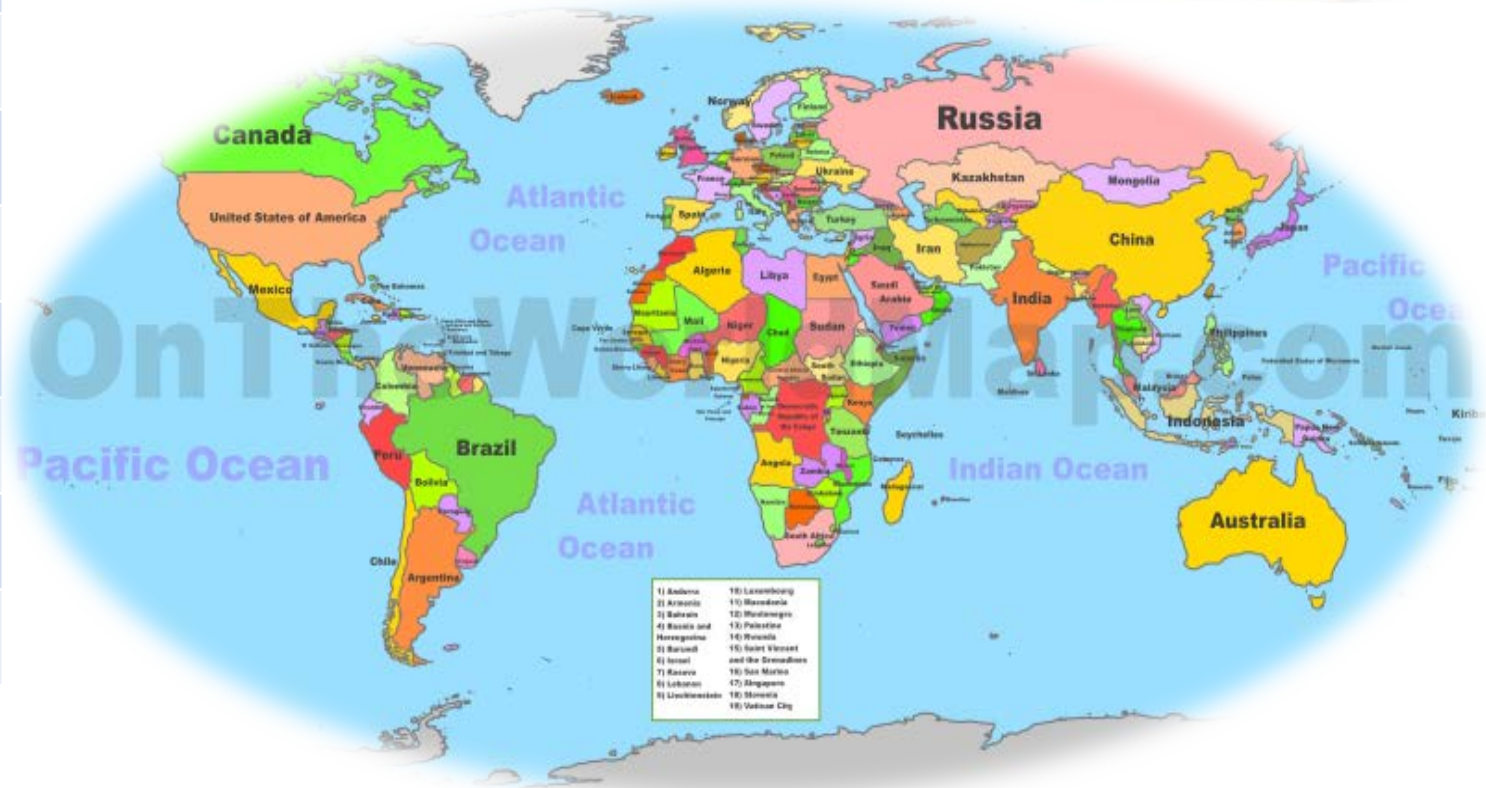


NSRRC - 2018



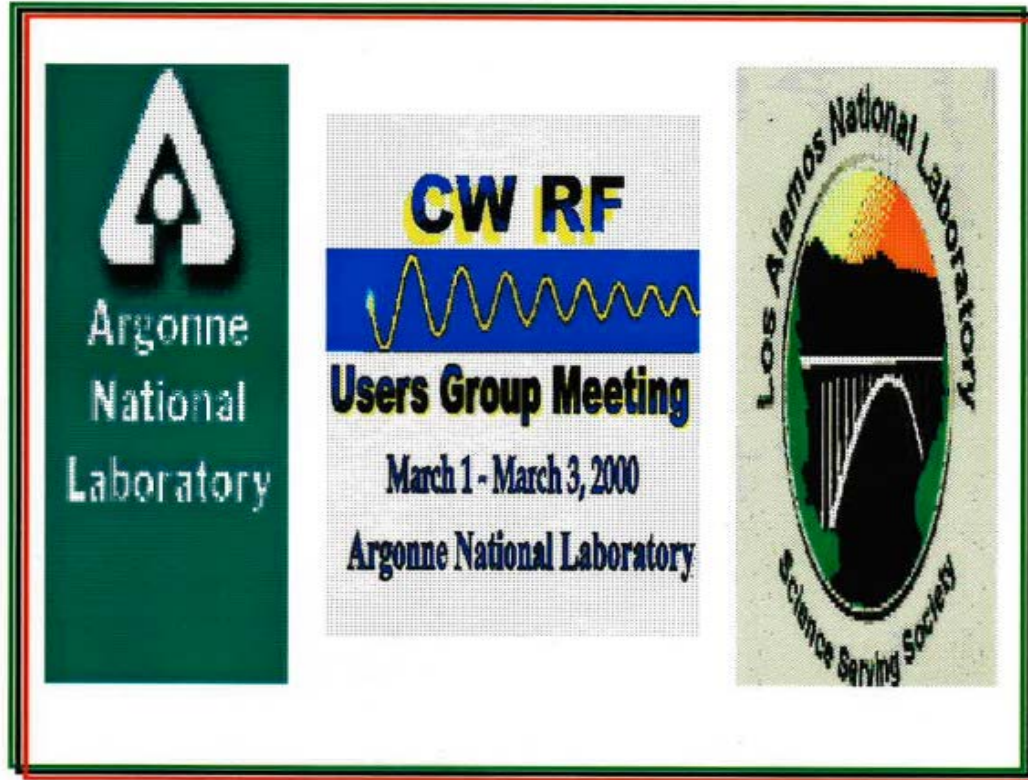
Highlights - Numbers speak for themselves

Year	Host	No. of Attendees
2000	ANL	20
2002	ANL	30
2004	PSI	35
2006	ANL	32
2008	CERN	60
2010	ALBA	64
2012	BNL	64
2014	Elettra	80
2016	ESRF	99
2018	NSRRC	86



Highlights - ANL, 2000 (Inaugural)

Welcome



1st Annual Meeting

Highlights - ANL, 2000 (Inaugural)

17 talks



CW RF
Users Group Meeting
March 1 - March 3, 2000
Argonne National Laboratory



CW RF
Users Group Meeting
March 1 - March 3, 2000
Argonne National Laboratory



CW RF
Users Group Meeting
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Argonne National Laboratory



PROGRAM

Wednesday, March 1, 2000

9 AM Welcome and Introduction -- Doug Horan - ANL

9:15 - 9:45 Conception of the 500 MHz RF Systems and Operational Experience at DESY-2, DORIS, PETRA-e and HERA-e Michael Ebert - DESY

9:45 - 10:15 10 Years of Operational Experiences with the LEP RF High-Power Systems -- Hans Frischholz - CERN

10:15 - 10:30 Break

10:30 - 11:00 Transmitter Operation at ESRF -- Christian David - ESRF

11:00 - 11:30 ESRF RF System Arc Detector Design and Operation
Jean Maurice Mercier - ESRF

11:30 - 12:00 Advanced Photon Source Klystron Operational History
Doug Horan - ANL

12:00 - 13:30 Lunch

13:30 - 14:00 Overview and Operation of the RF System for the LEDA Accelerator and Future Applications -- Mike Lynch - LANL

14:00 - 14:30 Cathode Follower RF System for High-Intensity Proton Synchrotr
Yoshiro Irie - KEK

14:30 - 14:45 Break

14:45 - 15:15 Operating Experience with Klystrons and Cavities
Jim Judkins - SLAC

PROGRAM - cont.

Thursday, March 2, 2000

9:00 - 9:30 Automatic Phasing of the Eight RF Systems at HERA-e
Michael Ebert - DESY

9:30 - 10:00 Low-level RF Experience with PEP-II
Paul Corredoura - SLAC

10:00 - 10:15 Break

10:15 - 10:45 Parallel Klystron Operation at APS -- Doug Horan - ANL

10:45 - 11:15 Klystron Collector Failure at LEDA, Symptoms and Cause
Dan Rees - LANL

12:00 - 13:30 Lunch

13:30 - 14:00 Reliability of the UVC DC Power Supplies -- Alex Cours - ANL

14:00 - 14:30 Initial Performance Challenges, Solutions and Reliability Results of the First Two Continental SSM IGBT Power Supplies
Joe Bradley - LANL

14:30 - 14:45 Break

14:45 - 15:15 +ACI - SPEAR 2/3 RF + ACI -- Sam Park - SLAC/SSRL

19:00 - No-Host Dinner

PROGRAM - cont.

Friday, March 3, 2000

9:00 - 9:30 High-Power Test Results for RF Components at 352 MHz and 700 MHz -- William Roybal - LANL

9:30 - 10:00 APS Storage-Ring Cavity Components -- Justin Jones - ANL

10:00 - 10:15 Break

10:15 - 11:00 Analog Gap Voltage Regulation System in the APS Storage-Ring
Doug Horan - ANL

12:00 - 13:30 Lunch

13:30 - 15:00 Tour of APS RF Systems

15:00 - Meeting Adjourned

Highlights - ANL, 2002

- Operating the PSI RF Systems at 1MW CW Beam Power -Peter Sigg, PSI
- SNS RF System Design - Dan Rees, LANL
- The Doris HOM-Coupler Story - Michael Ebert, DESY
- Performance of the APS 350MHz RF Systems - Doug Horan, ANL
- Measurement of Harmonics for LHC Klystrons - Daniel Valuch, CERN
- Operation of the RF at the ESRF - Jean Maurice Mercier, ESRF
- Fast RF Phase Shifter for High Power Application -Yoon Kang, SNS
- OPEN DISCUSSION - Methodology for RF System Personnel Safety Shutdown



Highlights - PSI, 2004

27 talks

- **Operating Experience with the SLS RF-Systems** - Marco Pedrozzi, PSI
- **ESRF RF System: Status and Developments** - Jorn Jacob, ESRF
- **The RF System of PETRA-III** - Michael Ebert, DESY
- **ELETTRA RF plants: Present Status and Upgrade to Higher Power** - Alessandro Fabris, ELETTRA
- **Spear3 RF System and Operation** - Sam Park, SLAC
- **High Power 352 MHz Solid State Amplifiers for the SOLEIL Synchrotron Light Source** - Ti Ruan, SOLEIL
- **Installation and Operation of IOTs for RF Separation in Jefferson Lab's Main Accelerator** - R. Nelson, JLAB
- **350MHz Fast Ferrite Tuner Testing at APS** - Doug Horan, ANL
- **352MHz High Power, Fast Ferrite Phase Shifter** - Daniel Valuch, CERN



Highlights - PSI, 2004



Highlights - PSI, 2004

DINNER AT HABSBURG CASTLE



Highlights - PSI, 2004

DINNER AT HABSBURG CASTLE



Highlights - ANL, 2006

FORTH CW AND HIGH AVERAGE POWER RF WORKSHOP Argonne National Laboratory			
AGENDA			
SUNDAY April 29th			
Reception	1830	Building 401 5th Floor	
Monday May 1st Building 360- Room A224			
830	Welcome and Introduction		
900	The Spallation Neutron Source Accumulator Ring RF System	T. Hardek	ORNL
940	Status of the SOLEIL RF Systems	C. Thomas Madec	SOLEIL
1010	Coffee Break		
1030	High Power Solid State Amplifier Developments at PSI	M. Gaspar	PSI
1110	RF Projects at Jefferson Lab	R. Nelson	JLAB
1150	The Installation and Commissioning of the IPNS Third Cavity	M. Middendorf	ANL
1230	Lunch		
1400	Status of the ESRF Radio Frequency System	J. Jacob	ESRF
1440	SPEAR RF Operation and Possible Changeover	S. Park	SLAC
1520	Coffee Break		
1540	Modern and Crowbarless DC Power Supply for CW Applications	W. Tron	PSI
1620	Performance Report on the 20kV/25A Anode Power Supply System Built for the KEK/ANL/ISIS Low Output Impedance Collaboration	D. Horan	ANL
Tuesday May 2nd Building 360-Room A224			
900	150 kW Power Plant for the Elettra RF Sustain Upgrade Project	A. Fabris	Trieste
940	TRIUMF Cyclotron 23 MHz RF System	Y. Bylinski	TRIUMF
1010	Coffee Break		
1030	Coaxial Switch, High Power Load and Higher Harmonic Absorber for PROSCAN	M. Schneider	PSI
1110	Development of TEM High Power RF Vector Modulators for Charged Particle Accelerator	Y. Kang	ORNL
1150	Power Test of a 325 MHz Hybrid for Fermilab Proton Driver	D. Sun	FNAL
1230	LUNCH		
1400			
1440			
1520	FREE AFTERNOON		
1540			
1620			
Wednesday May 3rd Building 360-Room A224			
900	Design and Applications of Polyphase Resonant Converter-Modulators	W. Reass	LANL
940	High Power RF Systems in the Fermilab Linac	A. Moretti	FNAL
1010	Coffee Break		
1030	LINAC Commissioning with the SNS HPRF Systems	M. McCarthy	ORNL
1110	Clean up and Bead Pull of the LANSCE Coupled Cavity Linac Module 6	K. Young	LANL
1150	The Partial Discharge Tests of the High-Voltage Cable and other Components at APS	A. Cours	ANL
1230	LUNCH		
1400	Experience with the Klystron Procurements and Testing for the SNS Accelerator	D. Ress	LANL
1440	352 MHz Test Stand at the Advanced Photon Source	D. Horan	ANL
1520	Coffee Break		
1540	Bunch-by-Bunch Feedback and NC HOM Damped Cavities for Current Increase at the ESRF	J. Jacob	ESRF
1620	APS Particle Accumulator Ring Upgrades in Supporting of Improvement in Bunch Purity and	A. Grelick	ANL
1900	Workshop Dinner	Five Seasons Country and Sports Club	
Thursday May 4th Building 360-Room A224			
900	Feasibility of Short Pulses at the ESRF	J. Jacob	ESRF
940	SC Deflecting Cavities for Short X-Ray Pulse Generation at the Advanced Photon Source	A. Nassiri	ANL
1010	Coffee Break		
1030	Open Dissusion and Closeout		
1200	LUNCH		
1330	Tour of APS RF Systems		



The 4th CW and High Average Power RF Workshop will be held at the Advanced Photon Source, Argonne National Laboratory April 17th -20th 2006.

The goal of this workshop is to share experience with synchrotron facilities and high average power linac rf systems including high-power klystron, high voltage power supply, power coupler and tuner and discuss new ideas for high power rf system upgrade.

Workshop Chair: D. Horan (ANL)

Workshop Co-Chair: D. Rees (LANL)

Scientific Program Committee

- M. Ebert (DESY)
- J. Jacob (ESRF)
- Y. Kang (ORNL)
- M. Middendorf (ANL)
- A. Nassiri (ANL) - Chair
- P. Sigg (PSI)



Local Organizing Committee

- R. Brzowski (Workshop Secretary)
- C. Eyberger (Chair)
- D. Horan
- K. Jaje
- M. Middendorf
- A. Nassiri

Workshop information is available at:

<http://www.aps.anl.gov/CWHARP06.html>



Argonne National Laboratory is managed by
The University of Chicago for the U.S. Department of Energy

Highlights - ANL, 2006



Fourth CW and High Average Power RF Workshop

Argonne National Laboratory

Argonne, Illinois, USA

May 1-4, 2006

Highlights - ANL, 2006

@Work



Highlights - ANL, 2006



Highlights - ANL, 2006

Dinner at 5 Seasons Country Club

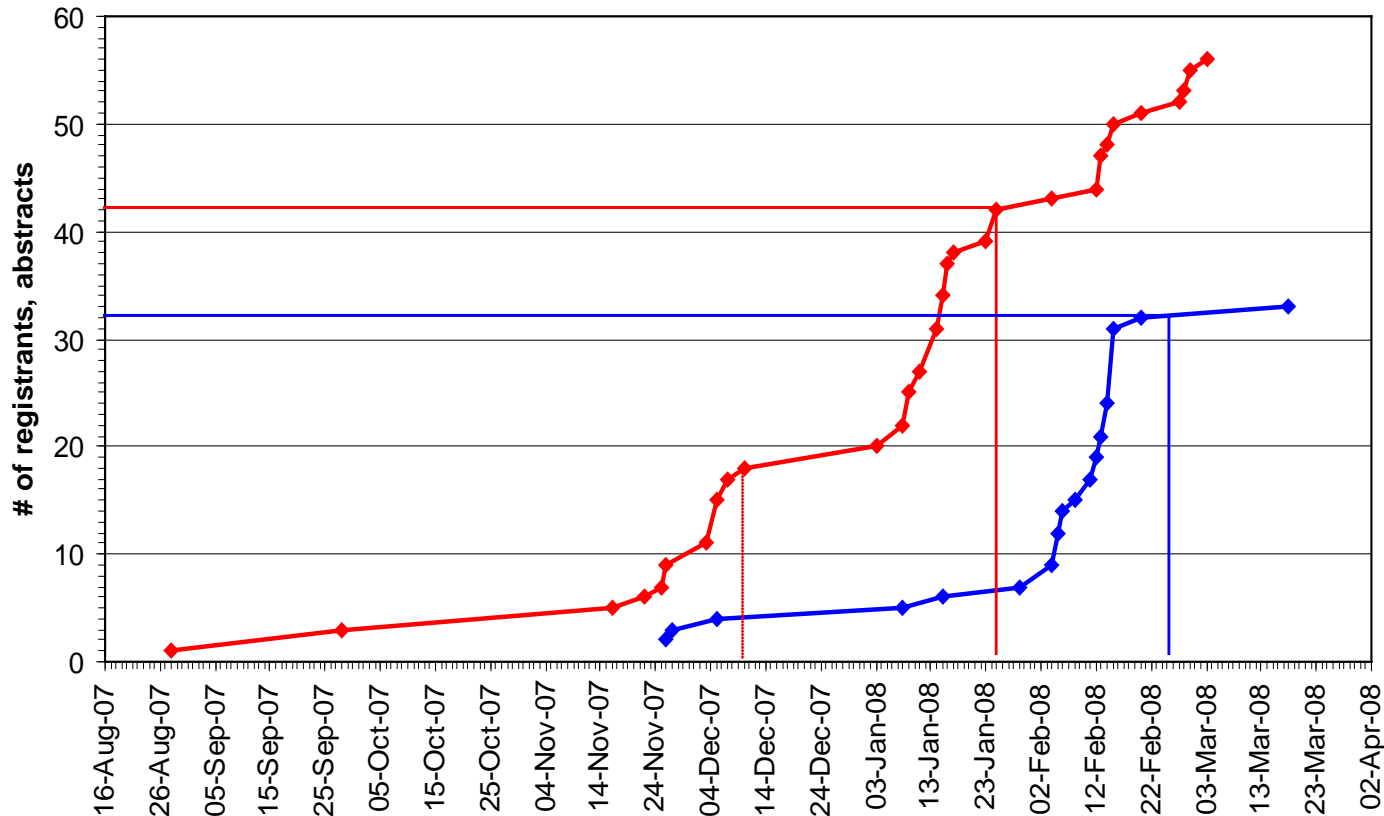


Highlights - ANL, 2006



Highlights - CERN, 2008

- To allow our US colleagues who can not participate personally to attend the workshop whole event will be transmitted by a video link to the Argonne National Laboratory near Chicago, US.



The predriver chain :
1 kW tetrode + 10 kW tetrode

2008 Fifth CW and High Average Power RF Workshop

The Fifth CW and High Average Power RF Workshop will be held at CERN, Geneva, Switzerland, March 25 - 28, 2008. The goal of this workshop is to share experiences among designers and users of CW and high average power RF systems that utilize high-power klystrons, gridded tubes, combined solid-state architectures, high-voltage power supplies, high-voltage modulators, power couplers and tuners. New ideas for high-power RF system upgrades and novel ways of RF power generation and distribution will also be discussed.

Workshop Committees
 Workshop Chair: Daniel Valuch (CERN)
 Workshop Co-Chair: Doug Moran (ANL)
Executive Program Committee
 Ali Haddad (ANL), Chair
 Erik Jensen (CERN), Co-Chair
 Oliver Brunner (CERN)
 Hansruedi Fierz (PS)
 Jörn Jacob (BEP)
 Yoon-Kang Shin (OAS)
 Jim Ross (ANL)
Organizing Committee
 Daniel Valuch (CERN)
 Sam Park (SLAC)
 Dan Pines (ANL)
 Doug Moran (ANL)
 Annette Cobos (CERN, workshop secretary)

CWRF2008
 25 - 28 March 2008
 CERN, Geneva, Switzerland
 Workshop on High Power RF
<http://www.cern.ch/CWRF08>

Highlights - CERN, 2008

Workshop Summary

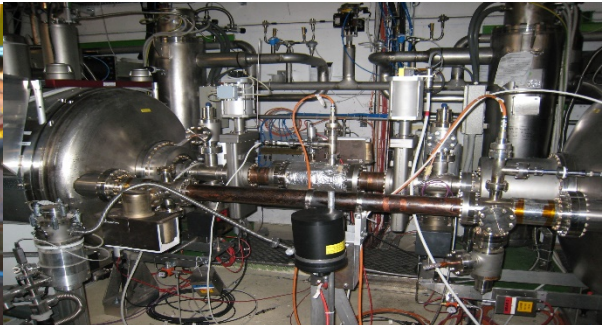
- It seems the era of monster multi-megawatt CW klystrons for large next generation accelerators is over. There are only few customers left
- Demands for high power pulsed klystrons for e.g. medical applications and new linacs are rising
- Many new light sources are being built around the world. More than single high power station many $\sim 100\text{kW}$ stations are required. But... “clean” RF power
- New devices like IOTs, diacrodes or solid state devices can do the job
- The solid state segment is rising. More and more labs are working on high power ($\sim 100\text{kW}$) amplifiers
- We do not yet have enough experience with solid state amps. ~ 5000 hours running time of one amplifier is not sufficient to compare with the tube technology.

Will be a very good subject for the 2010 meeting as more operation hours and experience will be available.

Highlights - CERN, 2008



Underground Tour of Accelerator/RF



Highlights - CERN, 2008



Highlights - CERN, 2008



Highlights - CERN, 2008

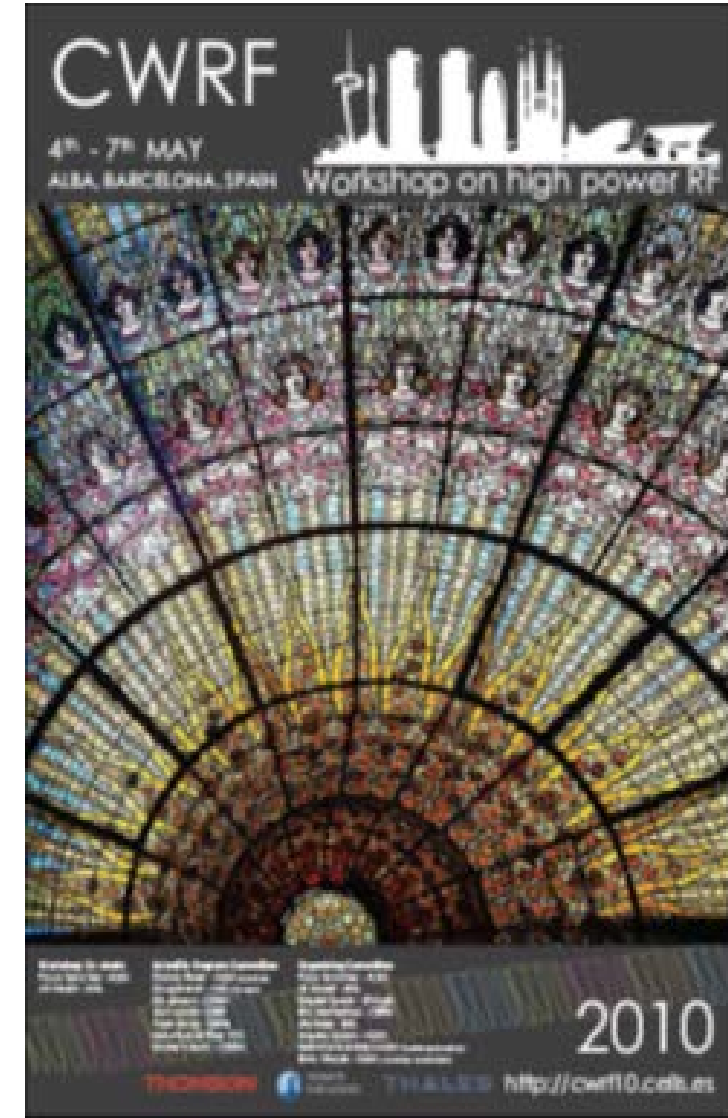


Highlights - ALBA, 2010

Hot topic – IOT vs. Klystron vs. Solid State – Paco Sanchez

Output Power, Efficiency and Gain:

<u>Klystron</u>	<u>IOT</u>	<u>SSA</u>	
60 - 1000 kW	80 kW	700 W	180 kW
62 %	71 %	70 %	60 %
40 dB	25 dB	20 dB	53 dB
		(module)	(Tower)



Highlights - ALBA, 2010

Hot topic – IOT vs. Klystron vs. Solid State – Paco Sanchez

Purchase Cost in kEuro/ kW:

<u>Klystron</u> 400 MHz / 250 kW	→ ~ <u>230 k€</u>	→ ~ 0.9 k€/ kW
<u>IOTs</u> 500 MHz / 80 kW	→ ~ <u>50 - 70 k€</u>	→ ~ 0.6 - 0.9 k€/ kW
* <u>SSA</u> 352 MHz / 200 kW	→ ~ <u>740 k€</u>	→ ~ 3.7 k€/ kW (300W) ~ 2.8 k€/ kW (700W)

***N.B:** SSA from SOLEIL data (4 “towers” of 200 kW). The complete transmitter includes transformer + HV rectifier + control system, ...), but SOLEIL manpower is not included. All components were built in the industry according to the SOLEIL specifications)

Highlights - ALBA, 2010



Highlights - BNL 2012



Highlights - BNL 2012

Atlantis Aquarium

Shark Dive

- 10 + volunteers have signed up for the shark swim- they have shark logos on their name tags to identify them- greet them during the breaks
- We will chose 2 of these brave souls to swim with the sharks after the Banquet (their last meal?)
- There is a sign up sheet for those who wish to add their name to the list of volunteers- it is not too late!
- We will vote for the two swimmers during this afternoon's coffee break: Put an X next to two of the volunteers names and those with the most votes will swim!

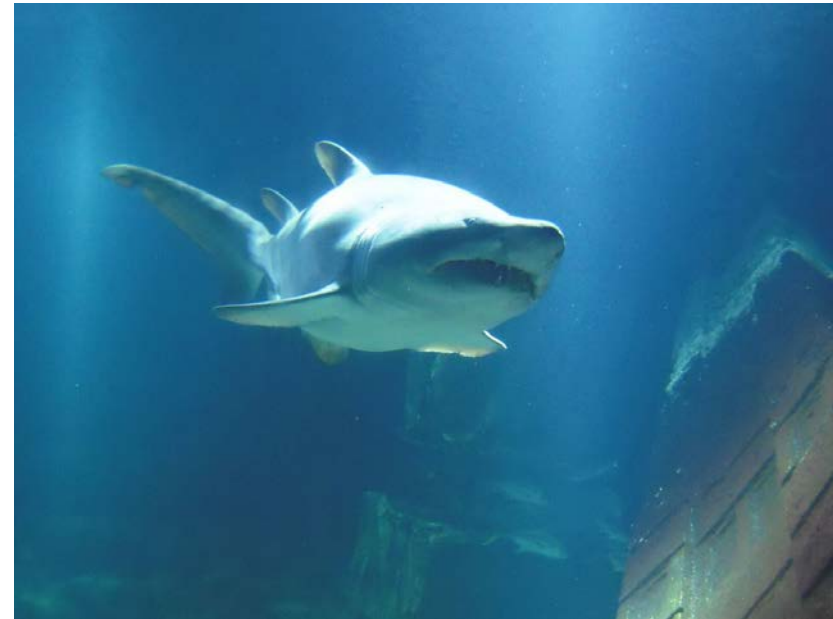
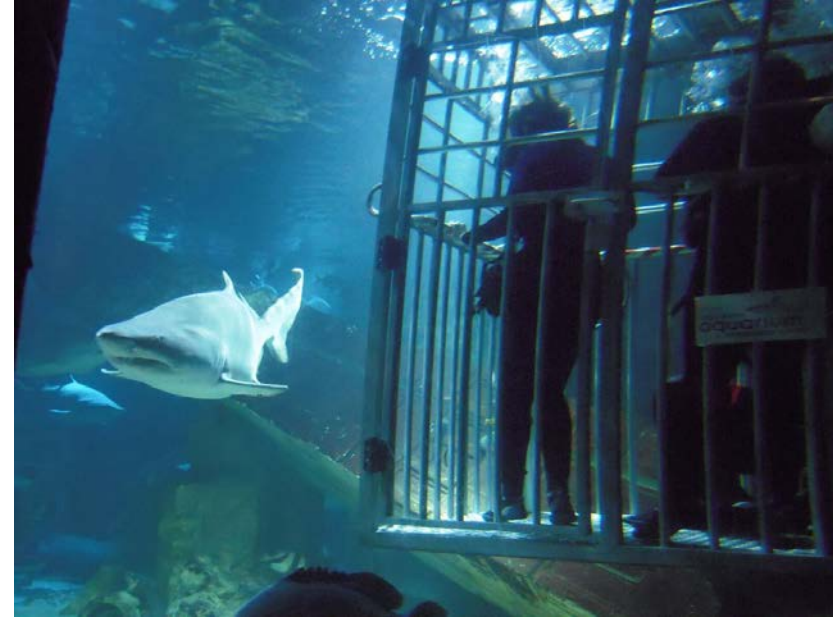
May 7th - 11th
CWRF2012
WORKSHOP ON HIGH POWER RF
<http://bnl.gov/CWRF2012>

Workshop Co-chairs	Scientific Committee	Organizing Committee
Jim Rose Ali Nassiri	Daniel Valuch (CEFN) Jorn Jacob (ESRF) Doug Horan (APS) Patrick Marchand (SOLEIL) Eric Montesinos (CEFN) Ken Baptiste (ALS) Rick Nelson (JLAB) Hans-Rudolf Fitze (PSI) Young Kang (ORNL)	Jim Rose (BNL) Ali Nassiri (APS) Francis Perez (ALBA) Morten Jenson (Diamond) Erik Jensen (CEFN) Shigeki Sasaki (SPRING) Paula Callejas-Lynn (BNL)

DANFORDS
HOTEL & MARINA
Port Jefferson, NY
hosted by
BROOKHAVEN
NATIONAL LABORATORY

Congratulations to our shark divers Rocio Santiago-Kern and Mark Middendorf

Highlights - BNL 2012



Highlights - BNL 2012

IOT Hot Topic Summary

Availability/Obsolescence time of IOT's

Not much said about the topic. Slow rate of development was evident

Capital and Operational costs

Technical Considerations (power, reliability, footprint, ops and maintenance

Although acknowledged there was not a good discussion about the arcing problem in IOT's causing constant trips. It was my impression that these arcs were more common than in klystrons- is this a limiting factor in ultra-high reliability?

1) Linear in power with lots of headroom great for feedback systems seems to be a strong point for IOT's

Long term trends in cost, power per device

Development costs are high- vendors burned in development of 1.3GHz 13kW tubes- not likely to pony up \$ or euros again

Estimate given of ~1M\$ per year for 3 years to develop ~500kW IOT for ESS

Highlights - Elettra 2014



CWRP 2014
May 13-16, 2014
Hotel NH - Trieste, Italy

Continuous Wave and High Average Power RF Workshop

Contact: cwrp2014-loc@elettra.eu
www.elettra.eu/Conferences/2014-CWRP/

SCIENTIFIC PROGRAM COMMITTEE	INTERNATIONAL ORGANIZING COMMITTEE	LOCAL ORGANIZING COMMITTEE
Dong Hwang - SPC Chair (ANK)	Alessandro Fabris - Workshop Chair (Elettra Sincrotrone Trieste)	Alessandro Fabris - Workshop Chair
Daniel Valuch - SPC co-Chair (CEA)	Alexia Nassiri - Workshop co-Chair (ANK)	Mariella Atteneh
Kenneth Baynath (LBNL)	Erik Jensen (CEBN)	Sofiane Desari
Hans-Rudolf Fieser (PSI)	Morten Jonsson (ESS)	Paolo Delgado
Hiro Jacob (SRF)	Francois Peres (ALBA - CEIIS)	Claudio Serpico
Yuan Kang (ORNL)	James Ross (BNL)	
Patrick Marchand (Synchrotron SOLEIL)	Shigeki Suzuki (SPRING-8)	
Eric Montanari (CEBN)		
Richard Nelson (SLAC)		

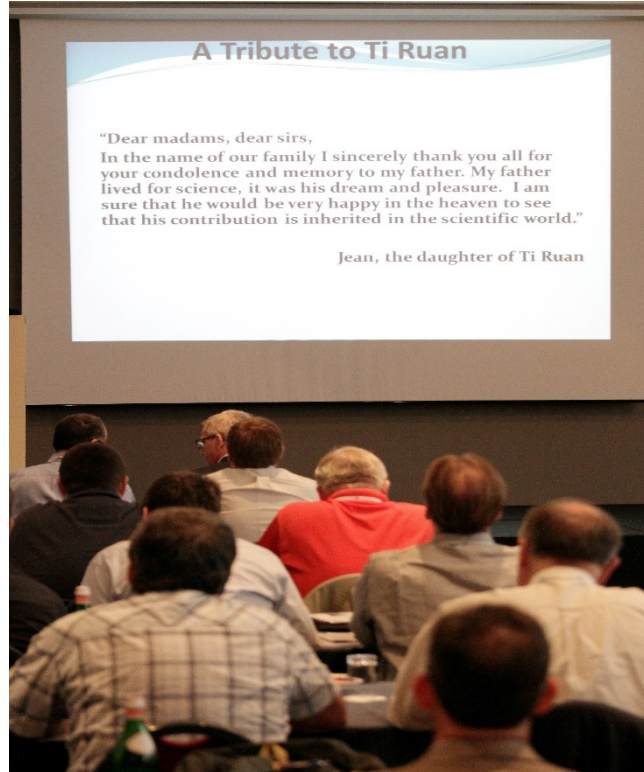


Elettra Sincrotrone Trieste

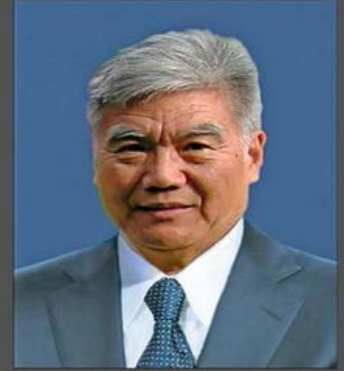


Highlights - Elettra 2014

Robert Lopes' tribute to Ti Ruan



Do not forget who was THE pioneer in the domain of high power solid state RF amplifiers



Ti RUAN, 1936 - 2014



SOLEIL R&D with 352 MHz SSPA's

Development of new RF modules, based on 6th generation LDMOS ($V_d = 50V$)

→ $P_{mod} \sim 700 W$, $G \sim 20 dB$, $\eta > 70\%$ at 352 MHz

[With original LR301 (28V), $P_{mod} = 315 W$, $G = 13 dB$, $\eta = 62\%$ @ 352 MHz]

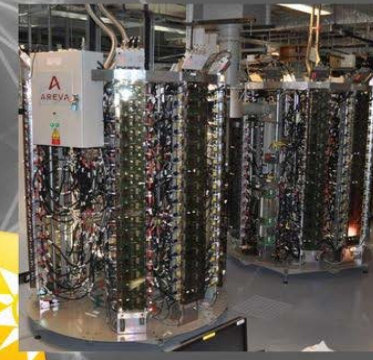
→ **Huge improvement** : $P_{mod} \times 2.2$, better performance (G , η , linearity) & thermal stress strongly reduced (ΔT : - 60 °C) → longer lifetime



ESRF upgrade → Replace 1 MW klystrons by 150 kW SSPA's (1 per cavity)

→ 2009, SOLEIL transfer of technology with ELTA-AREVA

→ 7 SSPA's of 150 kW, built by ELTA under SOLEIL license



BO : 4 x 150 kW SSPA's in use since January 2012
2 trips in ~ 5 years of operation → refill postponed

SR : 3 x 150 kW SSPA's in use since October 2013
2 trips in ~ 3 years of operation → beam loss

Trips, due to youth problems, which are now fixed

BO + SR : ~ 1 800 transistors → not a single failure !

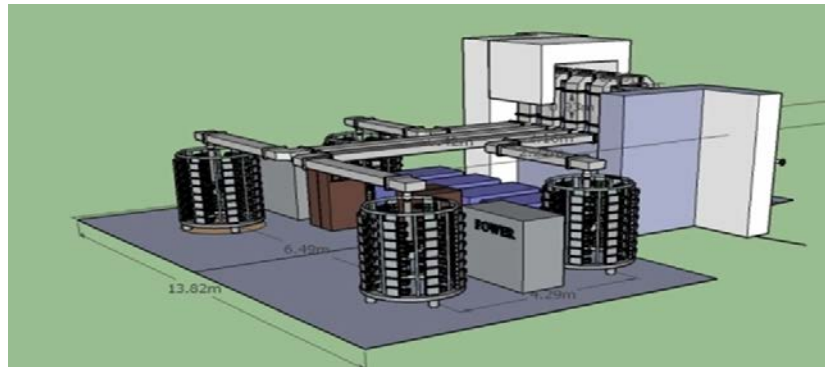
Efficiency (dc to RF) : 58% (dc-dc converters)
With new ac-dc converters → η (overall ac to RF) > 60%

ESRF 150 kW 352 MHz SSPA from ELTA/SOLEIL

Highlights - Elettra 2014

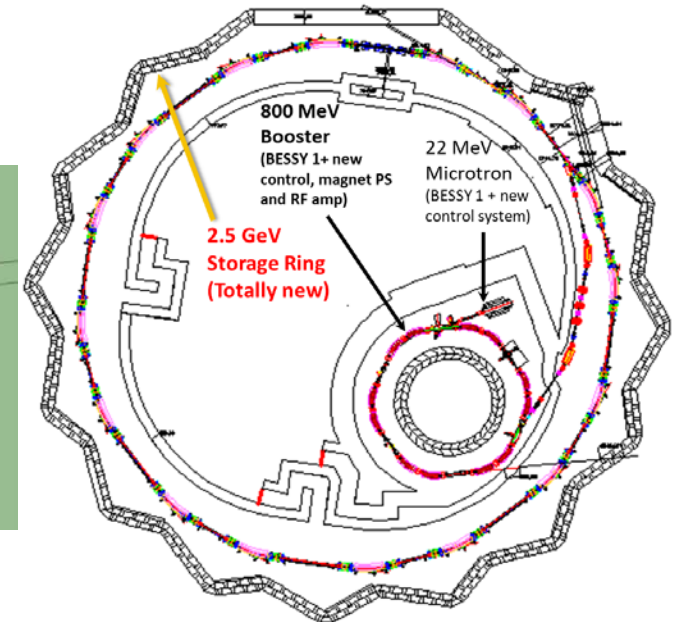
Jim Rose – BNL

- Early commissioning results of the NSLS-II high power rf systems
 - SR commissioning started Feb. 2014 using PETRA cavity
 - Beam current limited to 25 mA (no active beam interlocks)
 - Single and coupled bunch instabilities seen, not limiting progress
 - Booster RF system tested to 90 kW, ramps from 600 W to 60kW at 1 Hz. Petra cavity temperature adjustable +/- 5°C to move HOM's -not required yet..
 - System has been very reliable-No problems with Thomson Comark/Ampegon) transmitter, L3 IOT, Ferrite Inc. circulator, AFT loads



Nashat Sawai– SESAME (Jordan)

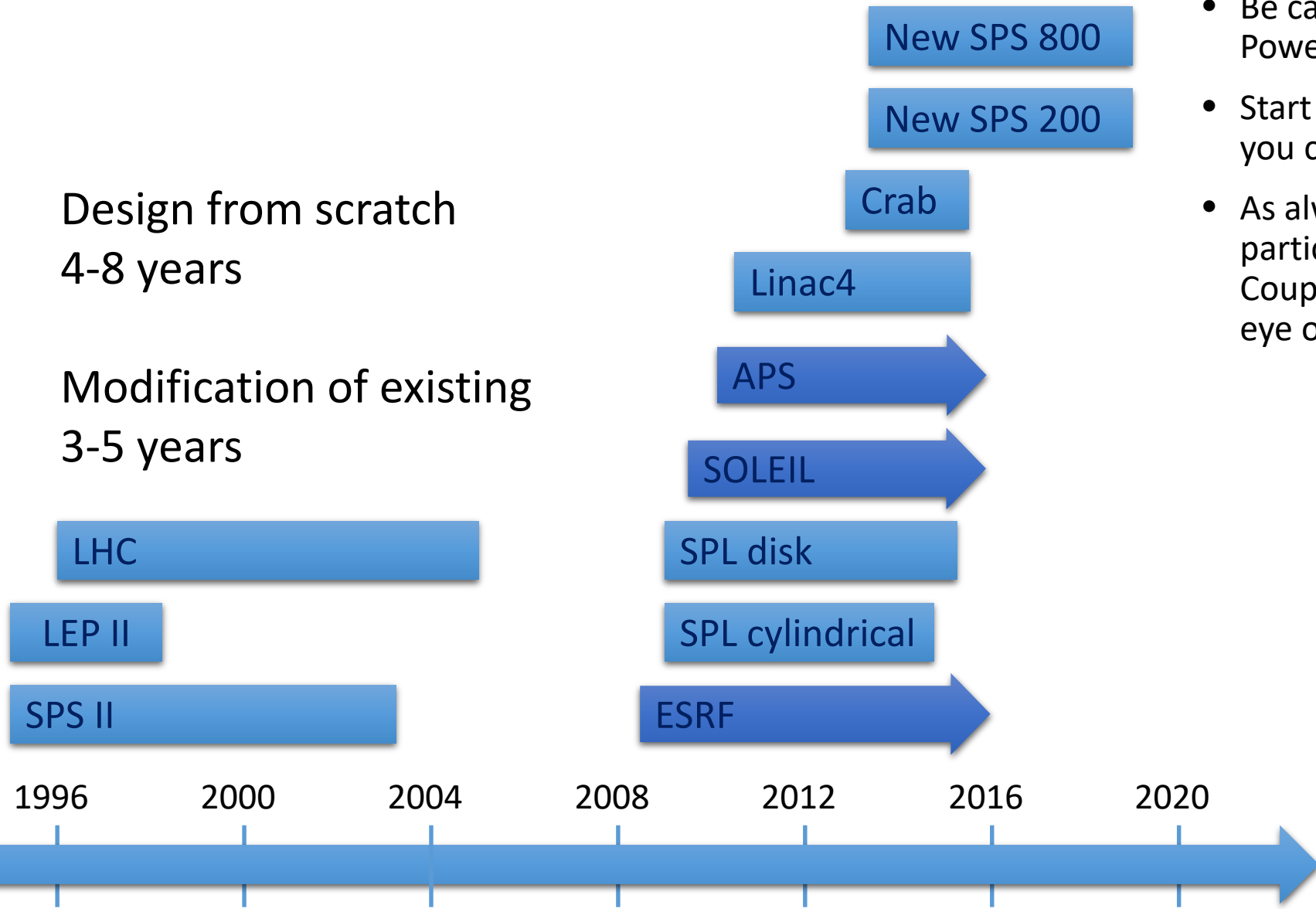
- A 2.5 GeV synchrotron radiation facility, under construction near Amman, Jordan.
- The members are Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority and Turkey.
- Observers: Brazil, China, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Sweden, Switzerland, UK and USA.
- 500 MHz 80 kW SSA (x 4)



Highlights - Elettra 2014

Eric Montesinos – CERN

20 years of high average fundamental power coupler designs at CER



Conclusion

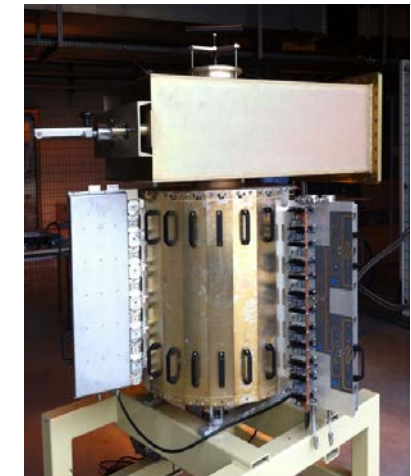
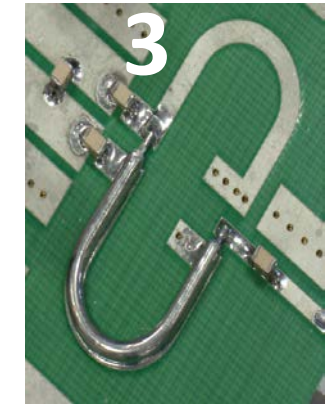
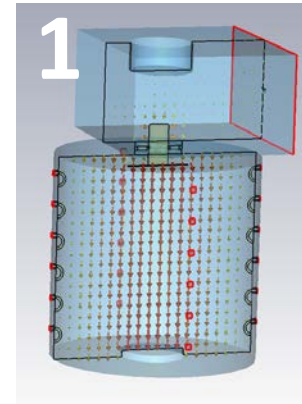
- Be careful of the lifetime of Fundamental Power Couplers !
- Start the next design as soon as possible (as you complete one)
- As always, the Devil is in details, that is particularly true with Fundamental Power Couplers, so do not forget to keep a careful eye on everything !

Highlights - Elettra 2014

Michel Langlois - ESRF

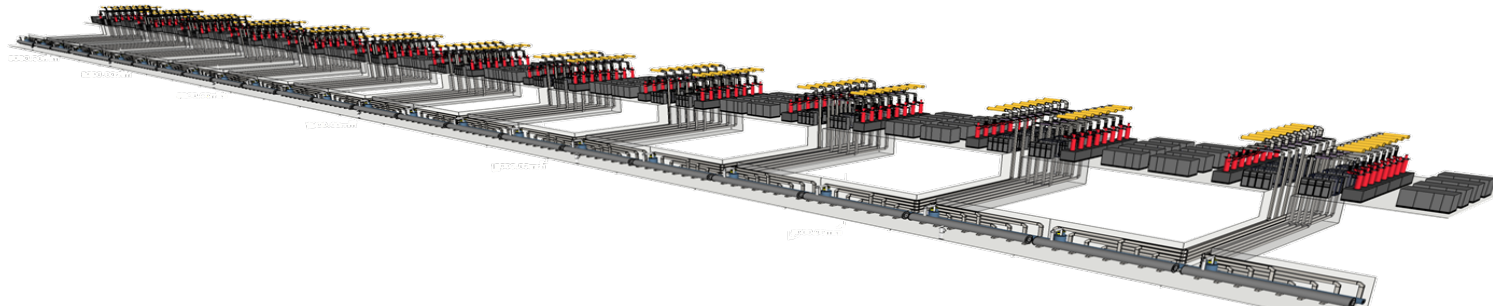
SSA using a cavity combiner

- 5 ideas could make it happen
 - Make use of a cavity combiner to provide compactness
 - Use of-the-shelf power supplies
 - RF modules feature planar baluns, no chock and no trimming
 - RF and DC distribution use the same support as the rf modules
 - The modules are not individually shielded



Morten Jensen – ESS

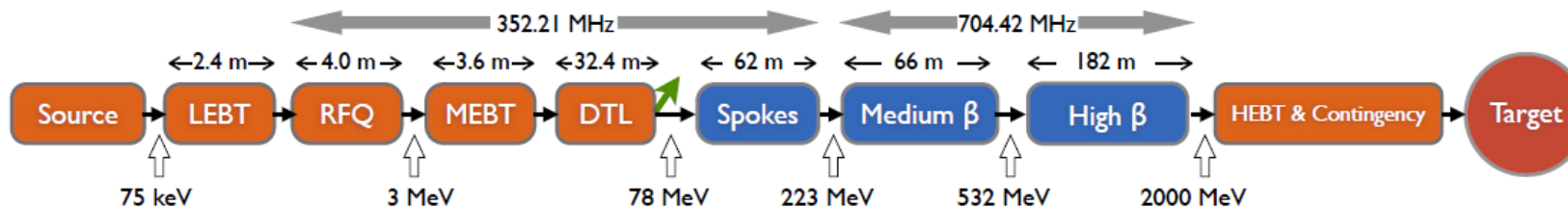
The ESS RF systems and the plan for new developments



26 Spoke Cavities
352 MHz
2*200 kW Tetrodes
(Alternative under consideration)

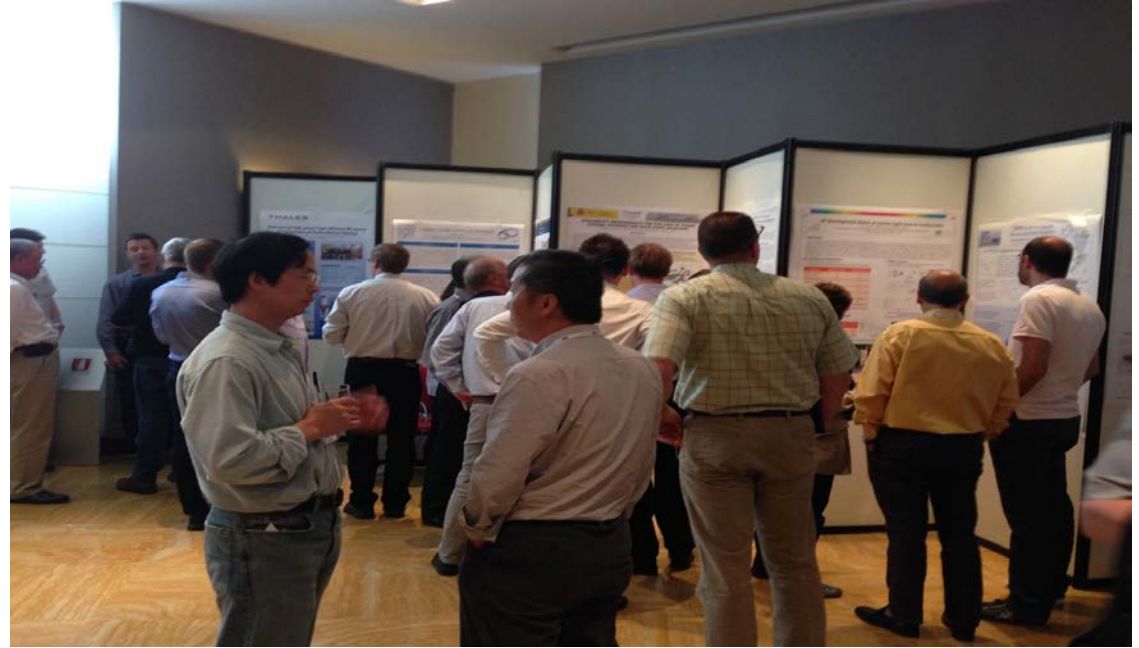
36 Medium Beta
704 MHz (6 cell)
1.5 MW Klystrons
Power splitting under consideration

84 High Beta
704 MHz (5 cell)
1.2 MW IOT
1.5 MW Klystron as backup



Highlights - Elettra 2014





Highlights - ESRF 2016

Erk Jensen – CERN

Recent developments towards very high efficiency klystrons

Motivation

- Future large scale accelerators
 - FCC – CW 800 MHz, 110 MW
 - ILC, pulsed, 1.3 GHz, 88 MW
 - CLIC, pulsed, 1.0 GHz 180 MW
- Combination of three methods promises a significant increase in klystron efficiency (approaching 90%)
 - Congregated bunch
 - Bunch core oscillations
 - BAC (**B**unch, **A**lign velocities, **C**ollect outsiders)
- HEIKA collaboration (High Efficiency International Klystron Activity)
- A prototype 40-beam MBK allowed to validate the approach. An old tube ($\eta = 42\%$) was refurbished, implementing the new methods, and reached 66% with 52 kV.



Highlights - ESRF 2016

**"CHÂTEAU DE VIZILLE"
FROM THE 17TH CENTURY. IT NOW HOUSES THE MUSEUM DEDICATED TO THE FRENCH
REVOLUTION IN 1789.**



Highlights - ESRF 2016

AT HÔTEL RESTAURANT CHAVANT - BRESSON



Highlights - ESRF 2016

All-in-One



Looking to future

- This workshop serves the accelerator community well by bringing together RF experts from users facilities, research institutes, and industries to discuss high power rf systems.
- We certainly will be very busy at least for a decade AND more!
 - Exciting times, a number of ongoing and new accelerators on the horizon.
 - Light Sources - Sirius (Brazil), ESRF-EBS(France), APS-U(USA), SPring8-II (Japan), LCLS-II-HE (USA), ALS-U (USA), ALBA-U ?(Spain), ILSF (Iran)
 - High Energy – PIP-II (USA), LBNF(USA), HiLUMI/HL-LHC (Switzerland), FCC (Switzerland)
 - Nuclear Physics – ARIEL-II (Canada), eRHIC –EIC (USA), FRIB (USA), HIAF (China), RAON (Korea), FAIR (Germany), Cyclotron (Italy)
 - Spallation Sources – ESS (Sweden), PPU (USA)
- We should advance rf performance limits as technology evolves (clean rf power, higher power density, higher efficiency – 80% or better, compactness, power-on-demand,) while maintaining high reliability and availability/uptime
- RF performance and functional requirements drive the choice of high-power rf sources and auxiliary components. The “one size fits all” approach will not work. Different applications – different technologies.

Many thanks

Foremost to all
570 participants
since 2000



**Thank
You!!!**

Many thanks

*Also, our deepest thanks, sincere
gratitude and appreciation to all
Local Organizing Committee
members.*



Many thanks to

<i>Year</i>	<i>Host</i>	<i>Chair</i>
2000	ANL	Doug Horan
2002	ANL	Doug Horan
2004	PSI	Peter Sigg
2006	ANL	Doug Horan
2008	CERN	Daniel Valuch
2010	ALBA-CELLS	Paco Sanchez
2012	BNL	Jim Rose
2014	Elettra	Alessandro Fabris
2016	ESRF	Jorn Jacob
2018	NSRRC	Ming-Chyuan Lin

Many thanks

Let's not forget our International
Organizing and Program
Committee Members! A special
shout-out to Daniel, workshop
indico grandmaster!

Many thanks

Finally, we want to sincerely thank NSRRC Local Organizing Committee, staff and particularly Ming-Chyuan for all their hard work. Congratulations on putting together an impressive workshop.



We all had a BEARY good time!

Thank you for your warm and kind

HOSPITALITY

