

Brief Summary on ESLS-RF Workshop 2010



Cristina Pasotti

Main RF components for Storage Ring

- **Accelerating structure 100 - 352 - 500 MHz**
 - normal conducting single/multi cell cavities
 - superconducting cavities
- **Power plant**
 - klystron transmitter (high power station)
 - IOT based transmitter (medium power station)
 - solid state amplifier (modular design)
- **RF control and diagnostic**
 - digital low level RF
- **RF tools**
 - input power coupler, cavity combiners, ...



NC accelerating structures

- Normal conducting single/multi cells cavities are well known structure.
- SLS has confirmed this choice

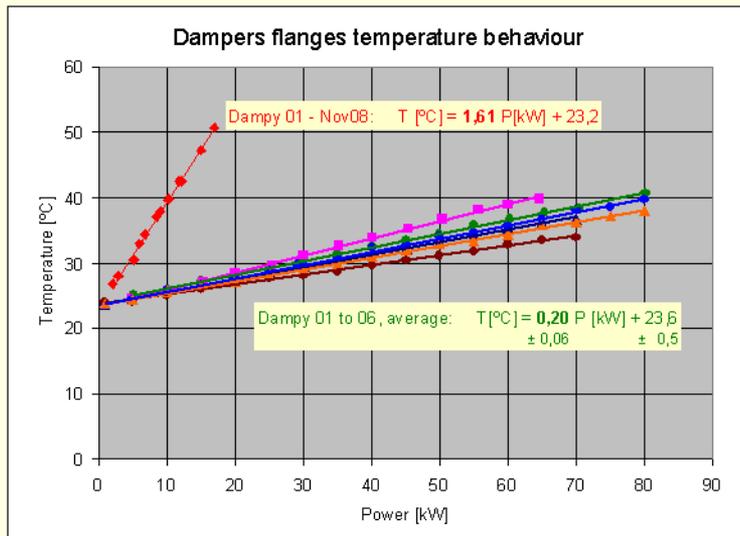


Courtesy F. Perez (ALBA)



ALBA accelerating structures

- To avoid H.O.M. longitudinal instability: **DUMPY CAVITY**. NC single cell equipped with wave guides to extract HOM's field.
- Installed and full RF power tested.



*RF power level vs temperature.
Courtesy F. Perez*

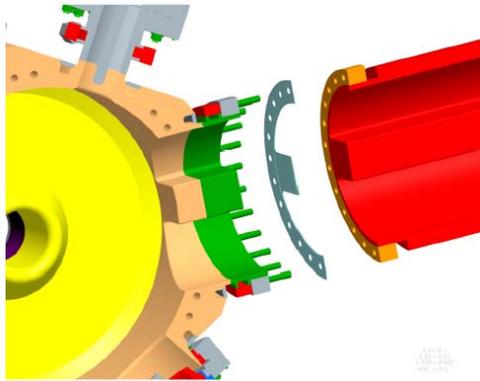


ALBA cavities. Courtesy F. Perez

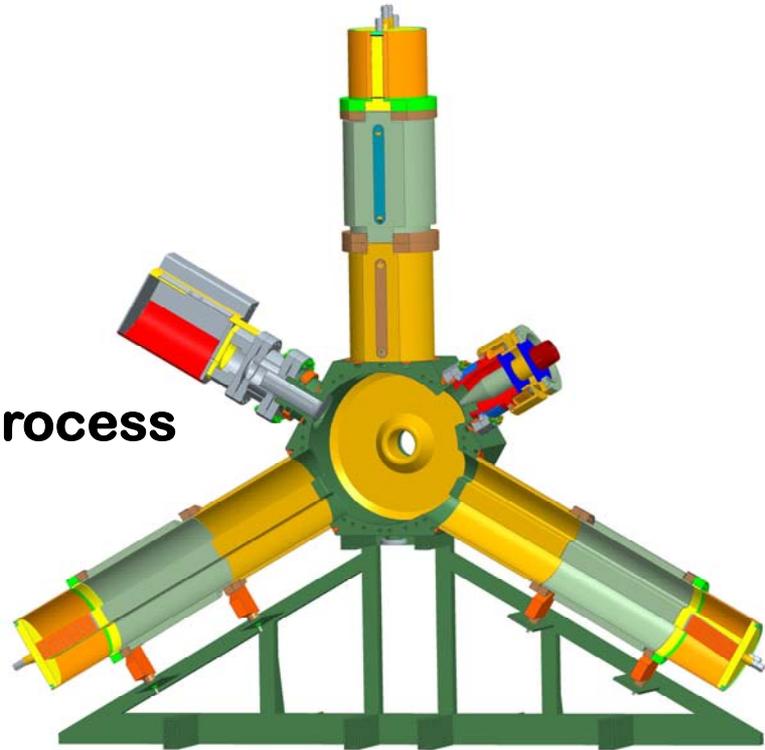


BESSY II Accelerating structures

- **BESSY HOM damped cavity :**
 - Long. Impdance $< 11 \text{ K}\Omega$
 - Trans. impedance and $60 \text{ k}\Omega/\text{m}$
 - Rshunt $\sim 3.4 \text{ M}\Omega$
 - 100 kW expected operation
- **Bessy II new cavity: ordering process**



*“no gap” modification for the ridged WG
(ALBA, ESRF, HZB)
Courtesy E. Weihreter*

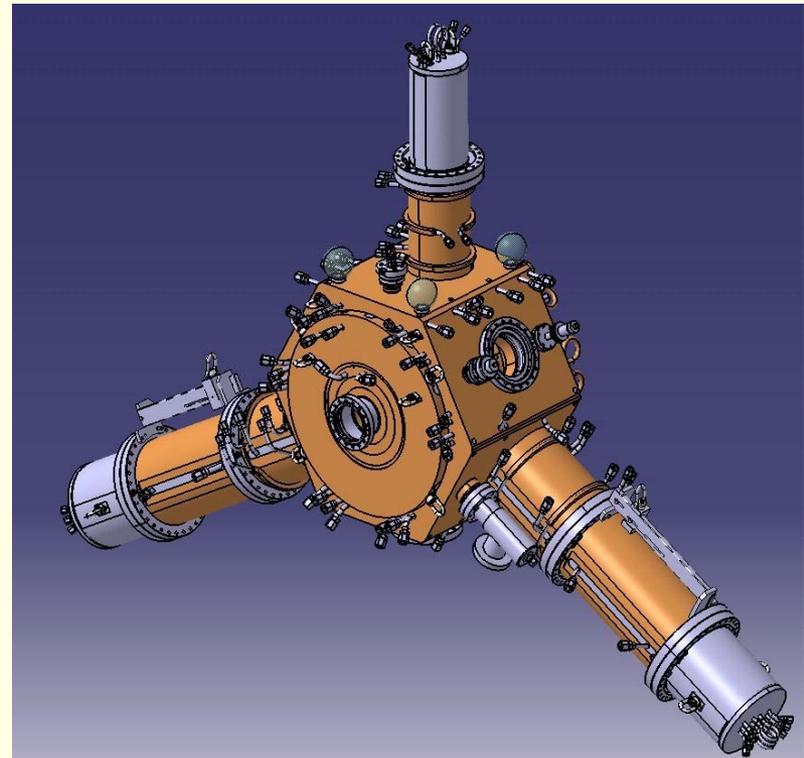


HZB BESSY II new cavity. Courtesy E .Weihreter



ESRF of accelerating structures

- ESRF RF upgrade: 6 cavities (5 cell each) replaced by 18 NC cavities single cell HOM dumped
- 9 MV with at least 12 cavity
- operate at 0.3 A
- power capability for 0.5 A
- HOM longitudinal impedance below threshold for 1 A.

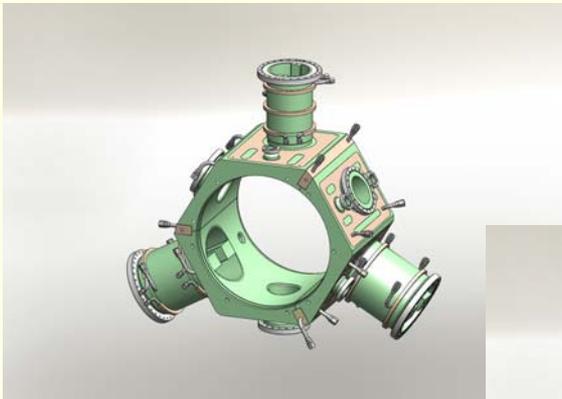


ESRF 352 MHz Cavity. Courtesy J. Jacob

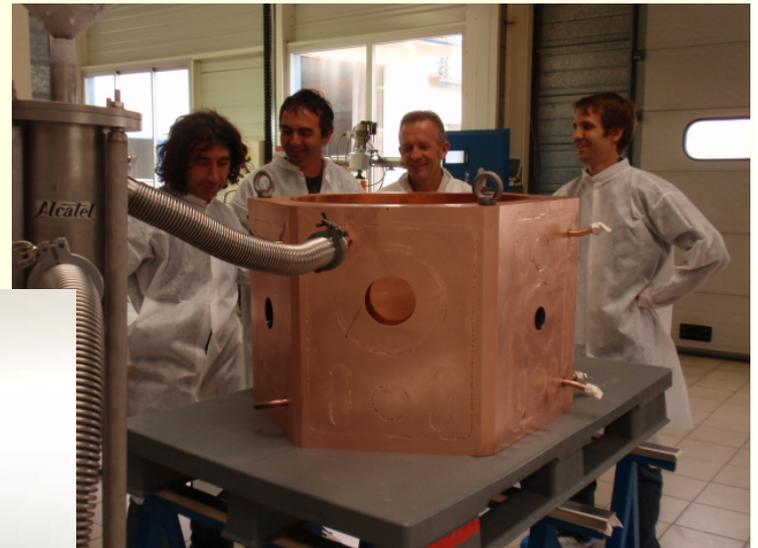
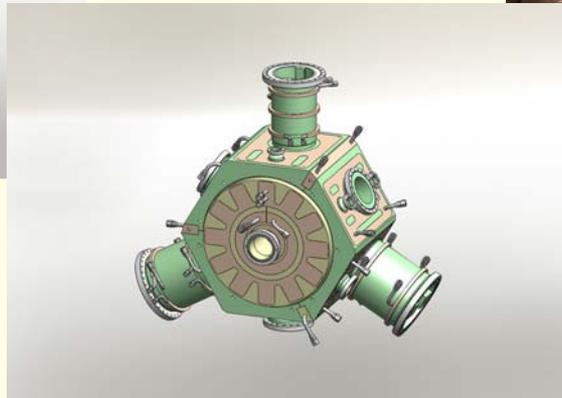


ESRF accelerating structure

- ESRF has performed cavity design and validation of prototype, mechanical and thermal design “in house”.
- three prototypes under fabrication: on November first delivery
- create a market for fabrication of this device

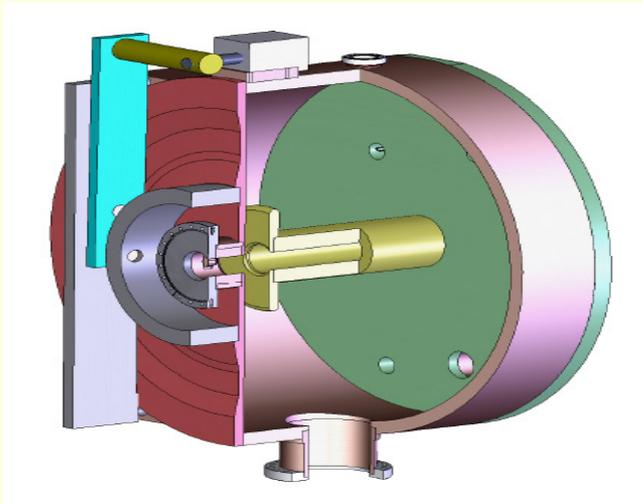


Courtesy V. Serrière

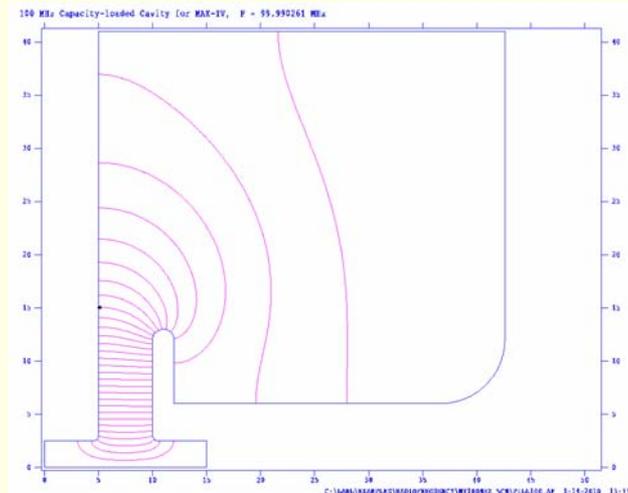


MAX IV accelerating structure

- For MAX IV rings the optimized design of the existing Max II and Max III 100 MHz cavities (higher voltage and improved heat exchange capability)
- 2 RF station (60 kW each) required for 1.5 GeV ring
- 6 RF station (120 kW each) required for 3.0 GeV ring
- Call for tender for cavity fabrication



*Max II and Max III cavity
Courtesy Å. Andersson*

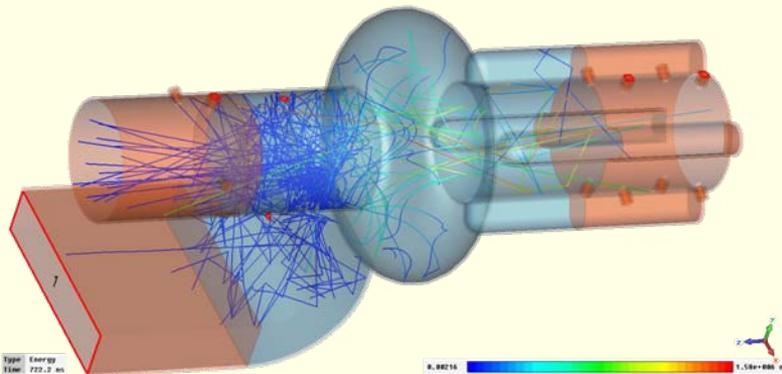


*Max IV Inner cavity shape
Courtesy Å. Andersson*



SC Accelerating structures

- superconducting cavity operational at Diamond and Soleil, 3rd harmonic (Elettra, SLS)
- experience good reliability, but when they fail... their recover takes relatively long time



*DIAMOND multipacting studies
Courtesy M. Jensen*



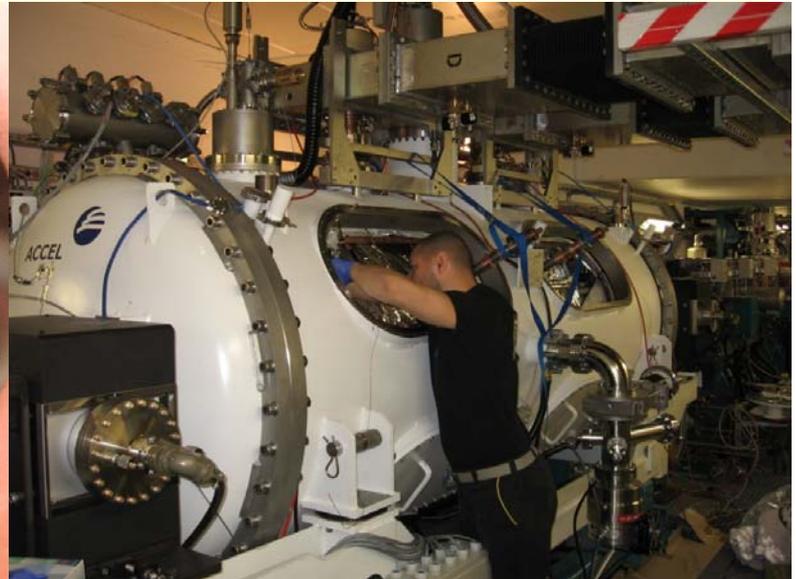
*SOLEIL cryo-module
Courtesy M. Elajjouri*



SC accelerating structures

- need redundancy in the system (compressor, spare cryo-module), carefully maintenance procedure
- further optimizations required: mechanical design (plunger, pick up), and simulation (multipacting studies)

*DIAMOND, pick up and bellows
Courtesy M. Jensen*



*SOLEIL planetary gearbox replacement
Courtesy M. Elajjouri*



Klystron-based Power Plant



cavity 3
(2nd
harmonic)
cavity 2
cavity 1
e-
gun

SLS klystron (EEV K3418P)
Courtesy L. Stingelin

- Klystron-based transmitter: several “sizes” from 800 kW (Petra III) to 180 kW (SLS) to 60 kW (Elettra). Typical gain ≈ 40 dB
- the market: who’s going to build them, cost, delivery time, know how.
- Storage (HZB) and refurbishing (SLS) problems



HZB-Bessy transmitter plant. Courtesy W. Anders



I.O.T. based power plant

- IOT typical “size” at 500Mhz is 80 kW cw, gain \approx 23 dB. The required power level is reached combining two/four tubes together
- IOT plants at Diamond and Elettra (E2V D2130, TH 793 and TH 793-1 LS) at MLS (CPI CHK5900W1), Alba (TH 793-1 LS)



*TED TH 793-1 LS installation at Diamond before December 2009
Courtesy M. Jensen*



*TED E2V D2130 installation at Diamond after December 2009
Courtesy M. Jensen*



I.O.T. based power plant

- Elettra has two sockets system: one E2V (June 2010) and one TED tube (TH 793 last installation aug-2009)



TED TH 793-1 installation at Elettra before June 2010



E2V D2130 installation at Elettra after June 2010



I.O.T. based power plant

IOT performances :

- **MLS: 2.5 years of operation for CPI without complains**
- **Recently Diamond (Dec. 2009) and Elettra (Jun. 2010) have chosen E2V ones.**
 - **Diamond: no troubles for booster (TH 793), but lots of failures in the storage ring for TED ones. Good behavior of E2V tubes, few trips just at start up.**
 - **Elettra: lack of reliability for TH 793 (too many trips), severe failure for TH 793-1 LS. Now D2130 tube's total hours are 2860, total trips 9. 89% of the trips in the first 1200 hours. Too early to definitively assess its performance.**
- **Alba: some troubles during IOT commissioning phase**
- **Up to now, TED tube does not match the reliability demand for LS. The experience of next machines (ALBA and CERN PS) will tell us more.**



Solid State power plant

- SOLEIL 352 MHz Solid state amplifier: 20000 hours of operation \approx 100% operational availability. **Brilliant!**
- In house development & design
- R & D of new RF modules
 - Frequencies from 88 to 500 MHz
 - Output power from 1.0 to 0.7 kW
 - Gain > 18 dB
 - Efficiency > 67%
- 2 systems of 50 kW @ 476 MHz (LNLS) successfully tested
- Technology Transfer agreement with private company to build 14 towers of 75 kW for ESRF

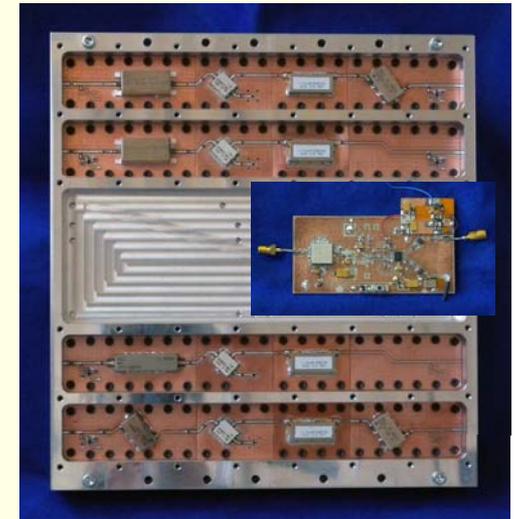
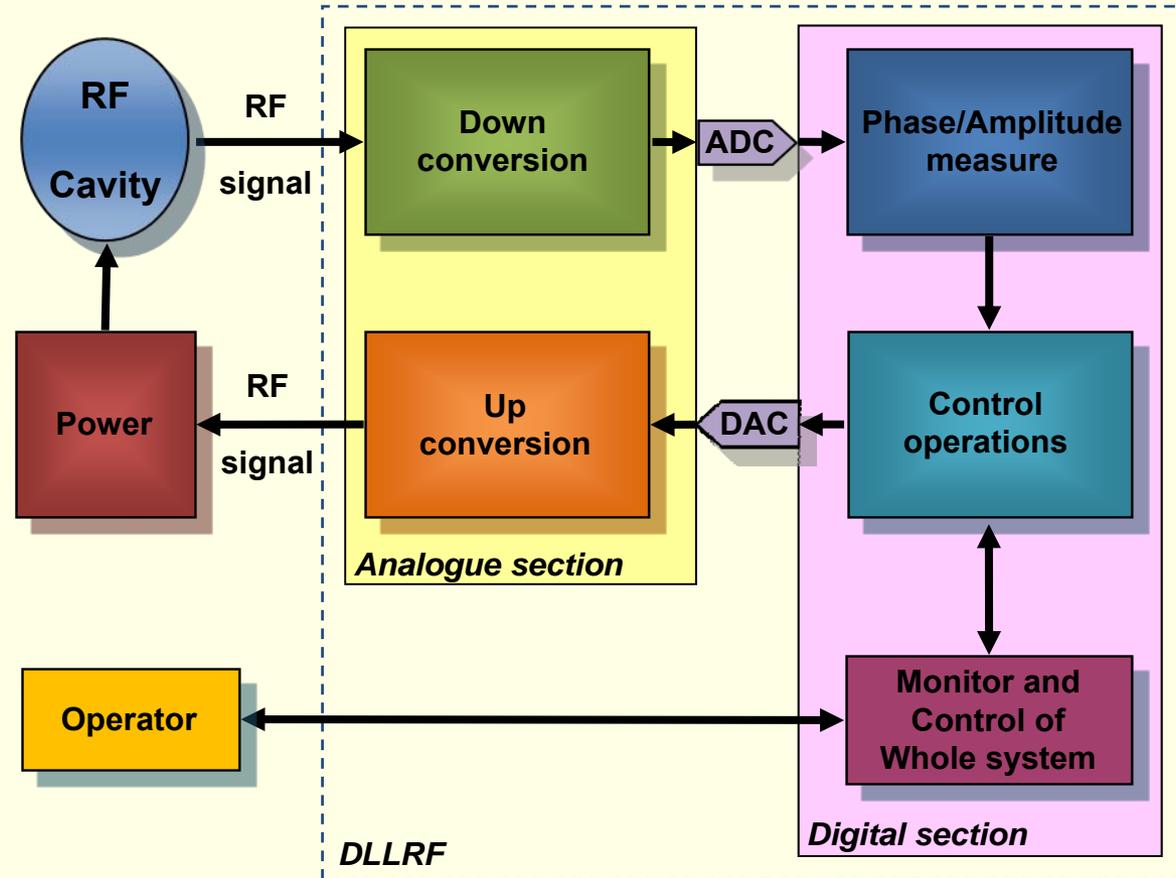


*SOLEIL: solid state power tower
Courtesy M. Elajjouri*



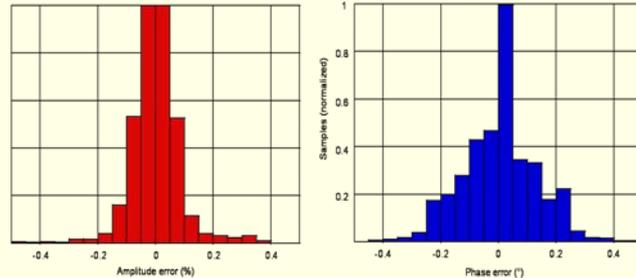
Digital LLRF

Elettra digital LLRF layout and down conversion board prototype



Digital LLRF

- LLRF Alba Booster is fully commissioned. Automatic start up procedure
- Prototype and first results for Soleil booster and storage ring.
- Prototype and first results for ASTRID

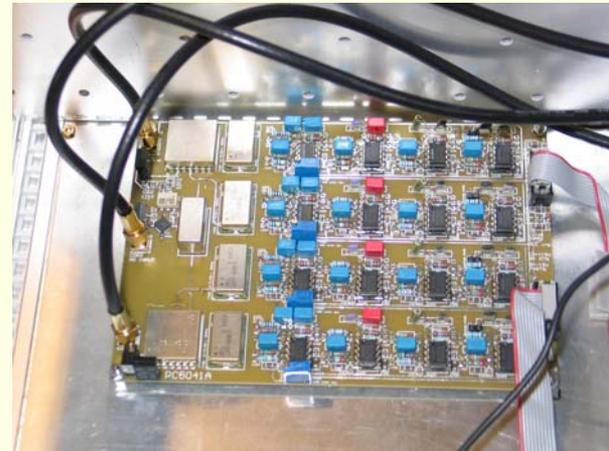


Amplitude (left) and phase (right) error distributions

Measured errors

Amplitude error: 0.3% rms

Phase error: 0.2° rms



SOLEIL: Direct RF and Digital I/Q feedback loop performances. Result at 300 mA. Courtesy R. Sreedharan

ASTRID: I/Q demodulator and 100 kHz low pass filter. Courtesy J.S.Nielsen



RF “strategies”

- collaboration to control cost and push benefit
 - Common spare parts for save operation & storage (HZB proposal for klystron)
 - Common call for tender for cavities and associated equipment (Max IV and Astrid2)

- in house development, design, and, when feasible, fabrication
 - IPC and cavity development (CERN ESRF SOLEIL)
 - IPC (SLS)

- keep high the interest of private companies in making RF devices
 - “know how” shall not be lost
 - avoiding “mono” supplier





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Science Update

Rotational and core level spectroscopies as complementary techniques in tautomeric/conformational studies: 2-mercaptopyridine

S. Melandri, L. Evangelisti, A. Maris, W. Caminati, B. M. Giuliano, V. Feyer, K. C. Prince, M. Coreno



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25-26/11, 2010

