10th ESLS RF MEETING
28 Sept. 2006 Morning Session : *New developments*
Chairman summary - P. Marchand

Low Level RF system development for SOLEIL (R. Sreedharan)

The LLRF system in use at SOLEIL consists of fully analogue "slow" amplitude, phase and frequency loops, complemented (for the storage ring) with a direct RF feedback in order to cope with the high current Robinson instability. Amplitude and phase stability better than 1 % and 1° (pk-pk), respectively, are achieved in routine operation. To date, stable beam current up to 300 mA have been stored with the RF feedback disabled; in return, the stability requires some cavity detuning and therefore an additional reflected power of ~10 kW.
A fast digital FPGA based I/Q feedback is presently under development (SOLEIL-CEA collaboration). Its main components (Heron board including ADC, FPGA and DAC, IF converter, VCO, I-Q modulator and filtering board) have been checked individually and they are being assembled together for testing the complete unit.
A Matlab-Simulink based tool has been worked out in order to simulate the beam-cavity interactions in presence of feedback loops; it predicts that loop gains of ~ 10 are enough to ensure the stability at full beam current and maintain the residual phase error below 0.5° in presence of the actual microphonic disturbances (Δf of ± 100 Hz, as measured on the cryomodule).
A multibunch transverse feedback, based on the FPGA board used at Spring8, is also under development.

Low Level RF Control System for the Diamond Storage Ring (A. Watkins)

The LLRF of Diamond is based on an analogue I/Q feedback (amplitude & phase control) and a frequency tuning loop acting on a stepper motor. The system is interfaced to a VME-EPICS environment.
The measured performance of the I/Q feedback is quite good with pk-pk values of about 1.1% in amplitude and 1.5° in phase. The main trouble comes from the frequency tuning loop, which has to handle phase variations of more than ± 15°. Further investigations are necessary in order to evaluate the contributions from tuner, cryogenics, amplifier, etc. Moreover a better control of the tuner backlash and hysteresis must be achieved.
More generally, further calibration and optimisation are necessary for finalizing the system (power, voltage and phase measurements, Gain vs BW, offsets and non linear effects compensation, etc.); the development of a simplified operator interface is also required.

Waveguide to coax transition (WATRAX) Prototype for the ALBA cavities (P. Sanchez)

WATRAX, is a transition which allows connecting a standard WR1800 waveguide onto the ALBA DAMPY cavity. It is designed to handle up to 150 kW and fit with water pipes passing through it for the cool down of the cavity coupler window. The geometry has been optimised (matching versus plunger shape and position), using the CST computer code.
For the storage ring (resp., booster) version, with a transmitted power of 150 kW (resp., 80 kW), one anticipates a max E-field below 300 kV/m (resp., 170 kV/m) and a dissipated power of about 120 W (resp., 20 W). Low power measurements on prototypes of each version (built by AFT) agree quite well with the simulations.

During the first high power tests of the booster model at DESY, some arcing occurred at power level between 65 – 80 kW, due to a bad contact on the inner conductor; after repair, over 160 kW were transmitted with negligible reflected power and max temperature ~ 50°C. The power tests of the SR model showed an unexpected high level of reflected power, ~ 20 kW at 250 kW. Low power tests and matching optimisation will be repeated at CELLS.

Cavity Power Combiner (CACO) for the ALBA cavities (M. Langlois)

CACO is a cavity power combiner which combines the power from two IOTs for feeding into the ALBA DAMPY cavity. The two 4”1/16 input coaxial lines are coupled to the cavity with loops while a capacitive post couples the cavity to a WR1800 wave guide.
As compared to hybrid combiners, it has the advantages of being more compact and of filtering the harmonics.
Low power measurements on a prototype, built by Thales, showed a quite good matching (S11 = -27 dB) on each input. High power tests were also performed by Thales and a total power of 150 kW, from two IOTs, was transmitted into a dummy load; about 3 kW were reflected towards each IOT and the cavity wall temperature remained below 50°C.
Ideally, in case of failure of one IOT transmitter, the other one can still transmit nearly its full power to the load, provided that the length between the IOTs and CACO cavity is properly adjusted. Power measurements showed that in practice, additional compensations are required (plunger in the wave guide, coupling post height adjustment) in order to achieve this condition.