2nd Session: New facilities - Summary of Chairman (Jörn Jacob)

This session was devoted to reports from new facilities under construction: the Willy Wien laboratory (200 to 600 MeV SR near BESSY), SOLEIL, DIAMOND and ALBA. This summary essentially addresses points that were discussed at the meeting: namely that the new facilities will all make use of IOT or solid state amplifiers instead of klystrons, that they will implement HOM damped cavities, either NC or SC, instead of conventional cavities with e.g. HOM detuning, and, finally, that modern high bandwidth digital FPGA boards will increasingly be used for low level RF control.

➢ IOT

Being already state of the art in today’s 60 kW TV transmitters, IOT are now widely proposed for accelerator RF systems at 500 MHz, and even at 1.3 GHz as heard in Session 4. For a lower energy and optimized budget project like the Willy Wien laboratory, klystrons are considered obsolete and an IOT appears to be the most economical solution. The two medium energy machines ALBA and DIAMOND need as much as 150 kW and 300kW per cavity, respectively, which will be obtained by combining the power from 80 kW IOT. DIAMOND will make use of waveguide couplers with appropriate phase shifters allowing to remain operational even when an IOT is not powered. ALBA has launched the design of a combiner cavity named *CaCo*, which is more compact and at the same time acts as a harmonic filter. A prototype is being built and will be tested by Thales, and a more sophisticated version is being designed at ALBA, with a movable plunger in the output arm to restore matched operation when only a single IOT is powered.

W. Anders asked why not simply launching the development of high power IOT, thereby avoiding the use of combiners. However, as a possible drawback, one could again be confronted with the problem of small productions for scientific applications and loose the benefit from using standard tubes also built in TV transmitters. It was also recalled that several years ago, tube suppliers had discussed with CERN about the possibility to develop 300 kW IOT for 352 MHz applications. But the development costs, supposed to be partly supported by the customers, were too high, even in case of a share with APS and ESRF. Morten Jensen gave a detailed report on the difficulties to raise the power from 60 kW to only 80 kW: 300 kW with 4 IOT could finally be demonstrated at DIAMOND, but with signs of arcs after 10 hours of operation. This deserves further development work in collaboration with the supplier (Thales). Is perhaps a 80 kW IOT already a special product for scientific applications with all the draw backs of small series productions?

➢ Solid state amplifier

In his detailed report on the SOLEIL progress, Patrick Marchand presented the R&D history of the modular 352 MHz solid state amplifiers: up to 190 kW are obtained by combining the power from 724 modules of 300 W each. The required space per kW of RF is extremely low since almost all functionalities are distributed at the level of the individual modules, from the power supplies to the isolators. The system is dimensioned such as to tolerate individual faulty modules, thereby hopefully guaranteeing a large MTBF and availability. After some difficulties with the first series of transistors, finally a robust version of LDMOS POLYFET transistor is used. A 50 kW tower has been tested for 1000 hours without trouble. The workshop participants reiterated their old concern about high power reflections or power picked up by the cavities from the beam that could overload some modules' output isolators - even if reciprocity in principle imposes the backward power to be split exactly as the forward power is combined. Patrick Marchand replied that he has turned around these arguments and concluded that the feared avalanche destruction of many modules cannot occur. To illustrate this, he showed the unwanted test result from a badly assembled 2.5 kW combiner, that had arced and been burnt. During this event, probably high reflections have occurred without provoking any damage on the 300 W modules. With four 50 kW towers already mounted, and a present fabrication rate of 1 tower/month, the required RF amplifiers will be completed in time for phase 1 of the SOLEIL SR commissioning starting in March 2006. LNLS, one of Ti Ruan's first "customer", and SLS (see session 5) are now also developing solid state amplifiers based on the SOLEIL design.

- **Klystron**

In the discussion about the optimum RF amplifier technology for accelerators, one should also consider the required total power. For higher energy machines, like the ESRF, with 1 MW of beam power or more, the use of 1.3 MW super klystrons also has advantages. Knowing that auxiliary power supplies cause most of the RF trips, it is not yet clear if replacing one klystron with 16 IOT would improve the reliability. The possible replacement of a super klystron with nearly 5000 solid state modules should also be re-addressed in the light of the experience at SOLEIL with 600 kW of beam power in phase 2.

- **HOM damped SC cavities**

DIAMOND and SOLEIL are installing strongly HOM damped superconducting cavities on their storage rings, which clearly constitutes the most effective way of getting rid of spurious HOM. But such a sophisticated technology also requires a long R&D period. In this respect, DIAMOND benefits from the mature Cornell development that had started in the 80's and from its successful transfer to industry. The SOLEIL cavity also relies on nearly 10 years of R&D, on the long experience of CEA and CERN in SCRF as well as several tests and improvement phases, including a one year test with beam at the ESRF. It is interesting to note that ACCEL manufactures the DIAMOND cavities as well as the second SOLEIL module. The cryogenic plant too constitutes a challenge for the construction and the operation phase. The whole RF community will closely watch the incidence of this complex technology on the day to day operation of these light sources. Up to now, both projects are almost on schedule with the production and the installation of their RF systems.

- **HOM damped NC cavities**

For the Willy Wien laboratory and ALBA, the strongly HOM damped normal conducting "EU cavity", called *Dampy* in Barcelona, has been selected. Details on the status of its development were addressed in Session 4. For ALBA, the main advantage of the compact NC design allows to house 6 cavities in 3 short straight sections, leaving free the medium and long ones. The time schedule hopefully leaves room to terminate the development of the EU cavity. Note that the cavity body has already been ordered for the Willy Wien laboratory, for which the start of machine commissioning is foreseen in March 2007.

- **FPGA for Lowe Level RF**

It might be worth reporting that high bandwidth digital FPGA controllers will more and more be used for the low level RF control. For instance SOLEIL plans to replace the initial analog amplitude and phase loops around the cavities with a fast digital loop implemented on a FPGA. ALBA is developing digital IQ modulation./ demodulation with FPGA and expects a phase precision better than 0.05 º.