27th September 2006 - Afternoon Session: *Beam dynamics*
Summary of Chairman (Jörn Jacob)

M. Eriksson: How to fight CBI with long bunches and Landau-Cavities

In the first talk of this session, Mikael Eriksson showed *"How to fight CBI with long bunches and Landau-Cavities"* on MAX II. The scheme includes the new 100 MHz strongly re-entrant, non symmetric "Mushroom" shaped accelerating cavity. The electrical field of the accelerating mode is concentrated near the rather short accelerating gap and has no component on the rear plane of the cavity, where only the HOMs exhibit strong E-fields that are easily damped through E probes: a simple selective HOM damping scheme. Moreover, the cavity geometry provides as much as a factor 5 between the fundamental and the lowest HOM frequencies. So, with the passive 500 MHz Landau cavity operated for a bunch elongation from 3 to 10 cm rms, not only the lifetime is nearly doubled from 3… 4 to 6…8 Ah, but the beam coupling to the higher frequency HOMs is also reduced. Including Landau damping, the combination of these effects guarantees an operation without LCBI at MAX II. Also thanks to the narrow spectrum of the elongated bunches, the rigid transverse bunch modes can be stabilized by means of a rather small positive chromaticity, whereas higher order transverse head-tail modes are broken by the spread in synchrotron frequencies. Thanks to the gain in lifetime, MAX II needs to be refilled only once per day with a subsequent decay from 250 to 130 mA.

T. Weis: Beam instability investigations at DELTA

Thomas Weis first gave an introduction on the machine status and the operation of DELTA as a 1.5 GeV user facility. In 2006 a beam availability of 90 % was achieved for a maximum current of 130 mA and 8-10 h lifetime. While most of the experiments use photons between 5 eV and several 100 eV, the superconducting asymmetric 5.3 T wiggler delivers 4 to 30 keV radiation. Thomas Weis then focused his talk on recent "Beam instability investigations at DELTA". A new diagnostic tool provides bunch by bunch, turn by turn filling pattern measurements, which are exploited for postmortem analysis after a LCBI driven beam loss. An over-sampling technique based on a small difference between the 4th RF harmonic and the 2 GS/s sampling frequency is applied to resolve the shape and find the peak signal for each bunch over several turns. Proper filtering yields the filling pattern. The system also gives real time LCBI detection by evaluating the FFT of the phase modulated signal over 700 turns. The system has been used to investigate the LCBI driven by the HOMs of the DORIS type cavity. Data were also taken when the first EU cavity prototype with tapered HOM antennas coupled to external loads was installed at DELTA, in order to check the effectiveness of HOM damping. Only one LCBI was observed, which is not attributed to the EU cavity since it is also detected with the DORIS cavity. However, its exact cause is no yet identified even though, according to simulations carried out by F. Marhäuser / BESSY, the strip line kicker is a good candidate.

E. Weihreter: HOM damped cavity development at BESSY

Ernst Weihreter showed the design evolution of the strongly HOM damped 500 MHz "EU cavity", which has been developed in the frame of an EU funded project in a collaboration between BESSY, SRS, DELTA and the National Tsing Hua University / Taiwan. The first high power prototype was

equipped with tapered ridge waveguide antennas acting as high pass filters, which couple all the HOMs to external loads by means of integrated waveguide-to-coax transitions and coaxial feed-throughs. This prototype was successfully tested at DELTA, where it was operated during several months for beam acceleration instead of the DORIS type cavity. Thorough investigations at beam energies between 500 and 1500 MeV revealed only one LCBI, which was definitely not attributed to the EU cavity. In parallel to these tests, improved HOM dampers with ferrite absorbers in the vacuum were designed, yielding a reduction by a factor 3 to 4 of the maximum residual HOM impedances. With this design, computer simulations predict that the thresholds of LCBI would be above the maximum stored current for the considered 3rd generation light sources ALBA, SLS, DELTA, BESSY, ELETTRA, NSRRC and ALS. This compares well with other strongly HOM damped NC and SC cavity approaches. ACCEL has recently delivered the first cavity with ferrite dampers to BESSY for the 600 MeV Willy Wien Ring. Low power HOM measurements as well as high power RF conditioning are foreseen this autumn, and commissioning on the new Metrology Light Source in early 2007. This cavity design will also be used to power ALBA and to upgrade BESSY II. The RF community will carefully watch the coming RF tests and soon the commissioning with beam, with a particular attention to the ferrite absorbers, which constitute its most delicate parts.

M. Svandrlik: Status of the 3rd harmonic sc-cavities at ELETTRA

Michele Svandrlik introduced his presentation with a status report of ELETTRA. The machine is operated 25% of time with 150 mA at 2.4 GeV and 75% of time with 330 mA at 2.0 GeV. The availability is typically 95 %. The operation will be interrupted by a 3 months shut down at the end of 2007 to connect the storage ring to the new booster, which is now in construction. In parallel, the project for the X-FEL FERMI is starting. Michele Svandrlik then presented the status of the passive superconducting 3rd harmonic cavity Super-3HC. Thanks to the achieved bunch lengthening and the subsequent increase in lifetime, the tedious refilling and necessary energy ramping needs only to be done every 48 hours. The complete cure of LCBIs by Landau damping is the other essential feature of the 3rd harmonic cavity. Although an optimized maintenance and follow up strategy for the operation of Super3HC and its cryogenic plant has resulted in an overall good reliability, some technical problems persist. The tuning problem could be solved partially by slowing down the speed of the step motors, which are located in the isolation vacuum. But only cell 2 is in operation at high voltage and ELETTRA is waiting for more robust gear boxes in order to be able to run cell 1 as well. At the restart after the last maintenance period, the turbines of the liquefier where blocked: the mechanics were found to be strongly corroded and the cooling channels obstructed by rust. Similar problems where also experienced at SLS who operate the same type of liquefier. The operation of Super3-HC could be resumed at ELETTRA after installation of the spare set of turbines. Both SLS and ELETTRA are pushing the supplier for a new turbine design.