In a Nutshell

- MAX IV 3 GeV storage ring commissioning to start July 2015 and design parameters should be achieved by June 2017.
- For the following period 2017–2026, MAX IV Strategic Plan sets several upgrade goals; most important are brightness improvements and a more flexible timing structure.
- Brightness improvements shall be achieved through coupling reduction, better matching of straight section optics to IDs, and an upgraded optics with lower lattice emittance.
- We present a first upgrade candidate that allows for a 33% brightness increase without requiring new power supplies or recabling magnets.

MAX IV 3 GeV Storage Ring

Aerial photograph of the MAX IV site taken on May 15, 2014 (courtesy P. Nordeng).

- Recently: linac beam commissioning commenced.
- July 2014: 3 GeV storage ring building construction completed; immediately followed by start of installations.
- July 2015: 3 GeV storage ring commissioning starts.
- June 21, 2016: inauguration of the MAX IV facility.
- June 2017: 3 GeV storage ring post-commissioning activities completed; design parameters achieved.

Results

- Lattice emittance has been reduced to 269 pm rad (-18%) while matching of the straight section optics to IDs has been improved.
- Resulting optics shows DA that is both compatible with existing injection scheme and gives sufficient Touschek lifetime.

- The overall result is a 33% increase of brightness without requiring any new power supplies or recabling of magnets.
- Emittance blow-up from IBS at 500 mA stored current (5 nC per bunch) will be strong; will necessitate bunch lengthening from harmonic Landau cavities.
- Can expect Landau cavities and IDs to result in equilibrium emittance below 250 pm rad even at 500 mA stored current.
- Future studies will focus on nonlinear optics improvements and a further reduction of lattice emittance.

Max IV Emittance Reduction and Brightness Improvement

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Strategy & Limitations

- Define three stages of optics upgrade: 1) modifications that do not require new power supplies or recabling, 2) allow exchange of magnet power supplies, 3) allow recabling of magnets so existing families can be split.
- This study deals with the first stage: modify strengths of existing quadrupole families in arcs and ID straights within power supply limits.
- DA requirements are considered unchanged since injection scheme shall be retained.

Optics

- Increased focusing strength in the arc quadrupoles → reduced arc dispersion → lattice emittance reduced from 328 pm rad (design) to ≈270 pm rad.
- Vertical beta function in the ID straights can be lowered to 50% (or less) of its 2 m design value by retuning the quadrupole doublets in the ID straights → pay attention to peak value in the matching cell dipoles (limits vertical acceptance, increases natural vertical chromaticity).
- Horizontal beta function in the ID straights can be lowered to 7–8 m without spoiling DA and hence injection efficiency.
- So far, reasonable DA achieved for candidates where the vertical beta function in the ID straights remains above 1 m while limiting the horizontal beta function reduction to ≈7.5 m.
- Adjustments with the PFSs in the dipoles (allowing +/− 4% overall tuning of the vertical focusing gradient) have so far not been required.
- Peak dispersion reduced by 20% → 18% reduction of emittance.
- Reduction of dispersion → reduction of momentum compaction → increase of RF acceptance → improved Touschek lifetime (in addition to Touschek lifetime growth from emittance reduction!).

Achromatic of the MAX IV 3 GeV storage ring. Quadrupoles indicated in red. Quadrupole doublets in the straights (circles) and horizontally focusing quadrupoles in the arcs (arrows) are highlighted.

Machine functions for one half of an achromat of the MAX IV 3 GeV storage ring. Design optics are indicated with dashed lines, solid lines indicate modified optics.

Max IV Project → http://www.maxlab.lu.se/maxiv

TUPRI026, IPAC’14, Dresden, Germany, June 15–20, 2014