CALCULATIONS FOR A HIGH POWER BEAM DUMP FOR B*ERL*inPro

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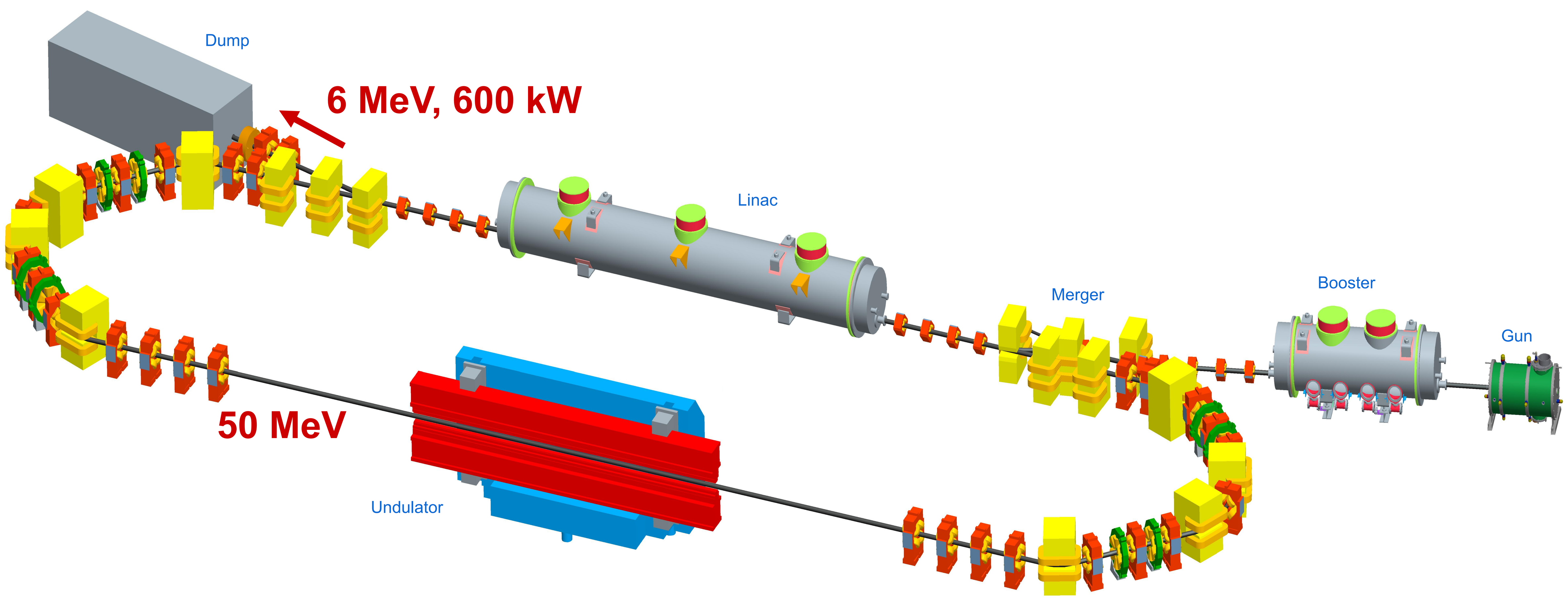
HZB Helmholtz Zentrum Berlin

Abstract

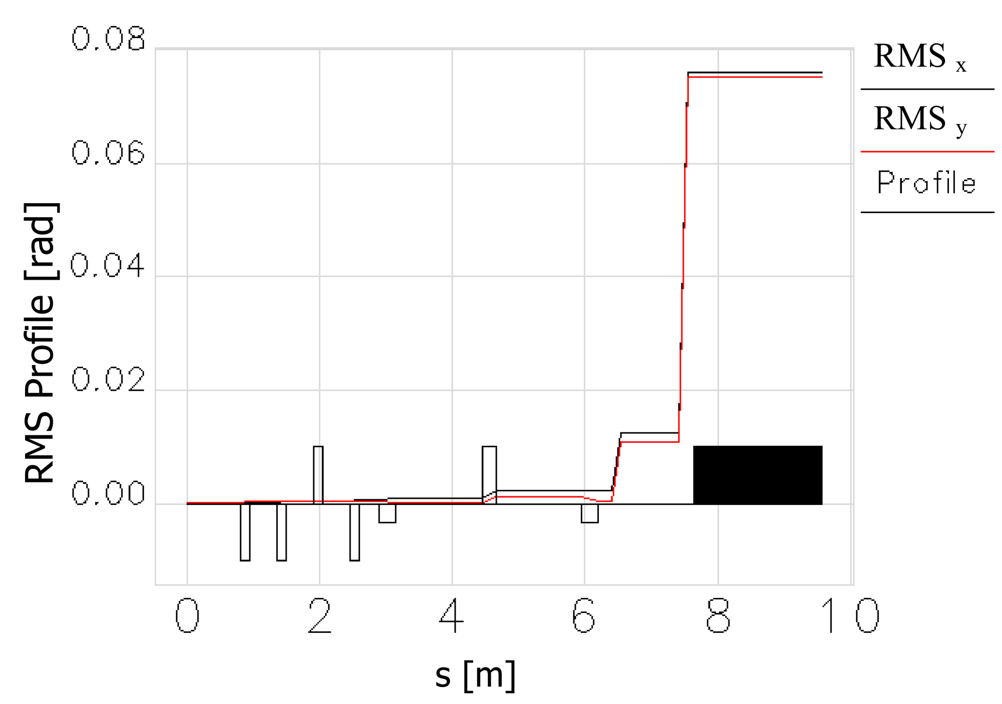
In January 2011 the Helmholtz-Zentrum Berlin started the design of the Berlin Energy Recovery Linac Project B*ERL*inPro as a demonstrator of ERL science and technology [1,2]. The maximum energy is 50 MeV, the maximum current is 100 mA (cw), low energy parts of the machine (injector, beam dump line) are operated at about 6 MeV. Due to the high beam power of 5 MW in the ring, 600 kW in the beam dump, the accelerator will be built subterraneously [3]. For the beam dump surface one has to consider a heating up at this low energy of 6 MeV due to the comparatively small penetration depth of the radiation. To contribute to the construction of the beam dump we used the simulation code FLUKA [4, 5] to calculate not only the dose, but also the energy deposition into the material varying about different beam parameters (beam size, angle, divergence). These data are combined with an ANSYS calculation to find the appropriate temperature profile. So we optimized the design and the necessary beam parameters successfully.

Machine-layout and parameters



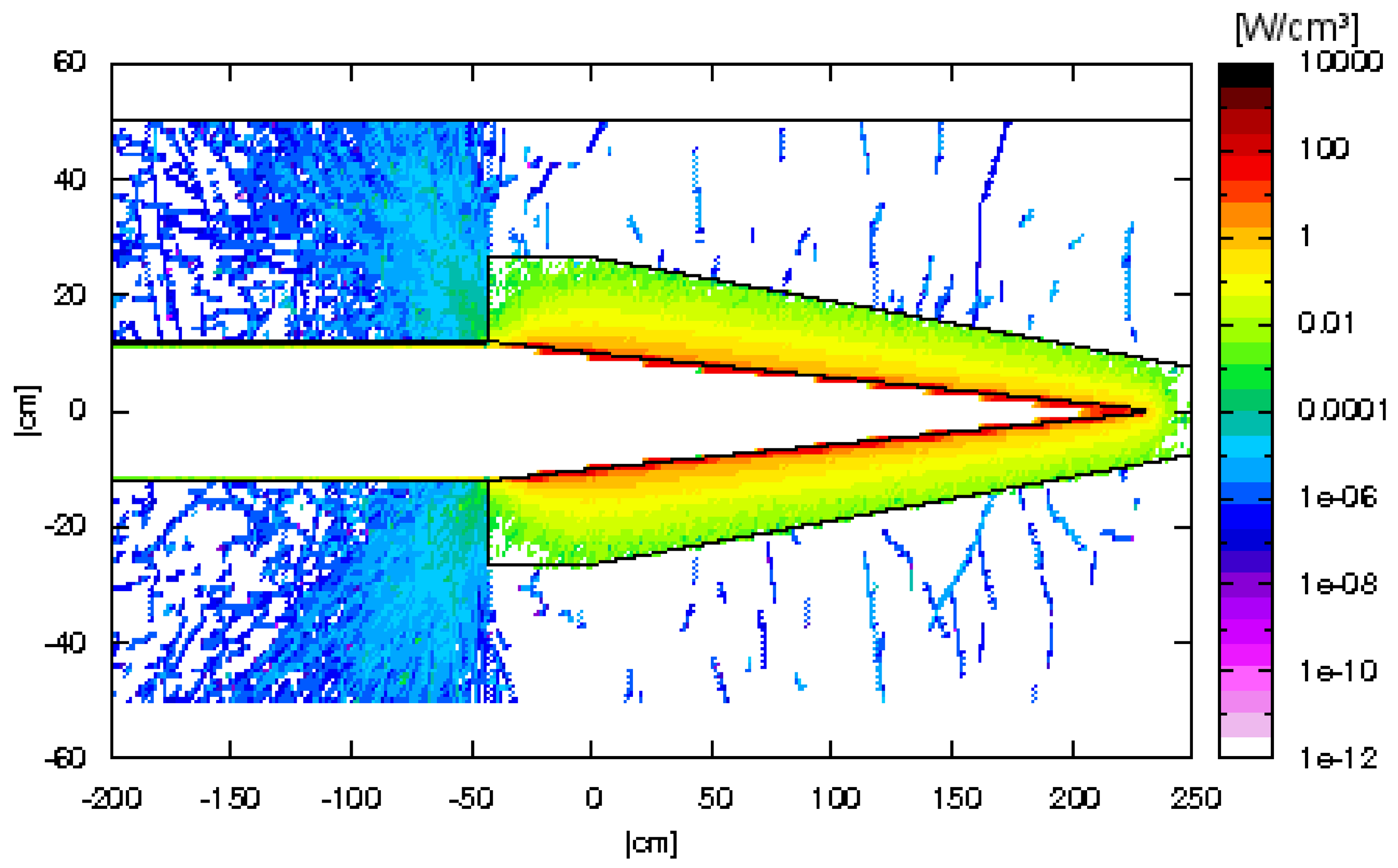
	High flux	flexibility
Max. beam energy	50MeV	50MeV
Max. current	100mA	
Nominal bunch charge	77pc	up to ~10pC
Pulse length	2ps	down to ~ 100fs
Rel. energy spread	~10^{-4} range	~10^{-2}
Rep. rate	1.3GHz	variable
Normalized emittance	< 1mm mrad	some mm mrad

Beam characteristics [5]



Challenge: Low penetration depth at 6 MeV, but high power leads to heating of the beam dump surface.

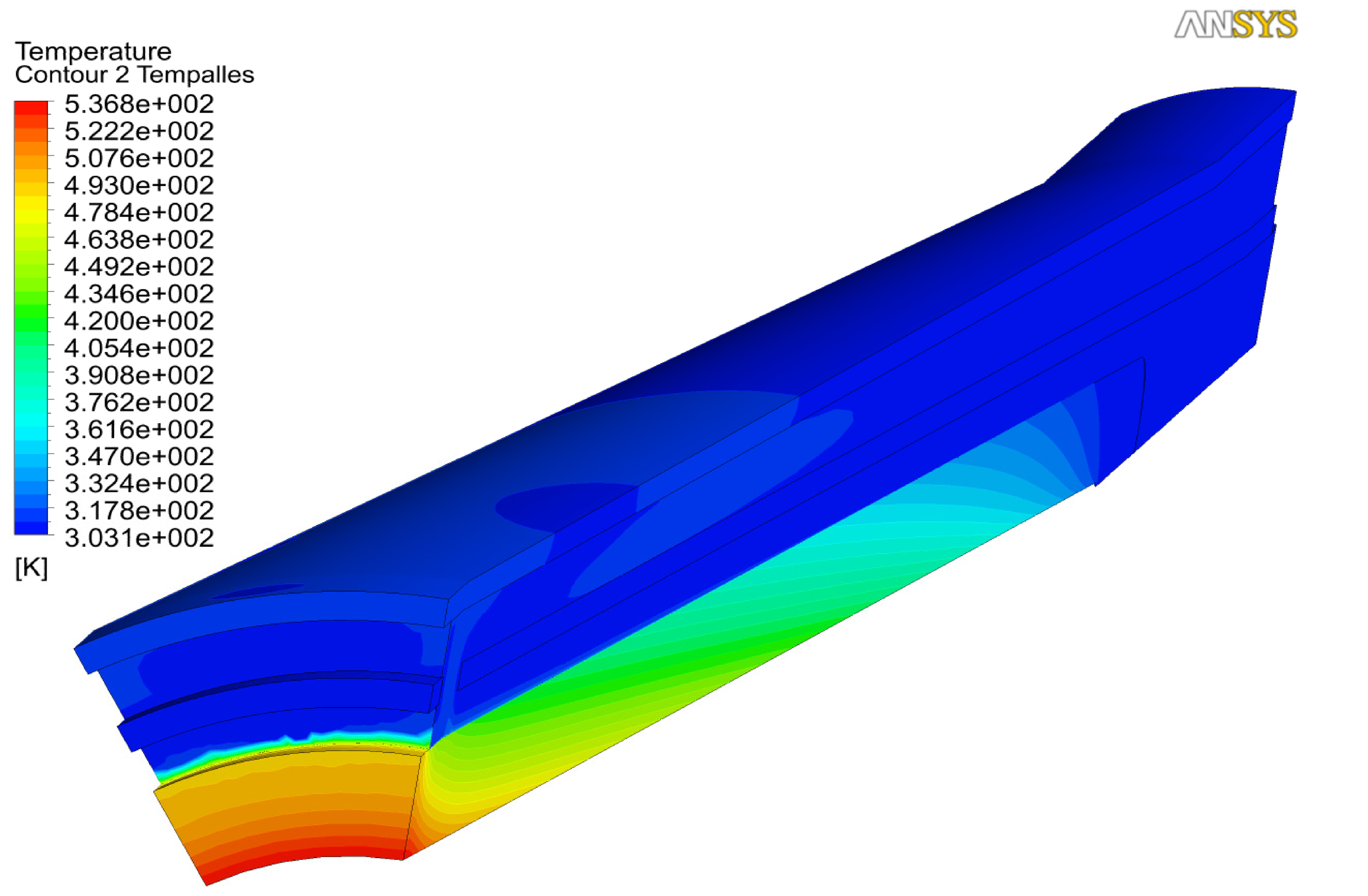
Energy distribution (FLUKA simulation)



- Cone made from Cu (length: 2.94 m, max. ø: 0.265 m)
- Beam characteristics: two dimensional Gaussian distribution, radius: 2.5 cm, divergence: 150 mrad

→ Max. power at the surface is then below 100 *W/cm*³.

Temperature profile (ANSYS calculation)



- Cooling medium: water at 30°C
- Flowing speed of water: 3 m/s
- Max. temperature: about 250°C

Conclusion and Outlook

- With a combination of FLUKA with ANSYS we achieve an appropriate temperature profile of the B*ERL*inPro beam dump (also applicable for the design of other accelerator components).
- A further decrease of the max. temperature (to about 150°C) is planned.
- The high beam power can be handled in a safe way and the detailed design is in progress.

[1] M. Abo-Bakr et al., "BERLinPro: A prototype ERL for future light sources", SRF09, Berlin, Germany (2009)
[2] BERLinPro-Project-Team, "Conceptual Design Report BERLinPro", Helmholtz-Zentrum Berlin (2012)
[2] K. Ott, M. Helmecke, "The shielding design of BERLinPro", IPAC 2011, San Sebastian, Spain (2011)
[3]G. Battistoni et al., "The FLUKA code: Description and benchmarking", Proceedings of the hadronic Shower Simulation Workshop 2006, Fermilab, United States (2006), M. Albrow ed., AIP Conference Proceeding 896, 31-49, (2007)
[4] A. Fasso et al., "FLUKA: a multi-particle transport code", CERN-2005-10 (2005), INFN/TC_05/11, SLAC-R-773
[5] M. Abo-Bakr, private communication

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