Feedback Control of E-Cloud Instabilities

5 year LARP R&D proposal

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LARP SPS and LHC Ecloud 5 year proposal

Overall Goals - R&D effort in 2009 - 2015

- develop beam dynamics/feedback dynamics simulation models

- validate several simulation codes against accelerator measurements

- develop reduced linear dynamics models useful to design/estimate feedback controllers

- develop experimental techniques to estimate Ecloud effects for stable and unstable systems

- evaluate possible control techniques, understand trade-offs between robustness, controllability, and system complexity

- develop the detailed requirements for a new wideband feedback system architecture

- Proof-of-principal technology R&D on GHz bandwidth (e.g. 2 - 4 GS/sec.) processing, backend

- Prototype proof of principle processing channel, implement feedback algorithm, machine studies and comparisons with models.

- Develop diagnostic and operational tools and codes to understand the system performance via accelerator measurements

- Recommend architecture and technology for a general-purpose wideband feedback system useful to control Ecloud-driven instabilties for SPS, LHC and other facilties. Design Report and recommendations

Goals -FY2008/2009 LARP Ecloud effort

understand Ecloud dynamics via simulations and machine measurements

- Participation in E-Cloud studies at the SPS (June, August 2008), additional measurements 2009

- Analysis of SPS and LHC beam dynamics studies, comparisons with Ecloud models

- Adaptation of SLAC's transient analysis codes to Ecloud simulation data structures

Modelling, estimation of E-Cloud effects

- comparisons of Warp and Head-Tail models, results

- comparisons with machine physics data (driven and free motion), validation of models, estimates of dynamics

- extraction of system dynamics, development of reduced (linear) coupled-oscillator model for feedback design estimation

- develop tools to analyse unstable data, quantify and compare system dynamics

- evaluate feasibility of feedforward/feedback techniques to control unstable beam motion, change dynamics. Estimate limits of techniques, applicability to SPS and LHC needs

- Identify critical technology options, evaluate difficulty of technical implementation

- Participation in LHC transverse feedback system commissioning

Decision Point - late 2009/2010

Is the Ecloud dynamics feasible for feedback control? What techniques are applicable?

Research Goals - 2010 - 2011

- Modelling of closed-loop system dynamics, estimation of feedback system specifications

- Evaluation of possible control architectures, possible implementations

- SPS Machine Physics studies, development of transient-domain instrumentation

Decision point 2011 - Proof of principle design studies, estimates of performance

Research Goals 2011 - 2015

Technology R&D - Specification of wideband feedback system technical components

Technical analysis of options, specification of control system requirements

- Single bunch control (wideband, within bunch Vertical plane)- Required bandwidth?

- Control alogorithm - complexity? flexibility? Machine diagnostic techniques?

- Fundamental technology R&D in support of requirements - Kickers and pickups?

- wideband RF instrumentation, high-speed digital signal processing

Develop proof of principle processing system, evaluate with machine measurements

System Design Proposal and technical implementation/construction project plan