

## LEReC Laser Systems – Operations Post Mortem

### LEReC DC gun tests (May 5 - Aug 11, 2017)

- chiller room overtemp and chiller fuse swaps, sleep-mode of local PC for chiller)  
*installed new laser diode and chiller (Oct, 2017)*
- loss of oscillator mode-lock  
*de-coupled laser room and anteroom airducts*  
*replaced 5T Bard with 3T Bard*  
*reduced phase noise on oscillator's external rf input*
- motion controller reliability issues  
*mitigated noise-induced errors in linear and rotary motion controllers*  
*(upgraded micro-switches for operation at 25V rather than 5V and added filters)*
- half-wave plate alignment error (mechanical)  
*modified mechanics – removed 'pinch'*
- half-wave plate logic  
*changed to have HWP in during cw operation (not out) so that any rotational error will reduce laser power in cw mode and not increase leakage during pulsed mode*
- laser turnoff procedures / insufficient manpower for 24/7 coverage  
*provided procedures and training to Collider Accelerator Support staff*
- laser-related safety  
*added physical locks to all laser enclosures in RHIC tunnel*  
*(3 for CeC, 2 for LEReC and 1 common to both CeC and LEReC)*  
*integrated laser shutters into RHIC Access Controls*

➔ all above issues resolved without recurrence, laser-related safety upgrades continue

### LEReC full beamline commissioning (Mar 6 - Sep 16, 2018)

- chiller low flow fault  
*cleaned all water lines, added algaecide and corrosion inhibitors, started routine preventative maintenance*
- expert-only switch from pulsed to CW mode  
*(necessitated by drifts in EOM extinction ratio), use of new AOM will retire this complication*
- high power on cathode  
*limited by thermal lensing*

- intensity fluctuations shot-to-shot  
*improved local shielding of Calmar oscillator*  
*developed laser intensity and beam-current based feedback (>8/30/18)*
  - intensity fluctuations, 20 minute cycle  
*installed local dehumidifier (7/25/18)*  
*developed laser intensity and beam-current based feedback (>8/30/18)*
  - chiller failure (6/21/18)  
*replaced – 3 hour downtime*
  - extinction ratio  
*detailed study of system latencies*  
*relocated intensity control behind EOM*  
*achieved for operations >200:1 (sufficient for KPP requiring 30 mA, insufficient for design 50 mA beam current)*  
*use of new AOM will retire this complication*
  - extra laser pulse (7/23/18)  
*resulted after changing crystal/interferometer configuration, diagnosed and corrected using transverse-mode deflecting cavity*
  - position stability  
*slow (to correct temperature-induced position drift between laser trailer and RHIC tunnel) and fast (to mitigate air flow in laser trailer) position feedback planned*
  - laser parameter changes with laser power  
*outcome of thermal lensing*
  - laser-related safety  
*will add laser enclosure interlocks into RHIC Access Controls*  
*will add Laser Controlled Access (LCA mode for high-power laser alignment) into RHIC Access Controls*
- ➔ all above issues to be resolved with three new developments underway:
- 1) AOM procurement (due mid-November) and installation to enable >30 mA electron beam operation with extinction ratio > 300:1 (design current is 50 mA)
  - 2) Alternative approach to dealing with thermal lensing with constant power through temporal shaping crystals and intensity control moved downstream of temporal shaping, reference talk by P. Inacker
  - 3) Installation of fast and slow laser position feedback