FACET-II Radiation Safety Systems Development

Feng Tao, Brian Bennett, Nate Lipkowitz

Menlo Park, California, USA

MOPHA142

ICALEPCS 2019

Introduction

Facility for Advanced Accelerator Experimental Test (FACET)-II is an upgrade of the FACET.

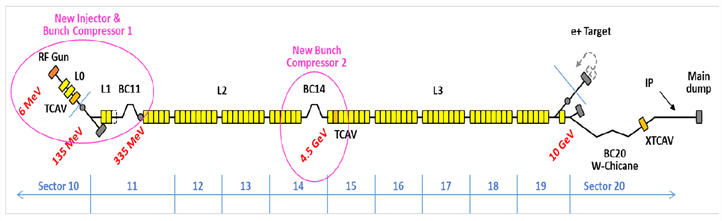
- Primary purpose: plasma wakefield acceleration
- Reduced the length of FACET by half
- Multiple stage upgrade:
  - Stage 1: new injector, two bunch compressors
  - Stage 2: positron source

RSS includes: Personnel Protection System (PPS) and Beam Containment System (BCS) has been modified with some modernization to meet the requirements

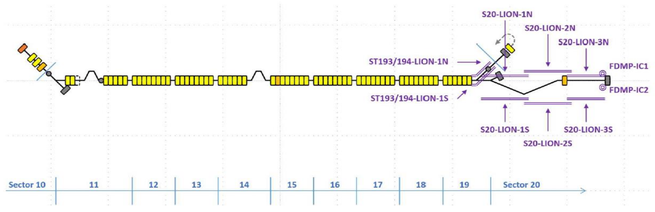
Requirements

FACET-II key parameters:

Parameter	Unit	Nominal	Range
Rep Rate	Hz	30	1 - 30
No. of bunches/pulse	-	1	1
Bunch charge	nC	2	0.5 - 5
Final beam energy	GeV	10	4 - 13
Final peak current	kA	72	10 - 130
Final beam power	W	600	2 - 1950



BCS Requirement:



3 shutoff paths:

- Gun Solid State Sub-booster from "accelerate" to "standby" timing
- Linac Sub-booster put into "staggered standby" timing state
- A dedicated laser safety shutter to block the laser to the photocathode

PPS Requirement

Interlock to RF hazards

- Gun/L0-A/L0-B/TCAV RF modulators
- Accelerating RF power supply VVSs
- Accelerating RF modulators in S19/S20

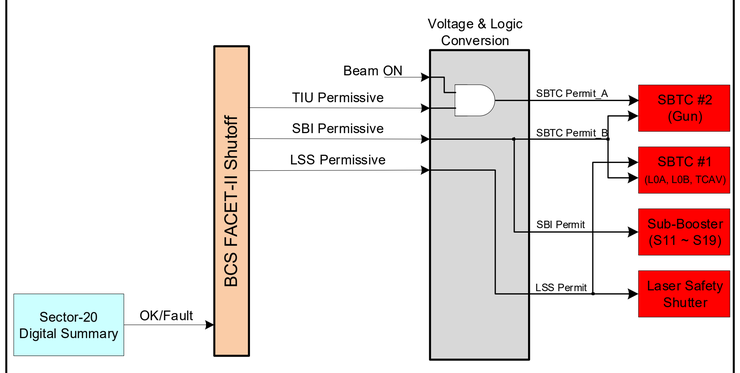
Two "stopper" sets for access:

- Positron Vault Stopper: extraction line EXT-ST1/ST2/HBEND
- Backward beam stopper: RST1F/BX01F/BX02F

3 BSOICs to detect radiation leakage

- Use Thermo Fisher ion chambers for dose rate measurement/interlock
  - One in entrance to S10 Injector Vault
  - One in entrance to Positron Vault
  - One in S20 Injector Vault

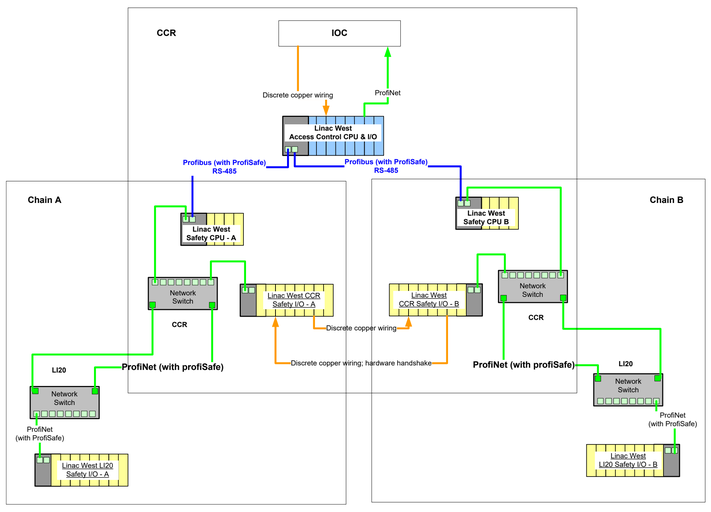
BCS System Architecture



Relocate Shutoff Chassis from MCC to S10

- S20 DSC to summarize faults from Beam Loss Monitors (BLM)
- Add a MBC remote PLC I/O drop for global operation integration: Beam ON/OFF, Reset
- Re-use the legacy connections to SBI, interface to timing system, VME crate and modules for communication to EPICS
- Re-use the existing cable plant to reduce the cost of long haul cable

PPS PLC Architecture



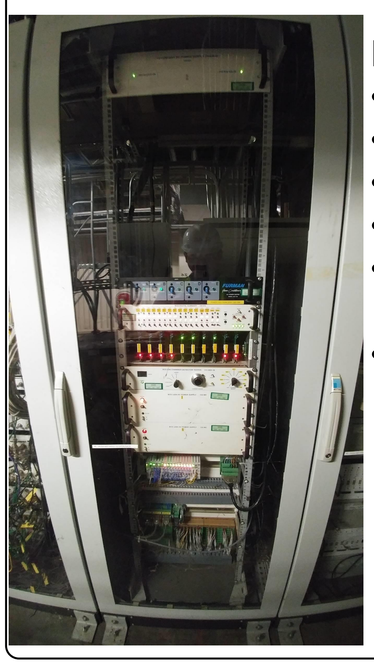
- Access control: Siemens S7-315F with standard I/O, also responsible for the state machine
- Safety control: Dual redundant S7-315F with safety I/O for safety functions
- Zone PPS: S10-S20 relay based system unchanged
- S10 Injector Vault: new PPS zone control with Siemens/Pilz for access/safety control
- Secure loop chassis: to sum up each zone PPS "Ready for beam" statau
- Set entry loop chassis: to sum up radiation generation device "OFF" status and send to PPS before it allows access to accelerator tunnel
- Legacy systems rely on CAMAC, VME for communication to EPICS
- New PLC based system directly use Siemens CM module for communication to EPICS
- Needs to exchange zone PPS status to upper stream (LCLS-II) PPS and downstream (LCLS) PPS

BCS Hardware

nmlaser shutter & controller

Digital Summary Chassis (v2)

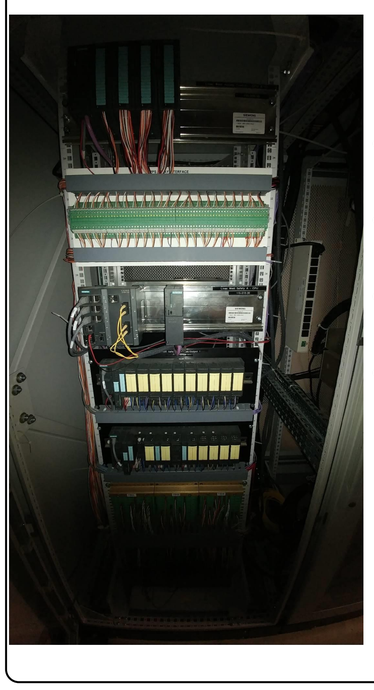
Sub-booster Trigger Chassis (v2) & Shutoff Chassis



BCS Rack in S20:

- Power Supply
- DSC
- PIC/LION
- PIC/LION Tester
- LION Power Supply
- Beckhoff I/O coupler for EPCIS

PPS Control Rack



PLC Rack in CCR:

- Access Control PLC & I/O
- Chain A safety PLC & I/O
- Chain B PLC is on the back
- Siemens HMI is in a separate rack

Conclusion

- Thorough risk assessment is important for RSS design; passive shielding can simplify BCS requirements
- Systems are adapted from previous FACET, should think about the long term upgrade path.