# LCLS PHOTOINJECTOR

## A. Introduction – Jym Clendenin

### 1. Comments on Report of Previous TAC Meeting

### 2. Current State of Injector R&D

### 3. Overall Plans and Schedule

## B. Injector Experimental Progress – John Schmerge

**GTF experiments results and plans**

## C. Simulations for Photoinjectors – Cecile Limborg

**For current GTF experiments; and**

**For LCLS photoinjector—when operating rf gun with 120 MV/m peak field**

# 1. Comments on Report of Previous TAC Meeting

## •*Increased support for injector R&D*

**Task Force for LCLS Low Emittance Electron Gun formed during period of mystery beam shapes and anomalously high emittances at GTF:**

| | |
|---|---|
| Lowell A. Klaisner | Leader |
| Jym Clendenin | LCLS Injector Manager |
| Bob Phillips | Microwave Engineering |
| Eric Colby | Gun Design |
| Roger Miller | Beam Dynamics |
| Paul Bolton | Laser |
| John Schmerge | GTF |

**Met November 2000, through February 2001—one more meeting in September 2001.**

**Useful recommendations for:**

**Improved diagnostics and beam measurements at GTF;**

**Load-lock design presented;**

**Explanations for observed beam shapes discussed. Now attributed to sharp cross over of gun solenoid pancake windings.**

**January 2001, new resources allocated to injector R&D:**

**New hire of B.S. laser physicist;**

**2 accelerator physicists added (for spring 2001 only) part-time;**

**Additional M&S funds sufficient to include upgrade of GTF control and laser systems.**

**September 2001, additional physicist (Dave Dowell) hired.**

## •*Beam dynamics and code comparison*

**Additional PARMELA simulations for GTF beam have led to many insights.**

**Simulation specialists have set up group (chaired by Eric Colby, including especially Cecile Limborg and Valentin Ivanov) to compare gun simulations using PARMELA and PIC codes:**

**PARMELA looking surprisingly good.**

## 2. Current State of Injector R&D

### •*Gun Test Facility (GTF)*

**Goals:**

**The overall goal of the GTF R&D remains a demonstration of ~$10^{-6}$ m emittance for a 1 nC beam.**

**Parameterize beam performance and compare with simulations.**

**Understand how gun design affects beam performance, e.g., how field balance affects longitudinal emittance.**

**Significant progress during past year:**

**Good QE, low dark-current using single-crystal copper cathode;**

**Laser stability, uniformity, reliability greatly improved, but at expense of laser energy;**

**Better understanding of $e^-$ beam shapes;**

**Measured emittance for 100 A beam (for <1 nC) matches simulations.**

## •*LCLS injector plans*

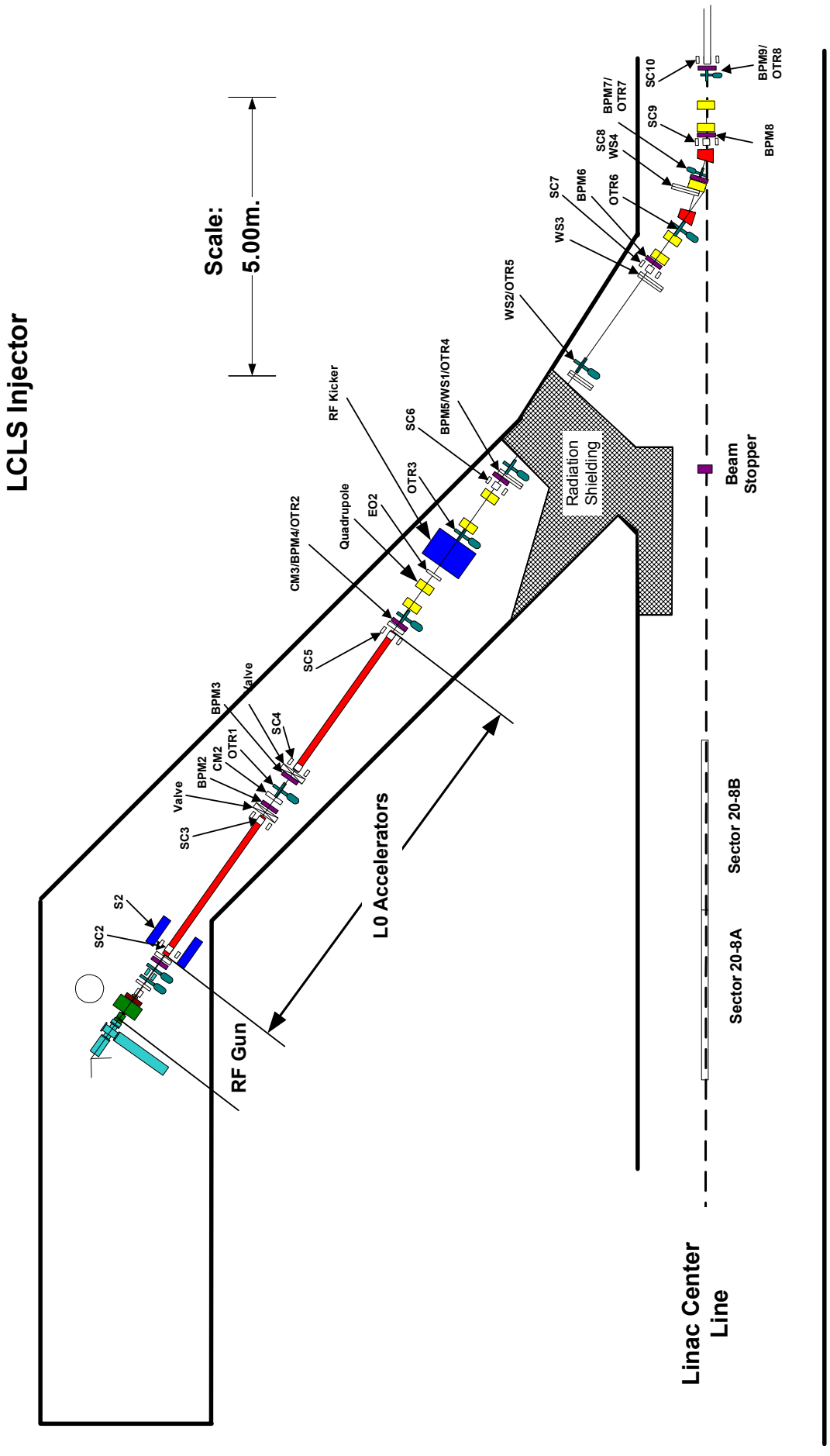
**Injector Vault.**

**The optics for shallow angle (35°) beamline have been worked out:**

- **Allows matching under wider range of injector conditions;**
- **More space for diagnostics—including rf kicker for longitudinal emittance studies;**
- **No need to cut notch in vault wall.**

**Present design to Radiation Committee in January 2002.**

**Radiation wall with appropriate penetrations to be installed during summer 2002 linac shutdown.**


LCLS Injector
Scale:
5.00m.
RF Gun
L0 Accelerators
Linac Center
Line
Sector 20-8A
Sector 20-8B
Beam
Stopper
Radiation
Shielding
S2
SC2
SC3
Valve
BPM2
CM2
OTR1
BPM3
Valve
SC4
SC5
CM3/BPM4/OTR2
Quadrupole
EO2
OTR3
RF Kicker
SC6
BPM5/WS1/OTR4
WS2/OTR5
WS3
SC7
BPM6
OTR6
SC8
WS4
SC9
BPM7/
OTR7
SC10
BPM8
BPM9/
OTR8

## •*RF gun*

**Funding for fabrication of LCLS rf gun not expected until construction funds available in FY04.**

**Plan is to use a 1.6-cell S-band symmetrized rf gun similar to present GTF gun.**

**GTF gun designed for 10 Hz. A similar gun with added cooling has been tested in Japan at 50 Hz, but LCLS will operate at 120 Hz.**

**Additional desired features:**

**Load lock;**

**Symmetric rf feed.**

**Initial conceptual design being done at BNL (Xiji Wang).**

**Large thermal gradients to be avoided;**

**Detailed thermal-mechanical simulations under way.**

**Pre-conceptual load-lock design proposed by Bob Kirby (SLAC).**

## •*Laser system*

**Funding for LCLS Ti:sapphire laser system not expected until construction funds available in FY04.**

**Development of basic system presently conceived as a 2-year project, with an additional year to finish state-of-the art details.**

**Begin low-cost R&D this year using exisiting *Coherent Mira* femtosecond laser in the polarized source lab.**

**Light shack preparations:**

**Finish clearing out building at S-20;**

**Prepare bid package.**

# 3. Plans and Schedule (leading to FY04)

| | FY02-1 | 2 | 3 | 4 | FT03-1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| **GTF:** | | | | | | | | |
| **Control system upgrade** | x | x | | | | | | |
| **Laser system upgrade** | x | x | | | | | | |
| **Basic beam measurements @ 30 MeV** | | x | x | | | | | |
| **Basic beam measurements w/o booster** | | | | x | x | | | |
| ***New working point* measurements @30 MeV** | | | | | | x | x | x |
| **LCLS Injector:** | | | | | | | | |
| **Install radiation wall** | | x | | | | | | |
| **Prep S-20 gallery room** | | ? | ? | | | | | |
| **Prepare laser room bid package** | | | x | x | | | | |
| **Install laser clean room** | | | | | ? | ? | ? | |
| **RF gun conceptual design** | x | x | x | x | | | | |
| **Laser R&D** | | x | x | x | x | x | x | x |
| **$Cs_2Te$ Cathode R&D** | x | x | x | | | | | |

**John Schmerge will report on GTF results and plans in more detail.**

**Cecile Limborg will discuss simulations for both GTF and the LCLS injector.**