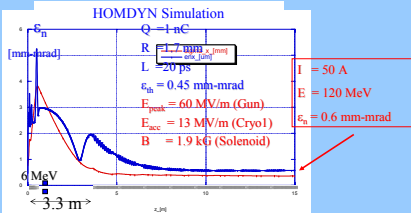
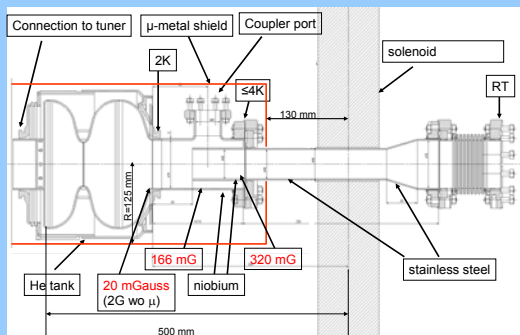


Participation in D55 Superconducting RF Guns

An ultra-high brightness, high duty factor, superconducting rf photoinjector



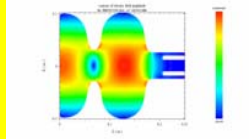
In the past, for an implementation of SRF guns it was always assumed that one needs strong focusing inside the gun, near the photocathode. This assumption has been partially driven by relatively low achievable gradient at that time. An interesting solution to transverse beam control near the cathode, so-called "RF focusing", has been proposed in. Unfortunately this method requires a deformation of the cathode plane causing nonlinear field perturbation that may cause significant emittance growth in the injector. We discuss in the next sections an alternative scheme in which RF focusing is not required. This optimized SRF gun is the scaling of existing high brightness source designs (LCLS, SPARC) to lower frequency of 1.3 GHz.



L-band SC gun design with coaxial coupler

Table 1 SRF gun parameters

f	MHz	1300
E_{peak} at cathode	MV/m	60
$\langle E_{acc} \rangle$	MV/m	32
$B_{peak} / \langle E_{acc} \rangle$	mT/(MV/m)	4.47
$E_{peak} / \langle E_{acc} \rangle$	-	1.87
Specification for Q_0	-	8×10^7
P_s at nom gradient	W	~ 20

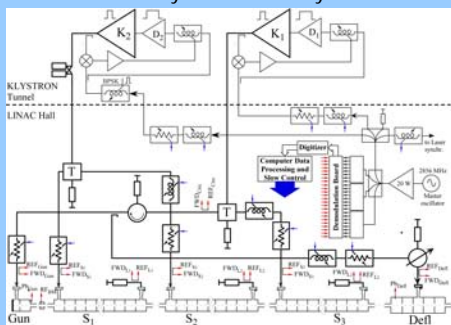


$$E_z = \frac{r}{2} \frac{\partial}{\partial z} E_z(z, 0) + \frac{r^2}{16} \frac{\partial^2}{\partial z^2} E_z(z, 0) + \dots$$

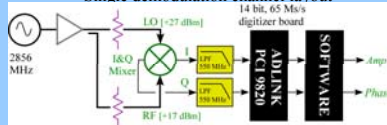
Participation in D53 Novel Feedback Techniques

Design of the SPARC RF synchronization system providing klystron intra pulse phase lock

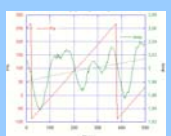
SPARC RF synchronization system



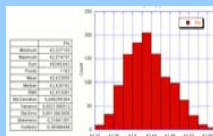
Single demodulation channel layout



Minimum detectable RMS phase noise ≈ 20 fs



Typical mixer response for amplitude (green) and phase (red)



Typical RF pulse phase noise analysis

Participation in D52 Photoinjector dynamics

Development of the RETAR code

Self-Consistent 3D modelling of electron beams: the code RETAR

This Code is developed to study the dynamics of high-brightness electron beams. The aim is to study the dynamics in photoinjectors and in magnetic compressors, where the interaction of the beam with its self-field is of crucial relevance to optimize the performances of these devices, either in all cases where the bunch is involved in strong coherent synchrotron radiation effects.

The EM self-fields are calculated directly in terms of the values of the charge density $\rho(x,t)$ at time t and at all earlier times, through the following equations (Obtained manipulating the usual retarded forms of the Lienard-Wiecher Potentials)

$$\mathbf{E}(\mathbf{x}, t) = \int d\mathbf{x}' \rho(\mathbf{x}', \tau) \mathbf{Q}_E(\mathbf{x} - \mathbf{x}', \tau)$$

$$\mathbf{B}(\mathbf{x}, t) = \int d\mathbf{x}' \rho(\mathbf{x}', \tau) \mathbf{Q}_B(\mathbf{x} - \mathbf{x}', \tau)$$

velocity terms

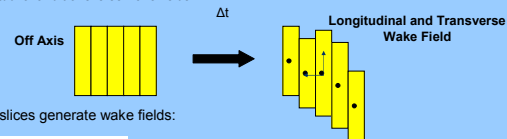
$$\tau = t - \frac{1}{c} |\mathbf{k} \cdot \mathbf{x}| \quad Q_E = \frac{n \cdot (\mathbf{n} - \beta) \cdot \beta}{|\mathbf{k} \cdot \mathbf{x}|^3 (1 - \beta \cdot \beta)^2} \quad \frac{n \cdot \beta (1 - \beta \cdot \beta)^2}{r^2 |\mathbf{k} \cdot \mathbf{x}|^2}$$

$$Q_B = \frac{n \times (\beta (1 - \beta \cdot \beta) + \beta \cdot \beta \cdot \mathbf{n})}{|\mathbf{k} \cdot \mathbf{x}|^3 (1 - \beta \cdot \beta)^2} \quad \frac{n \times \beta (1 - \beta \cdot \beta)^2}{r^2 |\mathbf{k} \cdot \mathbf{x}|^2}$$

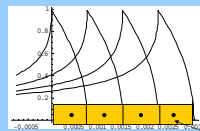
Radiation terms

Development of the HOMDYN code

- off axis beam dynamics
- Longitudinal and transverse wake fields



The single slices generate wake fields:



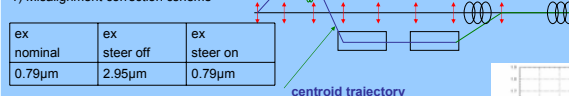
$$E_z^W(x_{i0}, \xi_i) = \sum_{j=1}^N q_j x_{i0} W_z(\xi_i)$$

$$E_y^W(x_{i0}, \xi_i) = \sum_{j=1}^N q_j y_{i0} W_y(\xi_i)$$

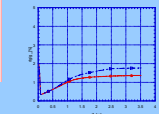
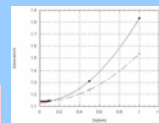
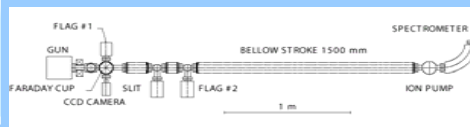
$$E_z(\xi_i) = \sum_{j=1}^N q_j W_z(\xi_i)$$

Wake fields for a single cavity: diffraction model
Wake fields for a periodic structure: asymptotic wake fields obtained numerically and fitted to a simple function

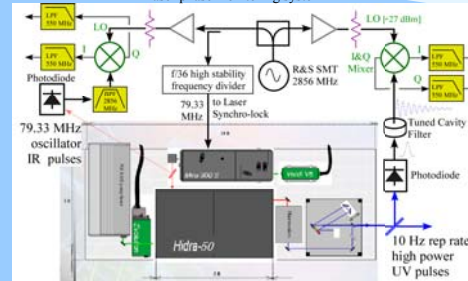
Applications to the SPARC project:
1) Misalignment correction scheme



Energy Spread and Emittance Degradation in the Emittance meter



Laser phase monitoring system



Preliminary laser phase noise measurement results:

• IR pulses, 79.33 MHz rep rate measured phase noise ≈ 650 fs rms (lowest measured value)

• UV pulses, 10Hz rep rate measured phase noise ≈ 630 fs rms (lowest measured value)