Center for the Advancement of Natural
Discoveries using Light Emission

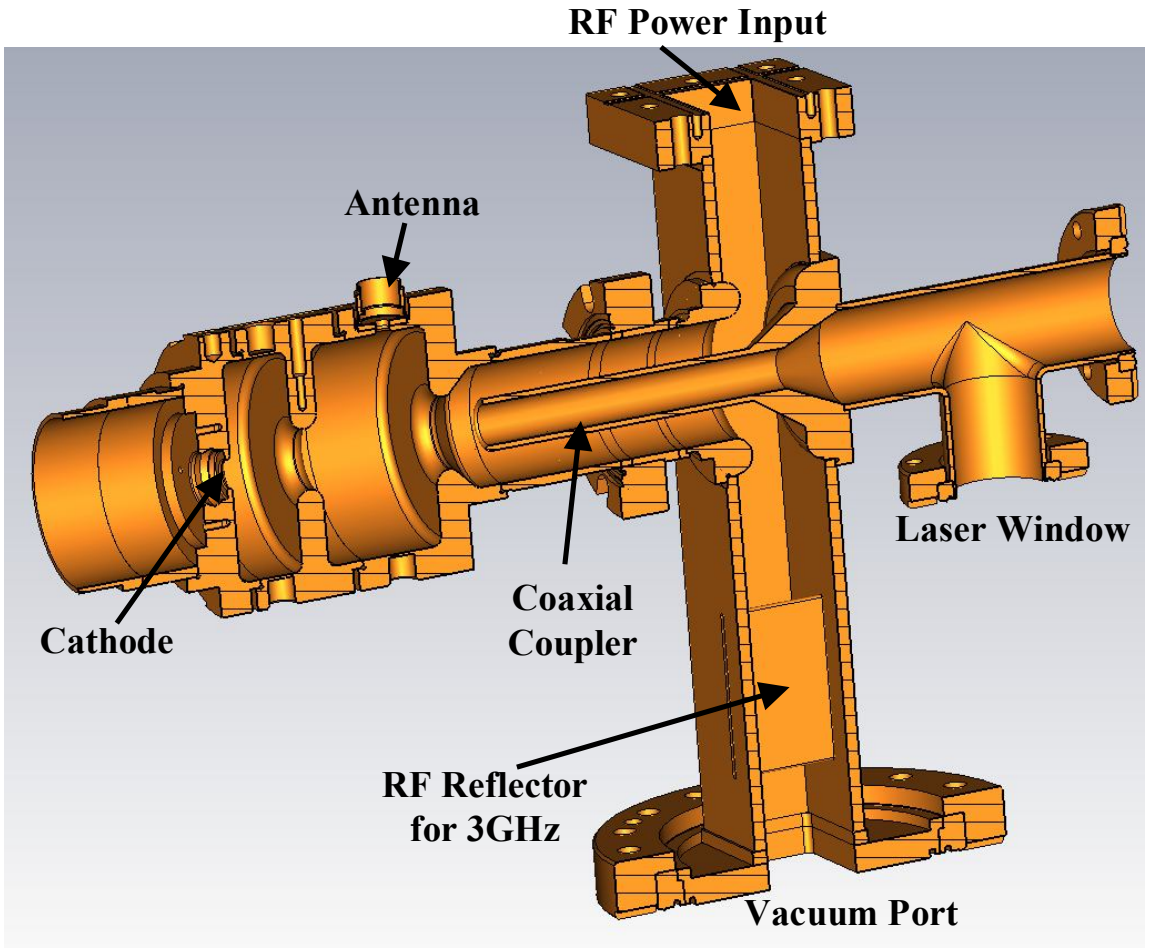
RF Gun Design and Performance for AREAL Linac

Andranik Tsakanian

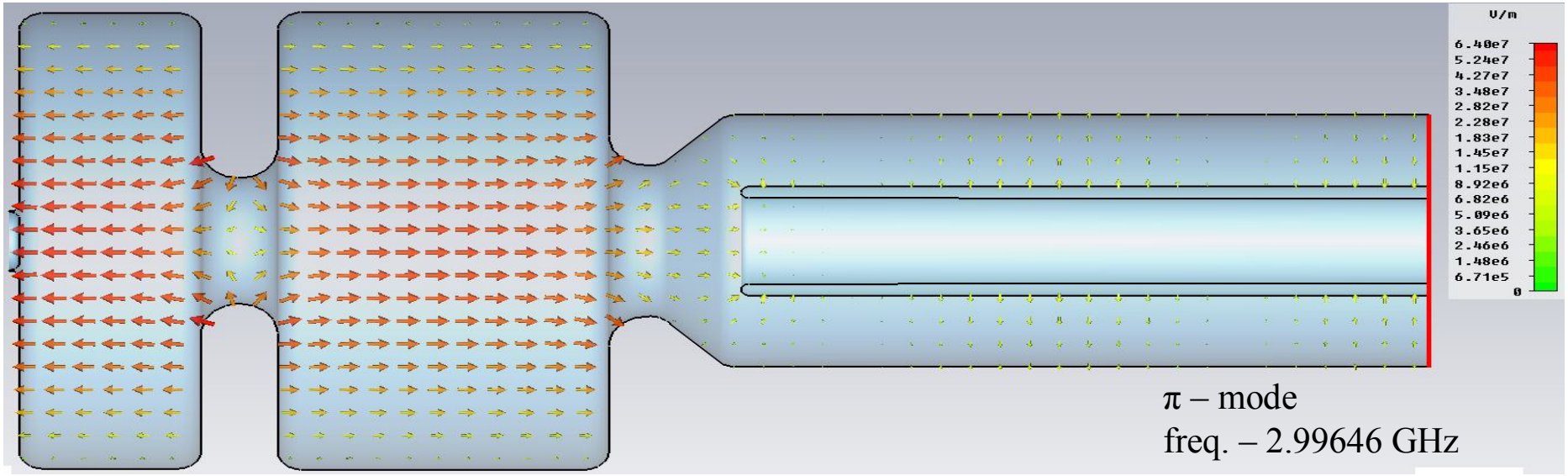
CANDLE, Yerevan, Armenia

CANDLE
26 June 2012

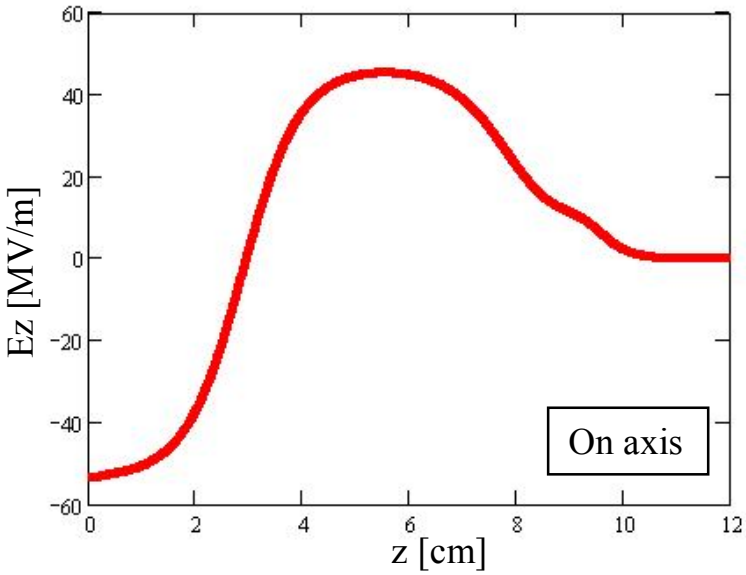
Layout of S-band Photocathode RF Gun
(DESY Design)



Resonant TM010 mode

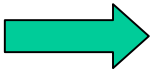


Cavity parameters for TM 010 resonant mode	
Frequency – f [GHz]	2.99646
Unloaded quality factor – Q_0	15292.34
Shunt impedance – R [MΩ]	4.234953
R/Q_0 [Ω]	276.933
External quality facor – Q_e	15434.52
Loaded quality factor – $Q=(1/Q_0+1/Q_e)^{-1}$	7681.55
Coupling factor – $\beta=Q_0/Q_e$	0.99
Natural filling time (loaded/unloaded) – $\tau=Q/(2\pi f)$ [μs]	0.408



Expecting parameters for *6MW* input power

AREAL design parameters (single bunch mode)	
Bunch charge	10 – 200 pC
Bunch length	5 – 10 ps
Repetition rate	1 Hz



Expected cavity parameters for *P=6MW* input power	
Maximum acc. voltage $V_{acc} = \sqrt{P \cdot R / Q_0 \cdot Q_e}$	5.07 MV
Maximum acc. *Ez* field	117.3 MV/m
Maximum beam power $P_b = I_b \cdot V_{acc}$	~ 1mW

Expecting parameters for *6MW* input power

AREAL design parameters (single bunch mode)	
Bunch charge	10 – 200 pC
Bunch length	5 – 10 ps
Repetition rate	1 Hz

Expected cavity parameters for *P=6MW* input power	
Maximum acc. voltage $V_{acc} = \sqrt{P \cdot R / Q_0 \cdot Q_e}$	5.07 MV
Maximum acc. *Ez* field	117.3 MV/m
Maximum beam power $P_b = I_b \cdot V_{acc}$	~ 1mW

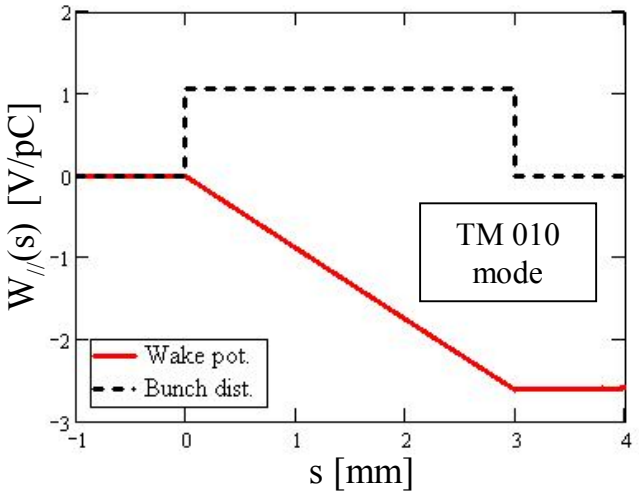
Beam induced voltage on TM 010 accelerating mode (Wake fields)

Wake function → $w_n(s) = 2K_n \cos\left(\frac{2\pi f_n}{c} s\right) e^{-\frac{s}{c\tau_n}}$ $\qquad K_{010} = \frac{2\pi f_{010}}{4}\left(\frac{R_{010}}{Q_{010}}\right) = 1.315 \frac{V}{pC}$

Wake potential → $W_n(s) = \int_{-\infty}^{s} w_n(s-s') \cdot \rho(s')\, ds'$

Beam loading

Maximum induced voltage by 200pC bunch and rectang.-charge distribution (L=3 mm) → $V_{b,induced} = 0.525\, kV$



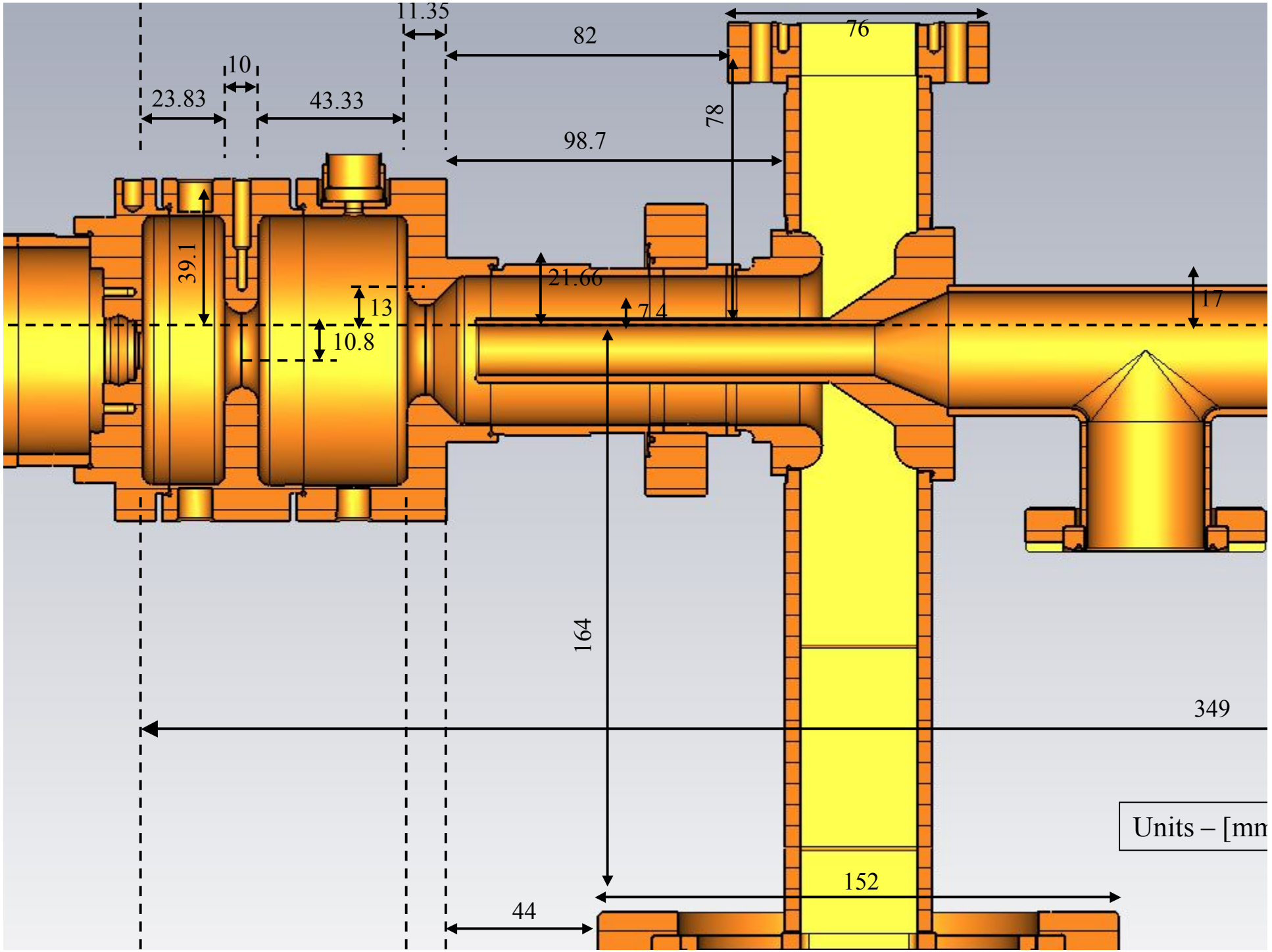
Further Steps

- Coupler performance
- Coupler optimization for solenoid space

Further Steps

- Coupler performance
- Coupler optimization for solenoid space

Thank You for Attention!


11.35
82
76
10
23.83
43.33
78
98.7
39.1
21.66
13
7.4
17
10.8
164
349
Units – [mm
152
44