Wake Fest 07 - ILC wakefield workshop at SLAC

BEAMLINE HOM ABSORBER

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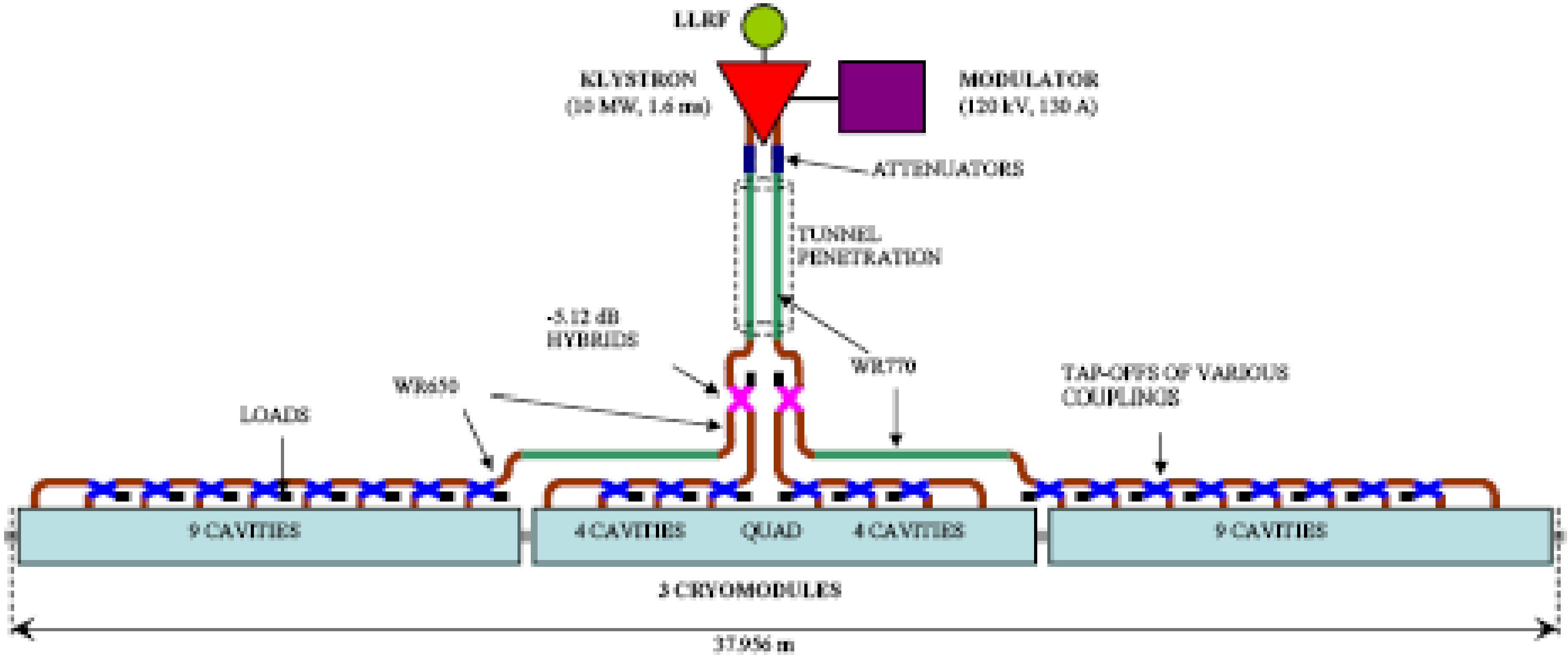
December 11, 2007

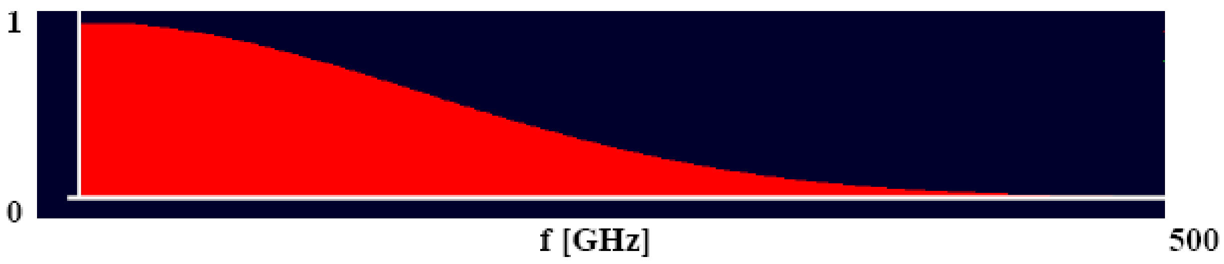


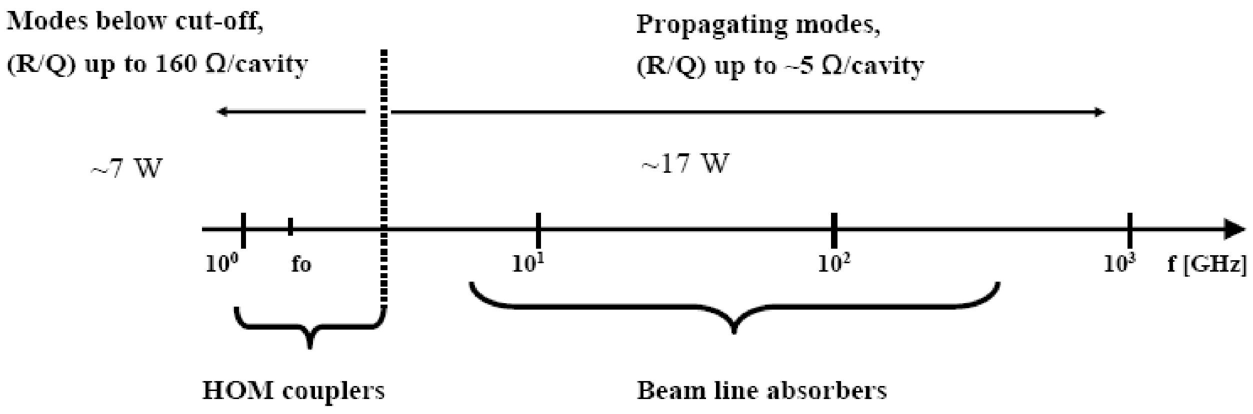
An ILC main linac rf unit.

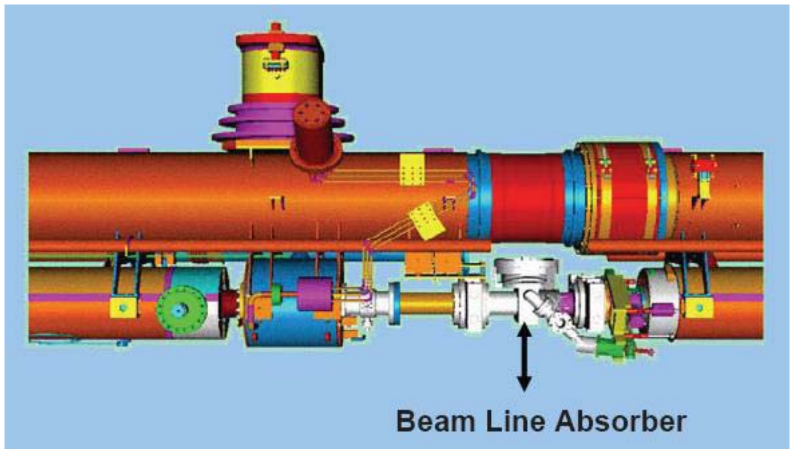
RF frequency 1300 MHz
Accelerating gradient 31.5 MV/m
Average beam current in pulse 9 mA

Bunch charge 3.2 nC
Bunch length σ_z=300μm
Number of bunches per pulse 2625

Beam spectrum: 3.2 nC, σ_z = 0.300 mm, $\Delta f_{i,i+1}$ = 2.967 MHz







T.Higo, et al, IId ILC Workshop

HOM losses:
(M. Dohlus, absorber_zeuthen_dohlus.pdf)

$f_{rep} = 5$ Hz
$T_{HF} = 0.95$ ms

a) Collider (500GeV)

$\sigma_{bunch} = 400\ \mu m$
$N_{bunch} = 2820$
$q_{bunch} = 3.2$ nC (9.5 mA)

losses per module (12x9cells):

$P =$ 23.3 W
$P(f > 5$ GHz$) =$ 17.4 W
$P'(f > 10$ GHz$) =$ 12.7 W
$P'(f > 20$ GHz$) =$ 8.1 W
$P'(f > 50$ GHz$) =$ 3.0 W
$P'(f > 100$ GHz$) =$ 0 .7 W

A loss factor dependence vs. the bunch length
(I. Zagorodnov, T. Weiland, TESLA 2003-19)

$\sigma, \mu m$	Numerical	Analytical	TDR
1000	86.4	90.2	90.4
700	95.9	95.8	95.6
500	105	104	103
400	110	110	108
300	117	116	114
250	122	120	117
125	135	133	128
75	138	141	134
50	143	146	138

Table 1.Comparison of the numerical and analytical loss factors in V/pC.

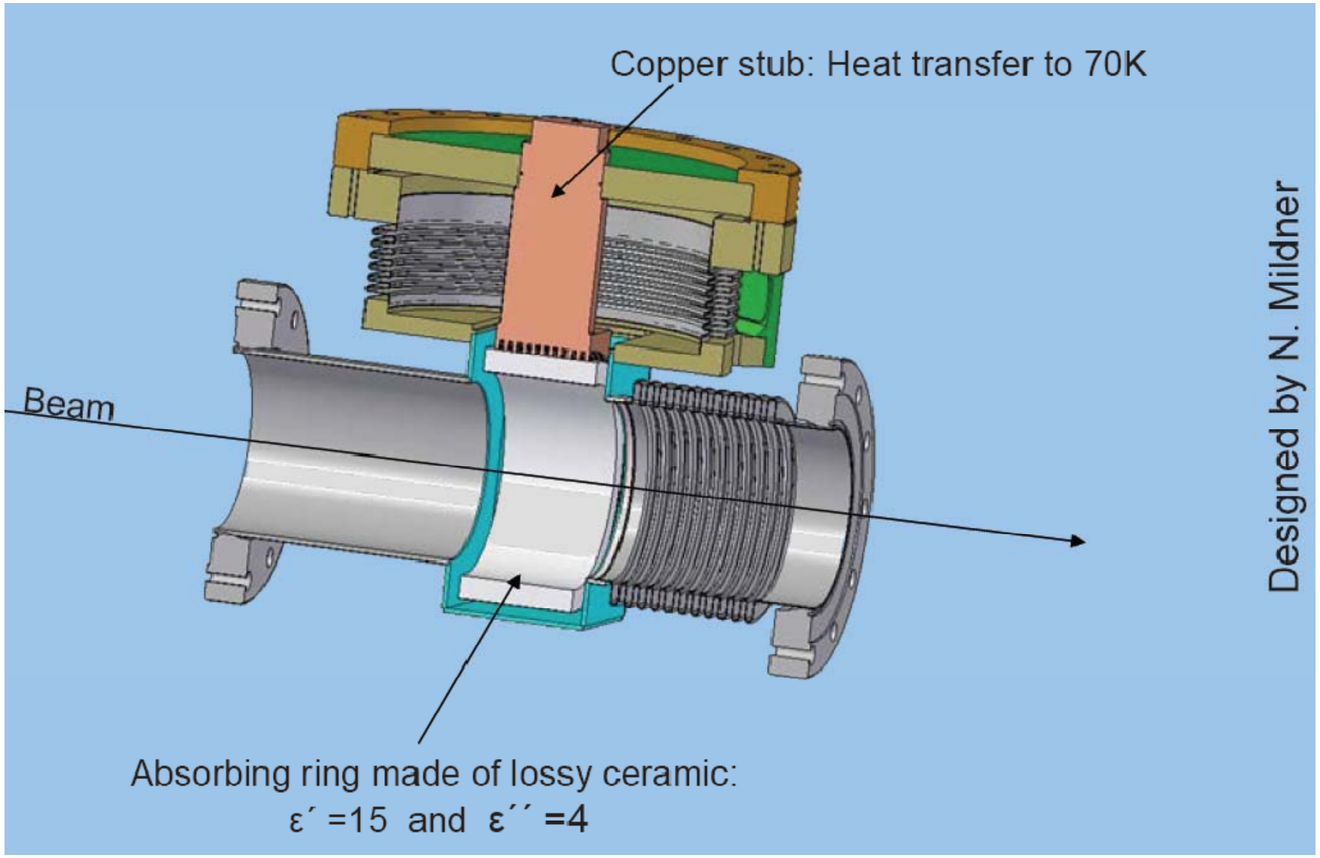
For a 300-µm bunch, the total losses in 8x9cells are about **16 W**. The cut - off frequency for TM01 mode is ~ 2.9 GHz. The power in the propagating modes equal **~ 12 W**.

Losses in the cryo-module:

Ohmic losses in the RF structure,	2K:	6.0 W
Vacuum chamber* (image currents),	4K:	0.08 W
Bellows* (image currents),	4K:	0.07 W
Valve	4K:	0.01 W
Static losses	2K:	1.7 W
HOMs (estimations):		
Vacuum chamber*,	4K	0.8 W
Bellows*,	4K	0.5 W
HOM losses in the RF cavities	2K	need to be determined!
(depend on the HOM absorber efficiency)		

*Stainless steel, no Cu coating

DESY HOM absorber:



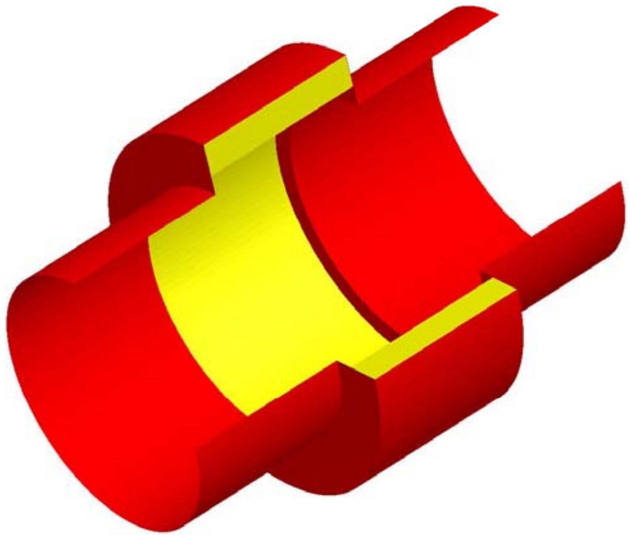
- Lossy material- Ceradyne 137 CA .

- Various materials were investigated, and Ceradyne137 CA was found to be most relevant.

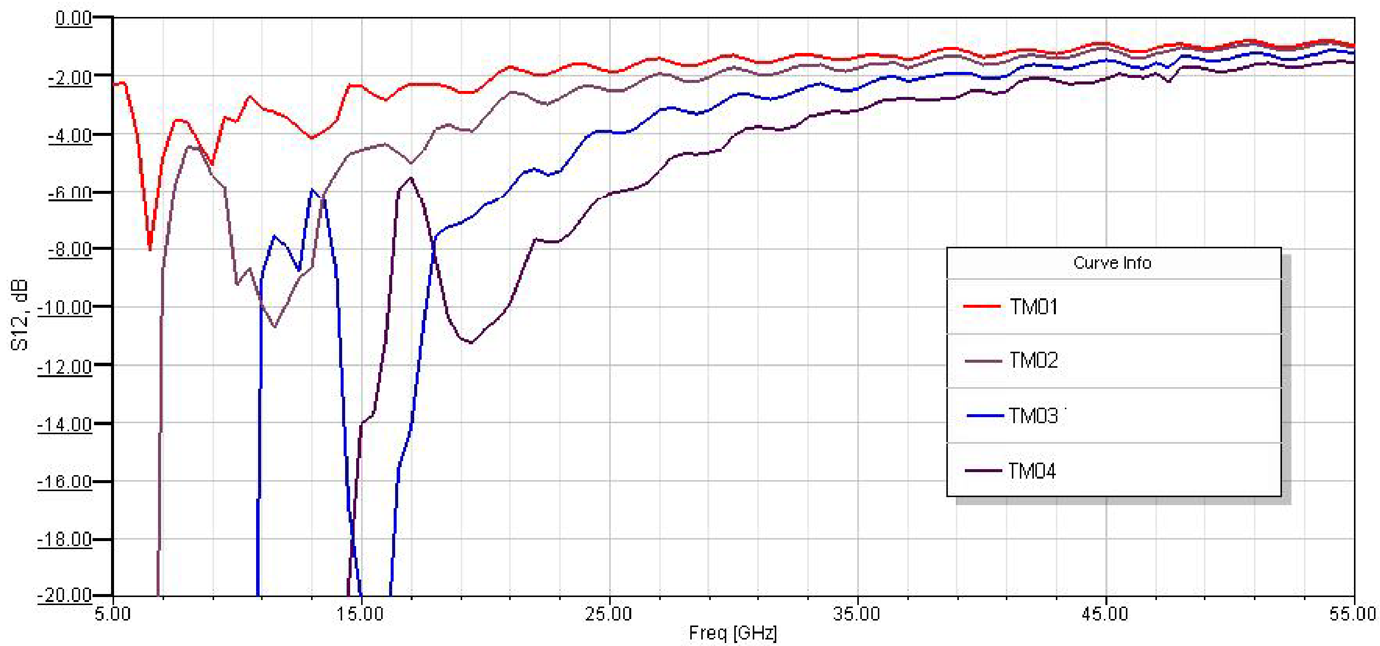
- Parameters: ε =20-40, loss tangent 0.2-1.

- Ceradyne characterization:
  - Cornell: 78 K, transmission line measurements (1-40 GHz);
  - DESY: pillbox (2-9 GHz), X-band taper (10-15 GHz).

Absorption efficiency estimations.



Simple model of HOM absorber: the ring has the length of 50mm, internal diameter of 90 mm, and the thickness of 10mm (DESY style).



- At the frequencies higher than ~30 GHz absorption is about 20% and decreases when the frequency increases.

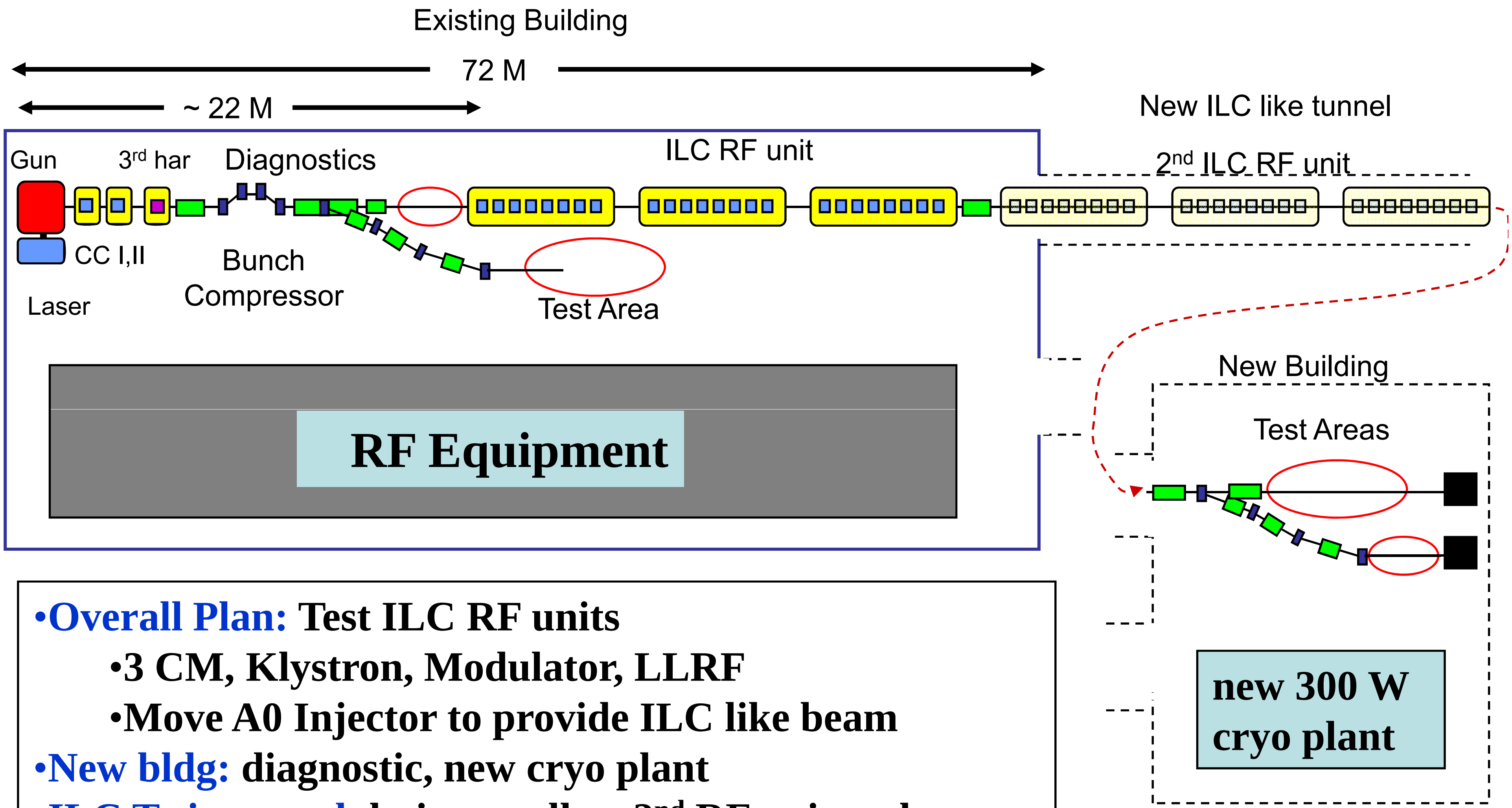
- Efficiency is smaller when the ring internal diameter is the same as the beam pipe diameter, or 78 mm.

- Various dimensions were analyzed and DESY dimensions were found optimal.

- Note that RF losses in the cavities increase with the frequency.

- HOM absorber efficiency will determine HOM losses in the cavities, and thus, **the total cryogenic losses**.

RF Unit Test Facility



- **Overall Plan:** **Test ILC RF units**
  - **3 CM, Klystron, Modulator, LLRF**
  - **Move A0 Injector to provide ILC like beam**
- **New bldg:** **diagnostic, new cryo plant**
- **ILC Twin tunnel** **design to allow 2nd RF unit and to study tunnel layout and maintenance issues**

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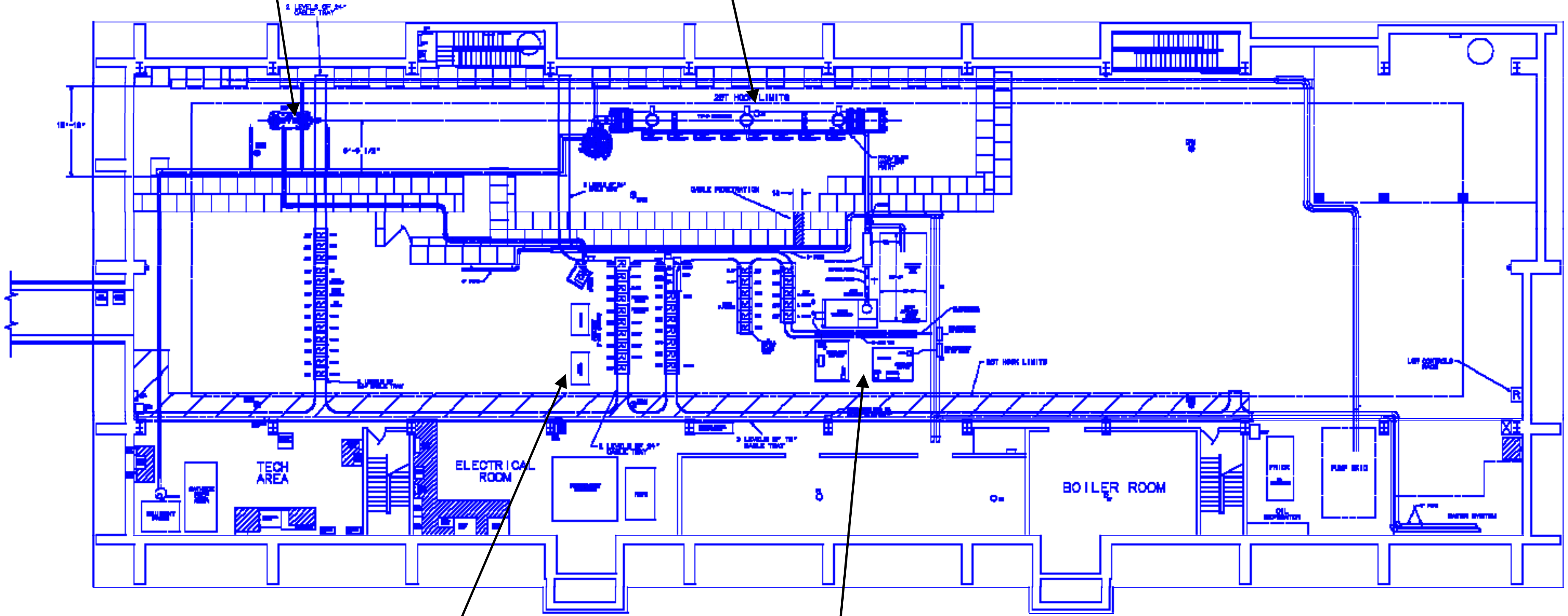
Phase-1 Layout

Capture Cavity 2
(CC2)

Cryomodule-1
(CM1) (Type III+)



CC2 RF System

5 MW RF System
for CM1

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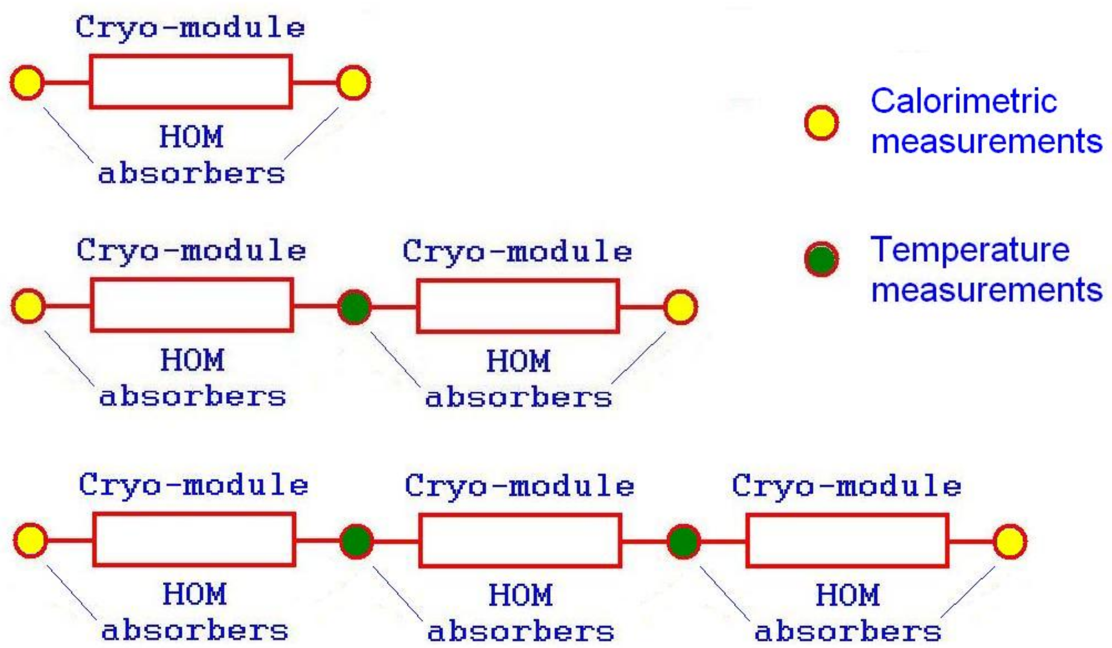
Direct measurements of the HOM losses:

- Measurements of the power dissipation in HOM absorbers at NML.
- The number of modules in NML will be increased one at a time;
- The power absorbed in HOM absorbers will be measured for different number of modules.
- The power loss vs. the number of modules will allow to extrapolate the losses distribution between the HOM absorbers and RF cavities for the long system.



Summary

The Ceradyne rings characterization is planned.

•At frequencies below 10 GHz measurements are consistent (DESY);

•At higher frequencies the measured data spread is higher (Cornell);

•Special measurements are planned up to 40 GHz using tapered waveguide.

Calorimetric and temperature measurements of the losses in HOM beam pipe absorbers are planned.