ARES : THE INFN PROJECT

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1. *Introduction*

ARES, a specially funded accelerator development program includes LISA at LNF, and R&D programs on SC cavities and RF Guns both at LNF and in the University-based partecipating INFN Sections.

R&D activities are briefly described in a separate paper. We only mention here that, as concerns RF cavities, the year 1991 was mostly dedicated to setting up a cavity handling and test facility, including a vertical cryostat. Two 500 MHz 4-cell cavities (one bulk Nb and the other Nb film on Cu) are being manufactured in industry. On RF guns, theoretical and preliminary experimental work towards a photoemissive, SC gun, capable of high peak and average current has been done.

LISA is a small accelerator physics and SC-RF test-bench linac [1] .It will also serve for an IR FEL experiment (SURF) funded in collaboration with ENEA-CRE Frascati [2]. Its construction stage is now near completion and commissioning is scheduled to start in December; full operation and activities on the FEL experiment are scheduled for 1992.

The most relevant parameters of the accelerator and of the FEL are listed in table 1.

2. *LISA costruction progress report*

All major main accelerator components have been delivered and orders placed for most parts of the 25 MeV linac output transport line.

Table I - Parameter list of the LISA accelerator and FEL.

Nominal energy	25	MeV
(with recirculation)	(49)	MeV
Bunch charge	40	pC
Microbunch length	1.3	mm
Microbunch repetition frequency	50	MHz
Peak current	6	A
Duty cycle	<10	%
Invariant emittance	10^{-5}	π m rad
Energy spread (@25 MeV)	$2\ 10^{-3}$	
Macropulse frequency	10	Hz
Undulator periods N	50	
Undulator wavelength λ_u	5	cm
Radiation wavelength @ 25 MeV	11÷18	μm
Optical cavity output coupling	2	%
Optical cavity passive losses	5	%
Power in cavity	6	KW

1 A.Aragona et al., 1988 EPAC Proc. (World Scientific, Singapore,1989) p. 52

2 M.Castellano et al., Nucl.Instr. and Meth. A296 (1990) 159

The last months of 1991 will be devoted to commissioning the injector and to the completion of the RF cavity installation and cryogenic circuit.

The 100 keV thermionic gun has been tested separately: a 1 ms long pulse of 200 mA @ 100 keV was obtained with a normalized rms emittance, measured at 90 keV, of 8 10^{-6} m rad. This performance fulfils the design requirements.

Table 2- LISA RF cavity parameters

Frequency	MHz	500
Nominal accelerating field	MV/m	5
r/Qo	Ω/m	380
Nominal Qo @ 4.2 °K		2 10^9
Number of cavities		4
Number of cells		4
Active length	m	1.2
Voltage /cavity	MV	6
Power/cavity @ 1.3 mA	KW	7.8 (12)
Qext		6.5 10^6
Bandwidth	Hz	77

The 1.1 MeV injector [3] is mechanically fully assembled and ready for cabling. All main components have been laboratory tested at full specs and commissioning in the accelerator hall is expected to start in October.

A detailed measured field map has been produced of each magnet and of the spectrometer forming the 1.1 MeV arc, because large fringe field effects call for accurate modelling of the beam transport .

The four 4-cell, 500 MHz, bulk-Nb SC cavities, ordered from industry and whose parameters are listed in Table 2, have been factory tested in a pulsed regime before delivery.

Stand-by losses and unloaded Q were measured calorimetrically, the loaded Q was evaluated measuring the He bath evaporation rate, the accelerating field has been measured using a calibrated probe. Field emission.was also monitored.

In the pulsed RF mode all cavities reach average accelerating fields in excess of the specified 5 MeV/m without quenching, although at lower Q_0 than expected. The zero-field limit value of Q_0 is also within specs. The measurements of Q_0 vs E_{acc} are shown in fig.1.

CW operation at the design field of 5 MeV/m required more cooling power than available at the factory; this limitation is expected to be overcome after 'in situ' He processing and RF conditioning

The refrigeration plant consists of a closed-cycle helium refrigerator and of the cold box and transfer lines to the four cryostats. The 300 W @ 4.5 °K , TCF 50 Sulzer refrigerator, installed and tested, can handle the following heat loads at 4.2 K° : cryostat static losses ≈ 20 W, transfer line and distrib. box static losses ≈ 15 W, RF heat production within the cavities ≈ 160 W. Some extra capacity is left to shorten the cool-down time and provide the required safety factor.

The refrigerator also supplies the fluid for 80 °K cooling of both the cryostat radiation shields and the distribution system.

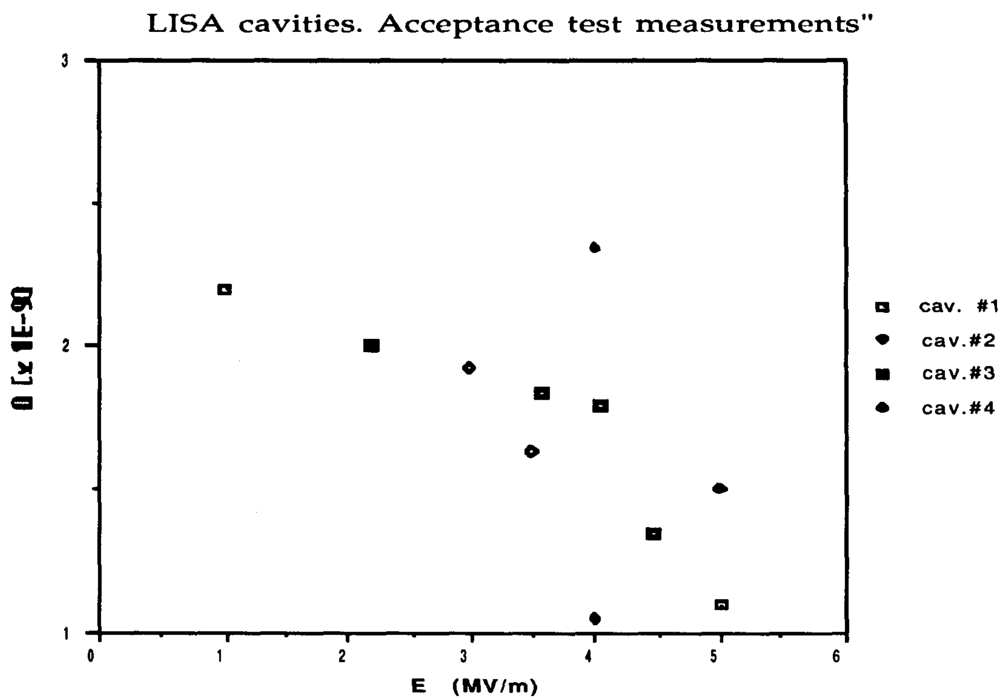

Figure 1. Pulsed-RF test of the LISA 4-cell modules

Its automatic remote controller manages the various operation modes : cool-down , warm-up, recovery from failure , emergency procedures etc.

3. *Gun test and emittance measurements*

The main gun characteristics are listed in Table 3. Extensive tests have been carried out at various anode voltages and beam currents . Emittance has been measured by the fixed screen - variable focusing method: the beam spot picture on the screen is acquired by a frame grabber and recorded on disk for off-line analysis.. The pulse length ~ 1 ms corresponds to FEL operation mode. Measurements of longer pulses, or at higher repetition rate, were prevented by the excessive power deposited in the fluorescent screen.

TABLE 3. LISA gun: main characteristics

	Design	Measured
Perveance [µP]	6	6
Current [mA]	200	300
Energy [KeV]	100	100
Emittance [mm mrad] @ .2 A	≤ 10	8

The measured emittance versus current, at various anode voltage, is plotted in fig.3. The normalized emittance at the nominal operating condition is 8 10^{-6} m rad, consistent with the design value.

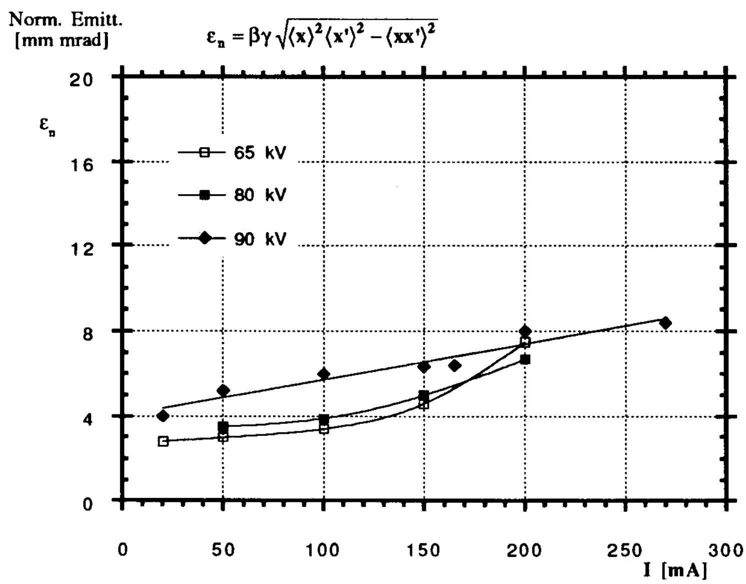

Figure 2 . LISA Gun : emittance versus current.

4. *FEL progress.*

The magnetic elements of the 25 MeV transport line (Linac to FEL) will be delivered by industry in October. The detailed design of the vacuum chamber, the diagnostics and the ancillary equipment is under way. The assembly of the hybrid NdFeB permanent magnet undulator, designed by Ansaldo and ENEA, has been completed. Preliminary measurements indicate a rms variation in field amplitude of 0.3% [3]. Detailed magnetic measurements and fine tuning are under way. The mirror holders and the terminal vessels of the optical cavity are in construction.

[3] F.Rosatelli et al., San Francisco Particle Accelerator Conference 1991