HIGH POWER PROTON LINAC PROGRAM IN KOREA

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Abstract

The final objective of KOMAC (Korea Multi-purpose Accelerator Complex) project is to build a 20 MW (1 GeV, 20 mA, cw) high power proton linear accelerator which is used for basic researches, industrial applications, and nuclear transmutation. Since 1997, KAERI (Korea Atomic Energy Research Institute) has been developing a front end of KOMAC, which consists of a injector, 3MeV RFQ and 1MW RF system. The front end is the 1st phase of KOMAC development, and developed in KTF (KOMAC Test Facility). The second stage of the KOMAC project is to extend the proton energy to 100MeV. A feasibility study has been performed and a proposal was approved by the Korean government. The project will start in the middle of the year 2002. The KOMAC project also includes programs related to utilizing the proton accelerator for developing the advanced technologies such as nano-technology and bio-technology. The details of the KOMAC project will be presented in this conference.

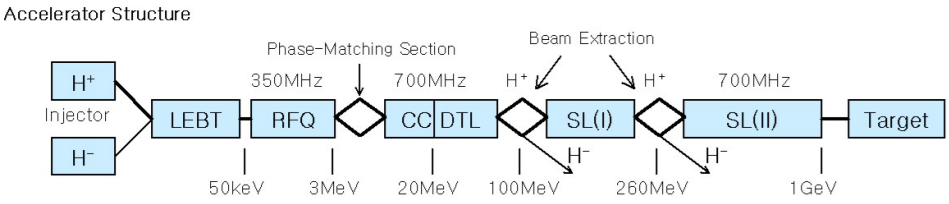
1. INTRODUCTION

Since 1996, KAERI had proposed to build a high power proton linear accelerator of 1GeV and 20mA under the KOMAC program. Figure 1 shows the accelerator structure and parameters of KOMAC. The key issue of the KOMAC design is to accelerate both H+ and H- to 1GeV while partially extracting H- at 100 and 250MeV. The major H+ beam (18mA and 1GeV) will be used for nuclear waste transmutation and nuclear physics experiments while utilizing the minor H- beam (2mA) for the basic research and medical therapy study. As the 1st phase of the project, KAERI had developed the proton accelerator technologies in KTF. In the KTF, 3MeV proton accelerator have been constructed and tested. The 2nd phase of the project was approved by the government, and will start in September 2002.

2. 1ST PHASE PROGRAM OF KOMAC

In the 1st phase, we have developed a cw proton accelerator technologies at KTF where 50keV proton injector, LEBT, 3MeV RFQ, and 1MW rf system, CCDTL cavity are developed. Initially it will be operated in 10% duty pulse mode and then extended gradually in cw operational mode. The status of KTF is shown in Figure 2.

The technology developed in KTF had been used for industrial applications, such as ion irradiators and surface modifications of polymers. The development of beam applications and the technology transfer to industry are important issues in KOMAC project. For 2nd phase of the project, the technology transfer to industry and the beam applications will be enhanced.



Design Parameters

Parameter	RFQ	CCDTL1	CCDTL2
Frequency (MHz)	350	700	700
Input/Output Energy (MeV)	0.05/3	3/20	20/100
Input/Output Current (mA)	23/20	20/20	20/20
Transmission (%)	95.4	100	100
Average Gradient (MV/m)	-	0.57	0.85
Length (m)	3.24	29.8	94.2
Synchronous Phase (deg)	-(90-31)	-(60-30)	-30
Quadrupole Lattice Period	-	8βλ	8βλ
No. of Quadrupoles	-	130	173
Quadrupole G•L Prod. (T)	-	2.6	2.6
Trans Emitt. (π mm-mrad)*	0.2/0.23	0.32	0.32
Long Emitt. (π deg-MeV)*	0.246	0.57	0.60
Aperture-Radius (mm)	2.4-3.6	5-7.5	10
Aperture-Radius/RMS-Beam Size	-	4-6	8
Copper RF Losses (MW)	0.350	1.15	3.43
Total RF Power Required (MW)	0.418	1.49	5.03
Power per Klystron (kW)	1000	1000	1000
No. of Klystrons	1	2	6

Parameter	SL1	SL2	SL3
Frequency (MHz)	700	700	700
Optimized β	0.45	0.53	0.71
Input/Output Energy (MeV)	100/140	140/260	260/1000
Input/Output Current (mA)	20	20	20
# of Cells per Cavity	6	5	4
# of Cavities per Cryostat	4	4	4
# of Cryostats	4	12	74
Average Gradient (MV/m)	1.64	1.64	1.64
Peak Surface Field (MV/m)	<18	<18	<18
Length (m)	24.4	73.2	451.4
Synchronous Phase (deg)	-30	-30	-30
No. of Doublet Quads	4	12	74
Trans Emitt. (π mm-mrad)*	0.32	0.32	0.32
Long Emitt. (π deg-MeV)*	0.60	0.60	0.60
Aperture-Radius (mm)	40	45	60
Aperture-Radius/RMS-Beamsize	32	36	48
Coupler Power (kW)	50	50	50
Power per Klystron (kW)	1000	1000	1000
No. of Klystrons	1	3	19

Figure 1: Schematic Layout of the KOMAC Linac

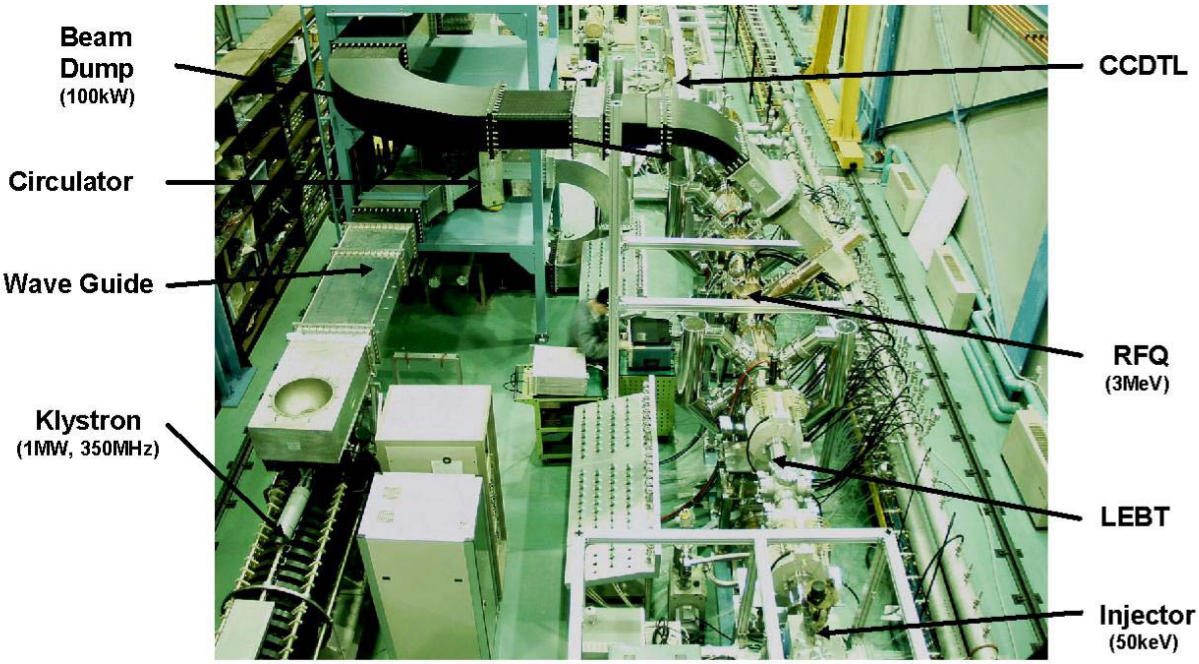


Figure 2: Plan of KTF 20MeV Accelerator

3. 2ND PHASE PROGRAM OF KOMAC

The government launched "21C Frontier R&D Program" to enhance national capability in science and technology. The 2nd phase KOMAC program, "Proton Engineering Frontier Project" had been approved as a Frontier Project.

The goals of 2nd phase KOMAC program are as follows;

- Construction of 100MeV proton linac
- Development of beam utilizations and applications
- Promotion of Related Industrial Technologies

The project schedule, the accelerator development, and beam utilization plan are shown in Figure 3.

The site preparation will be set up with the condition that land, ground leveling and related supporting facilities will be provided by a host institution or province. The site will be selected after the evaluation in Jun. 2003.

The major beam utilization and application areas are as follows;

- Functional Material & Beam Machining
- New Gene Resources
- Simulating Radiation Environment in space
- Fast Switching Power Semiconductor
- User Program Development

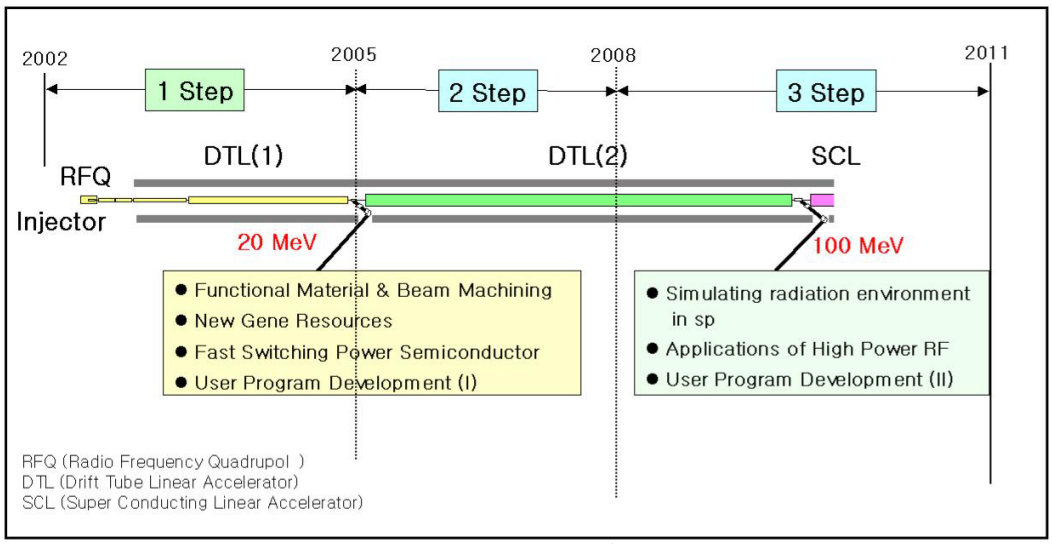


Figure 3: Approved Program of 2nd Phase of KOMAC

4. A POSSIBILITY FOR FURTHER PROGRAM EXTENSION

Figure 4 show the application areas of proton beam, and it is clear that for future needs of proton beam, an accelerator of GeV are required. For GeV proton accelerator, as R&D of 2nd phase KOMAC project, the following technologies, that are the technical issues, will be developed;

- Negative Ion Source
- Continuous Beam Sharing
- Super-Conducting Cavity

With GeV accelerator, the KOMAC program will be extended to spallation neutron source and its applications.

The KOMAC User Group is already formed. About a hundred of experts from the fields of material science, life science, nuclear science, physics and industry are joined in the group. Within the program, the KOMAC project will support the User Group who will be the major users of GeV accelerator for many application areas.

5. CONCLUSION

KAERI is developing the KOMAC program that consists of 1GeV proton linac for an accelerator driven transmutation experiments and an additional purposes in the industrial, and basic science areas as Korean national research facility. In the 1st phase of KOMAC, the KTF accelerator which includes injector, LEBT, RFQ, CCDTL and RF system has been developed. In parallel, applications with keV and MeV accelerators are being developed such as ion irradiators, surface modification of polymers. In the 2nd phase, an 100MeV linac and several beam lines of 20MeV and 100MeV will be constructed, and several applications with high current proton beams, and an user program for future extension of the program are planned.

ACKNOWLEDGEMENT

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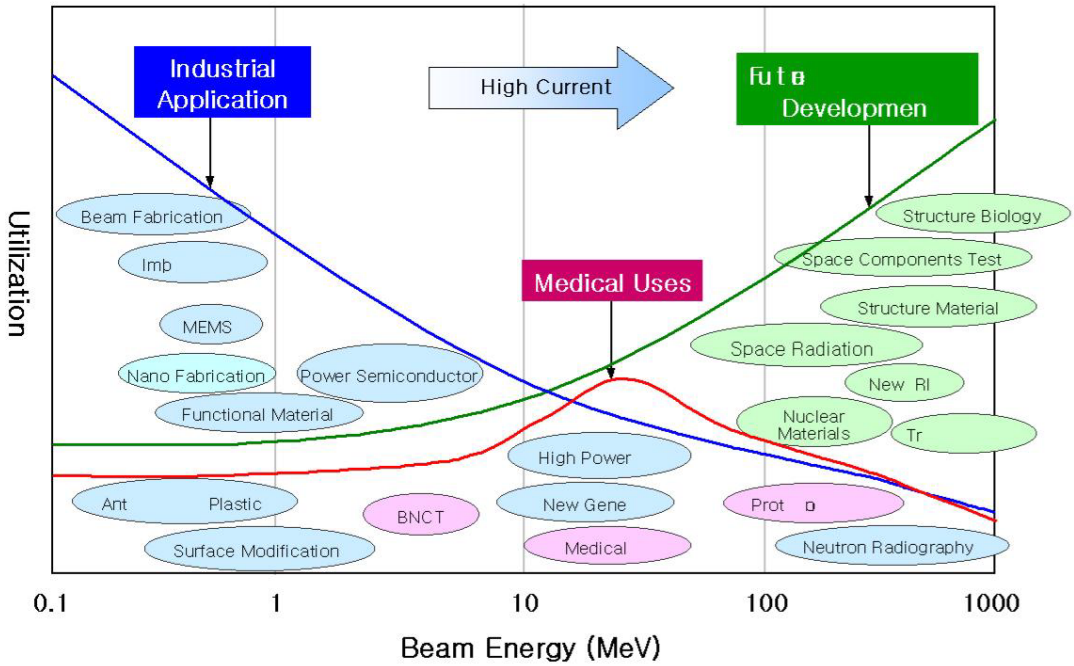

Figure 4: Role of High Power Proton Accelerator