25 October 2016

Delay on:	**Milestone MS34 –** ***New Frascati beam line components installed***
Delivery date in Annex 1:	M18 (October 2016)
Expected delivery date:	M30 (October 2017)
Short justification for delay	Delay in funding of additional magnets and vacuum components from INFN due to general review of the overall Beam Test Facility (BTF) upgrades project.

The improvements of the Frascati beam-test facility (BTF) object of Task 15.4 (Improvements of the test beam infrastructure at INFN-LNF) are based on the doubling of the existing beam-line. A second beam-line has to be added in the BTF experimental area, by splitting the beam with a fast dipole and a two-way vacuum pipe. This would allow to run in parallel two different setups, but requires to realize and install a second set of beam diagnostics, both for the monitoring of the beam intensity, and of the beam spot size and position.

The new magnetic elements and vacuum components are funded by INFN. The project has been subject to a review of the INFN Machine Advisory Committee (MAC) prior to getting full funding of the BTF upgrades project. The new planning has however caused a delay of the bidding process for the new beam-line components, requiring to postpone the milestone from month M18 to M30. This will probably impact on the deliverable *D15.4 – New Frascati beam line*, due to the necessary commissioning of the new lines with beam.

1. INTRODUCTION

Test beam and irradiation facilities are the key infrastructures for research in high energy physics detectors: WP15 comprises improvements of test beam and irradiation facilities at various European sites which address these demands and are designed towards qualitative and quantitative enhancements of possibilities offered to users.

The INFN Frascati Beam-Test Facility (BTF), delivering electrons and positrons in the 50-750 MeV energy range, has been successfully running and fully booked since 2004 [1-3]. In order to improve the access capability, a second beam-line will be added in the BTF experimental area, by splitting the beam with a fast dipole and a two-way vacuum pipe. The installation of a Bremsstrahlung target and the new tagging dipole for the photon beam on the second line will double the BTF capacity but will require the installation of a second set of beam diagnostics for the monitoring of the intensity, spot size and position of the beam. The existing GEM time-projection trackers, will equip one of the two beam-lines. A new tracking system capable of providing a real-time feed-back on the beam spot size and position, as well as a fast and accurate (<1 mrad) measurement of the direction of the particles will be realized for the other beam line.

2. PROGRESS OF TASK 15.4.1

2.1 BEAM LINE DESIGN AND PREPARATION

The new beam-lines will be derived from the existing BTF transfer line. The existing BTF line derives from the end of the LINAC and includes a beam-attenuating system made by a target, collimating and momentum-defining slit collimators and a momentum-selecting dipole magnet. A 10 m transfer line with two FODO quadrupole doublets finally drives the beam to the BTF experimental hall.

In the new configuration the beam will be split in two branches immediately after entering the BTF hall: the final part of the existing beam-line will be modified in order to allow a better beam quality and control, while a second line will perform a further 105° turn to drive the beam into a second hall, currently used as BTF control room, as shown in Fig. 1.

Fig. 1 BTF line splitting plan.

The final design of the beam line has been carefully optimized in order to get the required beam parameters, in particular sub-mm beam spot size and <1 mrad beam divergence, in both the new BTF lines [4].

The specifications of the new magnets have been prepared, as well as the requirements for the vacuum system. The actual design of vacuum pipes, supports and all mechanical parts is under way.

From the infrastructure point of view, in order to realize a new beam-line in the hall currently used as a control room, two main activities have to been carried on: a new control room has been equipped (not immediately next to the BTF main hall, but few meters away), so that it will be possible to modify the former control room as a second experimental area. In order to cope with the radiation protection rules, in particular it will be necessary to realize a shielding capable of keeping the radiation doses outside the area within the required limits.

At the same time, a complete FLUKA simulation has been developed, in order to evaluate the dose rates map as a function of the new shielding configuration, in the hypothesis of realizing a bunker with removable shielding blocks, as in the present BTF experimental hall (see Fig. 2).

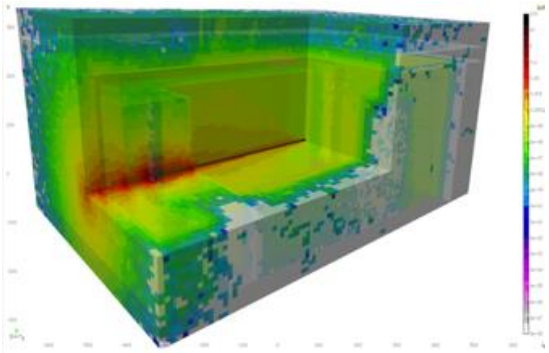

Fig. 2 New BTF bunker simulated dose rate with FLUKA.

2.2 PROJECT REVIEW AND FUNDING

The funding of the new elements (magnets, mechanics and vacuum) is provided by the INFN, and is estimated around 1 M€, only for the doubling of the BTF line. The doubling of the BTF lines is part of an extensive upgrade of the BTF and LINAC, submitted to the INFN management, costing about 4 M€.

Due to the amount of required resources, the INFN management implemented an extensive review of the project which was performed by the INFN Machine Advisory Committee (MAC). The aim of the review was to advise the INFN and Frascati Laboratory managements on: establishing priorities in the upgrade program; checking the personnel resources, especially in terms of possible interference with other large projects planned in the Laboratory in the medium and long term; and finally identifying possible criticalities.

A first presentation from the responsible scientist for BTF and its upgrade (P. Valente) took place at the first INFN-MAC meeting[1], on Nov. 12, 2015. The Committee, even though evaluating positively the project progress, asked for a detailed document aiming at clarifying, in addition to specific technical points, the time-plan of the upgrades and the interaction with the Laboratory and its accelerators activities.

A detailed report, with a revision of the time planning of the project, was then released[2], and presented in a second meeting of the INFN-MAC, on March 16-17, 2016.

The response of the Committee has been positive, and within the BTF upgrades project, priority was given to the most urgent consolidations of the LINAC and to the preparation and installation of the new BTF lines; the energy upgrade of the LINAC was instead considered a lower priority.

[1] The INFN-MAC meetings calendar can be found at https://agenda.infn.it/categoryDisplay.py?categId=788

[2] https://arxiv.org/abs/1603.05651

Minutes of the meeting were sent to the INFN Executive Committee in May 2016. We report here an unofficial translation of the relevant findings and recommendations, with the permission of the INFN-MAC chairperson (A. Variola, INFN):

- *The presentation was thorough and the illustrated cost solid. The division in work packages for the LINAC upgrade and for the experimental area upgrade well matches the costs with the different activities.*
- *A close follow-up for the radiation protection dossier for the new experimental hall is recommended.*
- *A strong and continuous coordination with the Laboratory direction is recommended for securing the availability of all specialized professionals needed for the different phases of the project. This personnel availability has to be compatible with all other Lab activities.*

Even though the final green light for the financial resources needed for the LINAC consolidation and BTF new beam-lines has been finally given in summer 2016, this has shifted the possibility of issuing the large bids procurement of the new magnets to the last months of 2016.

2.3 NEW PLANNING FOR NEW BEAM LINE

The definition of the elements of the new lines has been completed; since the full funding has been finally granted, the procurement of the magnets, mechanical and vacuum parts, can be started, compatibly with the administrative procedures, between the end of 2016 and the beginning of 2017.

According to the new plan, shown in the GANTT chart in Fig. 3 and 4, the bid procedures will be started after the final validation of the specifications. We expect five to six months for the completion of the bids, and three months for the delivery of the magnets and the other parts.

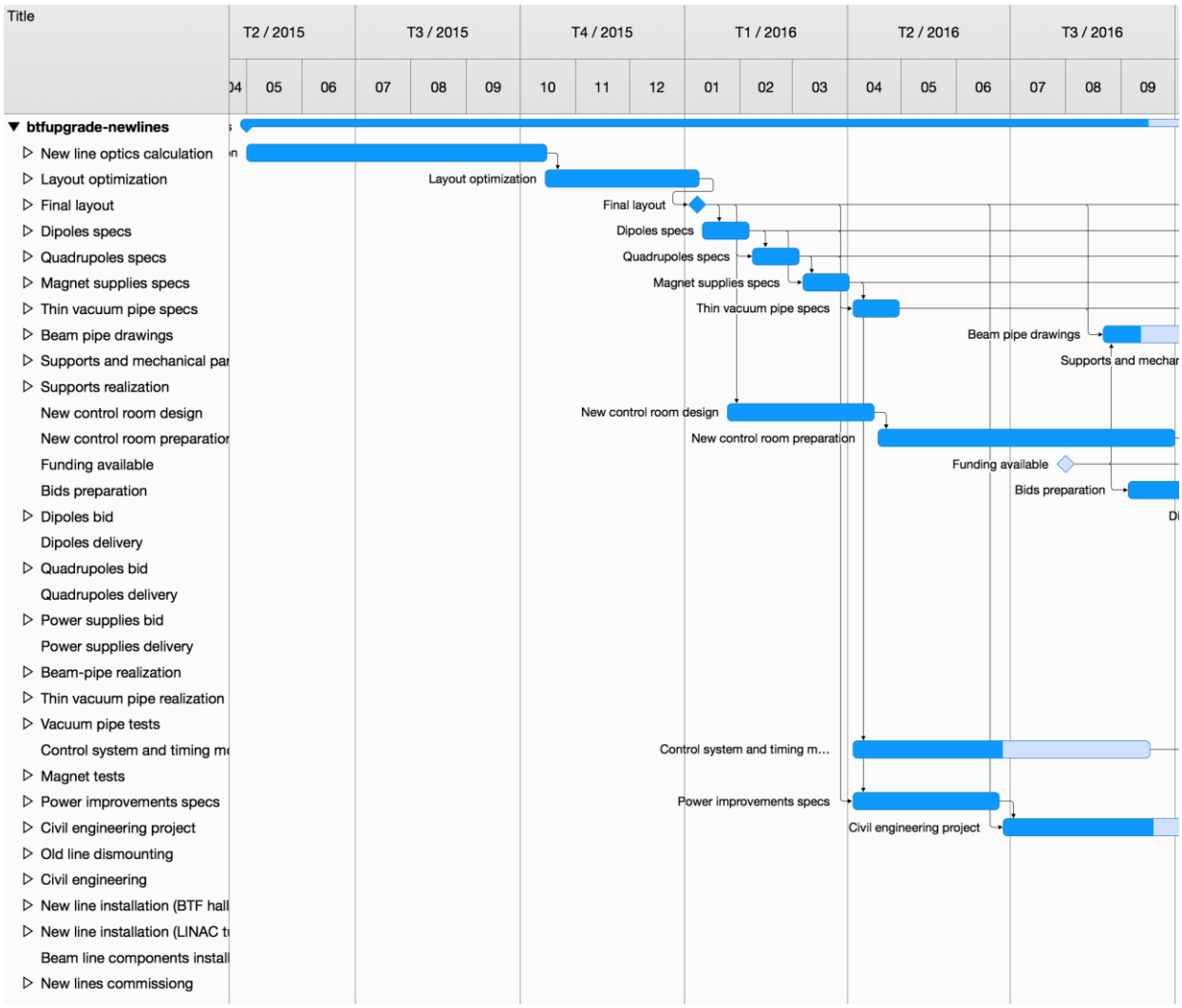

Fig. 3 BTF line splitting updated planning (until T3-2016).

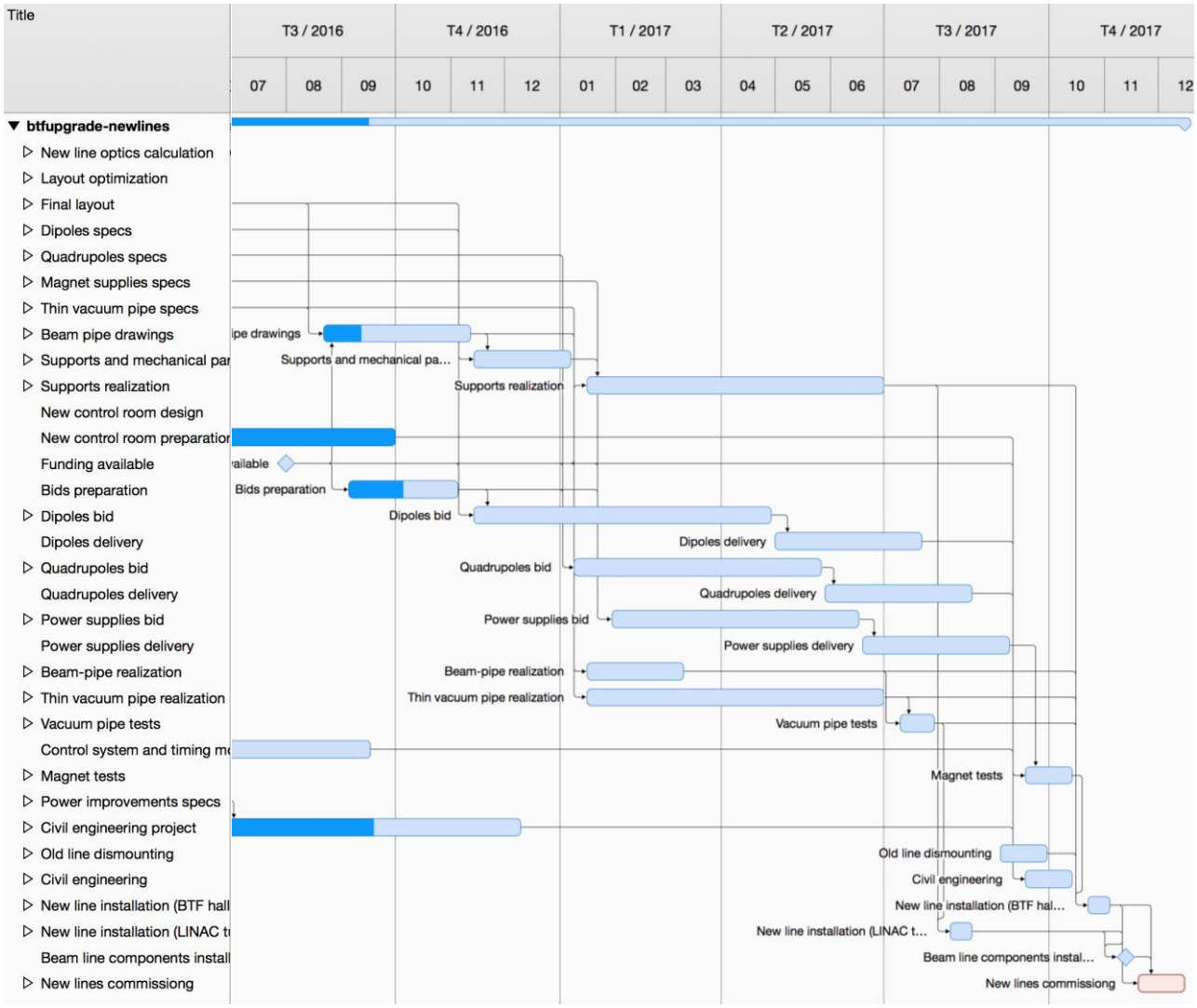

Fig. 4 BTF line splitting updated planning (from T3-2016).

3. CONCLUSIONS

The milestone MS34 will be delayed by approximately 12 months, as shown in the new plan in Fig. 2, from M18 to M30. The activities that require the dismounting of the old BTF beam-line and thus stopping the activities of the facility, as well as – for a shorter amount of time (approximately two weeks) the LINAC – are now foreseen for the 2017 summer extended shutdown. This is needed in order to allow the delivery and test of the new components, especially magnets, and for minimizing the impact on the activities of the accelerator complex. As a consequence, the activities in the last months of 2017 are quite compressed. Nonetheless, this is expected since this is the final phase of the project when all separately developed components will be assembled together in the new lines.

The preparation of the new beam detectors, services, controls, etc. will be proceeding in parallel with the activities related to the beam-lines upgrade, so that the one-year delay of this milestone can be re-absorbed at least partially, minimizing the impact on the corresponding deliverable.

The most important effect of the delay in the revised plan is indeed that of pushing the commissioning of the new lines very close to the date originally foreseen for the deliverable (D15.4: New Frascati beam line – M30) and of the other task milestone (MS70: Photon tagging components installed – M30).

The main concern is that this new planning foresees a few weeks for the commissioning with beam of the installed components and the verification of the beam parameters, which leaves very little margin for unexpected issues during the tests with beam. Any problem in the commissioning phase will then directly affect the time of the deliverable by a period up to 6 months.

4. REFERENCES

[1] B. Buonomo et al. IEEE Trans.Nucl.Sci. 52 (2005) 824-829.
[2] P. Valente et al., Nucl.Phys.Proc.Suppl. 150 (2006) 362-365.
[3] B. Buonomo et al., Conf.Proc. C0806233 (2008) THPC143.
[4] P. Valente et al., arXiv:1603.05651 [physics.acc-ph].