Beam Physics Note
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La Taxe Optique

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Abstract: So that we can see.

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1 Introduction

Pilot beam threading methodology at ISAC fiducializes expected transmissions and beam profiles from manually established saved tunes [1]. Operators are made to qualitatively reproduce expected diagnostic measurements when preparing beam for experiments, using these as a starting point. Historically, there has been a lack of systematic model based investigations at TRIUMF-ISAC, owing to a variety of factors which are outside the scope of this document.

This has resulted in a status quo in which precisely built optics models of the ISAC accelerator and transport lines [2, 3, 4, 5, 6, 7, 8] in the code TRANSOPTR[9] cannot explain the on-line state of the tune in many occasions[10]. As an example, recently undertaken development investigations by the beam physics group have found that the OLIS terminal must be considerably detuned from model predictions to achieve expected beam properties[11]. Another case is encountered at the ISAC-DTL, where model computed optics settings are frequently found to underperform manual detuning[12] on-line. This paradoxically suggests that both the assumed σ-matrix and machine transfer matrices deviate from assumptions. It is consequently arduous to establish concordance between machine and model.

As a response to this, the TRIUMF high level applications (HLA)[13] project has been initiated, aiming to develop software capable of assisting operators in the establishment, maintenance and diagnosis of tunes. However, this endeavour is premised on the assumption that the system is theoretically controllable by optics models. The example of such an application, quadrupole scan tomography at ISAC[14], has further evidenced the difficulties in using model based HLAs. In that particular case, a tomography web application has been developed, only to find that computed settings do not agree with on-line diagnostic observations. A subsequent investigation of the OLIS transport line revealed a series of deviations from the design drawings [15] including a misplaced quadrupole and changes to spherical bend skimmer configurations.

The central premise of this report is that, without model-machine concordance, the HLA endeavour at TRIUMF cannot feasibly be expected to succeed; operations will always be forced to retreat to manual detuning in order to achieve satisfactory beam delivery. Repeated experience has also shown that it is exceedingly difficult and time consuming to train a pool of operators on such manual methods, since they are ultimately imprecise and hard to quantify.

2 Taxation With Representation

This state of affairs results in the perpetual burdening of both the Operations and Beam Delivery groups for machine configuration. This further renders difficult the involvement of operators in the development of beams, which in turn further alienates them from beam physicists. It also limits awareness of the latter vis-à-vis pressing issues which are routinely encountered on-line. Coordinators in both operations and beam delivery must then constantly intervene to deliver beams to experiments on-schedule, which concentrates tuning experience and yeomanry in a still more restricted set of hands. As the ARIEL era begins at TRIUMF, with an anticipated tripling of delivery and a corresponding increase in subscription, this is untenable.

The remainder of this document explores an alternative model by which this undesirable state of affairs can be brought under control and ultimately reversed. Changes will be required to both the philosophy which revolves around the tuning of beams, the nature of the operator role at ISAC and their relationship with beam opticians. In turn, the latter will have closer dedicated interactions with operators, providing them a constant set of eyes upon the apparatus, as the pursuit of remedy to perennial issues is undertaken.

It has been observed by Baartman[16] and Planche[17] that 520 MeV operators narrowly collaborate with beam physicists in the sandbox of dedicated beam optics development shifts[1]. In particular, regularly scheduled beam development, owned by and answerable to the Beam Physics group, dually acts as an opportunity for ongoing operator training while also providing beam opticians with much needed access to the apparatus. Given the sliding shift schedule followed by RIB Operators at ISAC, regular scheduling will also democratize tuning and training opportunities, maximizing fairness amongst all operators.

Postulate 1: There is a need for regular beam development at TRIUMF-ISAC, owned by the Beam Physics group, which involves RIB Operators as part of continuing on-the-job training.

So that this development and interaction time is equitable and can proceed free of the pressures of the beam delivery schedule, it must also be as strongly decoupled from the former as much as possible.

Postulate 2: ISAC beam development must be separate from beam delivery considerations; experiment delivery tunes must be established during dedicated setup time, which does not overlap with development.

In the further interest of equitability and inclusion of all operators, they must be the agents which are allowed to tune during these shifts. Additionally, in order to maximize opportunities for operators, development should span more than a single operator shift, minimally two shifts but optimally three.

Postulate 3: RIB operators at ISAC must be made available to tune during these development shifts; this must be an operational priority otherwise divisional goals will likely not be achieved.

[1] Beam optics development ”beam development” is in this document understood as being separate from ion source or beam composition development.

Postulate 4: A full 24 hour time period for development would encapsulate three consecutive operator shifts; it is therefore seen as the optimal format.

As there exists a (quite reasonable) rule within the RIB Operations group by which radioactive beam is given operational priority in times of short staffing, due to both its high demand and limited availability, thought must be given to potential friction by this structure.

Postulate 5: An operator per shift must be identified in advance and scheduled as the participant for development. This operator will not be considered available for either maintenance or radioactive beam interventions during their shift. Alternate staff must be made available to relieve this operator during this period.

The nature of the measurements and exercises which are carried out will likely change from one development period to the next. These may be sequential, in which the work carried out by the first operator shift is continued by the second and so on. Alternatively, the exercise may be self contained within a single 8-hour period, meaning each operator during the development period repeats the entirety of the manipulation. In any case, a clear outline of the work must exist beforehand.

Postulate 6: All development shifts must be accompanied with a pre-existing procedure document, which will be elaborated by the Beam Physics group and provided to the participating on-shift operators in advance. This will include manipulations and specifications as to what documentation is expected.

Postulate 7: The development shifts belong to the Beam Physics group in the same manner that experiment time belongs to experiments. Only the Beam Physics group can opt to forfeit the time for alternative use, should it judge it necessary.

Finally, there is a question of frequency, which depends on a multitude of factors. These development periods should be scheduled such that each of the active RIB operators has a reasonable expectation of being assigned to development at least once per 10-week period, which corresponds to one full cycle of the current RIB Operations schedule. Assuming 1,680 hours of scheduled beam delivery per 10 week interval and further assuming a complement of 10 RIB operators, each expected to be included in one 8-hour development shift in such a period:

Postulate 8: A 5.71% Tax imposed by the Beam Physics group for each 10-week block of scheduled delivery produces 96 hours (12 operator shifts) per operational scheduling period, meaning RIB operators can each expect to be included at least once per cycle. This translates to 4 days of development for 70 days of scheduled delivery.

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