STAR-TOFp Implementation Plan

STAR-TOFp Group

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Abstract

This document updates the cost and schedule sections of the TOFp Proposal.

1 Scope

The so-called TOFp SysTest-I has been underway since early June 1999. Actual slats, PMTs, bases, and final electronics have all been exercised in concert under realistic conditions. There were no surprises. No R&D remains. The adopted voltage system performed well. The present FEE circuit (version 5) is unchanged except for overall dimensions since version 2 of approximately February 1999. The rest of the tray is conventional, and in many cases, exactly the same as the similar pieces of the STAR-CTB.

A TOFp channel count per tray of forty-one (41) is the largest that is mechanically conservative. The optimum arrangement was determined by developing detailed AutoCAD drawings and by building a "fake TOFp" tray, which is shown in Figure 1. The dimensions of the fake slat asssemblies include the slat wrapping and are in general conservative by ~1mm in all directions.

The TOFp tray will consist of forty-one (41) slat assemblies and ten (10) FEE boards. These assemblies are arranged in ten rows of either 4 or 5 slats assemblies per row. Starting at η=0 and going out to η=1, there will be one row of five slats, then nine rows of four slats. There is then plenty of space for internal cabling and electronics, as well as approximately 20cm of free space at the tray end to accommodate the necessary feedthroughs.

The slat size, formulation, PMT type, time resolution, and other aspects of the tray interior are all as described in the original proposal. [1] The utilities required from STAR are described in Ref. [2]. The only differences between design of the full system as originally proposed and the design at present are the following.

- The CW high voltage system of V. Astakhov *et al.* was adopted. [4] This removes the need for the development and construction of these bases at Rice,

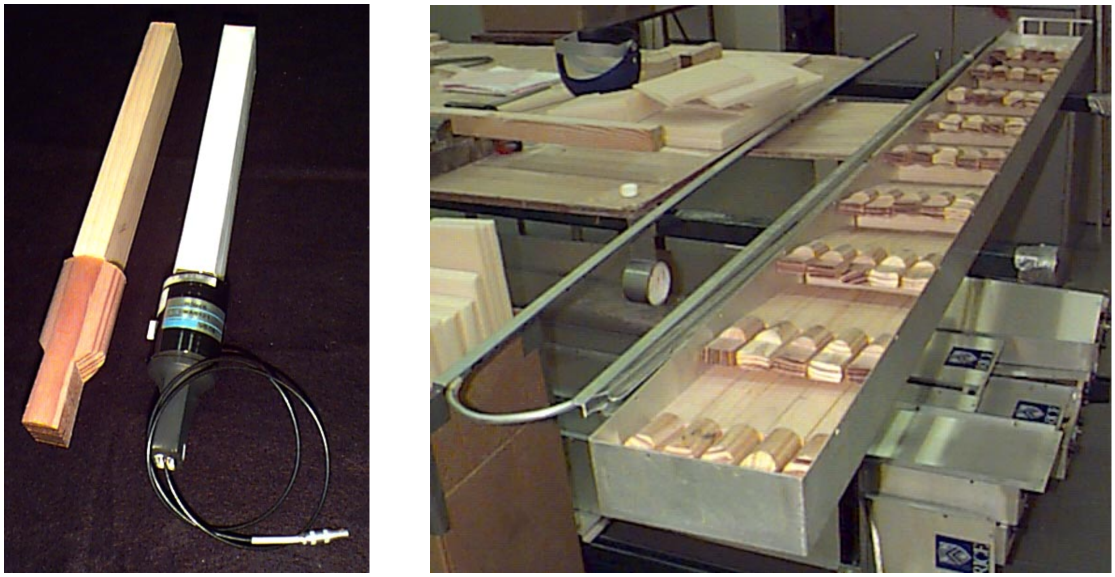

Figure 1: Shown in the left frame is a fake TOFp slat assembly on the left and an actual final TOFp assembly slat on the right. Shown in the right frame is the fake TOFp tray loaded with 45 fake slat assemblies and the final foam wedges giving the correct slat angle distribution. Also, seen on the left in this frame is a preliminary cooling loop.

and practically it also removes the need for an interface between TOFp and STAR Slow Controls. Specifically, the items no longer needed are the HDLC mother and mezzanine boards inside the tray, as well as the the TOFp Radstone board and TOFp-dedicated VME crate on the platform. The HVSys cells are smaller, less ponderous, lower power, competitively priced, and can be produced quickly.

- Results obtained on the amplitude and timing cross talk for the proposed Amphenol FlatCoax cable indicate such a choice is acceptable, but marginally so, if every channel in this cable is "active." More conservative alternatives for the long signal cables are FlatCoax with "empty" conductors between active conductors, or singly-stranded coax such as RG-58/U or one of the RG-62's. There is no difference in cost between these alternatives. The only differences regard the cross sectional area needed to allow the passage through STAR of $\sim$80 channels of the given cable type. This is thus entirely an integration issue, with RG-58/U coaxial cable (λ<18 dB/100m at 200 MHz and v=0.66c) being the most conservative overall considering the attenuation, cross talk, signal velocity, and cross sectional area.

- We no longer believe it is physics- or cost-effective to implement a TOFp system without the presence in STAR of a detector than can provide high-resolution electronic "starts." Discussed in the proposal [1] is the TOFp performance given only ZDC starts ($\sigma_{TDC}\sim$250ps-1ns) and an offline correction based on the TOFp information. Such a system works only in the most central Au+Au collisions, and only after the tedious offline correction. Based on discussions with many in STAR, we believe that a simple and highly conventional "psuedo-VPD" (pVPD) could be constructed for less than ~10 k$ and trivially installed outside of STAR. Such a detector would allow the TOFp to perform efficiently over a much larger range of impact parameters and without the need for the painstaking offline start correction. We thus make our strongest possible request that such a pVPD be supported if the TOFp is supported. No money is requested for pVPD components - all pVPD costs are already covered via contributions from collaborating institutions. There are a number of highly capable STAR collaborators *outside of the core TOFp teams* that have already expressed an interest in the bringing the pVPD to reality. The TOFp FEE are, as is, highly applicable for pVPD FEE and extremely compact. Commercial equipment-pool electronics are also a highly applicable alternative if there is sufficient space near each of the two pVPD arms to place one mini-NIM bin.

- There has been a large boost to the manpower available to the project via the joining of two groups from Wuhan and Beijing, China, represented by Prof. LIU Lianshou of IOPP/CCNU. This group has agreed to provide *both* the hardware and software for the interface between TOFp and STAR's TRG and DAQ systems, as well as twenty-five (25) Hamamatsu R5946 PMTs. New manpower in the area of TOFp software has been proposed by Declan Keane's group at Kent State. The same group is also contributing 4k$ towards pVPD detector hardware, which should cover the pVPD scintillator and shields. New manpower at Rice for TOFp (at least a portion of a new PostDoc position) is also foreseen, supplementing the already large TOF group there. The remainder of the TOFp Group as listed on the original proposal also remain on-board and dedicated to installation in March, 2000.

The costs for the TOFp System, including the contributions from the collaborating institutions but excluding all of the (completed) R&D funded as part of SysTest-I, are described in Section 2. The schedule is presented in Section 3.

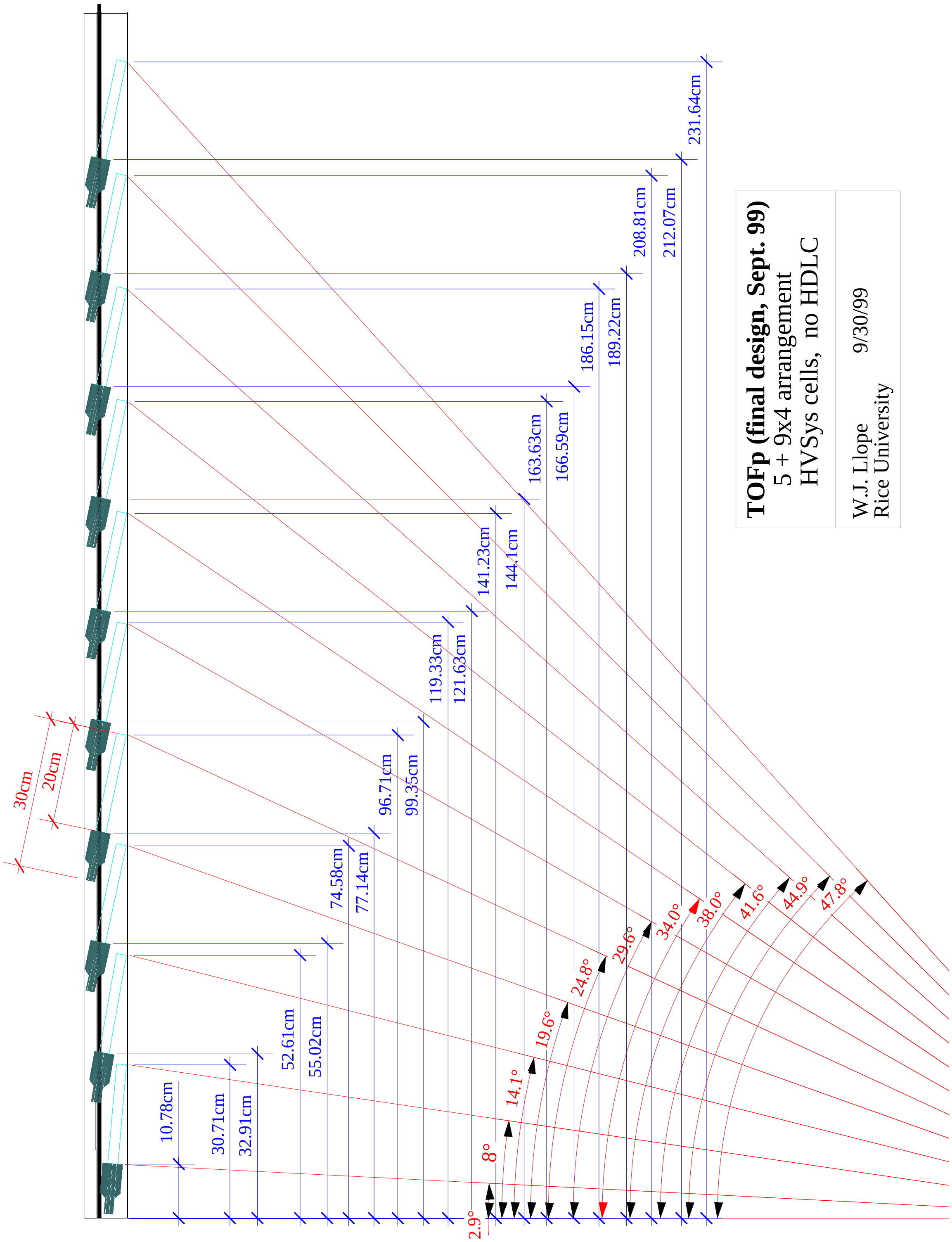

Figure 2: A dimensioned side view of the final TOFp geometry.

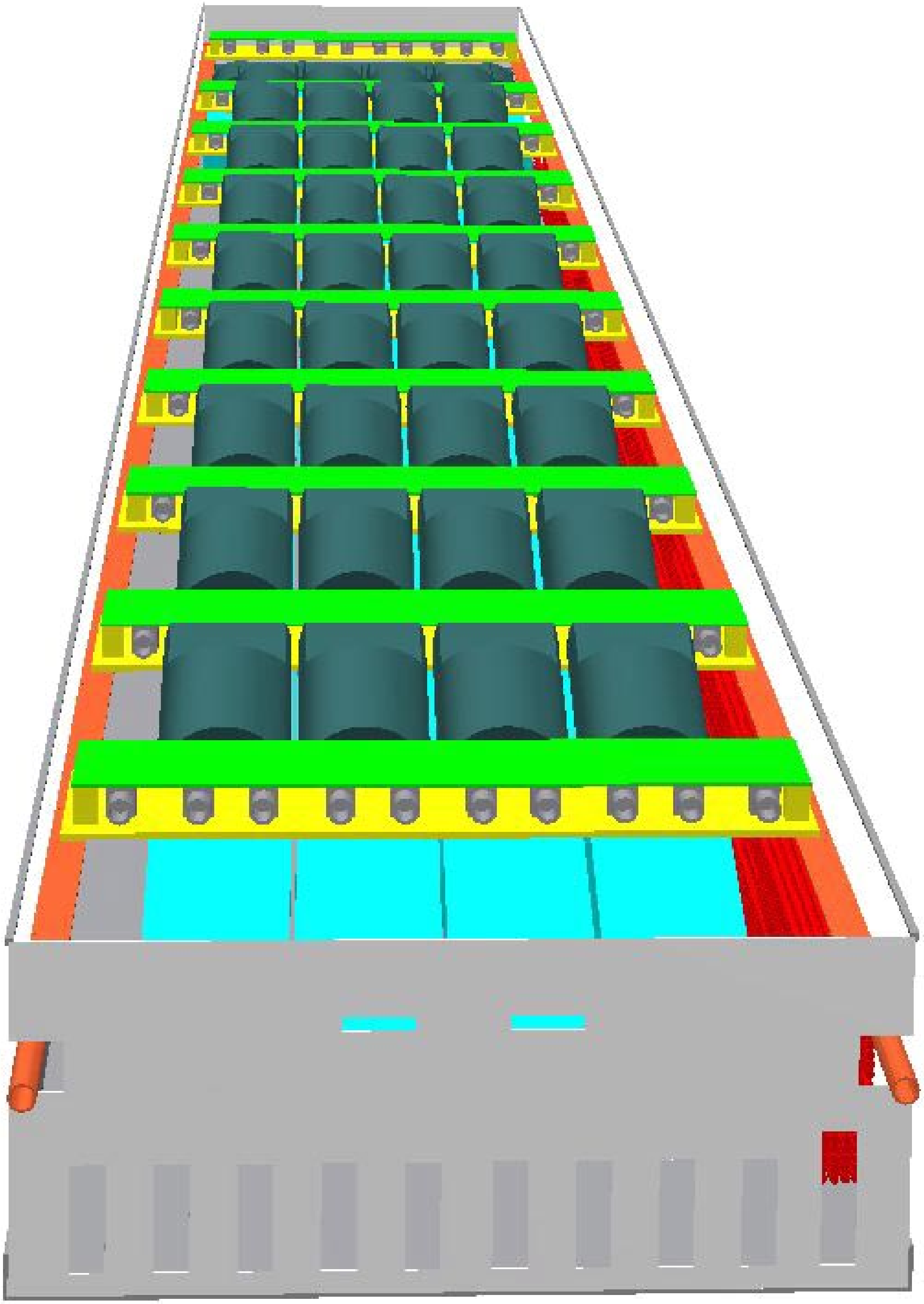

Figure 3: A rendered perspective view of the filled TOFp tray from AutoCAD. The sides and top of the tray, as well as the HVSys bus cable, are not shown.

2 Cost

In this section, we discuss the costs. These are summarized in Table 1. The contingency assumed for some items is shown between the parentheses in this table. The meaning of the numbers in parentheses for the quantity and cost columns differ, as now described. In the quantity column, the notation, *e.g.*, "45(4)" means that 45 slats are to be purchased, and of these 45, four are extras as a "unit contingency." For the corresponding cost column, the cost listed is the unit cost ($98.50) times 45, scaled upwards by the "cost contingency" shown in the parentheses, *i.e.* 45*98.50*1.1 = $4875.75. If the cost is shown in italics, this is a contributed item and is not included in the final totals at the bottom of the table.

No R&D remains. The costs listed are for the construction of the final pieces only. All "pre-production" costs have already been covered by the SysTest-I funding. The slat assembly construction, testing, and tray construction are all performed by physicists.

There is no labor in the present project. The only labor-intensive item is the stuff/test of the FEE. This will be shopped out. There is thus no overheaded items here.

The "tray hardware" cost item is now based on a much more mature design of the tray interior, based in part on the ongoing mechanical development using the "fake TOFp." Also much more mature now is the design of the TOFp cooling loop and its interface to the STAR water systems. Agreement on the connections and required parts exists amongst TOFp and the TPC water contacts (B. Stringfellow and A. Lebedev).

The PMT order will include the specification of upper limits on both the RT ($\leq$2.5ns) and TTS ($\leq$500ps), which go beyond the standard gain specification used for the CTB of 1:10. The latest cost per R5946 with the additional timing specs is $1,278 each.

The actual installation cost for 120 trays of STAR CTB was zero dollars, excluding physicists' hours. [5] Thus, the installation cost of one (1) TOFp tray is also zero dollars. The TOFp installation will also be done entirely by physicists.

Items that were neglected in the original costs tabulation due to insufficient information on the design have now been added to the table (specifically the thermocouple interface), as these areas have become fully defined since the Review II. The LV power supply, power distribution, and remote threshold control are also areas in which costs were neglected in the previous cost estimate. These areas are now fully defined. However, the costs for these has been covered by the Systest-I funding and we are already buying/building these pieces. The quotes and delivery time A.R.O. estimates for the other significant items in this table have also been double-checked.

The costs for the components for a pVPD detector are included in the table. As discussed elsewhere and above, we feel it is not reasonable to implement a TOFp without a pVPD. No additional money is requested for the pVPD. Contributions from collaborating institutions will provide the scintillator, shields, cables, and simple clam-shell mounting pieces. All other pVPD components are obtained at no cost from previous experiments or from equipment pools such as HEEP.

3 Schedule

In this section, we present the schedule. This is depicted with all logical relationships shown in Figure 4.

The tray will be constructed at Rice University. The manpower for this construction already exists. All jigs and other construction infrastructure are already in place. The platform components and the interfaces are being constructed at BNL and in China by the Wuhan/Beijing collaborators. The manpower for this construction already exists. As the FEE design is final, the FEE fabrication will be shopped out. The HVSys cells will be produced in Dubna. The other electronics are commercial and in hand.

The critical path is defined primarily by the 2 month delivery time of the Hamamatsu PMTs. A staged PMT delivery would be beneficial, and would certainly be insisted on during negotiations with Hamamatsu. It should be mentioned that the Wuhan/Beijing collaborators have proposed that they purchase 25 such PMTs. Indeed, a few weeks ago the order was placed for these 25 donated PMTs.

The schedule lists the installation of the pVPD at the same time as the TOFp installation. As the pVPD is exterior to STAR, the pVPD could in principle be installed anytime earlier as well. The core TOFp group is not responsible for constructing the pVPD detector elements. Others in STAR are already in place for this. The pVPD electronics are trivial and can easily be handled by the TOFp Group if necessary.

Table 1: The updated cost for the TOFp System, including contributions from collaborating institutions. The contingency assumed for certain items is shown between parentheses. The costs shown in italics are the costs of contributed items. See the text for the details.

ITEM	SOURCE	QUANTITY	LABOR ($)	EQUIPMENT ($)
Tray Interior				
Tray hardware	Oaks Precision	1	0	1740(20%)
BC420 slats	Bicron	45(4)	0	3465(10%)
Foam/Glue/Wrapping	various		0	1250(25%)
R5946 PMTs†	Hamamatsu	25	0	*31950*
R5946 PMTs	Hamamatsu	20(4)	0	28116(10%)
FEE Boards	Rice v.5	12(2)		
Parts			0	5520(20%)
Stuff/Test§				8775(17%)
Cables				
RG-58/U Coax int.	Belden	82×20'	0	1400(10%)
RG-58/U Coax ext.	Belden	82×250'	0	3960(10%)
Low voltage & buses	Newark	1	0	1200(25%)
Connectors	Lemo & BNC	82+82+82	0	4320(10%)
HVSys				
Cells	Astakhov *et al.*	45(4)	0	4500(20%)
System Module‡	Astakhov *et al.*	1	0	2750(10%)
Platform				
Patch Panel	Rice	1	0	4964(25%)
CAMAC Crate	HEEP	1	0	0
NIM Bin & logic	HEEP	1	0	0
P/S 708 Disc	HEEP	6(2)	0	0
LRS ADC & TDC	HEEP	6(2) ea.	0	0
Trigger TCD Board	LBNL	1	0	4200(20%)
1992 Thermocouple Term. Panel	Kinetics	1	0	730
3514 Scanning A/D	Kinetics	1	0	3110(10%)
3922 Crate controller†	Kinetics	1	0	*5000*
2601 24bit I/O†	BiRa	1	0	*1000*
2306 CPU, 32MB†	Motorola	1	0	*3000*
Installation				
Shipping	Rice			500(25%)
pVPD				
Detectors††		18(2)	0	*4000*
Mounting‡‡		2	0	*1000*
RG-58/U Coaxial‡‡	Belden	40(4)	0	*1200*
FEE	HEEP (or Rice v.5)	18(2) ch	0	0
Totals				127150
Total, excluding contributions				80000
Total per channel,¶ excluding contributions				1777

† Contribution from IOPP/CCNU *et al.*, Wuhan and Beijing, China.
†† Contribution from Kent State University, Kent, Ohio.
‡‡ Contribution from Rice University, Houston, Texas.
‡ One HVSys System Module (to be the backup) is already in hand.
§ Shopped out, thus not overheaded labor.
¶ 45 channels constructed was assumed, 41 of these are installed in the TOFp tray.

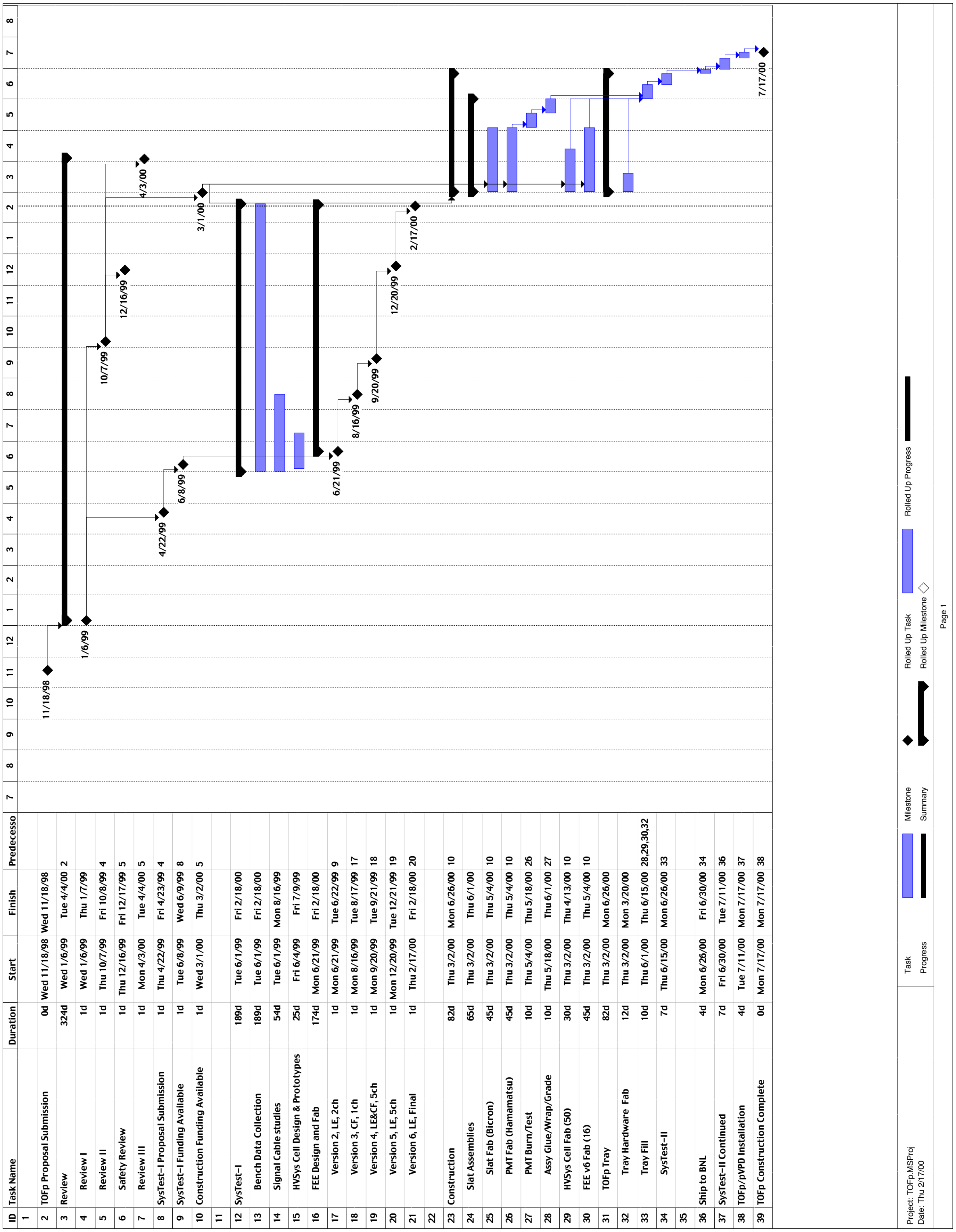

Figure 4: The TOFp timeline since the proposal and up to installation of the completed TOFp tray in STAR in the first week of March, 2000. The tasks are labelled by the number of working days to complete, of which there are five per (40 hr) week.

References

[1] “A ”Single Tray” Time-of-Flight Patch for STAR,” STAR TOFp Group, November 17, 1998. Available as described on http://bonner-mac8.rice.edu/~TOFp/-default.html.

[2] “TOFp Functional Requirements,” STAR TOFp Group, September 20, 1999. Available as described on http://bonner-mac8.rice.edu/~TOFp/default.html.

[3] W.J. Llope for the STAR TOFp Group, STAR Collaboration meeting, plenary session, January 1999.

[4] W.J. Llope for the STAR TOFp Group, STAR Collaboration meeting, plenary session, August 1999.

[5] R. Brown, private communication.