We reproduce below the section of the 2003 DAC report on the STAR TOF proposal with the response from STAR.

The development of a detailed proposal for a TOF in STAR, based on the MRPC technology, is the result of a world-wide concentrated R&D effort over the past few years. The STAR TOF group has contributed to this effort very significantly as it provided a testbed for evaluation of the detector performance under real \battle conditions", i.e. within the real RHIC background environment. Overall the STAR results are very impressive. The detector prototype has even been used for physics results. On the other hand, the committee perceived some issues to be considered by the collaboration. We list them in the following:

1. It is very important to analyze any problem which occurs at this very early stage. In particular, we highly recommend analyzing in every detail why 6 out of 28 modules seem to operate differently. To do this analysis, the TOF detector should be removed from STAR, take all faulty modules carefully apart, and determine that the reason for the deviation is either trivial or significant, An example of a trivial reason could be dust on the electrode surfaces, an improperly assembled unit, a wrong gap due to glass imperfections or the nylon line diameter variation, etc. An example of a significant reason for the malfunction could be: corroded glass surfaces, or development of photosensitive surface film deposits on the cathode surfaces. At first glance, it seems indeed unlikely that glass corrosion or surface chemistry can occur, given the fact that the average charge deposits are less than 2pC per track in this detector (as opposed to 1000pC in BaBar or Belle). Furthermore, one needs to stress that the Belle glass RPCs do work at this point. However, if there is an onset of multiple streamers in 6 out of 28 of the TOF detectors in STAR, the accumulated charge could be higher than 2pC/track. There was a group within the Belle collaboration, which reported buildup of a film on the cathode surface in the test chambers, which was responsible for the breakdown. For more on the film theory see: H. Sakai et al., Nucl. Instr. & Meth., A484(2002)153. In their case, the gas contained about 1000ppm of water. The paper proposes a theory that this film has a lower work function, and this causes the spontaneous emission of electrons from the cathode (for the anode such effect does not occur). This film could be easily removed by wiping it with a tissue and ammonia.

Six modules were seen to have excess streamers in some channels in tests conducted immediately after construction. Two of these had simple mechanical defects - a small amount of solder on a glass plate and a scratched glass plate. While manufacturing defects can be addressed with tighter quality control during the module assembly process, we are allowing for a failure rate of 30% in the construction budget and schedule. This is to insure that the modules installed in STAR pass very high performance standards and will provide excellent timing resolution in all channels. The other four modules showed no apparent mechanical defects. These modules were not significantly noisier than others and were installed in TOFr for run 3 but were not read out. We would like to observe the long-term performance of these modules before performing an autopsy. Some of these modules are being read out for run 4 and we will again be able to evaluate whether the ADC distributions continue to show excess streamers, as well as measure noise rates and timing resolution. Since the excess streamers were present in these modules at initial turn on, it is not likely to be the result of corrosion or surface deposits built up during operation but rather a construction or materials issue.

We expect the next R&D goal, to produce up to four trays of MRPC TOF, will provide invaluable experience with these and other important production and QA issues. The only effect of excess streamers that we have seen in test beam data is that the timing resolution is somewhat degraded.

Concerning deterioration of efficiency and noise performance when there is water present in the gas, we note that the study of Sakai *et al*. used a single gap chamber and found that the threshold for damage was operation for several weeks to several months with ~1000ppm water in the gas. The STAR MRPC modules will have much smaller charge per track than typical single gap chambers. The design specification for the STAR MRPC gas system is <20ppm water in the circulating gas. The system includes both a dryer and the ability to continuously monitor the water content in the circulating gas. Experience with the STAR TPC gas system shows that this specification is achievable. The Sakai paper also indicates that the chambers damaged by wet gas can be repaired by a noninvasive technique of flowing argon plus ammonia for about a day.

There are recent reports on aging effects in glass RPC chambers presented at the RPC2003 conference. In the talk by C. Gustavino, "Aging and recovering of glass RPC,"
(http://clrwww.in2p3.fr/RPC2003/talk/gustavino.ppt)
no change was observed in the rate capability of single gap glass chambers exposed to 2mC/cm^2 in a test beam while operating the chambers at elevated temperature (55^o C). In the talk by E. Scapparone, "Study of gas mixtures and ageing of the Multigap Resistive Plate Chamber used for the ALICE TOF,"
(http://clrwww.in2p3.fr/RPC2003/talk/scapparone.ppt)
data were presented for multi-gap chambers operated for 200 days in a test beam with an accumulated charge of ~14mC/cm^2 ñ equivalent to 54 years of ALICE operation. No HF was detected in the exit gas during operation at the limit of their monitoring(<0.02ppm) and after the exposure, there was no degradation in chamber performance ñ no increase in dark current and no degradation of efficiency or time resolution.
In the talk by L. Linssen, "Experience with the HARP glass RPCs,"
(http://clrwww.in2p3.fr/RPC2003/talk/linssen.ppt) she mentions (page 9) that the noise rates were stable over two years of operation (total flux was not mentioned but the instantaneous flux was ~0.1 Hz/cm^2)

2. The composition of glass could easily vary at the ppb level. Manufacturers of simple float glass usually do not care that much about such details. Perhaps, even physicists defending this detector concept may think the same. However, there are a very few people around who understand glass in detail from the first principles. For example, about 50 DIRC PMTs corroded very rapidly in the ultra-pure water from some reason. It turns out that the corrosion of the Borosilicate glass is modulated by only 4ppb of Zn. To see such a minute level requires using ESCA surface analysis methods. In case of DIRC, the ultra-pure water, hungry for ions, removed sodium from the glass. A small amount of Zn played the important stability role from some reason, which is not understood by us, but the manufacturer ETL agrees with our conclusion. In case of the TOF MRPCs, a new variable is that the glass is subject to a very strong electric field, plasma environment and UV light. Only long-term tests or real experiments in a high multiplicity environment, such as the STAR test, will prove that there is no problem. For more on the DIRC glass corrosion in water see: http://www.slac.stanford.edu/pubs/icfa/spring01/paper3/paper3a.html.

We agree, long term testing is the only way to know if the glass we have been using will corrode over a long time period due to the glass composition. TOFr' (the rebuilt tray installed for RHIC Run 4) contains modules that were read out in TOFr during RHIC Run 3 (plus some new ones), so we will be able to see and track any long-term variations in the performance of our MRPCs, should these occur. We also plan to disassemble several module each year to look for long-term aging effects.

As mentioned above, there are now also direct measurements by ALICE indicating impressive stability of glass MRPCs despite large particle fluxes.

3. Both providing and removing ~25kW of power from the experiment is non-trivial, and air-cooling seems a difficult challenge. We recommend looking seriously at both the cooling technology and total power usage. Water-cooling is likely to be a much more tractable solution than forced air cooling, and several parts of the electronics chain might benefit from additional effort to reduce total power. An obvious possibility is to replace the MAXIM preamp chip with the NINO chip, developed by Jaron's group at CERN or a similar discrete implementation. The advantages of using the NINO chip are a small power consumption (< 50mW), a truly differential input, resulting in a smaller noise, smaller cross-talk and smaller threshold voltage. The chip has ~1ns peaking time, which also gives a better timing resolution. Signal conversion and power regulation blocks probably also deserve some additional design effort.

The TOFp tray (original scintillator TOF patch in STAR) has a water cooling-loop and the rebuilt TOFr' tray also has a water loop. We will gain experience with this in the upcoming run. Since part of the electronics (FEE) is on the sealed trays and part (digitizers) is outside, both air and water cooling may be necessary.

The most recent review of the electronics design indicates that total power will be under 20kW. A preliminary engineering calculation indicates that 24kW can be removed by an air flow of 8000 cu.ft./min. (which can be provided by one 24in. fan) and a temperature drop of 5K. There appears to be sufficient integration space in the STAR detector to provide plenums for this air flow. We would also like the plenums on each tray to provide an rf shield for the electronics.

The preamp and discriminator constitute about one-half of the power load, so using the Nino chip would provide a major reduction in system power. The differential input is also of interest since it should provide a more stable rise time, hence improved timing resolution. We are currently investigating the availability of the Nino chip.

4. We recommend keeping a glass coupon from every TOF module. Such samples can be used for subsequent studies if some fault is found in a given detector. These coupons should be subject to ESCA surface analysis.

Keeping a sample from each batch of glass is a good idea.

5. We recommend to do precise charge accounting, in terms of charge per track, charge per cm^2, and as a function of time.

We already have the software tools in place and have been monitoring the high-voltage current and the particle flux since the initial installation of TOFr. The high-voltage current is monitored continuously and the value is recorded in a log file every minute. This high-voltage current for the most part measures current through the detector glass. The logical ì orî of several dozen channelís discriminator output is monitored continuously and recorded in a permanent data base. This should provide an accurate measure of the particle flux.

Finally, we would like to point out that a serious effort needs to be undertaken by the collaboration to develop a detailed budget for the construction project.

The DOE has requested a detailed management plan for the project that will include a detailed budget. We plan to provide this information to the DOE on a time scale of about one month following the receipt of this proposal by the DOE.