STAR NOTE NO. 228

External EMC Support Installation Study

Doug Fritz
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Introduction:

Because of budget and schedule pressures for the STAR Detector Project the November 1995 TAC review committee made several suggestions as to possible ways that these pressures could be reduced. One of these suggestions was to change the EMC support scheme so that the supports could be manufactured and installed at a later date.

This STAR Note documents the investigation into the feasibility of installing EMC supports from the outside of the STAR magnet after the magnet is completed and the TPC is installed.

Why install the supports after the magnet is completed?

1) Funding for the STAR project construction phase is limited and if the supports could be manufactured and installed at a later time, funding profile problems could be reduced. Currently the full supports are estimated to cost \$500K-\$600K (supports, rails, installation tooling etc.)
2) Installation of the supports is on the critical path for STAR (installation occurs at the end of magnet assembly). Postponing installation helps to reduce schedule pressure by approx. 2 months.

Brief description of the current “internally installed” support scheme:

The EMC modules fit in an annular space (44.7 cm) between the magnet coils and the CTB/TOF modules. There are 270 supports that are installed from inside the bore of the magnet. The supports fit between the magnet coils and attach to the inner surface of the magnet back leg steel (see fig. 1). EMC fibers are routed from the EMC modules to the electronics via gaps in the coils (approx. 13.4 cm wide) and then into orthogonal gaps in the backleg steel (approx. 18.8 cm wide). All 270 modules must be aligned radially and azimuthally to within 1 mm. The radial alignment takes place simply by making use of machined surfaces on the backleg steel. Rough azimuthal alignment takes place by surveying and match drilling the supports to the backleg steel in the early phase of magnet assembly. Final azimuthal alignment of the support rails takes place inside the bore of the magnet. The advantage of this scheme is to allow for easy access to the supports and rails during final alignment.

Brief description of a possible "externally installed" support scheme:
Externally installed supports would be slid in the gaps between back legs and then match up with gaps between coils. The supports would be fastened to the outer surface of the backlegs. The advantages of this scheme would be to reduce schedule and budget pressure for STAR. This pressure is reduced by postponing fabrication cost. There are however several problems that become apparent when thinking about installing the supports from outside the magnet.

1) Fiber Routing:

The gap between coils and backleg steel that is currently occupied by EMC fibers is the only possible location for an external support. If a support is positioned in this location little or no room exist for fiber routing (see fig. 2). Fibers can not be routed longitudinally out the ends of the detector because of excessive length (>10m).

2) Mounting Holes:

Four tapped and 2 reamed holes for each new supports would have to be accurately positioned and then machined at 270 locations on the back leg steel (1,620 holes). Using a Bux drill it is estimated that each feature would require 30-45 min. to complete (20-30 man weeks).

3) EMC Module Design:

Using an externally installed support precludes the mounting of the rails directly to the supports and an intermediate attachment plate is required. This attachment plate reduces the annular space allowed for the modules by approximately 2.5"(see fig. 2) and forces a redesign of the of the EMC modules. The EMC group (Tom Compte) has evaluated the impact of this change and has indicated the following:

"If you go from an 18 X0 calorimeter to a 14 X0 calorimeter, you go from sampling 95% of the shower to sampling 82% of the shower. (This corresponds to removing 2.5" of material.) This worsens your resolution by 10% just due to sampling effects. However, Vic Guarino (our engineer) tells me that this new mounting scheme requires us to add about 3 meters of clear fibers to the EMC readout, so we also lose e^(-3/7) of the light from the EMC. The combined effects would worsen the calorimeter resolution from about 16%/sqrt{E} to 22%/sqrt{E}.

Worse still is the prospect of fluctuations in the leakage. 1/e of the showers start 1 radiation length later. Looking at 40 GeV electrons (from e.g. W decay) these fluctuations are of order 500 MeV for an 18 X0 calorimeter, but more like 2 GeV for a 14 X0 calorimeter. This is the dominant source of resolution loss for a thin calorimeter.

The uncertainty in energy for a 40 GeV electron is a shade under 1.2 GeV for the current EMC. This would more than double to 2.4 GeV if we cut out 2.5

inches. But since the resolution increase is due largely to fluctuations in leakage, the single number "2.4 GeV" does not reflect how bad the situation really is, because of the long exponential tails.

Apart from the mechanical reasons that such a solution would be undesirable, there are strong physics arguments against reducing the depth of the calorimeter."

From: Tom LeCompte - STAR/CDF   Argonne, 28-NOV-1995

4) Rail Alignment:
Installation and azimuthal alignment of the attachment plate and rails on the supports would be exceedingly difficult because of the limited access. This tight annular space makes the possibility of damage to the TPC or TOF modules extremely high.

Conclusion:
Changing the EMC support scheme from an internal to external installation represents a major shift in the philosophy of how the EMC modules are supported and aligned. While anything is possible with enough time and money, (for example a different technology could possibly be used to allow for longer fiber lengths) if this scheme was deemed necessary it would probably be in STAR's best interest to remove the TPC and install the currently envisioned supports. Granted this would take a great deal of time, but when all things are considered it is probably the most cost effective thing to do especially considering the length of time it would take to machine new features on the back legs and the possibility of damage to the TPC. Items that would have to be designed or redesigned in order to install the supports from outside the magnet include the: EMC, EMC supports, EMC rail attachment plate, rail installation tooling, tooling for machining backlegs and azimuthal and radial alignment tooling.

FIGURE 1
EMC SUPPORT INSTALLATION STUDY
(INTERNAL INSTALLATION)
CURRENT PLAN

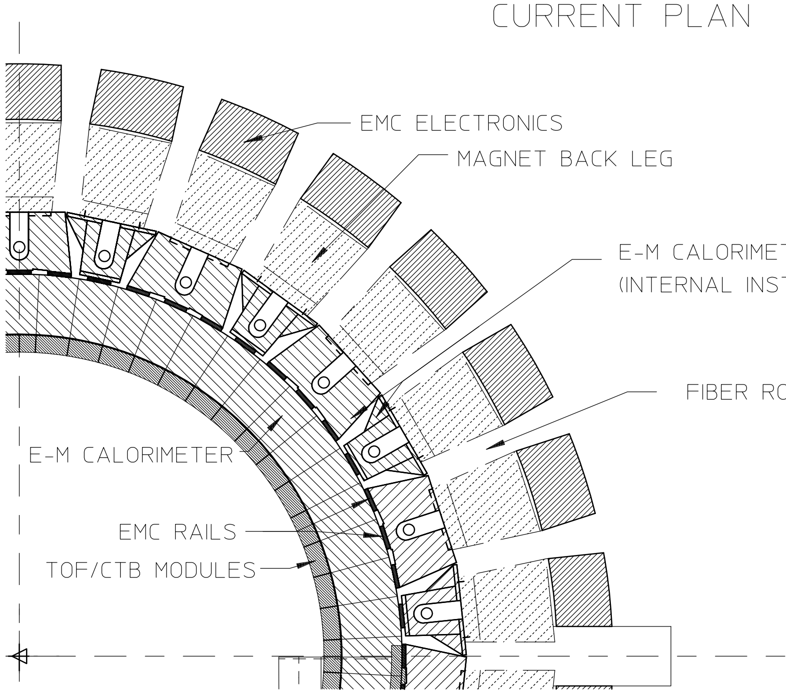

FIGURE 2
EMC SUPPORT INSTALLATION STUDY
(EXTERNAL INSTALLATION)