----- Original Message -----
From: Corvin, W. Clay
To: Chris Jensen ; Adolphsen, Chris ; Emil Huedem
Cc: Larsen, Ray S. ; shigeki.fukuda@kek.jp ; Tom Lackowski ; Emil Huedem ; Lee Hammond ; Nikolay Solyak ; Hitoshi Hayano ; lutz.lilje@desy.de ; Himel, Thomas M.
Sent: Saturday, February 25, 2006 1:42 PM
Subject: RE: Cooling Scheme

Hi Chris:
The power system model includes standard impedance (and loss) transformers, including the "RF power transformer that steps down from 34.5 kV to 480 V which might be another 3%" you asked about. In addition it includes the upstream system all the way to the power grid at 230 kV. Please see the attached 6 page file, PAGES 1 & 2, for the comparative power flow for 2 different charging power supplies setups.

The 34.5-0.48 kV transformer can exchange heat to either the tunnel air or to the tunnel water cooling system. The preferred choice is to the tunnel water cooling system. The back side of the transformer is specified to have an oil-to-water heat exchanger much like the ones used on the modulator transformers at Slac. It is far more efficient than air cooling. For every watt of energy put inTO the tunnel air it typically takes about another 0.4 to 0.6 watts of energy to remove the same energy FROM the tunnel air. Direct water cooling is more effective and it is already there for the technical systems and the totally enclosed water cooled racks (like those at the Slac BABAr detector). You can tell Emil to count on about 85% of the transformer heat loss will go to water and 15% will radiate to tunnel air. I would NOT use 3%, but would use something under 2% for transformer efficiency. The transformers are design loaded to NEC requirements were heat increases as the square of the current and the design load is limited to 80% of nameplate full load capacity. In addition the 80% limit provides thermal overhead for eddy current heating in the core laminations that are optimized for 60 Hz, and not higher power supply harmonic frequencies.

PAGES 3 & 4 of the attached file describe a suggested smaller alternative to the present 10 hertz proton driver charging supply that you have previously described. It reduces the overall footprint to where the charging supply is no longer the largest body part (in tunnel width) of the RF power system elephant. Please review this for adoption in the baseline. Two other power engineers here at Slac have concurred with the indicated suggestion and so do I. Please advise.

Leapfrogging ahead to the NEXT biggest RF elephant body part, the AC RF Power Transformer, I went ahead and did the detailed layout to make it skinnier in width by rotating it 90 degrees at the sacrifice of a depth because of required code working clearance. Such detail design would ordinarily be premature at the conceptual stage but since it would now have the widest footprint it seemed justified. Please examine PAGE 5 of the attachment and consider it for adoption in the baseline. This updated layout has also met with concurrence here at Slac.

As the immediate goal is to "right size" and not "super-size" the baseline tunnels for the BCD & RDR, I also provided our radiation people with the information on PAGE 6 so that the clear waveguide penetration insertion space just below the ventilation ducts can be determined correctly. Emil has never specified ventilation ducts smaller than 0.75 meters diameter @ 12 KCFM so that is what is shown. Slac engineers have never specified ventilation ducts smaller than 1.0 meters diameter @ 16 KCFM. (btw: for electrical guys, KCFM is NOT a radio station)

Best Regards,
Clay

From: Chris Jensen [mailto:ccjensen@fnal.gov]
Sent: Friday, February 24, 2006 3:12 PM
To: Adolphsen, Chris
Cc: Chris Jensen; Larsen, Ray S.; shigeki.fukuda@kek.jp; Tom Lackowski; Emil Huedem; Lee Hammond; Nikolay Solyak; Hitoshi Hayano; lutz.lilje@desy.de; Corvin, W. Clay
Subject: Re: Cooling Scheme

All,
The first modulator that was built for Tesla had a 90% electronic efficiency and an 85% overall efficiency. I.e., 5% of the input power turn into klystron collector heating during the rise time and 10% of the input power turns into heat dissipated into various other components.That gives 62% of the of the 85 % input AC mains power turns into RF power (using Chris' 62% klystron efficiency). The power lost during the klystron voltage rise time can probably be reduced.

Based on known water cooling of certain components and power dissipation calculations for the first modulator, I would estimate that 5% of the input power ends up in the air and 5% ends up in the water. This is in addition the the power lost in the RF power transformer that steps down from 34.5 kV to 480 V which might be another 3% (can anyone give a rule of thumb?)

Chris Jensen
Fermi

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On Feb 24, 2006, at 4:43 PM, Adolphsen, Chris wrote:

For purposes of defining the rf source requirements, assume that

beam train length = 1.00 msec (Tor agrees with this: note beam current = 9.50 mA, same as TDR)
cavity fill time = 420 microseconds (TDR value) * 31.5/23.4 = 565 microseconds
so rf pulse length is 1 + .565 = 1.565 msec
To define the average power requirement, assume klystron efficiency = 62%
Ray, Shigeki or ChrisJ can provide the modulator efficiency including rise time and charging supply efficiency

If the modulator efficiency were 85%, then to produce 10 MW, 1.565 msec rf pulses at 5 Hz at the klystron would require an average charging supply input power of [10e3 kW /(.85*.62)] * 5 Hz * 1.565e-3 sec = 148.5 kW. We may want to add a 5% overhead for uncertainties in the efficiencies.