



TA-02 Replacement Decision Briefing

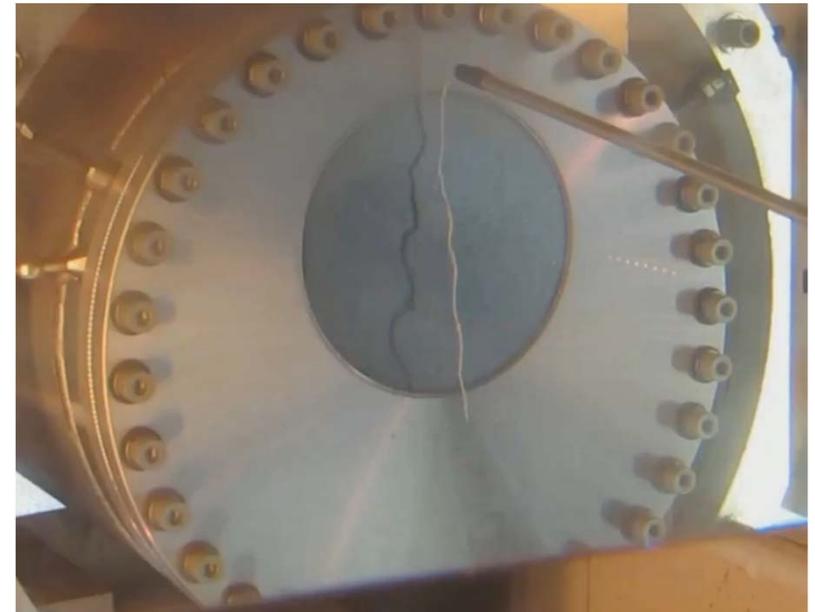
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7 June 2018

Situation

- TA-02 started leaking helium late in the evening of Saturday, May 5
 - This leak is similar to the leak of TA-01
 - TA-01 replaced 2016 shutdown
 - Leak was anticipated due to window weld
 - Leak rate was about 0.4 liters per minute, increased rapidly to near maximum
 - Leak is limited to 6-8 liters per minute, at which point pressure is allowed to drop
- TA-03 is “ready”
 - Still has suboptimal downstream window
 - New window delivery expected early August. Checkout is about one week.
 - Installation can be rapid, < 2 weeks at end of shutdown
 - If not used now, TA-03 will eventually be upgraded into a megawatt target
 - TA-04 is far along its assembly process
- Megawatt-capable target (TA-05 likely) planned to be installed summer 2019
 - Planned as part of NuMI Target Systems Upgrade AIP
 - High likelihood of readiness for 2019 shutdown
 - Readiness can be given priority to be ready earlier than 2019 shutdown



Options

1. **Install** TA-03 *immediately* with suboptimal window
 - Present downstream window on spare target is suspect design (failed on TA-01 & TA-02).
2. **Install** TA-03 at 2018 Shutdown with existing window
 - In case window is not ready
3. **Install** TA-03 at 2018 shutdown with redesigned window
 - New design has been prototyped, final window delivery expected in August.
4. **Operate** TA-02 (leaking) until 2019 shutdown, when replaced with megawatt-capable target
 - Megawatt-capable target installation planned for 2019 shutdown, regardless of operating target status
5. **Operate** TA-02 (leaking) until megawatt-capable target (TA-05) is *ready* - replace in run
 - Megawatt-capable target could be ready some number of months ahead of 2019 shutdown

Considerations

Cost	<ul style="list-style-type: none">• Cost of helium• Cost of target assembly
Resources	<ul style="list-style-type: none">• Resources to produce spares• Resources to monitor ailing target
Risk	<ul style="list-style-type: none">• Shortage of spares• ALARA
Run Time	<ul style="list-style-type: none">• Shutdown length• Run interruption
Performance	<ul style="list-style-type: none">• Target Degradation
Experience	<ul style="list-style-type: none">• New downstream window• Autopsy of TA-02

Option 1: Replace Immediately

Install TA-03 immediately with suboptimal window

Cost	<ul style="list-style-type: none">• Consumes a target• Maximally saves helium
Resources	<ul style="list-style-type: none">• Places greater strain to prepare TA-04• Minimal monitoring of ailing target
Risk	<ul style="list-style-type: none">• Early failure could result in downtime• Suboptimal window puts target at greater risk
Run Time	<ul style="list-style-type: none">• Incurs extra outage to exchange target (3-4 weeks)
Performance	<ul style="list-style-type: none">• Maintains target performance
Experience	<ul style="list-style-type: none">• Allows TA-02 to start cooling off for autopsy

Would nearly end the run at this point, decided against early

Option 2: Replace at 2018 Shutdown with old window

Install TA-03 at 2018 Shutdown with existing window

Cost	<ul style="list-style-type: none">• Consumes a target• Saves most of helium
Resources	<ul style="list-style-type: none">• Places greater strain to prepare TA-04• Marginal monitoring of ailing target
Risk	<ul style="list-style-type: none">• Early failure could result in downtime• Suboptimal window puts target at greater risk
Run Time	<ul style="list-style-type: none">• No additional downtime
Performance	<ul style="list-style-type: none">• Maintains target performance
Experience	<ul style="list-style-type: none">• Allows TA-02 to start cooling off for autopsy

Installing a suspect window is not very satisfactory

Option 3: Replace at 2018 Shutdown with new window

Install TA-03 at 2018 shutdown with redesigned window

Cost	<ul style="list-style-type: none">• Consumes a target• Saves most of helium
Resources	<ul style="list-style-type: none">• Places greater strain to prepare TA-04• Marginal monitoring of ailing target
Risk	<ul style="list-style-type: none">• Early failure could result in downtime• Window must be ready for timely installation
Run Time	<ul style="list-style-type: none">• No additional downtime• Less chance of run interruption
Performance	<ul style="list-style-type: none">• Maintains target performance• Can explore higher-power operation with TA-03 as spares are readied
Experience	<ul style="list-style-type: none">• Allows TA-02 to start cooling off for autopsy• Puts new window design into operation

Would certainly be the preferred route in a static-running environment

Option 4: Run Leaking Until 2019 Shutdown

Operate TA-02 (leaking) until 2019 shutdown, when replaced with megawatt-capable target

Cost	<ul style="list-style-type: none">• Does not consume target• Consumes large amount of helium (\$100k + effort)
Resources	<ul style="list-style-type: none">• Significant effort to monitor target and muon fluxes
Risk	<ul style="list-style-type: none">• Possible failure during run, incurring downtime• Maintains spare inventory
Run Time	<ul style="list-style-type: none">• No additional downtime
Performance	<ul style="list-style-type: none">• Performance is maintained, barring failure• Monitoring of performance is required
Experience	<ul style="list-style-type: none">• Delays cool-off of TA-02 and implementation of new window• Risks compromise of TA-02 autopsy data

Balance saving a target (potentially) versus the upkeep of an ailing target

Option 5: Run Leaking Until Megawatt Target Ready

Operate TA-02 (leaking) until megawatt-capable target (TA-05) is ready - replace in run

Cost	<ul style="list-style-type: none">• Does not consume target• Consumes large amount of helium
Resources	<ul style="list-style-type: none">• Places greater strain to prepare megawatt target• Significant effort to monitor target and muon fluxes
Risk	<ul style="list-style-type: none">• Possible failure during run, incurring downtime• Maintains spare inventory
Run Time	<ul style="list-style-type: none">• Incurs extra outage to exchange target
Performance	<ul style="list-style-type: none">• Performance is maintained, barring failure• Monitoring of performance is required• Fastest route to a megawatt target
Experience	<ul style="list-style-type: none">• Delays cool-off of TA-02 and implementation of new window• Accelerates implementation of megawatt-capable target• Risks compromise of TA-02 autopsy data

Probable the most aggressive approach, would require priority in resources

Recommendation

- **Adopt** Option 3 as preferred plan:
 - **Install TA-03 at 2018 shutdown with redesigned window**
 - Adopt Option 2 as contingency plan:
 - **Install TA-03 at 2018 Shutdown with existing window**
 - In case new window comes too late for shutdown (we presently estimate four weeks of float with a concerted approach)
 - Judgement call if timing is tight
- **Request** concurrence with this plan so that we can prepare
 - Also change treatment of TA-02
- We will take other reasonable actions to optimize operations
 - Preserve TA-01 & TA-02 as desperation spares
 - Verify TA-02 leak location on extraction
 - Improve instrumentation on target pressurization system
 - Maintain target production line
 - Target production has been delayed funding decision for AIP
 - Consider feature changes to improve robustness: wings, rounded corners
 - Explore higher-intensity operation with TA-03 as spare targets are readied