Possible Utility for Trident in Defense Programs (DP)

For FY13 and beyond, Trident can contribute to many projects in DP, HEDLP and LDRD. In addition, Trident is the best place for a significant amount of scientific enabling R&D for important facilities being proposed by LANL in FY12 to become part of the NNSA facilities road map. These include the MaRIE MPDH, as well as the High Intensity Laser Laboratory (HILL). We describe below in more detail how Trident can provide utility to specific programs.

C1:

- Diagnostic checkout for several C1 funded campaigns deployed at Omega
- Continued development of X-ray Thomson Scattering (XRTS) diagnostics
- Development of novel, highly efficient Kα x-ray sources driven by a short-pulse laser [e.g., Sefkow, *et al*., PRL **106**, 235002 (2011)], which may be possible to deploy at NIF ARC and Omega EP once developed at Trident. This source would enable better XRTS and Phase-Contrast Imaging (PCI) diagnostics for Weapons Physics Campaigns on these large facilities.
- Development and enabling R&D in support of the HILL facility. HILL addresses boost-relevant topics for the post 2020 PCF, via experiments detailed in the addendum to the HILL proposal. These experiments address topical areas such as:
    - Evolution of solid particles in a dense plasma
    - Radiative emission from corrugated surfaces
    - EOS of dense plasmas
    - Range of non-fully stripped ions in dense plasmas

C2:

A good recent survey of the many opportunities for Trident to be useful for C2-relevant science is contained in the Robbins report evaluating the proposed long-pulse laser for dynamic material experiments for the MaRIE MPDH.[1] The report considered several possible drivers, including a Trident-class laser. The concluding recommendations in the report say "**For materials science weapons research, we recommend that combination should include flexible gun and HE-drive platforms, laboratory-scale isentropic compression drive system, and small (table-top)-to-intermediate (Janus- or Trident-class) laser drive systems.**" When including its ability to load materials either via laser-driven flyer plates or direct-drive, the committee found that a Trident-scale laser has scientific utility in the areas of EOS, Strength/transformation kinetics, HE, Chemistry, Damage, and Ejecta.

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[1] **MaRIE MPDH Sub-committee on Shock Drive System Evaluation,** by David Robbins, Dana Dattelbaum, Jon Boettger, Cindy Bolme, Juan Fernández, LA-UR 11-04807

Based on consultation with the C2 Program Manager, the Program foresees the possibility of utilizing Trident in the areas of EOS, strength, damage, and Chemistry. In FY12, C2 initiated a project to evaluate interface dynamics as its first priority and this project could continue for up to 3 years. The array of diagnostics available at Trident is particularly noteworthy, especially if portable drivers are deployed at the facility. Candidate drivers under evaluation include an existing small gas gun in P-24, as well as a boom box designed for up to 25g of HE. Another potential and useful capability lies in reestablishing the capability to use Special Nuclear Material for dynamic materials experiments, as demonstrated on Trident a few years back.

C4

Trident cannot compete on energy with the larger Omega and NIF laser facilities. Radiation Hydrodynamic experiments require large laser driver energy and long pulses. Therefore, Trident is not the ideal facility to deploy such experiments. However, Trident is an ideal facility to develop and test diagnostics to be deployed ultimately at those larger facilities. It is also an ideal place to develop the advanced Kα x-ray source described above, which would also benefit C4 experiments.

C4 has recently begun an effort to better utilize experimental data taken at the larger facilities by reducing the uncertainty in the material properties often used in HED experiments. It is expected that Trident can play a role in developing a better understanding of materials such as plastics and foams in terms of the EOS through detailed measurements. Currently funded efforts in C4 are working to develop the theoretical understanding and the experimental validation of the EOS of CH, SiO2 and chlorinated foams under shocked or heated conditions. Beyond standard shock techniques (Us,Up), Trident has the ability to develop and field advanced diagnostics that could measure internal energy, pressure or other constraining properties that would drive and challenge theory. It is anticipated that the development of this EOS capability on Trident can be applied to a variety of materials in the future.

C10

Trident continues to be the facility of choice to develop and check out x-ray diagnostics destined for the larger Omega and NIF facilities in support of C10 campaigns.

An obvious C10-relevant scientific area where Trident continues to be the tool of choice for elucidating the basic science is in the area of Laser Plasma Instabilities (LPI). Presently on ignition targets, LPI represents a significant energy loss via backscattering, it limits the maximum power in the inner beam cone, and it may be contributing to significant capsule drive asymmetries azimuthally. And LPI will continue to be a limitation in the performance of advanced targets, such as high-temperature hohlraums and ignition targets driven by the higher laser energy available with green-light-drive on NIF. Trident can not only help us to continue to elucidate the dynamics of the LPI problem (e.g., with multi-hot spot experiments), but also to test proposed LPI mitigation strategies.

One mitigation strategy is to change the laser power from a relatively slow-changing waveform into a pulse train known as “STUD” pulses (Spike trains of

Uneven Duration and Delay), which may keep the LPI in the linear regime and reduce it to its theoretical minimum. The LANL LPI research community recommended an effort in STUD pulse research as the best hope to control LPI. However, there are reasons why the idea may not work (some scientific and some technological), and the scheme requires laser modifications that are expensive and hard to justify on NIF, or even Omega, without addressing those concerns and showing that STUD pulses can indeed control LPI on a more affordable scale, such as Trident. Therefore, it is a reasonable expectation that the STUD pulse work started on Trident in FY12 will extend to FY13 and beyond.

HEDLP

The 2009 Research Needs Workshop (ReNeW) outlines the most promising areas of research in this important field. It includes research in relativistic laser-plasma interactions, including its application for laser-driven particle acceleration. Trident remains arguably the best facility in the world for this research, by virtue of its unique capabilities. These include the best pulse contrast of any major laser facility, a suite of optical diagnostics unmatched by any facility of its size, and a complete suite of particle and x-ray diagnostics.

LDRD

LDRD is the way the Laboratory explores high risk, high payoff ideas. These are highly competitive and extensively reviewed, including its scientific excellence, feasibility and programmatic impact. Therefore they line up perfectly with the purpose and proposal evaluation criteria for the facility.