Extra slides: Actual slides from OLUG2019 used in F&R session

2019 Omega Laser User Group Workshop Findings and Recommendations

Outline of the next 38 slides

Additions/renewals/modifications to requests from last year

New requests

F&Rs related to Documentation

1. Have the Shot Request Forms “auto-save” the entered text

- Requested capability: Have the SRFs “auto-save” entered text to behave more like, say, Google Docs

- Impact of requested capability: make SRFs be less vulnerable to the PI nightmare of making a bunch of careful changes, forgetting to hit “submit” and not realizing that there’s a discrepancy between PI intent and the SRF data

- Proposal sponsor: Bob Heeter, LLNL, LANL, UMich….. (broad audience support)

2. Add diagnostic and beams info documentation to PI Portal

- Requested capability: Ensure that users have access to detailed, and up to date documentation on diagnostics and beam delivery.
- Capability requirements:
  - Bring operating procedures and diagnostic info pages back online (fix broken links)
  - Document diagnostic availability, capabilities, and history of repair/calibration
    - Ex: Document TIM-Frame-CCD compatibility in spreadsheet. Document differences, advantages, disadvantages between XRFCs (e.g. radiation hardening, contrast, sensitivity).
    - Similar request for spectrometers, (Etc…)
    - Include links to calibration data and history with diagnostic on PI portal
    - Specific request: Make Dante channel response/calibrations available and compatible with open source DANTE analysis software (in conjunction with UMich and LANL)
  - (As-shot info) Automatically process P510 info for every shot and make it available on PI portal – include timing and pulse width differences between request and shot.
- Impact of requested capability: Save time on both the user and facility end on sending emails to convey diagnostic information. Ensure that most accurate and up to date info is available for data analysis and shot day preparation.
- Proposal sponsor: LANL; LLNL, UMich, MIT

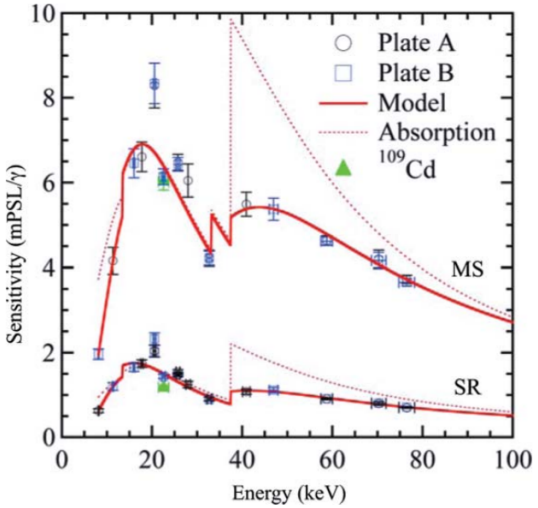
3. Tools for estimating diagnostic signal levels

- Requested capability: Tools to estimate diagnostic signal (signal-to-noise) levels to allow more accurate initial setups
- Capability requirements:
  - Build open source photometric tools for estimating signal registered by a diagnostic – any diagnostic!
    - Start with most frequently used diagnostics --- Ex. Bias settings for XRFCs
      - Starting point: add documentation for camera thresholds and sensitivities to the PI portal and update regularly
- Impact of requested capability: Fewer shots wasted on figuring out whether a signal is detectable. A standardized method for assessing whether a proposed experiment may detect something useful. Less time wasted on each group writing their own tools for the same standard OMEGA diagnostics.
- Proposal sponsor: LANL, LLNL, MIT

F&Rs related to Calibration

4. Extended image plate calibrations at < 10 keV and 200 keV – 1 MeV

- Requested capability: Image plate calibrations at < 10 keV and 200 keV – 1 MeV
- Capability requirements: *Are these within the capability of the new IP calibration station?*
  - <500 eV steps at photon energies < 10 keV.
  - Soft gamma spectra; would support gamma spectrometer development
- Impact of requested capability: Would enable extension of applicable ranges of IP use and development of new diagnostics
- Proposal sponsor: LANL, LLNL, LLE, MIT, UMich



As an example, Maddox et al (2011) sensitivity curves stop at ~ 10 keV

5. Calibrations for spectrometer crystals

- Requested capability: Calibrations for spectrometer crystals.
- Capability requirements: Measure reflectivity curves using a known source and periodically re-characterize crystals.
  - Solicit input on most commonly requested crystals to determine priority.
    - Add calibration data/documentation/references on PI portal
  - A calibration station is currently being developed at LLNL and one is currently available at Princeton
  - Historically individual users have been responsible for calibrations
- Impact of requested capability: Enables absolute measurements of spectral intensity, which provides an additional constraint on plasma temperature measurements. Enables photometric estimates for shot preparation (fewer wasted shots on low or no signal data).
- Proposal sponsor: LANL

F&Rs related to Diagnostics

6. Increase Dante filter and part availability

- Requested capability: Dante maintenance and documentation improvements.
- Capability requirements:
  - Mitigate damage to filters or increase replacement frequency (pinholes from debris strikes generate systematic errors in measurement).
    - *Bob Heeter: LLNL supplies filters and parts; LLNL expects increased part availability as DANTE capability is expanded on NIF*
  - Catalog filters and include as-shot info in header file necessary for calculating response functions
    - Complements use of open source Dante analysis software
- Impact of requested capability: Multiple campaigns are using indirect drive platform to mitigate preheat. Precise Dante measurements are critical for characterizing drive and constraining simulations on these campaigns.
- Proposal sponsor: LANL, LLNL, UMich

7. γ-ray spectroscopy for nuclear science at OMEGA

- **Requested capability:** γ-ray spectroscopy, both prompt & delayed emission, is a capability gap for nuclear diagnostics and science
- **Capability requirements:** Multiple groups are interested in γ-ray spectroscopy across a variety of different energy ranges
  - Prompt γ-ray spectrometer with sub-MeV resolution covering ~1 to ~20 MeV
    - Fundamentally new capability for the field; Enable nuclear structure measurements using neutron sources, heavy nuclei physics relevant to the r process and forensics, and searches for nuclear-plasma interactions.
  - Capability for gaseous debris collection and g-ray spectroscopy, analogous to the current NIF RAGS system and dismantled capabilities on OMEGA
    - RAGS exists on NIF but is expensive, data production at OMEGA is highly desirable
- **Proposal sponsor:**
  - Submitted by Alex Zylstra on behalf of collaborators at LLNL, LLE (Zaarah, Jim, …), LANL, MIT, …
  - Short-pulse community is also interested in gamma E > 300 keV
  - Nuno Lemos: interest in energies up to 200 MeV, would need increased shielding

8. Allow VISAR/SOP capability on TIM14 (EP)

- Current Requested capability: VISAR/SOP capability on TIM14 on EP
- Capability requirements: The same capability as on TIM12 VISAR/SOP: 2 VISAR legs, the same streak cameras, the same sweep speed choices and the SOP.
- Impact of requested capability:
  - Doubles data acquisition rate on Strength campaign RT ripple growth experiments
    - configuration limited to alternating VISAR and radiography on same TIM'; TIM12 is the only station capable of both ripple radiography and VISAR
      - Drive shots on first 2-3 shots using TIM12 VISAR and switch to a radiography diagnostic on TIM12
      - Adds uncertainty in understanding of the drive since shot-to-shot laser variations and target variations exist
- Proposal sponsor: Benefit to the HED materials campaigns. Programmatic POC: Jim McNaney (LLNL); Technical POC: Hye-Sook Park (LLNL), similar LANL interest

9. VISAR/SOP Upgrades/Improvements

- Short-term upgrades
  - fix WIGGLE issue on EP.
  - include slit view/alignment snapshot to data flow on server for each shot
  - deploy user portal with space-time distortion calibration info and data
  - absolute calibration of SOP sensitivity

- Longer term improvements
  - Multiwavelength system to provide broadband optical properties information for material science
  - 3rd leg to improve dynamic range in velocity and timing

- Proposal sponsor: Marius Millot (LLNL)

10. Implement hardware mitigation for early-time radiation artifact on XRFCs

- Requested capability: Make it possible to radiograph direct and indirectly-driven targets with XRFCs without large, high-Z shielding schemes
- Capability requirements: Implement hardware mitigation for early-time radiation artifact on XRFCs
  - LLNL has added ERASER capability to several GXDs on NIF to eliminate this artifact
    - Could OMEGA duplicate this technology?
- Impact of requested capability: Reduce dependence on high-Z shielding and complicating target design, classification review triggering, debris concerns
- Proposal sponsor: LANL, UMich

The infamous “chicken-foot” in its natural habitat

11. Add CR-39 processing capability at OMEGA

- Requested capability: Add CR-39 processing capability at OMEGA
- Capability requirements:
  - Dedicate staff time to supporting pRad measurements
  - Increase throughput in LLE CR-39 processing lab
  - Improve pathway for communicating needs to MIT (button in proposal that automatically starts discussion, or add contact info in SRF where pRAD is called out, or both)
- Impact of requested capability:
  - Remove bottleneck in CR-39 processing which sometimes even has led to necessity to postpone follow-on campaigns
- Proposal sponsor: LANL, LLNL

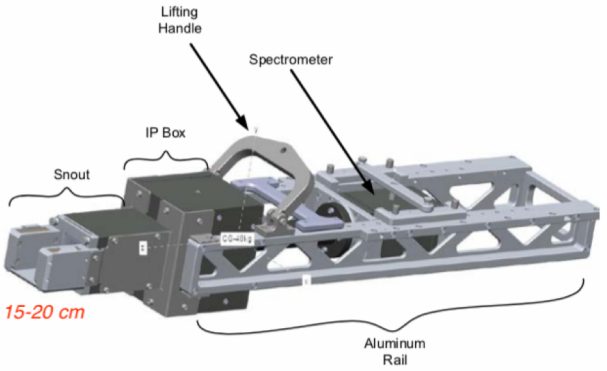
12. Ensure selectable pieces for SXI match inventory

- Requested capability: Limit number of SXI setups to the ones that can actually be supported
- Capability requirements:
  - Ensure functionality of SXI
  - Correctly label and organize pinholes (pinhole originally supplied by LLNL, stock has been depleted)
  - Limit selectable SXI setups to filters, mirrors and pinholes that are available
    - Keep documentation on historical setups
    - Make more readily available drawings for out-of-stock parts (according to Bob Heeter, there is a binder of drawings)
- Impact of requested capability: Imaging the extent and color of a soft x-ray source is vital to all experimental platforms being studied at LANL
- Proposal sponsor: LANL, UMich

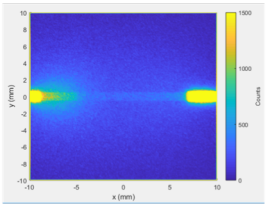
13. Add charged-particle signal mitigation to multiple diagnostics

- Requested capability: Add magnet or other mitigation strategy in front of x-ray detector and XRS to deflect electrons and other charged particles and prevent
extra signal at detector
- Capability requirements:
  - There are multiple existing designs for other diagnostics to do this (ex: HERIE, …)
  - Want high magnetic fields to deflect high energy electrons
  - Add a electron dump to reduce bremsstrahlung x-ray production
  - Put the magnet as close as possible to the target and as far as possible from the x-ray detector
- Impact of requested capability: Will benefit laser-solid interaction experiments and x-ray generation experiments. Allows use of XRS during short-pulse experiments
- Proposal sponsors: LANL, Nuno Lemos, LLNL

Existing setup at Omega EP - HERIE, w/ magnets on front

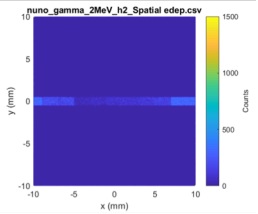


Gamma + electrons



Electrons
T = 2 MeV
1e7 events

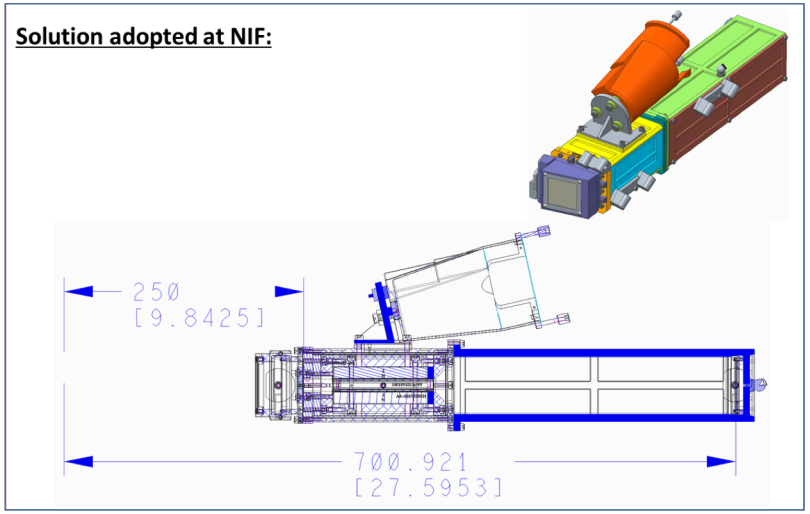
Gamma Only



Gammas
T = 2 MeV
1e7 events

14. Modify EPPS to measure higher energy electrons (E_{max} ~ GeV)

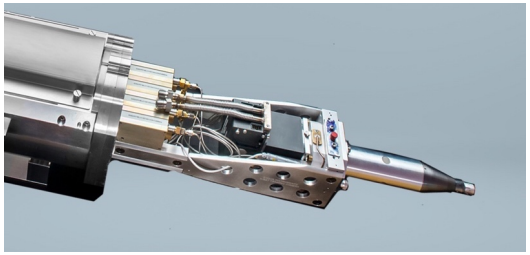
- Requested capability: Currently the electron beam spectrum at EP is measured using EPPS or the OSAKA spectrometer but it is limited to ~ 150 MeV – want to be able to go higher
- Capability requirements:
  - High magnetic fields to deflect high energy electrons
  - Add a electron dump to reduce bremsstrahlung x-ray production
  - Characterize the incoming x-rays simultaneously

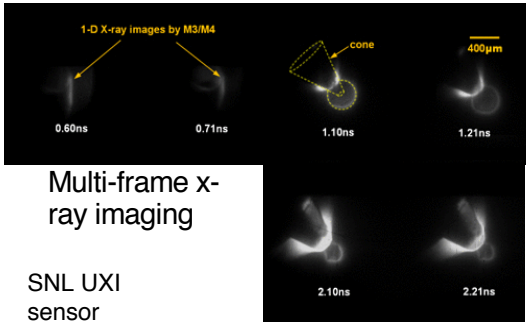


- Impact of requested capability: This new capability will benefit laser-solid interaction experiments, x-ray generation experiments and laser wakefield experiments
- Proposal sponsors: Nuno Lemos, LLNL; Louise Willingale, UMich

15. Add a SLOS for multi-frame single pinhole imaging

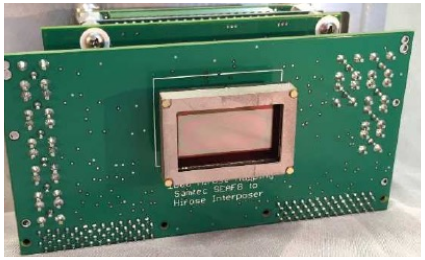
- Requested capability: Multiple Single Line of Site (SNL UXI detector based) cameras for multi-frame single pinhole imaging, or connected with the SCI (Omega and EP)
- Capability requirements: new TIMable cameras using the latest UXI CMOS technology to get 4-8 frames of x-ray images along a single line of site (single pinhole) in a 1ns on 1ns off type configuration, no time-dilation front end needed.
  - If compatible with SCI, you could do super-high resolution imaging with multiple frames
  - Could use multiple UXI sensors without time dilation
- Impact of requested capability: Data rate for any HED experiment can be improved by a factor of 4 to 8, making nearly single-shot experiments possible with an x-ray radiography movie of the experiment available. This would be game changing for many types of experiments.
- Proposal sponsor: LANL





Multi-frame x-ray imaging

SNL UXI sensor



16. Improve framing-camera pointing-procedures for x-ray imaging

- Problem to be addressed:
  Currently, it often takes several shots to get pointing right when using framing cameras for self-emission x-ray imaging (see example image; true for multiple different magnifications).
  - Could learn from NIF system optics tracking to get more accurate pointing?
- Impact of requested capability:
  Would allow valuable data to be collected from the first shot of a campaign, without losing shots to pointing adjustments.
- Proposal sponsor: MIT (Maria Gatu Johnson, Johan Frenje, Hong Sio, Patrick Adrian, …), others?
- Bonus:
  Getting timing and bias settings right also challenging
  - Bias ties back to FnR on calculating expected signal levels
  - Suggestion for standardizing parts in electronics path to minimize bias variation with repairs

17. Thomson scattering on DT shots for compatibility with DT^3He backlighter

- Requested capability: Thomson scattering operation on DT shots
- Capability requirements: LLE indicated that an assessment of contamination risk to Thomson optics must be conducted. The DT^3He backlighter has ~3 mCi tritium in fill
- Impact of requested capability: allows for simultaneous use of **DT^3He** (tri-particle) backlighter for radiography and Thomson scattering to characterize plasma, as is possible for D^3He backlighter operation
- Proposal sponsor: G Sutcliffe, CK Li, (will benefit many experiments with DT^3He backlighter)

18. Second and/or third Thomson Parabola Ion Energy Analyzer (TPIE)

- **Requested capability: Implementation of a second and/or third Thomson parabola diagnostic which would be identical to the existing TPIE currently used on OMEGA and OMEGA-EP**
- Capability requirements: No major design modifications would be required for these additional lines of sight TPIE, but one of them would need to be qualified for tritium use.
- Impact of requested capability:
  - TPIE is a versatile diagnostic that provides high quality charged particle spectrometry for experiments on both OMEGA and OMEGA-EP. It can have applications to ion acceleration experiments on EP (especially heavy ions or different charge states), stopping power experiments, lab astro etc.
  - Adding more TPIEs would allow this diagnostic to be used on more campaigns since currently scheduling this single instrument on both OMEGA and OMEGA-EP is challenging.
  - This capability would be important to the ARC-particles team who are investigating ion acceleration at different pulse-length and intensity regimes on OMEGA-EP. These experiments are anisotropic so the addition of the second line-of-sight TPIE would be crucial to their campaign.
- Proposal sponsor: Raspberry Simpson (MIT), Tammy Ma (LLNL), Derek Mariscal (LLNL), Jaebum Park (LLNL), Ginevra Cochran (LLNL) , Alex Zylstra (LLNL)

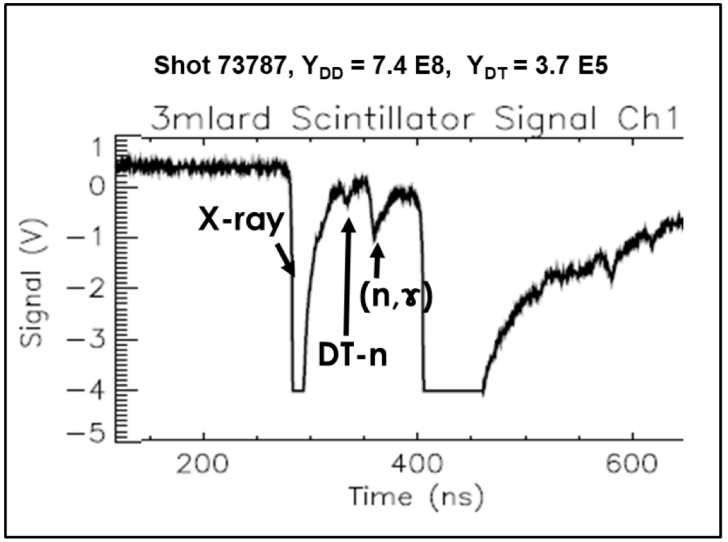
19. Request to implement a more sensitive nTOF detector for secondary DT-n measurements

- Goal: measure secondary DT-n at yields above ~5e5, in presence of a strong x-ray background signal, for accurate fuel-ρR determination (~10%).
- Secondary DT-n are routinely measured with the 3mLARD nTOF but X-ray and (n-γ) background are too significant for an accurate measurement. We need an n-TOF that is more sensitive to DT-n and insensitive to photon background.
- Any user who uses D^3He or D_2 gas-filled implosions will benefit from this measurement. Contacts: Arijit Bose (bose1@psfc.mit.edu)/Patrick Adrian (pjadrian@mit.edu)
- Interested parties: P. Adrian, N. Kadabi et al. (MIT), G. Kagan, S. Hsu (LANL).

- **The secondary neutrons are created in reactions:**

  D + D → p (2.5 MeV) + T (1.01 MeV)

  T (1.01 MeV) + D → α + n (11.8–17.1)



20. Investigate upgrades to fixed x-ray pinhole cameras

- Adaptions for measurements in the soft x-ray regime
  - Reduced filtration or removal of Be filter
    - Can IP replace CID?
- Improve dynamic range
  - More than one channel?
  - IP could also increase dynamic range
- Solicit interest in other potential upgrades

- Interested parties: Lan Gao (Princeton), Jim Knauer (LLE)

21a. Thomson Scattering capability on EP

- **Perform a feasibility study of an optical Thomson scattering diagnostic for EP, equivalent to the one available on Omega-60**
  - **Many experiments on Omega-60 could migrate to EP if this capability was available**
  - **Current experiments on EP would also benefit from the diagnostic capabilities of TS**
  - **Localized TS measurements would complement global images from current 4w probe**
- **Interested parties: Derek Schaeffer (Princeton), UMich**

21b. Stray light mitigation for Thomson EPW spectrometer

- **Implement narrower notch filter for electron plasma wave wavelength range**
  - **Replace current 10 nm filter w/ commercially available 1 nm filter to avoid clipping EPW signal**
- **Interested parties: Derek Schaeffer (Princeton), UMich**

F&Rs related to Target Capability

22. Tritium gas fill capability into a warm spherical capsule

- Requested capability: Tritium gas fill capability into a warm spherical capsule
- Capability requirements: Either diffusion or fill tube filling would benefit many campaigns
  - Filling station capable of handling (a) pre-mixed gas reservoirs such as DT, HT, and T3He, (b) pressurized system up to 15 atm, (c) room temperature targets and
  - Fill-tube filling station would allow monitoring of mounted capsule gas pressure at TCC before shot
- Impact of requested capability:
  - Have been relying on LLNL for these fills. Shipping process adds risk – LANL lost three shot days due to shipping issues last year. LLE fills are also always secondary to NIF fills on LLNL fill station.
  - Need for this capability will only grow (audience suggested to “bite the bullet now”)
- Proposal sponsor: LANL DARKMIX & Double Shell campaigns. Any campaigns requiring DT3He backlighter. Many nuclear campaigns

23. Special gas fills using variable fuel mixture, with or without tritium

- Requested capability: Special gas fills using variable fuel mixture, including tritium (HDT, DT, HT, T3He, Argon with T, etc, doping for DD or D3He)
- Capability requirements: Capsule filling station capable of mixing fuels of different percentages including or not including tritium
- Impact of requested capability:
  - Current tritium mix fills are currently completed at Livermore and transported to Rochester. Multiple errors ands mistakes in this process have lost shot days. Having the capability at Rochester simplifies experiment preparation and minimizes ability for mistakes.
  - Reoccuring problem for non-tritium fills – this specifically a problem for different dopant levels
- Proposal sponsor: LANL TrMix/AsymMix/DARKMIX

24. Planar Cryo system for EP

- Enable broad range of experiments using high performance of EP Laser and Diagnostics
- What experiments would be enabled with the planar cryo system on EP: Anything with liquid Hydrogen or rare gases , eos , shock and release, insulator to metal transition in the dense quantum fluid...
- Proposal sponsor: Marius Millot, LLNL

F&Rs related to Beams

25. Extended individual beam delay capabilities by a fixed amount

Cap. requirement: See if extending beam delays can increase backlighting capability

- Specifically, the ability to extend the delay in beams ***by a fixed amount***.
- Specific LANL request: 4ns delay on beams10, 15, 16, 17, 20, 28, 31, 33, 35, 37
- A more general capability would benefit to broader community. Lots of audience interest -- Multiple other LANL campaigns would benefit from the capability
- Impact of requested capability:
  - LANL campaigns: Adding tiny amount of extra observation timel enables the exponential growth of hydrodynamic instabilities to be readily observed.
    - CYLDRT: We intend to develop a higher convergence platform that will require still longer backlighted delays to reach the same punt of instability growth as the present CYLDRT experiments.
    - New capability will benefit hydrodynamic experiments in both cylindrical and planar geometry - MShock and CYLDRT are current campaigns.
  - General capability: Will allow greater freedom in backlighting without needing to sacrifice drive energy by using the second driver
- Proposal sponsor: LANL (Ray Leeper, Sasi Palaniyappan), General community

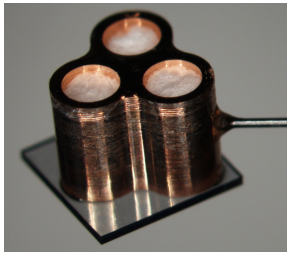
26. Omega: Any beam, any delay (or at least a 3rd leg)

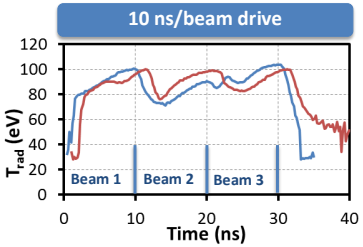
- Requested capability: Omega: Any beam, any delay (or at least a 3rd leg)!
- Capability requirements: any beam, any delay
- Impact of requested capability: later times for BL and drive separations, this will allow a broader range of HED studies on Omega, making at least 3 (or 4) different groupings of large delays possible gives the flexibility to think about very complex heating experiments to study heat transport and other complex hydro. Also with EP capabilities to Omega this would help amplify that capability
- Proposal sponsor: LANL (Flippo)

27. Longer duration OMEGA EP UV (and IR?) beams

- Investigate the feasibility of having longer duration OMEGA EP UV beams, e.g. 15-20ns
  - Audience also expressed interest in feasibility of longer IR beams
- Currently, each OMEGA EP UV can deliver 4.4kJ in 10ns. Three such beams sequentially fired in time have been used to demonstrate a sustained T_R= 90eV x-ray drive for 30ns
- Laboratory astrophysics experiments driven with long duration x-ray drives are important to establish connection and relevance to astrophysical scenarios

- Gatling-Gun in OMEGA EP has demonstrated T_R= 90eV for 30ns
- Measurement performed with CEA's miniDMX





- Capability will benefit:
  - Laboratory photoionized plasmas in steady-state, i.e. Photo-Ionization Equilibrium (PIE)
    - Longer duration x-ray drive will enable PIE at lower densities thus increasing astrophysics relevance
  - Could replace stitched pulses on some of current experiments
- Proposal sponsor: Mancini (UNR), LLNL, LANL

28. Opposing EP beams

- Requested capability: Opposing EP beams
- Capability requirements: Make 1 or 2 of EP beams have the ability to oppose the other two beams on EP.
- Impact of requested capability: This allows for more complicated colliding shock, jet, plasma experiments than can currently be executed on EP with the current geometry, and makes the facility as attractive as OMEGA for these experiments
- Proposal sponsor: LANL (Flippo), everyone else…

F&Rs related to OPAL

OLUG input is needed to shape LLE's proposal to build a 30 PW multi-beam facility

- The EP-OPAL project is in the process of defining a system for proposal under NSF MS-RI-2:
  - Geometry of experimental chamber(s)
  - Beam requirements: spatial, temporal control, relative timing & energy control, polarization
  - Diagnostic requirements: scale, location
  - Concept of use: rep-rated beams at 5 PW, multi-day campaigns, multiple target areas, EP integration
- User input is critical to make sure the system is capable of achieving the best science with new capabilities
  - We want to avoid missing important needs that are easy to design but hard to reconfigure.
  - Consider: "OLUG requests opposing beams on OMEGA-EP"
- An OLUG OPAL Working Group with bi-weekly or monthly web meetings leading up to the full proposal submission (Aug 2) would provide valuable user feedback on the initial facility design
  - Seeking interested members! Contact Hans Rinderknecht (hrin@lle.rochester.edu)
  - Other suggestions for feedback mechanisms?

This work is ongoing and we want and need your involvement!
How can we achieve the best science beyond current capabilities?

29. A UV probe, ~50-150 nm, using high harmonic generation

- Requested capability:
  - Requesting a feasibility study for a UV probe, ~50-150 nm, using high harmonic generation for interferometry of long scale length and higher density plasmas on Omega EP
  - This might be a good fit for development with OPAL
- Capability requirements: At 21ω(~50 nm), 1% of the critical density is ~4*10^21 cm^-3, this could be tunable by using different harmonics.
- Impact of requested capability: Measurements of density structure from blowoff, gas, or foam in a wide range of experiments at higher density and scale length. Sub ps interferometry measurements.
  - An example is the UM photoionization front experiment, which has a ~3 mm scale length
- Proposal sponsor: Heath LeFevre (UMich) hjlefe@umich.edu

30. Calibrate and cross-calibrate charged-particle diagnostics routinely used on OMEGA (added during Friday's session)

- Capability requirements:
  - Calibrate and cross-calibrate the suite of MIT charge-particle/neutron diagnostics (MRS, CPS1-H11G, CPS2, TPIE, PXTD, PCIS, WRFs) at OMEGA
  - Cross-calibrate the newly relocated CPS1-H11G with other charged particle diagnostics that are routinely used at OMEGA such as TPIE, CPS2, and WRFs.
  - Calibrate CPS1-H11G and CPS2 with the newly designed array plates
  - Calibrate TPIE diagnostic with new "CPS-mode" capability
  - Recalibrate PCIS, WRFs and PXTD
  - DD yield calibration using nTOFs and charged particle detectors
- Impact of requested capability: These calibrations are urgent and will be benefit by people who will use nuclear diagnostics in OMEGA experiments.
- Proposal sponsor: R. Simpson, J. Frenje, M. Gatu-Johnson, G. Sutcliffe, N. Kabadi, P. Adrian, C. K. Li; LLE: C. Forrest, H. Rinderknecht, and are fully supported by a large number of academic institutions, including U of Chicago, U of Michigan, Princeton U, Oxford U, U of California, U of Nevada and U of Rochester (LLE); and by national laboratories, such as LLNL, LANL, Sandia.

Provide 4ω probe corrections/calibrations

- Requested capability: Provide 4w probe corrections/calibrations.
- Capability requirements: Automate calculation for amorphic distortion present in polarimetry arm of 4w probe using 4w setup shots on the day
- Impact of requested capability: Expedites image reduction and increases turnaround for polarimetry data. Establishes a standard correction to allow comparison of data between shot days/platforms
- Proposal sponsor: LANL;