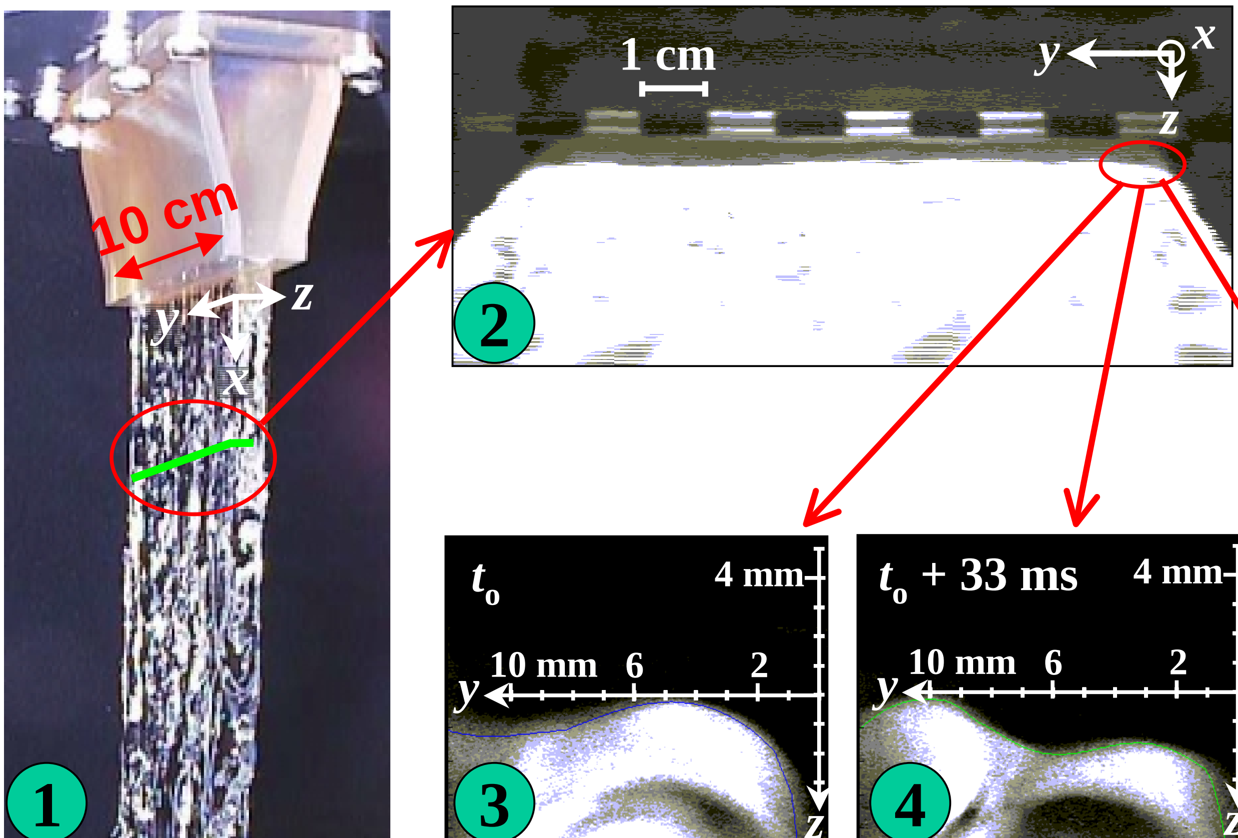
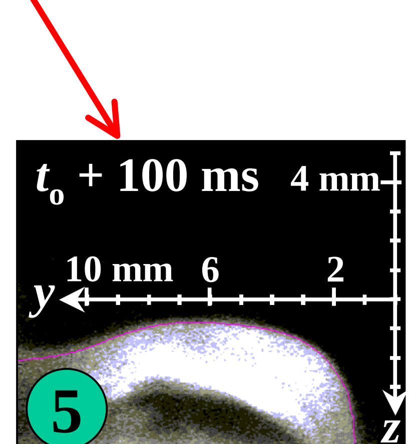
Thick-Liquid Protection:

J. A. Collins, D. Sadowski, M. Yoda and S. I. Abdel-Khalik—Georgia Institute of Technology

- Developed and implemented a non-intrusive, instantaneous method for measuring surface smoothness in turbulent jets.
- Water is dyed with 10^{-9} mole/liter of disodium fluorescein (uranine), a fluorescent dye that, when illuminated with green light, fluoresces in the yellow-green. The green line (image 1) on the jet shows where an argon-ion laser light sheet illuminates the flow along the y-z plane at a downstream distance of 15 cm, which corresponds to the center of the Flibe pocket in HYLIFE-II.
- Images are acquired by a CCD camera looking up the slab jet at a slight angle (image 2). Image processing is used to determine surface ripple and statistics. Images 3-5 show close-ups of the upper-right corner of the jet.





- $Re = 3.4 \times 10^4$
- 10×1 cm nozzle
- x = 15 cm from nozzle
- Maximum instantaneous ripple is ~ 2 mm at jet corners
- Large variations are observed over 10's of msec

Progress in IFE Technology: December 1999-March 2000, (Cont'd.)

Thick-Liquid Protection:

P. F. Peterson, C. Bauman, C. Jantzen and S. Pemberton—University of California at Berkeley

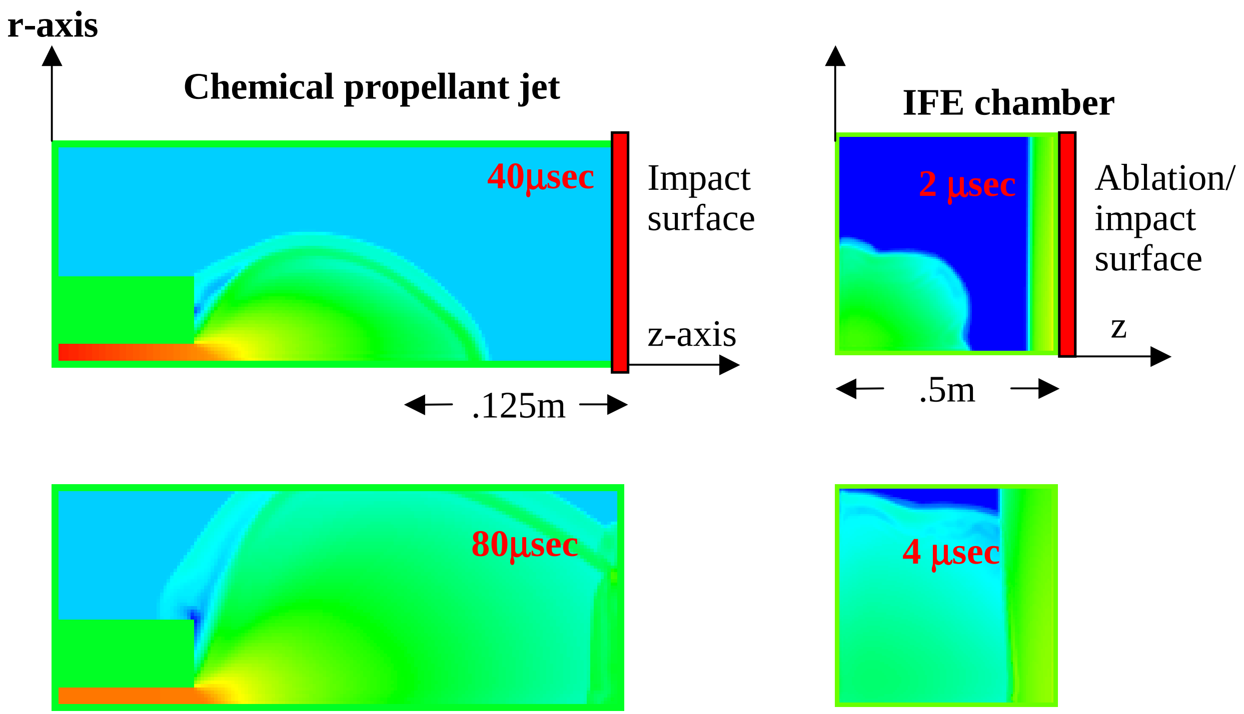
- Completed design and numerical analysis showing that chemical propellants can be used to simulate the impulse load delivered by IFE targets to thick-liquid jets in hydraulics response experiments.

- Completed safety analysis and obtained safety-committee permission to use chemical propellants, in blank shot-gun cartridges, for liquid jet disruption in the UCB liquid jet experimental facility.

- Fabrication of the firing mechanism is now underway.

- Numerical simulation allows comparison of scaled impulse for ¼-scale jet disruption experiments.

- Chemicals deliver impulse over longer time scale, but still rapid compared to > millisecond liquid response.



P.F. Peterson, "HIF Liquid Hydraulics Scaling and Pocket Design," presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California.

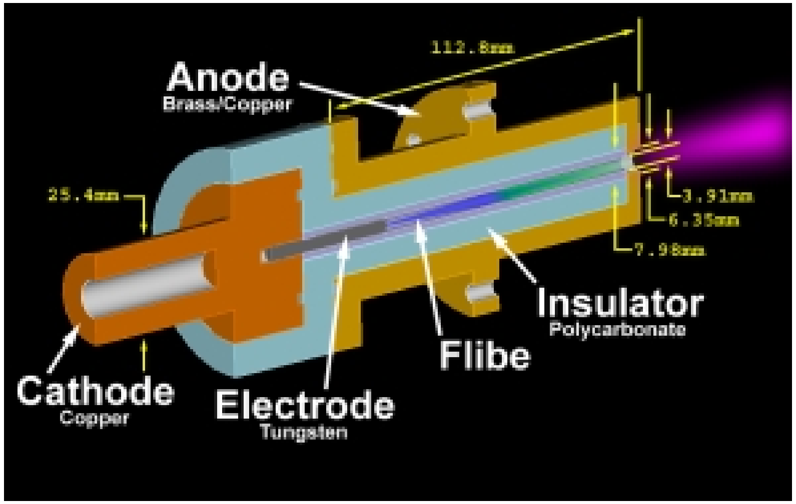
C. Bauman, S. Pemberton, P.F. Peterson, "Single-Jet Experiments for HIF Thick-Liquid Chambers," presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California.

C. Jantzen and P.F. Peterson, "Scaled Impulse Loading for Liquid Hydraulic Response in IFE Thick-Liquid Chamber Experiments," presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California.

Progress in IFE Technology: December 1999-March 2000, (Cont'd.)

Thick-Liquid Protection:

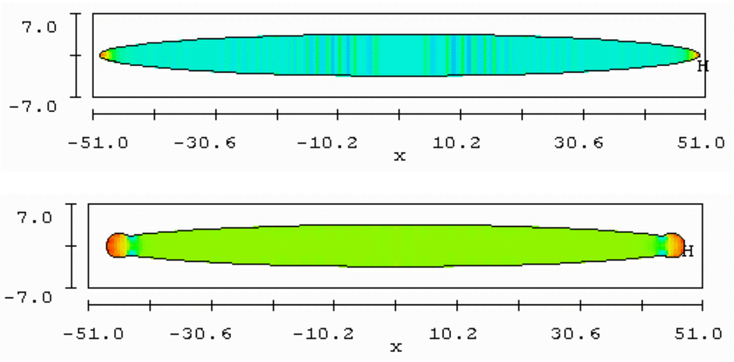
N. B. Morley—University of California at Los Angeles (see web site at www.fusion.ucla.edu/IFE)



- Flibe condensation rate experiment:
  - Designed and constructed "Pulse Forming Network" and "Plasma Gun“ (schematic shown at right) using old capacitors from Nova laser.
  - Began shakedown tests with a fair amount of ablated polycarbonate liner material. Stored energy of 0.625 kJ gave a current peak of 8 kA,and a pulse length of 40 μs.
  - A system for melting and casting of Flibe is under construction.

- Jet Modeling and experiments:
  - Modeling of "corner rounding" on rectangular jets indicates that an elliptical-shaped jet ends may be preferable to sharp corners in order to eliminate large corner waves (dog-bone shape) that appear to be largest surface disturbance.
  - Nozzle with rounded ends to be tested this month that will allow experimental validation of rounding technique, and ability to precisely measure "flat section" wave development with shadowgraph technique.

- Ablator calculations of aluminum GILMM indicate that hydro-motion during laser pulse duration will significantly reduce internal stresses predicted by original Moir calculation. Indicates that higher power laser pulses may be tolerated.



Top cross section shows jet at t=0 (close to the nozzle). Lower cross section shows jet at t=0.3 s (~ 3.6 m downstream of nozzle).

P. Calderoni, “Vapor Clearing Rates and Condensation Experiments for IFE Liquid Chambers: Progress,” UCLA Internal Report (Mar. 2000).

A. I. Konkachbaev, N. B. Morley, K. Gulec, and T. Sketchley, “Stability and Contraction of a rectangular liquid metal jet in a vacuum environment,” ISFNT-5, Rome, Italy (Sep. 1999). Accepted for publication in Fusion Engineering and Design.

Gas Dynamics and X-Ray Ablation:

R. R. Peterson—University of Wisconsin-Madison

- Developing velocity diagnostic for Wisconsin Shock Tube for shock interaction experiments.

- BUCKY code calculations for x-ray response experiments proposed for Z. Results show (Figures 1 and 2) that Z x-rays can produce shock in steel similar to what the target x-rays would in a power plant (LIBRA-SP).

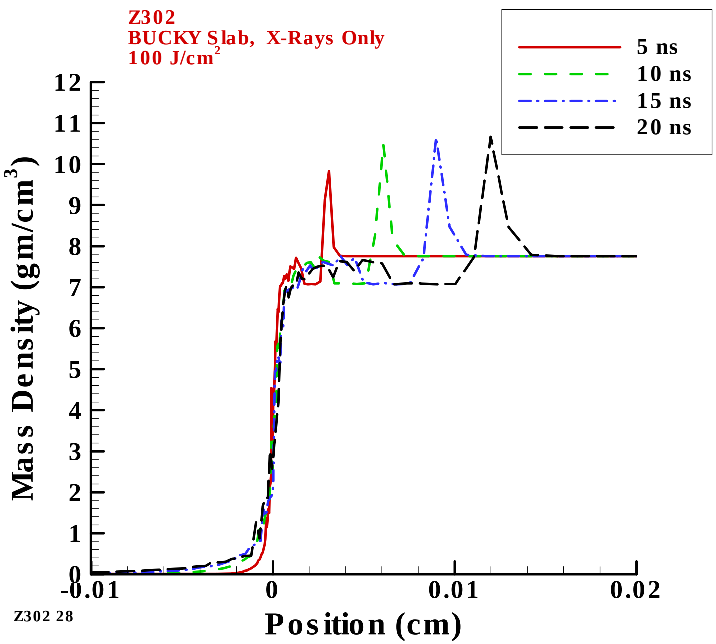


Figure 1. Mass density profiles at various times calculated in stainless steel with BUCKY. 100 J/cm^2 of x-rays with the spectrum and pulse width from Z shot 302.

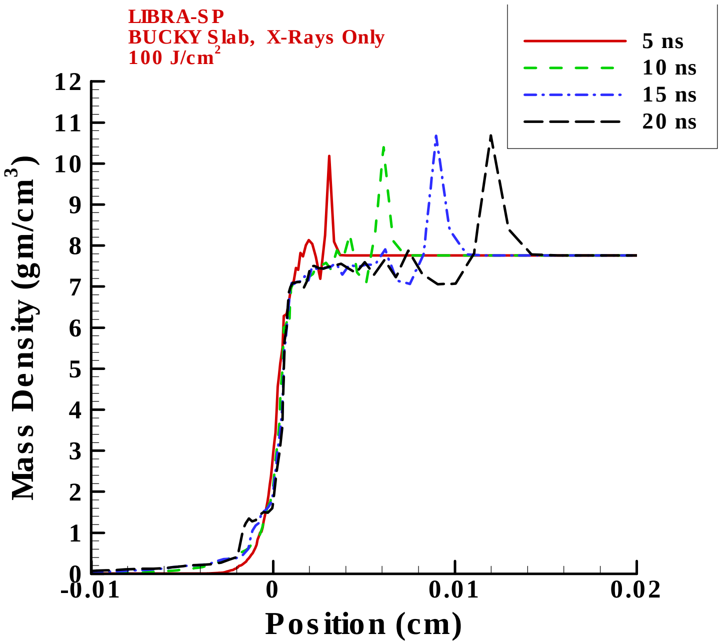


Figure 2. Mass density profiles at various times calculated in stainless steel with BUCKY. 100 J/cm^2 of x-rays with the spectrum and pulse width calculated for the LIBRA-SP target.

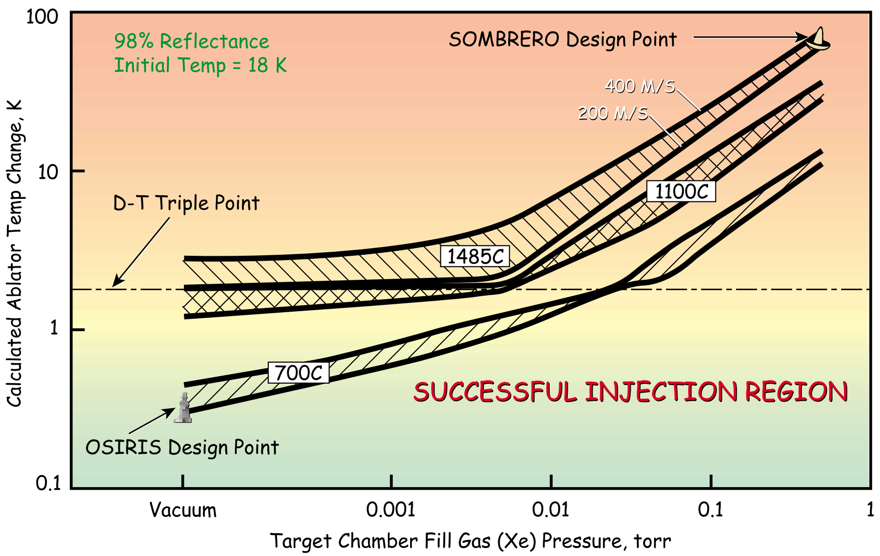
R. R. Peterson, C. L. Olson, T. J. Renk, G. E. Rochau, and M. A. Sweeney, "Chamber Dynamic Research with Pulsed Power," presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California.

Progress in IFE Technology: December 1999-March 2000, (Cont'd.)

Target Fabrication, Injection and Tracking:

D. Goodin, A. Nobile, G. Besenbruch, R. Petzoldt and W. Steckle—General Atomics and Los Alamos National Laboratory

- The thesis, "Thermal Analysis of Inertial Fusion Energy Targets", has been prepared by a San Diego State University Student working at GA. This thesis addresses the issue of target heating during injection for both direct and indirect drive targets. The figure illustrates one outcome of this work, indicating that the chamber fill gas pressure in the SOMBRERO design must be reduced to control target heating during injection.

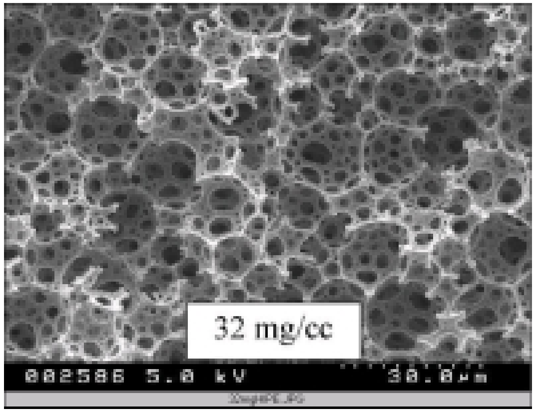


- Design concepts for target loading and for injection gas removal systems have been developed. Preliminary equipment layouts have been prepared.

- The System Design Description for the target injection and tracking system is being modified and a System Design Basis document is being prepared.

- Development of low-density, metal-doped organic foams for the LLNL heavy ion driven IFE target has begun. Foams with a composition of $(CH)_{0.97}M_{0.03}$ (where M is a metal atom) are the current focus. Metals must have the desired x-ray emission characteristics, acceptable ES&H properties, as well as chemistry and separation characteristics that are compatible with the reactor Flibe and balance of plant.

- To date, we have synthesized the polystyrene foam shown to the right with a density of 32 mg/cc. We are attempting to synthesize foams with lower density. We also are preparing to conduct experiments that will demonstrate the metal doping of our foams with various metals (Au, W, Ta, Hf, Re, and Bi) using a simple wet impregnation technique.



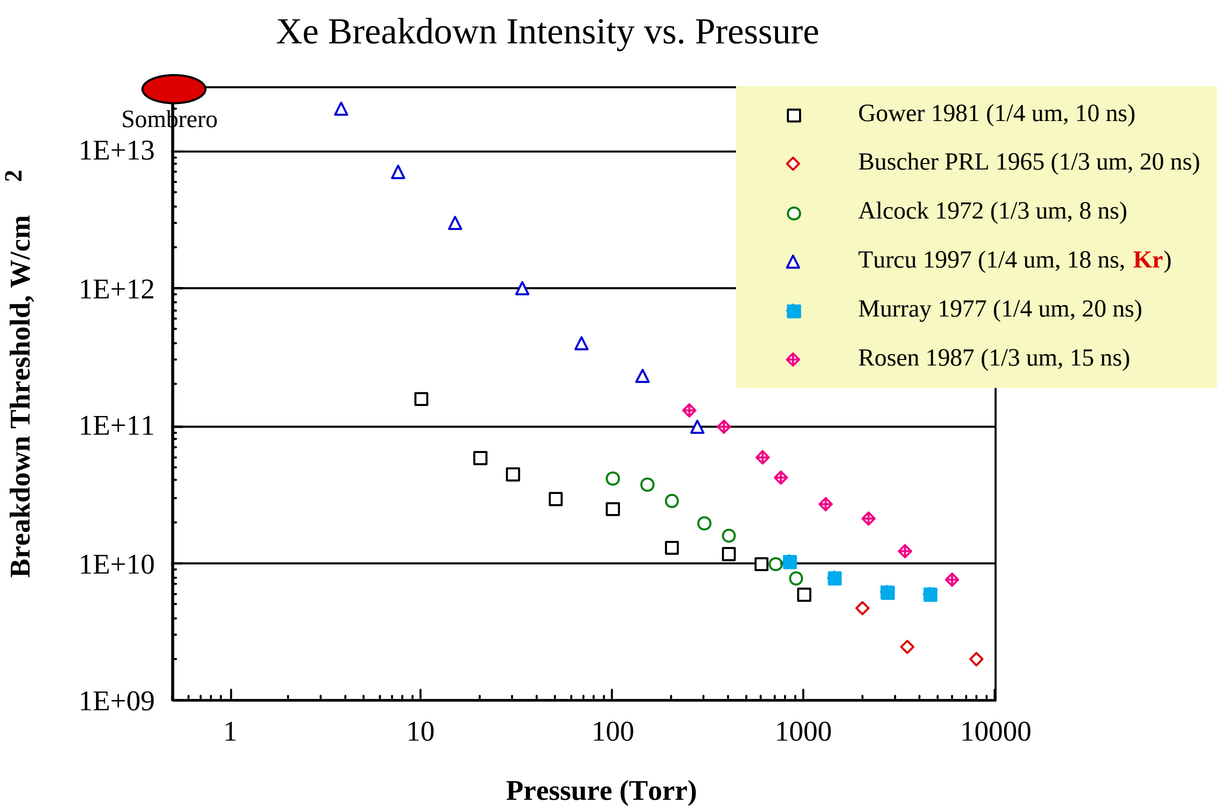
K. Schultz, "IFE Target Fabrication and Injection - Achieving Believability," presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California.

Progress in IFE Technology: December 1999-March 2000, (Cont'd.)

Laser Interactions and Final Optics Studies:

M. S. Tillack, F. Najmabadi, D. Blair, A. Newkirk, Z. Wang—University of California at San Diego

- Optics and diagnostics were tested at 532 nm. Temporal and spatial pulse shapes were obtained for both the primary flashlamp-pumped laser as well as a diode-pumped YAG test laser. Spot size and M2 were measured.
- Shack Hartmann wavefront software was written, a micro-lens array was purchased and initial wavefront data was acquired.
- Extensive literature searches on reflective UV optics damage and UV laser-induce breakdown were performed (see figure).
- Initial analysis and experiment planning for propagation studies were performed. Preliminary design of the test article was performed.



M. Tillack, "Laser-IFE Chamber Studies at UCSD," presented at Naval Research Laboratory (Mar. 2000).

Progress in IFE Technology: December 1999-March 2000, (Cont'd.)

Integration, Safety & Environment, Final Focus Magnet Shielding:

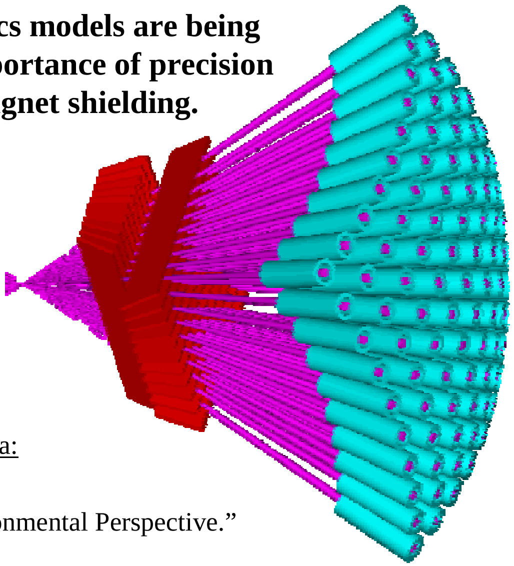
W. R. Meier, J. F. Latkowski, R. W. Moir, and S. Reyes—Lawrence Livermore National Laboratory

- Prepared annotated outline for OFES personnel for use in ongoing discussions regarding the expansion of International Energy Agency activities into IFE-related areas.
- Completed first detailed safety assessment for HYLIFE-II design. Modeled loss-of-coolant accident with simultaneous break of all beam tubes and failure of building wall. Maximally exposed individual dose < 0.6 rem (see table for breakdown). Additional accidents are being considered.
- Completed assessment of heavy ion fusion final focus magnet shielding problems as function of number of beams. Improvement of the shielding design to attain a reasonable magnet lifetime is underway.
- Completed assessment of candidate IFE target materials from perspective of recycling dose rate, waste disposal rating, and accident dose potential. Results will be used by target designers and fabricators to identify target materials that meet all requirements.
- Prepared FY01 and FY02 budget documents for the IFE element of the VLT for the OFES budget meeting in Germantown on April 4, 2000. Presented an overview of budget needs and progress in this area.
- Completed assessment of chamber, target and final focus integration issues for HYLIFE-II chamber in light of recent heavy-ion driver designs that require over 100 beams.

Tritium dominates the HYLIFE-II accident dose.

Radioactive source	Mobilized mass/activity	Release fraction	Dose at site boundary
SS304 corrosion/ oxidation products	0.5 kg / 1.31×10^{12} Bq	11%	43 μSv / 4.3 mrem
Vaporized Flibe	10 kg / 7.06×10^{15} Bq	12%	564 μSv / 56.4 mrem
HTO trapped in steel structures	1 kg / 4.99×10^{16} Bq	50%	5.34 mSv / 534 mrem

Realistic, 3-D neutronics models are being created to study the importance of precision Flibe jets upon magnet shielding.



Papers presented at the 13th International Symposium on Heavy Ion Fusion, March 13-17, 2000, San Diego, California:

J. F. Latkowski and W. R. Meier, "Final Focus Shielding Designs for Modern Heavy Ion Fusion Power Plants."

J. F. Latkowski, J. Sanz, S. Reyes, and J. Gomez del Rio, "Selection of IFE Target Materials from a Safety and Environmental Perspective."

W. R. Meier, "Overview of Chamber and Target Technology R&D for Heavy Ion Fusion."

W. R. Meier, J. J. Barnard, R. O. Bangerter, "A 3.3 MJ, Rb+1 Driver Design Based on an Integrated Systems Analysis."

R. W. Moir, "Chamber, Target and Final Focus Integrated Design."

S. Reyes, J. F. Latkowski, J. Gomez del Rio, and J. Sanz, "Accident Consequences Analysis of the HYLIFE-II Inertial Fusion Energy Power Plant Design."