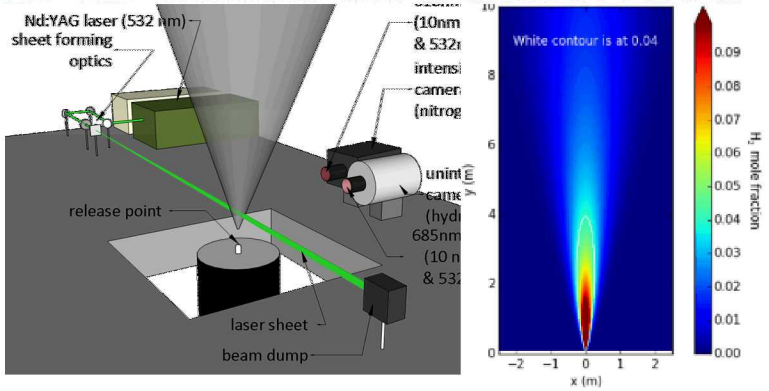
SAND2019-7179PE

Development, Validation, and Benchmarking of Quantitative Risk Assessment Tools for Hydrogen Refueling Stations

HyRAM
HYDROGEN RISK ASSESSMENT MODELS



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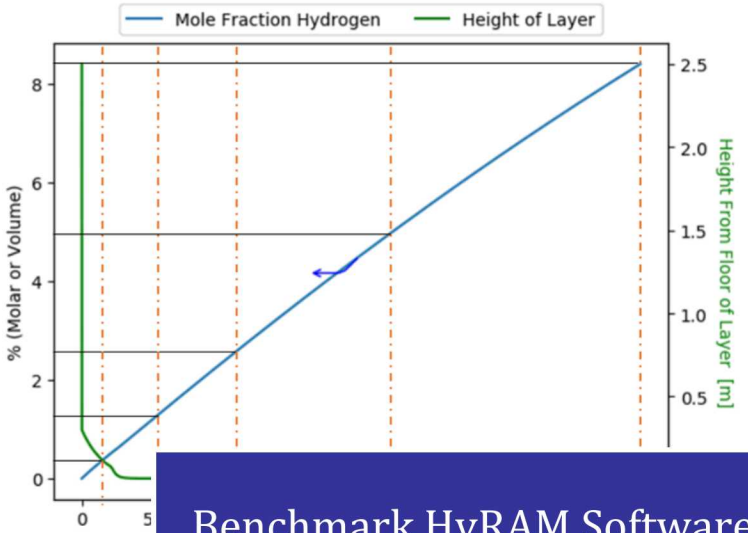
H2 Risk Assessment Workshop
July 3, 2019
SAND2019-XXXX

CRADA Tasks

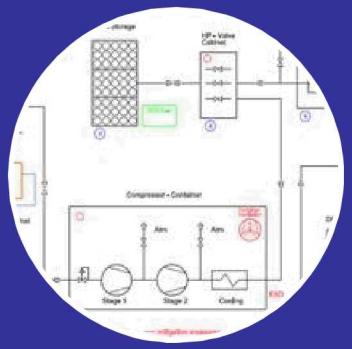
Objective: Utilize Sandia's hydrogen behavior models and quantitative risk assessment (QRA) methodology to defensibly revise safety codes and standards.



Benchmark HyRAM Software

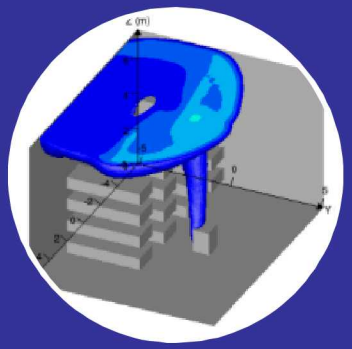
Develop diagnostic tool for 3D data for large scale experiments

Task 1: Benchmark HyRAM software

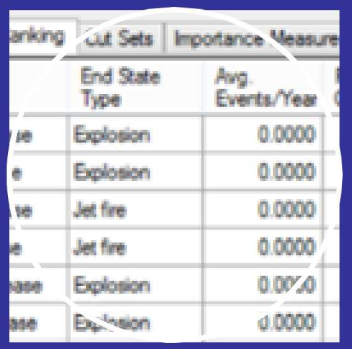


1. Select station designs to analyze

2. Perform risk analysis of stations using HyRAM while AL performs analysis using their models



3. Analyze and characterize differences between HyRAM and AL internal risk tool results



4. Document results

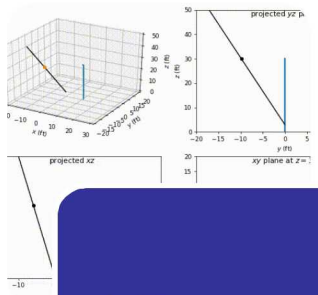
Task 1 is focus of this week's workshop

Task 2: Make quantitative measurements from large LH_2 experiments that enable defensible codes/QRA

1. Support CGA G-5.5 experiments

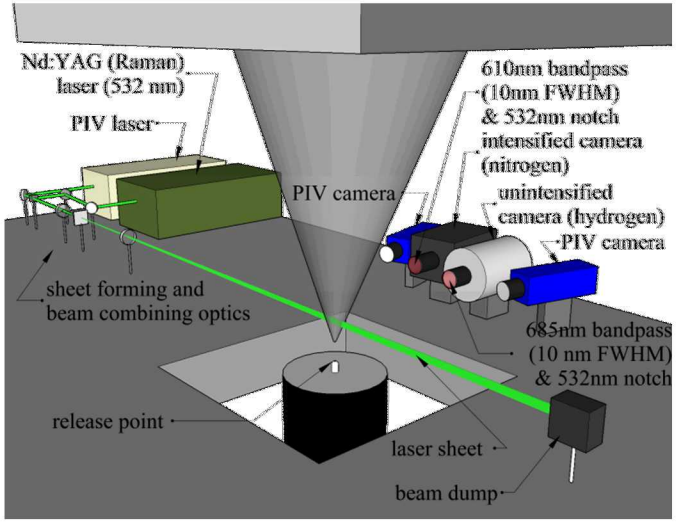
2. Finalize hardware build (illumination and light collection)

3. Prove functionality in real-world release



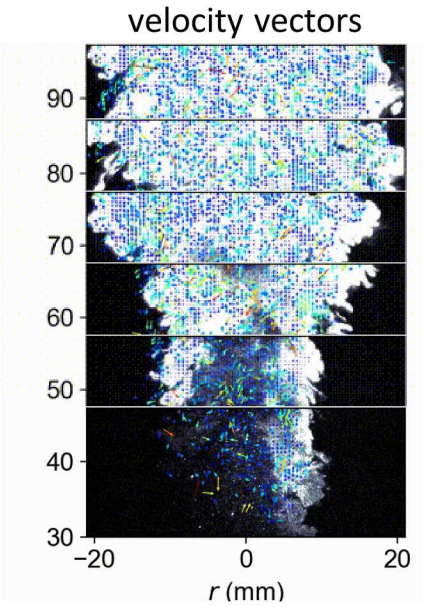
4. Document results

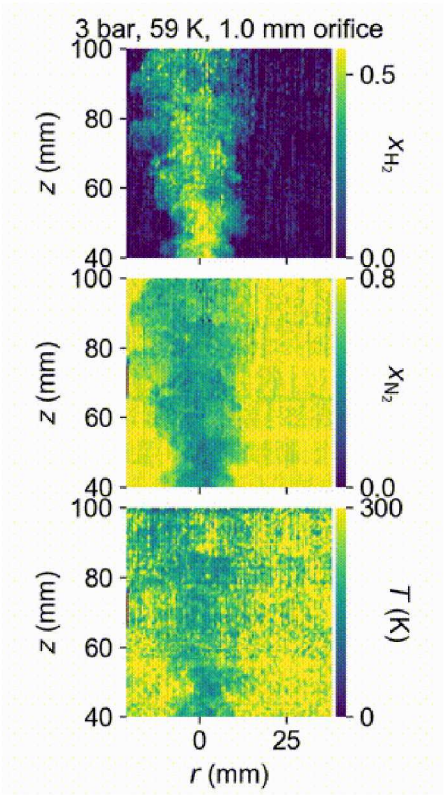
Task 2: H_2-N_2 Raman imaging and particle imaging velocimetry are used to measure concentration, temperature, and velocity of cryogenic H_2



Independent model parameters:

- ✓ T - temperature
- ✓ x - mole fraction
- ✓ v - velocity
- ✓ B - halfwidth (both velocity and concentration)



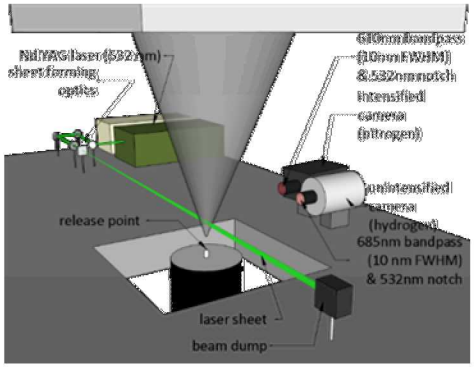


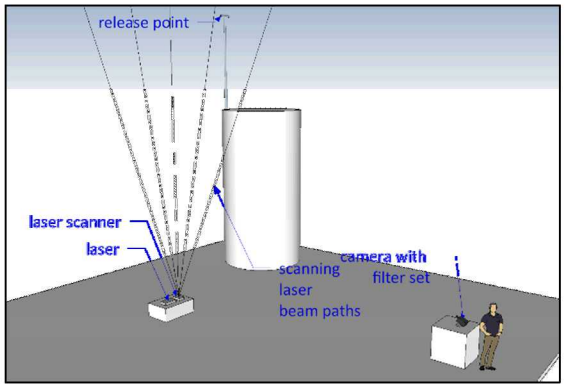
Task 2: Make quantitative measurements from large LH_2 experiments that enable defensible codes/QRA

- Support CGA G-5.5 testing task force measurements of LH_2 vent stack flames
  - Hardware support (providing Sandia owned sensors to support the work)
  - Analysis support (Sandia expertise in data analysis and documentation)
- Experimentally measure unignited hydrogen dispersion from LH_2 vent stacks
  - Develop a diagnostic tool for capturing high-fidelity quantitative data for large scale unignited LH_2 experiments
  - Measure vent stack dispersion for a range of flow rates and weather conditions

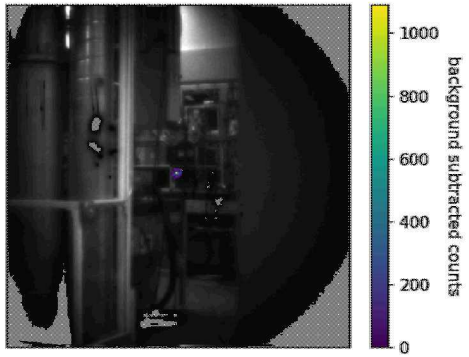
Task 2: Our lab-scale diagnostic is being modified to study LH_2 vents and large-scale experiments

- Uniquely fast optics enable collection of small Raman signal
- Imaged hydrogen from 40 foot standoff distance in the laboratory
- Demonstrated acceptable signal to noise for large-scale diagnostic
- Observed nearly 30 degree field of view (20 ft scene from 40 ft distance)





Raman signal overlaid on laboratory scene



Summary

Relevance: Build validated H2 behavior physics models and QRA tools that enable industry-led C&S revision.

Approach: *Benchmark HyRAM:* 1. Select station designs to analyze. 2. Perform risk analysis of stations using HyRAM. 3. Analyze results between HyRAM and AL internal risk tool. 4. Document results.

Experimental work: 1a. Support CGA G-5.5 testing task force experiments of LH_2 vent stack flame measurements. 1b. Finalize hardware build (illumination and light collection) needed for unignited dispersion diagnostic. 2b. Prove functionality by applying diagnostic to real-world releases. 3. Document results.

Progress: Work has begun to run scenarios using HyRAM. Experimental work is also in development.

Timeline: CRADA will expire in January 2020.

Thank you

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