604588

Final Summary of GRSP Activities

Development of Predictive Models of Advanced Propulsion Concepts for Low Cost Space Transportation

NGT8-52887
August 1, 2000 through October 31, 2002

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Advisor's Note

Mr. Morrell left the PhD program at Georgia Tech in September of 2001 to pursue a permanent job with GE Power Systems. This final report summarizes the GSRP research work Mr. Morrell was able to complete as a summer intern at NASA - MSFC during the summer of 2001 and represents the sum of work completed under NGT8-52887 from inception through project termination.

Dr. John R. Olds
School of Aerospace Engineering

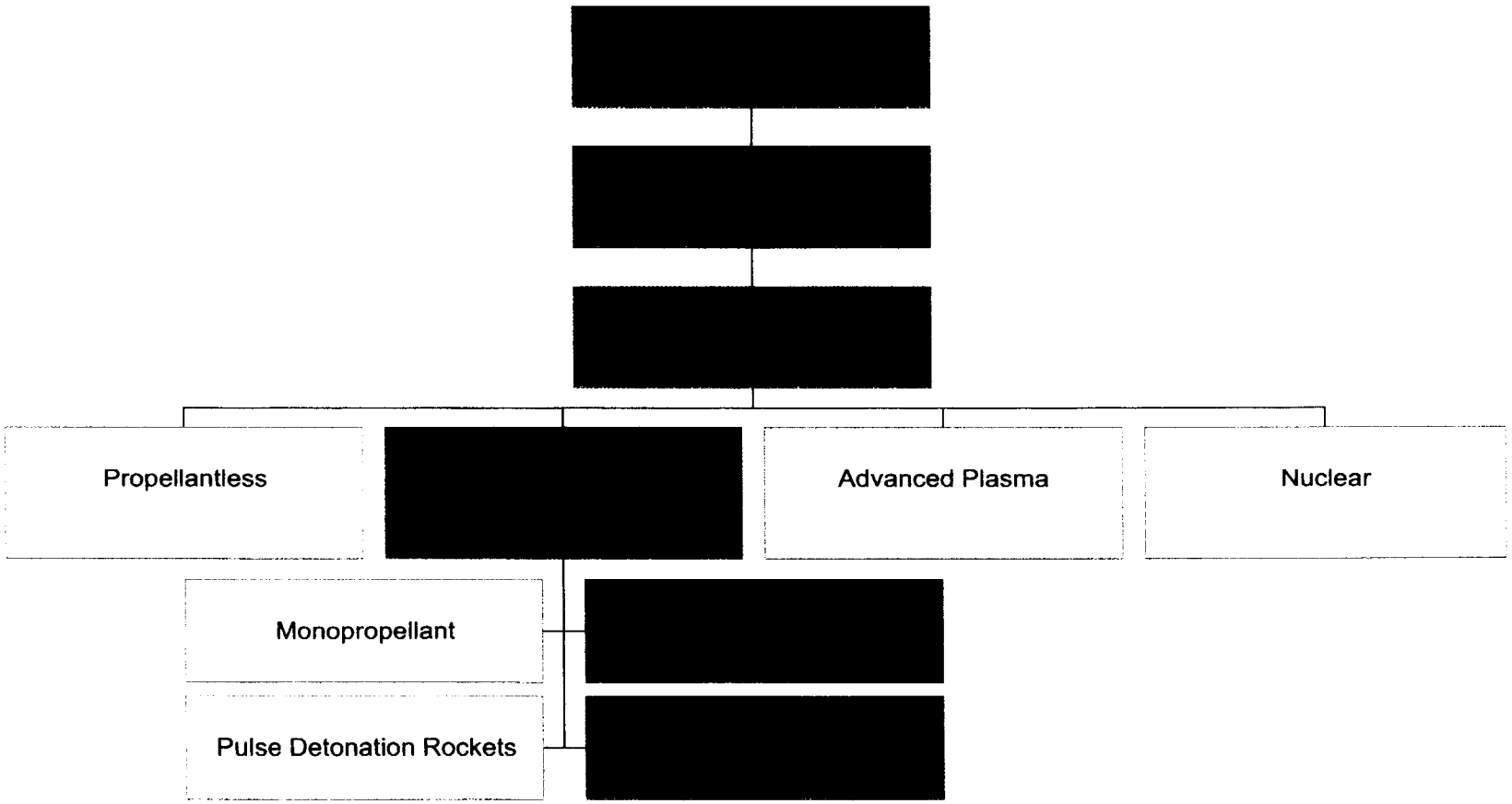
GSRP Summer Internship Experience at NASA MSFC

Randy Michael Morrell

NGT8-52887

Summer 2001

NASA TD40 Organization

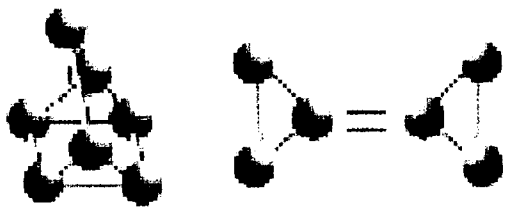


Combustion Physics Lab

- Unique facility for investigating high pressure rocket combustion
- Pressures of up to 6000 psi (~400 atm)
- $O_2 - H_2$ and O_2 – hydrocarbon flames
- Small scale, e.g. flow rates of 50 g/sec for 10 sec
- Optically accessible combustion chamber
- Bldg 4549 / TD40 Lab A

Advanced Hydrocarbon Fuels

- High Energy Density Matter (HEDM) hydrocarbons currently being researched by the military, principally the AFRL
- NASA interested in possible applications to future launch vehicles
- Plan to add AFRL chemist to the group to develop and synthesize these fuels 'in-house'

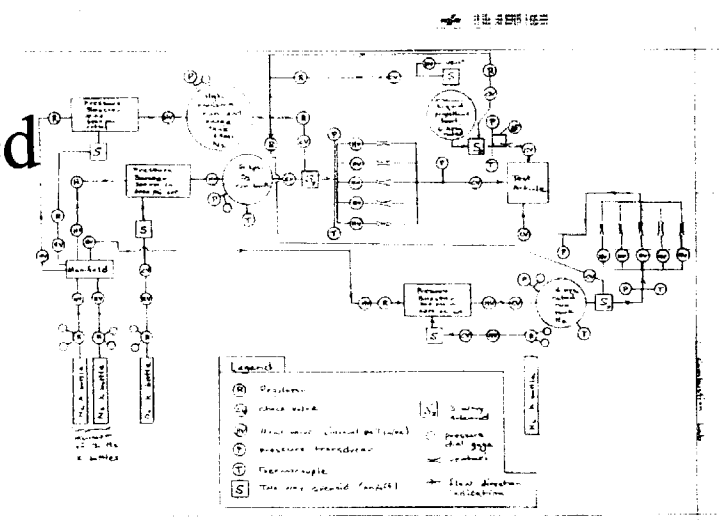


GSRP Summer Tasks

- Assist in the installation of the high pressure combustion facility
- Research issues related to high pressure combustion
- Literature review of HEDM hydrocarbon characteristics for future work

High Pressure Facility Installation

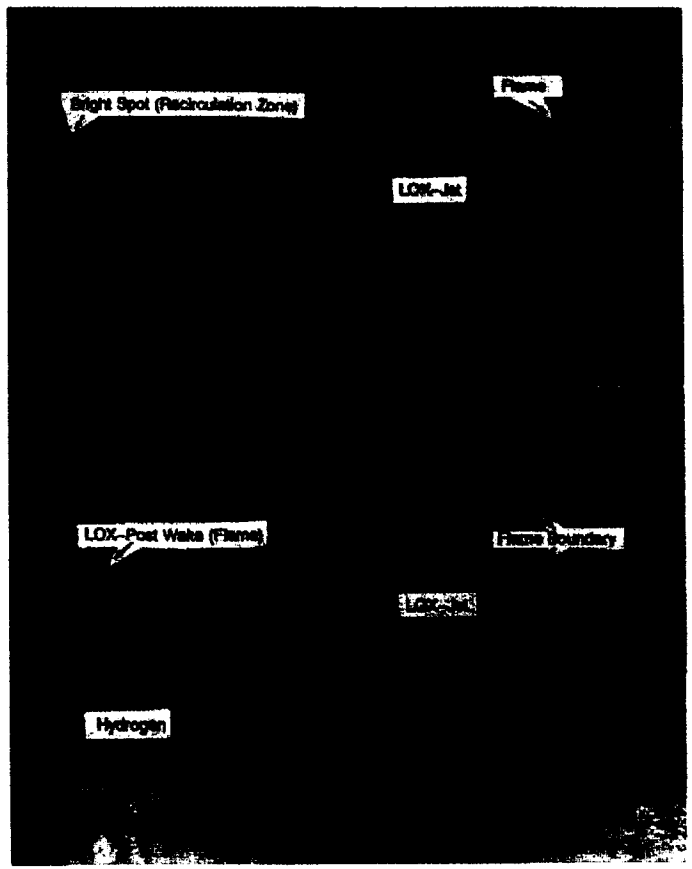
- Funding approved for the facility
- High pressure piping, pumps, and storage purchased
- Optical diagnostic equipment purchased
- Combustor funding applied for
- Waiting for lab space to be vacated



High Pressure Combustion Issues

- Supercritical behavior
  - local vs. global
- Mixing / shear layer interaction
- Diagnostic techniques in high density flows
- Scaling from lab scale to full scale

DLR Experimental Results



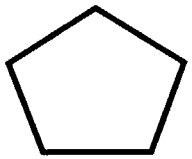
Mayer, W. et al, J. Prop. Power, Vol 12, pp. 1137-1147, 1996.

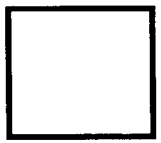
HEDM Hydrocarbons

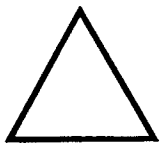
The energy content of a molecule is increased by adding unsaturation:

	$-(CH_2)_n-$	$H_2C=CH_2$	$HC\equiv CH$
ΔH_f (kcal/mol)	-4.9	+6.3	+27.0

The energy content of a molecule is increased by incorporating strain:

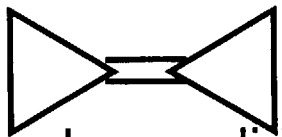






	cyclopentane	cyclobutane	cyclopropane
ΔH_f (kcal/mol)	-18.4	+6.8	+12.7

Selected candidate fuels:



$HC\equiv C\text{-}CH_2\text{-}CH_2\text{-}C\equiv CH$

	spiropentane	bicyclopropylidene	1,5-hexadiyne
Isp sec (RP-1 = 299)	311	313	312

* from PRC briefing to Rocketdyne

GSRP Summer Intern Summary

- High pressure lab now expected to begin installation this fall and operation this winter/spring.
- Limited work done to date on high-pressure, supercritical combustion. Most of work on supercritical combustion being done in Europe.
- Key contacts made with HEDM hydrocarbon researchers.