

# Critical Analysis of a Relevant Paper and Comparison with an MCNP Simulation of Slowing Down Time

22.106 Term Paper Presentation

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# Paper Citation

Benyon, T.D. and Mondal, M. A. W., “The Application of Space-Dependent Multigroup Theory to the Analysis of Neutron Slowing Down Time Experiments I: Light and Heavy Water Moderators,” 1971, *J. Phys. D: Appl. Phys.*, 4, 1843-1855.

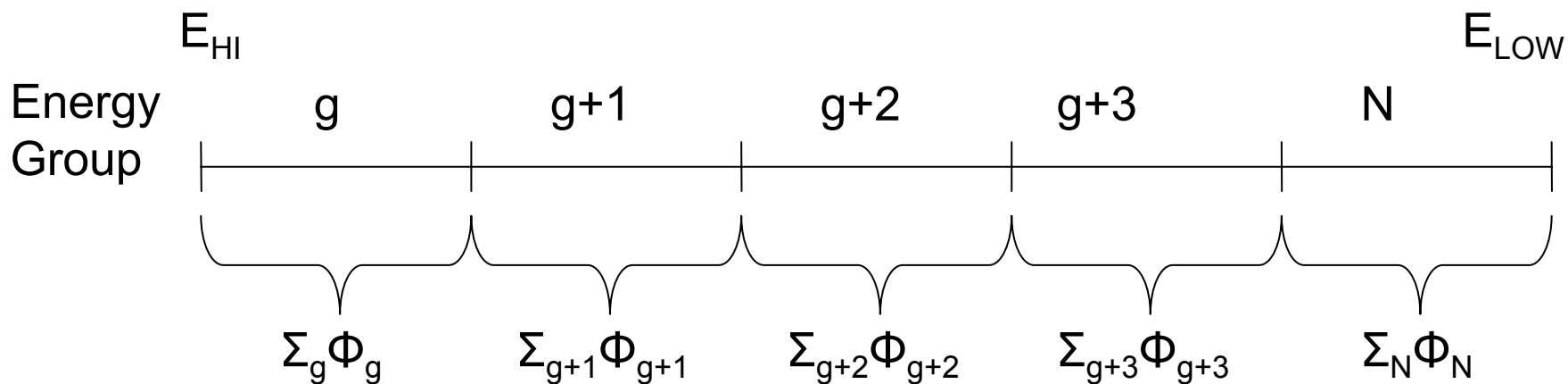


# Focus

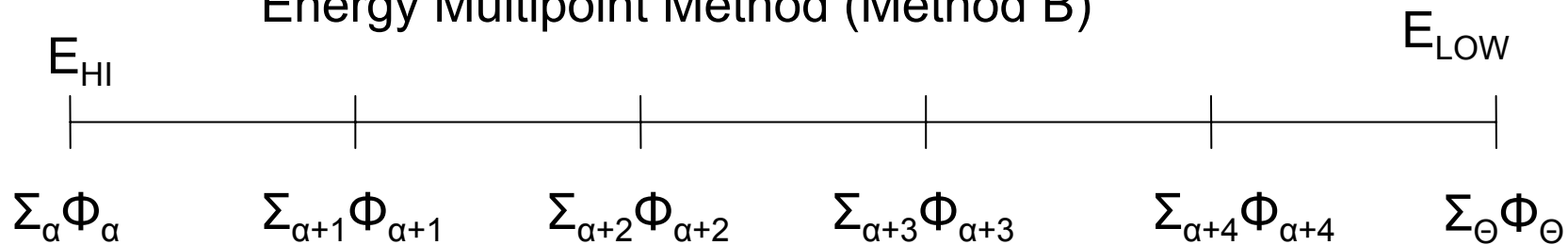
- Introduces new numeric solution method
- Solution of Neutron Transport Equation (NTE)
  - P1 Approximation
  - Diffusion Approximation
- Comparison with experimental results (3)
  - Metric: Neutron Slowing Down
  - Only 1 presented here
- MCNP simulation results for 1<sup>st</sup> experiment



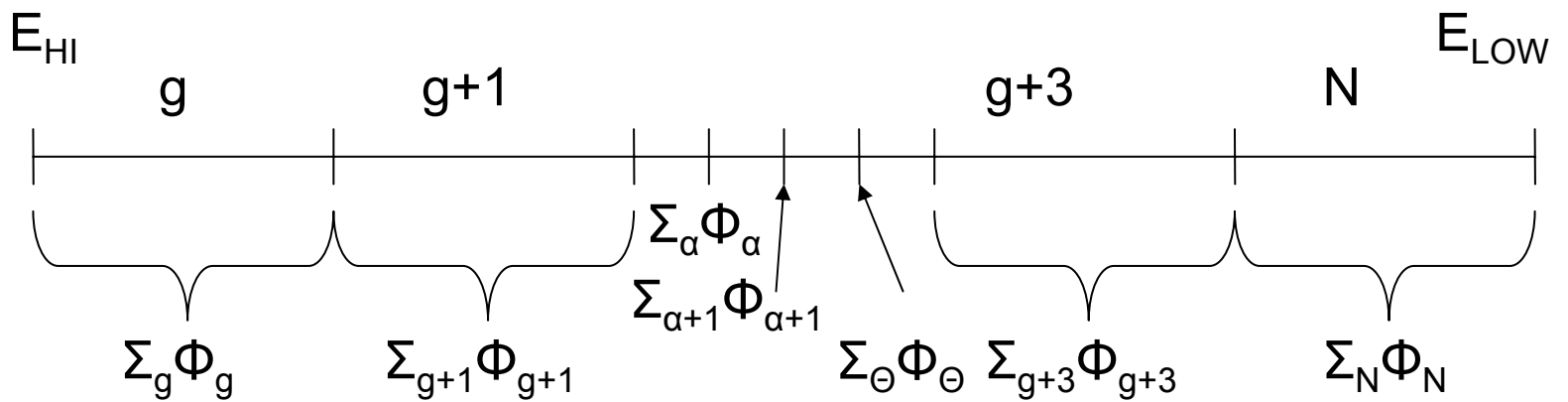
## Energy Multigroup Method (Method A)



## Energy Multipoint Method (Method B)



# Mixed Energy Multigroup/Multipoint Method (Method C)



## Experiment #1

- Möller (1966)
- 1 m<sup>3</sup> cube H<sub>2</sub>O
- Dilute Indium Sulfate
- Fast neutron source

Image removed due to copyright considerations.

Please see:

Experiment # 1 graph cited from: Benyon, T. D., and M. A. W. Mondal. "The Application of Space-Dependent Multigroup Theory to the Analysis of Neutron Slowing Down Time Experiments I: Light and Heavy Water Moderators." *J. Phys. D: Appl. Phys.* 4 (1971): 1843-1855.

# Experiment #1

## Comparison with MCNP Simulation

Image removed due to copyright considerations.

Please see:

Experiment # 1 comparison graph cited from: Benyon, T. D., and M. A. W. Mondal. "The Application of Space-Dependent Multigroup Theory to the Analysis of Neutron Slowing Down Time Experiments I: Light and Heavy Water Moderators." *J. Phys. D: Appl. Phys.* 4 (1971): 1843-1855.

# Possible Sources of Discrepancy

	Numeric Solution/Experiment	MCNP Simulation
Quantity Measured	Gamma flux from $(n,\gamma)$ capture in Indium	Neutron Flux
Detector Type	Gamma Point	Flux tally
Detector Distribution	??	Concentric Spheres
Source Isotropy	??	Yes





# Conclusions

- New method (C) matches experimental results well when applied to P1 approximation
- MCNP simulation results differ at greater distances from source
- Unearthing error will provide greater insight into original solution/experimental methods or simulation model



QUESTIONS?



## Experiment #2

- Chen and Lidofsky (1967)
- “Large tank of water”
- 14.1 MeV neutron source

Images removed due to copyright considerations.

Please see:

Experiment # 2 graph cited from: Benyon, T. D., and M. A. W. Mondal. “The Application of Space-Dependent Multigroup Theory to the Analysis of Neutron Slowing Down Time Experiments I: Light and Heavy Water Moderators.” *J. Phys. D: Appl. Phys.* 4 (1971): 1843-1855.

## Experiment #3

- Möller (1966)
- 1 m<sup>3</sup> cube D<sub>2</sub>O
- Fast neutron source

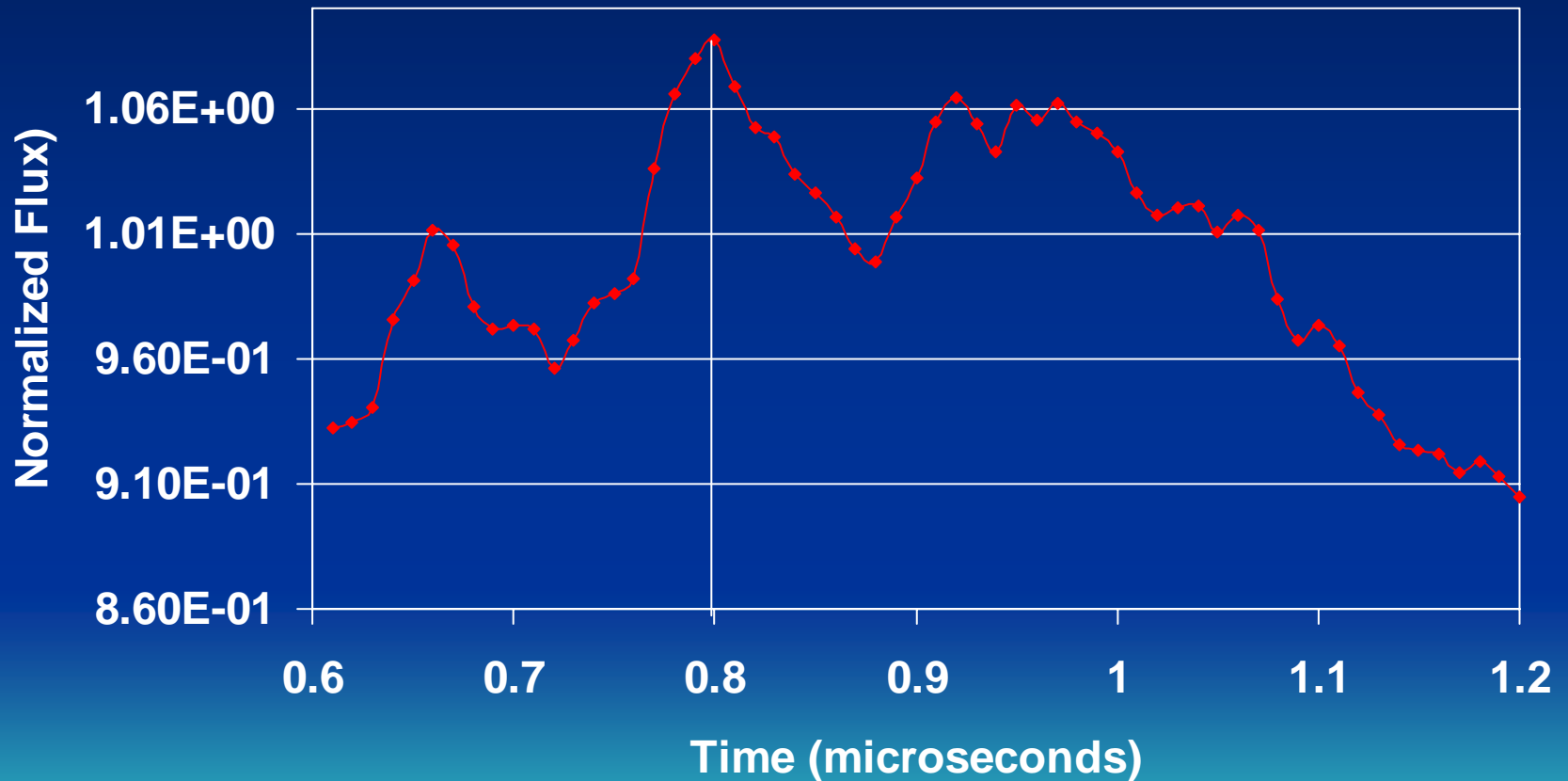
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Please see:

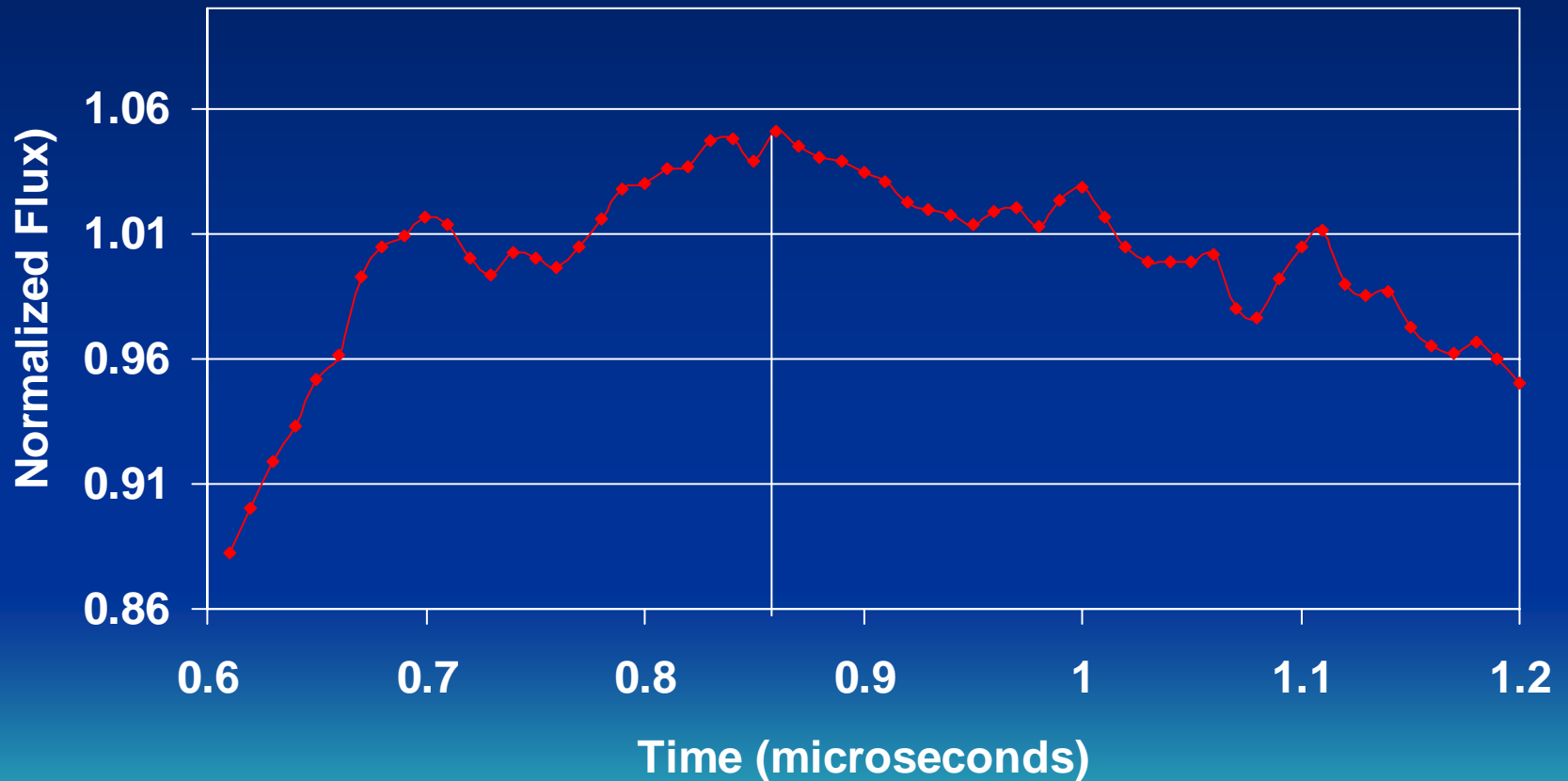
Experiment # 3 graph cited from: Benyon, T. D., and M. A. W. Mondal. "The Application of Space-Dependent Multigroup Theory to the Analysis of Neutron Slowing Down Time Experiments I: Light and Heavy Water Moderators." *J. Phys. D: Appl. Phys.* 4 (1971): 1843-1855.



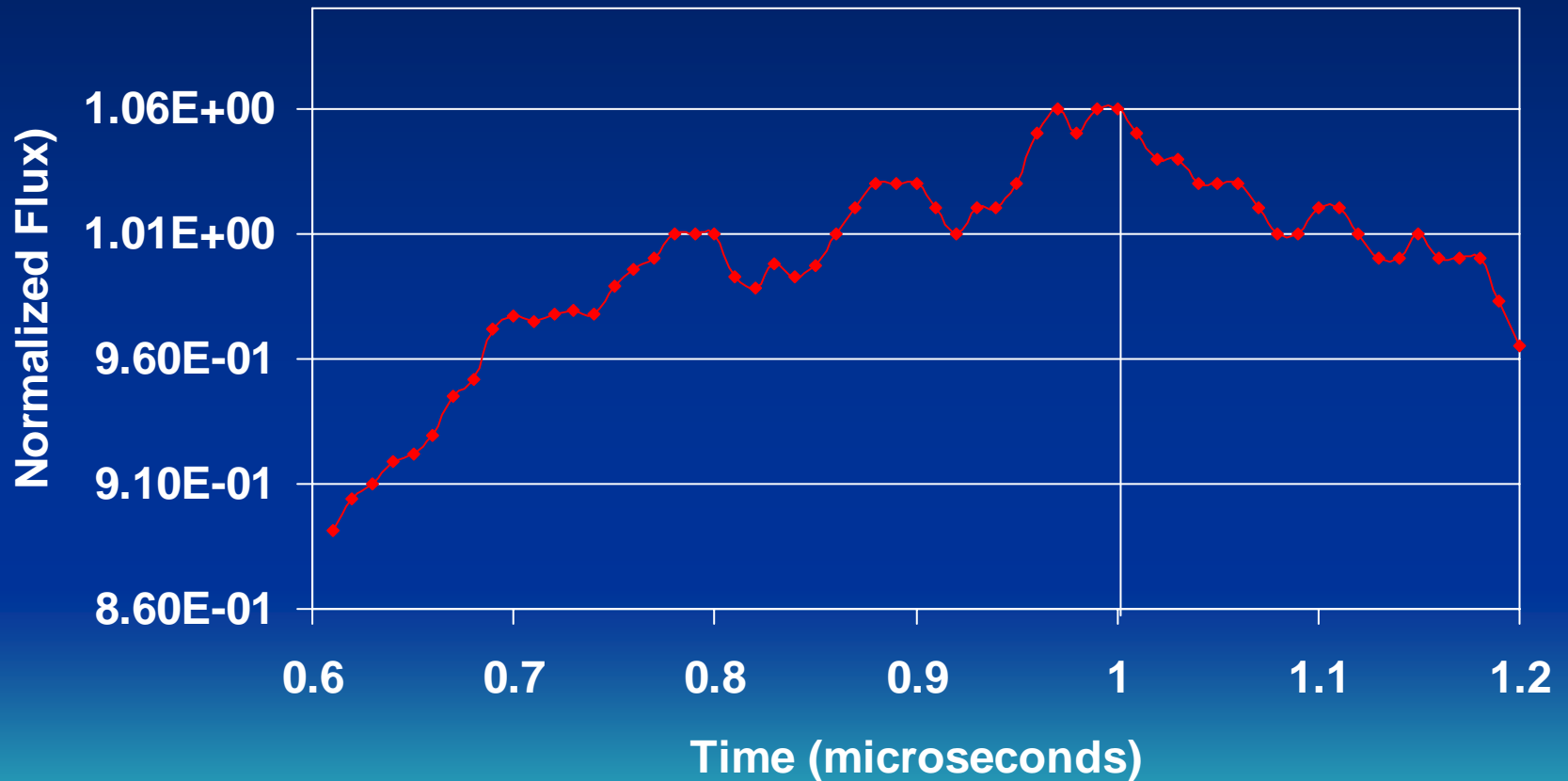
# Normalized Flux as a Function of Time at 4 cm



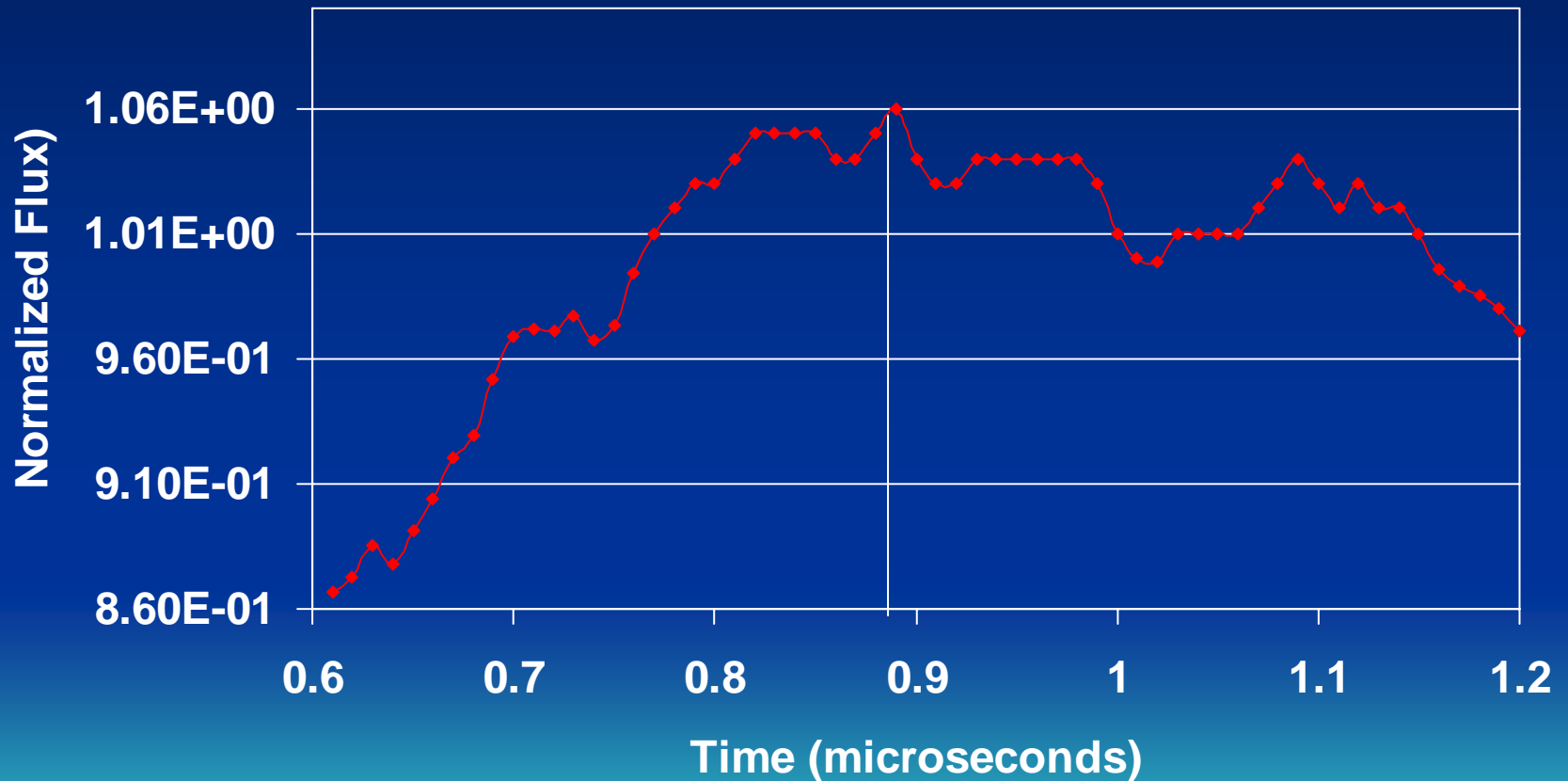
# Normalized Flux as a Function of Time at 8 cm



# Normalized Flux as a Function of Time at 12 cm



# Normalized Flux as a Function of Time at 16 cm





# Normalized Flux as a Function of Time at 20 cm

