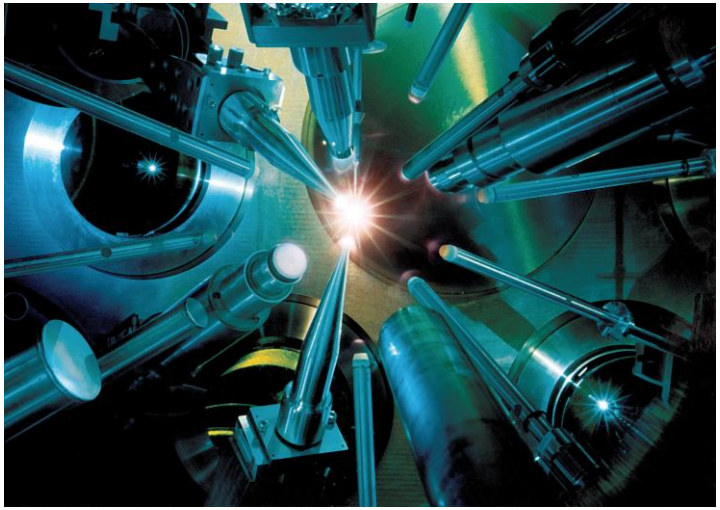

SCALING ARGUMENTS FOR MAGNETICALLY EFFECTED (COLLISIONAL) SHOCK EXPERIMENTS

Rachel Young

Magnetized Plasmas Meeting, OLUG 2018

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- Los Alamos National Laboratory: A. Zylstra
- Funding Statement: This work is funded by the U.S. Department of Energy, through the NNSA-DS and SC-OFES Joint Program in High-Energy-Density Laboratory Plasmas, grant number DE-NA0002956, and the National Laser User Facility Program, grant number DE-NA0002719, and through the Laboratory for Laser Energetics, University of Rochester by the NNSA/OICF under Cooperative Agreement No. DE-NA0001944.

Magnetized collisional shocks on OMEGA: scaling requirements and associated challenges

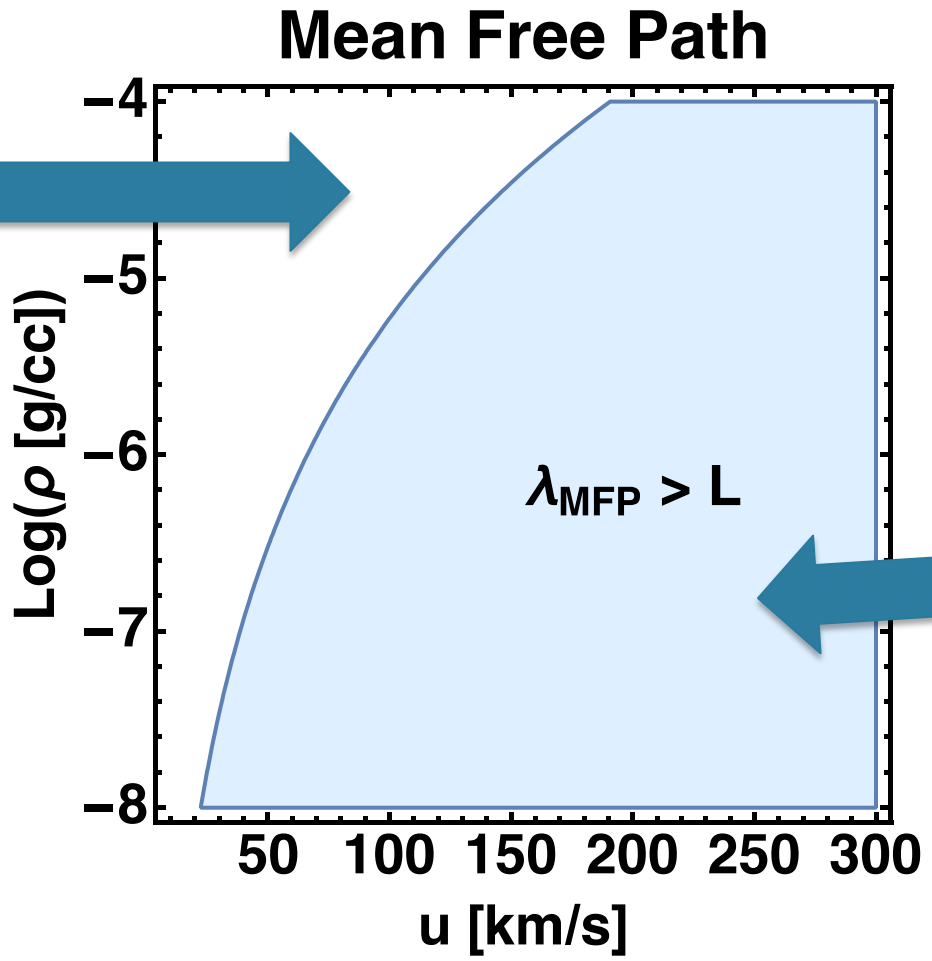
- **Scaling requirements**
  - What are the driving physical processes?
  - What are the constraints on length scales and dimensionless numbers?
- **Plasma parameters required**
  - What plasma parameters satisfy all the constraints?
- **Possible improvements**
  - How can the require parameter range be expanded?
- **An example: accretion shock experiment**
  - What did we see and why was the scaling less than ideal?

Criteria for a collisional magnetized shock

- **Collisional shock**
  - Super-sonic: $M > 1$
  - Mean free path in the collisional regime: $\lambda_{MFP} < L$
- **Observable magnetic effects**
  - Magnetic field does not diffuse away on the timescale of the experiment: $l_{mag} < L$
  - Field strong enough to effect flow: $\beta_{ram} < 5$

Each criteria is translated into a region plot

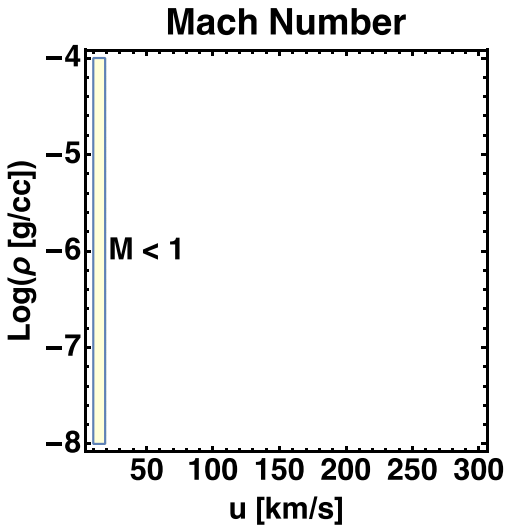
Collisional shock possible

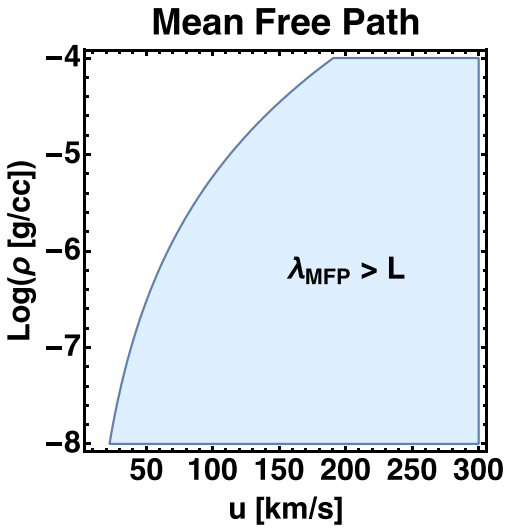


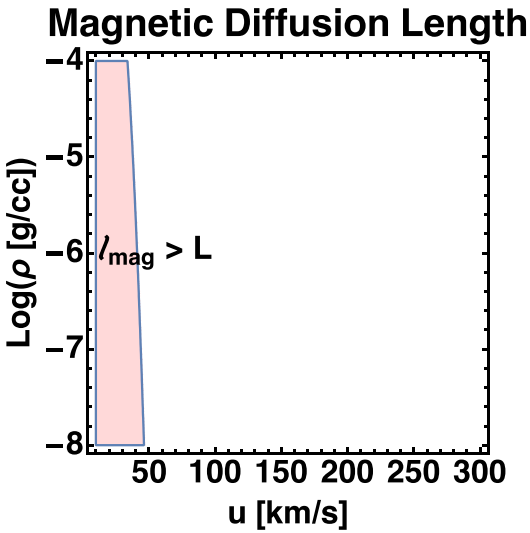
Mean free path is too high for a collisional shock

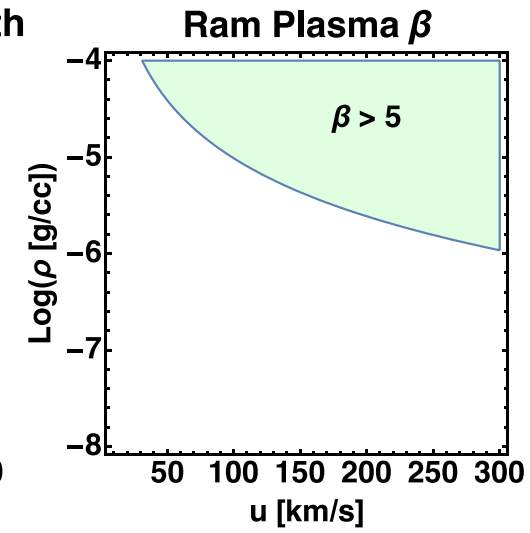
Carbon
10 eV
7 T

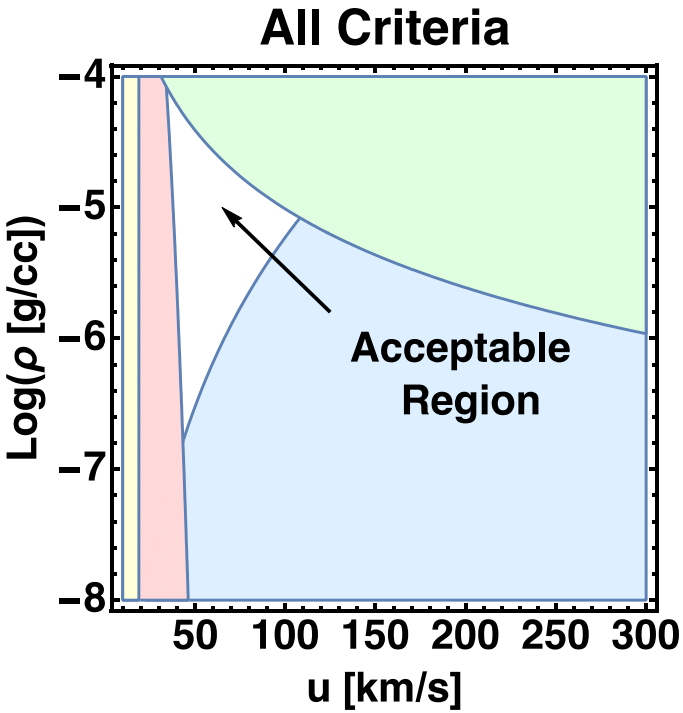
When the criteria plots are overlaid, the acceptable region is tight





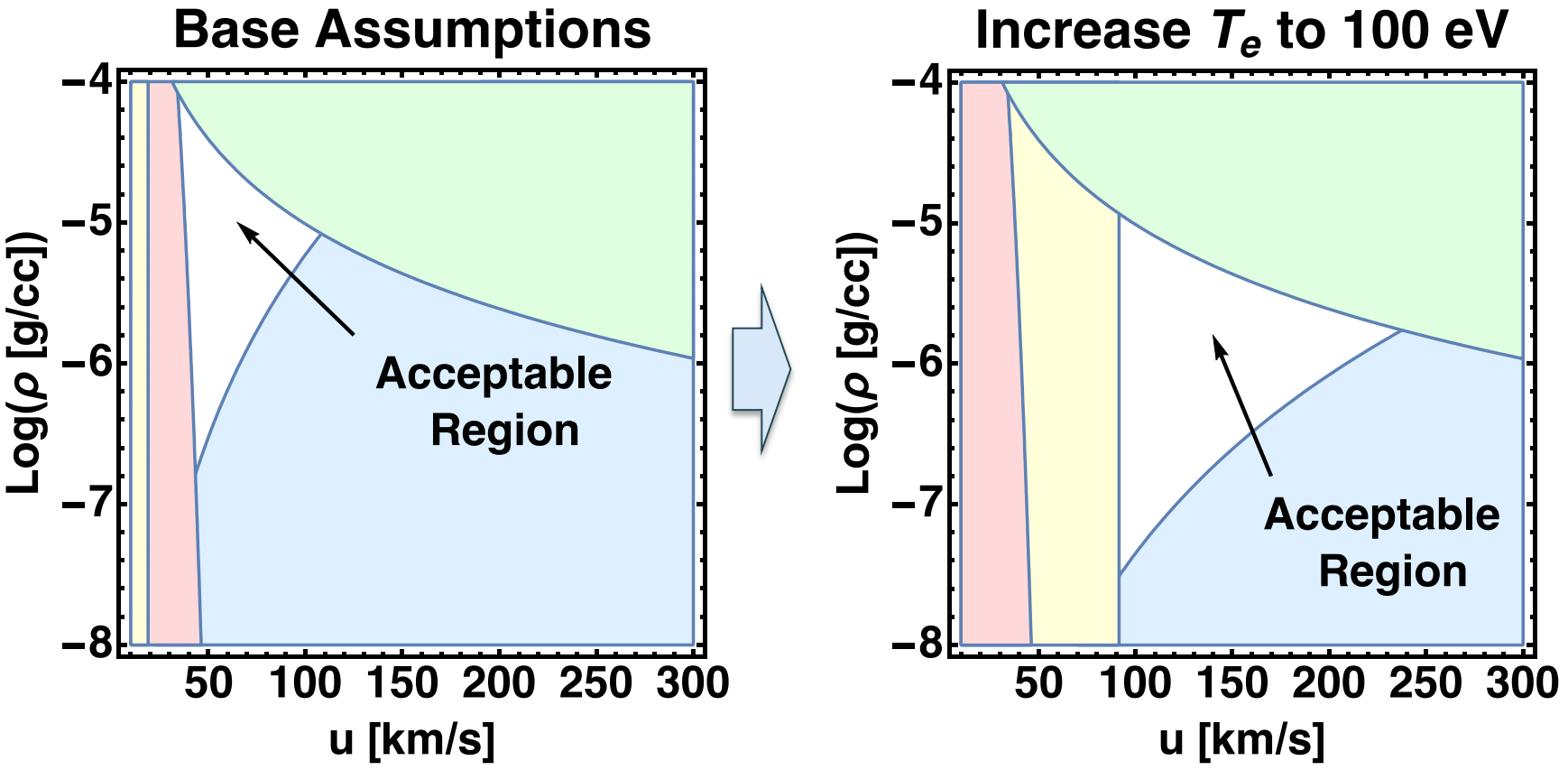






Carbon, 10 eV, 7 T, L = 1 mm

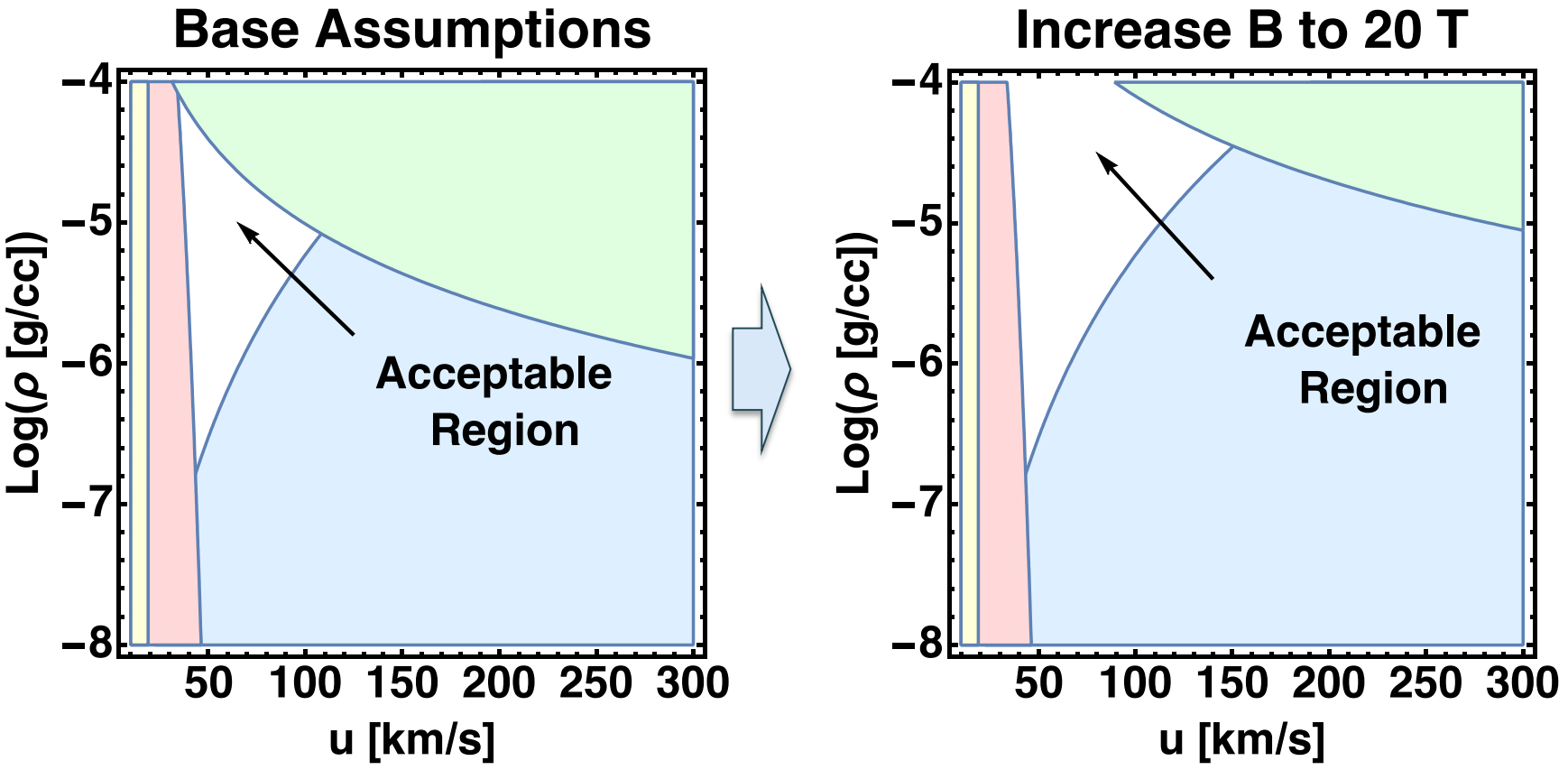
What if we increase the temperature?



Carbon, 10 eV, 7 T, L = 1 mm

Carbon, **100 eV**, 7 T, L = 1 mm

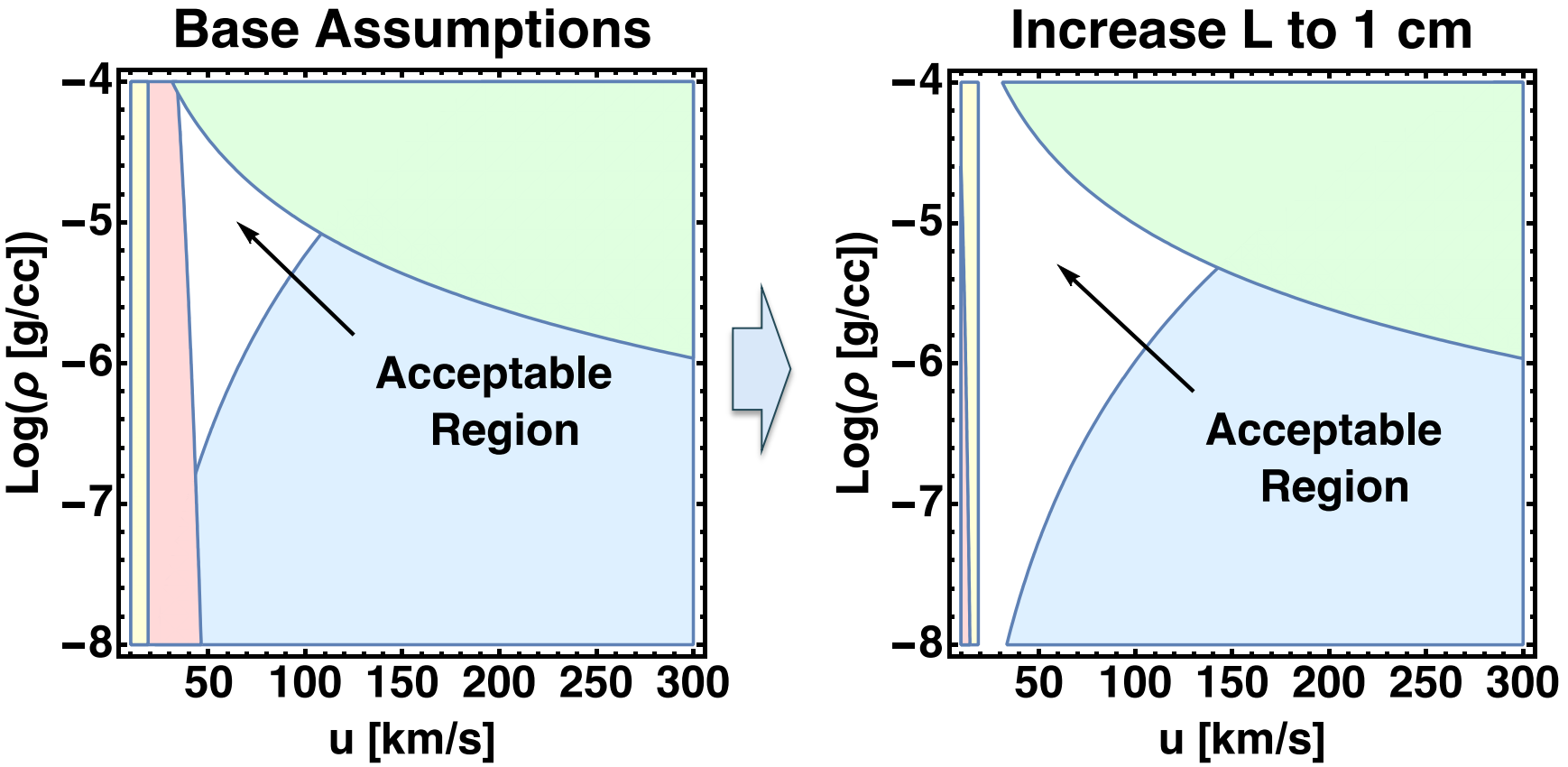
What if we increase the magnetic field?



Carbon, 10 eV, 7 T, L = 1 mm

Carbon, 10 eV, **20 T**, L = 1 mm

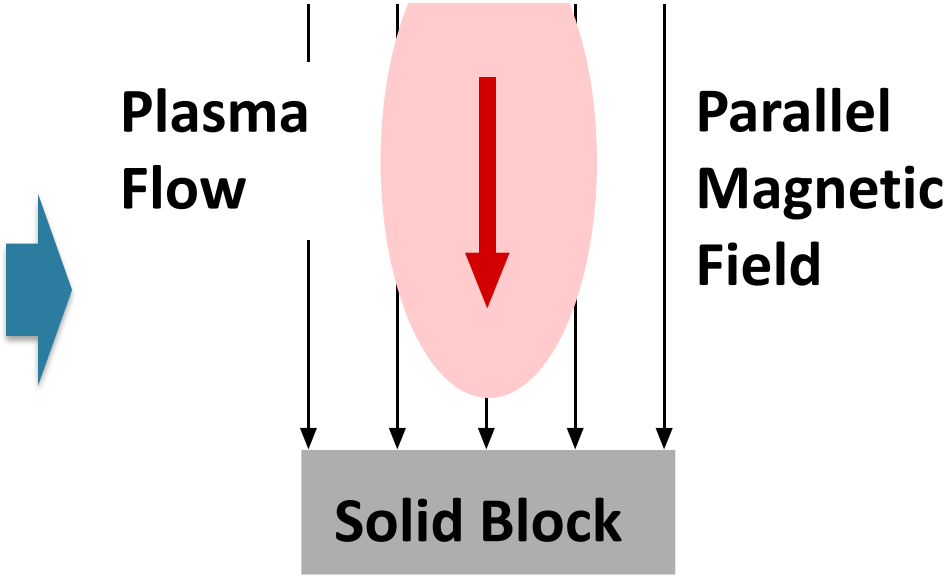
What if we increase the magnetic field?



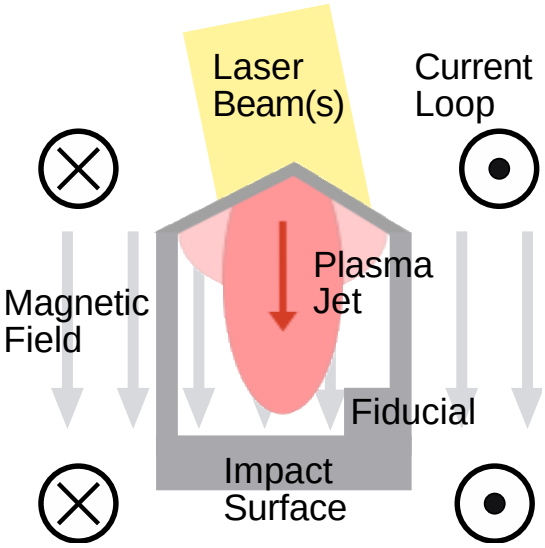
Carbon, 10 eV, 7 T, L = 1 mm

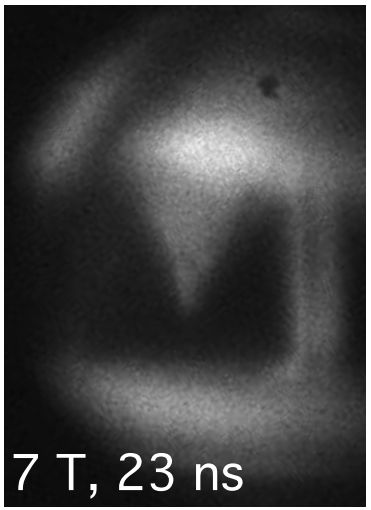
Carbon, 10 eV, 7 T, **L = 1 cm**

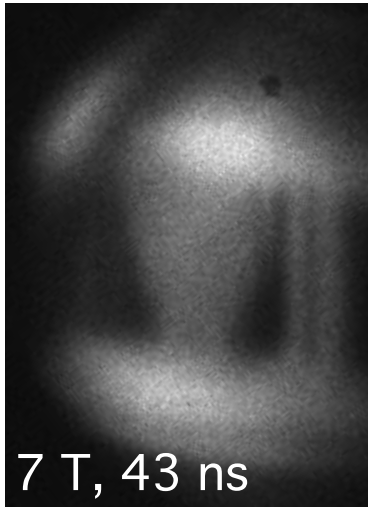
Accretion shocks motivate a scaled magnetized collisional shock experiment

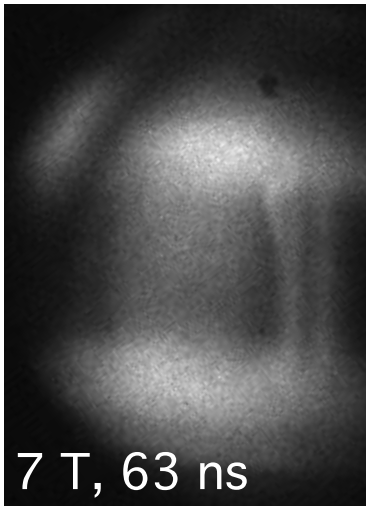


No magnetic field effects were observed

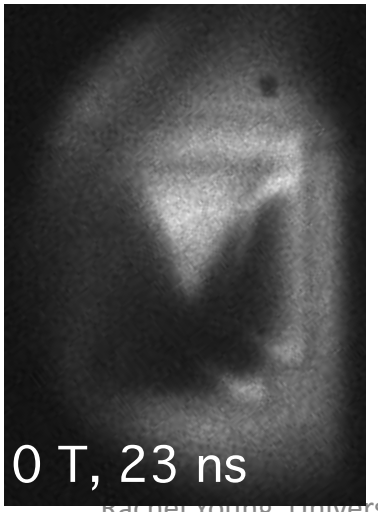


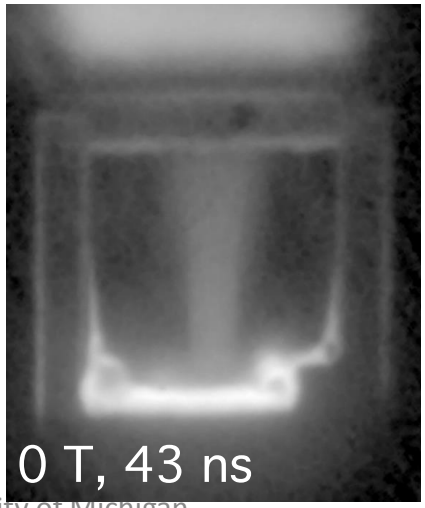


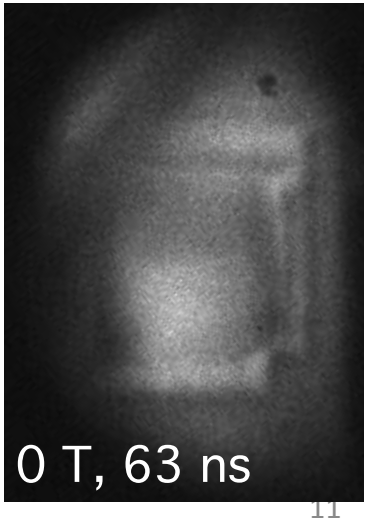




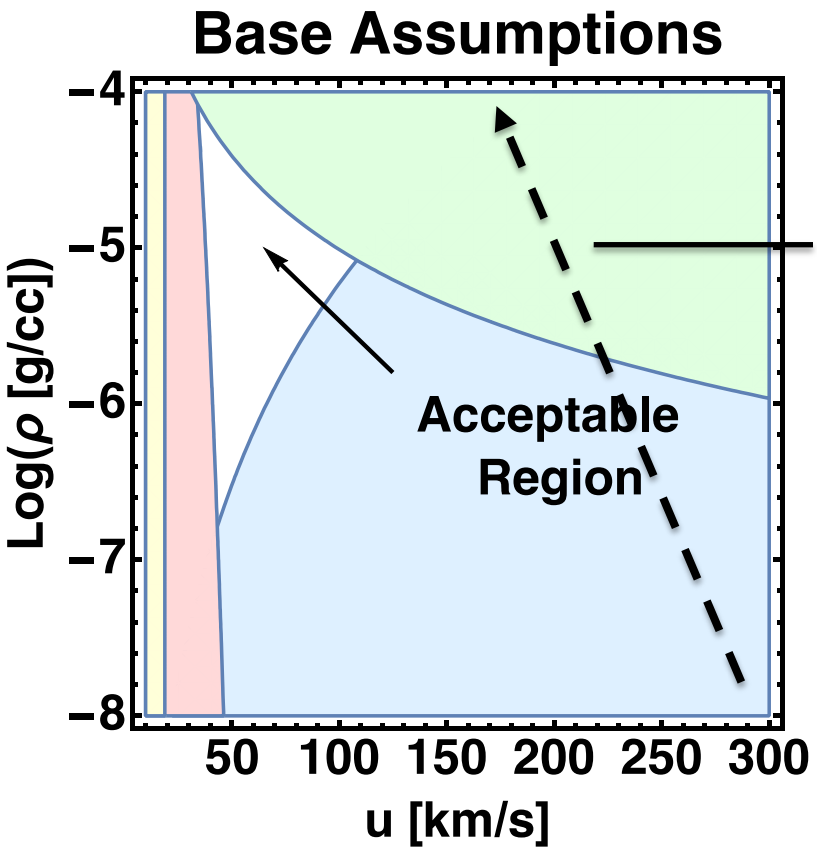
= 2.4 mm







Why? Density and velocity were too high



Plasma conditions with increasing time

CH, ~10 eV, 7 T, L = 1 mm

Magnetized collisional shocks on OMEGA: scaling requirements and associated challenges

- **Scaling requirements**
  - Super-sonic, Short mean free path, Short magnetic diffusion length, Plasma beta ram on the order of unity
- **Plasma parameters required**
  - Usually 50 km/s and 10^{-5} gm/cc
- **Possible improvements**
  - Changing the assumptions can expand the allowed parameter range
  - Only increasing magnetic field yields substantial improvement
- **An example: accretion shock experiment**
  - Density and velocity were too high to see a magnetic field effect