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DOE OFES/DP

THERMAL AND STRESS ANALYSIS OF A SOLID DT TEST SPECIMEN

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presented at the

Laser IFE Workshop

sponsored by

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Offices of Fusion Energy Sciences &
Defense Programs

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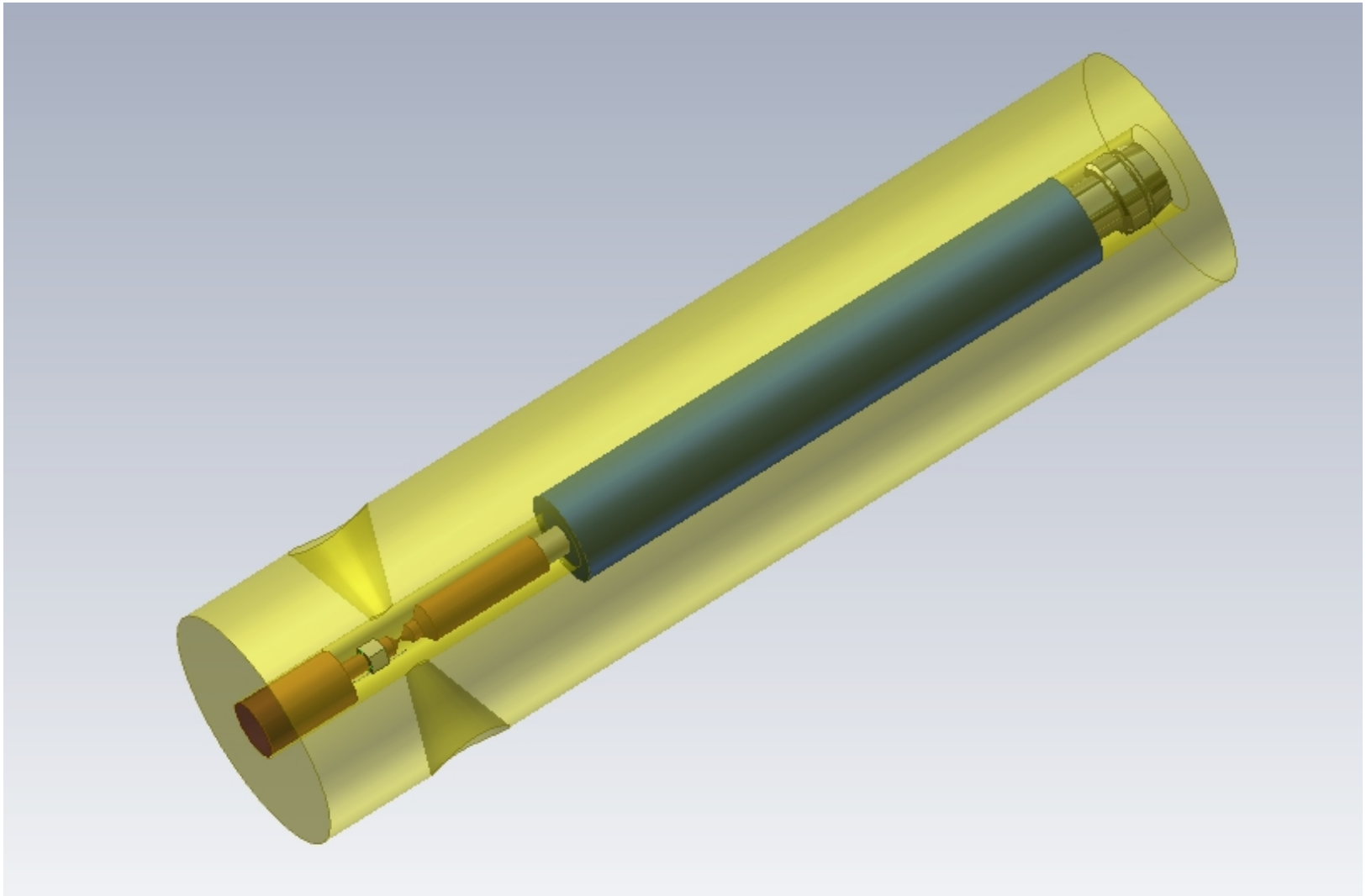
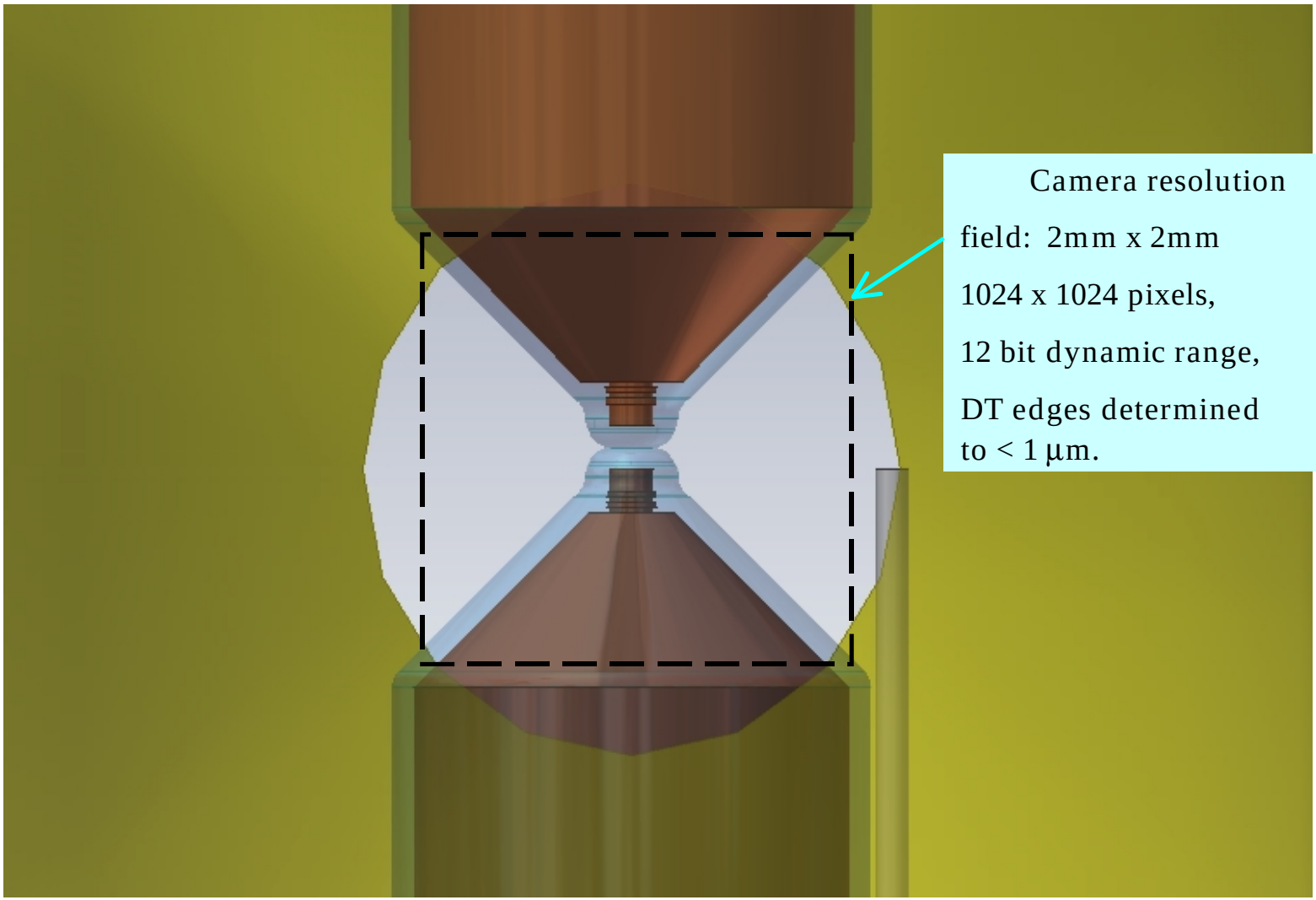
Target Injection-1: Target Materials Response - *LANL*

Overall Objective……	**Response of target materials to injection stresses**
FY 02 Deliverables…….	**1. Modify existing apparatus to accommodate new 'DT strain cell.'** **2. Assemble and bench-test strain cell using no hydrogen (warm experiments, using 'butter').** **3. Start experiments to measure DT yield strength and modulus.**
PI Experience……. ***(POC: J. Hoffer)***	**Extensive experience with DT and DT-layering**
Proposed FY02 Amount…..	**$ 200 k**
Relevance of Deliverables	
[X] NIF……	**Research in materials in NIF targets**
[ ] Laser RR Facility….	
[ ] Other DP/NNSA……	
[X] Energy……	**Needed for injection into chamber**
Related DP activities……	**Define experiments to measure the effect of a sudden thermal load on a DT-layered target**

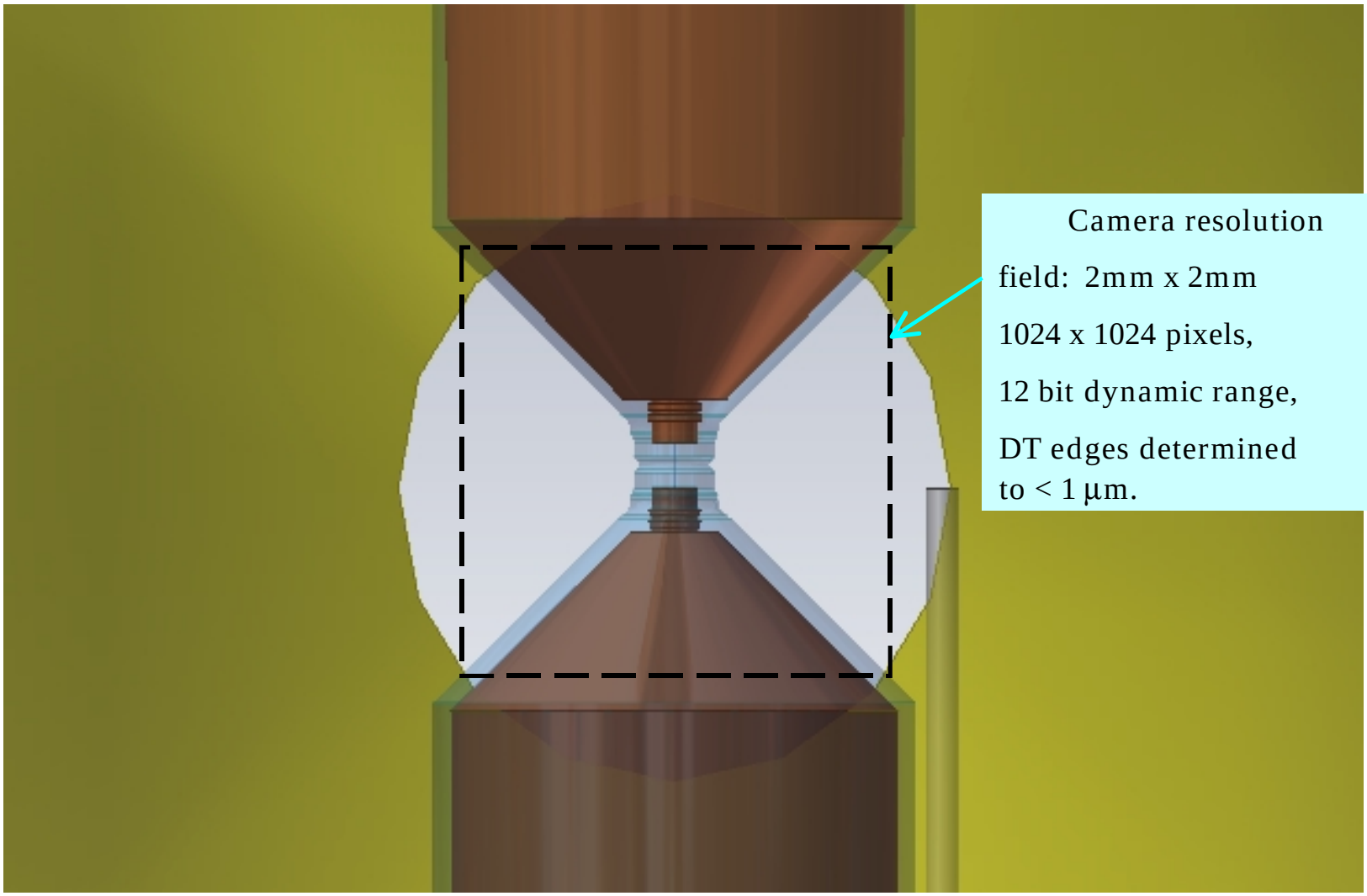
Finally, we enclose all of this assembly inside a tritium cell with optical ports:



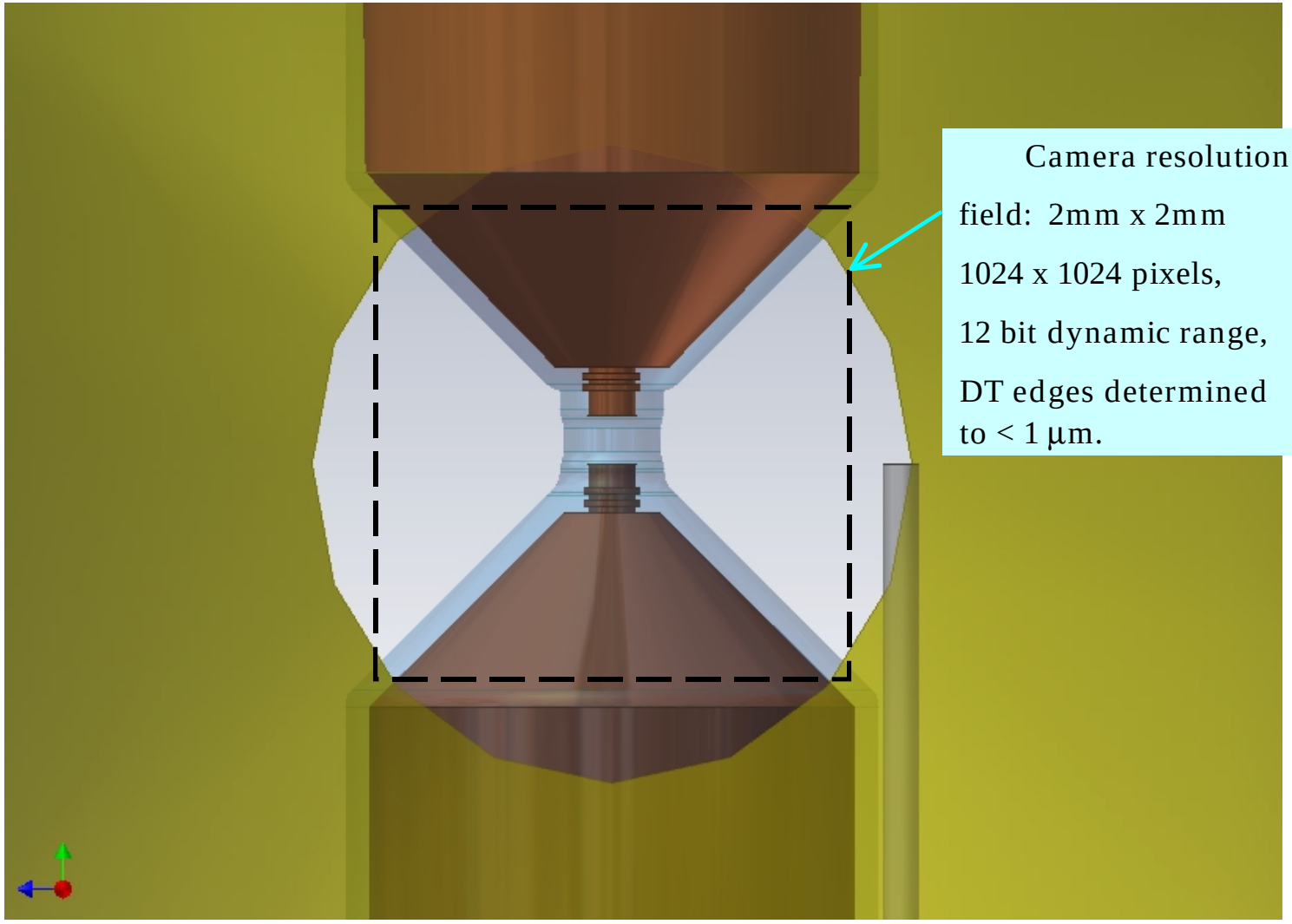
What the camera might see: (version ‘A’)



What the camera might see:
(version ‘B’)



What the camera might see: (version ‘C’)



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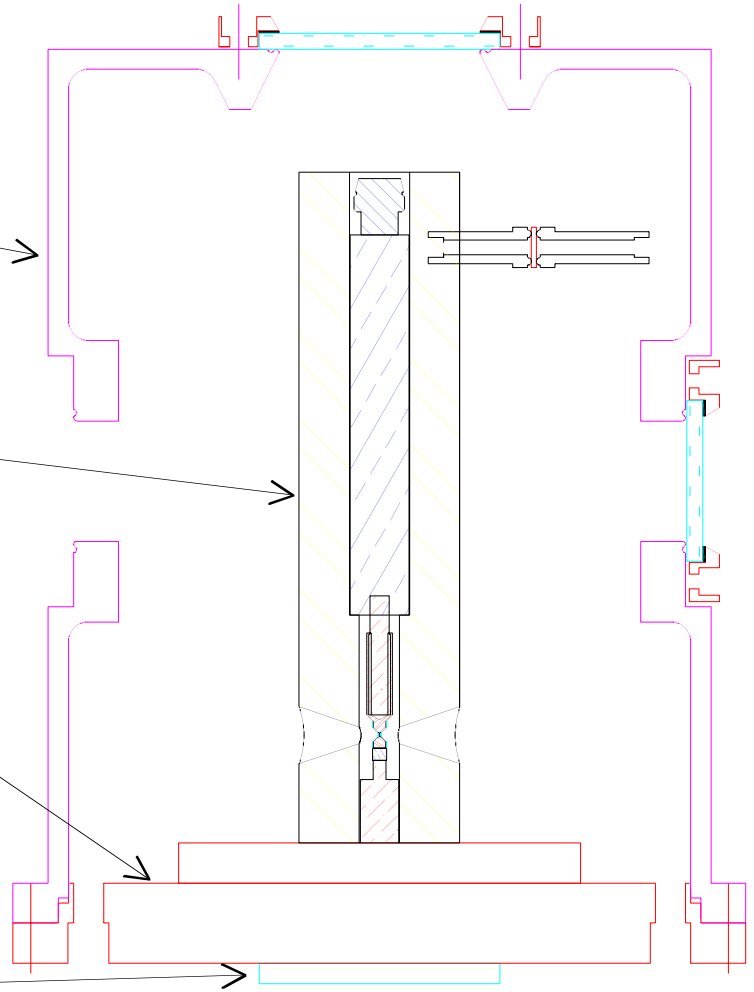
What's next?

- Complete design of the "DT-strain cell"
  - Perform thermal modeling of layer formation
- Perform strain analysis on proposed sample shape
- Redesign cryostat if necessary
  - this assembly may be too long for existing apparatus

In fact, the “DT-strain cell” is not too large, but the optics don’t fit our existing cryostat:

- existing “cold can” in optical cryostat
- “DT-strain cell”
- Existing “cold plate”
- Closed cycle helium refrigerator second stage (10–20 K) plate



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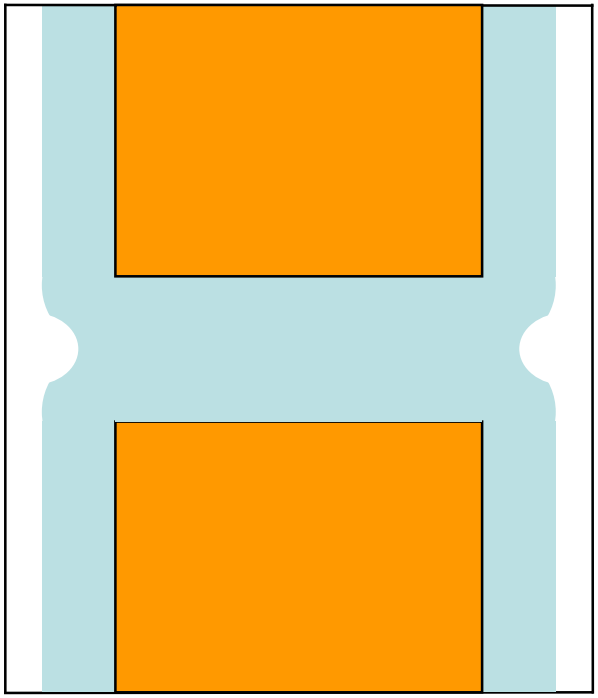
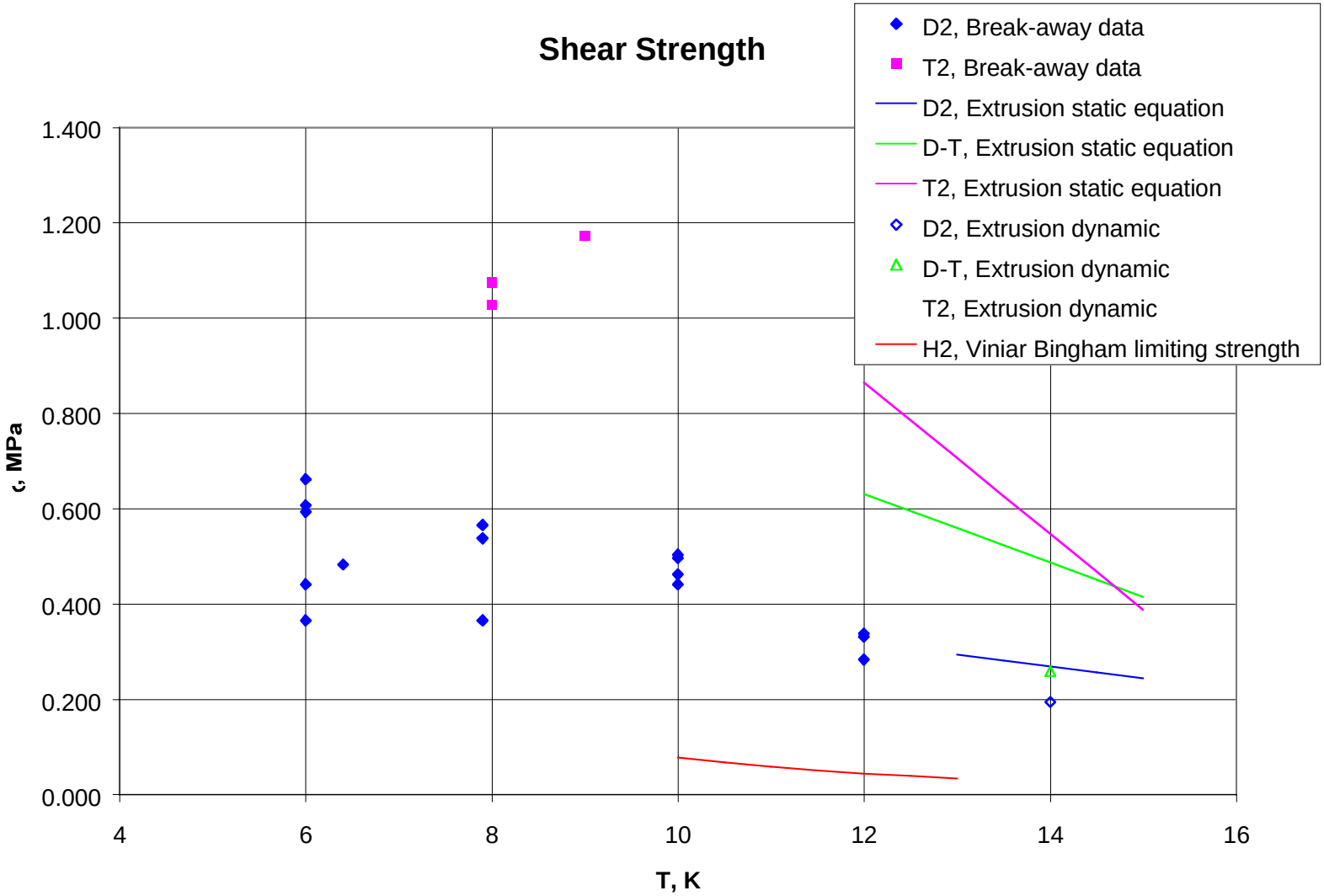
THERMAL & STRESS ANALYSES



TYPICAL SPECIMEN SHAPE

THERMAL EQUILIBRIUM SHAPE?

Hydrogenic solid shear strength data from ORNL H, D, T pellet experiments



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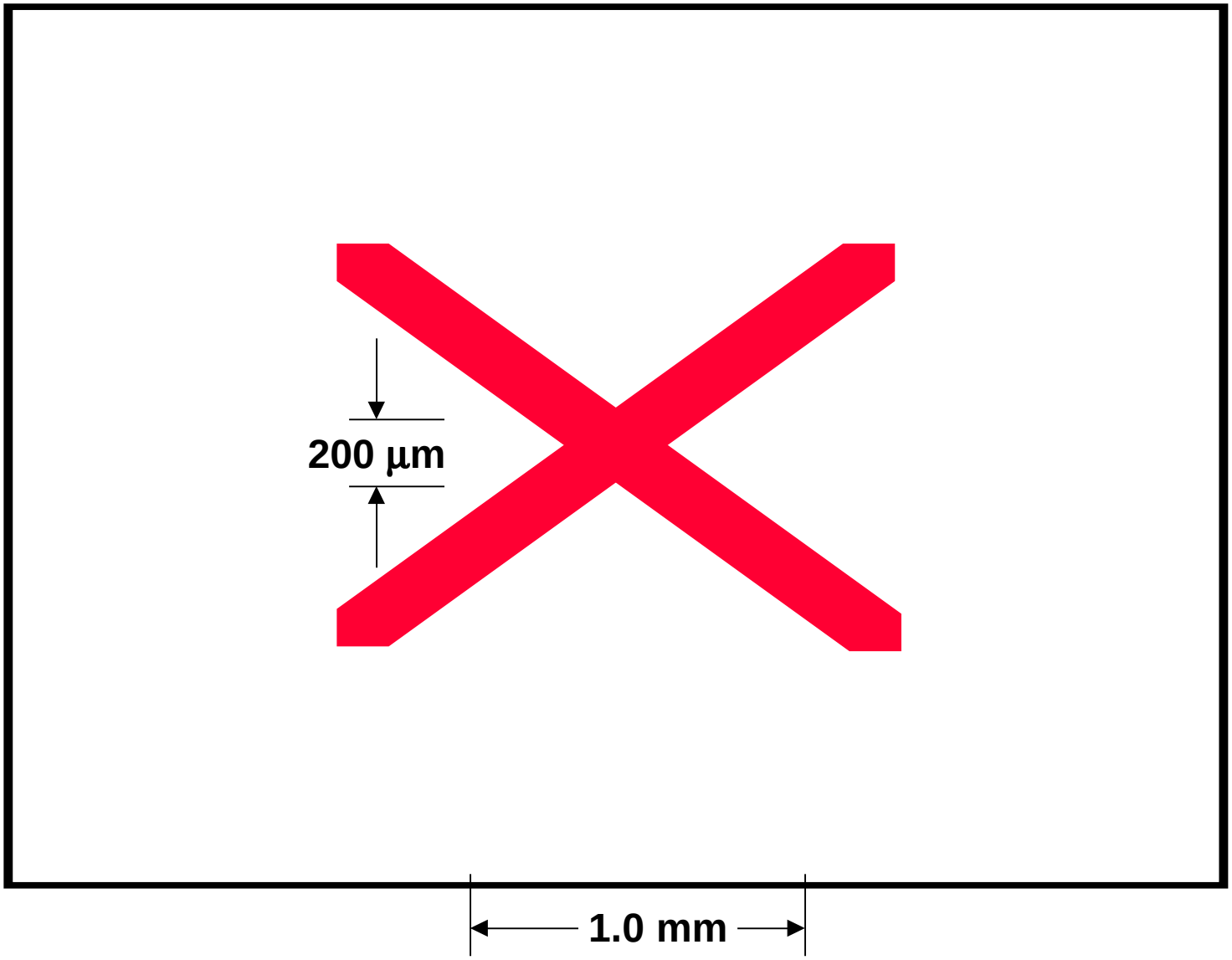
MATERIAL PROPERTIES AT 18 K

	Copper	DT
E (GPa)	138	0.02*
E_t (GPa)	-	0.002*
σ_y (MPa)	120	0.02*
ν	0.34	0.3*
ρ (g/cm^3)	9.03	0.254
K (W/m/K)	1800	0.33*
C_s (J/g/K)	0.05	17.7*
Q (W/m^3)	-	49 000

* estimate

THERMAL ANALYSIS – FE MESH



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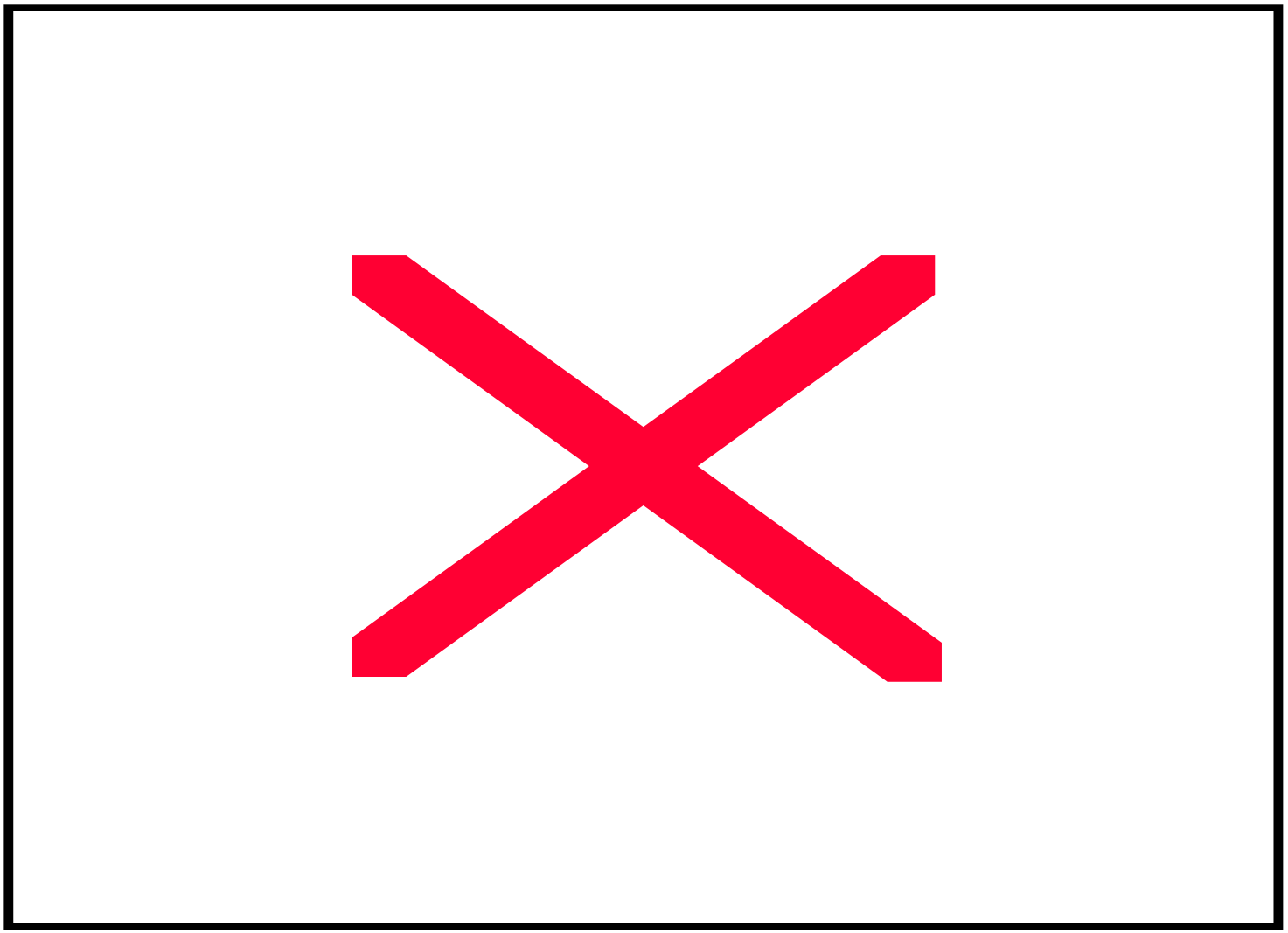
THERMAL ANALYSIS – ITERATIVE SOLUTION



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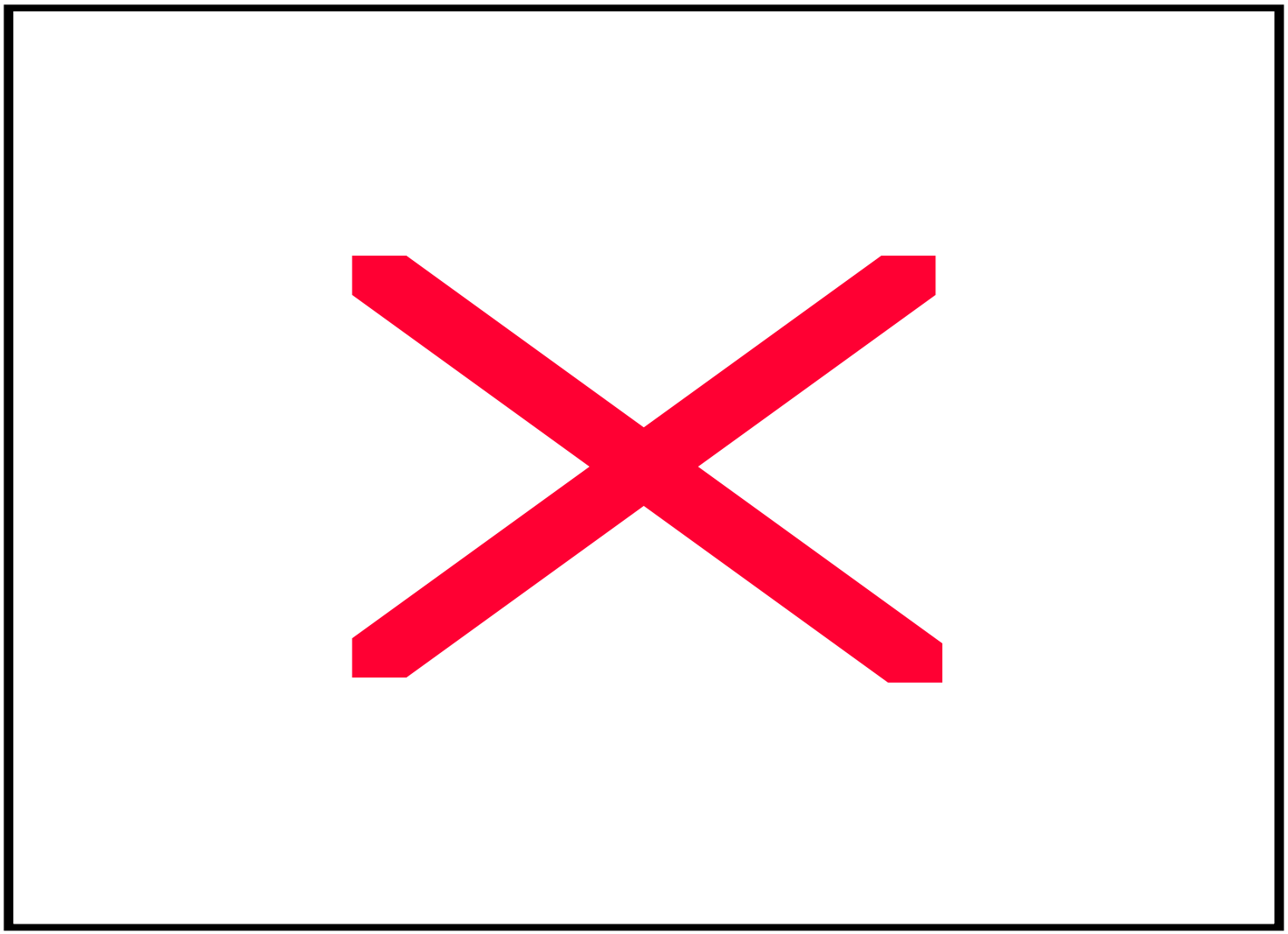
THERMAL ANALYSIS – NOTCH DEVELOPS



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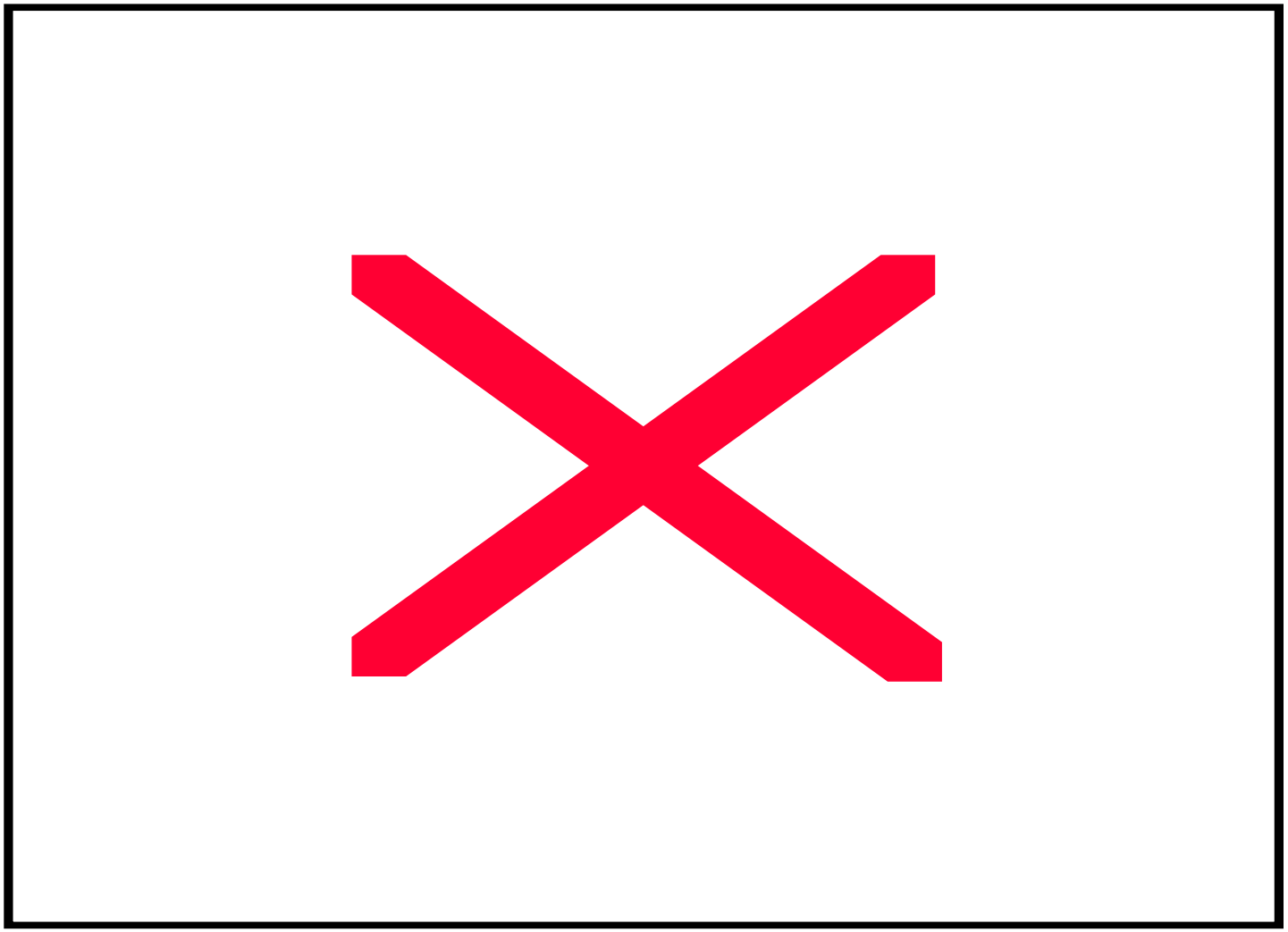
THERMAL ANALYSIS – 110 μm layer



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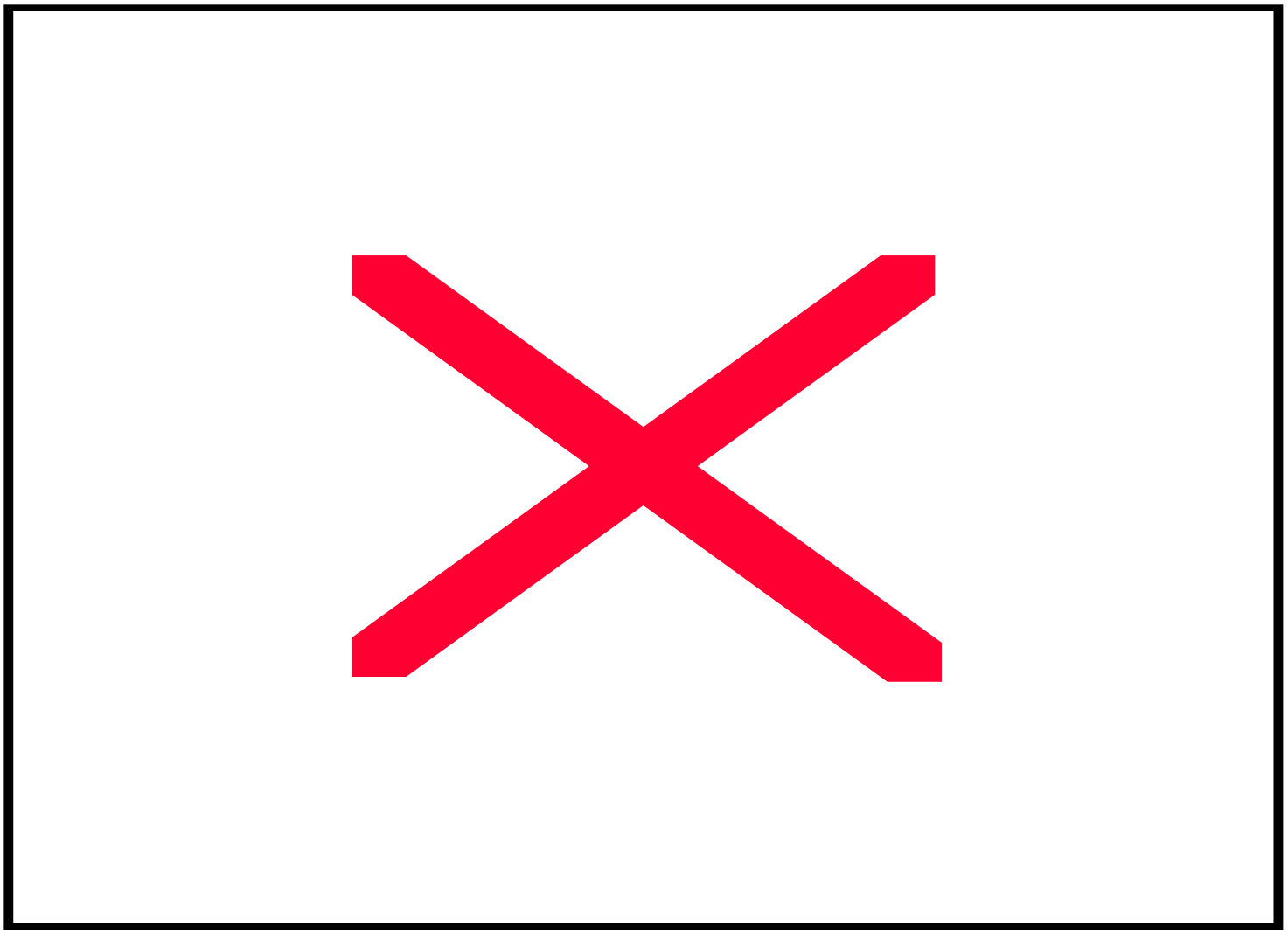
THERMAL ANALYSIS – DETAIL



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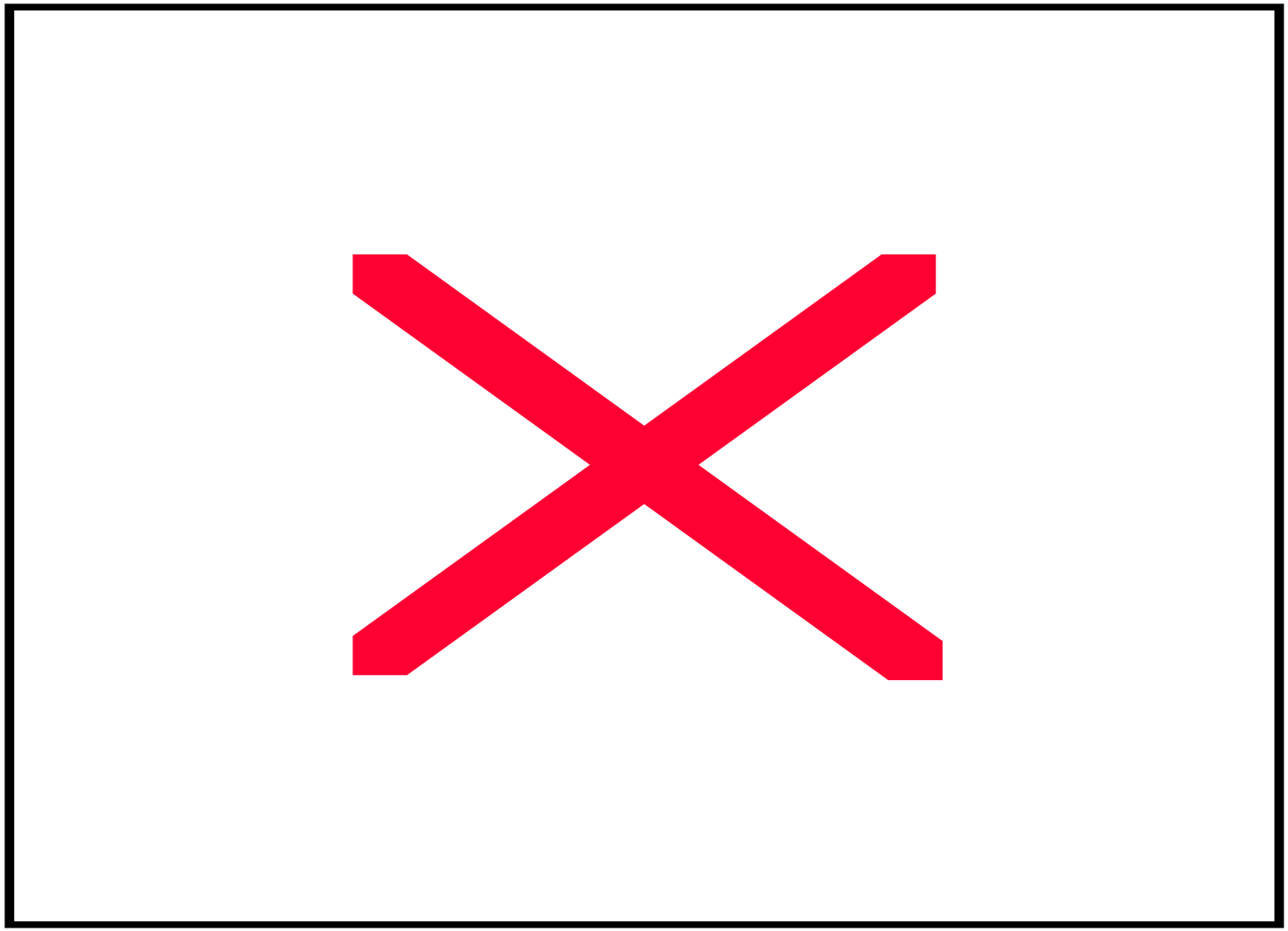
D2 Stress-Strain Response
Bol’shutkin et al., 1970

STRESS ANALYSIS – REFINED MESH



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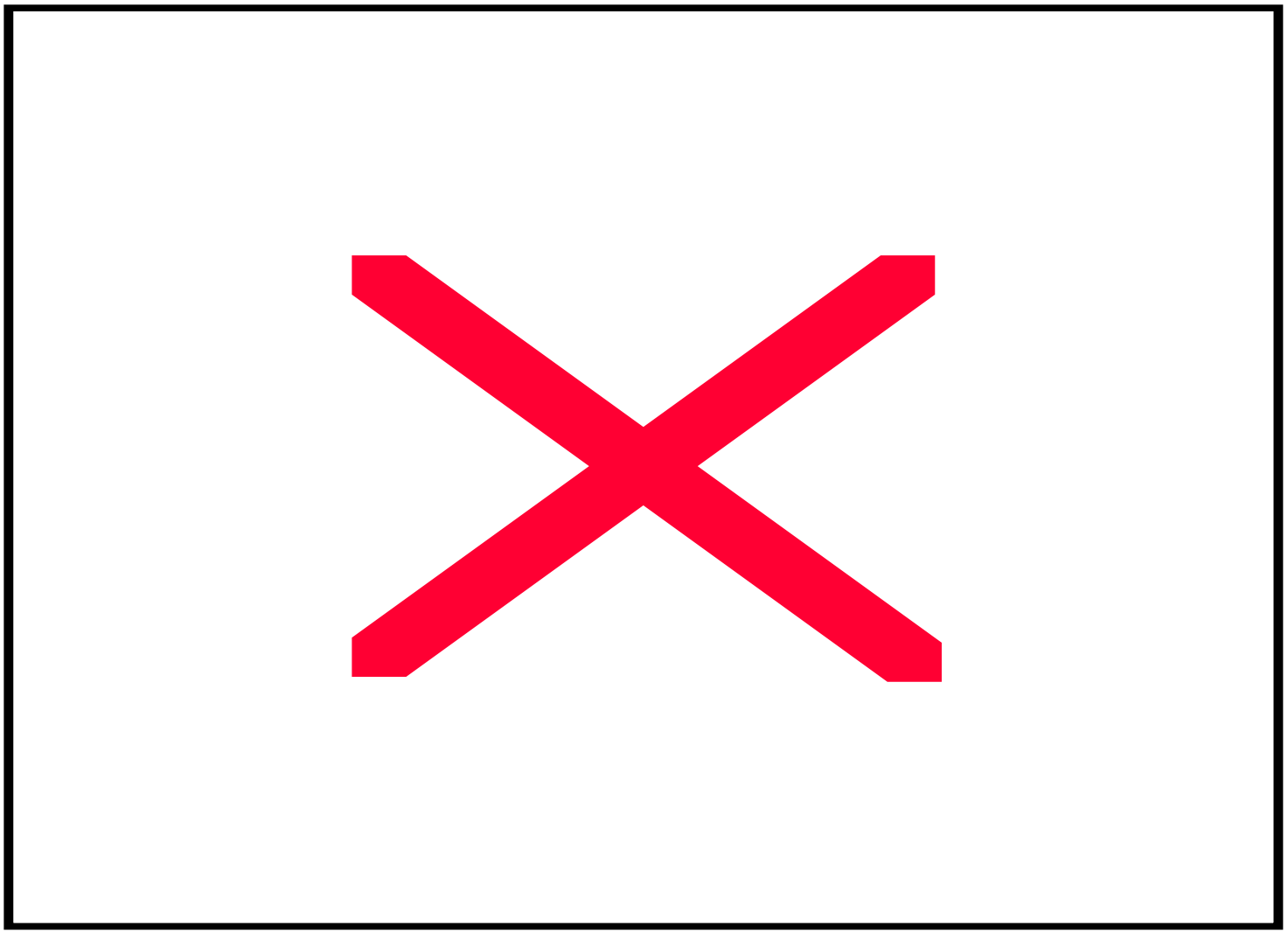
ELASTIC STRAINS: e = 0.0005



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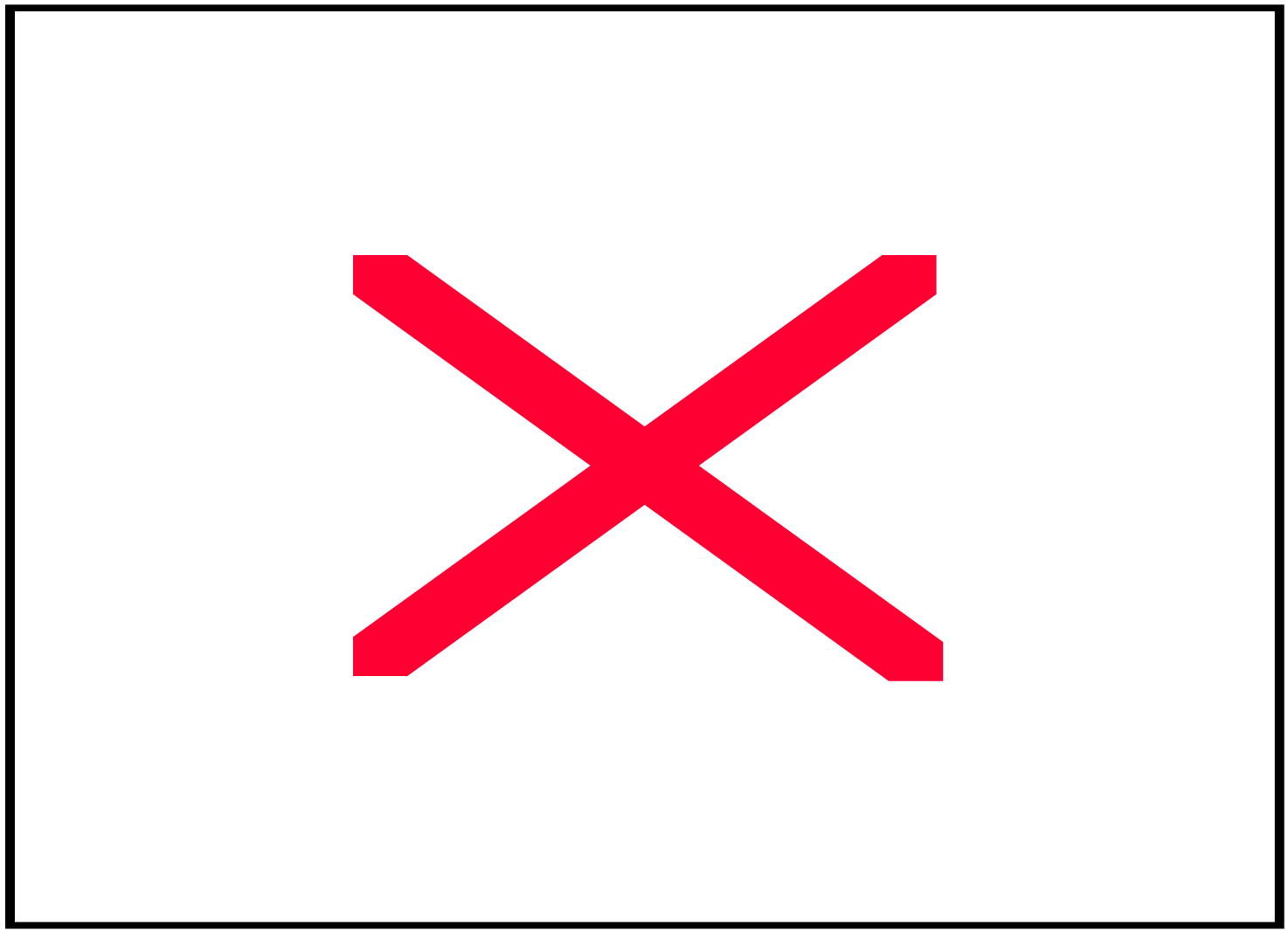
ONSET OF YIELDING: e = 0.001



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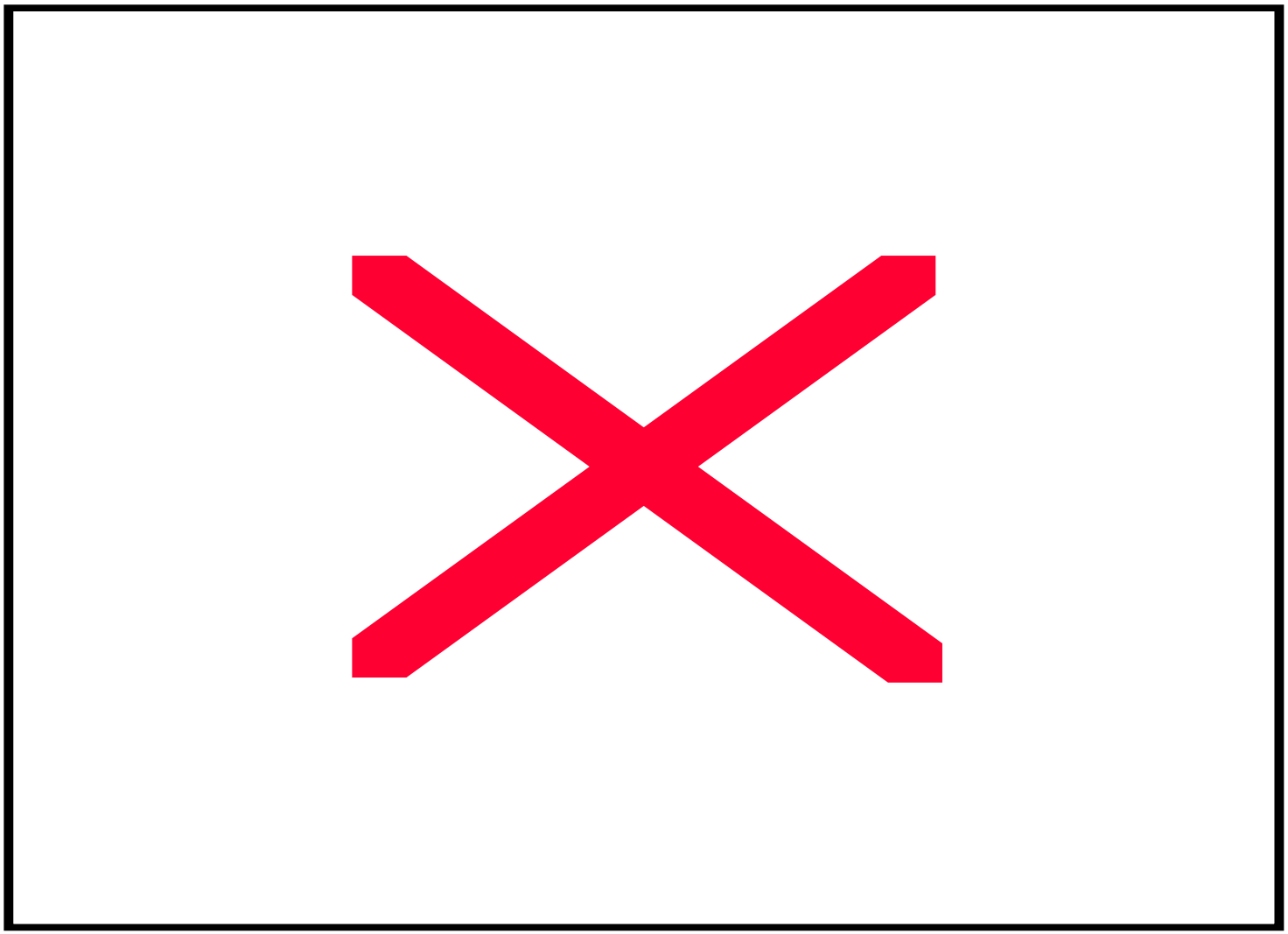
ADDITIONAL YIELDING: e = 0.0015



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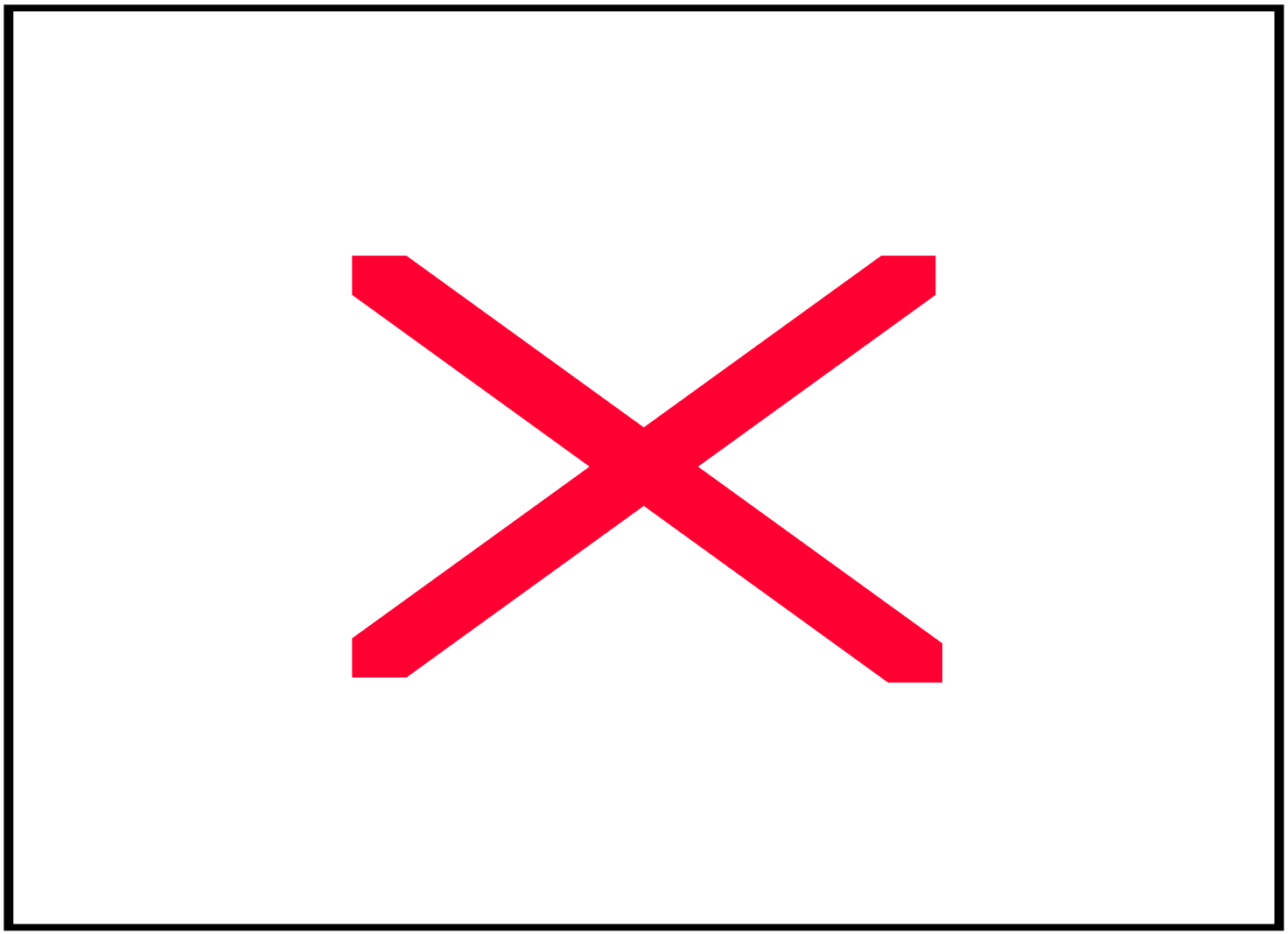
WORK HARDENING: e = 0.003



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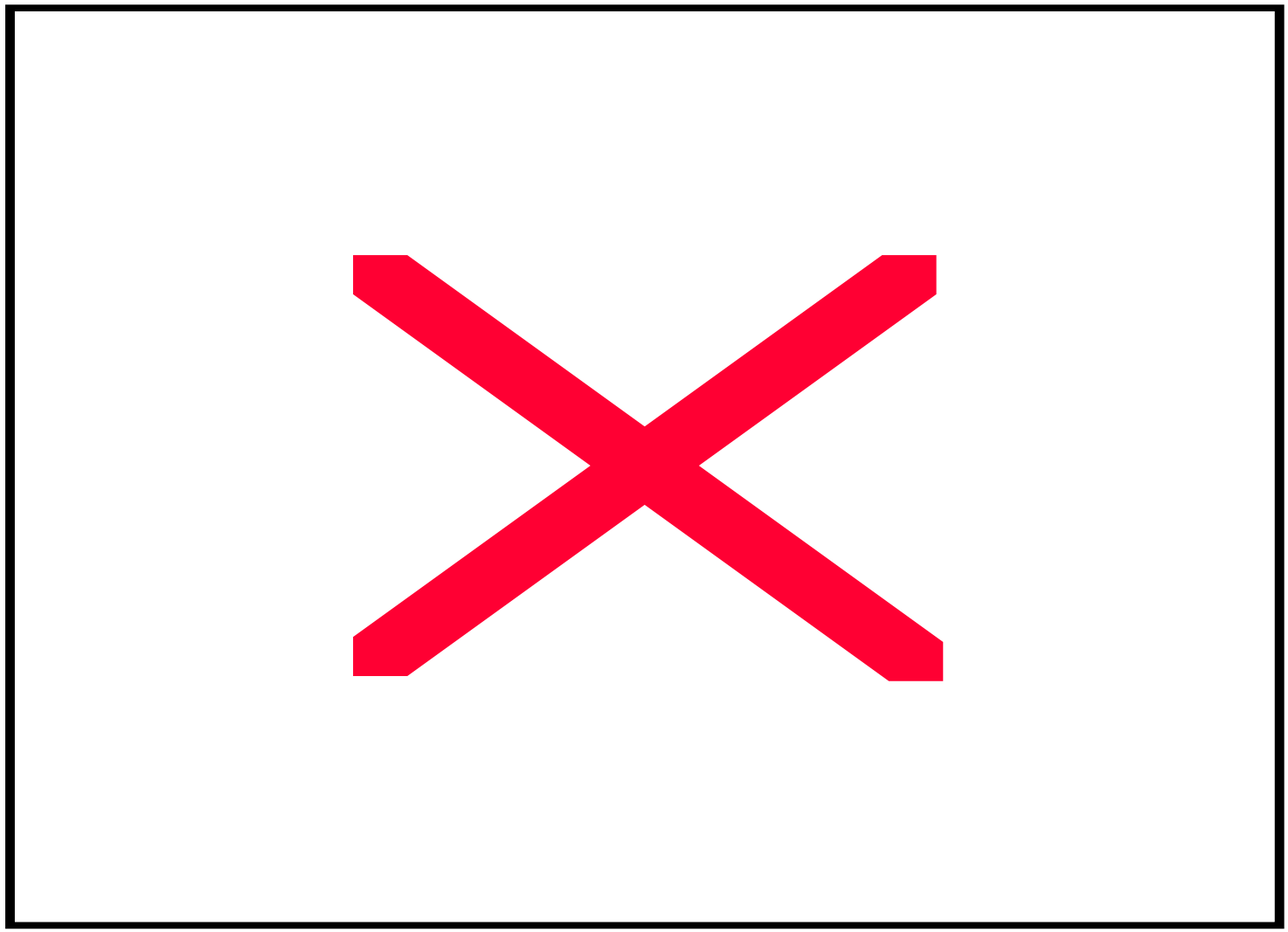
ADDITIONAL HARDENING: e = 0.004



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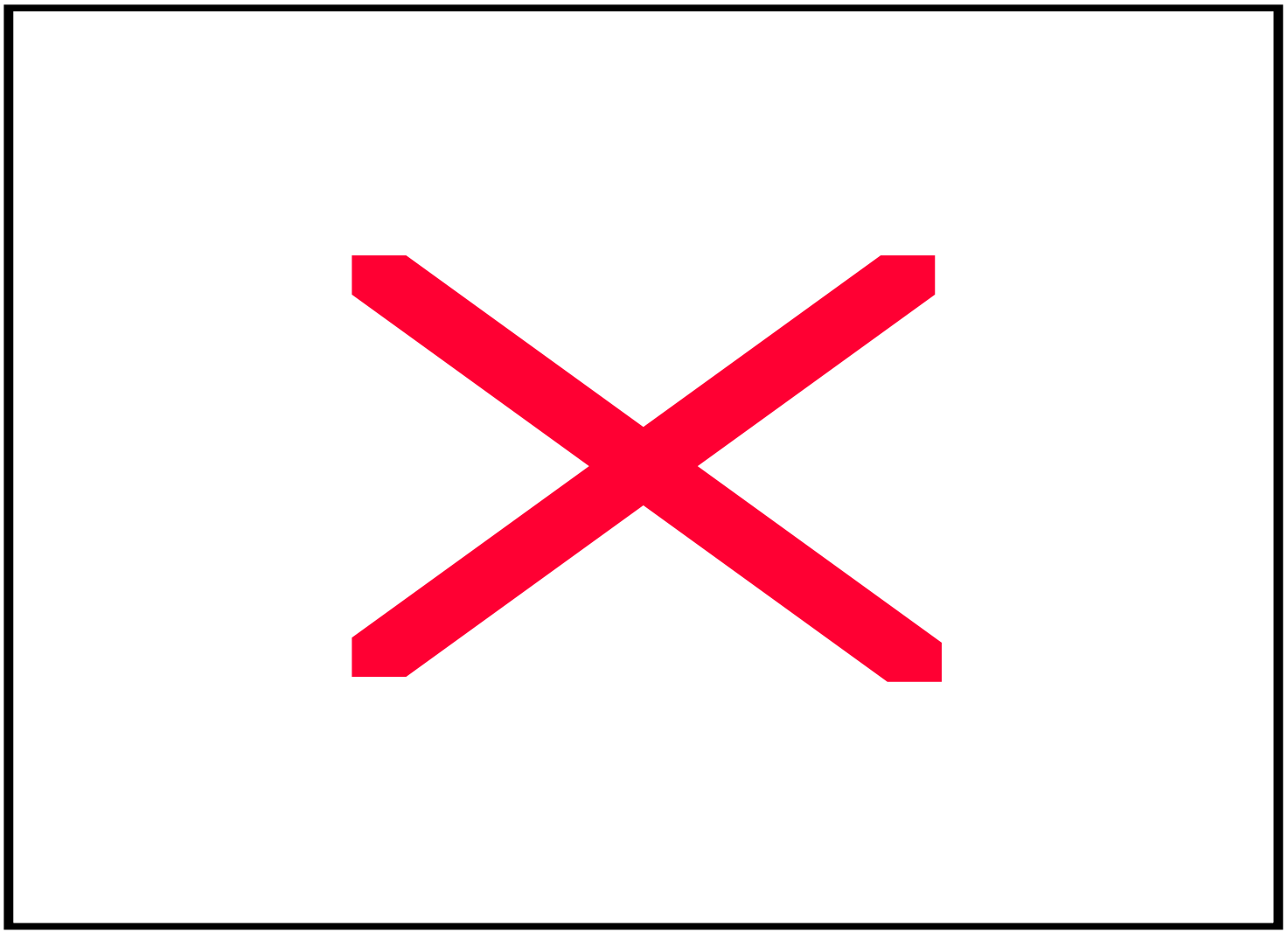
ADDITIONAL HARDENING: e = 0.006



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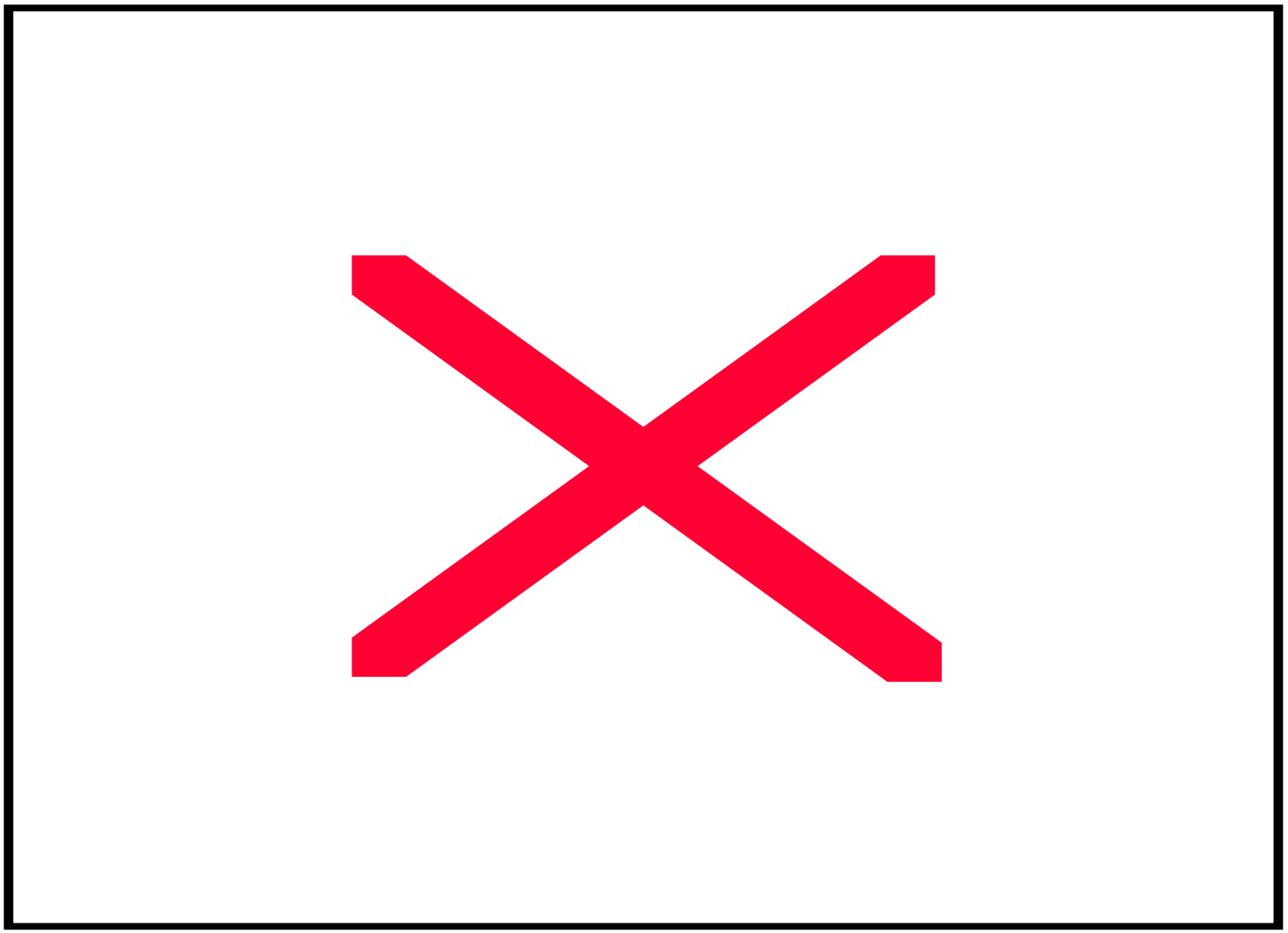
HIGH STRESS: e = 0.009



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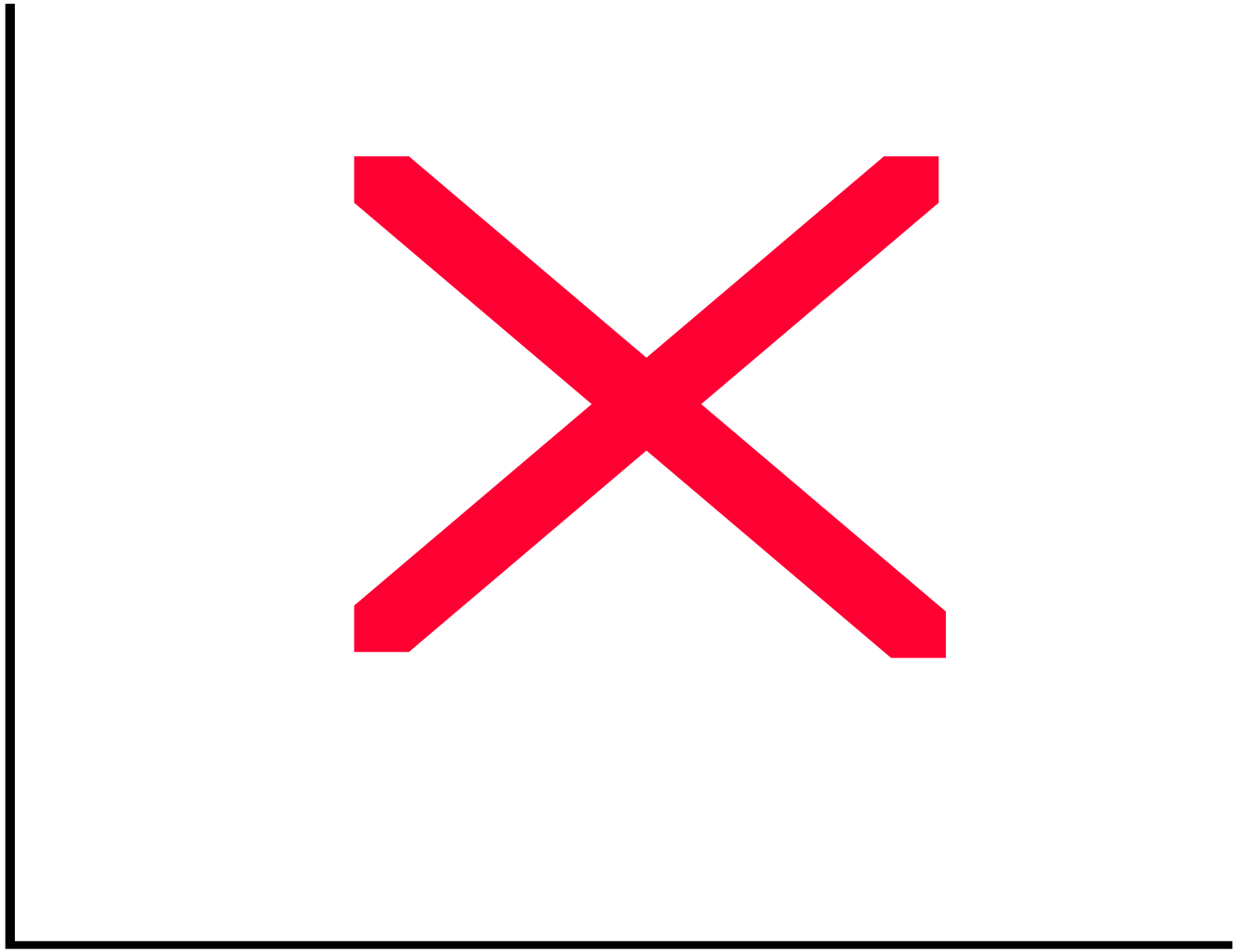
FEA LOAD-DISPLACEMENT RESULTS



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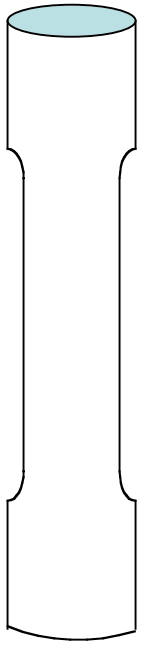
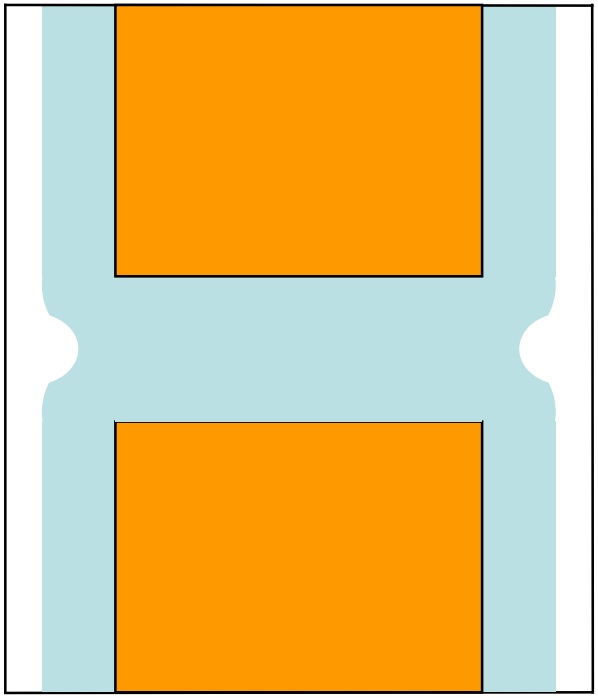
THERMAL & STRESS ANALYSES





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