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STIPV Irradiation Tensile Tests (with STIPIV and ATR)

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■ STIP V Irradiation at PSI

- MA956 - FeCrAl ODS 20Cr, 5Al
- MA957 – ODS 14Cr
- CROFER 22 APU - 22Cr
- 6-15 dpa, 250-900 He, 125-450C

■ STIP IV Irradiation at PSI

- Max dose achieved was 25dpa in steel
- Two high temperature excursions during the irradiation
 - 500-800C for 18hours
 - 1250C (maxed out) recorded on one thermocouple
- **A preliminary report of STIP-IV** Yong Dai -Spallation Neutron Source Division, Paul Scherrer Institut, Switzerland

■ ATR NSUF UCSB Irradiation

- 6.5 dpa at 296C



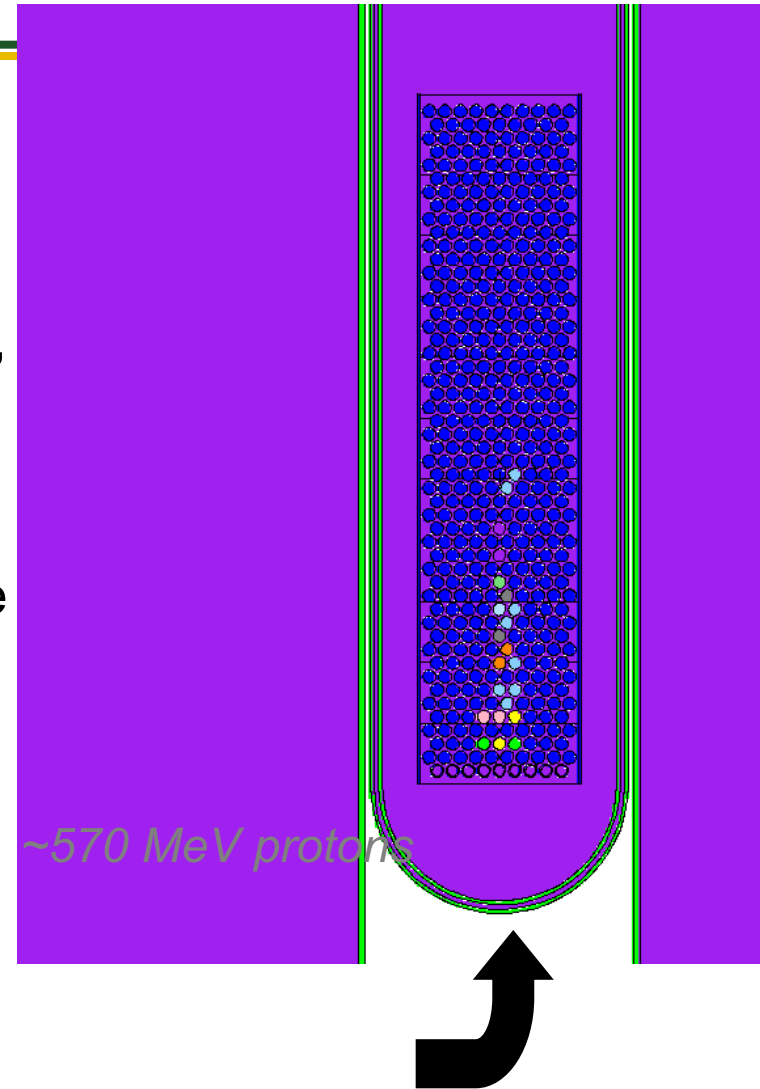




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■ **Materials for STIP IV irradiation include the following in tensile and TEM specimens:**

- Structural: HT-9, EP-823, Mod 9Cr-1Mo, 9Cr-2WVTa, T122, 5Cr-2WVTa, A21N, ODS strengthened F/M steels-12YWT and 14YWT (Fe-12Cr-3W-0.4Ti-0.25 Y2O₃, Fe-14Cr-3W-0.4Ti-0.25 Y2O₃), V-4Cr-4Ti, High purity Ta, single crystal Fe (for modeling studies)
- Fuels Matrices: ZrN, NiAl, FeAl, RuAl, MgO, Cubic ZrO₂, Fissionium

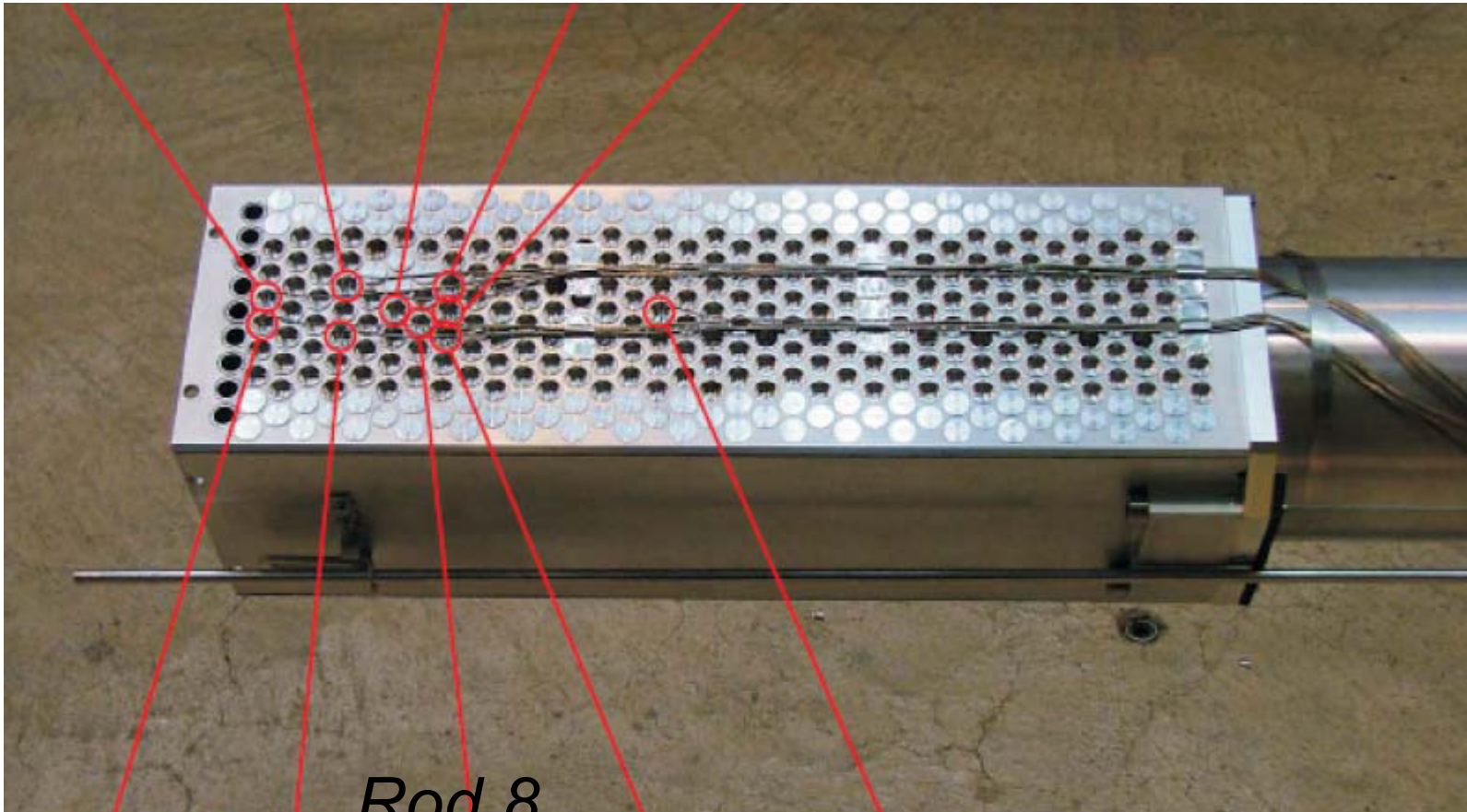




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STIP IV Target

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Rod 8
Rod 9



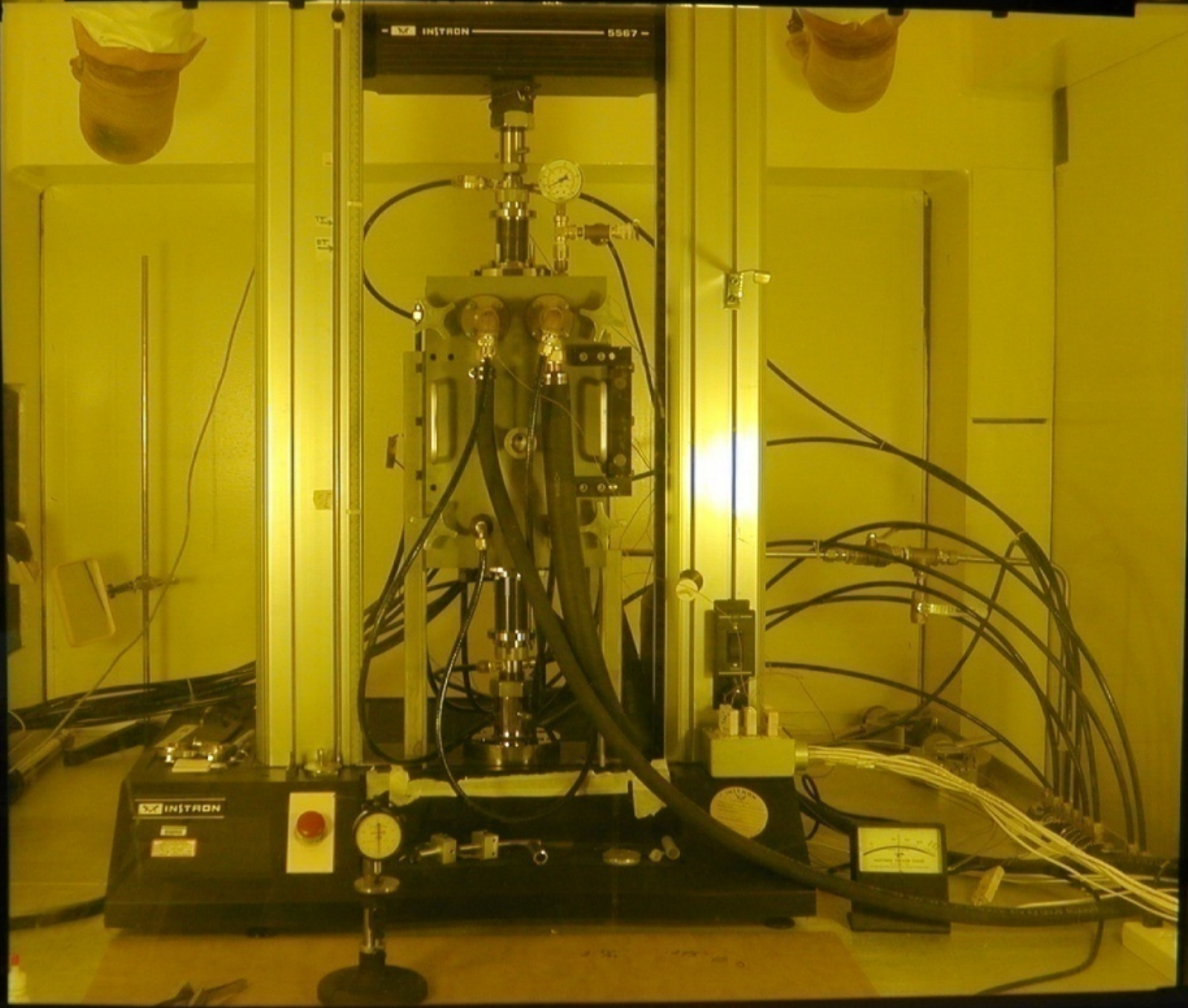
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CMR Building circa 1952

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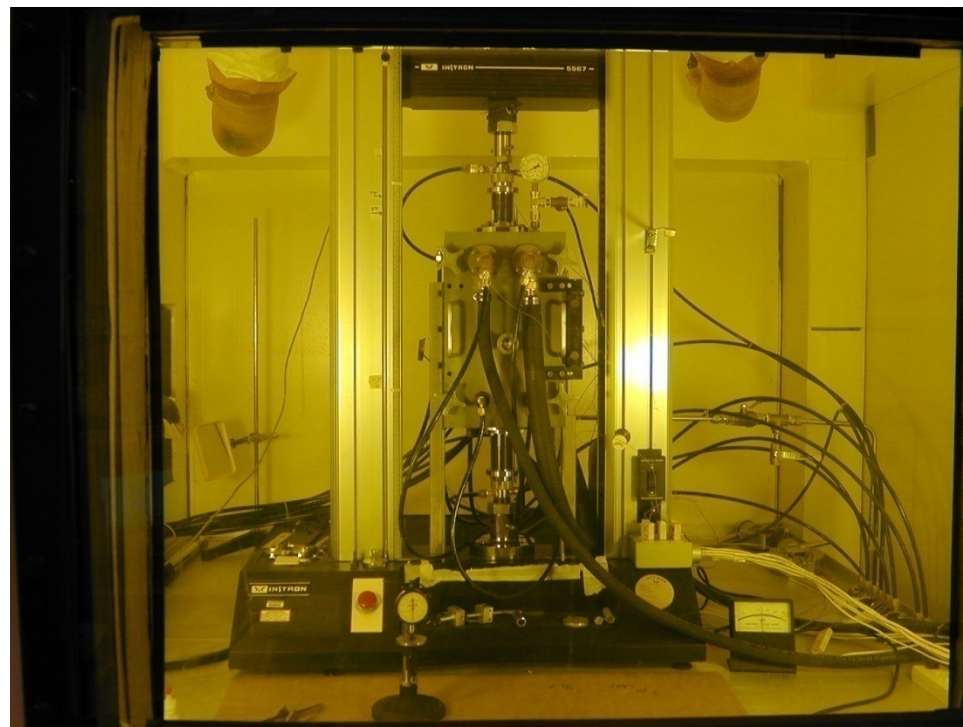
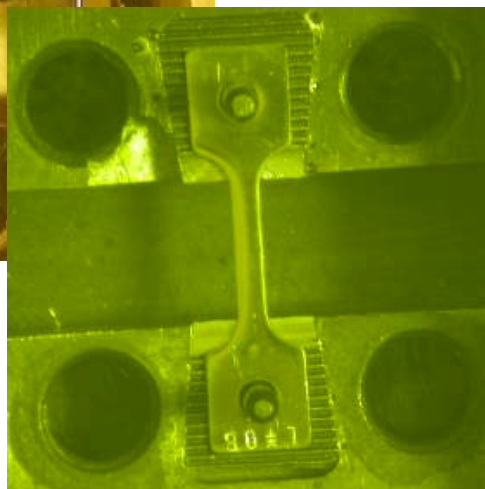
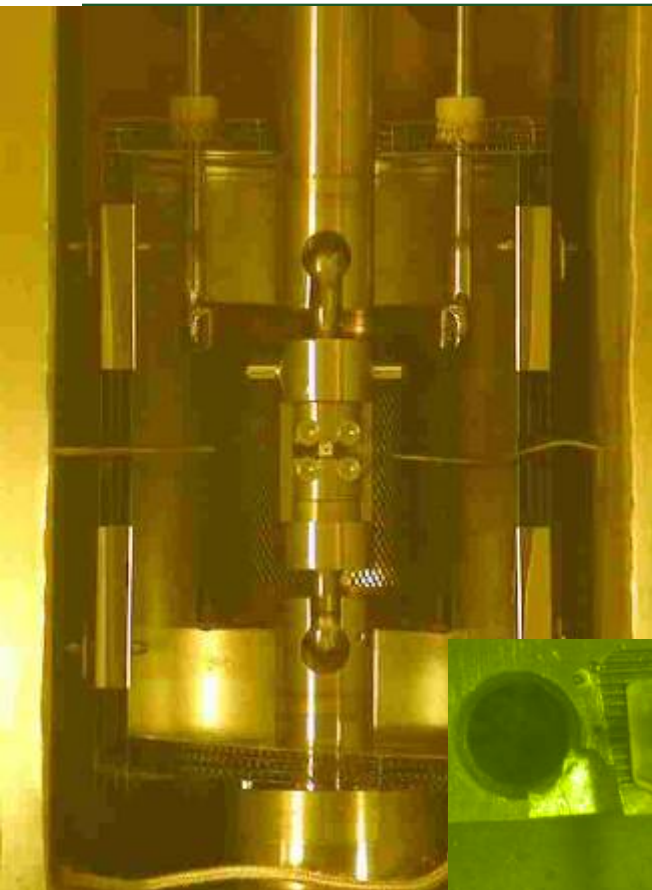






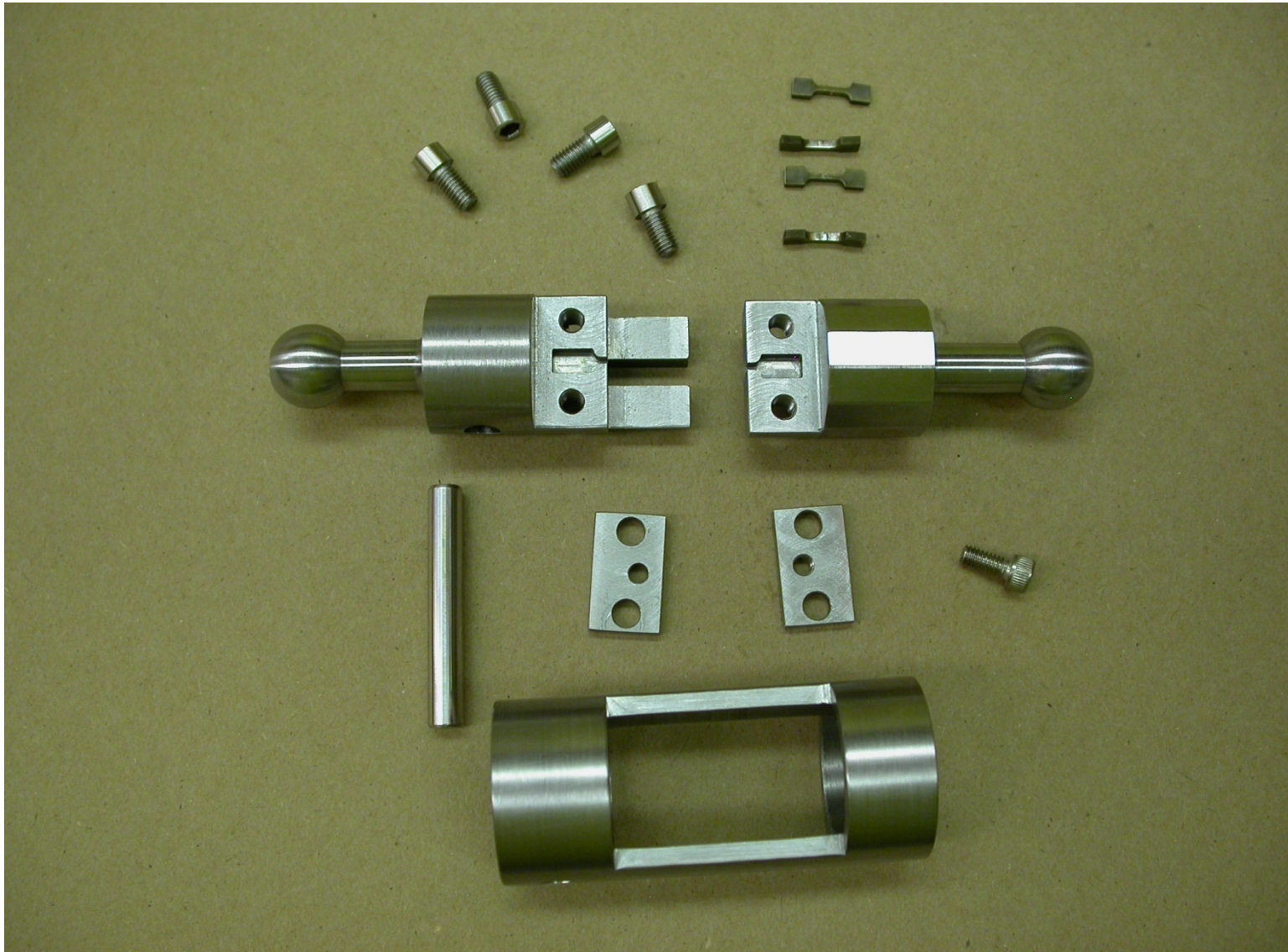
Tensile Testing in CMR Hot Cells

- **Capabilities:**
 - 25 to 700°C in ultra high purity argon
 - Shear Punch, Tensile, 3 pt. bend and compression testing capabilities.
 - 30kN Instron 5567 Screw driven frame





Shoulder Loading Fixture

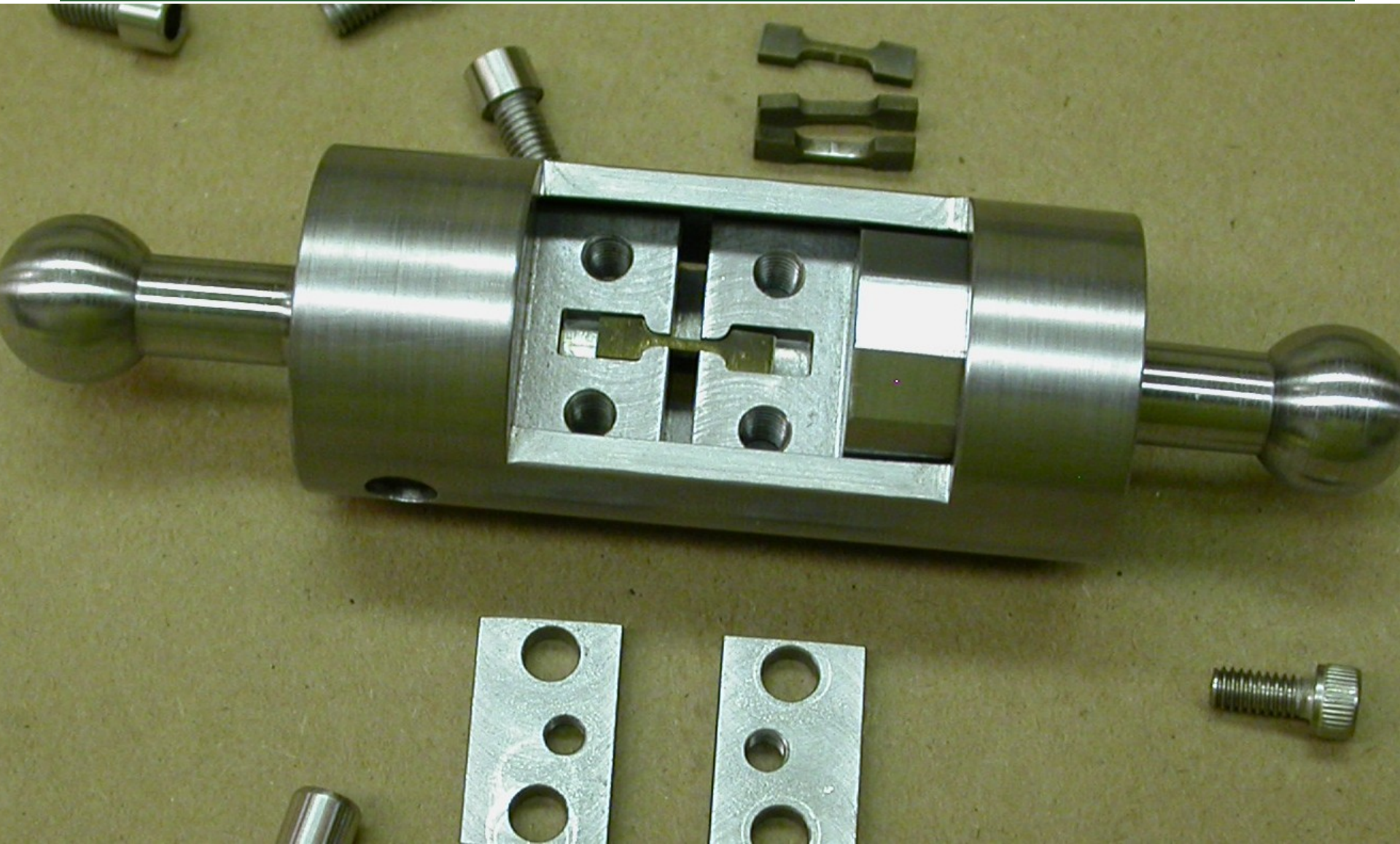




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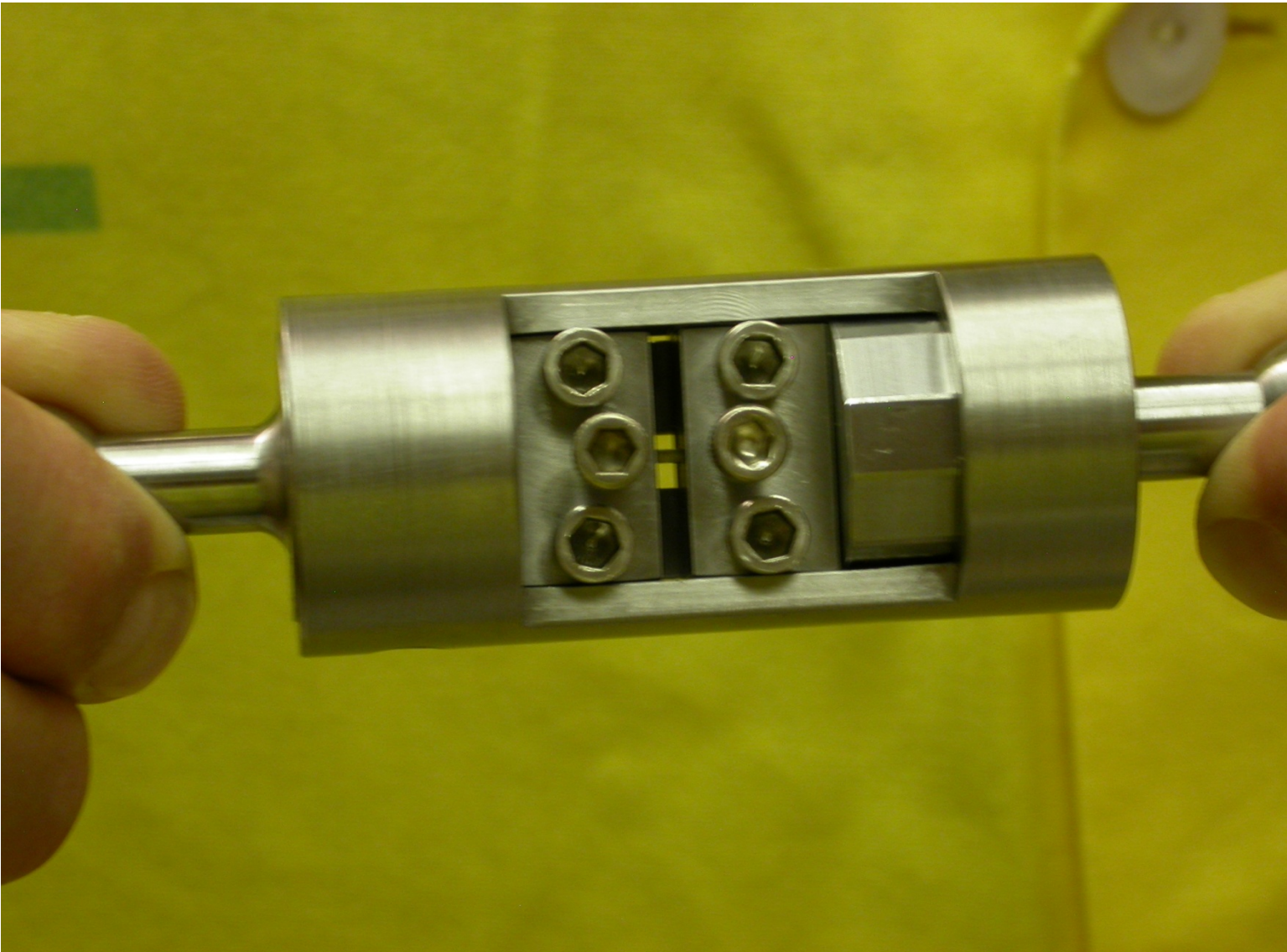
Shoulder Loading Fixture





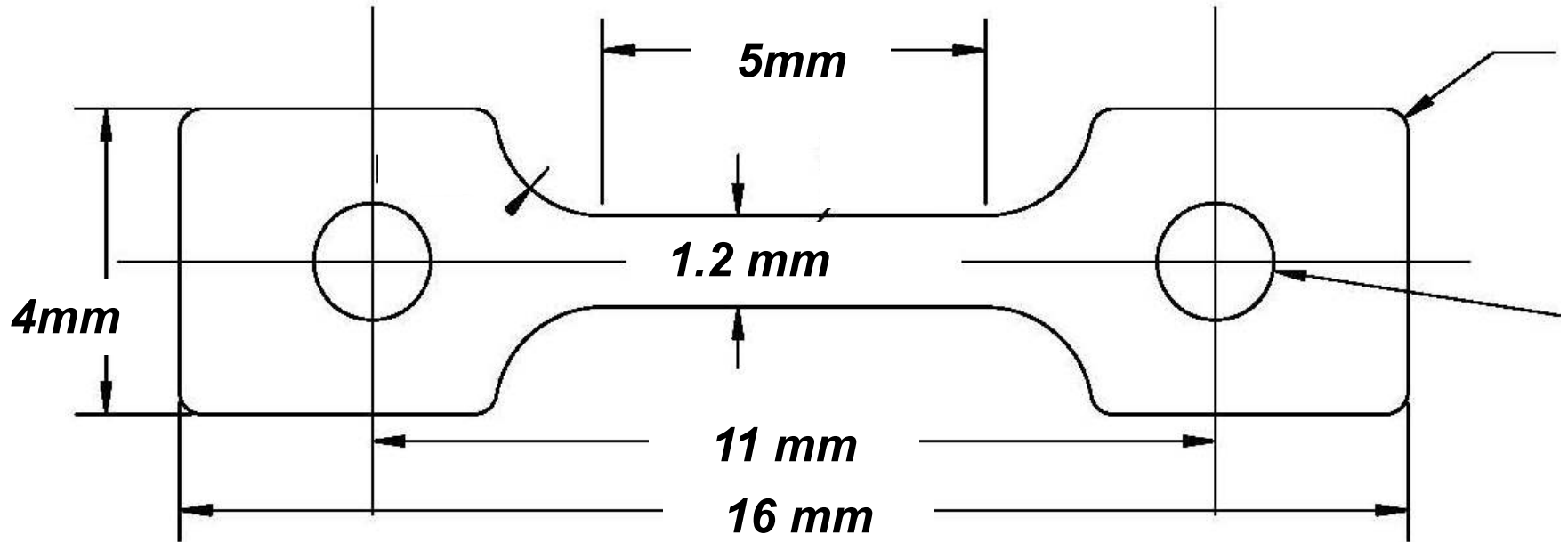
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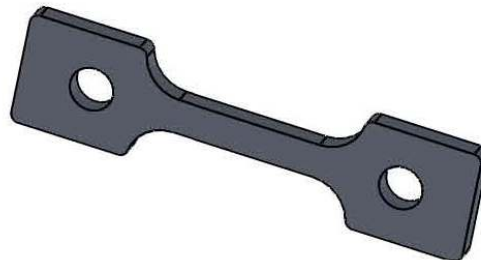




S1-Tensile Specimens



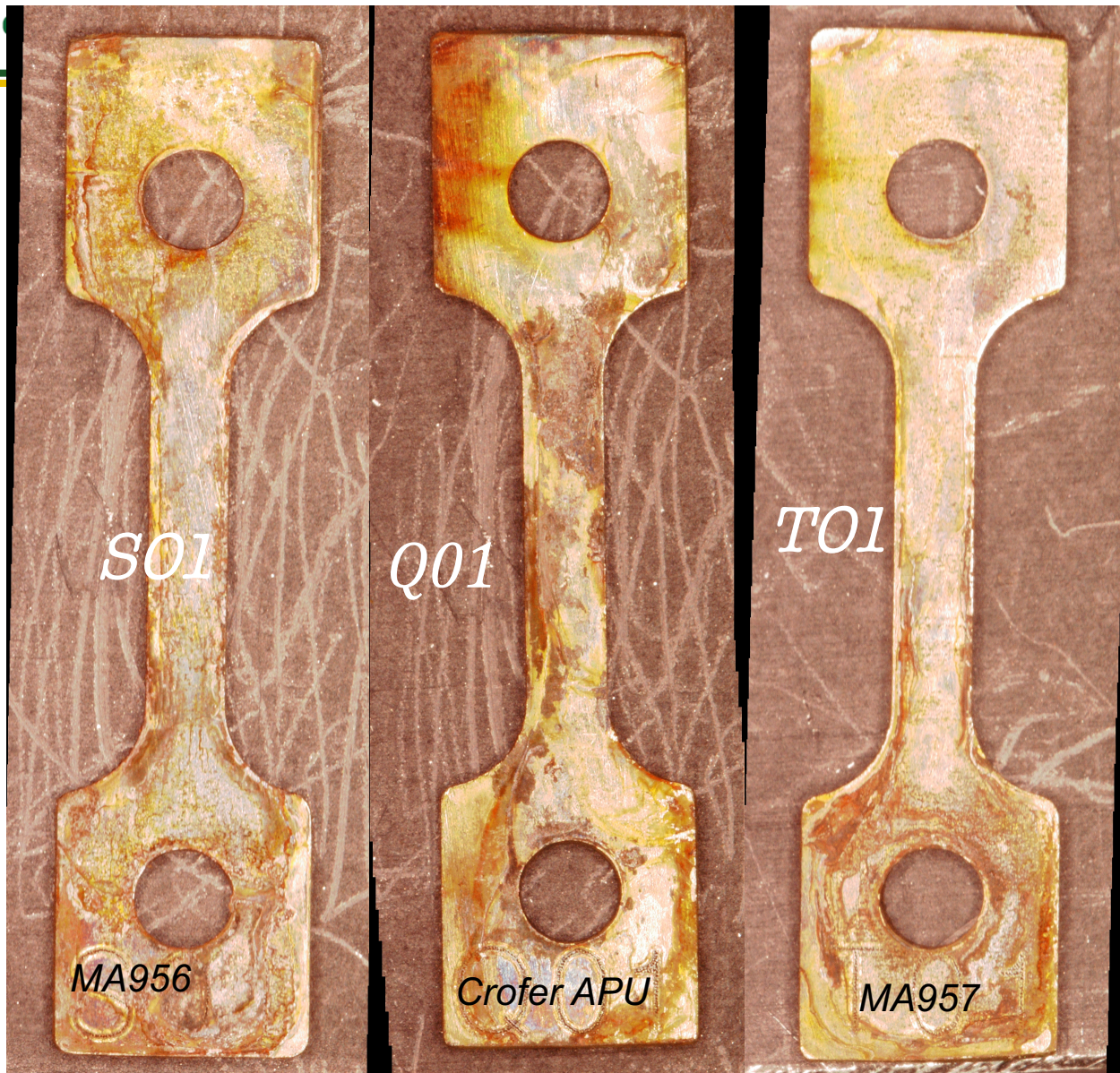
**0.75 mm
thick**





STIPV Actual Specimens

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Actual Irradiated Samples STIP IV



MA957

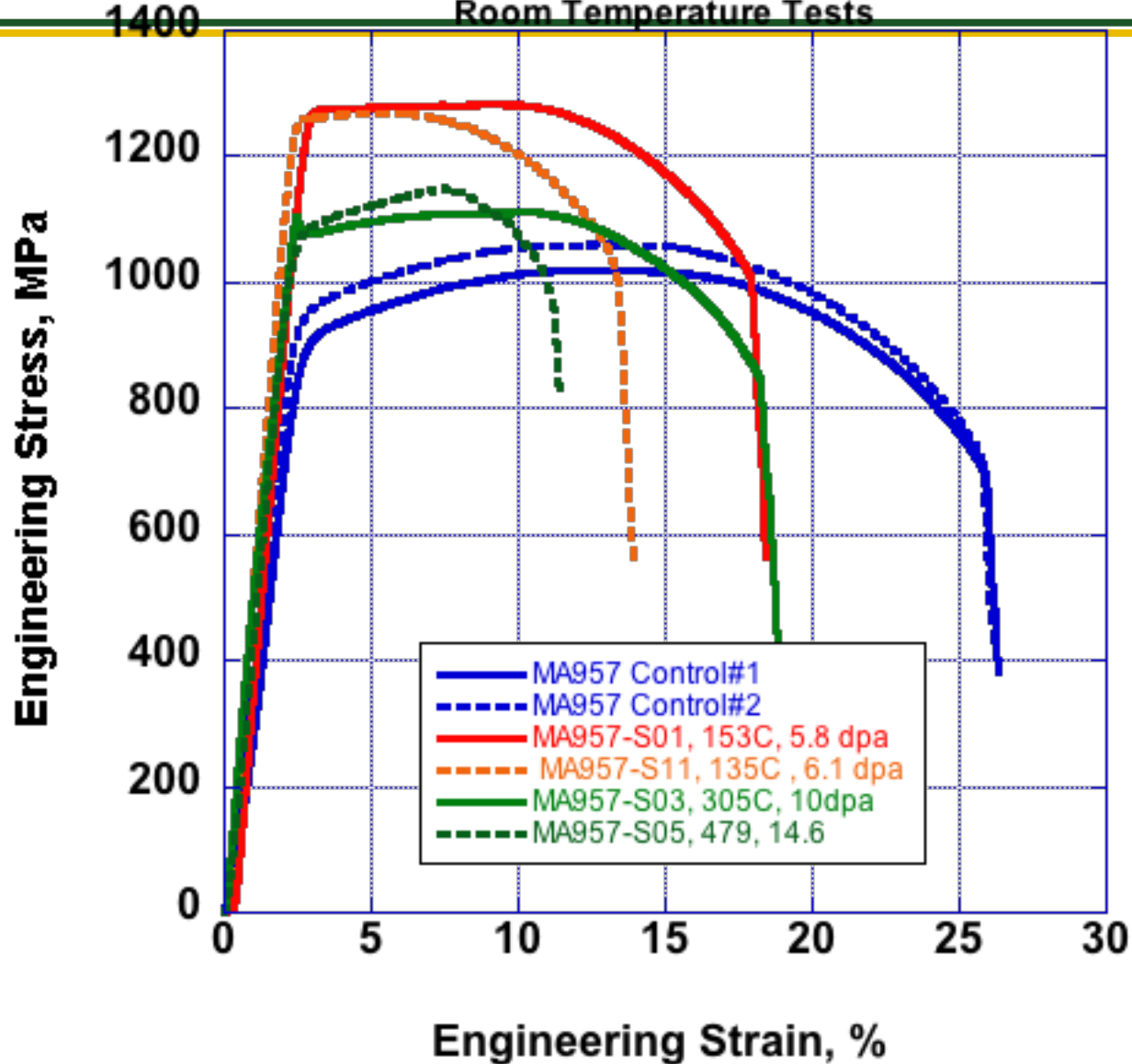


STIPV MA957

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STIPV, MA957

Room Temperature Tests

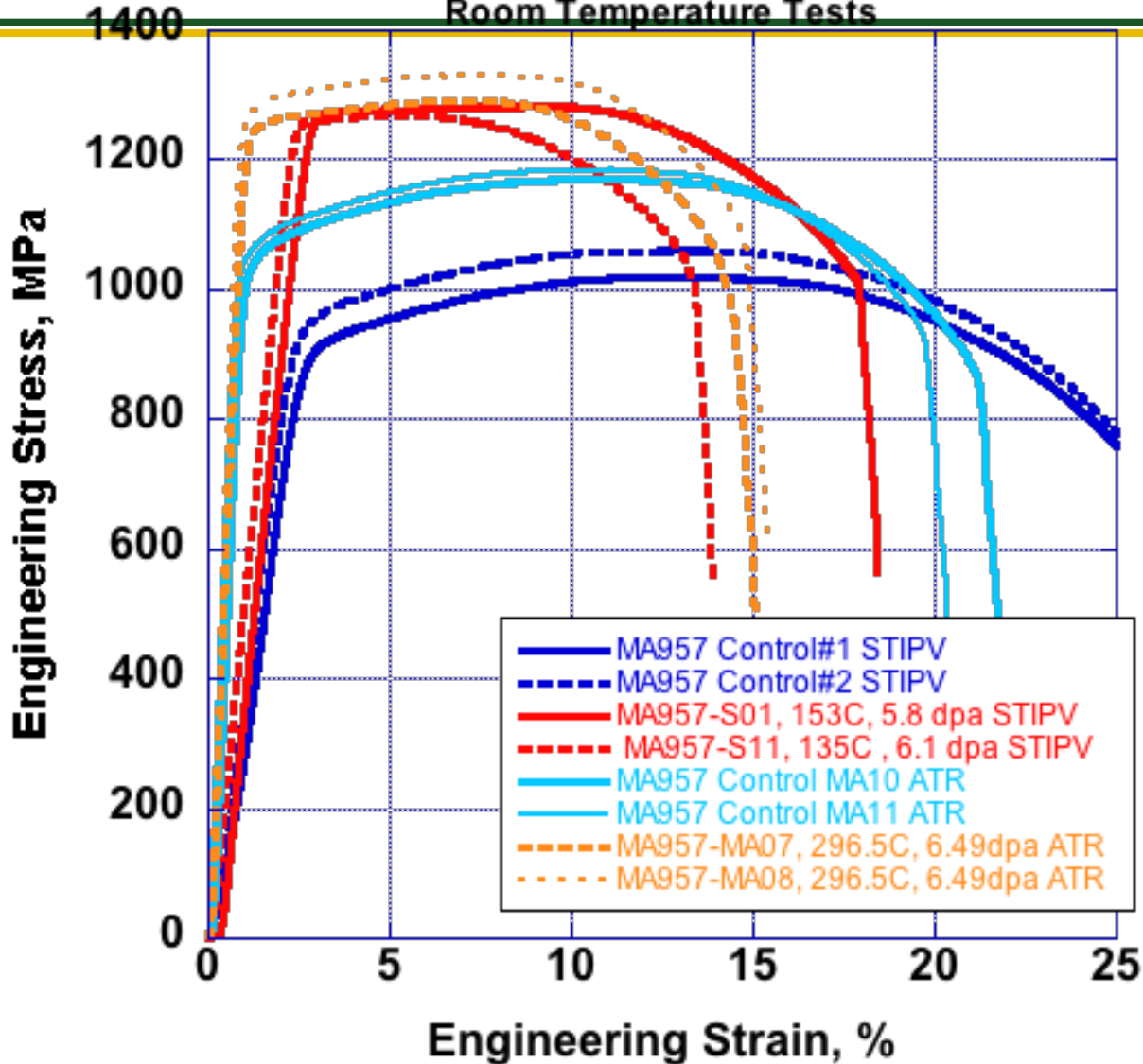




STIPV MA956 vs ATR

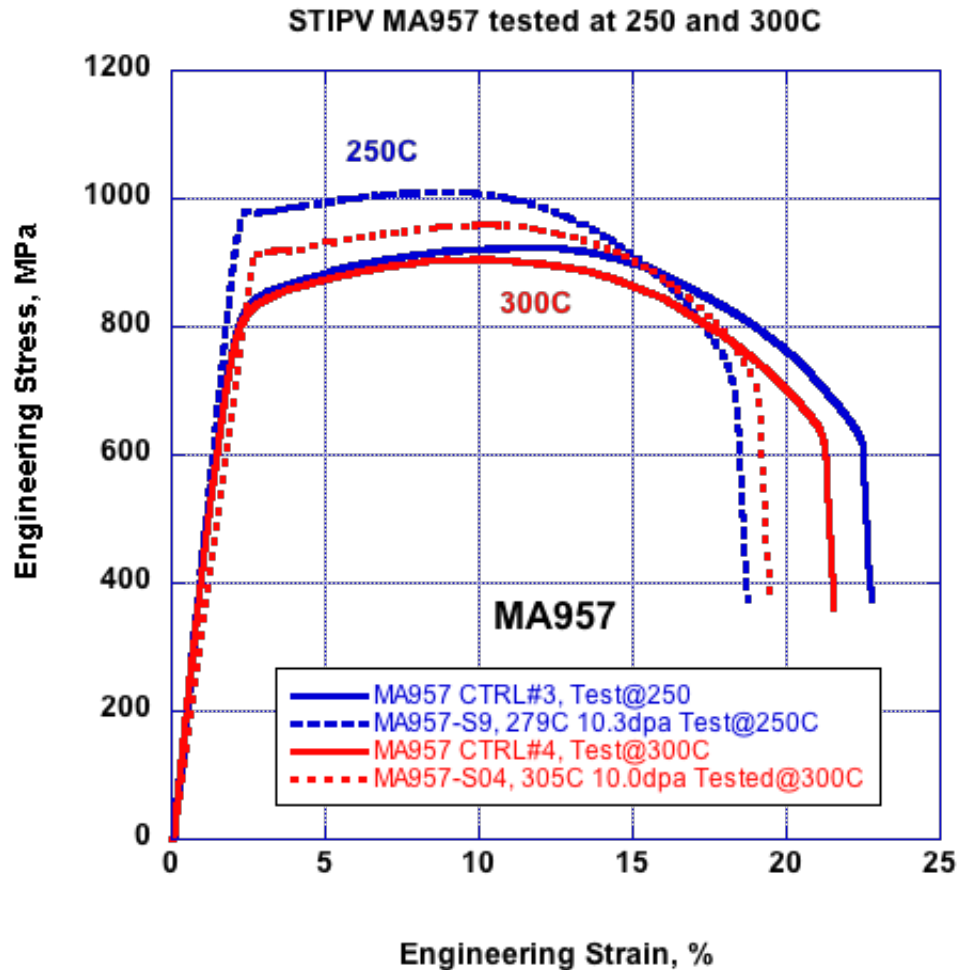
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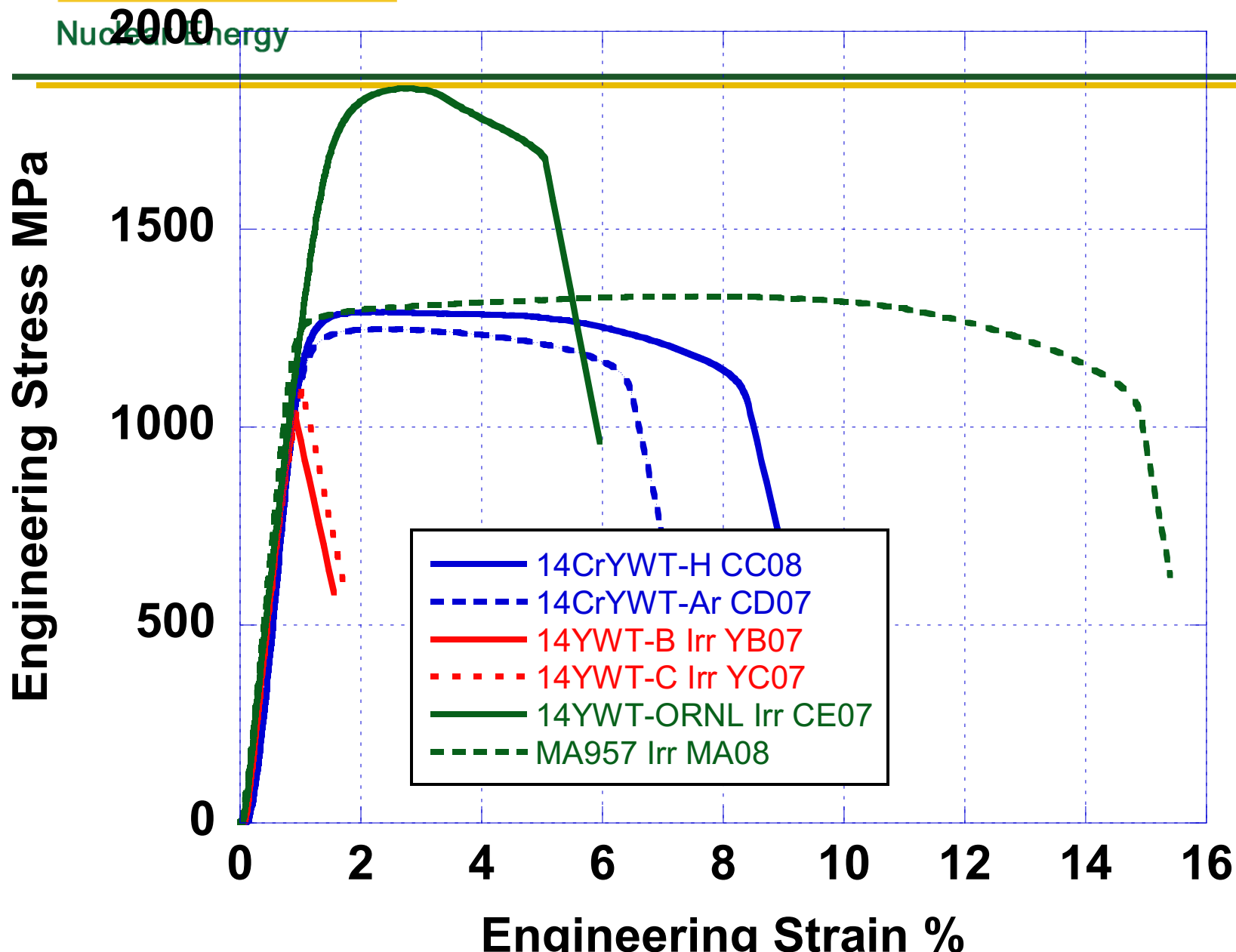
MA957, STIPV vs ATR
Room Temperature Tests





Elevated Temperature STIP V MA957







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MA956

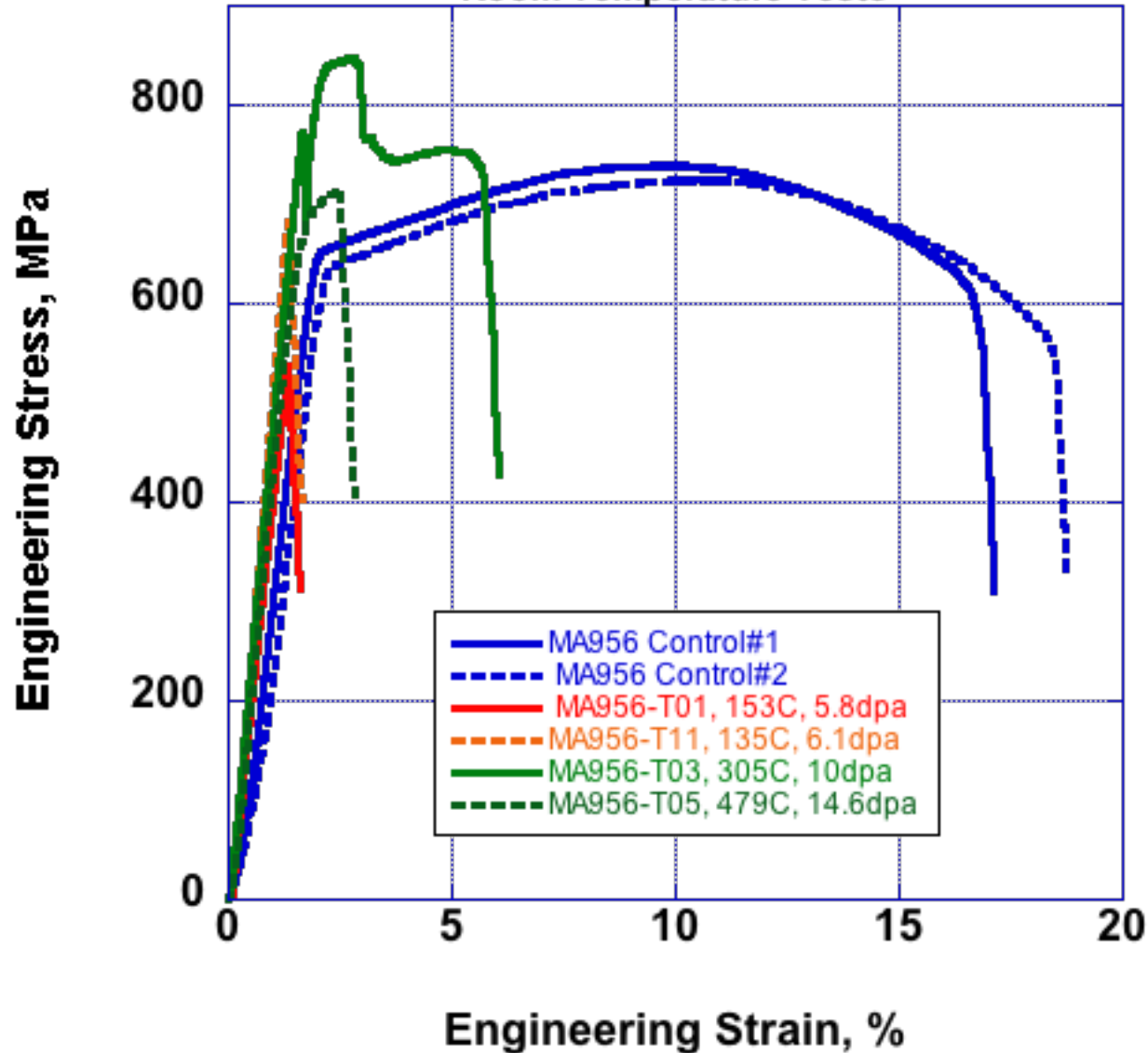


STIPV MA956

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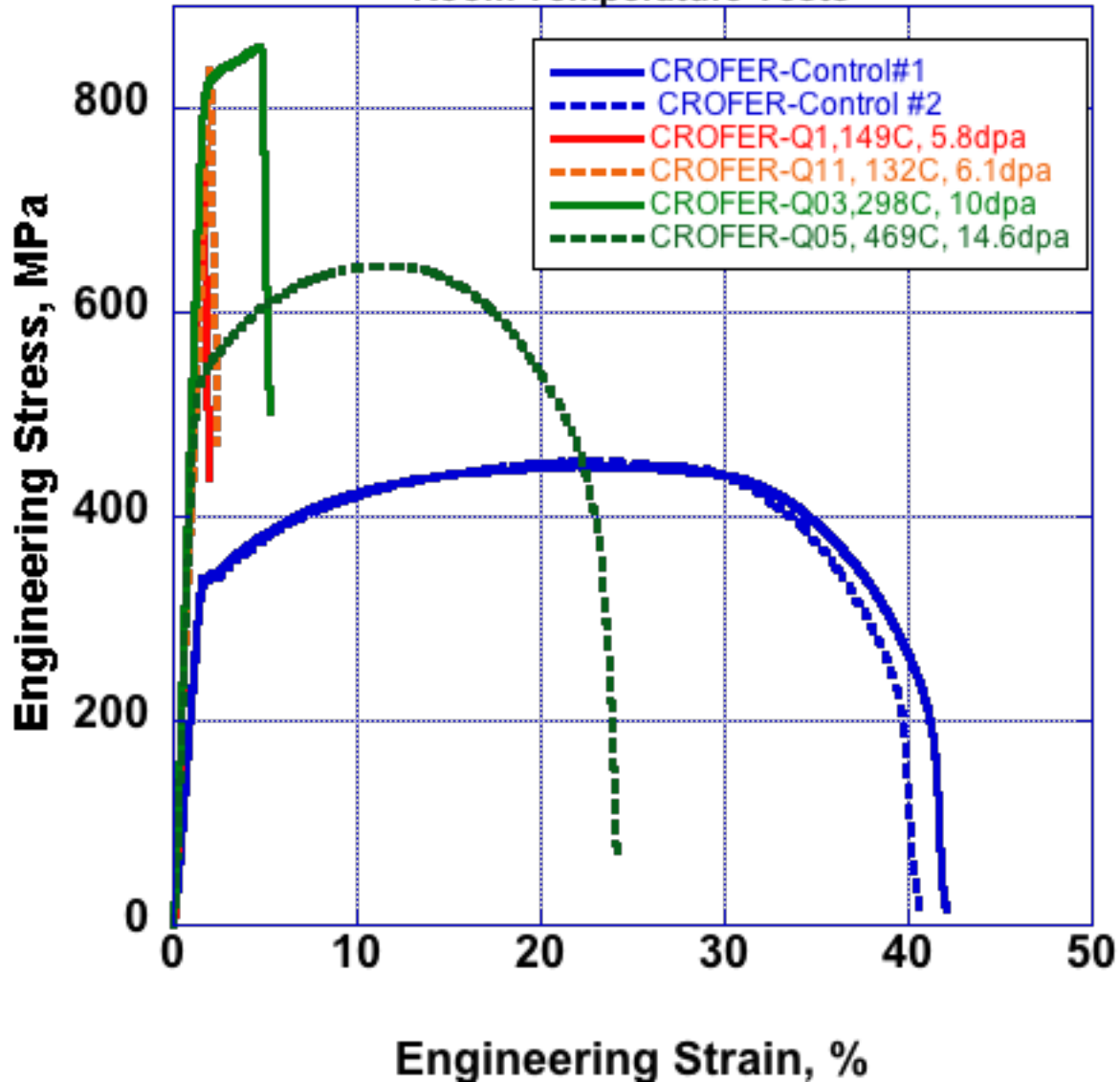
STIPV, MA956

Room Temperature Tests





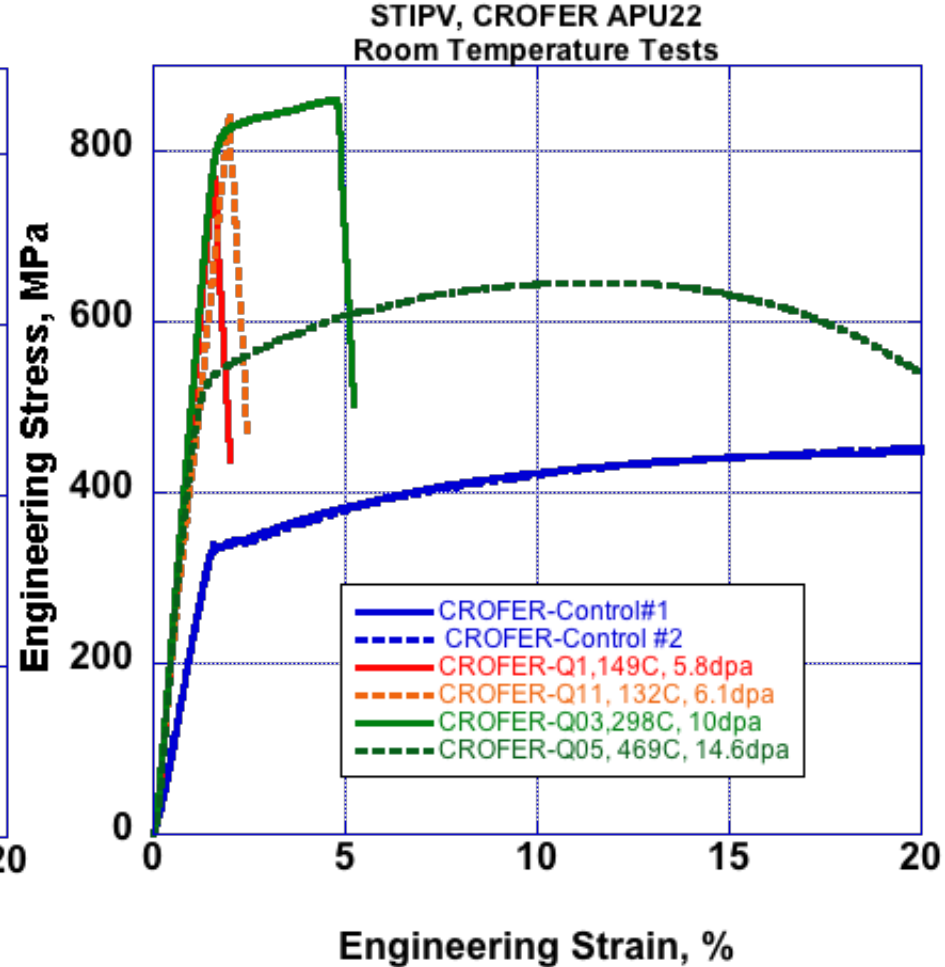
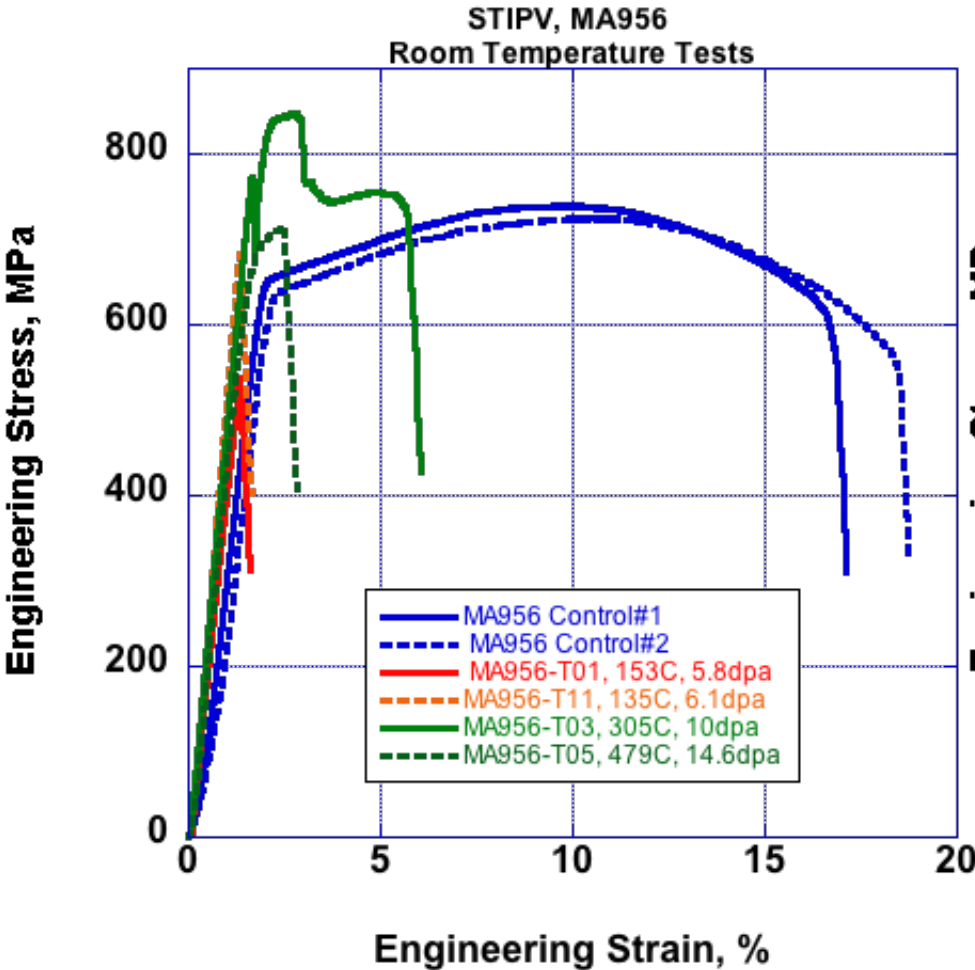
STIPV, CROFER APU22
Room Temperature Tests





STIPV MA956 vs CROFER APU22

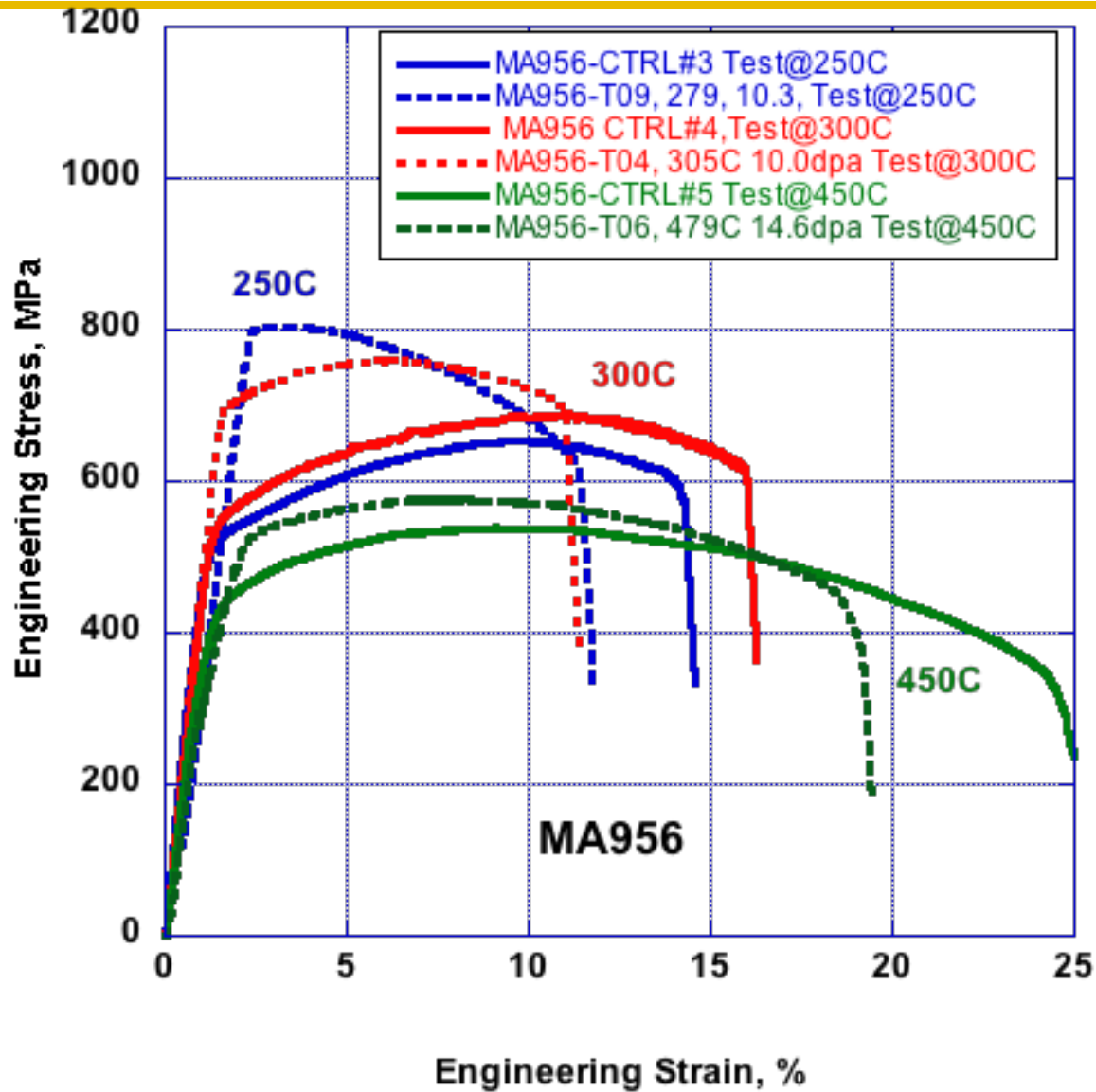
Same Scale, 20% Strain





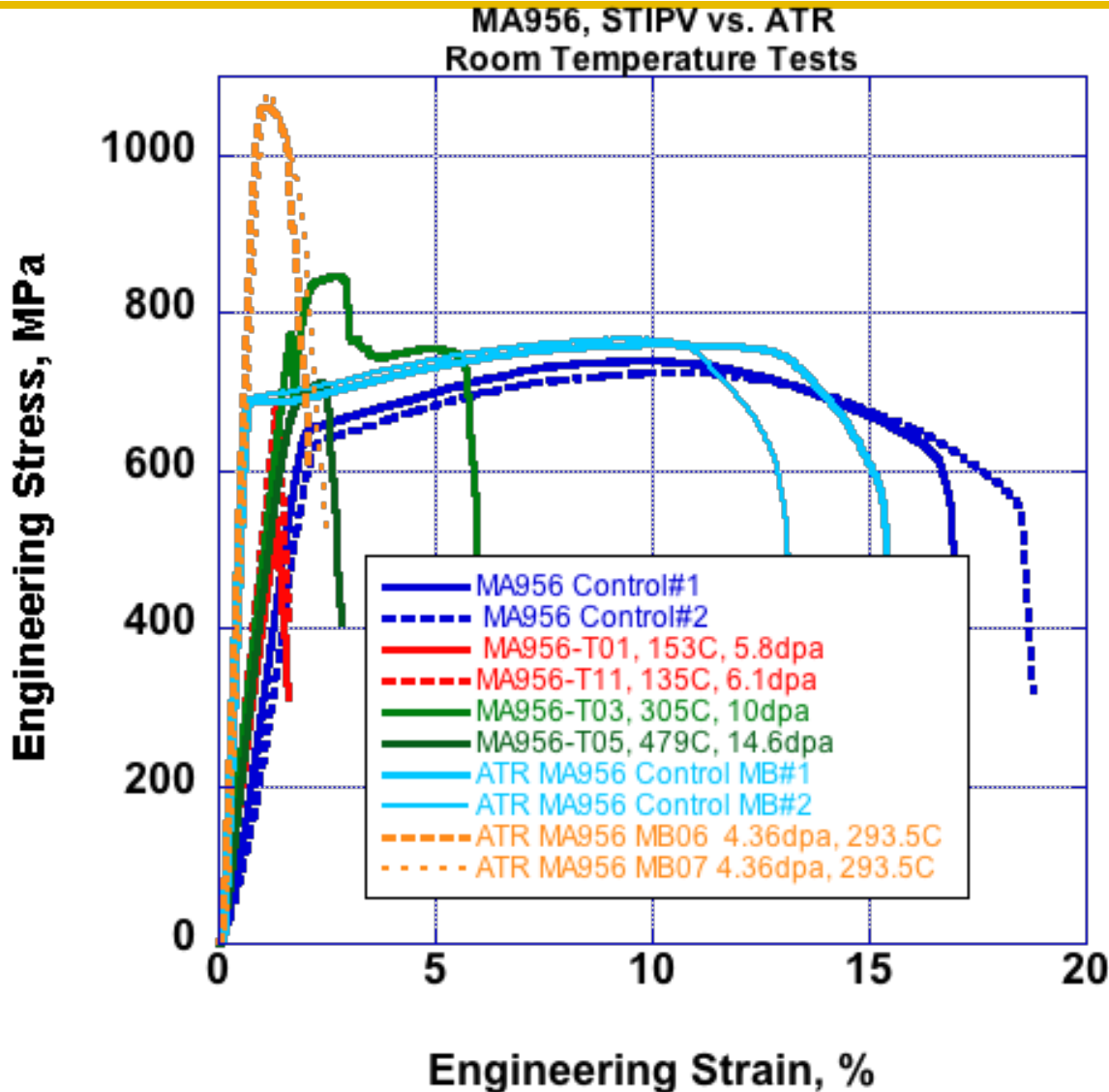
STIP V Elevated Temperature MA956

STIPV MA956 tested at 250, 300, 450C





ATR vs STIPV, MA956

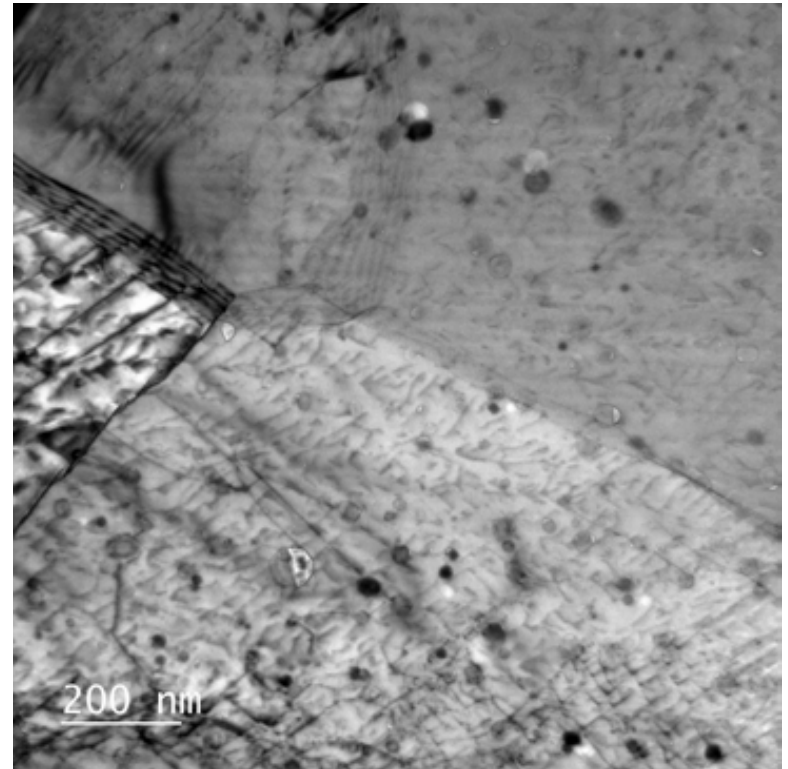
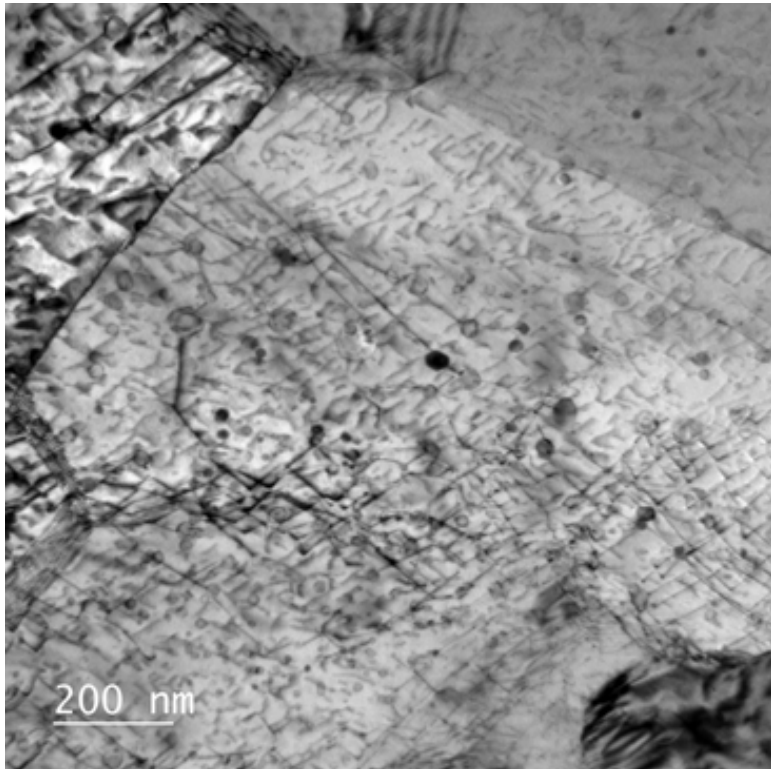




MA956 Fracture



TEM of As-Received MA956

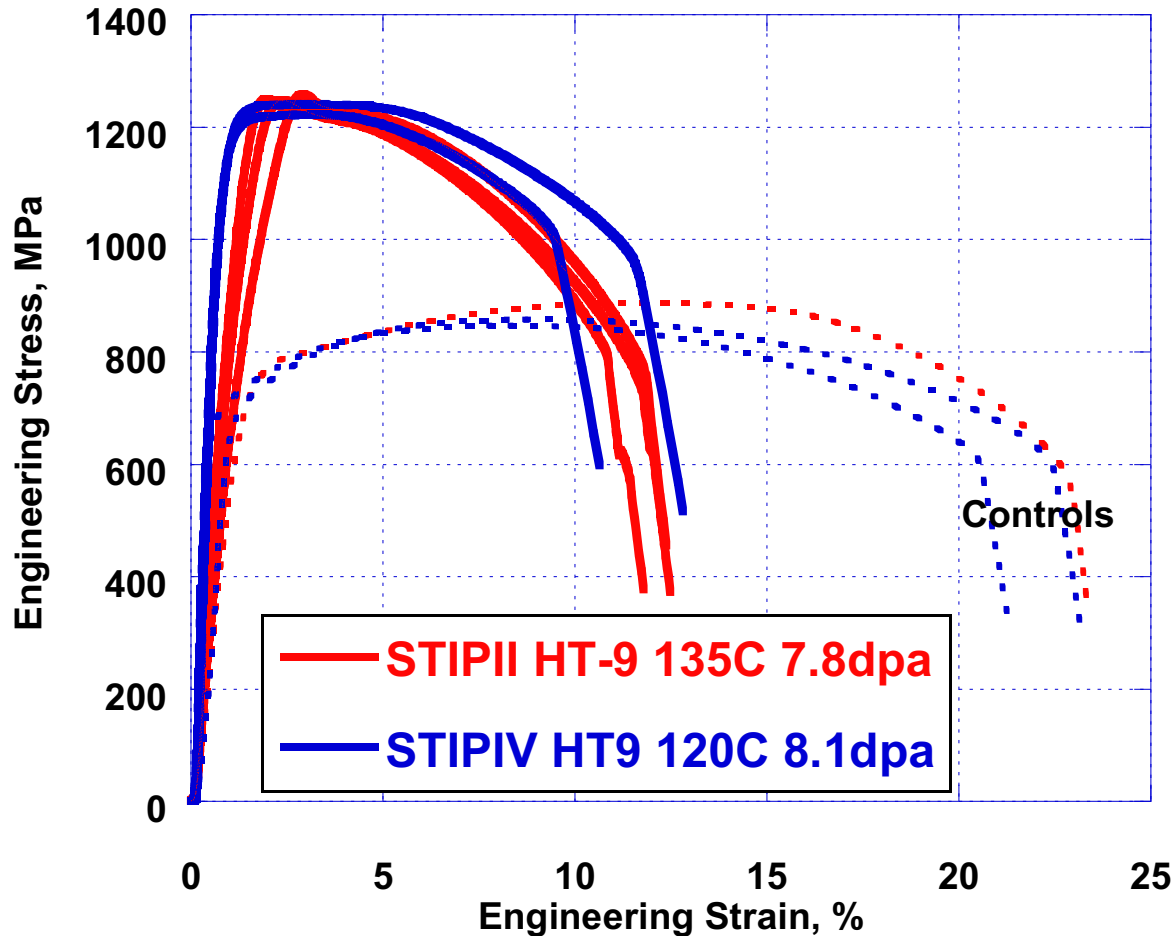


HT9, STIPII, STIPIV, ATR



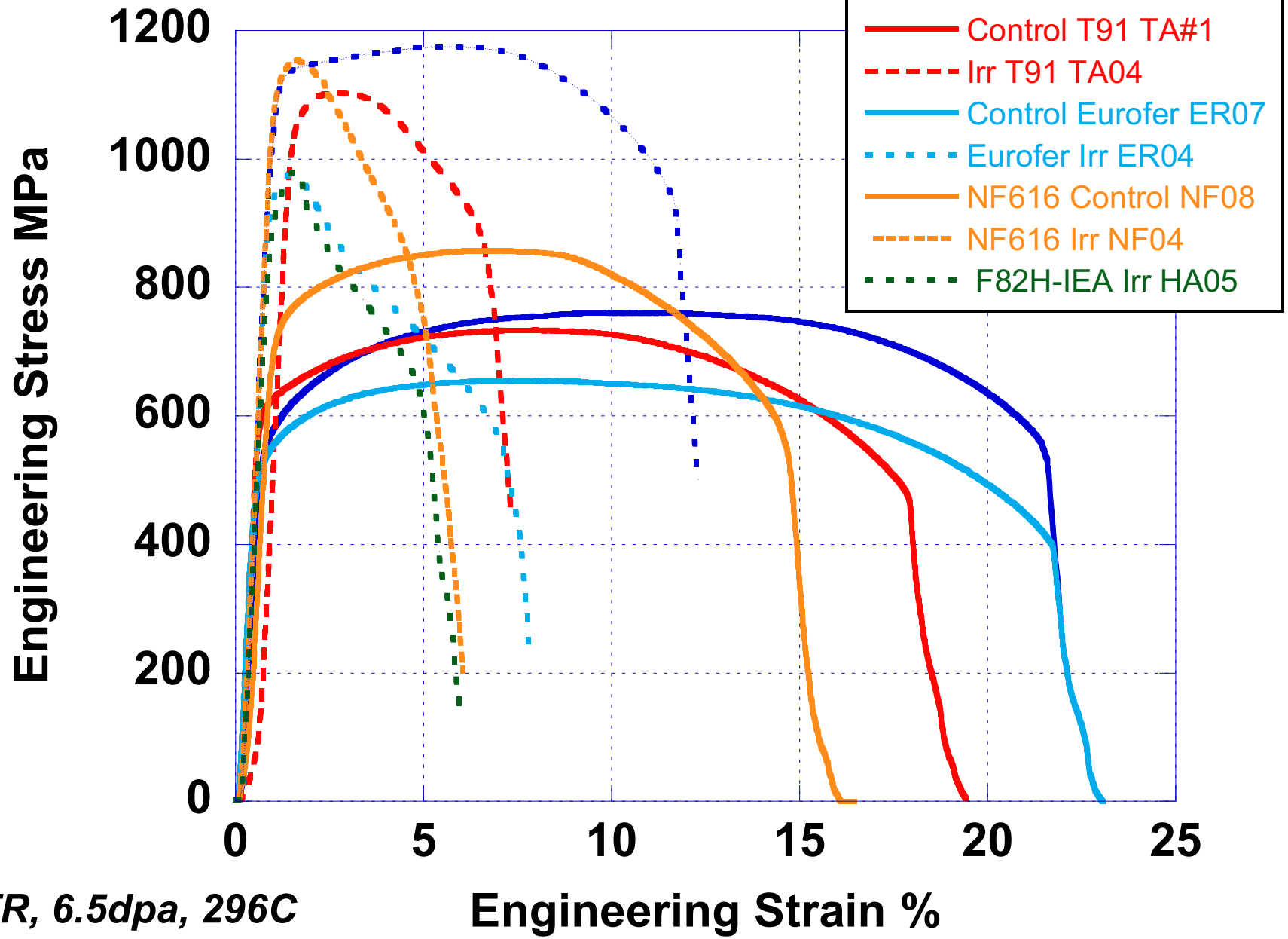
STIPII and STIPIV HT-9 Room Temp Tests, ~130C ~8dpa

STIPII and STIPIV, 130C 8dpa, RT tests





Control vs. Irradiated, All Ferritic



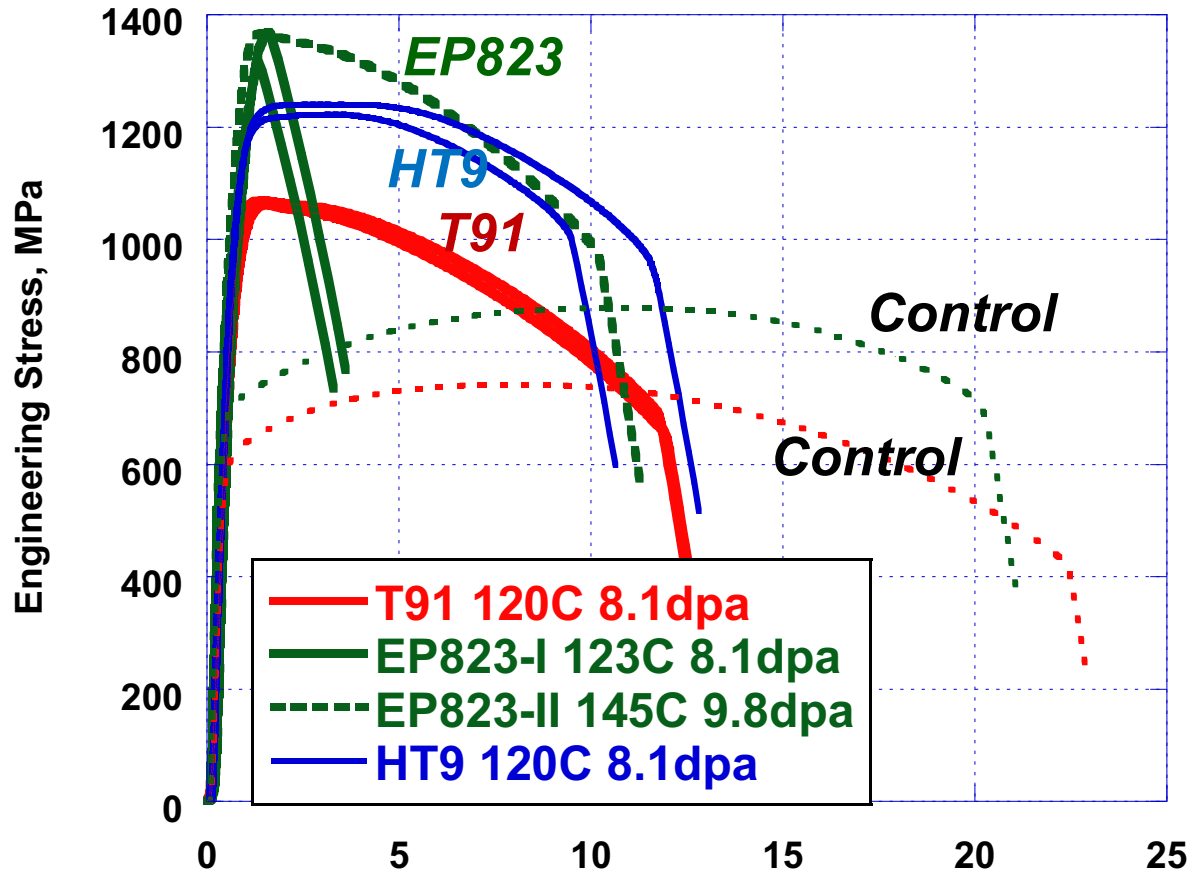
ATR, 6.5dpa, 296C

Engineering Strain %



T91 EP823 HT9, 120C 8dpa Room Temp Tests STIP IV

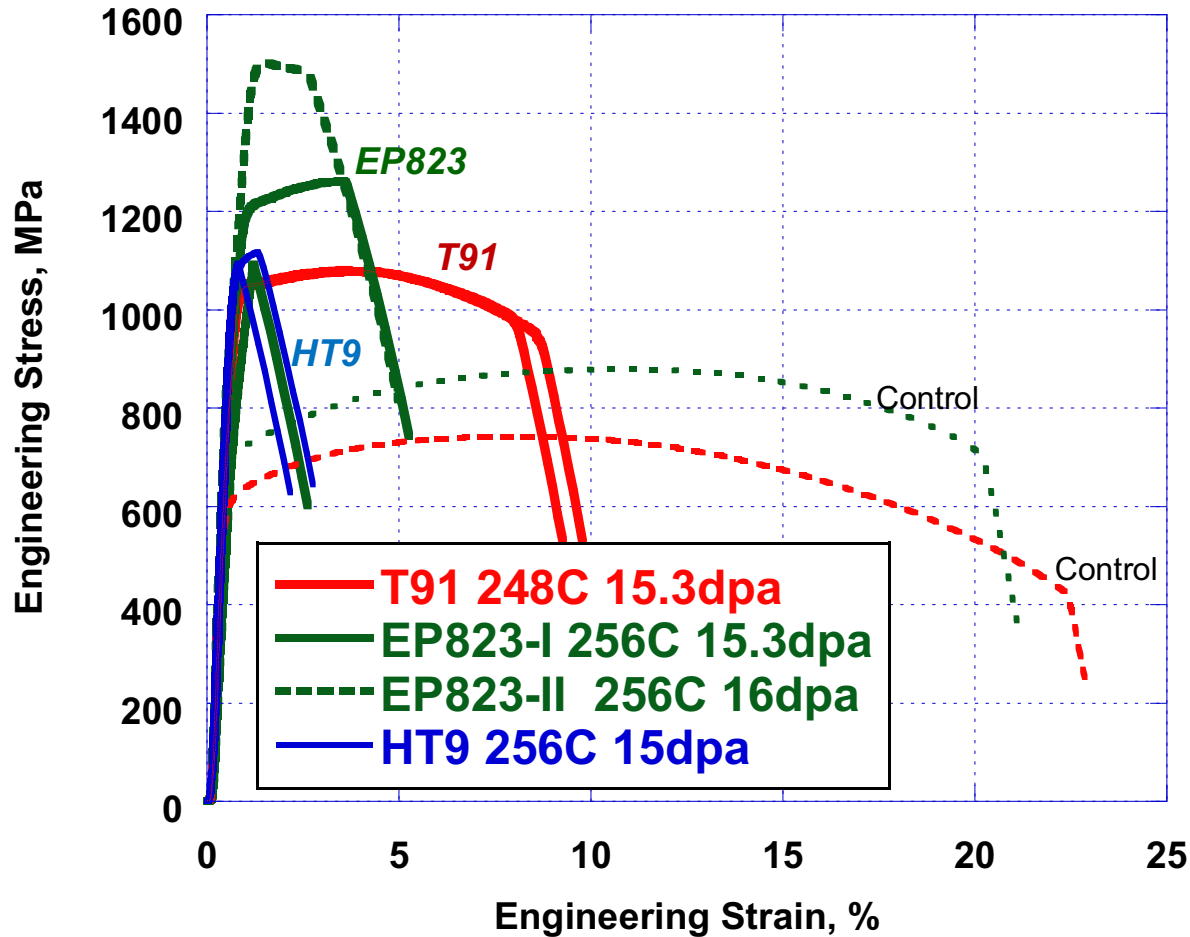
T91 EP823 HT9, 120C 8dpa, Room Temperature Tests





T91 EP823 HT9, 256C 15 dpa Room Temp Tests STIP IV

T91 EP823 HT9, 250C 15dpa, Room Temperature Tests



Conclusions

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- **StipV MA957 is excellent, good elongation as irradiated. Matches ATR irradiated data. Looking for consistent results in**
- **Crofer Alloy shows hardening no ductility, likely alpha prime**
- **MA956 shows no ductility, likely due to processing**
- **STIP II, IV, ATR data helps place some context in dose, temp, helium, but consistency among starting material, processing, needs to be better understood.**