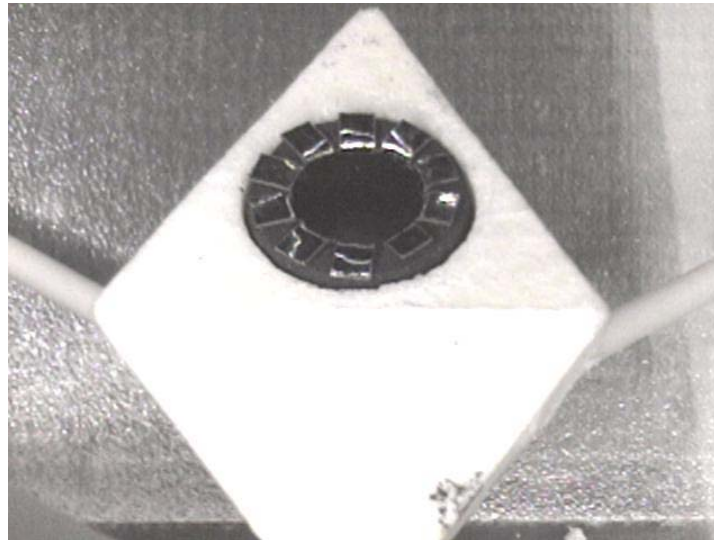


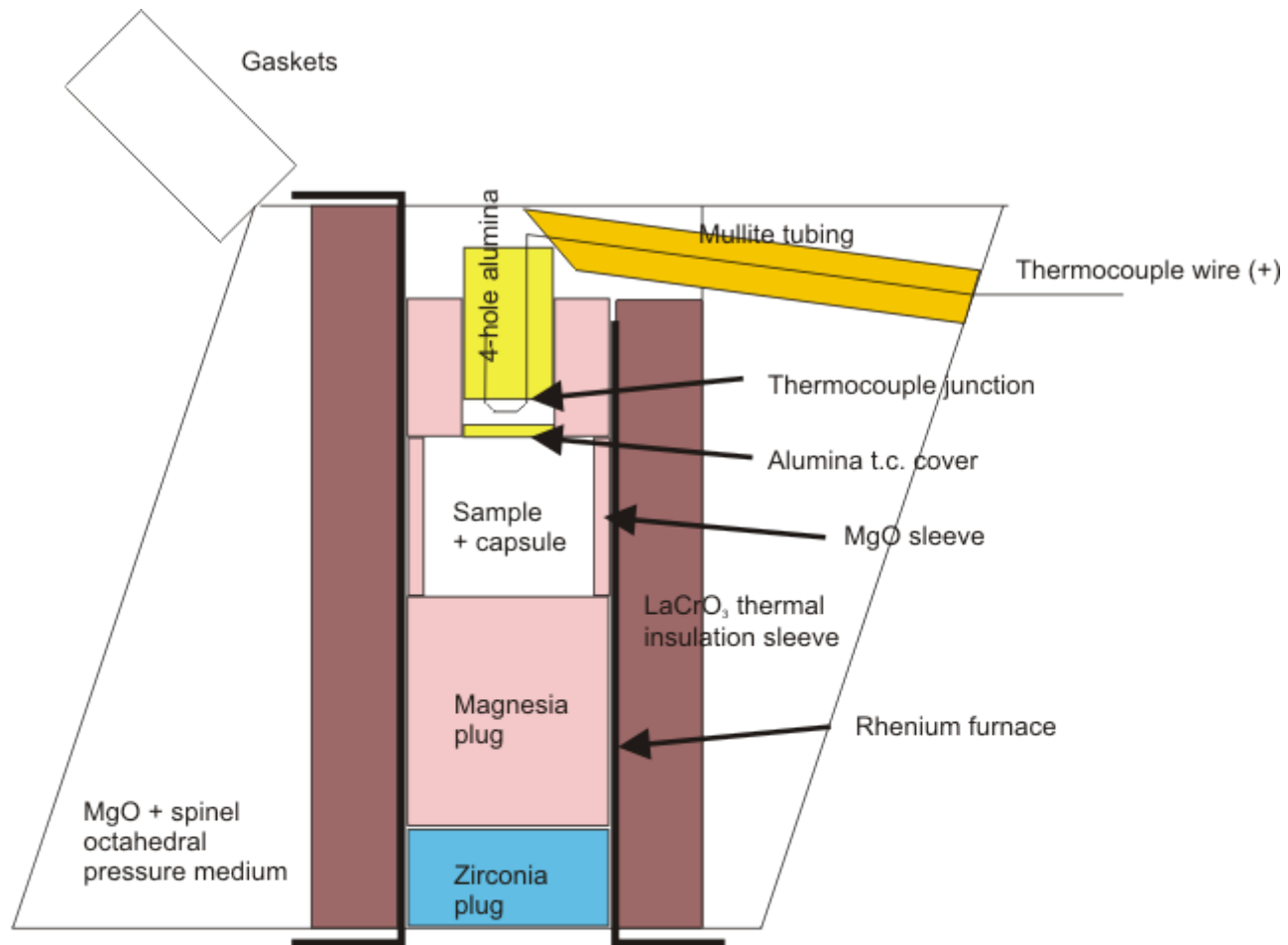
# Development of a CsCl pressure standard and its use in testing a series of multi-anvil cells (the COMPRES assemblies)

Kurt Leinenweber, Emmanuel Soignard, Yanbin Wang

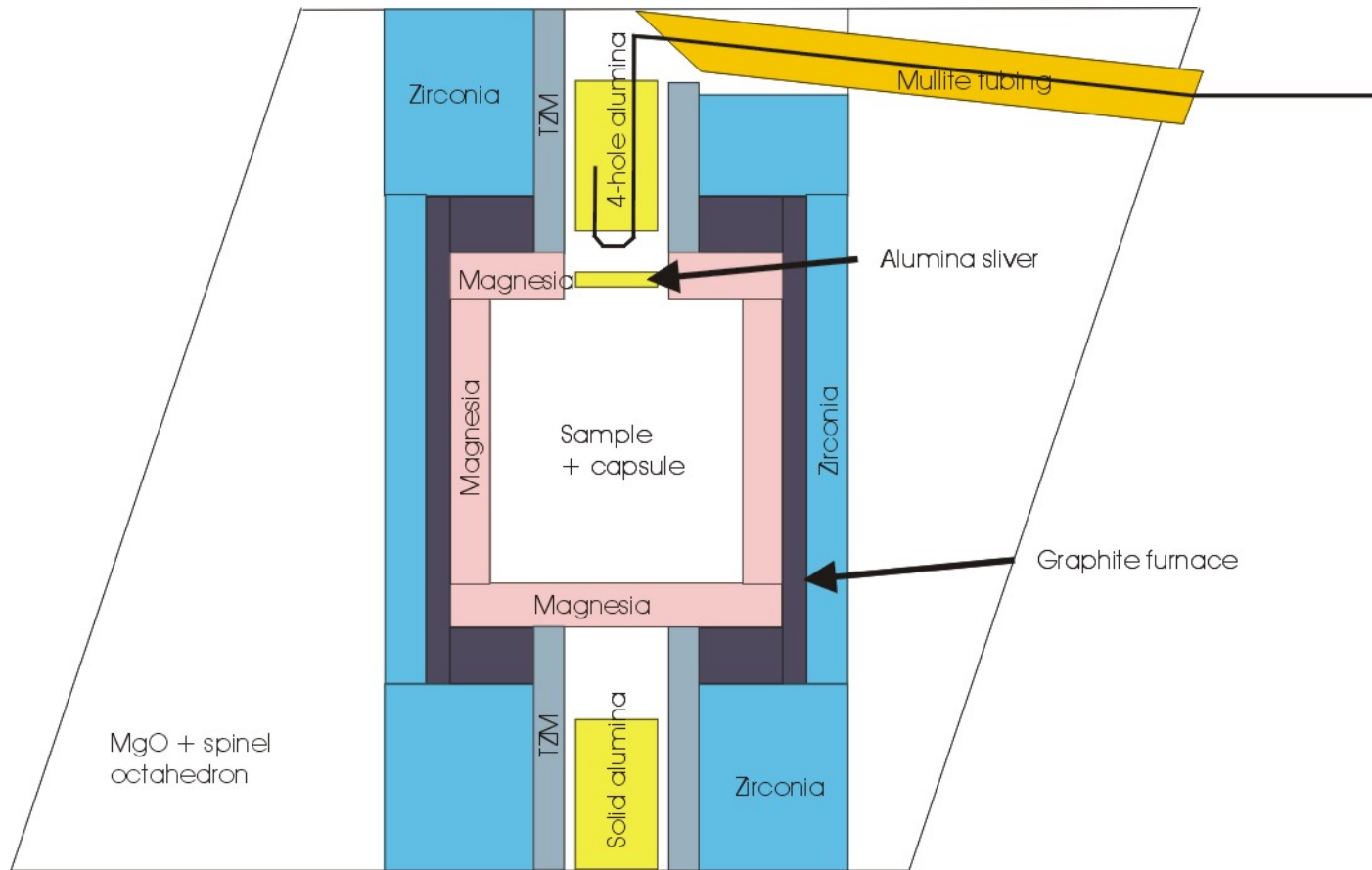


# Purpose

- We needed to calibrate multi-anvil cells for the COMPRES cell project
- (pictures of the cells to follow)
- But the cells are VERY absorbing, and we didn't want to alter them.



Example: COMPRES 10/5 assembly



14/8 "G2" assembly

Example: COMPRES 14/8 box heater assembly

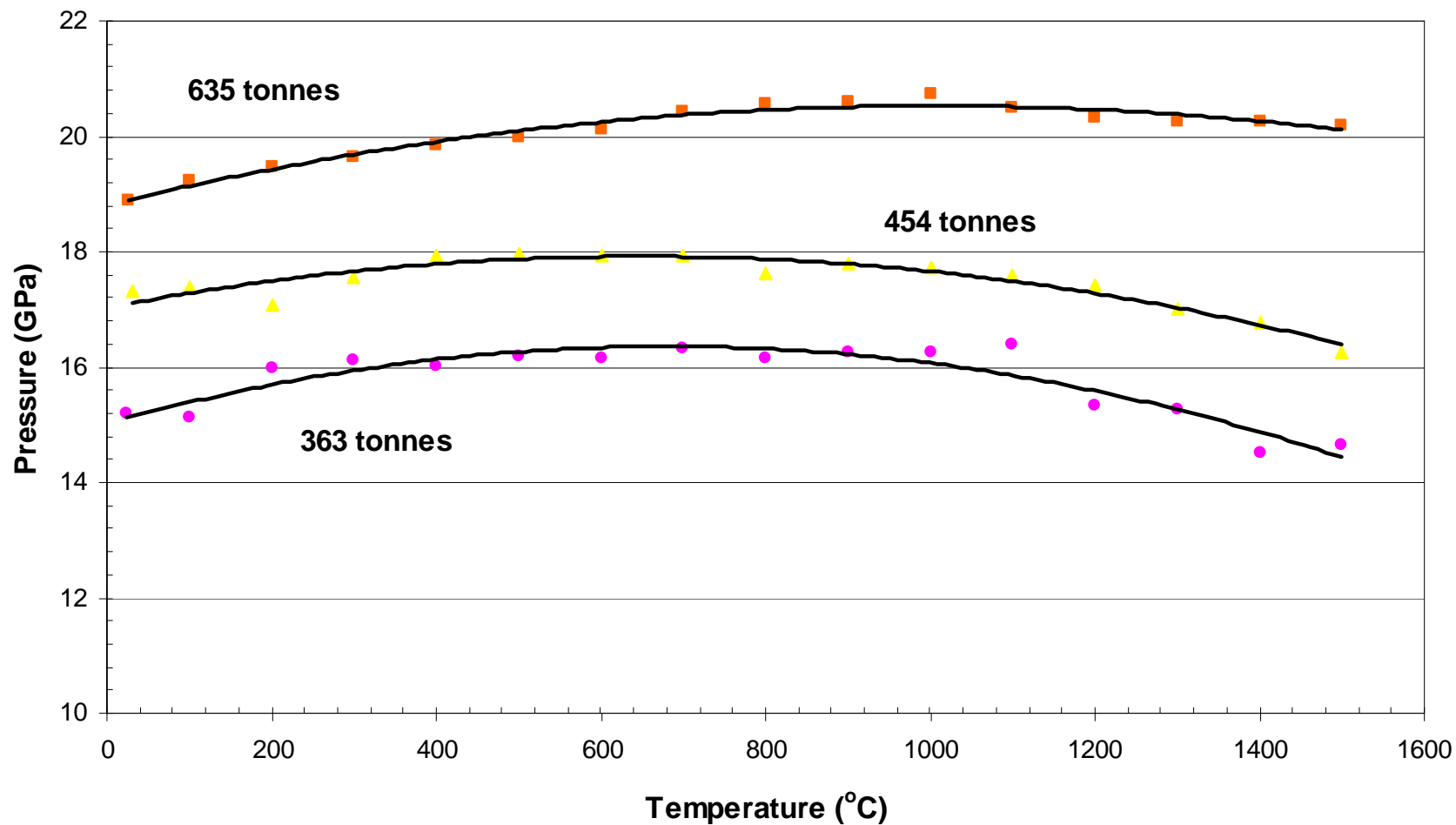
# Pressure standard

- We tried MgO and W, but soon settled on CsCl, and used the Decker (1971) equation of state for CsCl.

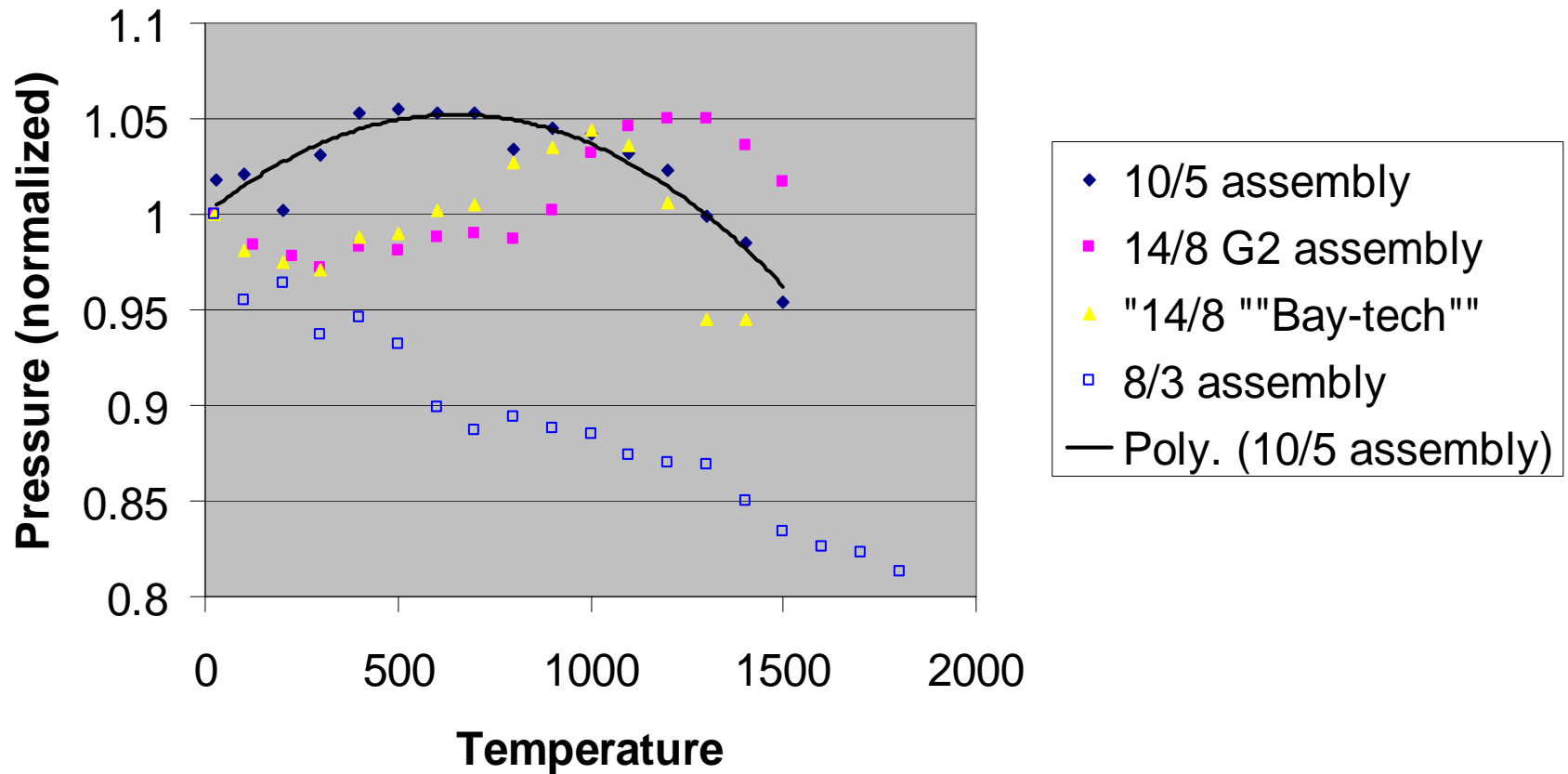
# Advantages of CsCl

- Good scatterer.
- Simple cubic symmetry, so no extinctions.
- Highly compressible ( $K_0 = 16$ ).
- High melting point compared to NaCl.
- No phase transitions at high pressure.

Effect of temperature on pressure of 10/5 assembly  
(CsCl pressure standard)

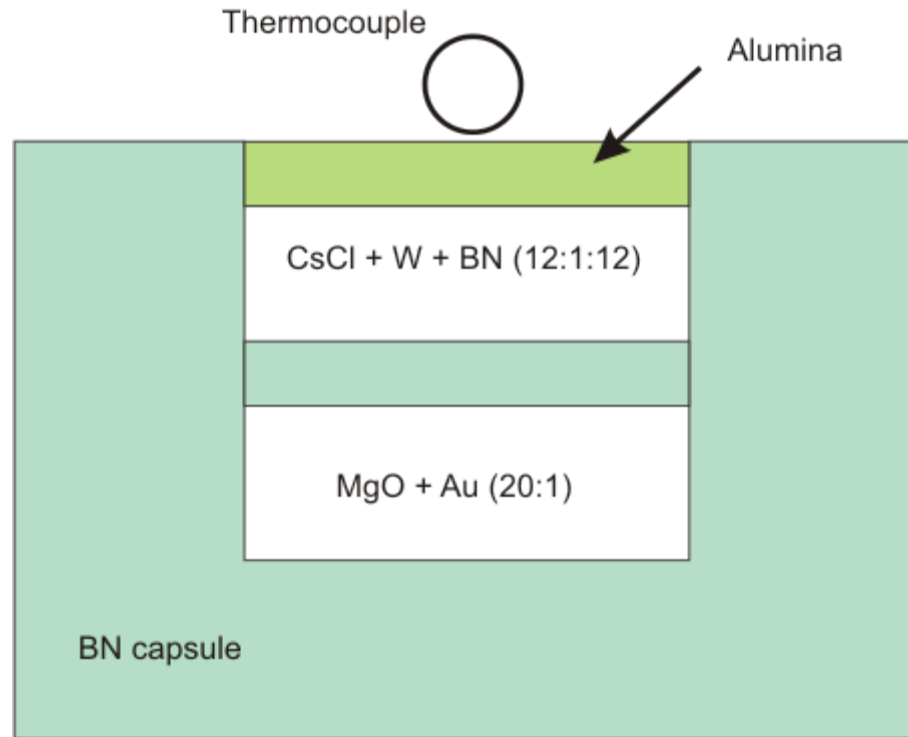


## Assembly behavior with temperature (CsCl standard)

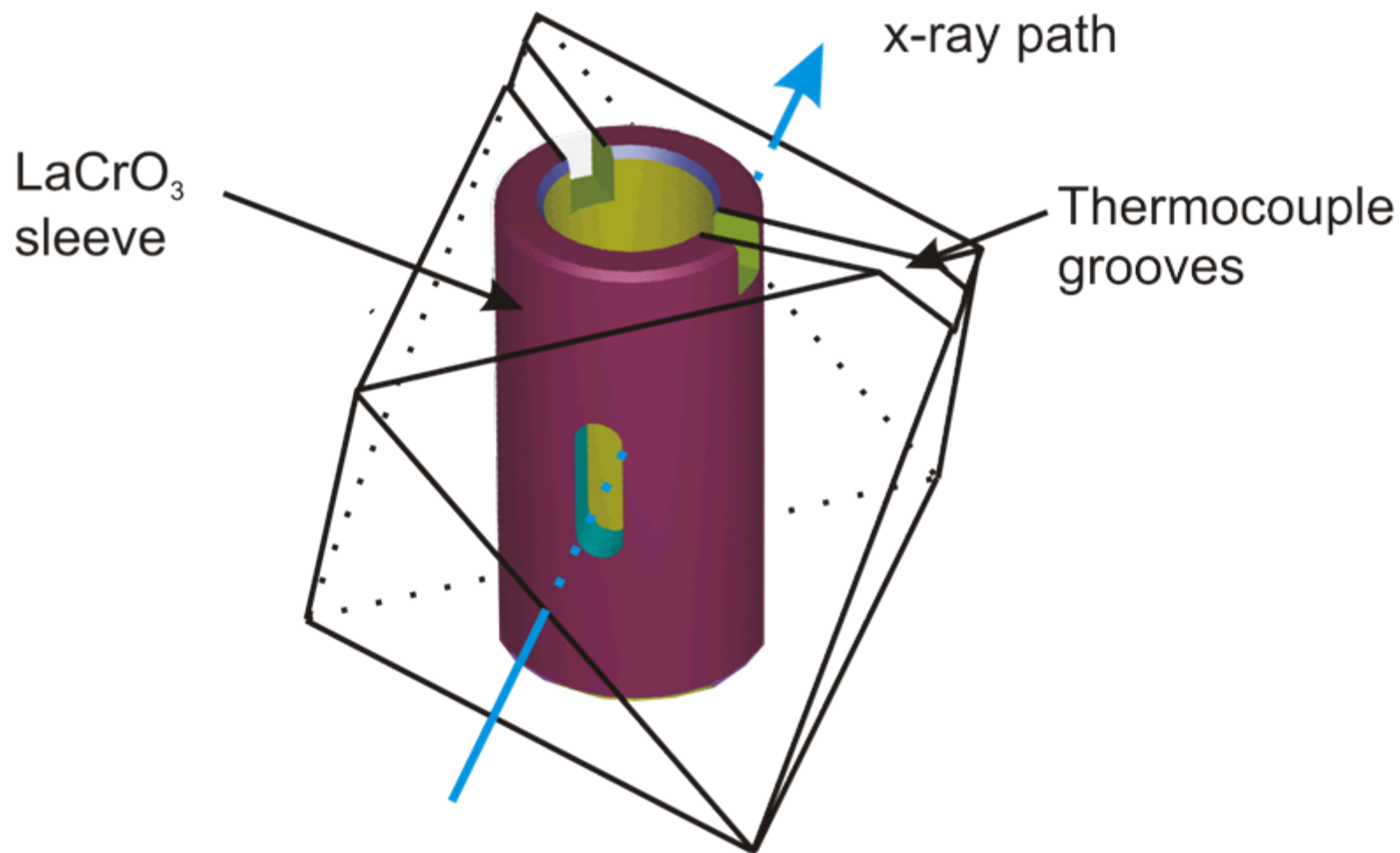




- Summary – CsCl is very useful for precise calibrations in many situations.
- However, how does Decker EOS for CsCl compare to better-known standards?
- The next part of this study is a comparison of CsCl to MgO, Au, and W.

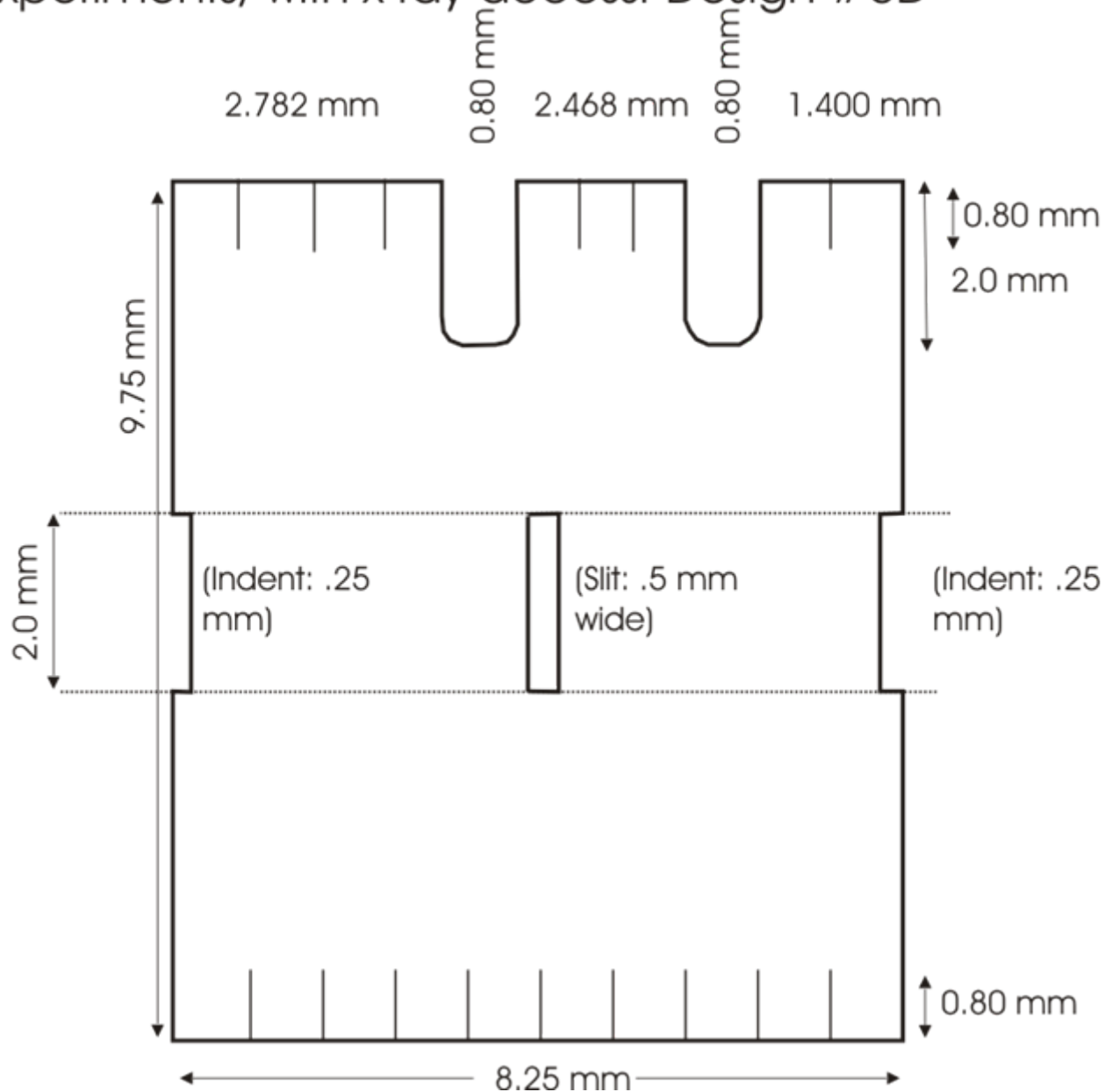


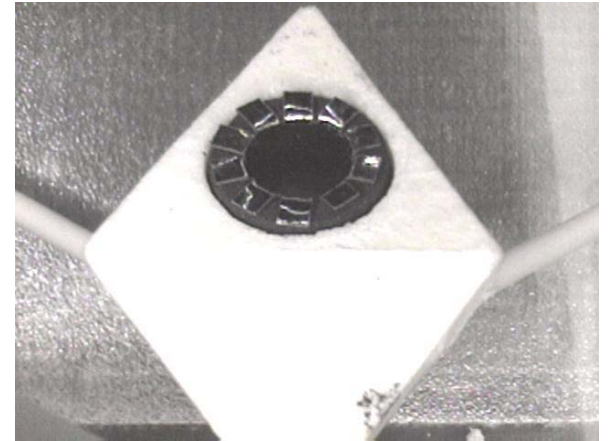
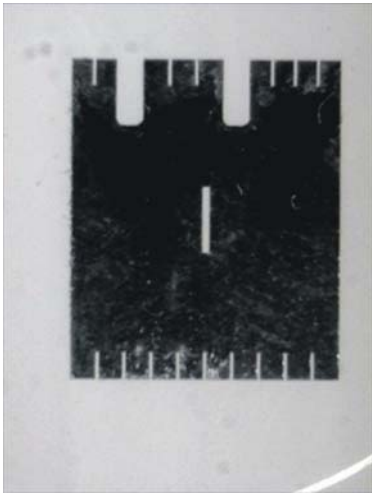
(Sample arrangement for equation of state comparison)



**Octahedral multi-anvil cell  
with x-ray access.**

Miniature rhenium furnaces for high-pressure experiments, with x-ray access. Design #6D





# *In-situ* assemblies

- Forsterite ( $\text{Mg}_2\text{SiO}_4$ ) sleeve replacing zirconia – below 14 GPa.
- $\text{LaCrO}_3$  and Re with windows – from 14 GPa to 22 GPa, up to 2000 degrees C.

The screenshot displays the Crystal Cracker software interface. At the top, the title bar reads "Crystal Cracker:T0696.001". The menu bar includes "File", "Translations", "Lattice", "Crystal System", "Plot", "Utilities", "Space Group Input", and "Help".

The main window features a large plot area showing a diffraction pattern with multiple colored peaks (yellow, red, blue, green, black). The x-axis is labeled with "0" and "3999". The y-axis is labeled with "0" and "1780". A "Mouse" control panel on the left includes buttons for "Point", "Hand", "Peak drag", "Volume", "Cell Edge", and "Full Strain".

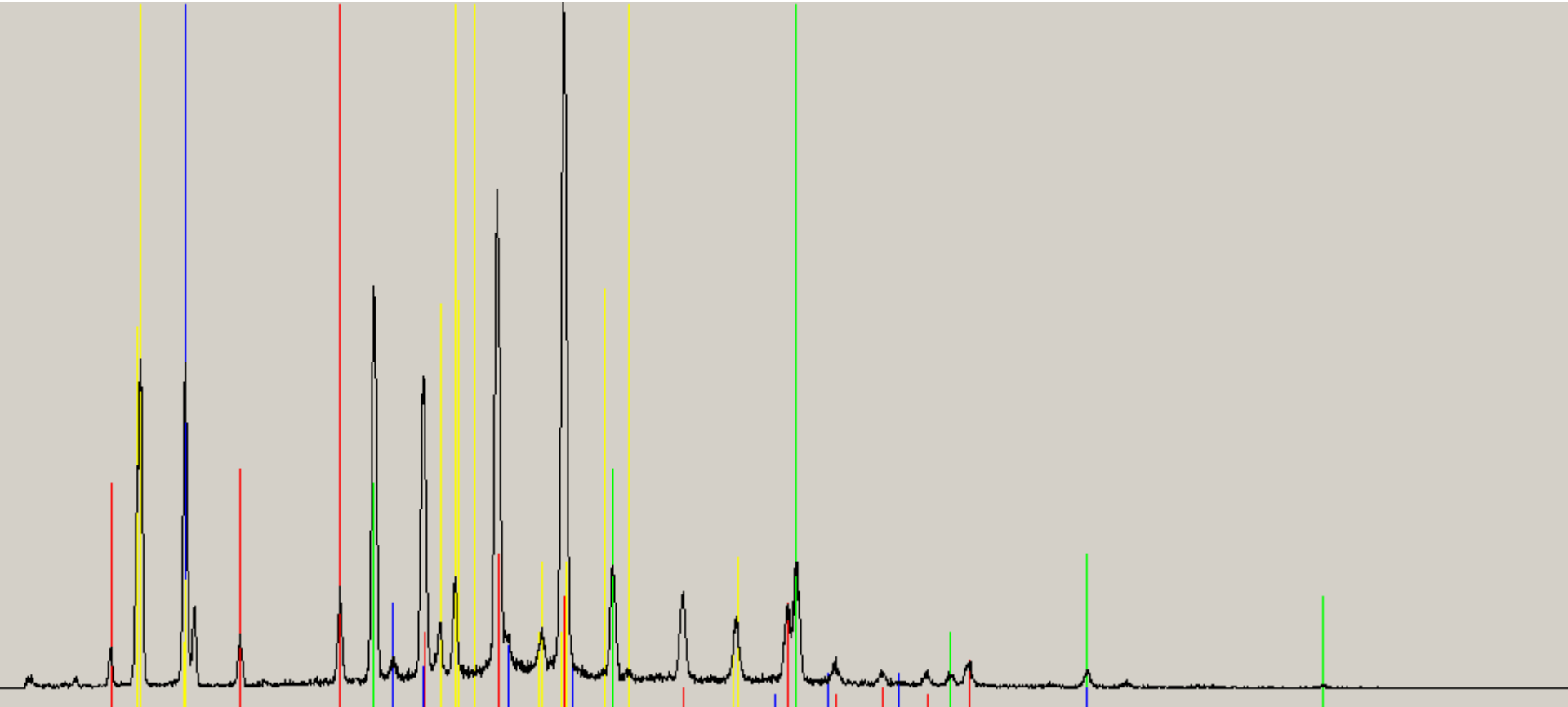
Below the plot area, there are several control panels:

- Show diffraction from:** Includes checkboxes for "Lines" (a, b, c), "Planes" (b-c, a-c, a-b), and "Everything" (a-b-c). A "Clear" button is also present.
- Axis Restrictions:** Includes radio buttons for "a = b = c; alpha = beta = gamma", "a = b", and "none".
- Reflection conditions:** A table with columns for hkl, Okl, hOl, hk0, and Clear. The rows show conditions like h00, 0k0, 00l, hh0, h-hl, hhl, hhh, and h,k,l permutat.
- Unit Cell Parameters:** Includes "Edge Lengths" (a, b, c) and "Angles" (alpha, beta, gamma) input fields. The current values are a = 2.76, b = 2.76, c = 4.4574, alpha = 90, beta = 90, gamma = 120.

At the bottom right, there is a "Save plot to a bitmap file" button and an "Undo" button.

Analysis was by homewritten program "Crystal Cracker."

# CsCl + W



Red: CsCl

Green: W

Blue: BN

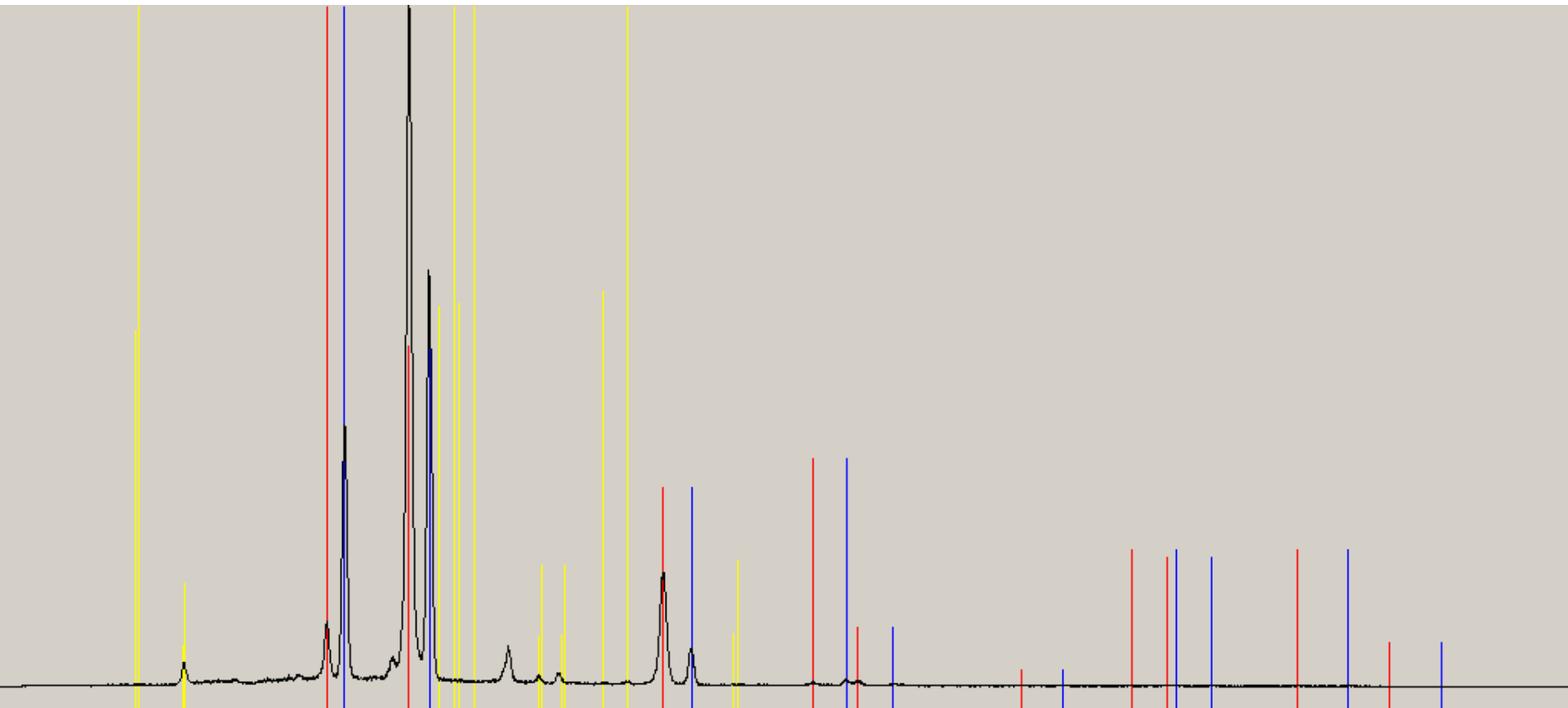
Yellow: Fluorescence

The program can move the lines with P and T (fluorescences do not move).

The pattern can be automatically fitted and P calculated from the equation of state of any standard.



# MgO + Au

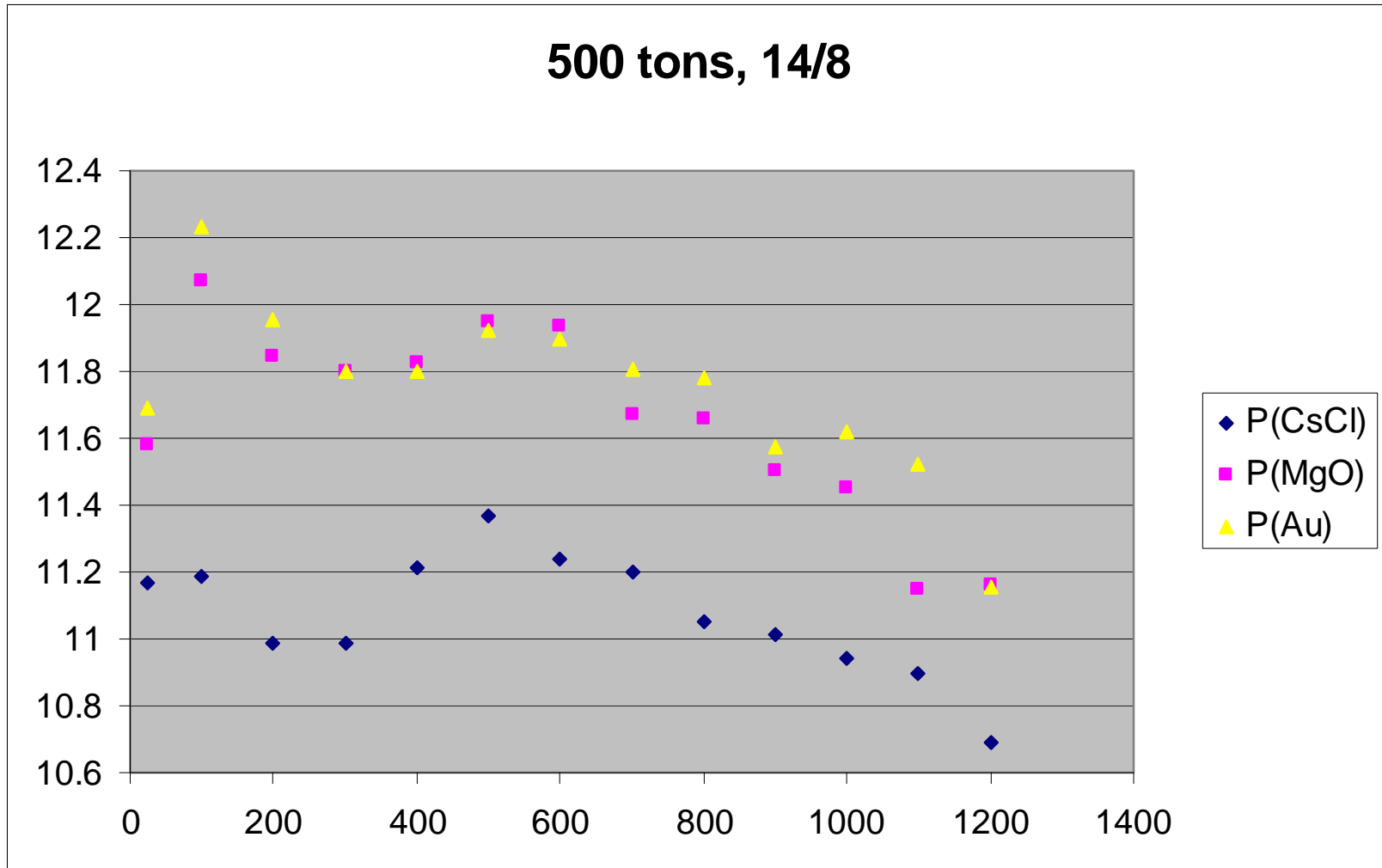


Red: MgO

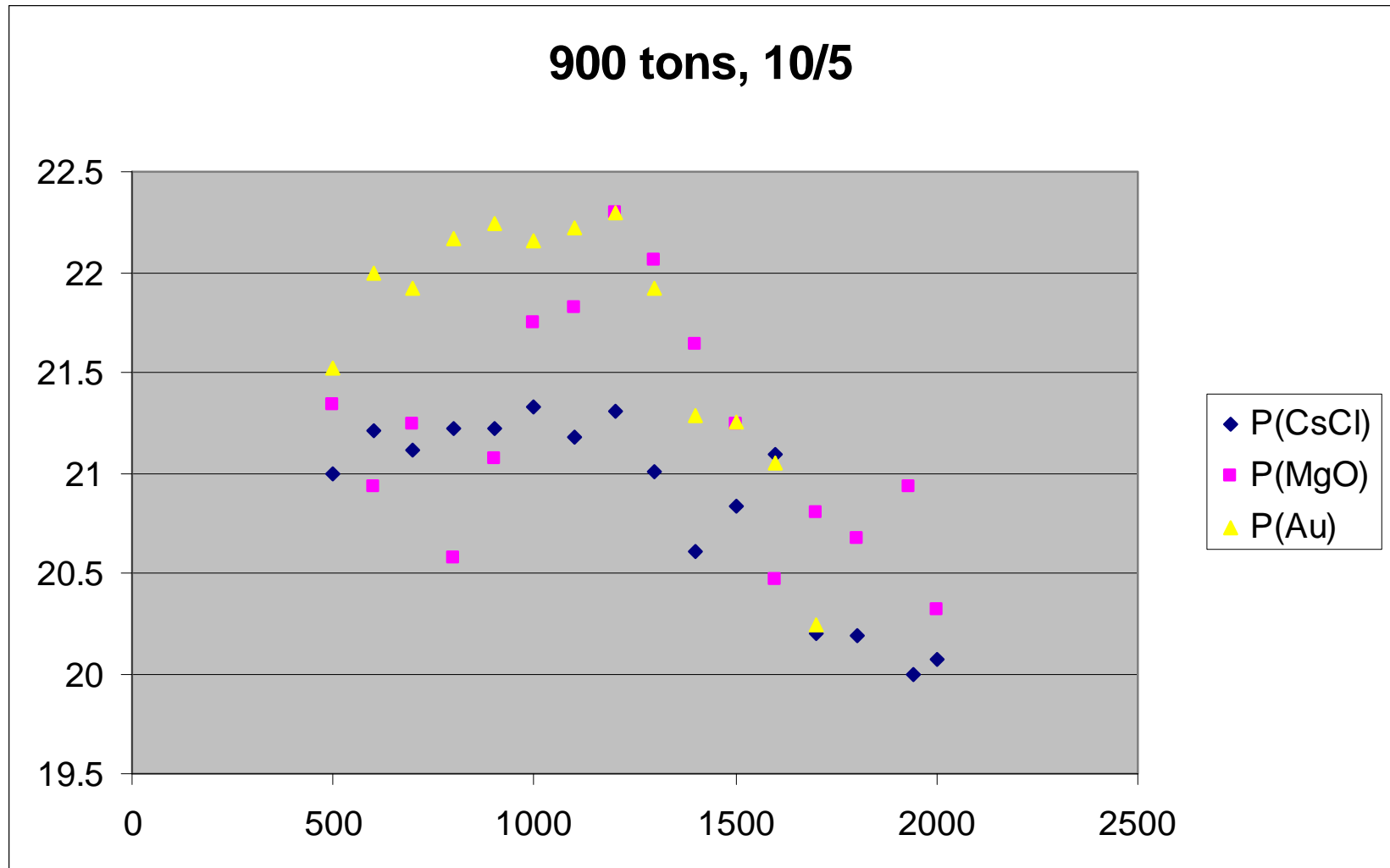
Blue: Au

Yellow: Fluorescence

# Results – comparison of CsCl to MgO and Au.



# Results – comparison of CsCl to MgO and Au (cont.)



# Summary

- CsCl is a good, sensitive pressure standard for high-resolution pressure measurements.
- The old Decker equation for CsCl is systematically lower than new MgO and Au equations of state by 1 GPa at moderate temperatures, ~0.5 GPa at higher temperatures (in the 10 – 20 GPa range).