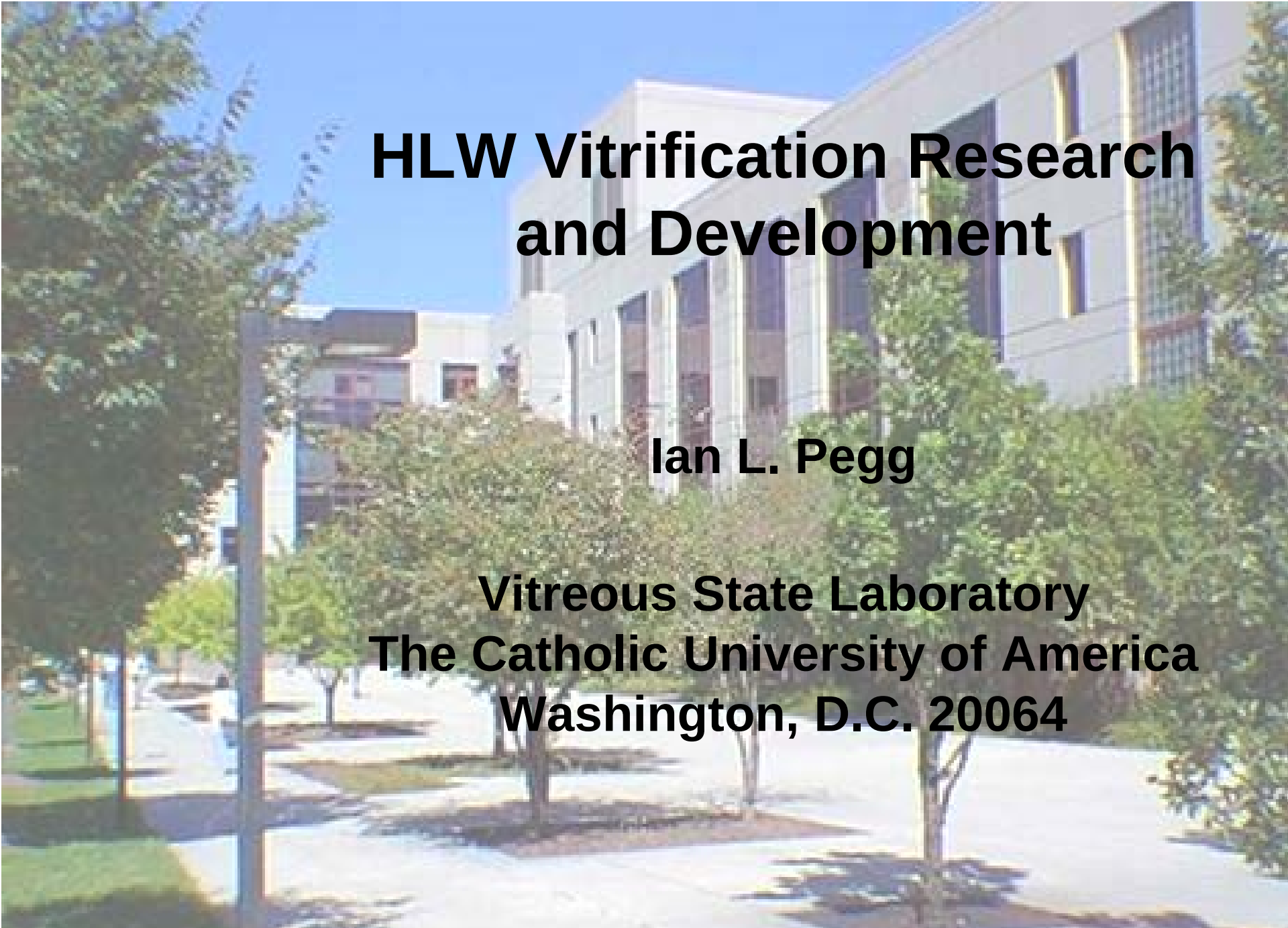

HLW Vitrification Research and Development

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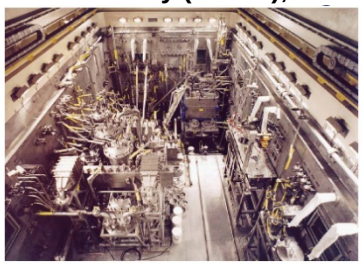
Vitreous State Laboratory

- Established in 1968; currently 80 staff
- Extensive chemical, physical, and materials characterization and pilot-scale testing facilities
- NQA-1 and DOE/RW-0333P QA Program

West Valley (WVDP), NY



SRS – M Area

Sellafield, UK

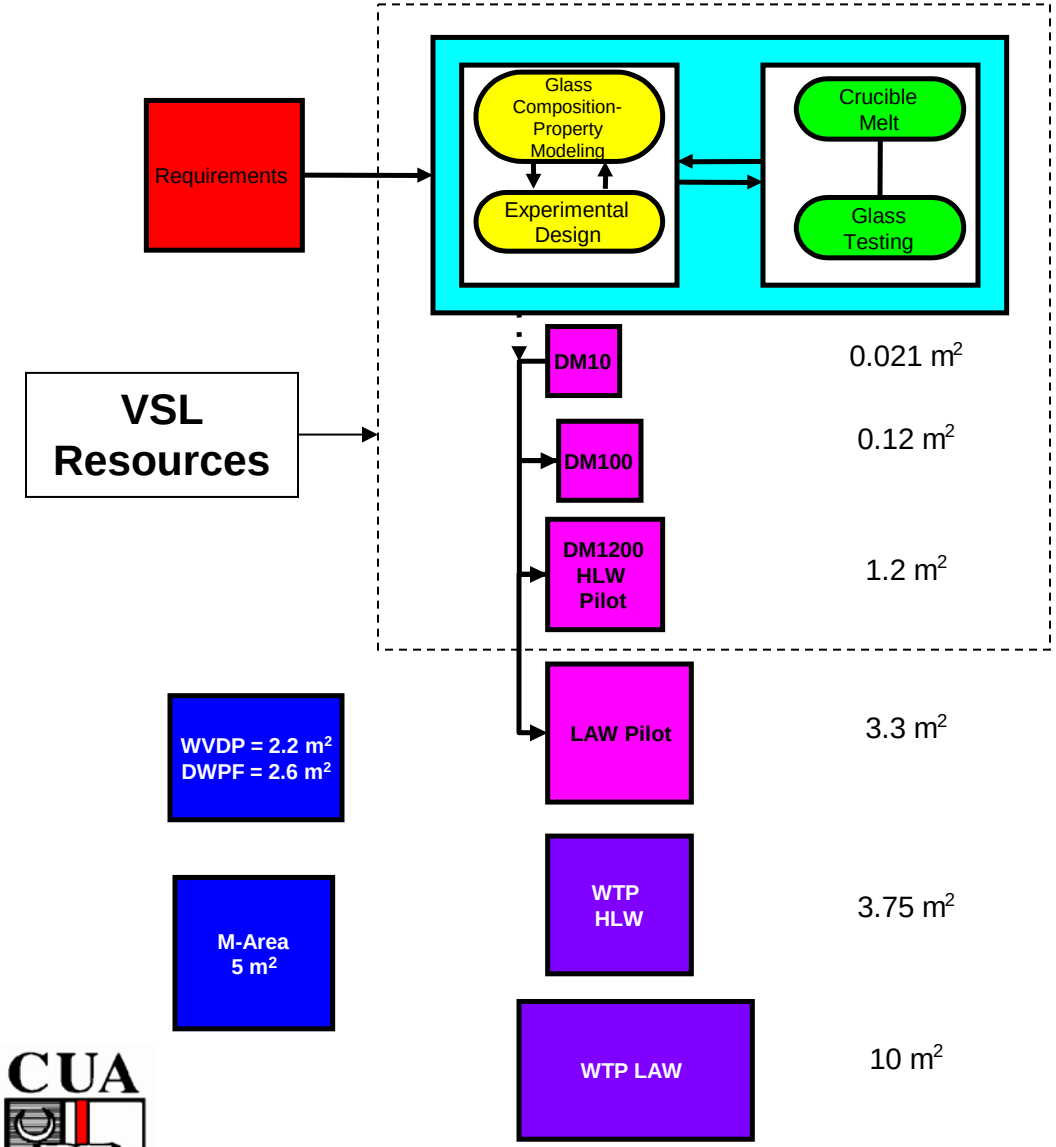
Savannah River DWPF

Rokkasho, Japan

- Developed the glass formulations used at WVDP and SRS M-Area
- Support to WTP since 1996
  - Baseline and enhanced HLW and LAW formulations & melter testing
- Support to Rokkasho since 2005
- Support to DWPF since 2009

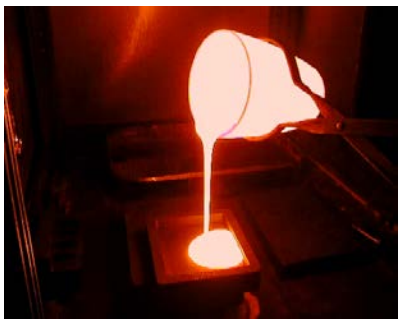
CUA

Vitrification Development and Scale-Up



- Computer-based formulation design and crucible melts to optimize glass properties
  - Product quality, processability, economics
- Dynamic testing in scale melters
- VSL melter systems include:
  - *The largest array of JHCM test systems in the US*
  - *The largest JHCM test platform in the US*
    - Two DM10s (0.02 m^2)
    - Two DM100s (0.11 m^2) + one spare
    - DM1200 (Hanford HLW Pilot, 1.2 m^2; ~50% DWPF scale)
  - Factor of 60X scale up
  - JHCM testing since 1985
  - Prototypical WTP pilot-scale off-gas systems

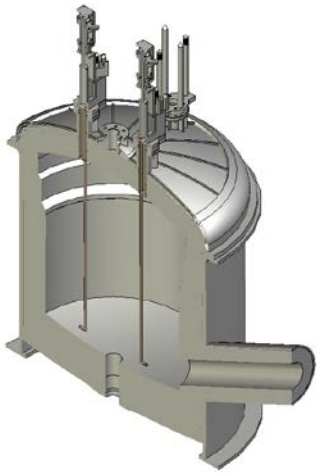
Integration of glass formulation with melter engineering is crucial

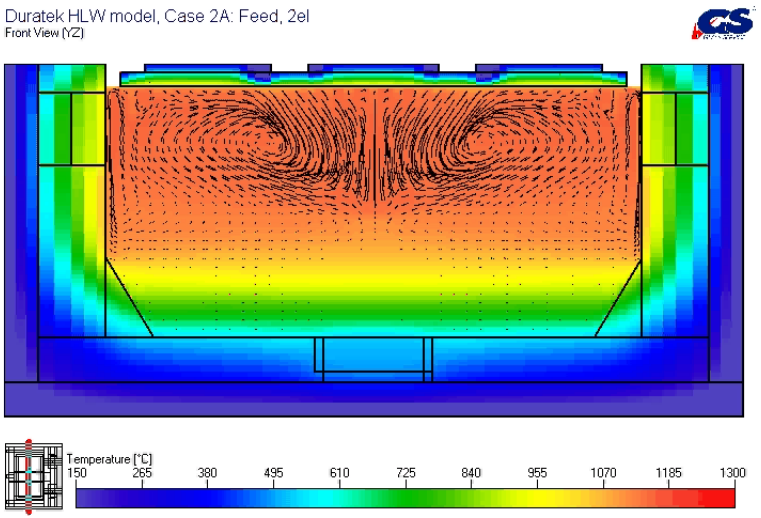


CUA

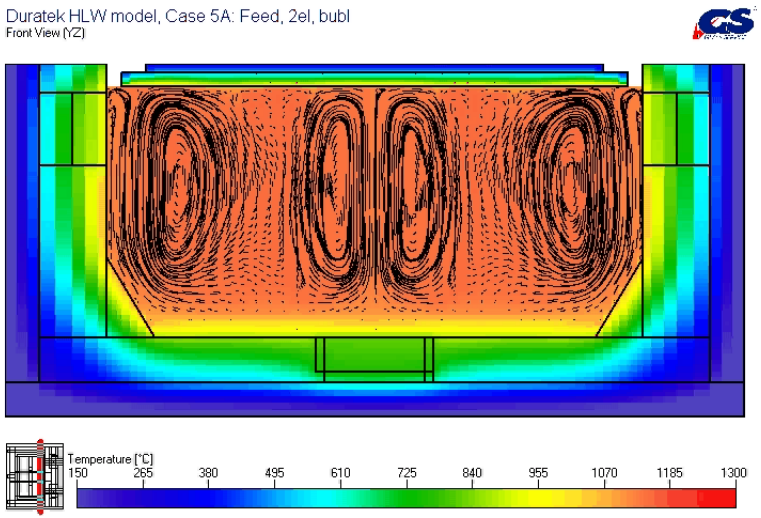
Melt Rate Enhancement

- Conventional JHCMs rely on natural convection in a viscous melt
- Melt rate is limited by heat and mass transport at the cold cap
- VSL developed active melt pool mixing using bubbler arrays
- Provides drastic increases in melt rates – Up to 5X
  - Incorporated into WTP HLW and LAW melters
  - Successfully retro-fitted into DWPF
- Higher waste loadings
  - Reduces temperature gradients
  - Suspends crystals (spinels, noble metals)



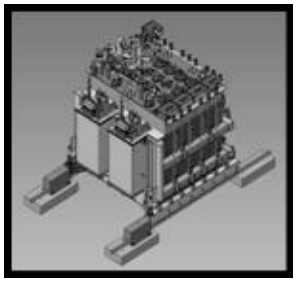


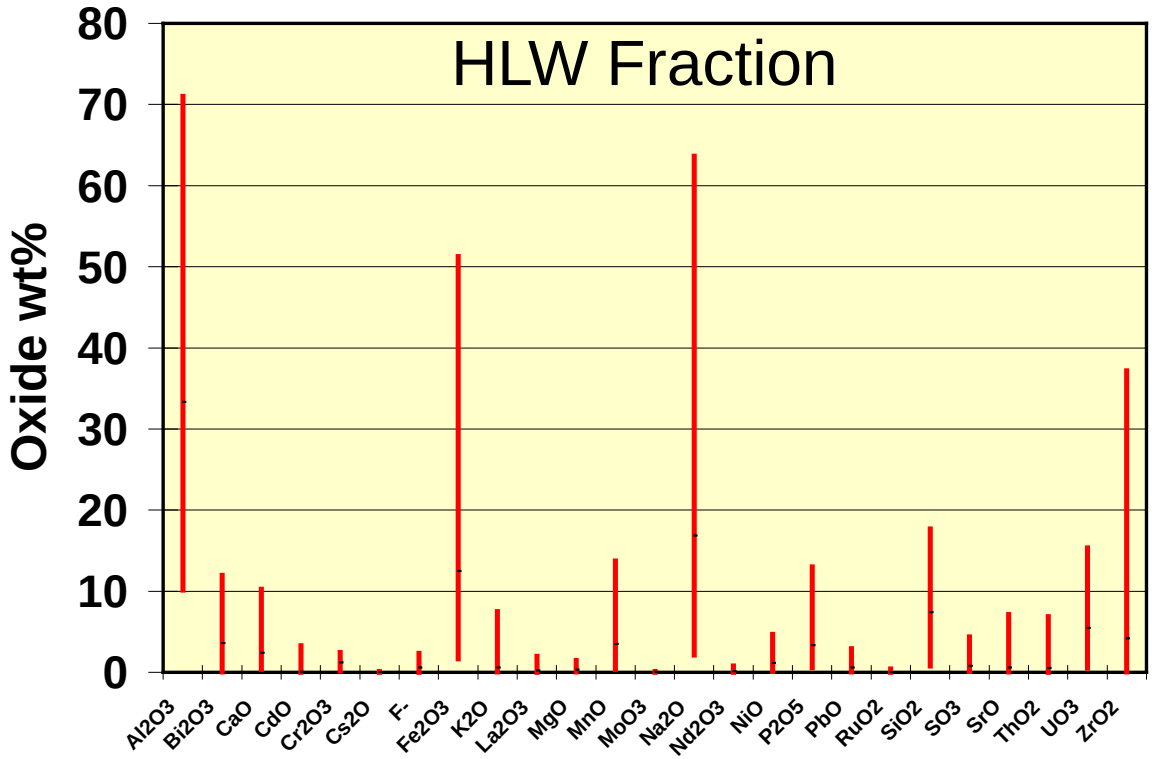
Unagitated JHCM
(West Valley, Original DWPF)



Agitated JHCM
(M-Area, WTP LAW, WTP HLW)

Hanford Tank Waste: Scale and Compositional Complexity





- WTP HLW – 2 melters, 7.5 MTG/d
  - This would require about 13 hot wall induction melter lines or about 6 cold crucible melter lines
- WTP LAW – 2 melters, 30 MTG/d
  - This would require about 50 hot wall induction melter lines or about 23 cold crucible melter lines
  - SLAW is estimated at ~3X LAW in System Plan 6

MTG/d = Metric tons of glass per day

Session Discussion Questions

- Recent significant vitrification accomplishments
  - Retrofit of bubblers into DWPF
  - Installation of cold crucible melter at La Hague
  - HLW vitrification completion at VEK
  - Hot commissioning of Rokkasho
  - Formulations with increased loading and melt rate for WTP
    - Streams limited by Al, Fe, Bi, P, Cr, S, Na, Zr, etc.
- Near future
  - US HLW compositional complexity implies great potential for further improvements through continued glass formulation development
  - Continued improvements in modeling glass property-composition relationships
  - Further upside through incremental advances in established technologies
  - “Software” vs. “Hardware” – Enhancements through changes in flow-sheet chemistry can be essentially transparent to the engineered facility