GEOTHERMAL WELL INSPECTION CAMERA

PermaWorks, SBIR Phase II, Yr 1 (Randy Normann, CTO; David Glowka, PI)

Existing downhole camera technology requires the geothermal well to be cooled. Cooling a geothermal well is every expensive and significantly ages the well's steel casing bond to the formation by changes in thermal expansion. Consequently, geothermal well owners rarely image inside their wells because no cameras exist for well temperatures greater than 200°C.

Project Objective

Develop a 250°C wellbore camera that...

1. Requires no well cooling, allowing inspection of active production and injection wells
2. Uses conventional, single conductor, 600°F wireline up to 12,000 ft long to greatly reduce deployment cost and triple the depth capability of existing cameras
3. Provides imagining of either the wellbore wall or downhole

Technical Challenges

1. No video chip is rated for temperatures over 125°C.
2. Imaging rock fractures requires high-definition images.
3. Most logging tools will not work on 12,000 ft of 600°F wireline.

Solution – Video chips and flash memory are very small, so actively cool them. Use flash memory to store HD images and transmit lower resolution. Operate other electronics at geothermal temperatures using RelChip's 32-bit 300°C microprocessor and PermaWorks' existing electronics.

In short, we are developing a camera with a hot side and a cold side, using CO_2 cooling.

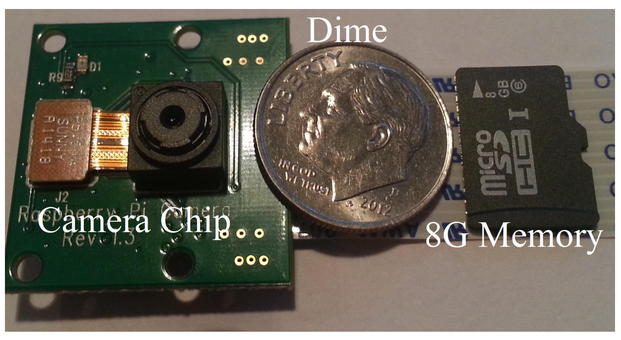

Figure 1. Video Chip & Memory

Thermal modeling and lab tests say we can keep it cool…

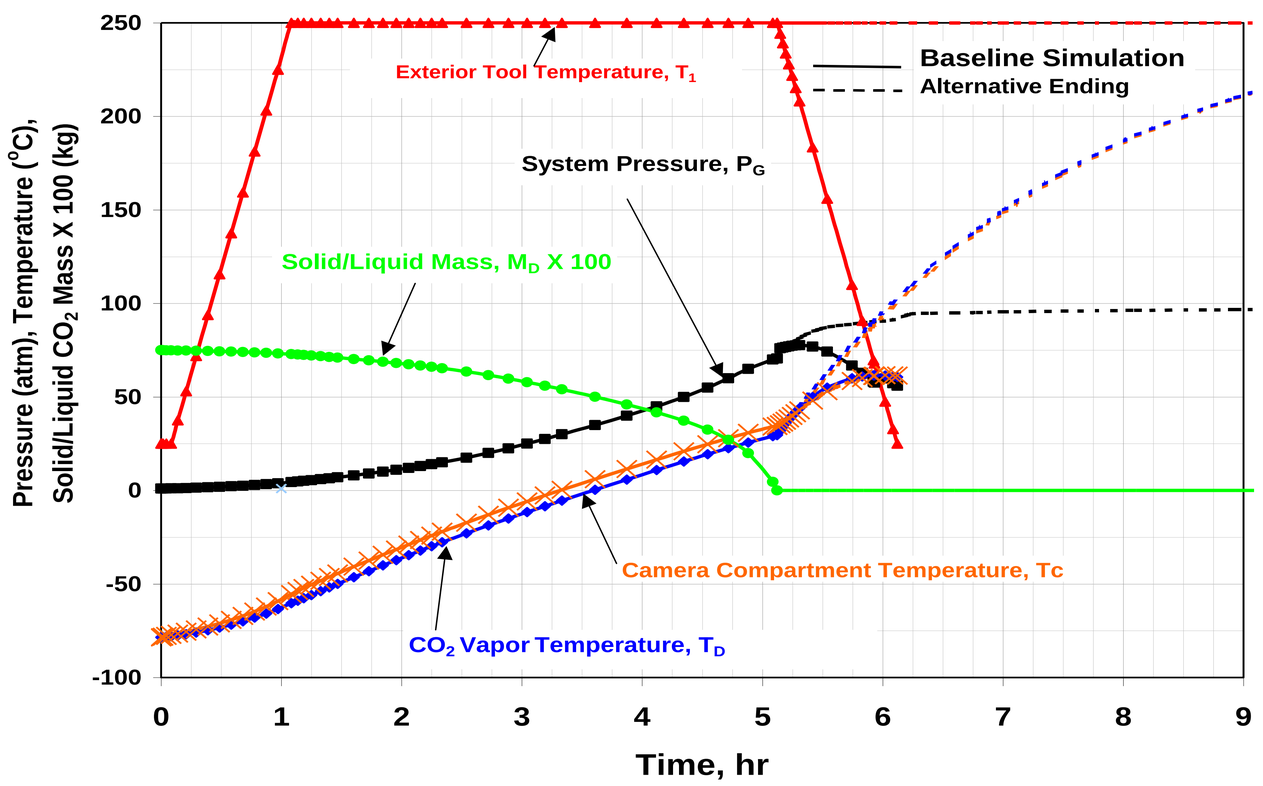

Figure 2. Thermal Modeling for Camera using CO_2 Cooling

To image the wellbore wall, we use a removable, conical mirror…

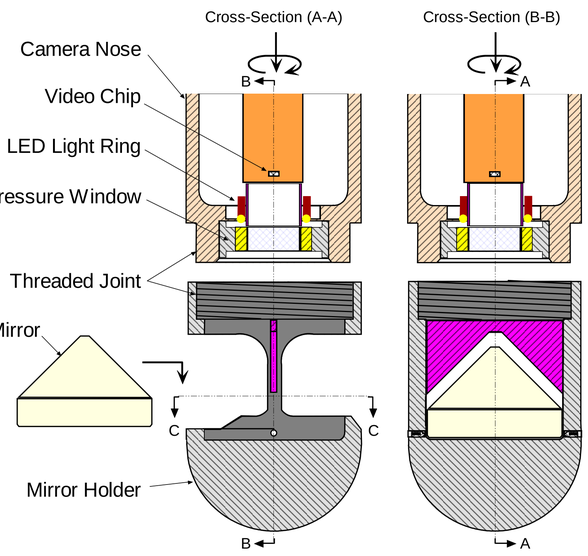

Figure 3. Conical Mirror

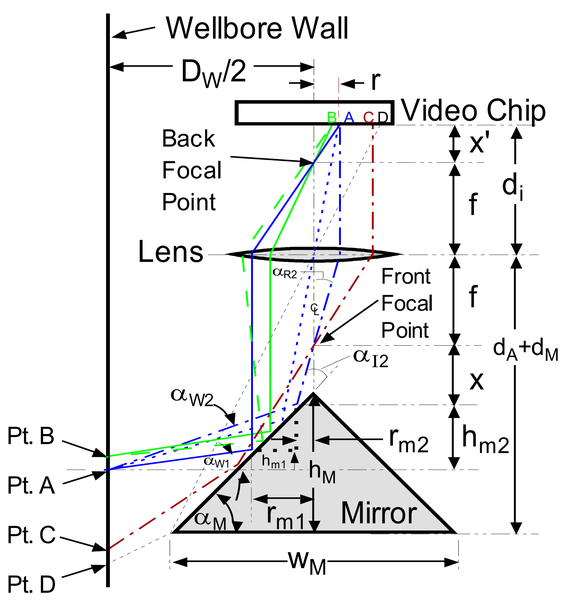

Figure 4. Conical Mirror Optics

Figure 5. Example of a deconvoluted conical-mirror image

Optical modeling and deconvolution algorithms promise high-resolution wellbore images...

High-temp ovens are used to test and validate the camera lights...

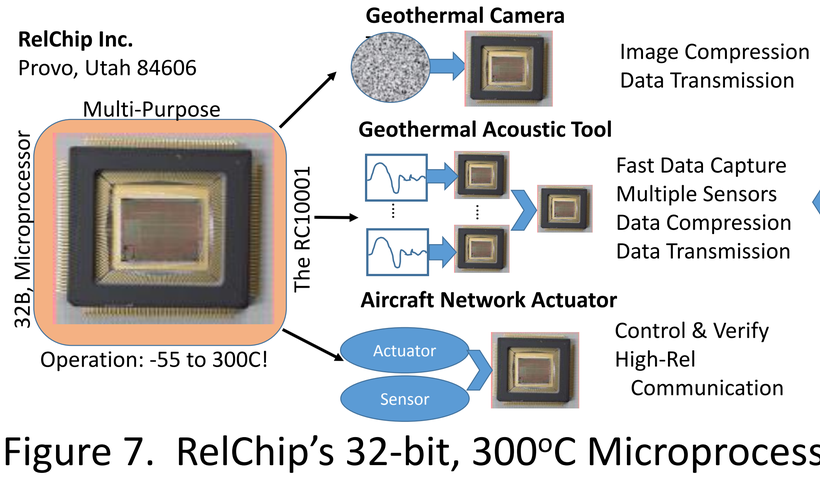

Figure 7. RelChip's 32-bit, 300°C Microprocessor

Developing a 300°C microprocessor for downhole processing...

Figure 6, 250°C Oven Lighting Test: (Left) SiC LEDs, 0.02A:3V; (Right) Oven Bulb 1A@7V

Conclusion – Our first-generation tool will be completed in Year 1. Year 2 plans are to field test and develop design improvements for a second-generation tool.