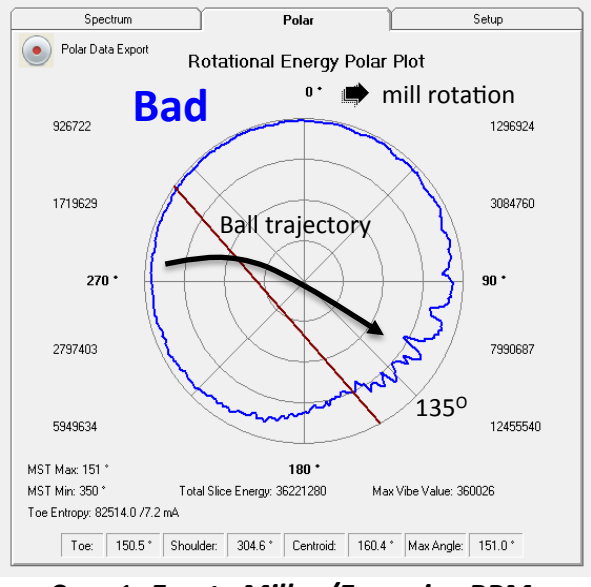
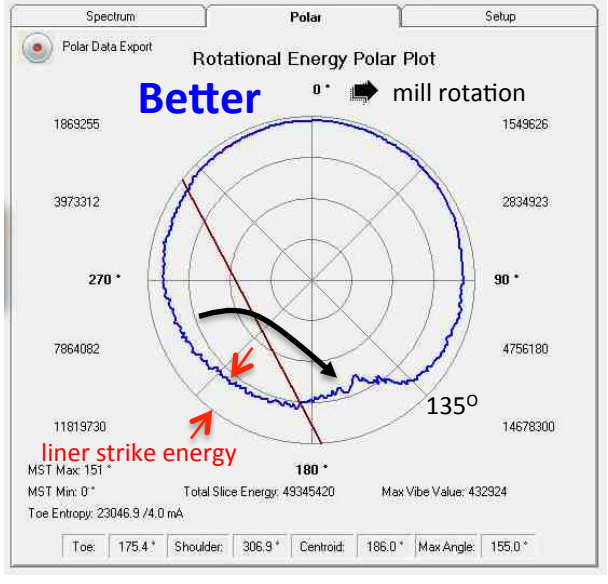
MineralScan MillSlicer Polar Plot Analysis – Shell Based Vibration Sensor



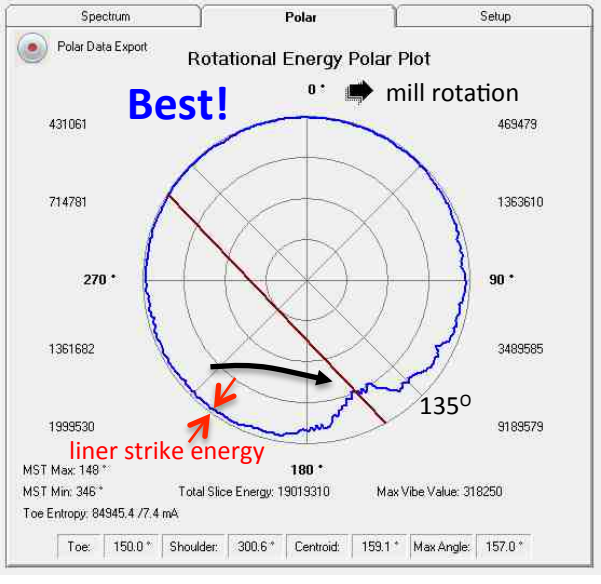
Case 1. ***Empty Mill w/Excessive RPMs***

- Mill is rotating in a clockwise direction
- Sensor on shell measures vibration energy in the full rotation and energy is plotted increasing toward the center of the plot
- ***RPMs are too high*** so balls ***strike high*** on the opposite side of the liner causing sharp energy peaks from 90 – 135 degrees.
- ***Extreme excessive wear/damage to the liners***



Case 2. ***Empty Mill w/Good RPMs***

- Snap shot taken on a mill being ground out at low speed (85% speed)
- No sharp peaks from 90 – 135 degrees which is good
- Liner strike energy from 135 – 270 degrees is high but there is nothing we can do about this, it is a result of the mill being empty
- ***Grind-outs should be always done at low speeds (80-85%) by cutting the feed***



Case 3. ***Full Mill & Cascade Grinding***

- When the mill begins to fill to levels above 50% on the shell sensor fill level trend, we see a ***focusing of the grinding energy*** in the region from 135 – 180 degrees
- Optimal cascade grinding is occurring and we are operating the SAG mill per it's intended design
- Ball to liner strike energy significantly reduces to very low levels. i.e. compare the liner strike energy between Cases 2 and 3 from 180 – 270 degrees
- ***Optimal grinding & minimal liner damage!***

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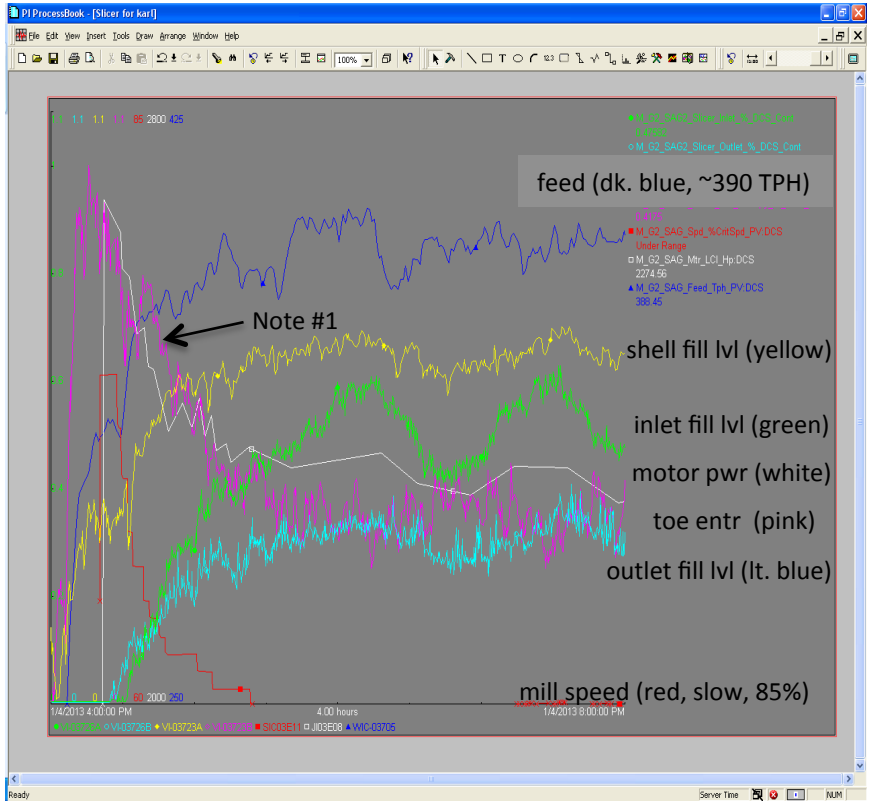
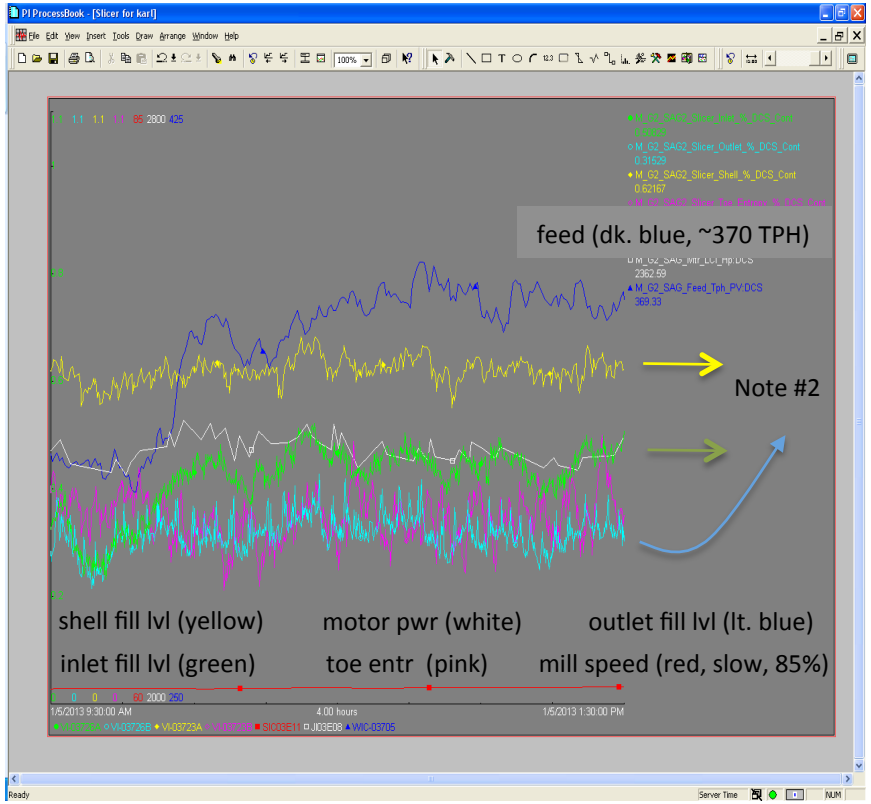
MineralScan MillSlicer Trend Summary – Inlet, Outlet, Shell Vibration Sensors



Case 1. ***Mill Start-up from Grind-out w/Reduced Speed***

- This trend was taken from the SAG upon start up where the feed was brought up first and then the speed was decreased to retain material.
- When all three fill level signals track one another, the material entering the mill = the material leaving the mill. ***This is good stable operation!***
- Note #1: Toe Entropy (pink) is a measure of how hard the balls are striking the mill shell. 100% = Very bad liner damage, 0% = minimal liner damage. ***This signal should be kept under 50% if possible.***



Case 2. ***Stable Operation w/Reduced Speed***

- Like the trend on the left, ***the goal is to flatten all three fill level signals*** (inlet, shell, outlet). When all three sensor signals are flat, we can begin to further fill the mill by either increasing feed or reducing mill speed. This should then result in ***all three signals stepping up together in a uniform manner which is the desired method to slowly step fill the mill. The shell sensor polar plot should also be used to indicate a full mill.***
- Note #2: Due to temperature limitations, the SAG mill could not be run at its maximum intended feed rate (590+ TPH) and filled to high fill levels. However if there were no limitations and the mill were to overfill, we can immediately detect this ***by observing that the outlet signal (lt. blue) takes off upward in comparison to the other fill levels. The output signal should therefore be used to detect blockages.***

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