

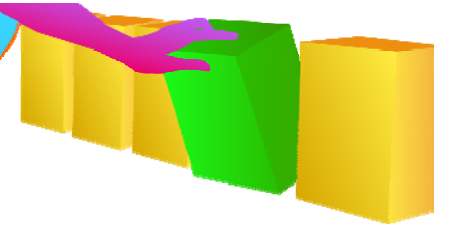
Wine Cask Shelf Life After Opening Package, Long- and Short-Term

Gail S. Becke

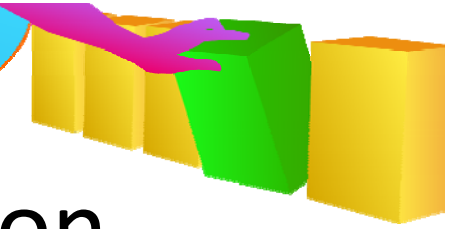
Advanced Film Development Manager

Scholle Packaging

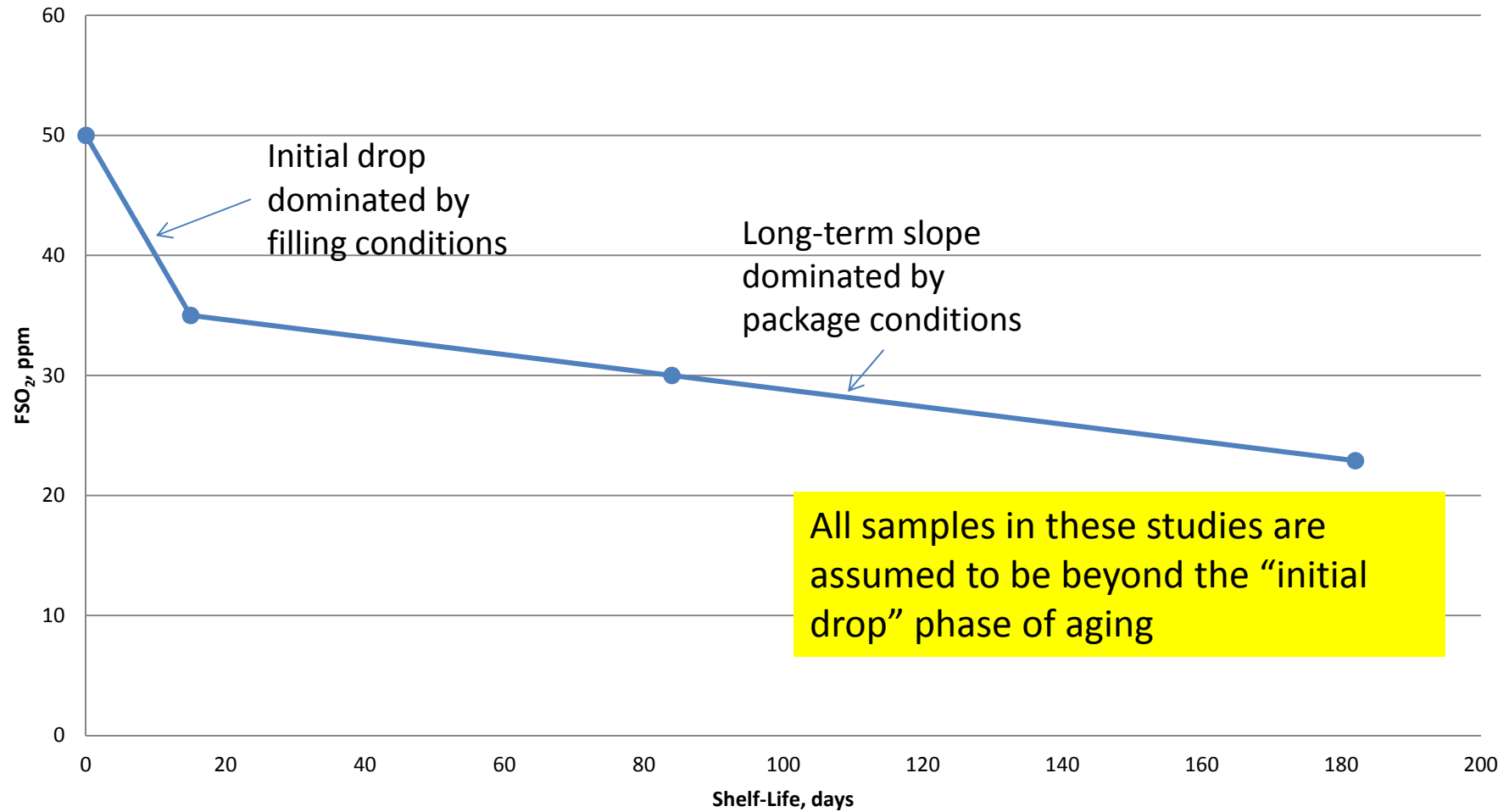
October 24, 2012

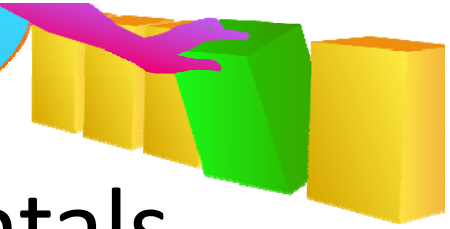


THEORY

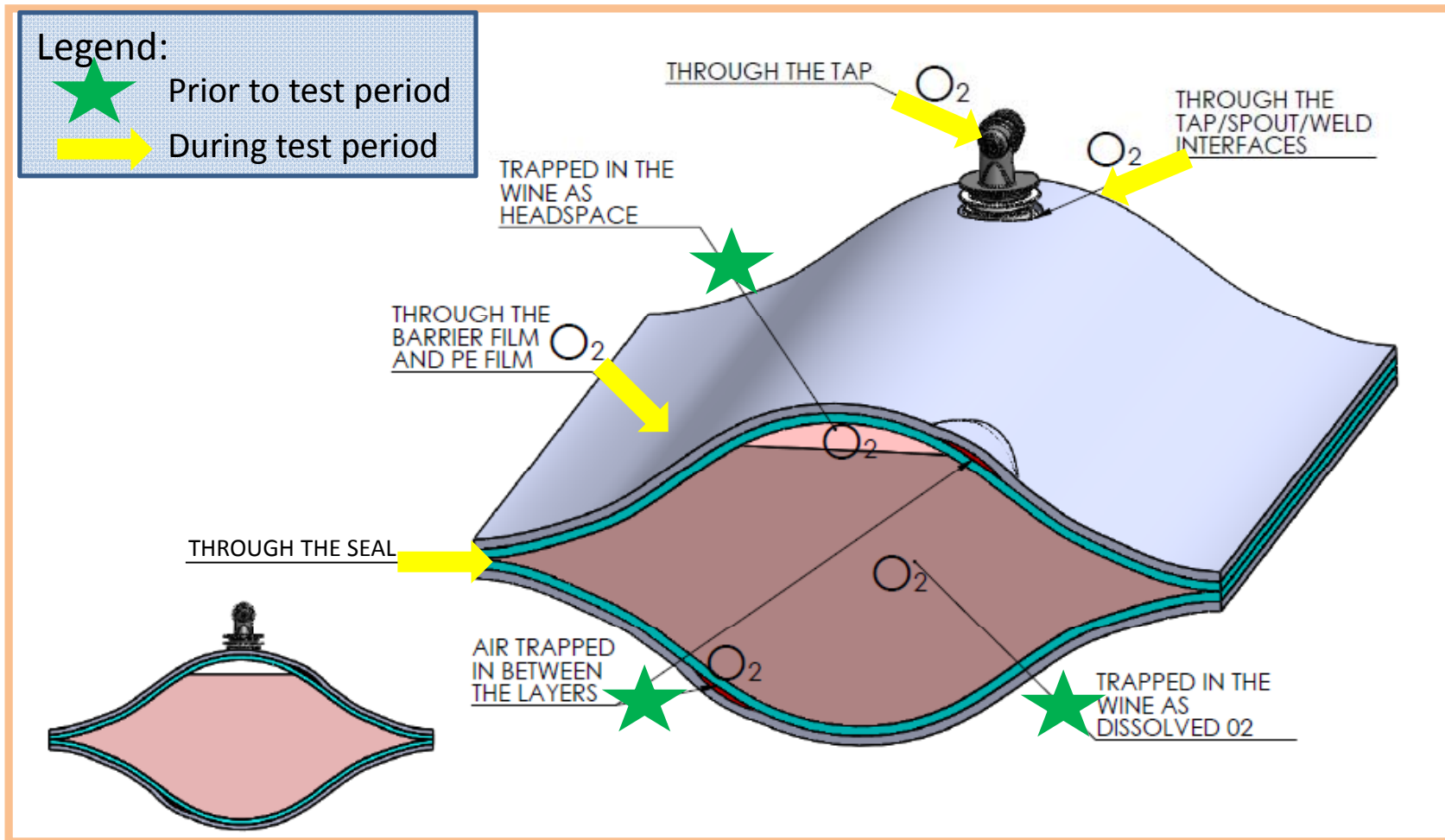


Theory of FSO₂ Consumption





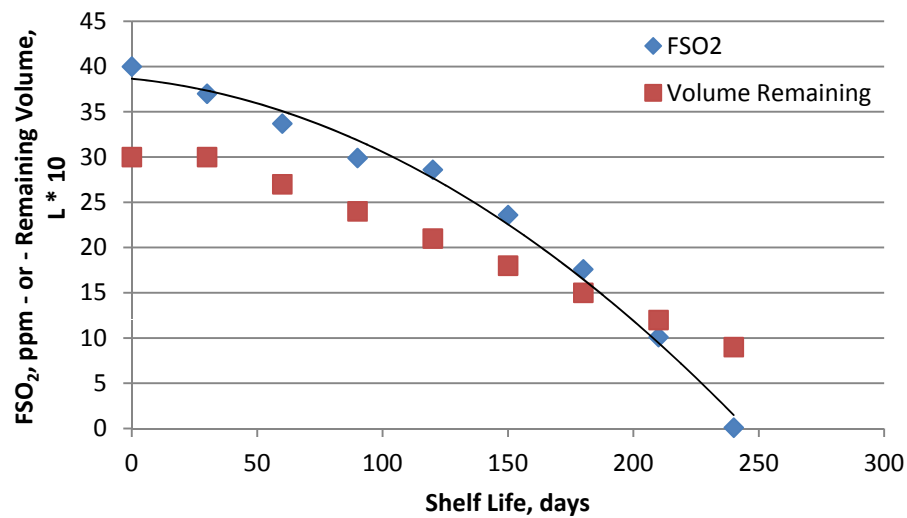
Analysis Protocol Fundamentals





FSO₂ Consumption Accelerates With Declining Bag Volume

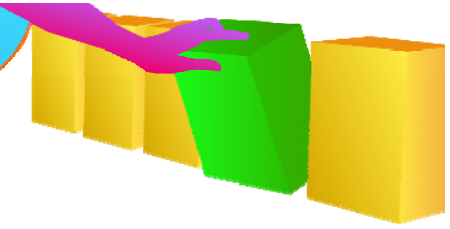
- Oxygen ingress through the bag is constant during test period
- As wine volume declines, the amount of FSO₂ consumed (in ppm) increases



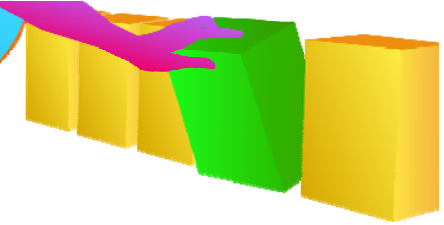
Wine Volume, L	Time, days	Oxygen ingress, mg	FSO ₂ usage, mg	FSO ₂ usage, ppm (mg/L)	FSO ₂ Level, ppm
3.0	0				40.0
3.0	30	4.5	9	3.0	37.0
2.7	60	4.5	9	3.3	33.7
2.4	90	4.5	9	3.8	32.9
2.1	120	4.5	9	4.3	28.6
1.8	150	4.5	9	5.0	23.6
1.5	180	4.5	9	6.0	17.6
1.2	210	4.5	9	7.5	10.1
0.9	240	4.5	9	10.0	0.1

Note: Based on stoichiometry, 2 to 4 mg FSO₂ are required to consume each mg of O₂ entering the bag

- Depends on wine type and chemistry
- Used 2 mg FSO₂ for this example

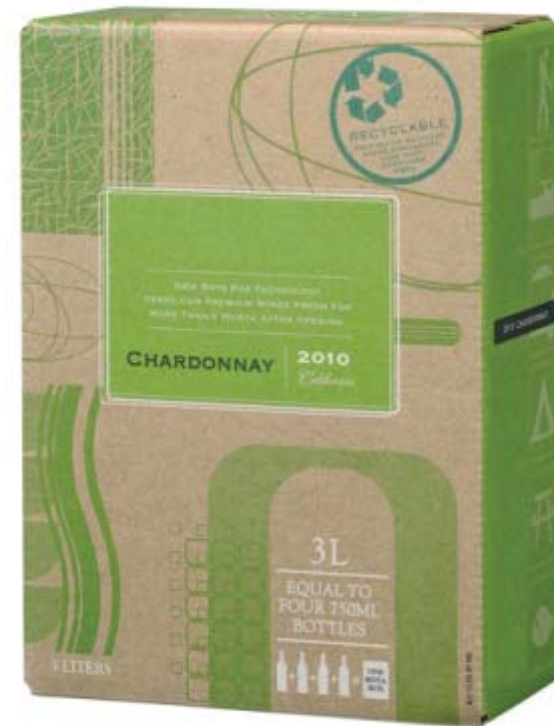


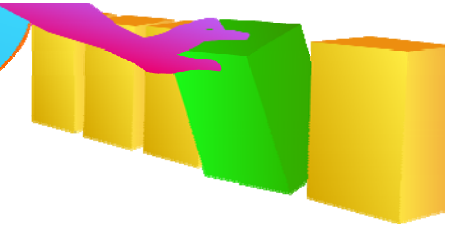
INTRODUCTION



Cask Shelf Life Test

- Two tests: Long and Short term
 - Long term study emptied casks in 6 to 12 months
 - Short term study emptied casks in 10 weeks
- Both long- and short-term tests used both red and white wines
 - Cabernet Sauvignon in both tests
 - Chardonnay in both tests
 - Pinot Grigio in one short term test
- All testing was performed with the same commercially available cask:
 - 3L
 - 12.625" x 10.5" 2-ply bag of EVOH coex/BON/PE laminate and PE films
 - Commercial spout and tap

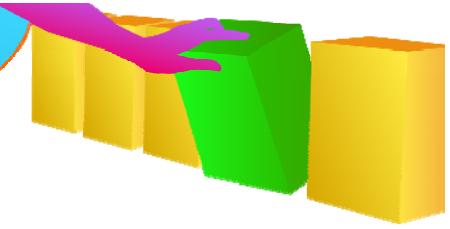




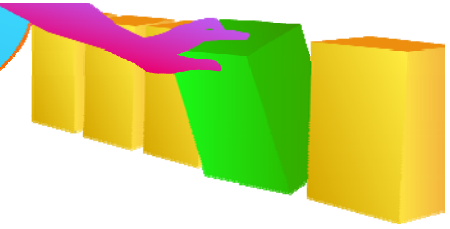
Test Method

- Each sample was tested by mechanical titration
 - Using Hanna Instruments, HI84100 miniTitrator
 - This device is marketed to the wine industry





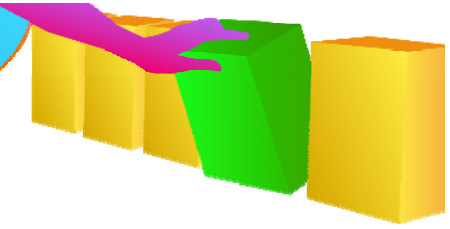
LONG TERM STUDY



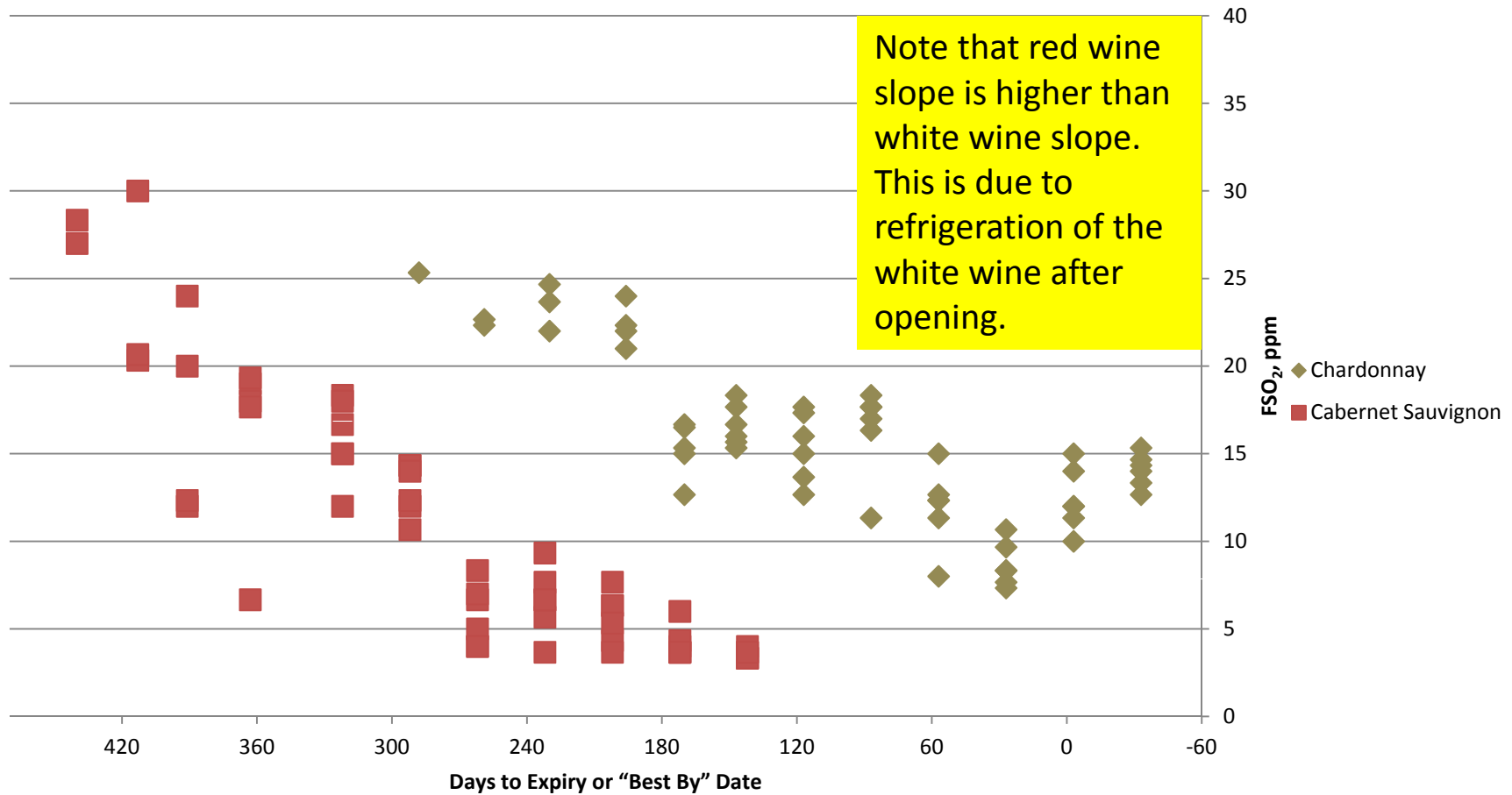
Wines Used in Long Term Study

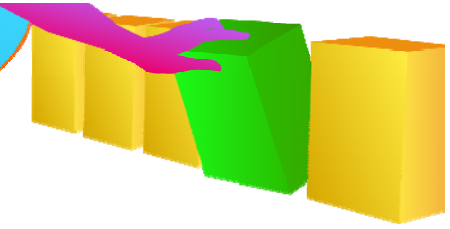
Test	Wine Variety	"Best By" Date	Number of Boxes
Long Term	Cabernet Sauvignon	Nov-12	6
Long Term	Chardonnay	Mar-12	6

- Boxes were opened in a “staged” manner
 - Box 1 was open on the first day of the test, Box 2 was opened one month later, ... , Box 6 was opened 5 months after the first box
 - Cabernet Sauvignon opening dates ranged from 475 to 325 days to expiry
 - Chardonnay opening dates ranged from 288 to 147 days to expiry
- Rate of Consumption was 300 mL/month
- Time to expiry was calculated using the time between the test date and the “best by” date printed on the box



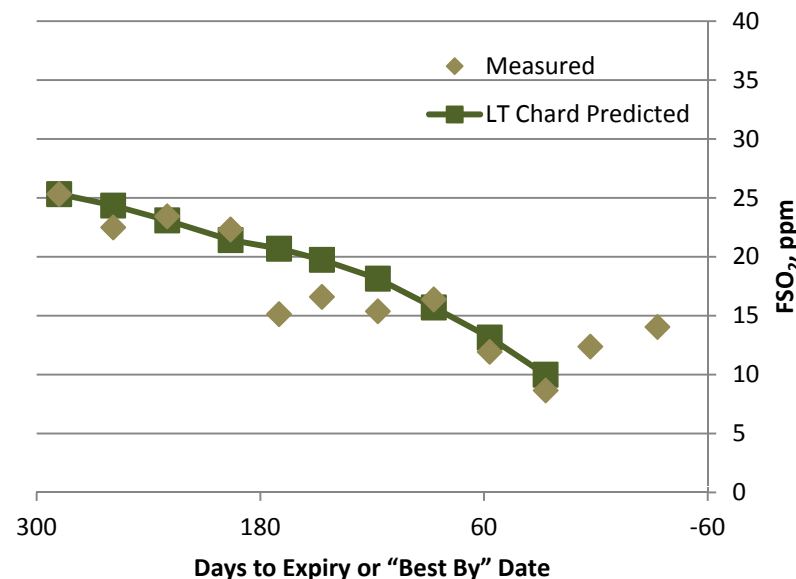
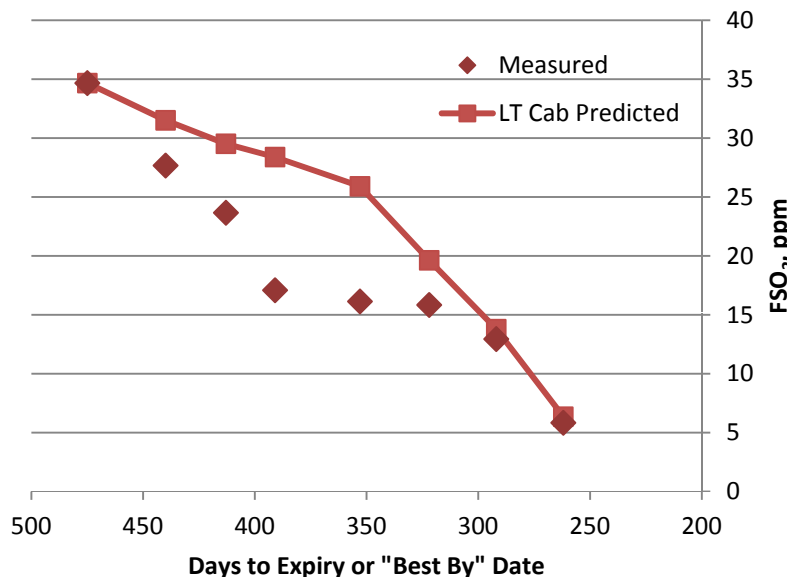
Long Term FSO₂ Raw Data



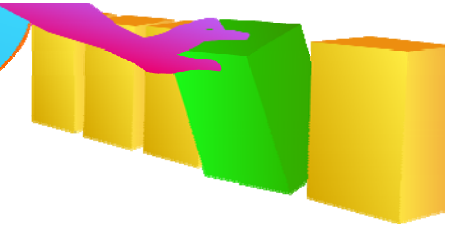


Long Term Study Observations

- Decline in FSO_2 can be explained by chemical reaction with oxygen that has entered the bag, in combination with the reduction in volume in the bag over time:

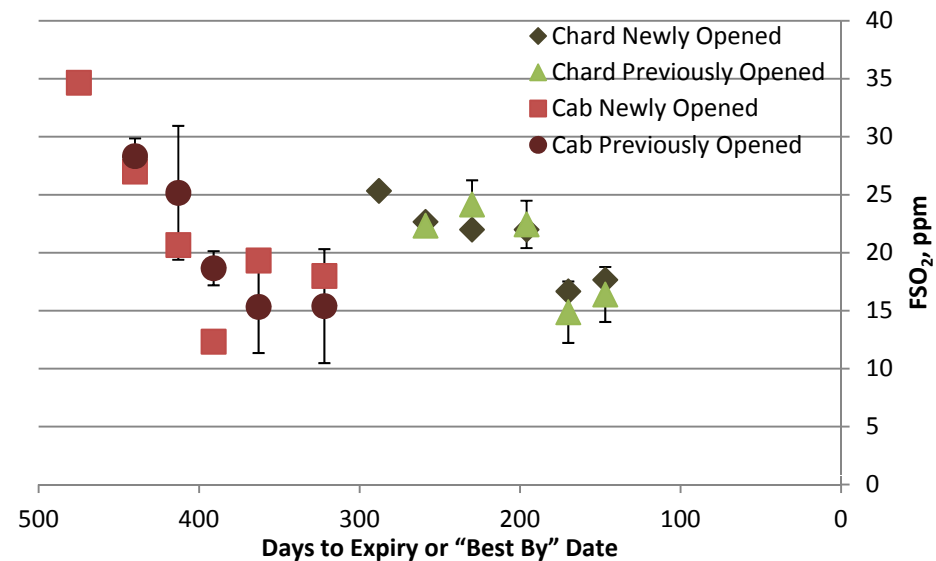


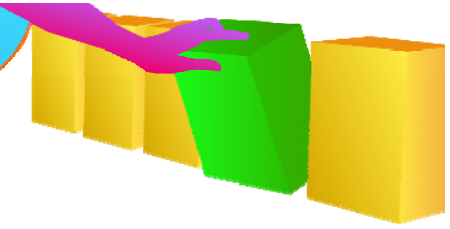
- Data fits theoretical prediction reasonably well with r^2 values at about 0.73
 - Until point where <10 ppm FSO_2 remains



Long Term Study Observations

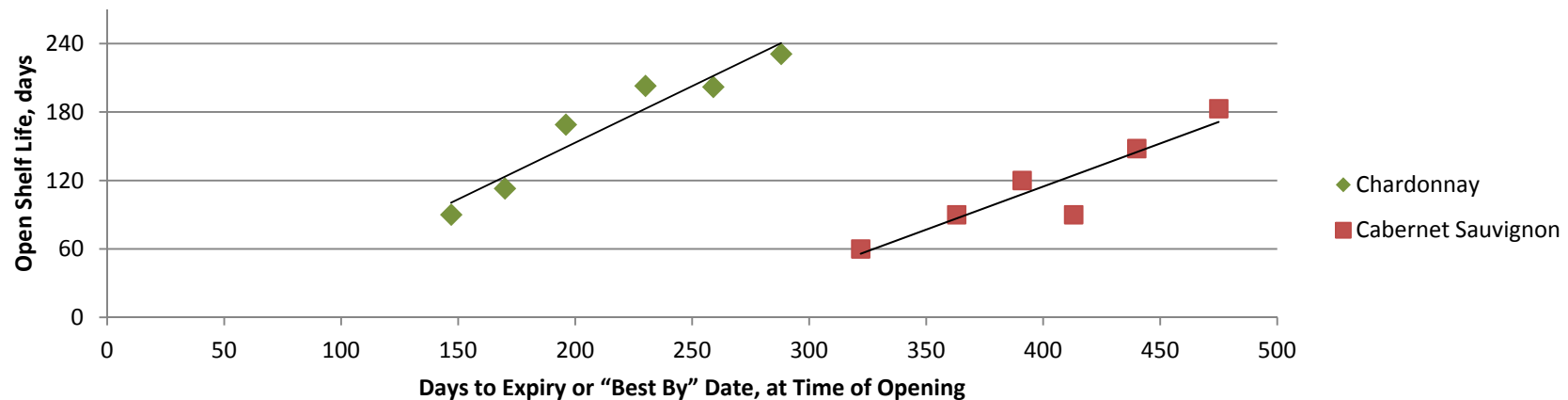
- Wine ages similarly within the box, ***whether the box is opened or not***
 - Full boxes opened at later dates correspond to FSO_2 level of all boxes opened earlier but tested on the same date
 - Only applies within a wine variety



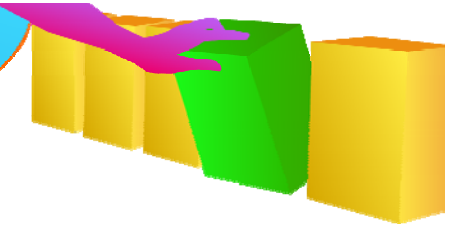


Long Term Study Observations

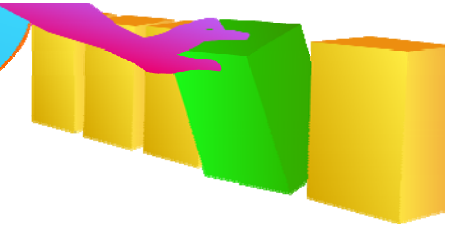
- Acceptable “open shelf life” for wine depends on age of wine at opening
 - “Open shelf life” is calculated as the length of time after opening before the box had one FSO₂ measurement ≤ 10 ppm



- In this study, all boxes had an open time of at least 60 days



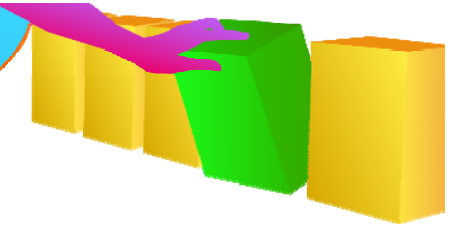
SHORT TERM STUDY



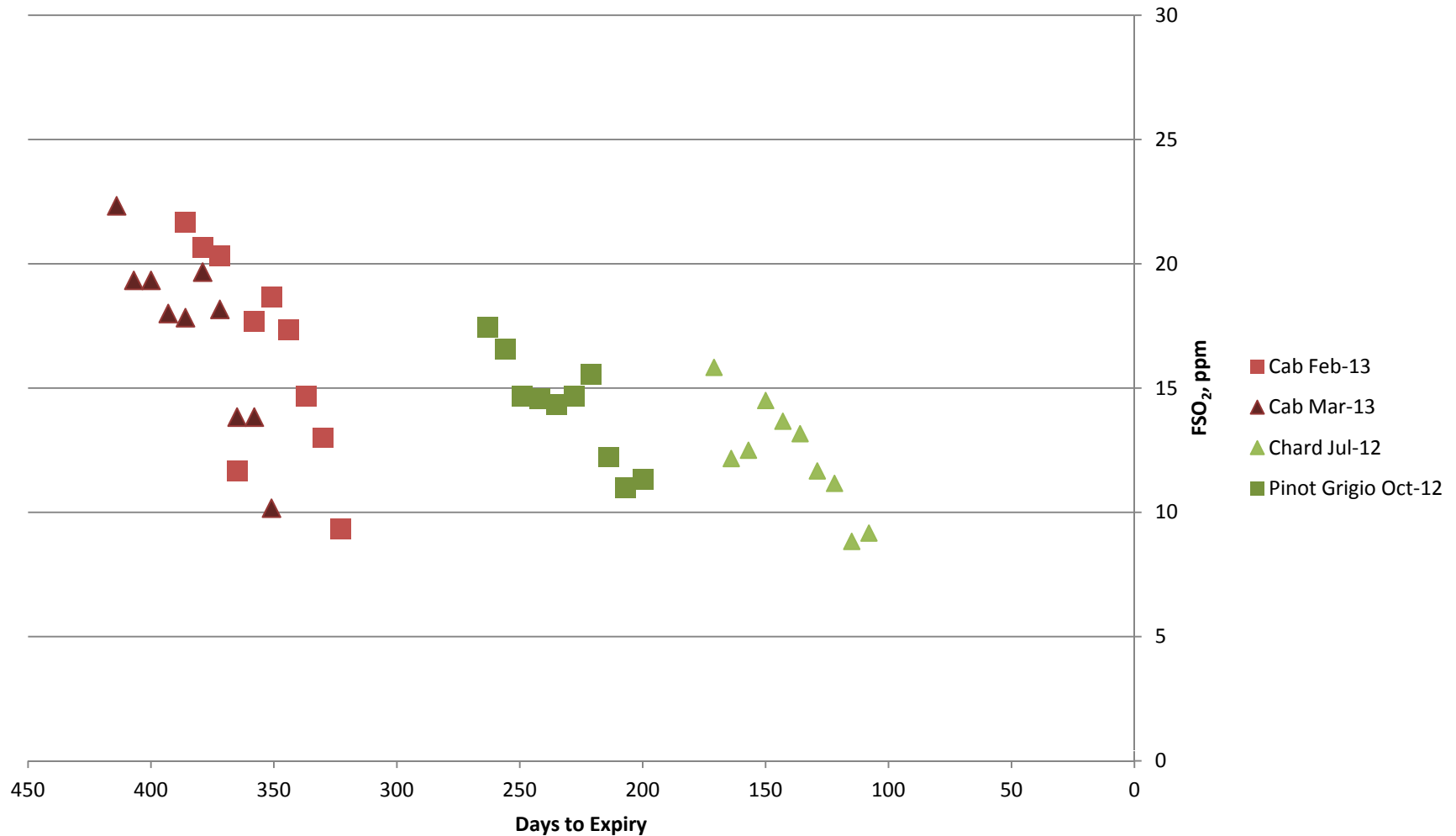
Wines Used in Short Term Study

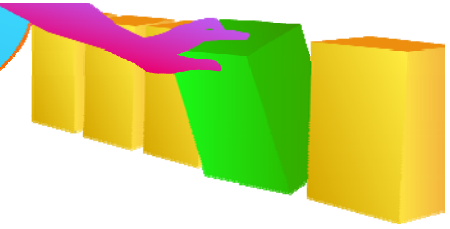
Test	Wine Variety	"Best By" Date	Number of Boxes
Short Term	Cabernet Sauvignon	Feb-13	1
Short Term	Cabernet Sauvignon	Mar-13	2
Short Term	Chardonnay	Jul-12	2
Short Term	Pinot Grigio	Oct-12	3

- All boxes from each type of wine and each “best by” date were from the same manufacturer and production date
- Rate of Consumption was 200 mL/week
- Time to expiry was calculated using the time between the test date and the “best by” date printed on the box



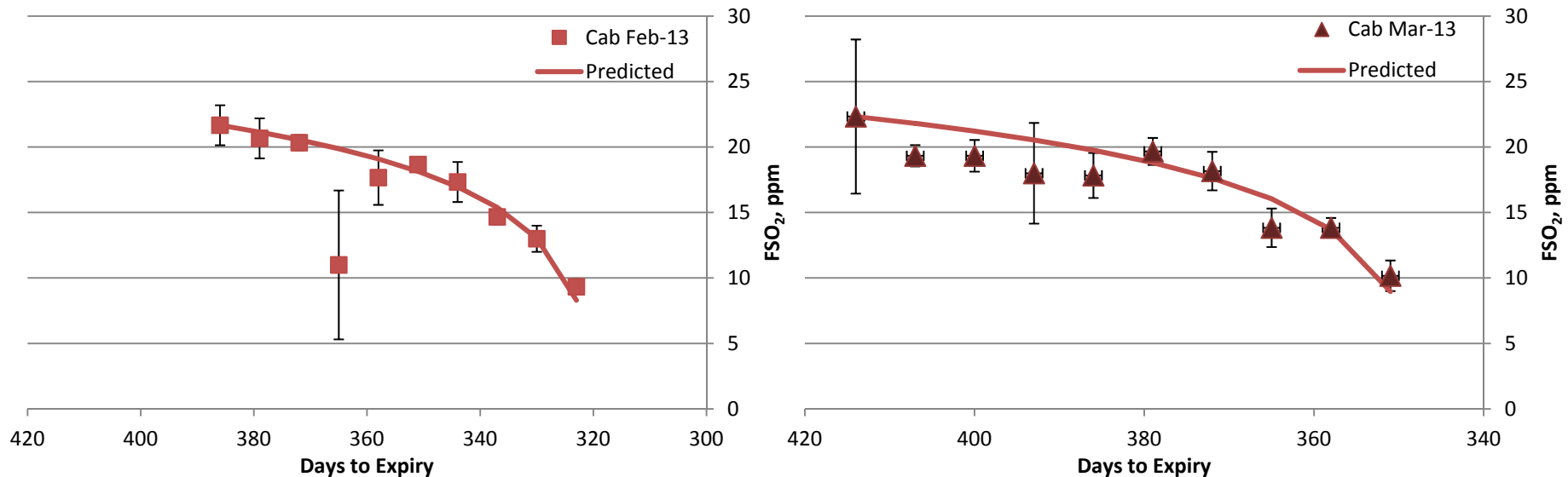
Short Term FSO₂ Raw Data



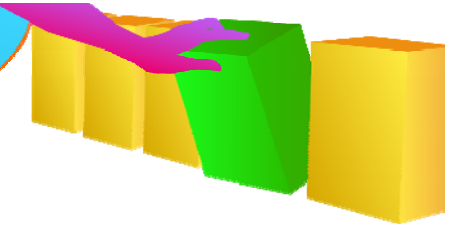


Short Term Study Observations

- Decline in FSO_2 can be explained by chemical reaction with oxygen that has entered the bag, in combination with the reduction in volume over time:

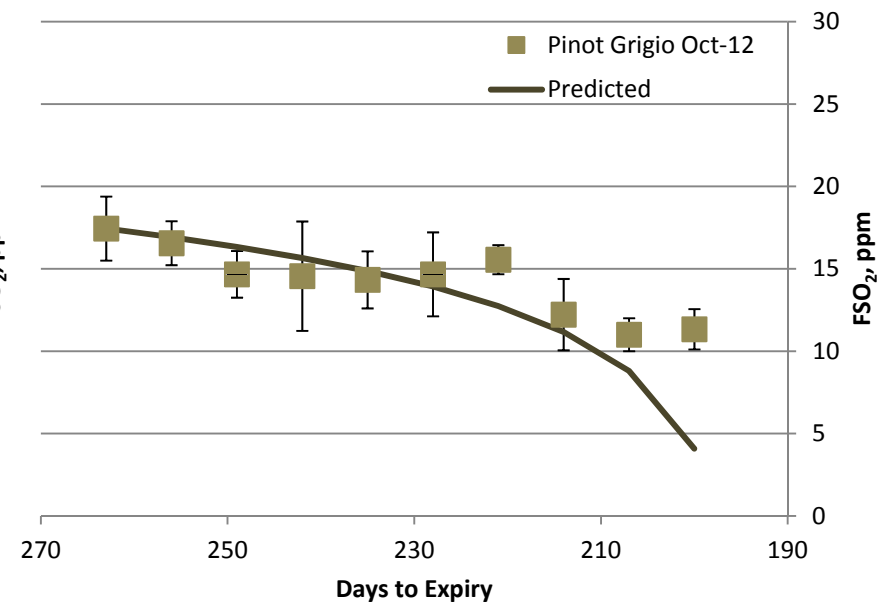
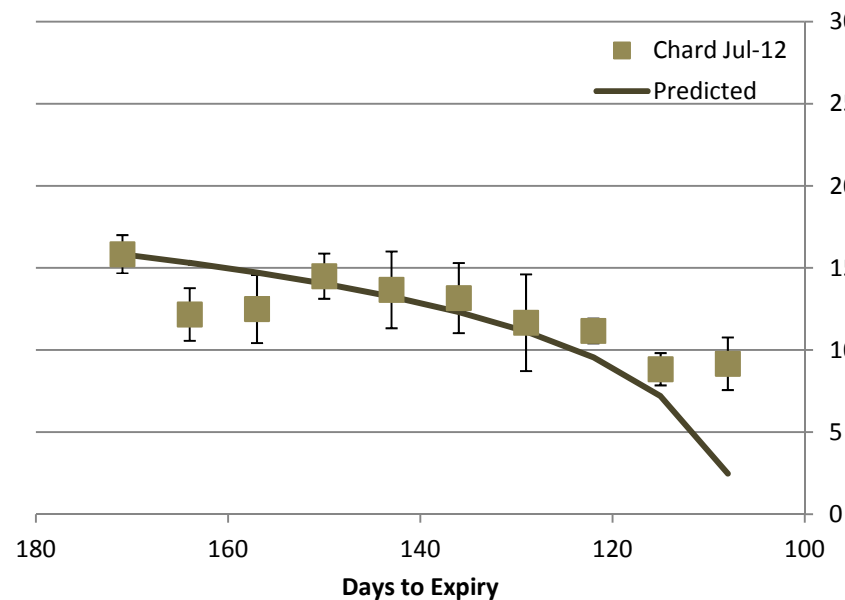


- Data fits theoretical prediction very well with r^2 values > 0.85 , when single outlier is removed

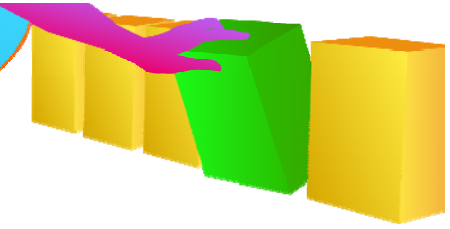


Short Term Study Observations

- White wine FSO₂ decline follows the chemical reaction with oxygen, in combination with the volume reduction:

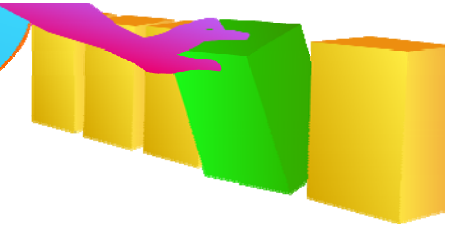


- Data fits theoretical prediction reasonably well with r^2 values over 0.7

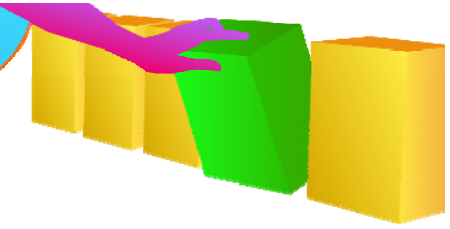


Short Term Study Observations

- Consistent with the long term study, open time depends on the wine age at the time of opening
- Cabs opened at >1 year to expiry exhibited more than 60 days of open time
- White wines with 6 to 9 months to expiry exhibited shorter open times due to lack of refrigeration



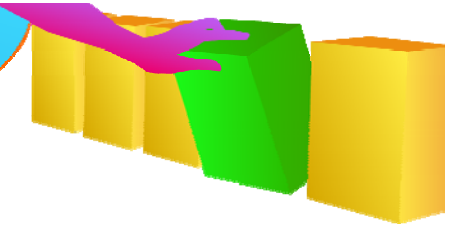
SUMMARY AND CONCLUSIONS



Summary and Conclusions

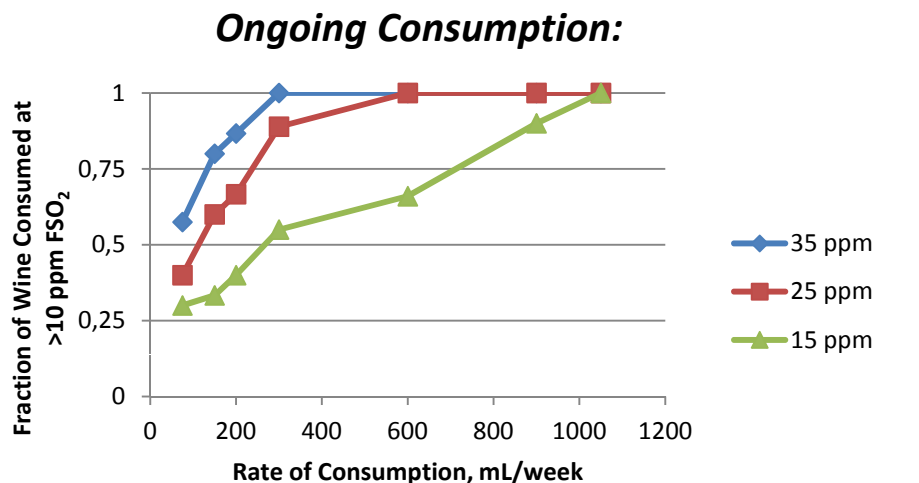
- Red and white wines were tested for FSO₂ levels during long- and short-term studies
- “Open shelf life” is a function of age at the date of cask opening and the rate of consumption of the wine

Fresh After Opening: 45 to 60 days



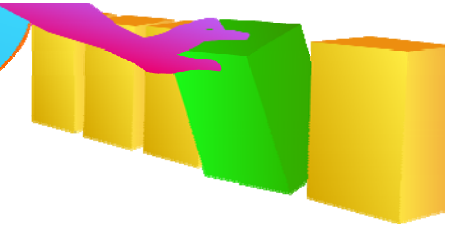
Summary and Conclusions

- Declines in FSO_2 once a cask has been opened are predictable
 - Modeled by oxygen ingress alone, while taking reduced wine volume and initial FSO_2 level into account
 - Strongly influenced by consumption rate
- Scenarios:



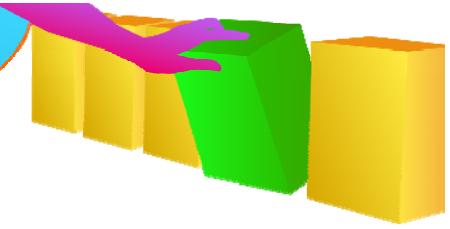
“Party” Consumption:

- Initial consumption of 2L
- Consumption rate to ensure wine is >10 ppm FSO_2 :
 - 35 ppm = 300 mL/wk
 - 25 ppm = 600 mL/wk
 - 15 ppm = 900 mL/wk



Acknowledgements

- These studies were conducted with the assistance of:
 - Allan Brown, Material Science Engineer, Scholle Corporation
 - Warren Villacreses, Material Science Specialist, Scholle Corporation



Questions?

Thank you for your time and attention!