SNEWS Update, High Rate Test Results, and Proposal for Automation

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Overall Update: News and Status

since Feb ’01

- Detector participation
- SNEWS software
- High rate test results
- Proposal for automation

UPDATE: Detector Participation

November ’01: SK offline

back at end of 2002

Current: LVD, SNO

Next: KamLAND

Borexino

AMANDA

} **we will hear**

SNEWS Coincidence Software Update

Servers: kaboom, gsboom

Code update:

Version 2.1 working

minor fixes after high rate test

Version 3.0 (Ronnie Misra, M. Eng. thesis)

- **2−way communication "anti−coincidence"**
- **Inter−server communication**
- **Security, robustness improvements**

now ready for integration

kaboom to be replaced this summer with newer machine, RH 7.2 (Wesley Jin)

Spring ’01: " High Rate Test" with SNO, LVD, SK

Run with lowered threshold s.t. coincident rate is non−negligible

1. Test performance of software, flush out any bugs

2. Check the nature of the alarm time distributions, confirm lack of correlations

High rate test data now analyzed

−> specific proposal for automation

High Rate Test Parameters

April 11, 2001 – June 23, 2001

kaboom (SK,SNO,LVD)
gsboom (SNO,LVD) **(Kamioka net problem prevented SK alarms)**

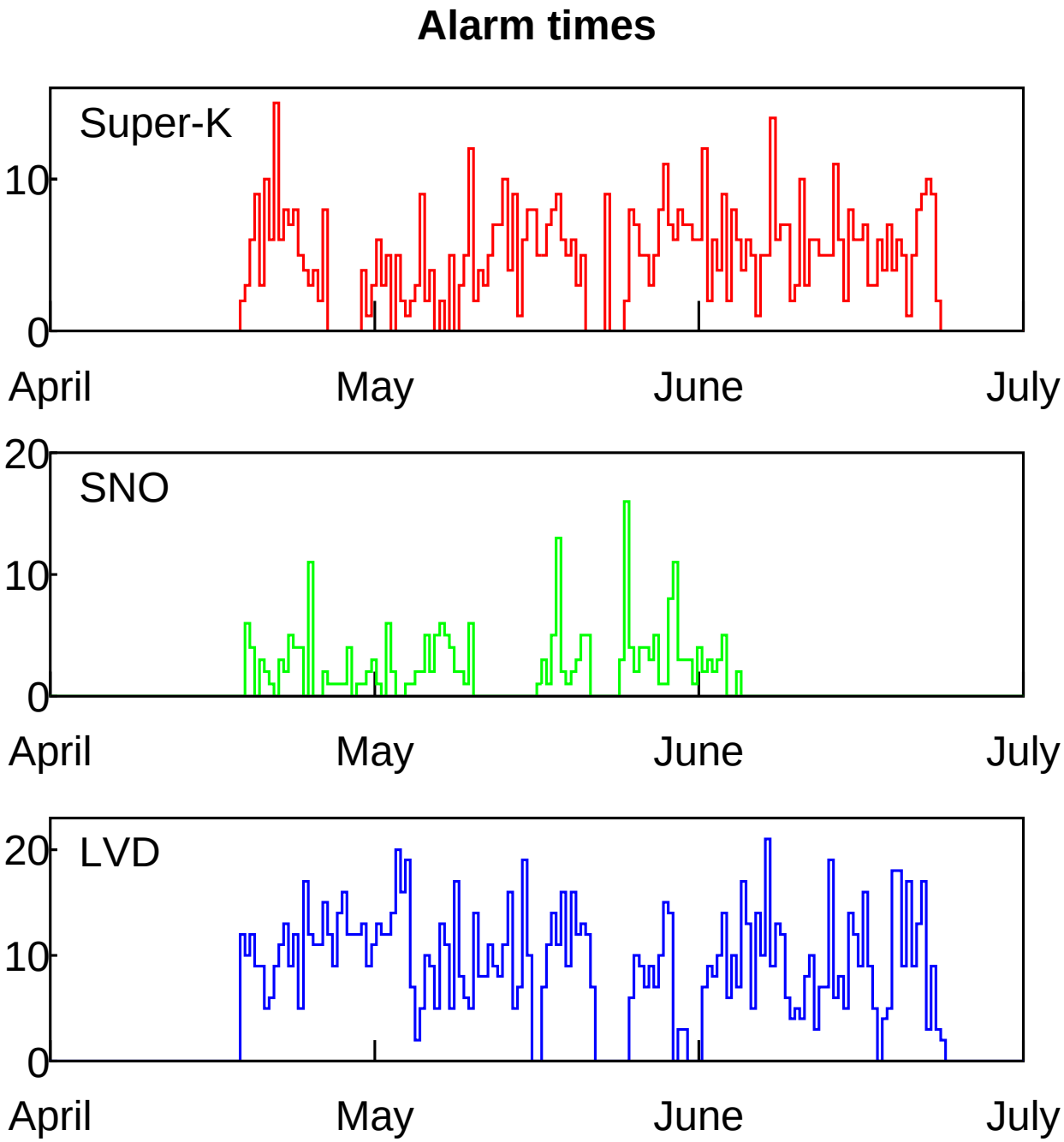
Each experiment set to have ~10−100/day alarm rate

Coincidence window widened from 10 seconds to 400 seconds

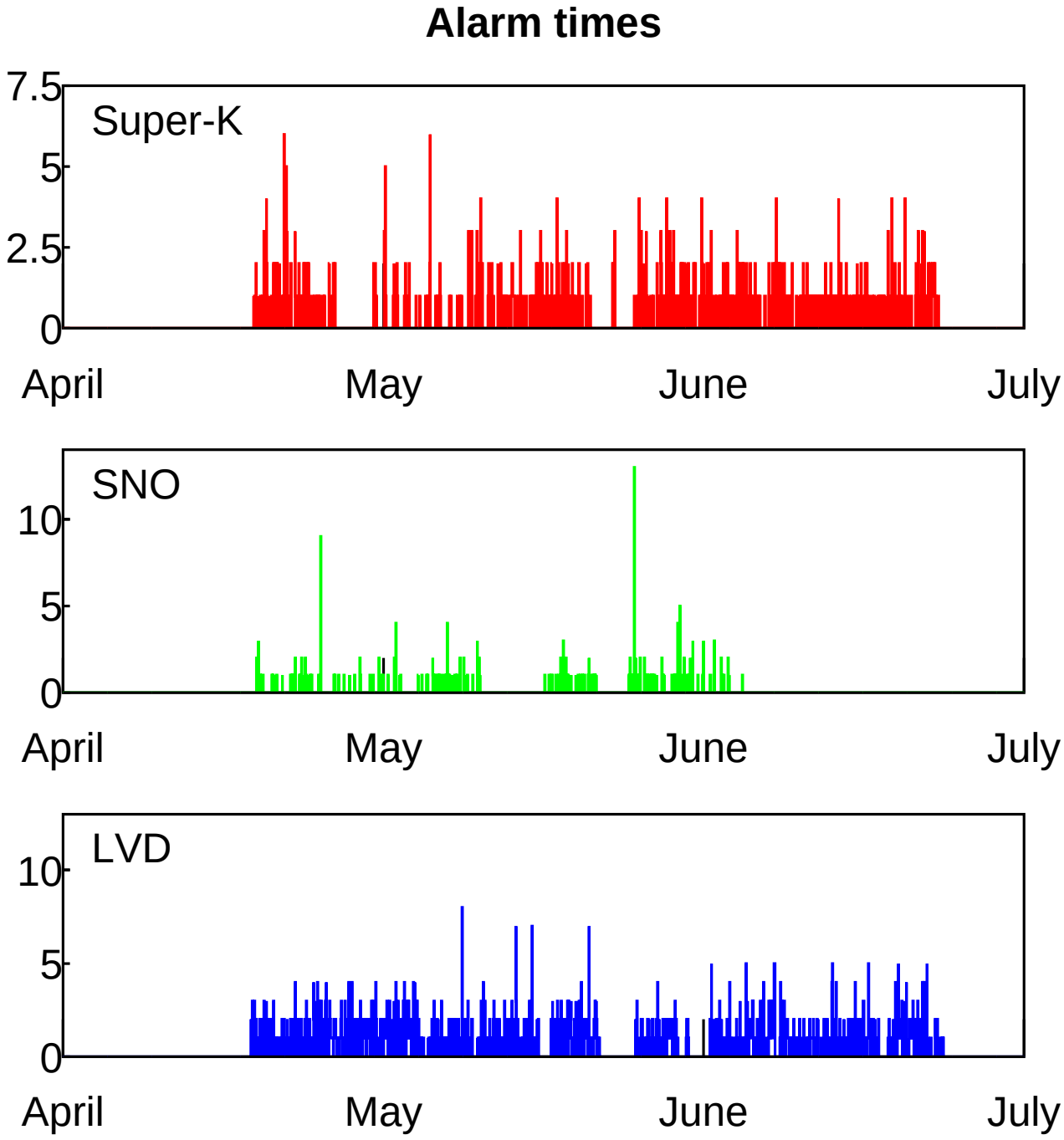
Data analyzed starting April 19, 2001

Data analyzed within subgroup only, as per privacy agreement

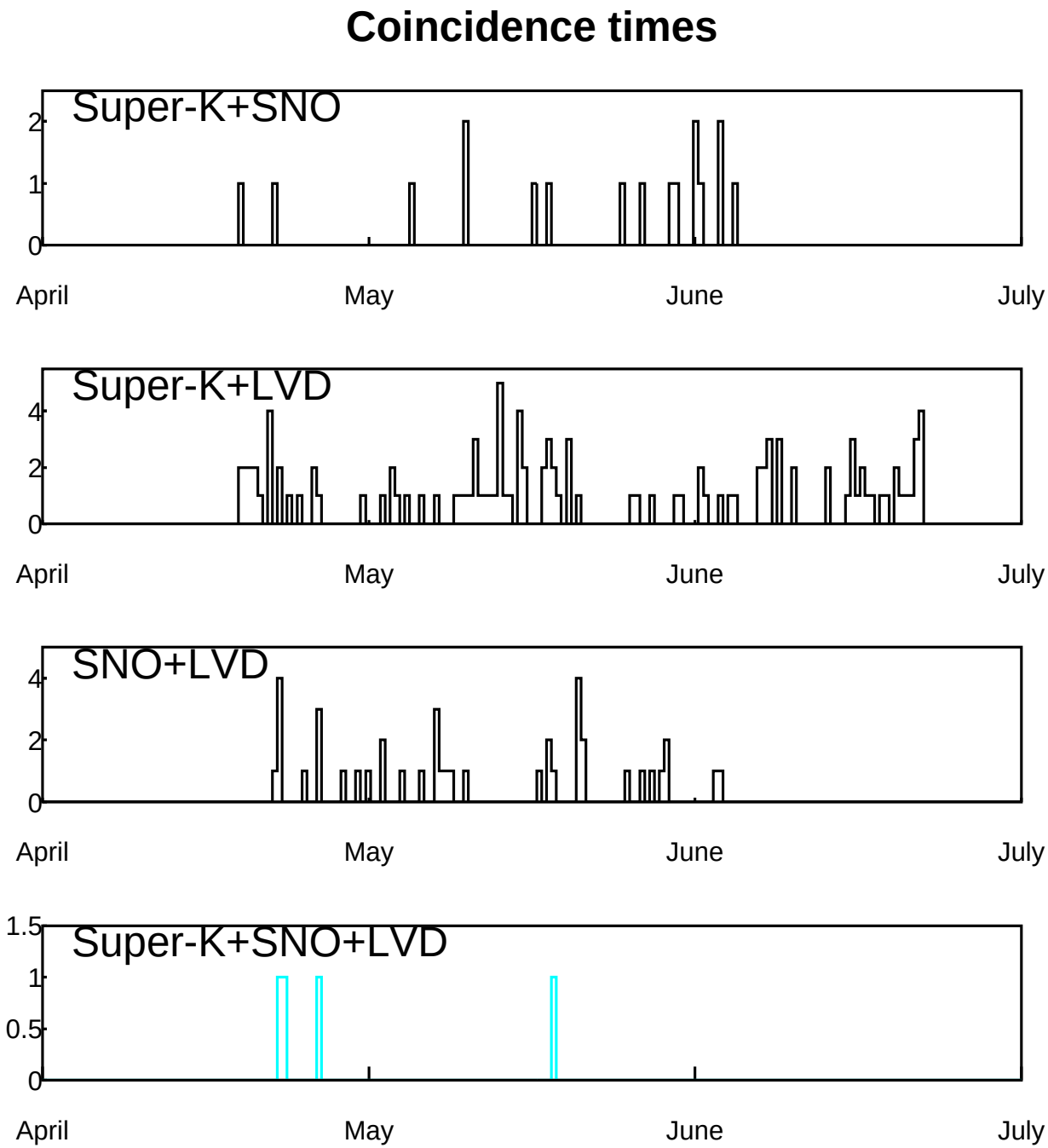
Results: alarm times



Same, with finer time binning



Coincidences as recorded by kaboom (repeats discarded)

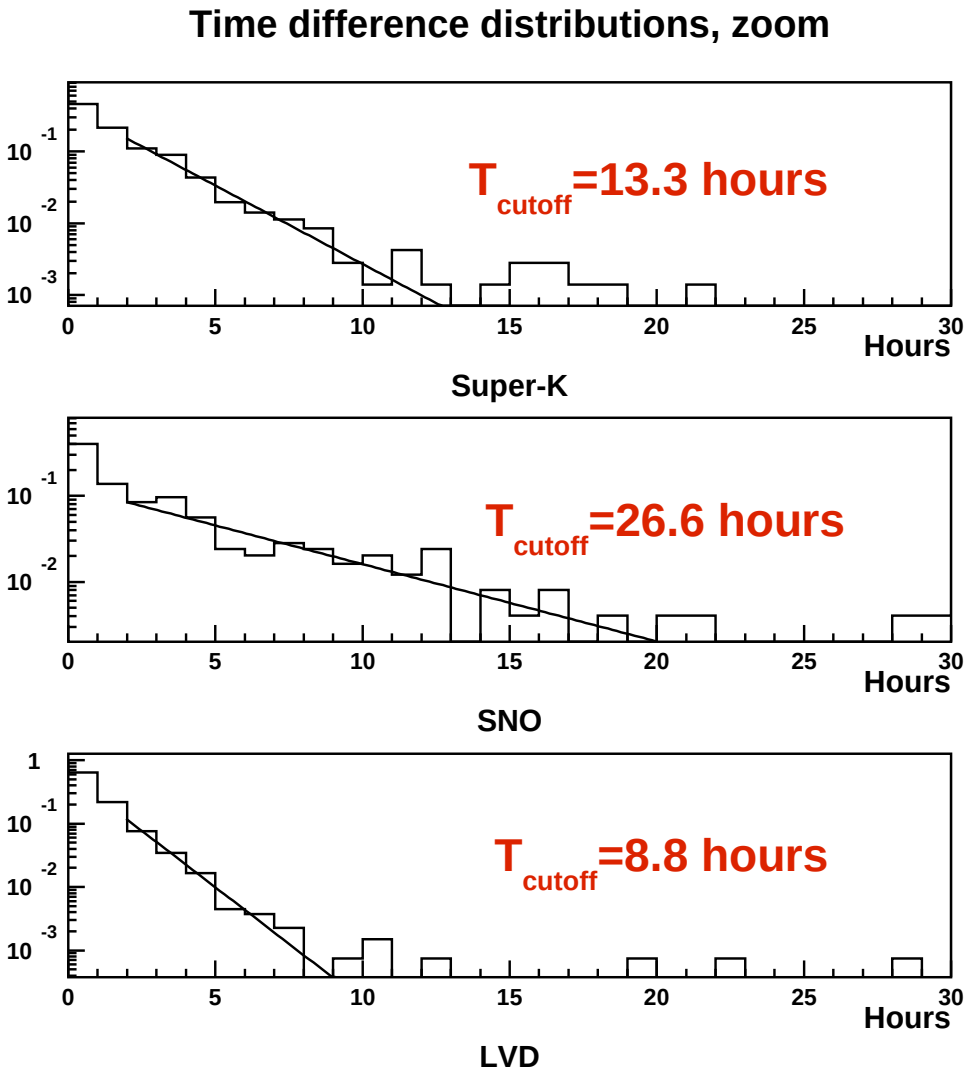


Live Time Estimate

Estimate live time using the *data themselves* (automatically takes into account dead time from any cause)

Assume dead if interval > T_{cutoff} where T_{cutoff} is an "improbably long" dead interval

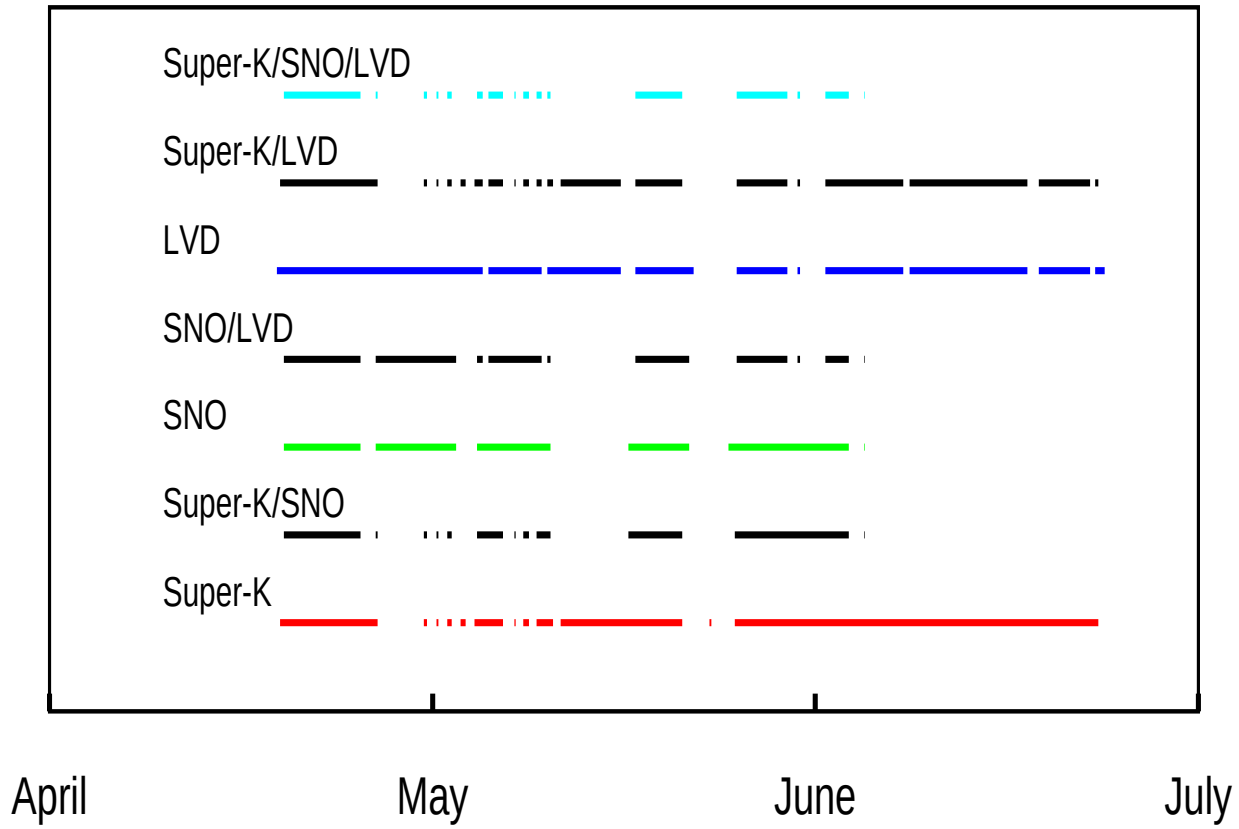
$$T_{cutoff} = \frac{\ln N_{alarm}}{\lambda}$$



(Underestimates at edges, overestimates inside interval)

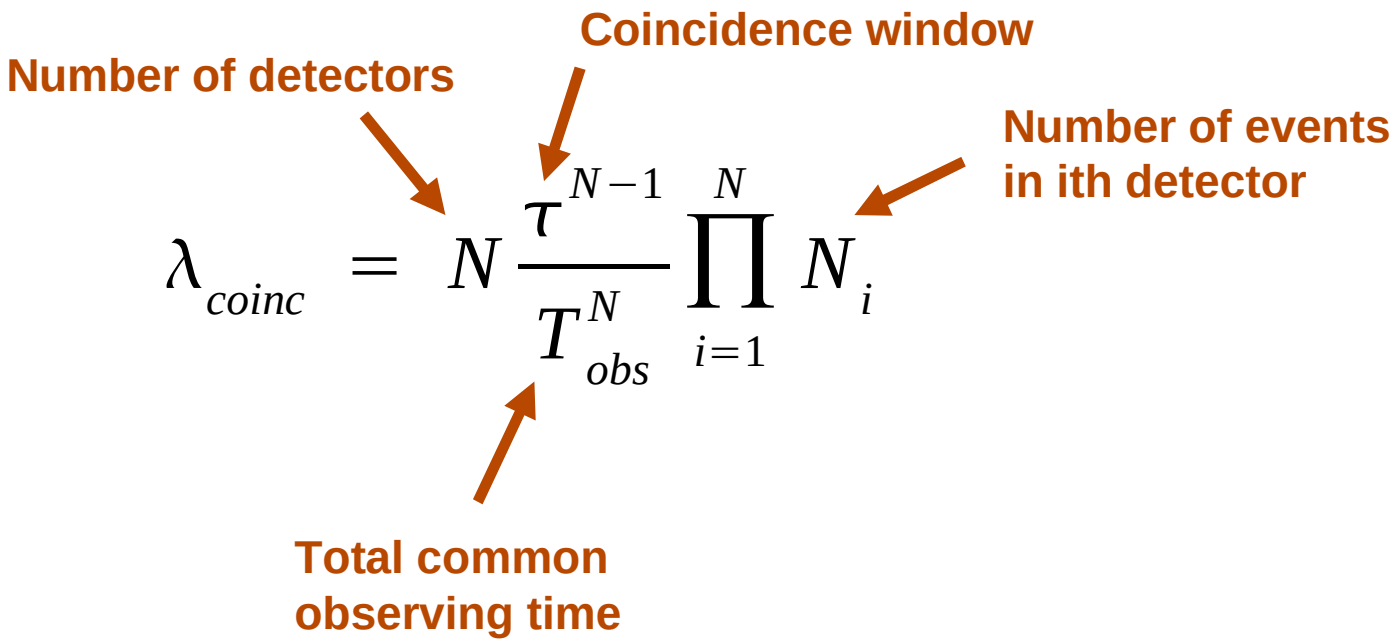
Overlap Periods

calculated in detail



What is the expected coincidence rate given the individual alarms?

For stationary, uncorrelated Poisson processes:



***However*, this is strictly valid only for *stationary* processes**

A different approach: the "time shift method"

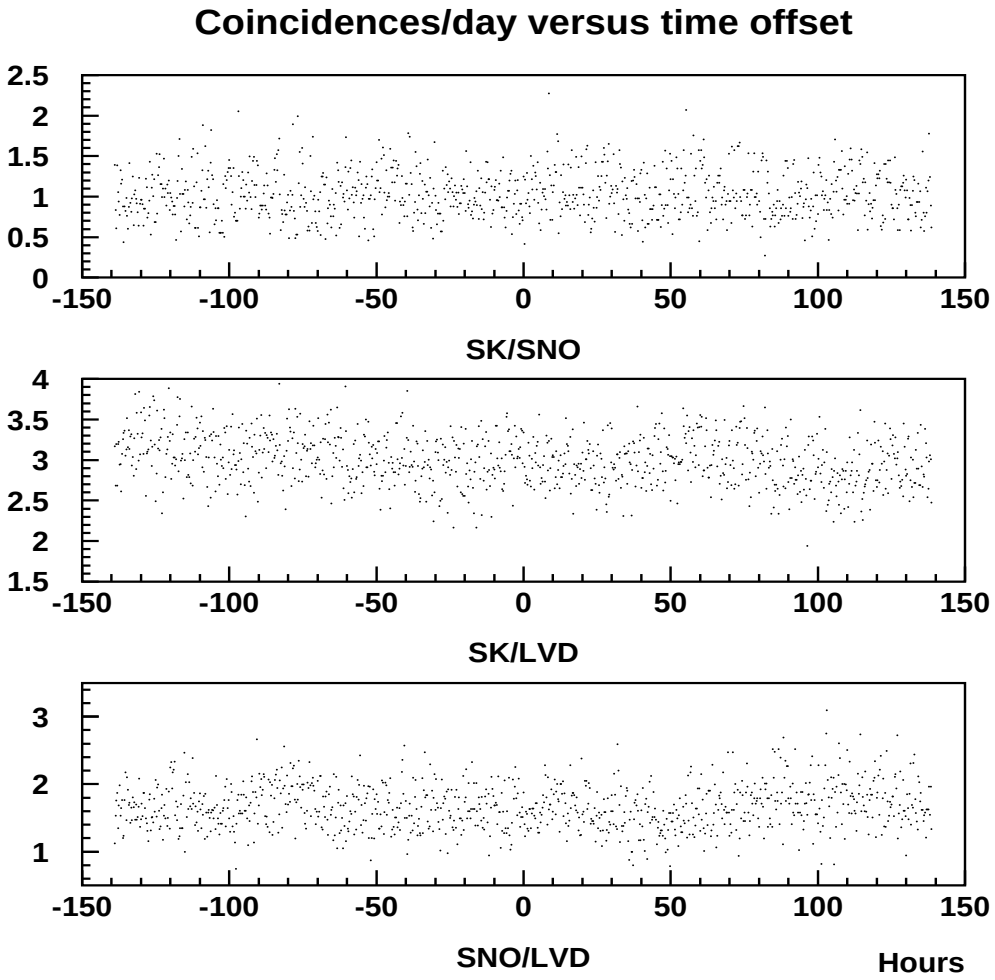
Refs: E. Amaldi et al., *Astron. Astrophys.* **216** 325 (1989)
Z. A. Allen et al., *Phys. Rev. Lett.* **85** 5046 (2000)

For any pair of detectors, shift all of one's alarm time values by Δt, determine n_c

Repeat for many values of Δt

Resulting distribution of n_c gives expected mean and spread of coincidences.. and should be flat if no correlations

Results from time−shift method: 2−fold coincidences



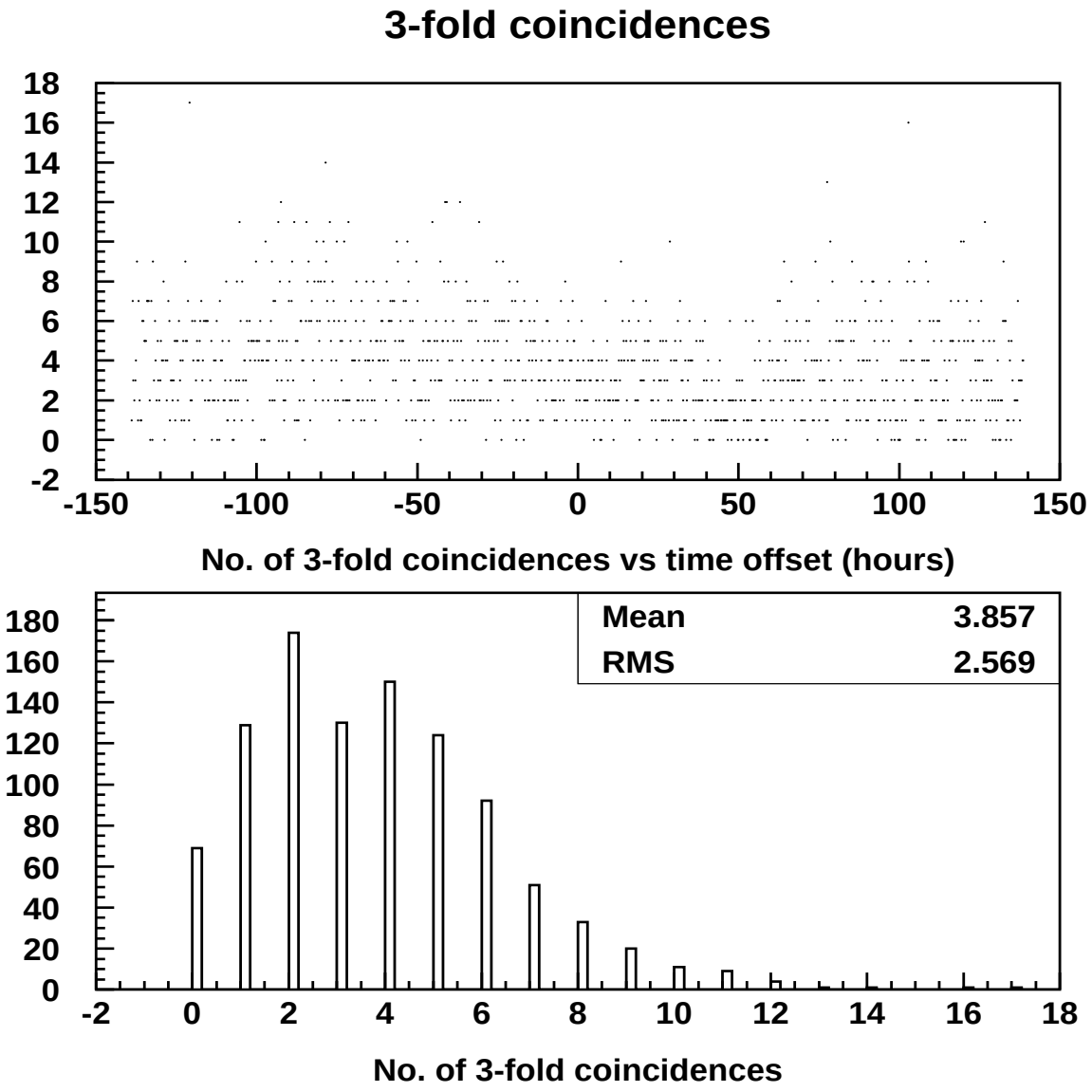
Conclusions from High Rate Test

1. Software works well!

2. Individual experiment rates slightly non−stationary, but clearly uncorrelated

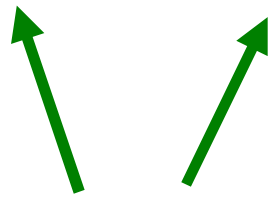
No cause for concern
for implementing proposal
to follow...

Time shifted 3−fold coincidences



Comparison of Expected and Observed Coincidences

Experiment Combination	Common live time (days)	SK/SNO/LVD alarms	N_{coinc} expected (eqn)	N_{coinc} expected (shift)	N_{coinc} observed
SK/SNO	$24.1^{+0.3}_{-0.5}$	334/187/-	24.1 ± 1	24.9 ± 7.0	30 (17)
SK/LVD	$4.6^{+0.3}_{-0.9}$	576/-/1025	122.6^{+5}_{-1}	133.8 ± 13.7	149 (112)
SNO/LVD	$27.7^{+0.2}_{-0.6}$	-/189/646	40.8^{+2}_{-1}	46.4 ± 9.2	52 (41)
SK/SNO/LVD	$19.6^{+0.3}_{-0.6}$	276/144/431	$2.9^{+0.3}_{-0.1}$	4.2 ± 2.9	4 (4)



good agreement

Proposal for Automated Running Mode

GOLD alert: clean, unambiguous coincidence for AUTOMATED alert

SILVER alert: coincidence with one or more problems

- **calibration or other tag on any alarm**
- **too few in coincidence at distant locations**
- **history of high rate**

Experimenters may then *upgrade* to gold (delay, but coincidence is not lost!)

(Note: not same as early "gold vs. silver queue" plan)

GOLD alert must have *all* of the following conditions met:

1. A two− or more fold coincidence within 10 seconds ☑

   (modify for more experiments)

2. At least two experiments at different laboratories ☑

3. Two or more alarms flagged as "good" ☑

4. Rate of alarms in past time intervals for all experiments involved not "too high" (must be consistent with 1/week) ☑

Quantitative Rate Criterion

For intervals $\{T_i\}$={10 min, 1 hr, 10 hr,1 d, 3 d, 1 wk, 1 mo}

require *consistency with ~1/week rate*

For the $\{n_i\}$ alarms sent by each experiment, require the Poisson probabilities $\{P_i\}$

$$P_i = \sum_{n=n_i}^{\infty} (\lambda_{max} T_i)^n \frac{e^{-\lambda_{max} T_i}}{n!}$$

each to be greater than P_{thr}

P_{thr}=0.5% corresponds to requirement of $\{n_i\}$<{1,2,2,3,4,5,11} for each experiment

Notes on this criterion:

If all experiments have mean 1/week rates, 4% of true gold alarms will be demoted to silver for P_{thr}=0.5%

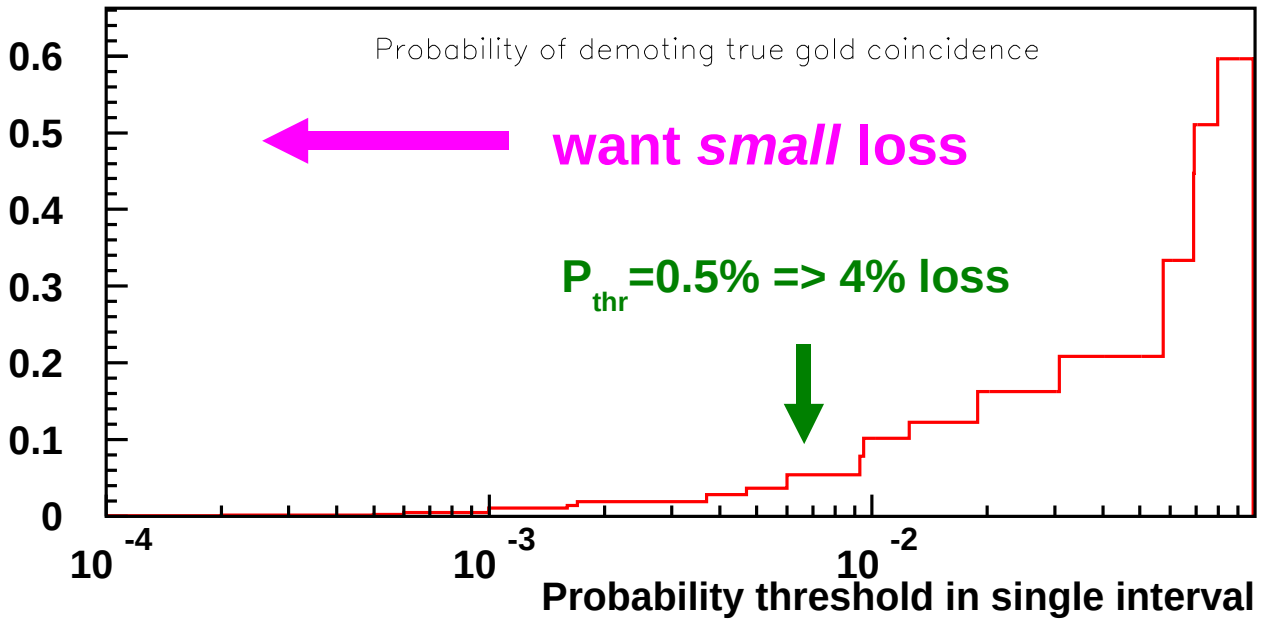
Another consideration: what if some experiment experiences overall average alarm rate increase?

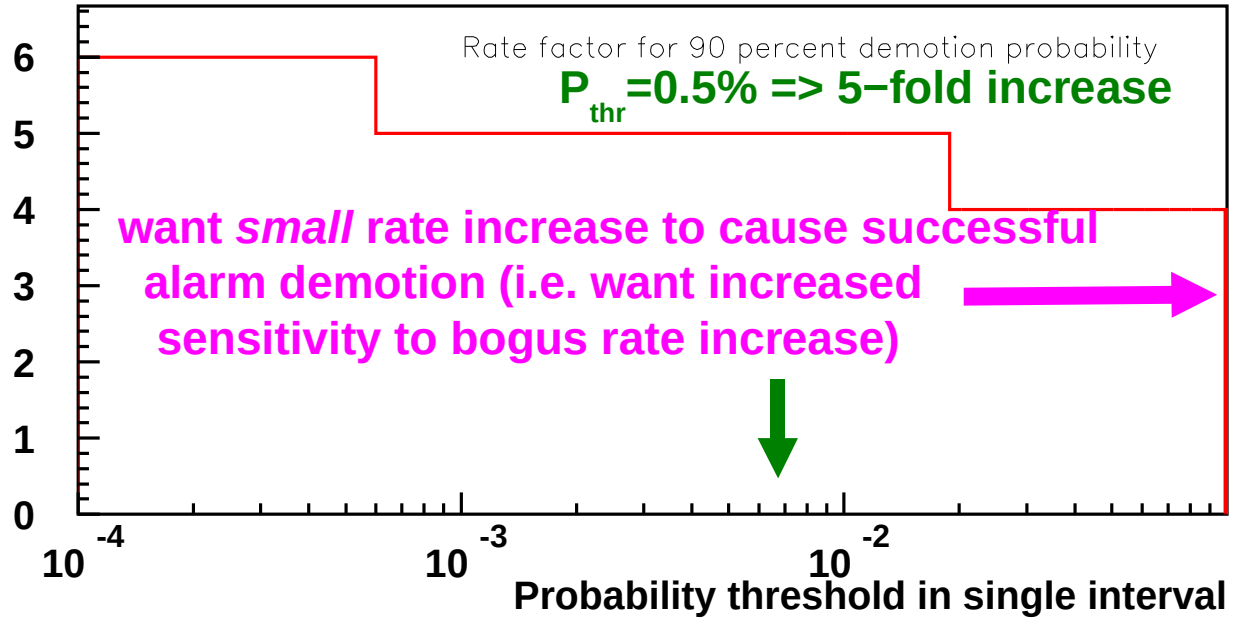
To choose criterion:

balance between prevention of

- **loss of too many true gold coincidences**
- **failure to demote alarms for mean rate increase**

Gold demotion probability threshold optimization





P_{thr}=0.5% results in acceptable loss and reasonable sensitivity to rate increase

(Note: *long term* rate increases will be monitored within subgroup)

To–Do List for Automation

1. Update existing code to implement gold/silver scheme

2. Deploy the system on uniform secure Linux machines

3. Security audit: national lab expert?

Summary

High rate test: no correlations, coincidence rates as expected

Propose gold/silver scheme: automated alert only for "gold−plated" coincidences; silver coincidences get human checking

Suppress automated alert for coincidences with high rate history (or other problems) => balance between fear of lost alert and fear of false alert!

Ready to go after to−do list items checked off