HDC-4-90

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Common Observations between DUMAND and other Detectors

John Learned
Hawaii DUMAND Center

This is a short note to document the results of a short calculation made in response to a query from Yousef Makdisi about the ability for DUMAND to simultaneously observe a celestial source in neutrinos while another instrument, located afar, is able to see the same source in downgoing muons.

We assume that the illumination of the earth is uniform, and that one only must be concerned with relative directions. The program (located in UHHEPb:[jgl.dum]common_time.for) simply calculates the source direction in detector coordinates for DUMAND and another detector, as a function of sidereal time, and integrates the number of hours per day for which the source is commonly visible. I take visible to mean at zenith angles greater than 80^{o} for neutrinos in DUMAND, and zenith angles less than 90^{o} in the other detectors. The latter assumption is not very good, though convenient, because the rate of downgoing (ordinary) cosmic ray muons depends strongly upon zenith angle. For example, the zenith angle dependance is about a $1/\cos^{3}$ for Soudan (and IMB) depth.

Figure 1 illustrates the calculation described, for four other locations: Soudan, Gran Sasso, Kamiokande, and the Kolar Gold Fields in India. One sees that for Cygnus X–3, located at declination 41^{o} North, the common time with Soudan is about 8 hours per day. The common time is much better, of course, for locations farther around the world. For the Gran Sasso site in Italy, where we have about 12 hours common time for some declinations (5^{o} to 35^{o} North), and about 11.5 hours simultaneously on Cygnus X–3. At the Kolar Gold Fields in India, we have 9–10 hours common time over much of the sky, from -50^{o} to $+65^{o}$. (This is relevant for the KGF EAS array, which has muon counters; the KGF neutrino/pdk detector is too small and too deep to be relevant here.)

Figure 2a shows the track of Cygnus X–3 in zenith angle at DUMAND and the other 4 detectors, with symbols in one hour steps. The lines at 80^{o} for DUMAND and 90^{o} for the other detectors divide the muon and neutrino observing regimes for throughgoing muons. One sees that for DUMAND and Soudan there is surprisingly (to me anyway) long common time, with Cygnus X–3 mostly between 20^{o} and the horizon at Soudan, and from 80^{o} to 120^{o} zenith angle at DUMAND. In fact there is quite a good split of the day between DUMAND observing in muons and neutrinos, while Soudan sees Cygnus X–3 above the horizon continuously.

Figure 2b shows the same detector combinations, but for a Southern hemisphere source, LMC X–4, at declination -66.4^{o}. The result is as one would expect: the object is in the neutrino viewing region of most of the detectors simultaneously.

The above exercise points out the importance of establishing relations with other groups for common data scanning. This can be most easily done off line, due to the relatively leisurely muon rate at DUMAND due to it's depth.

(revised 5/28/90 by adding Kamiokande to the plots, and adding the LMC X–4 plot.)

FIGURE 1

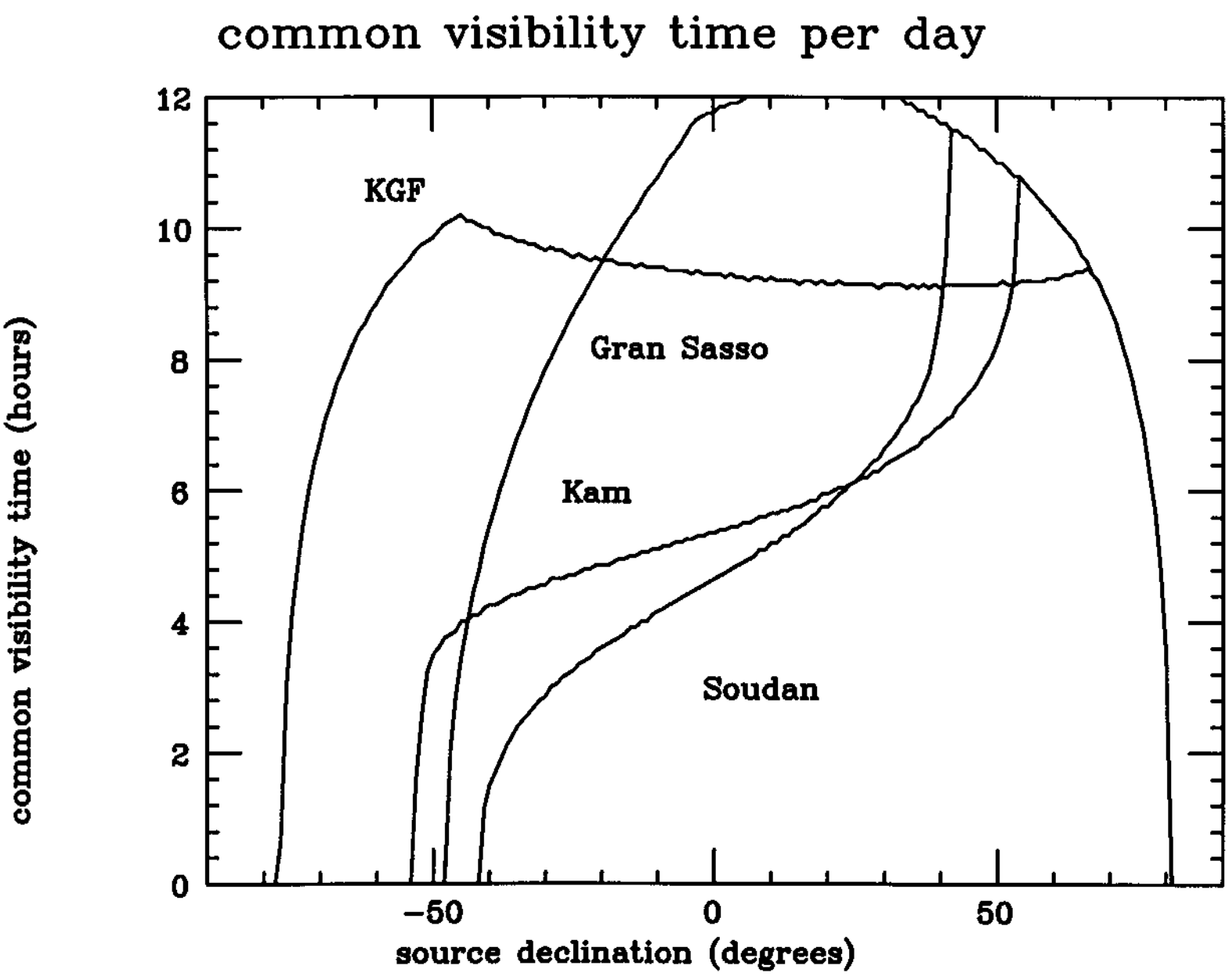
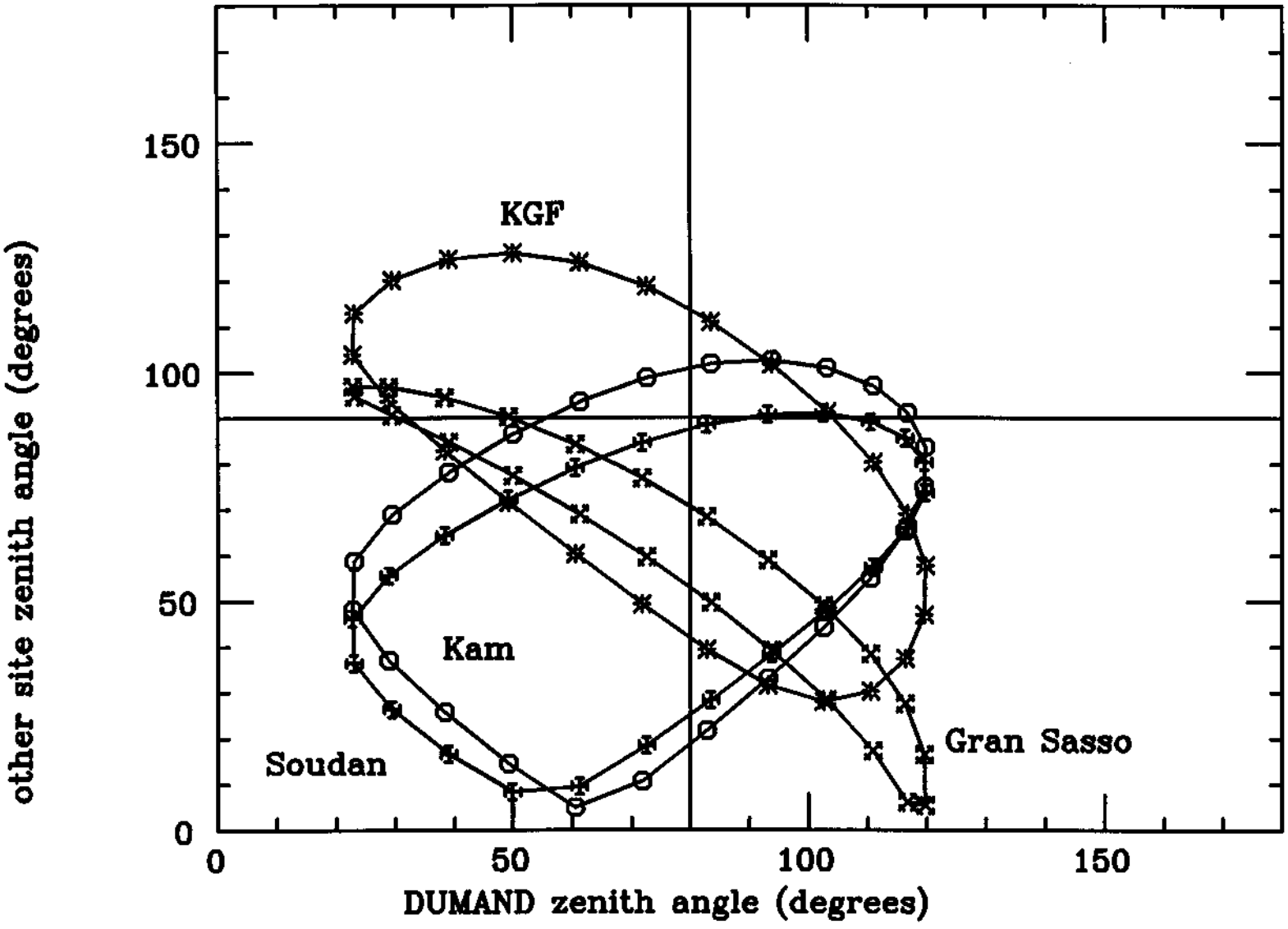

common visibility time per day
common visibility time (hours)
12
10
8
6
4
2
0
KGF
Gran Sasso
Kam
Soudan
−50
0
50
source declination (degrees)
jgl 5/90

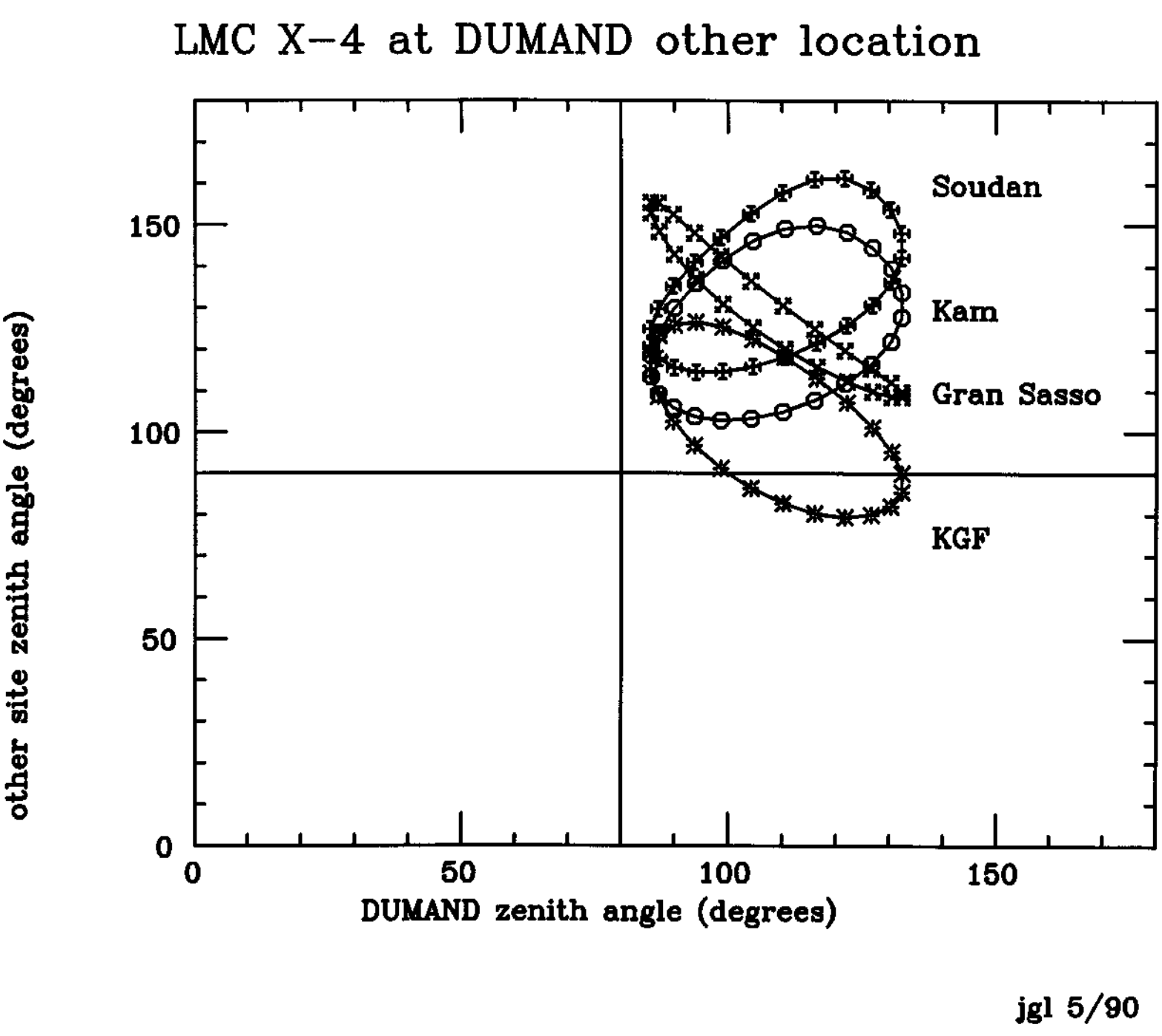
FIGURE 29

Cyg X−3 at DUMAND other location



jgl 5/90

FIGURE 2b


LMC X−4 at DUMAND other location
Soudan
Kam
Gran Sasso
KGF
other site zenith angle (degrees)
DUMAND zenith angle (degrees)
0
50
100
150
jgl 5/90