

Additional Information

for SPAC Method

Nov.23-24, 2008

IISEE, BRI, Japan

By T.Yokoi

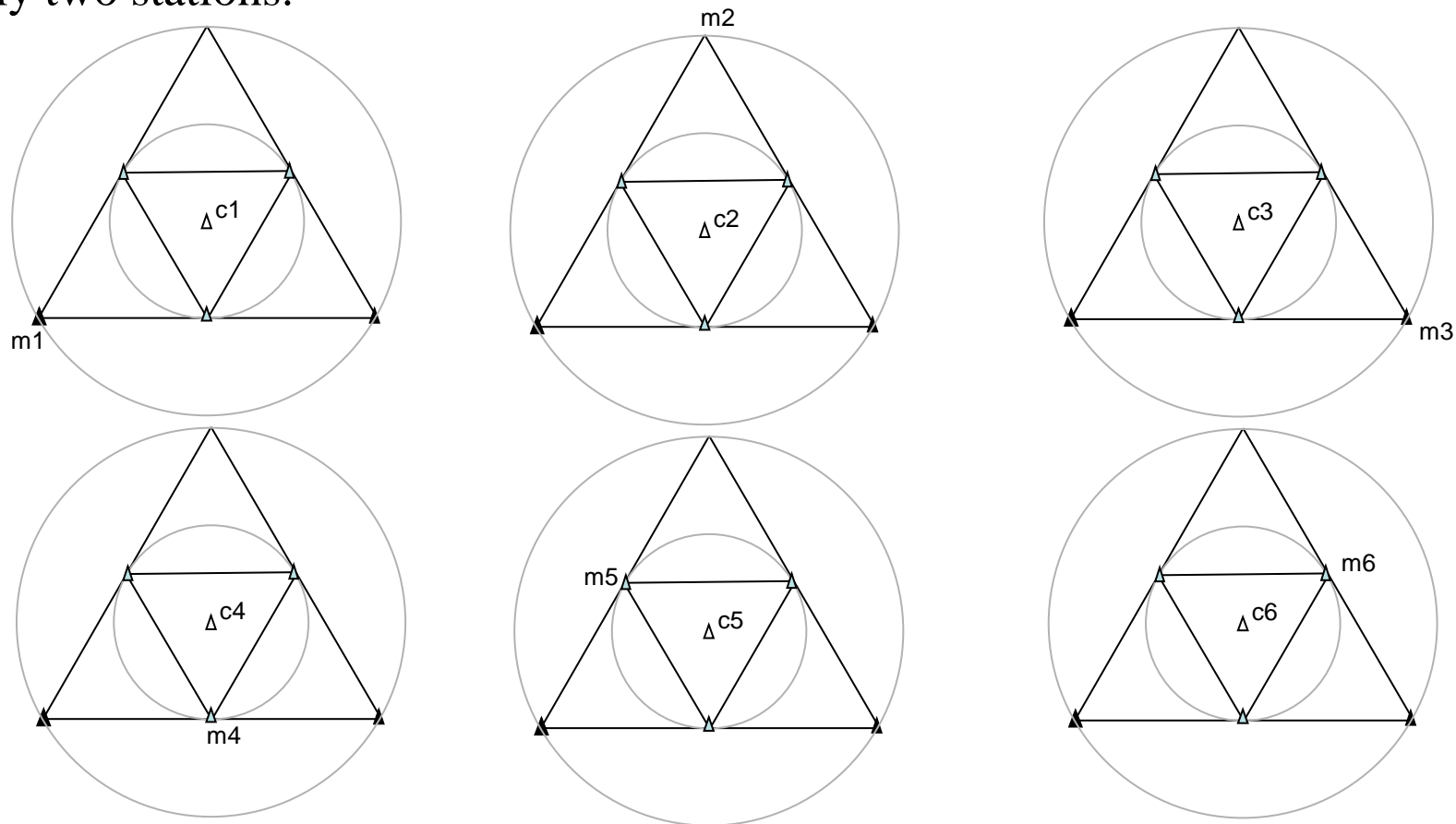
Pre-Symposium Training Course

7-th General Assembly of Asian Seismological Commission

Pivoting Array using only 2 seismographs simultaneously(2sSPAC).

Morikawa *et al.* (2004)

If microtremor is stationary over time, simultaneous measurement at all stations may be not indispensable but can be replaced with a series of simultaneous ones at only two stations.

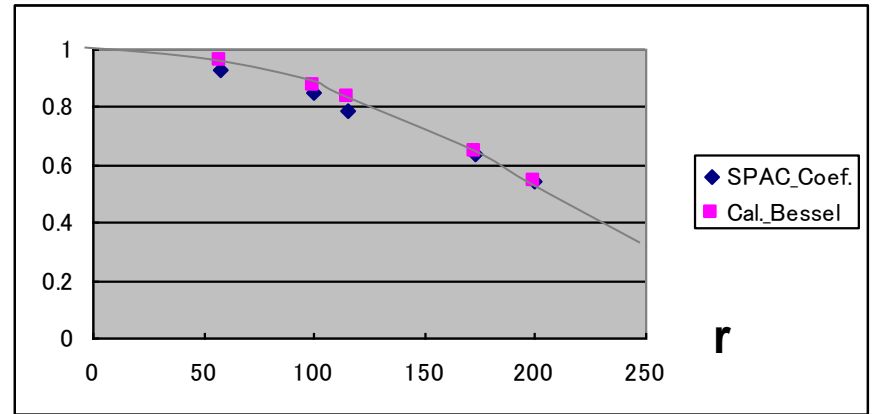
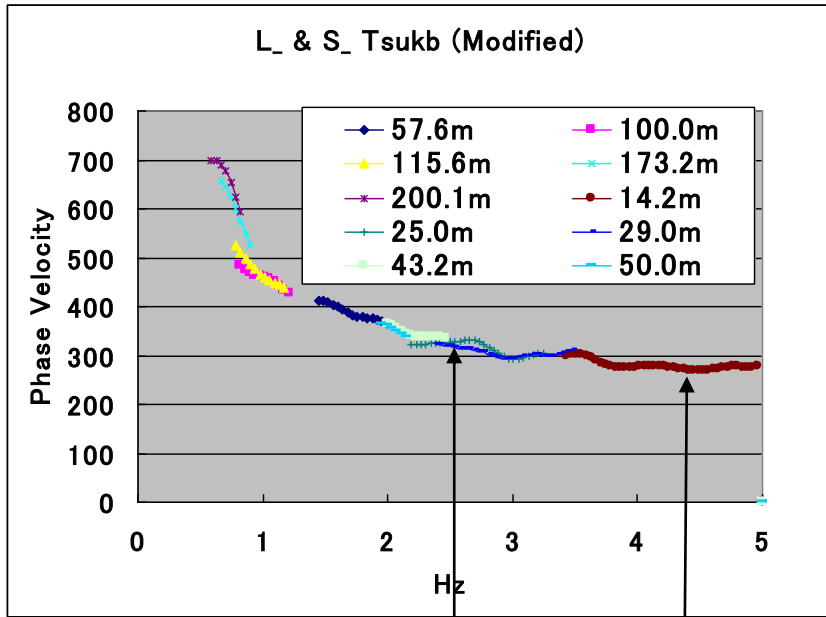


Attractive especially for deep exploration using long period seismographs, because their price is an astronomical number, but time consuming!

Is Array Configuration Appropriate ?

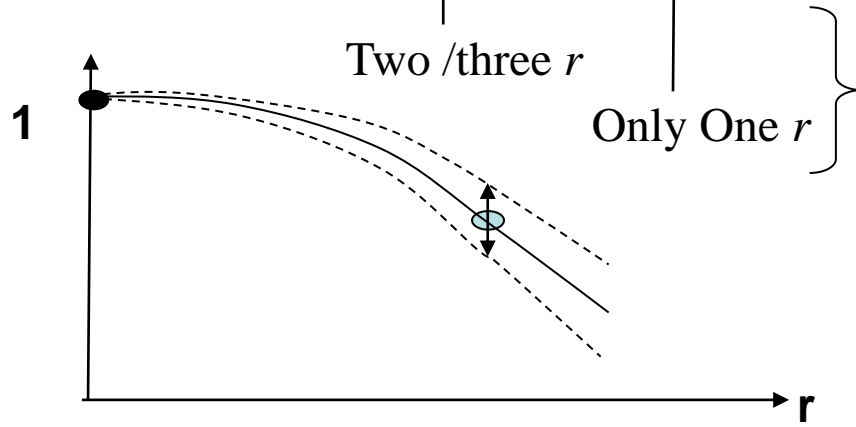
Perhaps it can be improved a little
more.

Example1



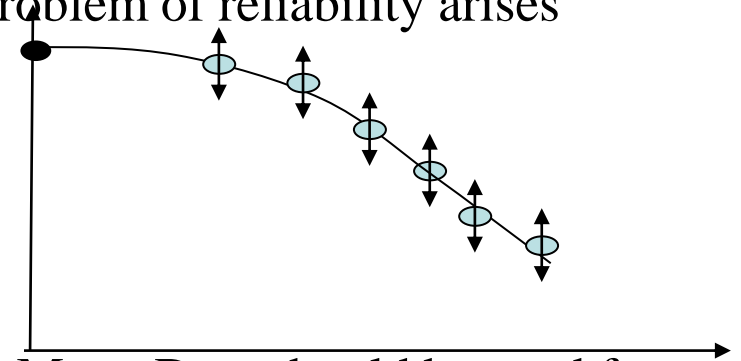
Comparison.dat

Fitting to $J_0(r\omega/c(\omega))$ is conducted for each frequency.



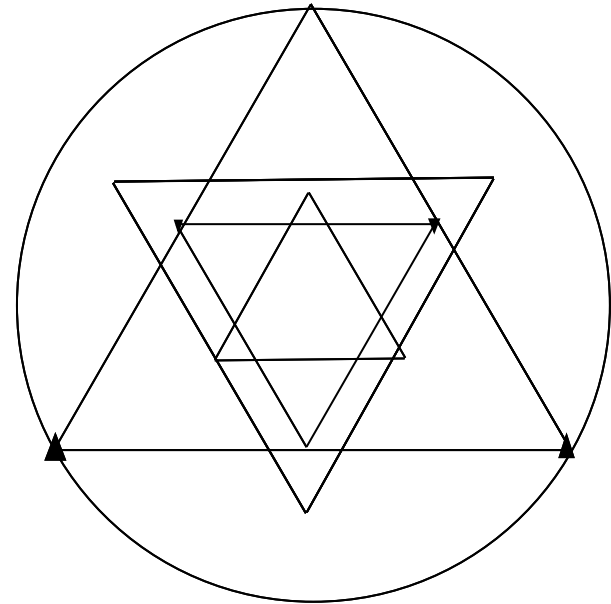
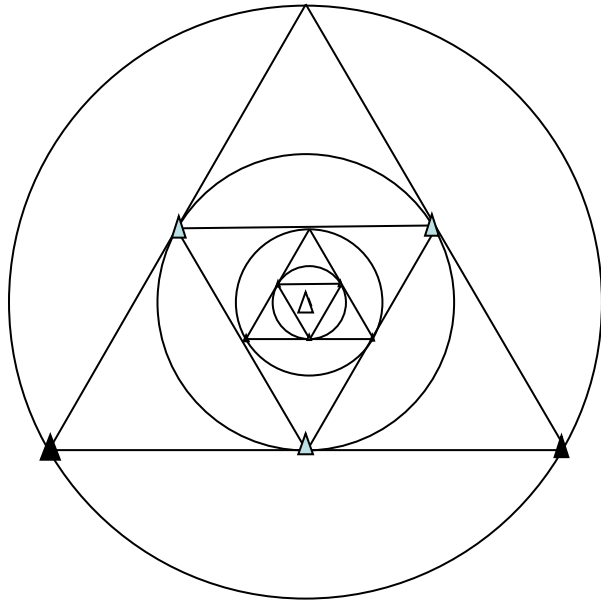
Error of the only one datum affect directly to the estimated value of $r\omega/c(\omega)$

Problem of reliability arises



Many Data should be used for every frequency to obtain higher reliability

A possible counter measure: variation of radius of triangles.

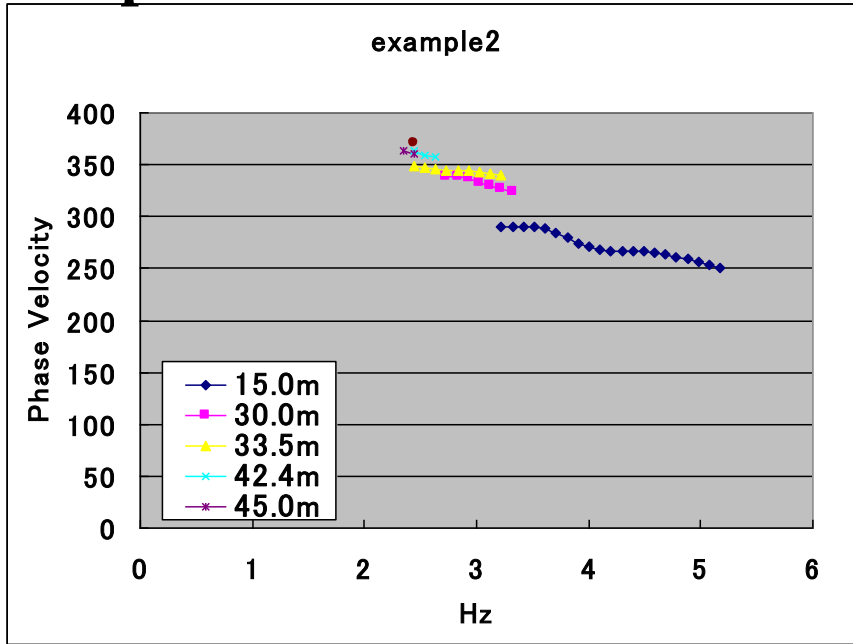


$$r \quad 1 : \frac{1}{2} : \frac{1}{4} : \dots$$

$$r \quad 1 : \frac{\sqrt{3}}{2} : \frac{3}{4} : \dots$$

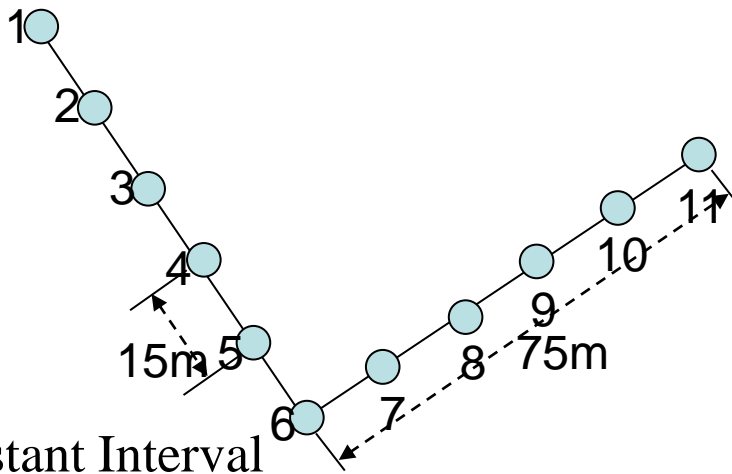
Optimum pattern can be a research topic

Example2

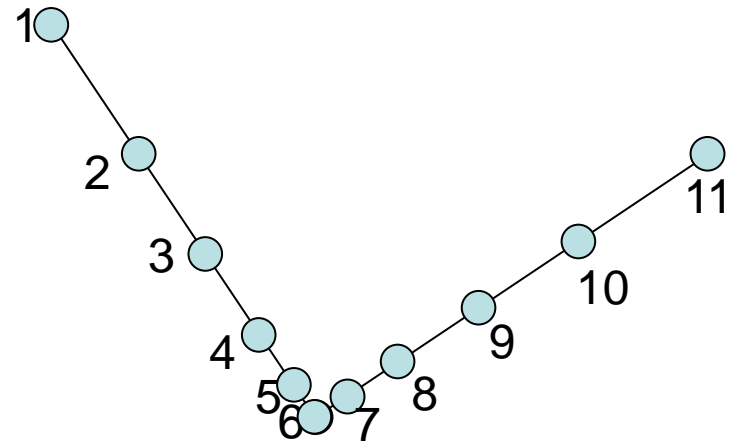


The same problem is observed in a severer way.

A possible counter measure



Optimum pattern can be a research topic



Is 3s-L-Shape Array useful ?

Perhaps “Yes”.

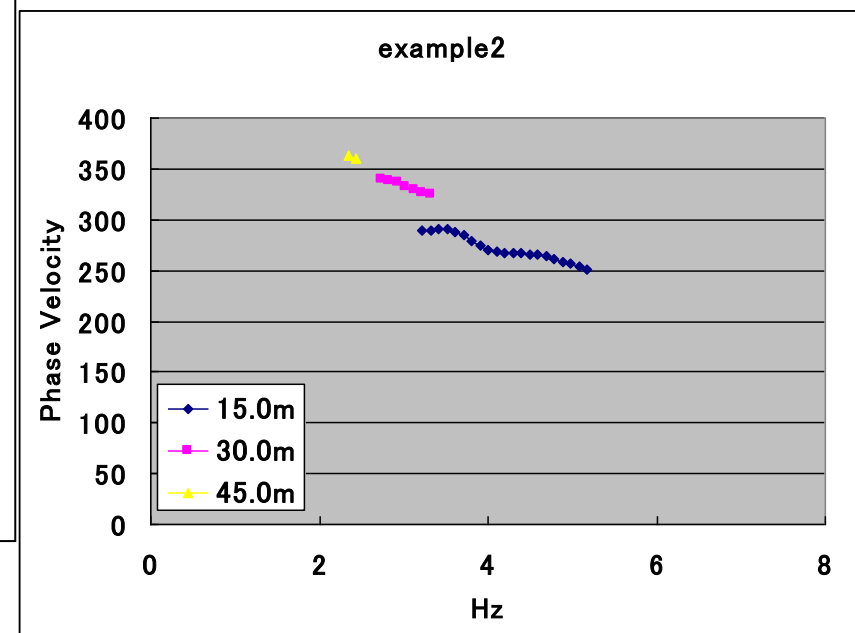
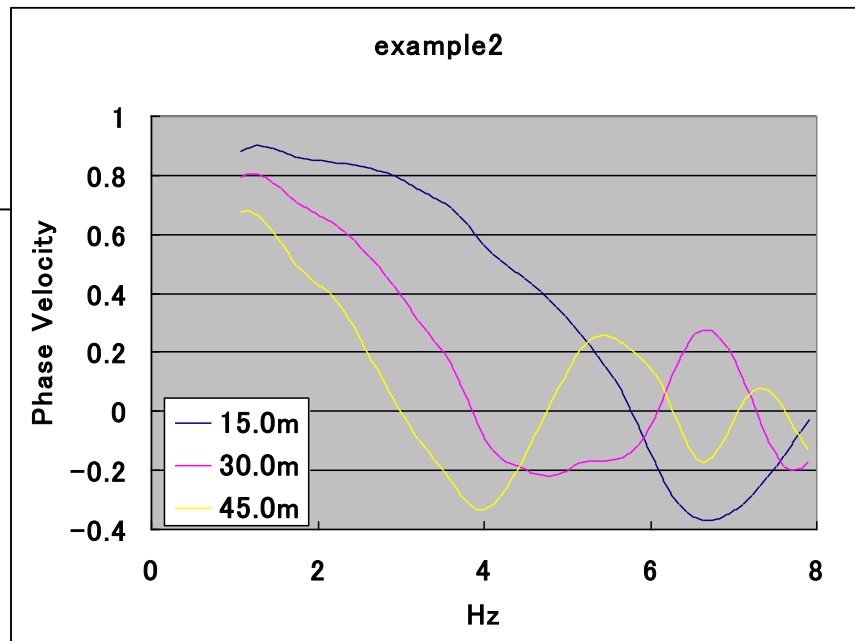
It is worth to test it by field observation, because it will make exploration possible with smaller budget for equipment

Example2

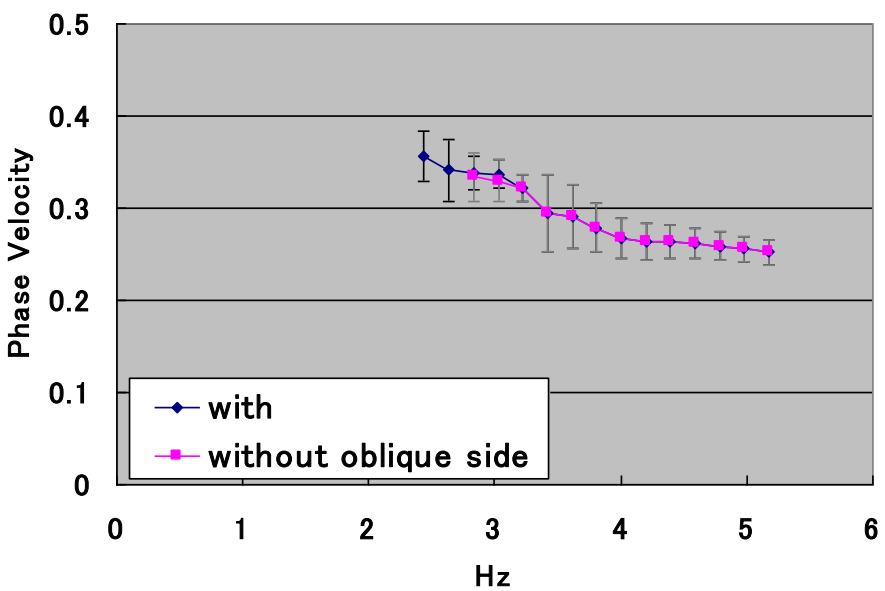
If the oblique side is not used...

Zcorrel3.prm

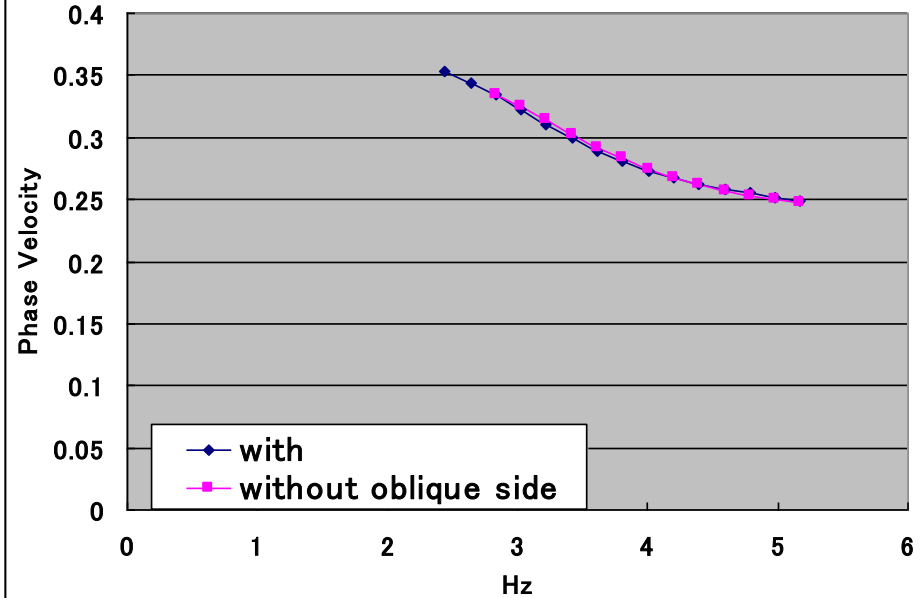
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256 14           :block_size(=<4096), block_number
11  0.04         :nch, dt
0 M  4.0         :kflg(=0 no effect), c1(A1), ajudge
10.0 0.1 0.7     :st0(sec), overlap_ratio, bw(>3.71/Td)
1.0  8.0         :fmin, fmax
10           :ndst
T0.dat          :input file name (A6)
T1.dat          :input file name (A6)
T2.dat          :input file name (A6)
T3.dat          :input file name (A6)
T4.dat          :input file name (A6)
T5.dat          :input file name (A6)
T6.dat          :input file name (A6)
T7.dat          :input file name (A6)
T8.dat          :input file name (A6)
T9.dat          :input file name (A6)
3
6 34 45 56 67 78 89 15.0
4 35 46 68 79      30.0
2 36 69            45.0
SPACLT.dat        :output file name(a10)
FRNGLT.DAT       :output file name(a10)
```



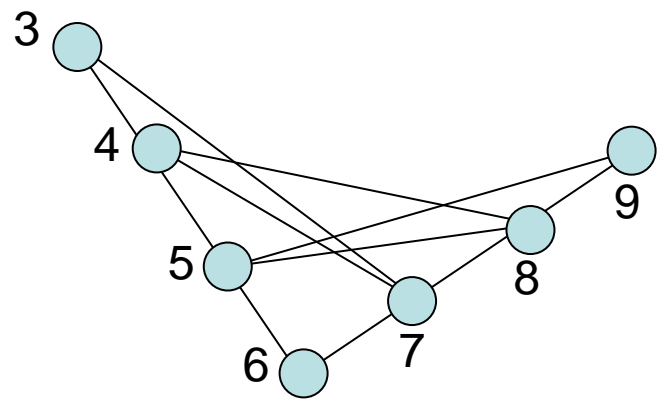
Comparison (Observed Phase Velocity)



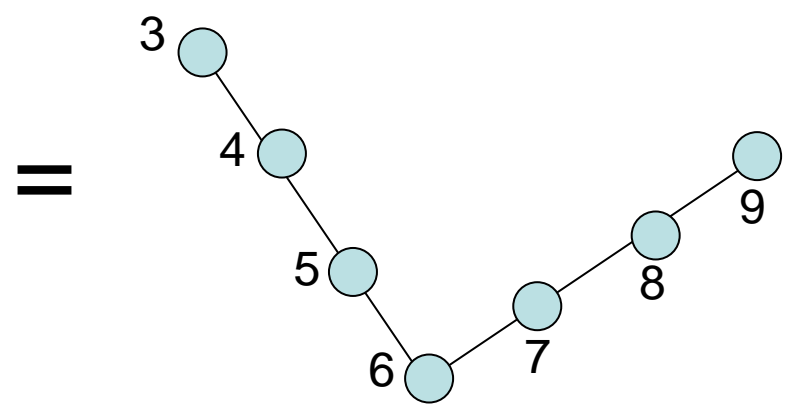
Comparison (Calculated Phase Velocity)



with

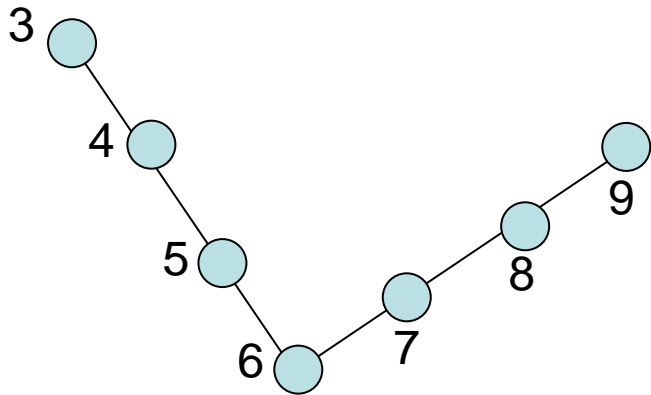


without

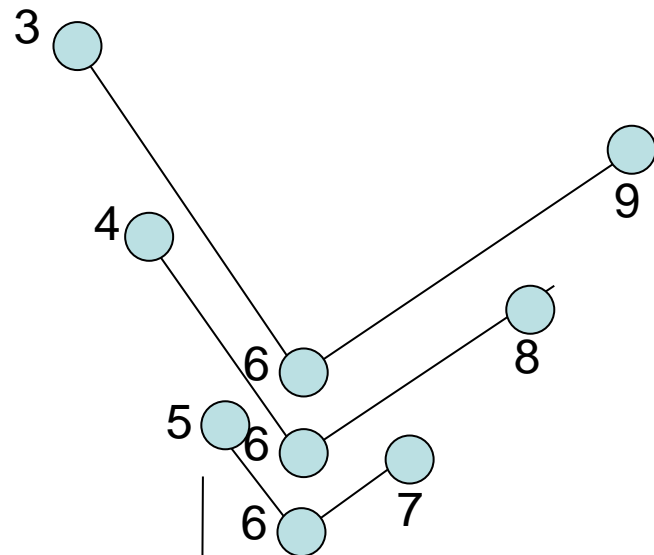


If microtremor is truly stationary over time (Analogy of 2sSPAC):

Simultaneous measurement using
L-shape Array with 7 stations



Simultaneous measurement using 3
configurations of L-shape Array
with 3 stations



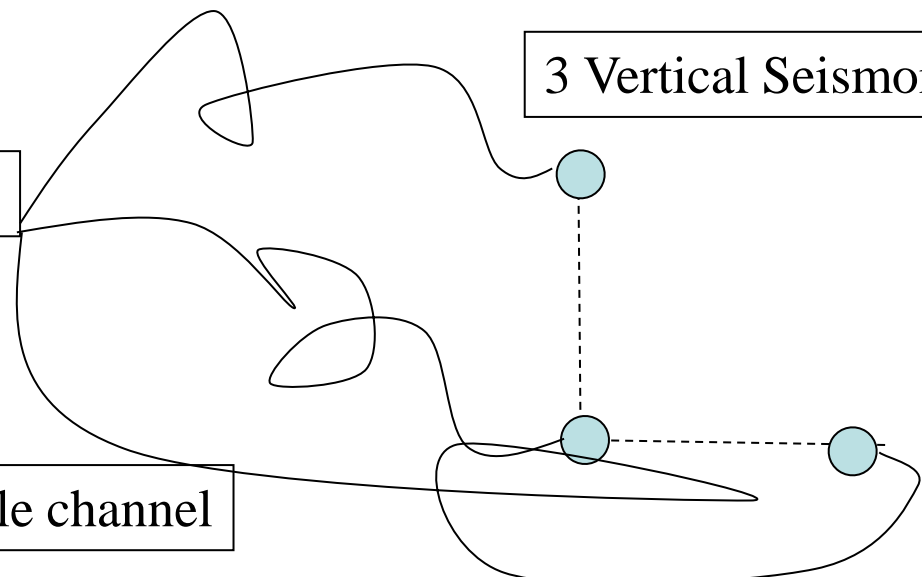
	=	
Time	less	more
Equipment	more	less

3s-L-Shape Array

3-ch Digital Recorder

3 Vertical Seismometer

3 cables of single channel

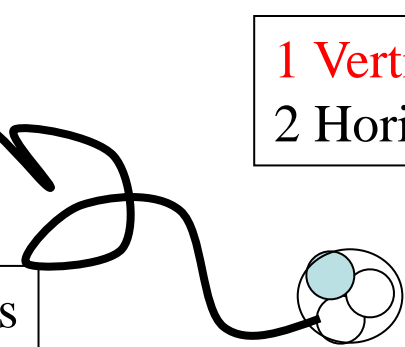


H/V

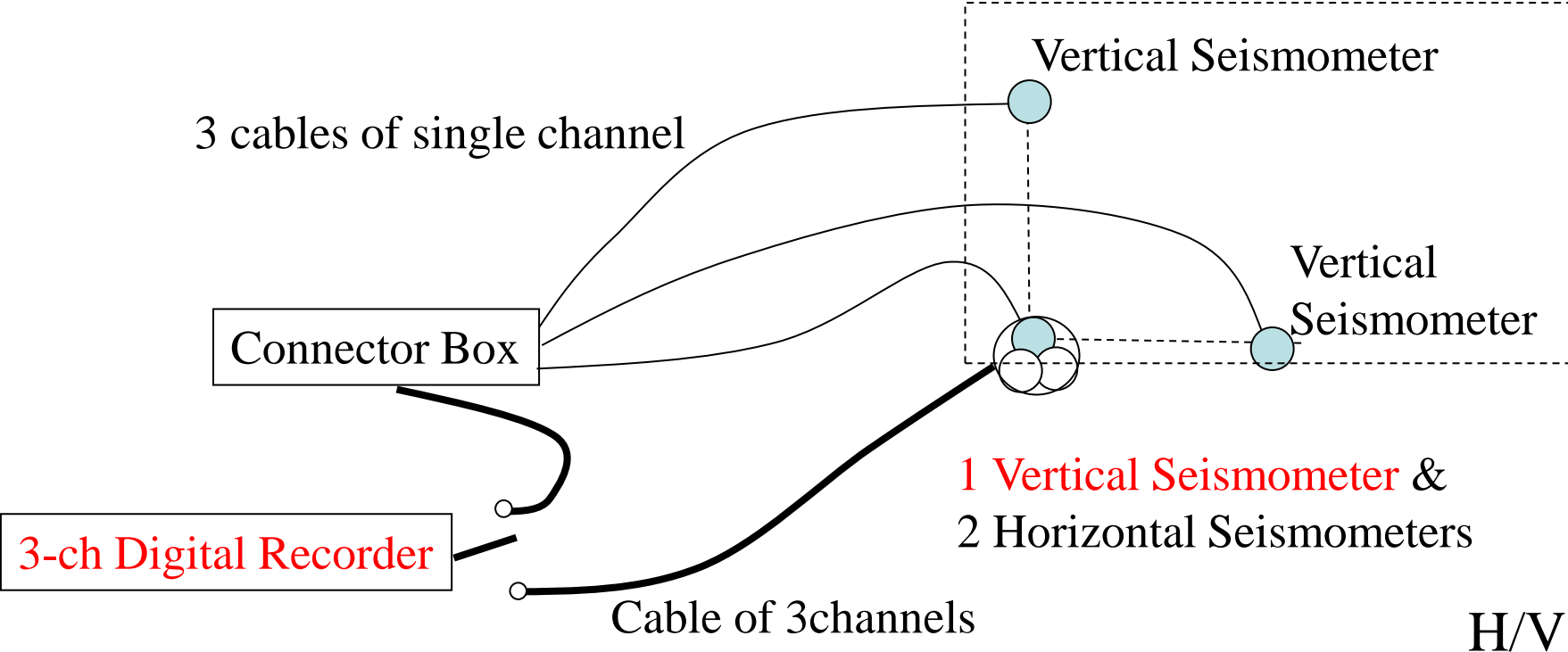
3-ch Digital Recorder

1 Vertical Seismometer &
2 Horizontal Seismometers

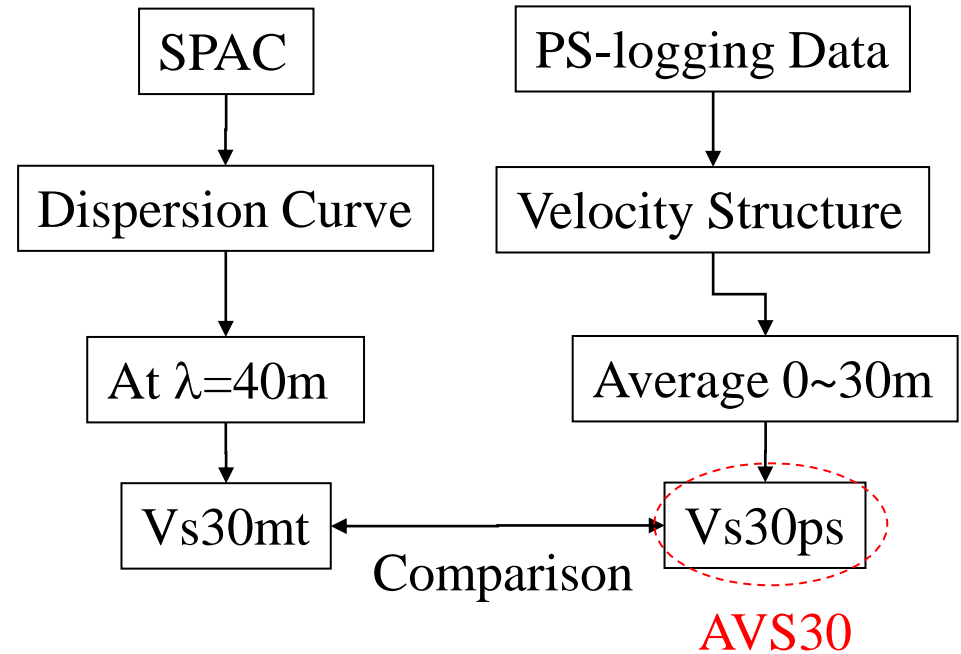
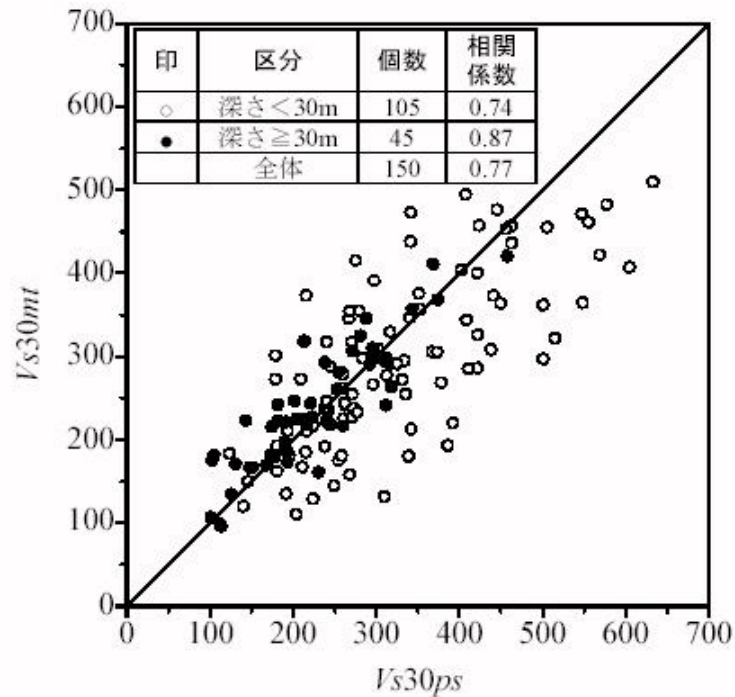
1 cable of 3channels



3s-L-Shape Array



Estimation of AVS30 from the phase velocity of Rayleigh waves that has the wave length 40m (Kon'no et al 2007)



○: Sites where PS-logging did not reach to 30m depth.

●: Sites where PS-logging reached deeper than 30m.

The data used are those obtained at 150 strong motion observation stations in Yokohama City.

Ratio Vs30mt/Vs30ps: Average 1.0, S.D. 0.25

Site Classification (NEHRP 2001)

E: $AVS_{30} < 180\text{m/s}$ (Soft Soil), $N < 15$

D: $180\text{m/s} < AVS_{30} < 360\text{m/s}$ (Stiff Soil), $15 < N < 50$

C: $360\text{m/s} < AVS_{30} < 760\text{m/s}$ (Very Dense Soil & Soft Rock), $50 < N$

Combination of Kon'no et al (2007)'s method with the site classification of NEHRP(2001) can be used for detailed survey of ground condition and micro zonation.

Reference:

Kon'no, K, T. Suzuki, Y. Kamata and T. Nagao, 2007, Estimation of Average S-wave Velocity of Ground Using Microtremors at Strong-Motion Sites in Yokohama, *Jour. of Japan Society of Civil Engineering*, 63, 639-654 (in Japanese with English abstract).

NEHRP, 2001, Recommended Provisions; National Earthquake Hazard Reduction Program. Part 1. Provisions (FEMA 368) prepared for the Federal Emergency Management Agency, Washington DC. Building Seismic Safety Council.