Investigation of Transmission Properties of Silica Aerogel

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Outline

–measurement technique

–systematic studies

–aerogel measurements

–comparison of aerogels

–transmission vs thickness

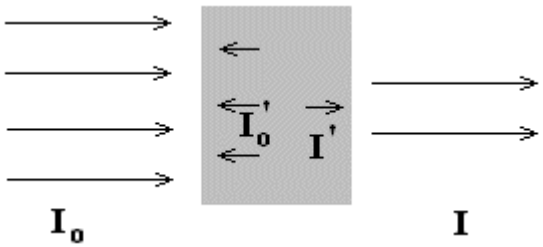
–conclusion

Introduction

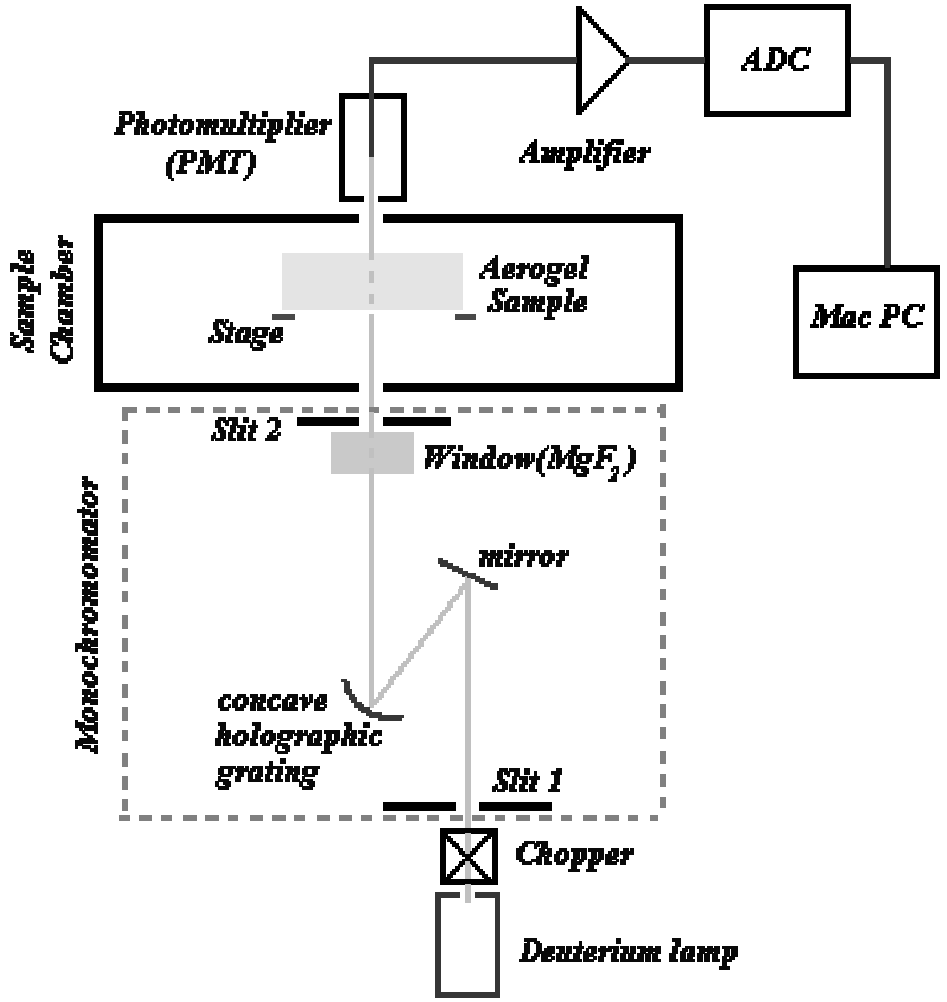
- Aerogel : will use in the BTeV RICH Detector
  - aerogel as a Cherenkov radiator
- Aerogel (general)
  - what it is
  - how it is made
  - why it is interesting (n between gas and liquid)

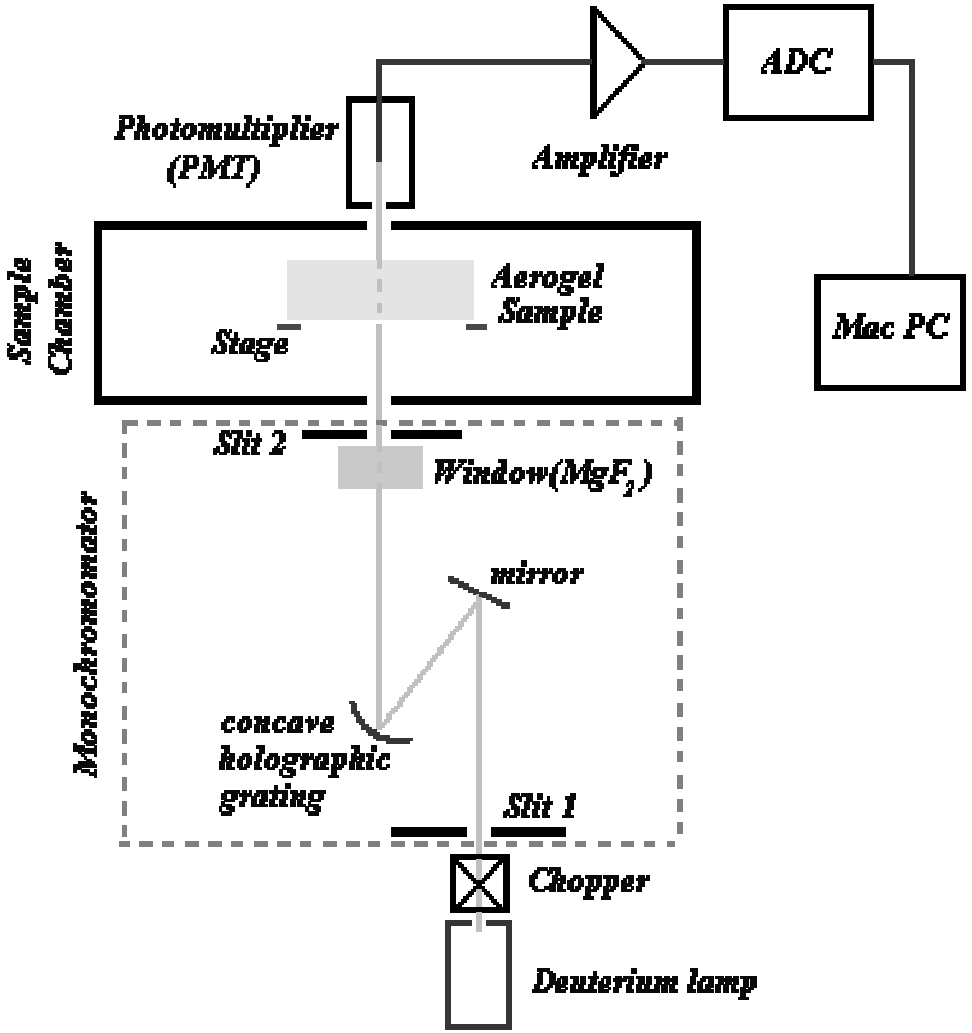
Transmission Measurement Technique

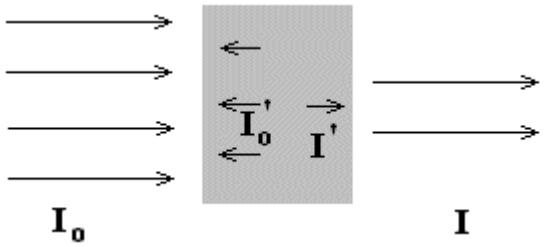
- Spectrophotometer
- External Transmittance
- voltage ratio
- how to measure it?



$$T_{ext} = I / I_o = V_{out} / V_{in}$$



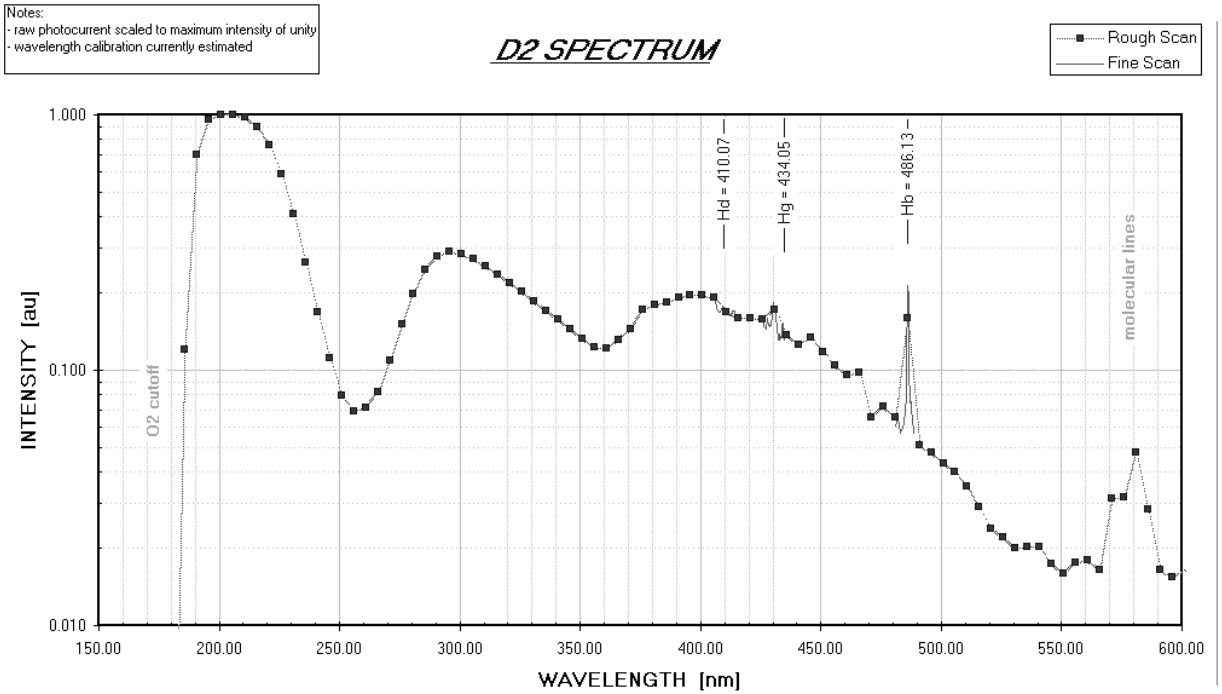

ADC
Photomultiplier
(PMT)
Amplifier
Sample
Chamber
Aerogel
Sample
Stage
Mac PC
Slit 2
Window(MgF2)
Monochromomator
mirror
concave
holographic
grating
Slit 1
Chopper
Deuterium lamp


I0
I'
I0
I

$$T_{ext} = I / I_o$$

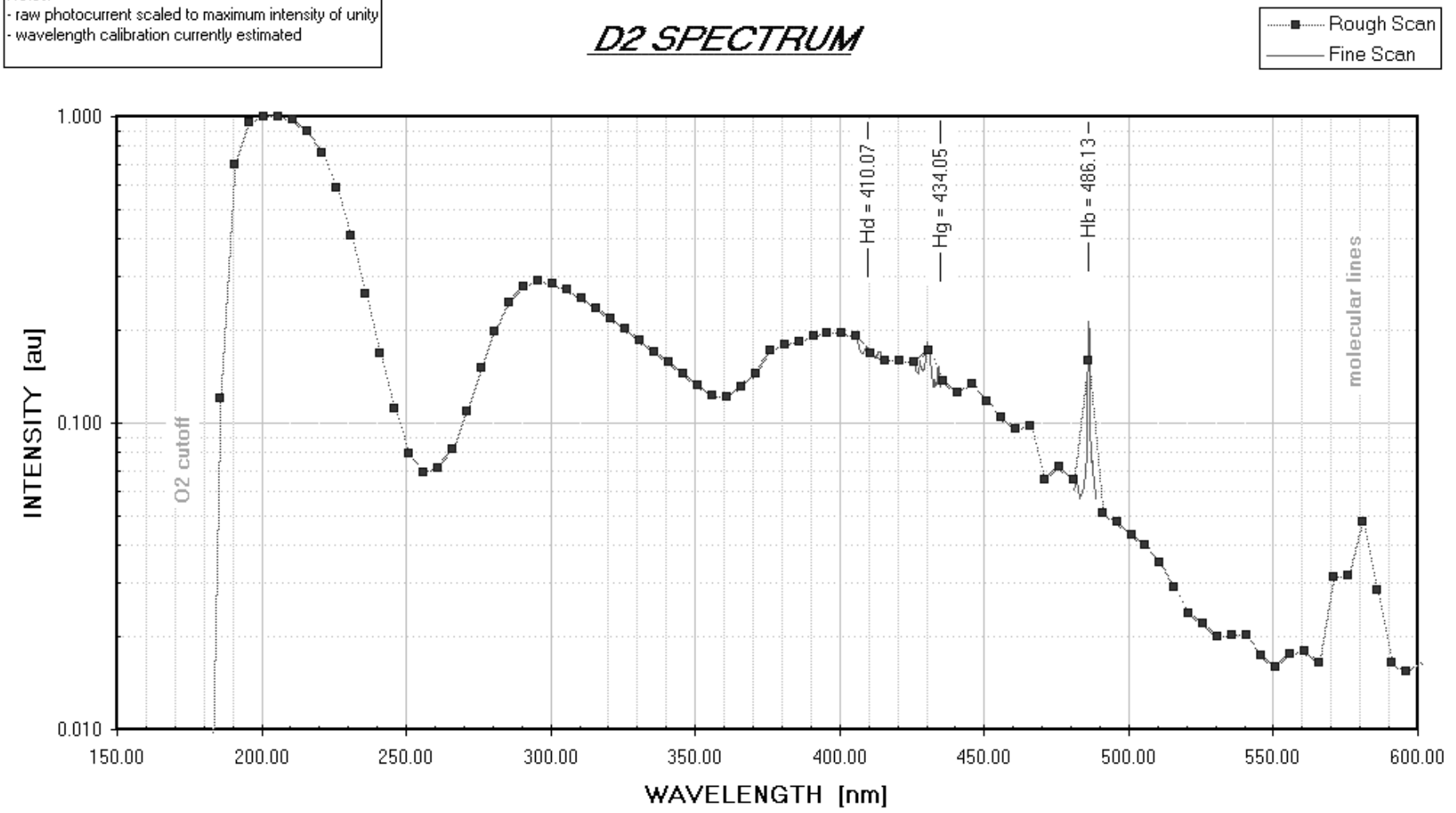
Systematic Studies

- did several other systematic studies (beam profile, glass, backgrounds, etc.)
- Deuterium lamp and calibration in least count scale to nanometer
- wavelength calibration



Notes:
- raw photocurrent scaled to maximum intensity of unity
- wavelength calibration currently estimated

D2 SPECTRUM

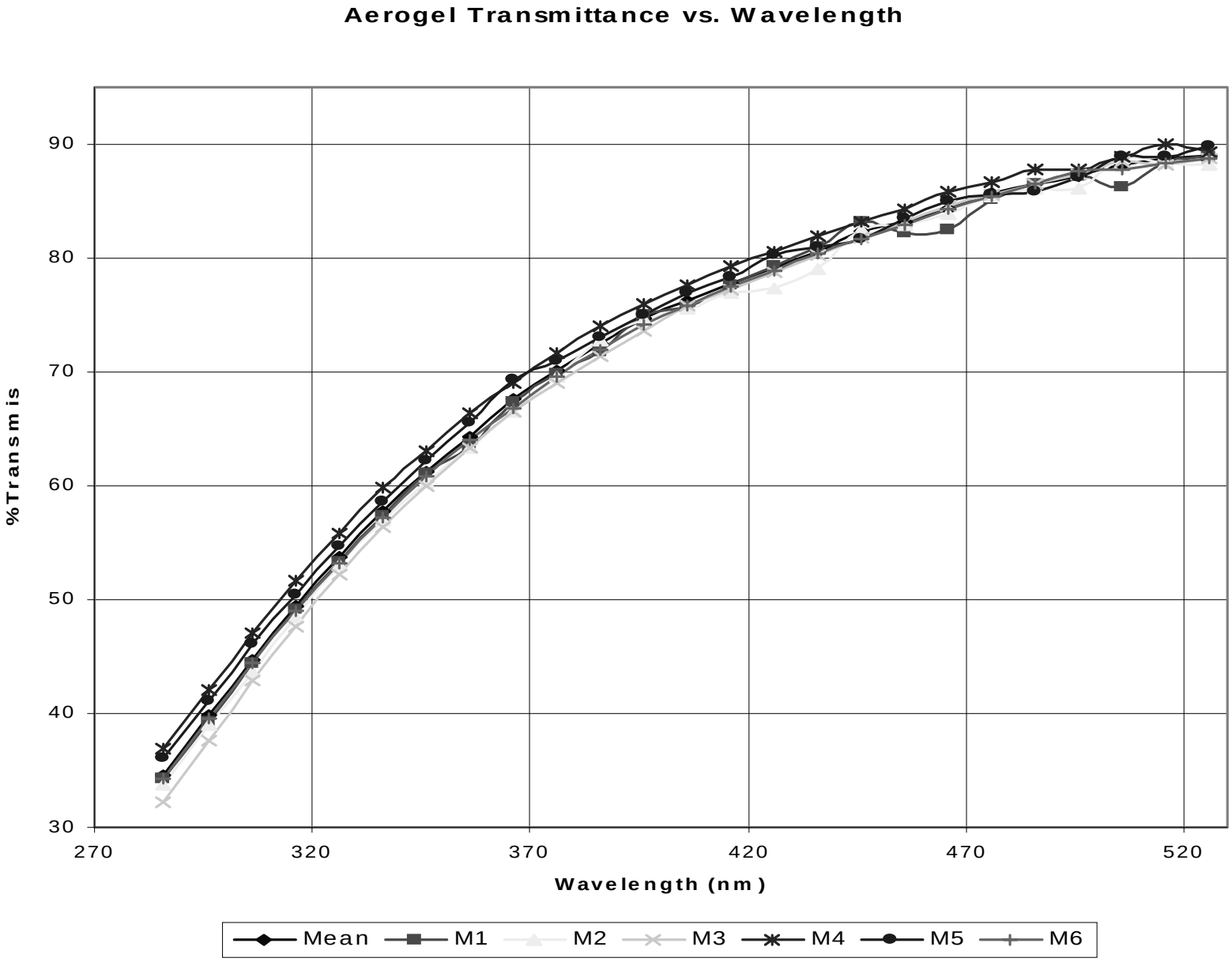


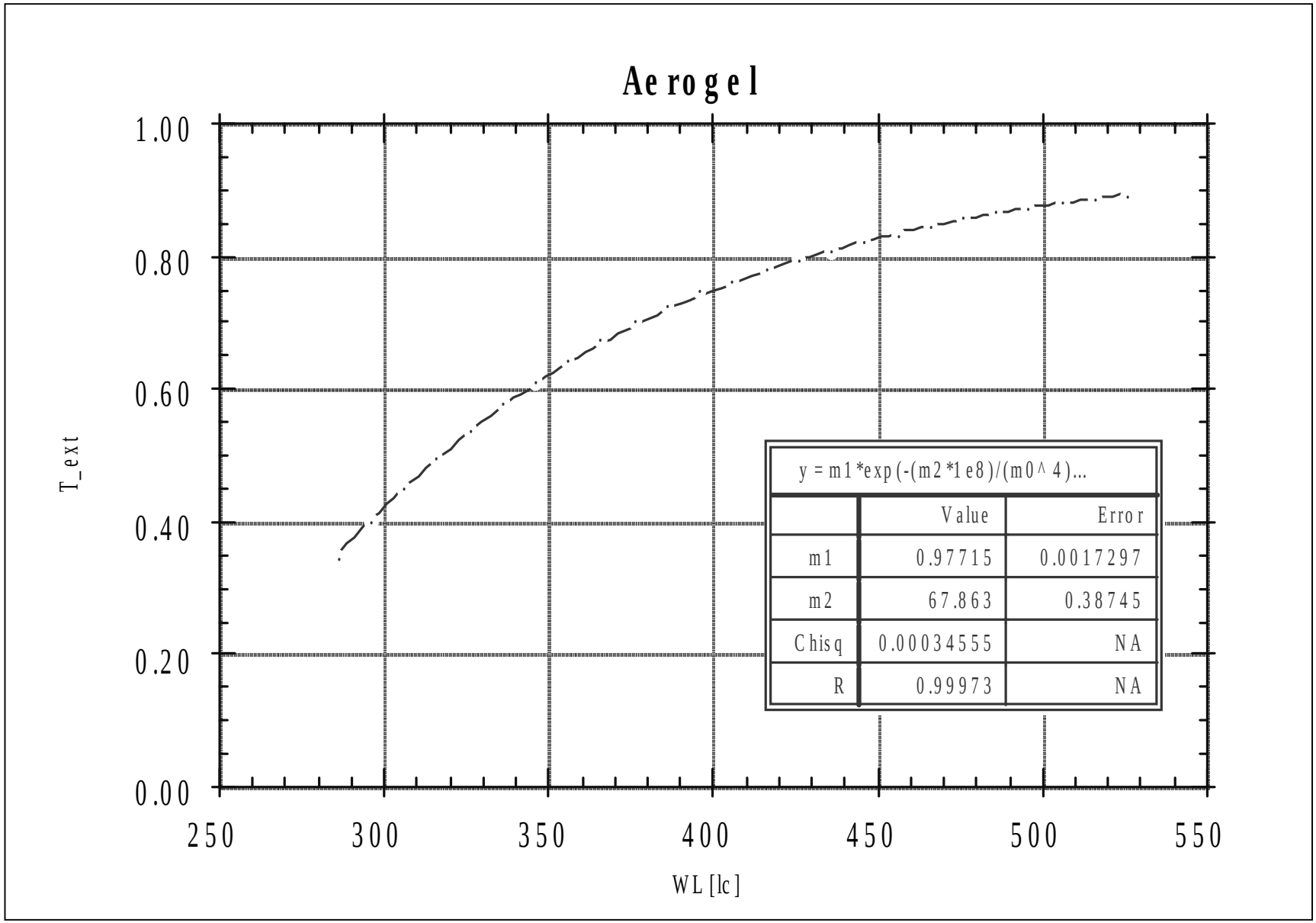
Aerogel Measurements

- Matsushita
- KEK EACC
- Novosibrisk 560-31-2
- KEK A10
- Comparisons

Matsushita Aerogel

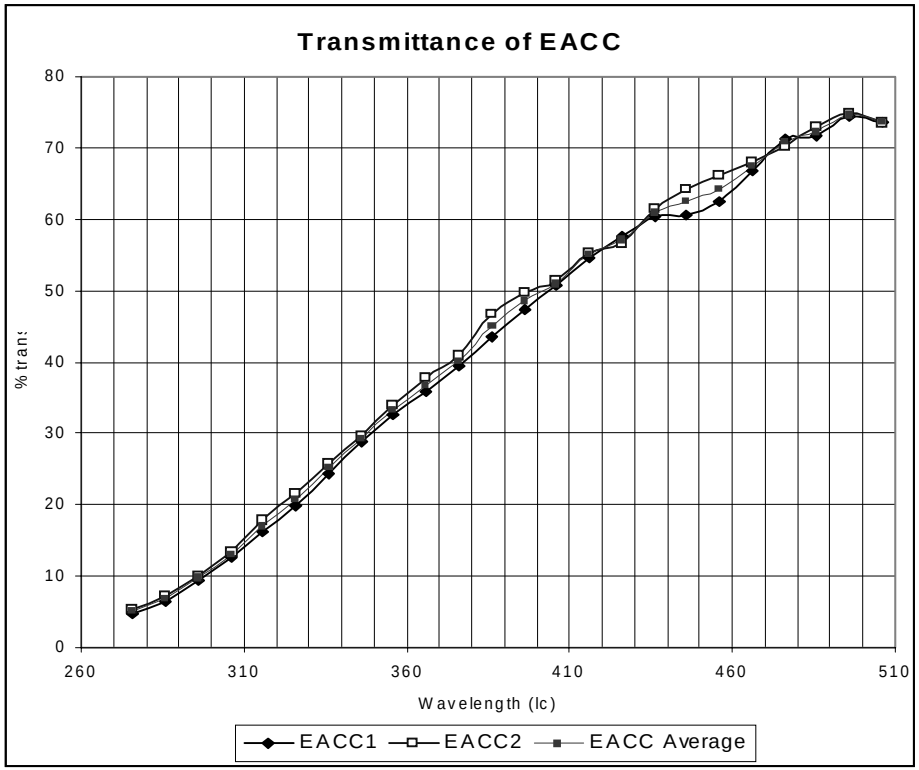
- Measurements of transmittance for each of 1cm samples
- surface scan for 1 cm thick sample
- (plot of measurements and mean)
- Hunt parameters AH,CH; list AH=0.98, CH=67.86 for Matsushita.

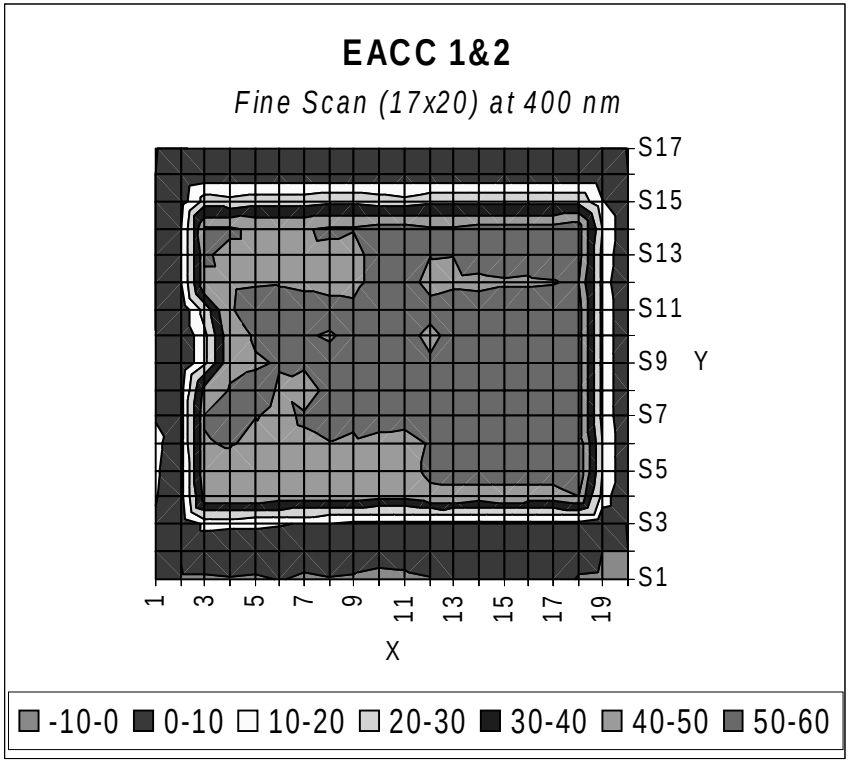

Aerogel Transmittance vs. Wavelength
%Transmis
90
80
70
60
50
40
30
270
320
370
420
470
520
Wavelength (nm)
Mean
M1
M2
M3
M4
M5
M6


Aerogel
1.00
0.80
0.60
0.40
0.20
0.00
T_ext
250
300
350
400
450
500
550
WL [lc]
y = m1*exp(-(m2*1e8)/(m0^4)...
Value
Error
m1
0.97715
0.0017297
m2
67.863
0.38745
Chisq
0.00034555
NA
R
0.99973
NA

KEK EACC

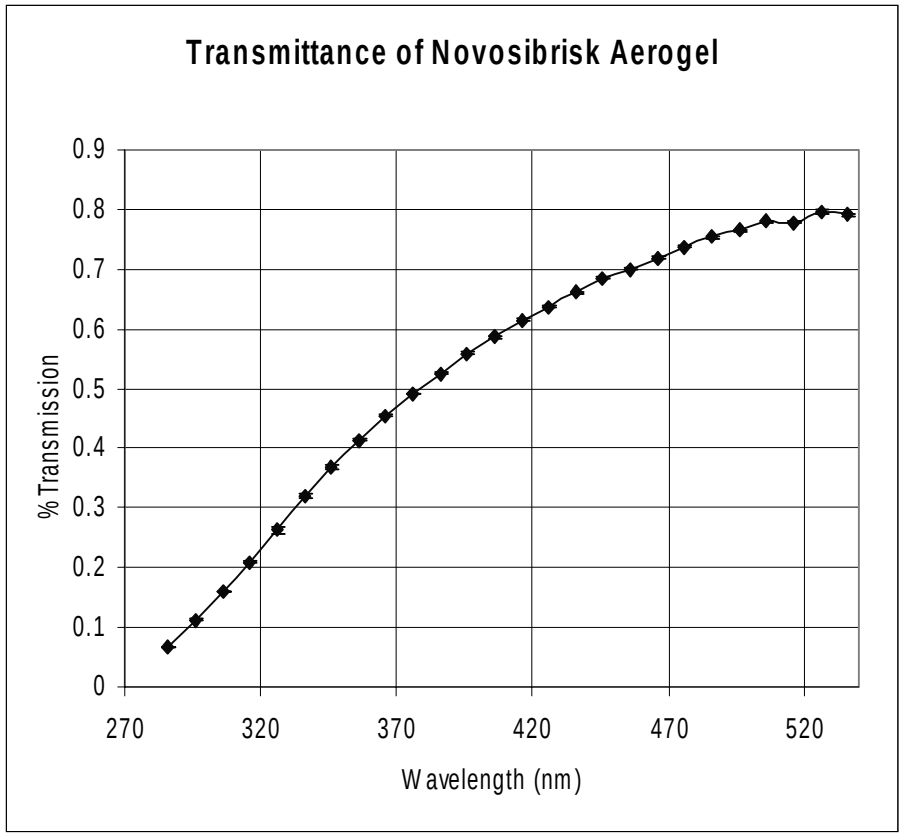
- Measurements of transmittance for each of the samples
- Surface scans for different wavelengths





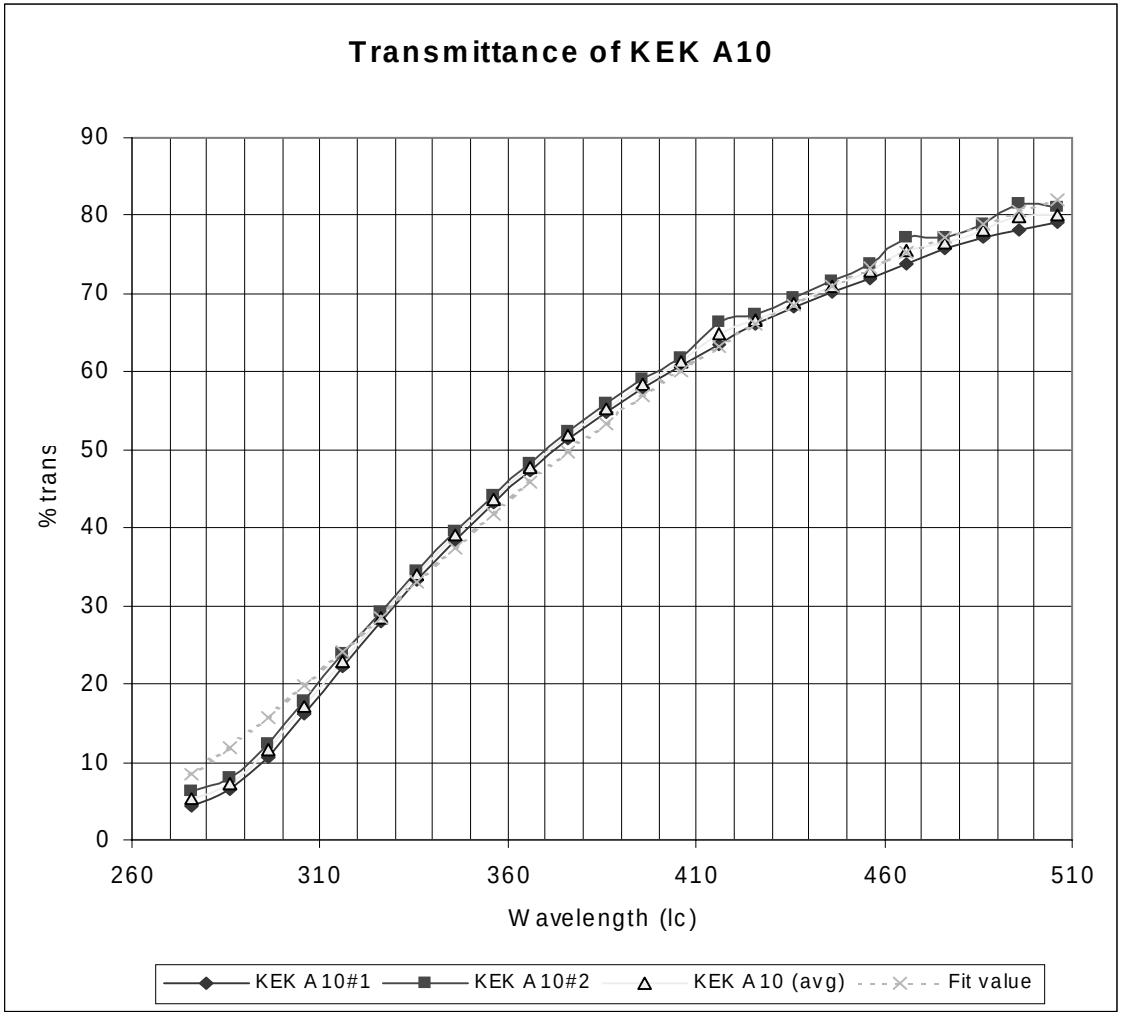
Novosibrisk

- Measurements of transmittance for each of the samples
- Surface scans for different wavelength



KEK A10

- Measurements of transmittance for each of the samples



Comparison of Different Aerogels

- Novosibrisk is the best one in terms of clarities.
- Matsushita aerogels compares favorably with Novosibrisk.
- Matsushita aerogels are quite better than KEK aerogels.
- (plot) and (table) normalized to 1 cm thickness

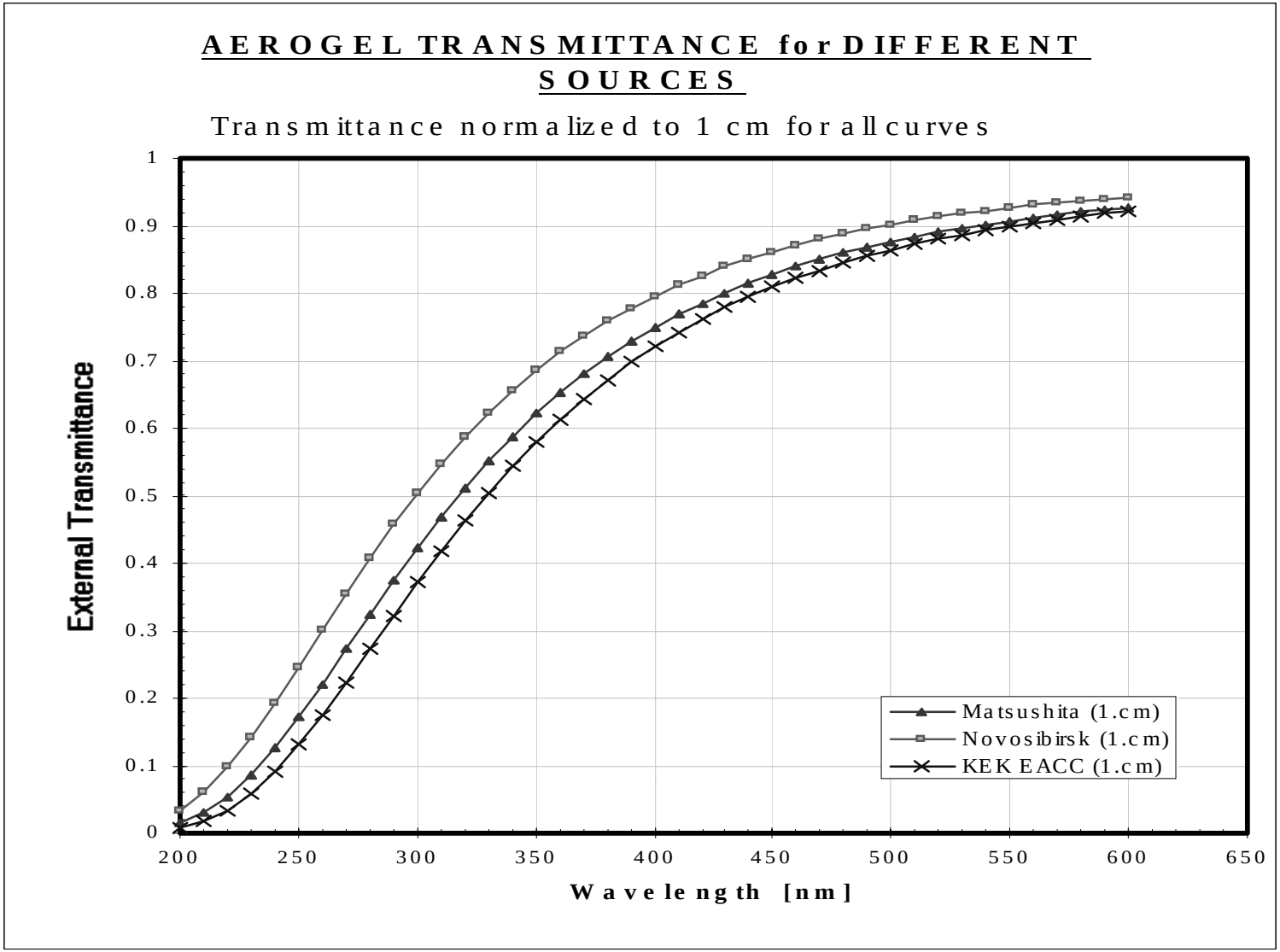
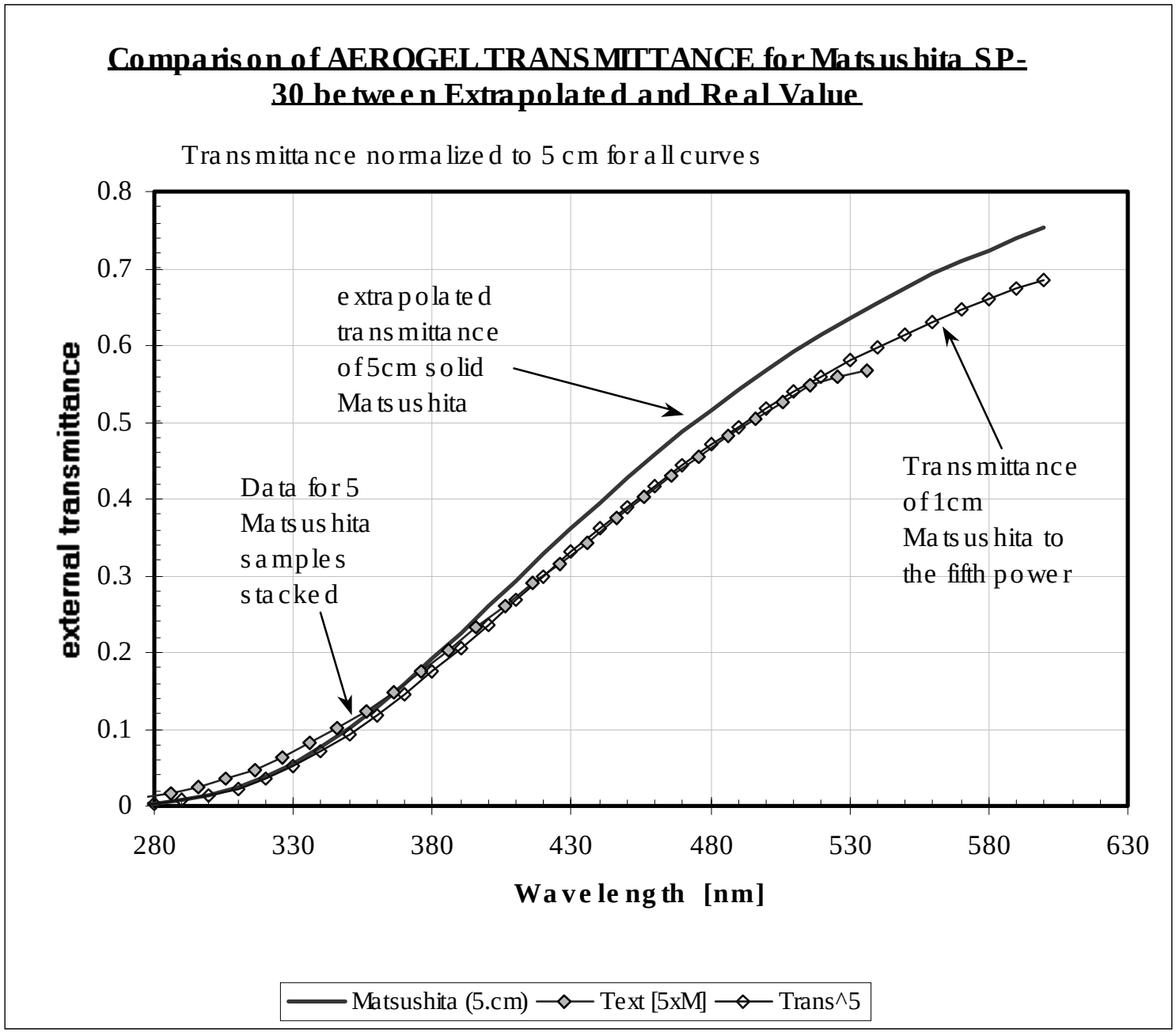

AEROGEL TRANSMITTANCE for DIFFERENT SOURCES
Transmittance normalized to 1 cm for all curves
External Transmittance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
200
250
300
350
400
450
500
550
600
650
Wavelength [nm]
Matsushita (1.cm)
Novosibirsk (1.cm)
KEK EACC (1.cm)

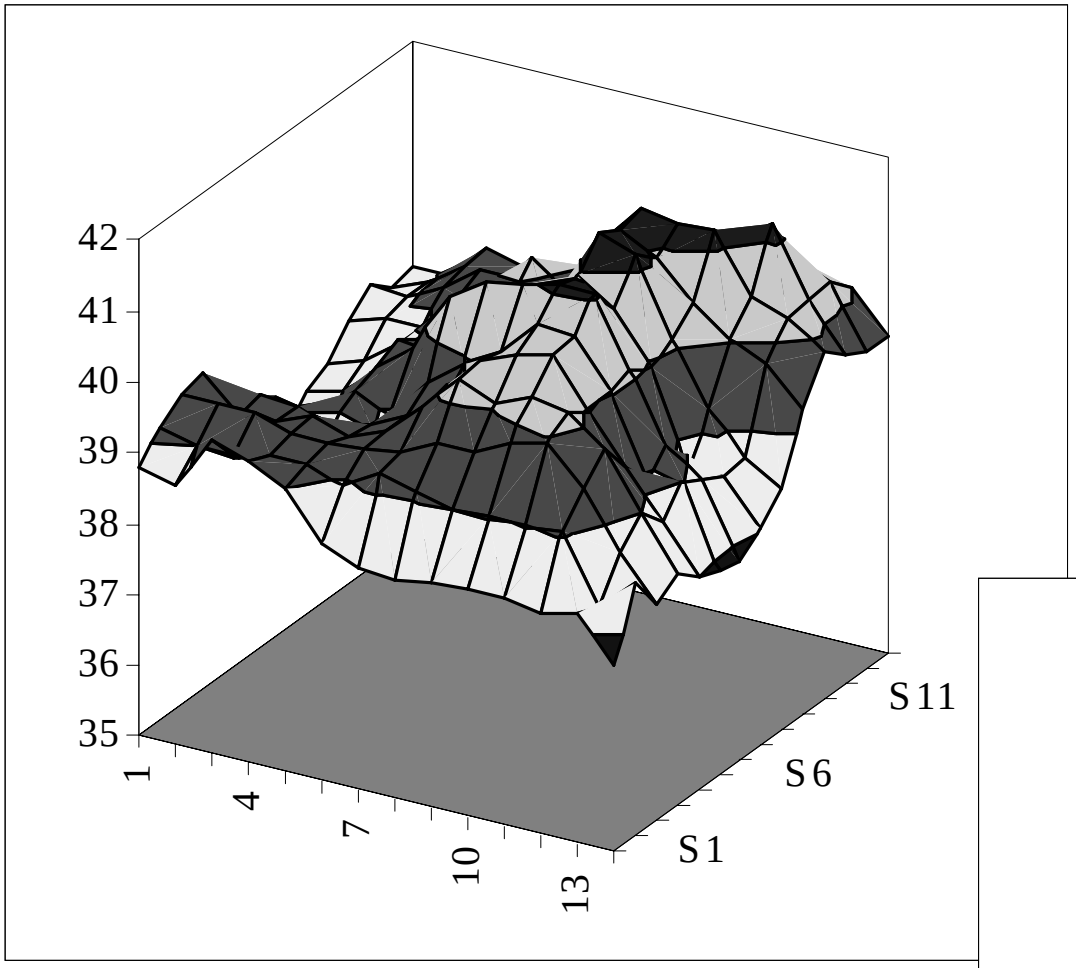
Table of Comparisons				
Sample (1cm)	n	A	C	Comments
Matsushita	1.030	0.997±0.002	67.863	Several slabs of equal thickness(1cm), quite old, stained ring on the surfaces, some cracks at the corner
KEK EACC	1.030	0.980±0.004	78.614	Two pieces of equal size, the widths of them are too short, hard to find the scan position, some fingerprints on the surfaces, some breakout around corner and meniscus around edges.
Novosibrisk	1.049	0.983±0.011	54.04	The clearest among all aerogels being tested, clear surface, and quite thick
KEK A10	1.028	1.0203 (questionable)	84.932 (questionable)	Several broken pieces, hard to scan, some fingerprints on the surfaces, breakout around the edges. The parameters obtained from this sample is questionable.

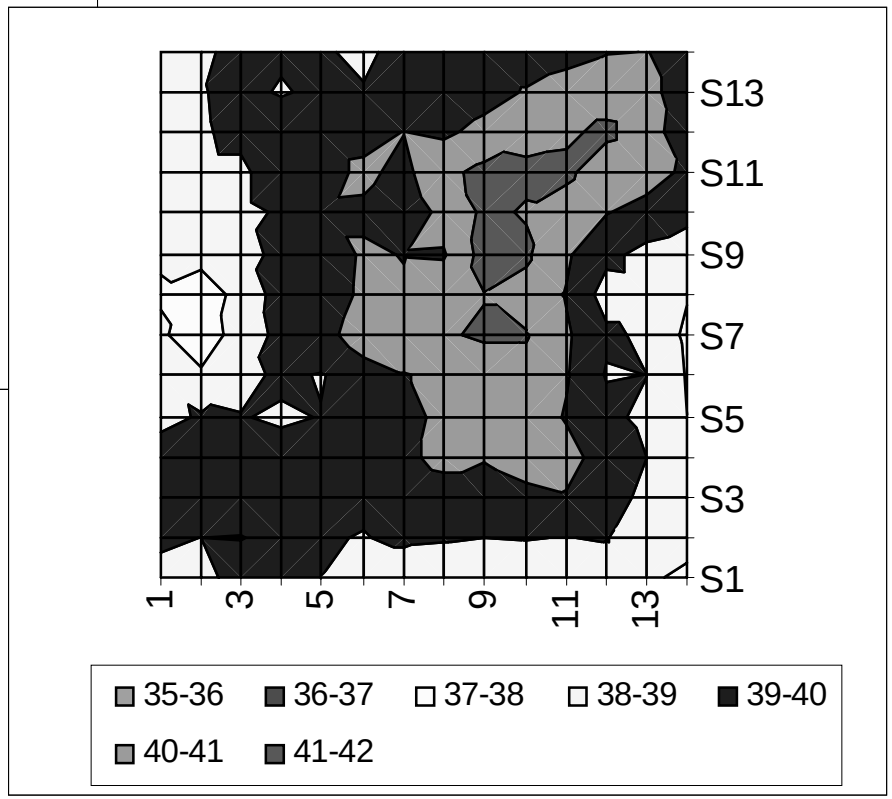
Table 4.1 Table shows comparisons between different kinds of aerogels

Measurement of Thick Aerogel

- Measurements of transmittance for stacked 1cm samples (Varied from 1cm to 5cm)
- Surface scans of stacked sample


Comparison of AEROGEL TRANSMITTANCE for Matsushita SP-30 between Extrapolated and Real Value
Transmittance normalized to 5 cm for all curves
external transmittance
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
280
330
380
430
480
530
580
630
Wavelength [nm]
extrapolated transmittance of 5cm solid Matsushita
Data for 5 Matsushita samples stacked
Transmittance of 1cm Matsushita to the fifth power
Matsushita (5.cm)
Text [5xM]
Trans^5


42
41
40
39
38
37
36
35
1
4
7
10
13
S1
S6
S11


S13
S11
S9
S7
S5
S3
S1
1
3
5
7
9
11
13
35-36
36-37
37-38
38-39
39-40
40-41
41-42

Conclusions

- Transmittance of normal incident light of an aerogel can be explained roughly by Rayleigh scattering formula.
- Transmittance of stacked aerogels is roughly a successive transmission of each of the aerogels.
- first -- I had fun (a real reason)
- second -- I got paid (a real reason)
- third -- I am leaving in three weeks (a real reason)