SOCIETY OF ACOUSTICS
(SINGAPORE)

E-Newsletter
September 2019 issue

Registration No	: 0331/1989
Year of Registration	: 1989
President	: Dr Gan Woon Siong
Secretary	: Prof Y F Zhou
Treasurer	: Dr Venu

CONTENT

- CONFERENCE NEWS
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- INTERNATIONAL ACOUSTICS NEWS
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I. CONFERENCE NEWS

The 27th International Congress on Sound and Vibration(ICSV27) will be held in Prague, Czech Republic from 11 to 15 July 2021.

Woon Siong Gan will be organising three structured sessions on:

Nonlinear acoustics and vibration

Acoustic metamaterials & phononic crystals: fundamentals and applications

Sound propagation in curvilinear spacetime

Please visit www.icsv27.org for more informations.

II. ANNOUNCEMENTS

The Society of Acoustics will be sending out invoices to members with outstanding membership subscriptions. Members are encouraged to make payment in support of the Society.

The E-Newsletters will be made available to industrial contacts in an effort to promote the activities of the Society.

The Society is also exploring the possibility of organising talks and other professional events in collaboration with acoustic societies of other countries.

II. ANNOUNCEMENTS

Membership Certificates will soon be made available to all members who had made full payments of membership dues

The Society aims to increase membership by inviting all persons, including those from the institution of higher learning and other related societies such as the Institute of Architects, Singapore and the members of the mechanical engineering division of the Institution of Engineers, Singapore who are qualified in the various field of Acoustics to join our Society.

We are especially keen to invite students to join our society and we are establishing the Youth Chapter soon.

III. MEMBER'S NEW ADDRESS

Please note that Acoustical Laboratory Pte Ltd has moved to the following new address:

WE HAVE MOVED

TO OUR NEW OFFICE AT

318 Tanglin Road, #01-56, Phoenix Park Campus,

Singapore 247979.

OUR CONTACT NUMBERS REMAIN UNCHANGED.

Tel: (65) 6465 6212 Fax: (65) 6465 6223

Email: enquiry@aclab.sg Website: www.aclab.sg

IV. MEMBERSHIP SUBSCRIPTION

- Fellow S$70
- Member S$50
- Associate S$30
- Student S$15
- Corporate S$200

FEE BASED ON ANNUAL RATE

FOR MORE INFORMATION PLEASE CONTACT: Dr. Woon Siong Gan at email: wsgan5@gmail.com

Membership application forms can be downloaded from the society website: www.acousticssingapore.com. Please complete and email to wsgan5@gmail.com

V. ARTICLE

My Role in the Founding of Condensed Matter Physics

Woon Siong Gan

Condensed matter physics is the branch of physics which deals with the macroscopic and the microscopic properties of matter. As its name suggests, it deals with the condensed phases of matter. Examples of condensed phases of matter are solids and liquids and Bose Einstein condensates which superconductors, liquid helium and magnetization.

V. ARTICLE

Until the 1960s, the solid state physics is well developed but the liquid state physics is still far behind in development. The reason is the liquid molecules are randomly distributed unlike the solid crystals are symmetrically aligned and easier to deal with. The only feasible method to deal with liquid state physics is statistical mechanics and use statistics to deal with the liquid molecules. In the 1960s, solid state physics combined with liquid state physics to form condensed matter physics which has an important

V. ARTICLE

component to deal with phase transition using statistical mechanics. In 1967, Philip Warren Anderson and Volker Heine changed the name of the solids state theory group of the Cavendish Laboratories, Cambridge to condensed matter theory group to reflect the importance of phase transition. Today condensed matter physics has largest number of members among the various divisions of the American Physical Society.

V. ARTICLE

My PhD thesis(1969)[1] from the physics department of the Imperial College London “Transport Theory in Magnetoacoustics”first introduced transport theory into condensed matter physics. In the past transport theory is only used in neutron science for nuclear reactor design. This thesis described the propagation of gigacycle ultrasonic waves in semiconductors in the presence of high magnetic fields and low temperatures.

V. ARTICLE

Also this is the first time to introduce magnetoacoustics to semiconductors . In the past magnetoacoustics was only for metals. My thesis showed that unlike metals, semiconductors do not have magnetoacoustic effect.

I coined or invented the name transport theory in condensed matter physics 1966 during my PhD works. Transport theory is today the key

V. ARTICLE

foundation for the theoretical design of materials. In my thesis, statistical mechanics approach based on Boltzmann transport equation was used for the treatment of ultrasound propagation in solids instead of the usual electron-phonon interaction of many body theory. The statistical mechanics approach has the advantage of dealing with phase transition from metal to semiconductor. In fact the use of warped energy surface model to represent semiconductor instead of the

V. ARTICLE

spherical energy surface model of free electrons model to represent metal is a form of topological phase transition. The Shockley tube integral was used to solve the Boltzmann transport equation to obtain the magnetoconductivity. It showed huge increase in the conductivity for semiconductor compared to that of metal.

Transport theory plays a key role in phase transition and phase transition in turn is an important component of condensed matter

V. ARTICLE

physics. Transport theory is the theory of transport properties. In a previous paper[2] I have shown the singularity behaviour of transport properties at the critical point of phase transition.

Statistical mechanics has an important role in condensed matter physics . The Boltzmann transport equation is the most important equation in statistical mechanics.

V. ARTICLE

To sum up, my PhD thesis played the role of introduction of statistical mechanics to condensed matter physics and the application of transport theory to phase transition.

References

1.Woon Siong Gan, Transport Theory in Magnetoacoustics, PhD thesis, Imperial College London, 1969.

2.Woon Siong Gan, The Singularity Phenomena in Physics, Society of Acoustics(Singapore), e-newsletter, June 2019.

Powerpoint Presentation of Tim Kuschel on 8 Aug 2019 on Design and Compliance Considerations of Reverberation Times in Difficult Acoustic Environments

Reverberation Times in Difficult Acoustic Environments

GUZ BOX design + audio

Presentation by:
Tim Kuschel MAAS, MAES, MASA
Acoustic Consultant

GUZ BOX design + audio
m: +61 408 273 034
e: tim@guzbox.com.au
w: www.guzbox.com.au

Introductions

- Introduction: Presenter, Tim Kuschel
- Architectural Porjects Coordinator
- Acoustic Consultant specialising in architectural + electro-acoustic consulting, including speech intelligibility
- Member, Australian Acoustical Society (AAS)
- Member, Audio Engineering Society (AES)

- Member, Acoustical Society of America (ASA)
- Member, Society of Acoustics Singapore (SAA)
- Member, SynAudCon
- Beta tester for AFMG – EASE, Reflex, Soundflow software + others

Introductions

- Introduction
- Brief overview of legislation + standards
- Discussion on Calculation of Reverberation Times
- Application
- But first, let’s consider a few spaces

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What is the reverberation time of these spaces?

Is reverberation equal everywhere?

How does speech and/or music sound in these spaces?
Definition: Reverberation Time
The reverberation time of an enclosure, for a sound of a given frequency or frequency band, is the time that would be required for the reverberantly decaying sound pressure level in the enclosure to decrease by 60 decibels, measured in seconds.

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10

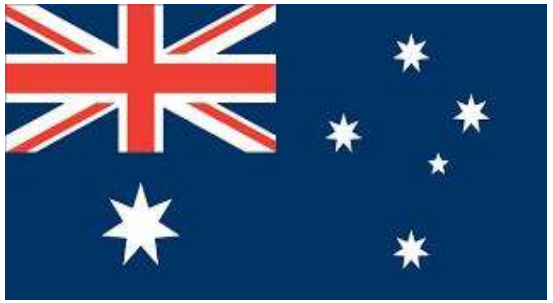

AS/NZS 2107:2016

Australian/New Zealand Standard™

Acoustics—Recommended design sound levels and reverberation times for building interiors

Legislation, Codes + Standards (Australia)

- The National Construction Code (NCC) now incorporates the Building Code of Australia (BCA)
- This is the main design document for design of new building works
- There is no requirement to provide any form of acoustic amenity, within any classification of building, within the current NCC/BCA



- Design considerations
- There is no requirement to provide any form of acoustic amenity, within any classification of building, within the current NCC/BCA
- AS 2107-2016 “Acoustics – Recommended design sound levels and reverberation times for building interiors” provides recommendations for design sound levels and reverberation times for various areas within building, including office areas, common areas, etc.
- Design considerations

Item	Type of occupancy/activity	Design sound level ($L_{Aeq,t}$) range	Design reverberation time (T) range, s
5	OFFICE BUILDINGS		
	Board and conference rooms	30 to 40	0.6 to 0.8
	Cafeterias	45 to 50	< 1.0
	Call centres	40 to 45	0.1 to 0.4
	Corridors and lobbies	45 to 50	< 1.0
	Executive office	35 to 40	0.4 to 0.6
	General office areas	40 to 45	0.4 to 0.6
	Meeting room (small)	40 to 45	< 0.6
	Open plan office	40 to 45	0.4 (see Note 1)
	Public spaces	40 to 50	0.5 to 1.0
	Quiet rooms	40 to 45	< 0.6
	Reception areas	40 to 45	0.6 to 0.8
	Rest rooms and break-out spaces	40 to 45	0.4 to 0.6
	Toilets	45 to55	—
	Undercover carparks	< 65	—
	Video/audio conference rooms	30 to 40	0.2 to 0.4

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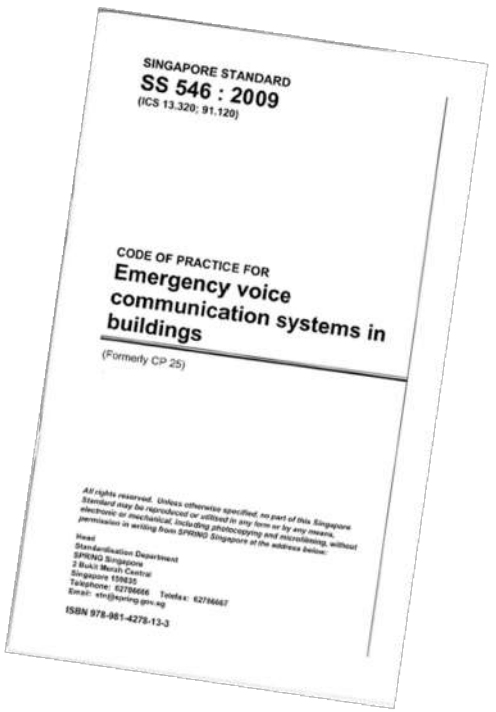

Measurement of intelligibility: AS1670.4-2015

At all places within the evacuation zone where ambient SPL (noise) is less than 85 dB(A) and RT60 ≤ 1.5 s
Where SNR > 10dB and RT60 < 1.0 s
Where VAD and VWD are used
Where speech intelligibility requirements can't be met
Where RT60 > 1.5 s

CIS ≥ 0.7 Or CIS ≥ 0.65 on standby power
No requirement to measure intelligibility
No requirement to measure intelligibility
Install VAD or VWD
???

Measurement of intelligibility: SS546:2009

Minimum value for Intelligibility
For persons familiar with messages
SNR ≥ 10dB
Where L_{A90} > 75dB
Where RT > 1.5s (500Hz and 2kHz)
Where listener to loudspeaker > 10m

0.5 STI

0.45 STI
Measured according to occupational noise
Assistance of qualified electro-acoustic designer should be considered
Assistance of qualified electro-acoustic designer should be considered
Assistance of qualified electro-acoustic designer should be considered

- Problems with current design of architectural spaces
- No requirement with Australian building codes and standards to provide any level of acoustic amenity in any class of building

Architects and building designers do not necessarily understand the complex interaction of acoustics within a space

- AS2107-2016 provides poor guidance for modern spaces – it's a recommended standard, unless referenced by other legislation
- Standards typically reduce RT to a single value

Eyring Equation

$$T_{RT60} = \frac{0.161\ V_m}{-S\ \ln(1-\bar{a})} = \frac{0.049\ V_f}{-S\ \ln(1-\bar{a})}$$

T_{RT60} = RT 60 Reverberation Time, [seconds]
V_f = Volume of Room, [cu ft]
V_m = Volume of Room, [cu m]
S = Total Surface Area of Room, [sq ft] or [sq m]
$\bar{a}$ = Average Absorption Coefficient of Room Surfaces

Sabine Equation

$$T_{RT60} = \frac{0.161 V_m}{S\,\bar{a}} = \frac{0.049\ V_f}{S\,\bar{a}}$$

T_{RT60} = RT 60 Reverberation Time, [seconds]
V_f = Volume of Room, [cu ft]
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S = Total Surface Area of Room, [sq ft] or [sq m]
$\bar{a}$ = Average Absorption Coefficient of Room Surfaces
$S\,\bar{a}$ = Total Absorption, [Sabins]

Assumptions of Eyring/Sabine formula

Eyring Equation

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$S\,\bar{a}$ = Total Absorption, [Sabins]

Assumptions of Eyring/Sabine formula

DESCRIBING REVERBERATION TIMES

Reverberation time must be equal everywhere

- Acoustic absorption is uniformly distributed throughout the space
- Eyring/Sabine formula does not consider the source of noise

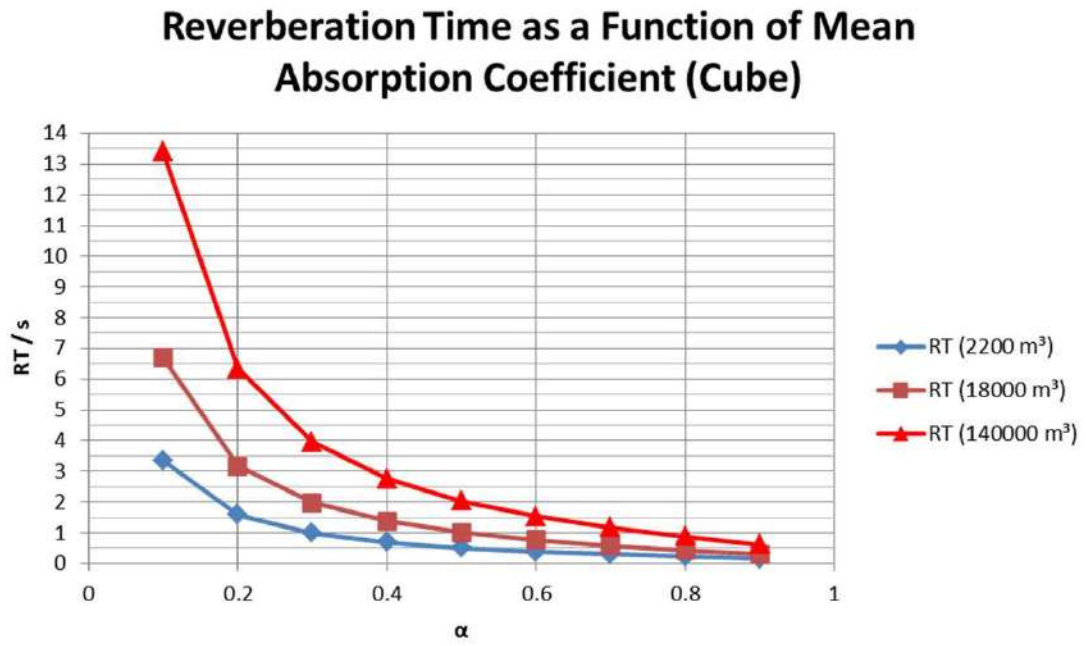
 Reverberation times may be affected through:

- Architectural design with little acoustic control – highly reflective surface treatments
- Low ceilings + acoustically reflective floor surfaces

Room size and % rate of absorptive materials

- Room shape: for example, theatres, traditional churches, long corridors or tunnels
- Diffusion/scattering of energy
- Sound source – orientation and directivity

DESCRIBING REVERBERATION TIMES



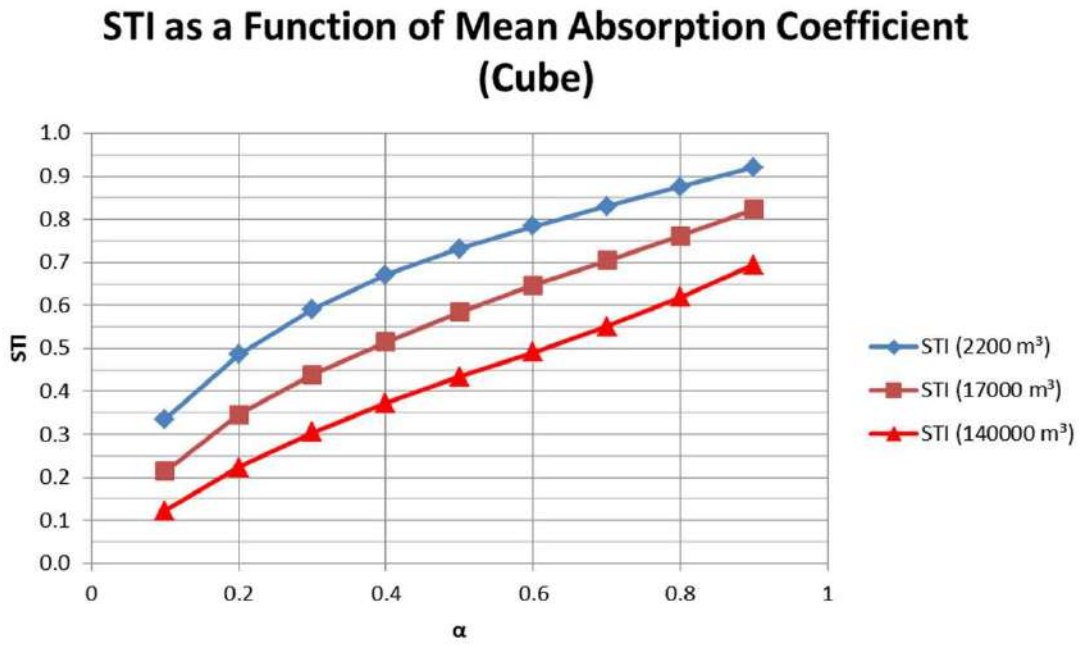
Relationship:

§ Small variation for large absorption

Increased sensitivity for acoustically hard rooms

=> A small variation of the RT is insignificant for STI in practice

DESCRIBING REVERBERATION TIMES



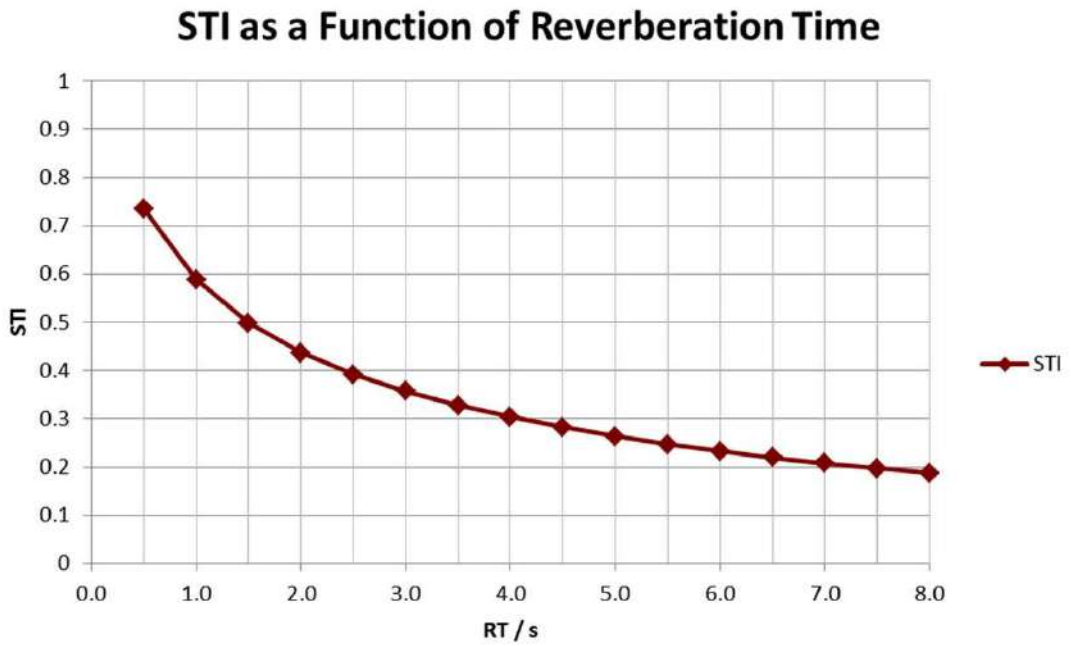
Relationship:

§ Functions compensate each other roughly

Course approximately linear

§ An error of α = 0.1 equals roughly an error of STI = 0.1

DESCRIBING REVERBERATION TIMES



Relationship:

DESCRIBING REVERBERATION TIMES

Requirements for different applications:

§ Conference rooms, lecture halls for speech reproduction

§ Churches, multi-purpose halls, “houses of worship”, theatres and concert halls for speech and music

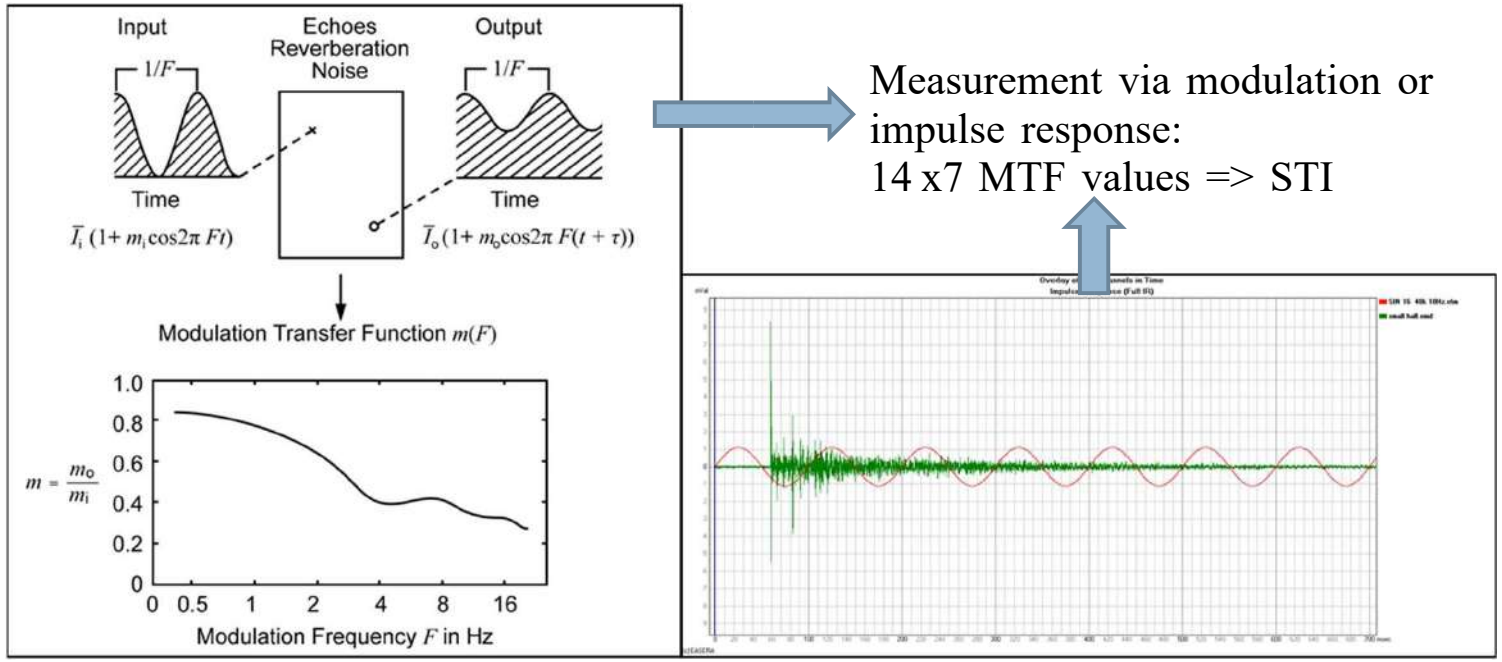
§ Stadiums, convention halls for public address

§ Railway stations and airports for public address and voice alarm

§ Hotels, public buildings, factories, power plants for voice alarm and evacuation

§ STI, STIPa; previously it was RaSTI, ALCons

Describing Intelligibility



Measurement via modulation or impulse response:
14 x7 MTF values => STI

Validity of statistical assumptions regarding RT in flat rooms:

- Is Eyring/Sabine approach still valid?

PREDICTING REVERBERATION TIME

§ In homogeneous diffuse field
§ Mean free path length l=4V/S is no longer valid

§ RT also depends on the location of the source(s)
§ RT also depends on the directivity of the source

Numerous corrections have been developed:
Kuttruff, Fitzroy, Arau, Tohyama, Millington-Sette…

PREDICTING REVERBERATION TIME

Geometrical Acoustics:

§ In geometrical acoustics, the description of the sound field is reduced to:

§ Energy

§ Travel time

§ Direction of Rays

- This approach is correct so long as the dimensions of the room are large compared to wavelengths and if broadband signals are considered

§ Geometrical acoustics is valid with sufficient accuracy in large rooms above the cut-off frequency ƒc = 2000 √(T/V)

Where T= Total surface area in room, V = Volume of room

Geometrical Calculation of RT

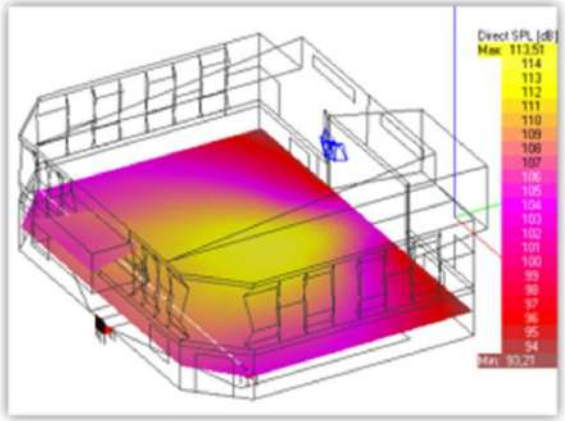
AFMG EASE: 'Enhanced Acoustic Simulator for Engineers'

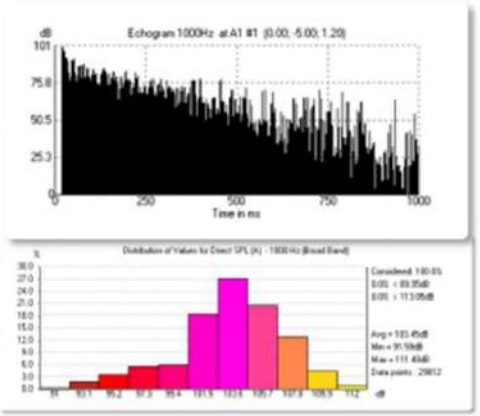
- Detailed room modelling of acoustic spaces

PREDICTING REVERBERATION TIME

Geometrical Acoustics:

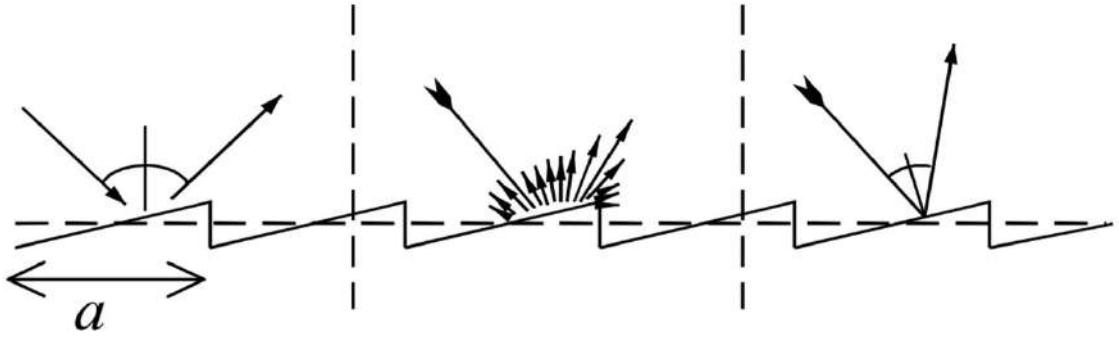
- Advanced simulation of audio system performance including SPL, STI and may other values – detailed
- mapping + presentations
- Become aware of obstacles that would remain hidden without simulation.
- Analyze and solve acoustical problems before they arise
- Ray-Tracing calculations for advanced real-world simulations





PREDICTING REVERBERATION TIME

Geometrical Acoustics: scattering of materials

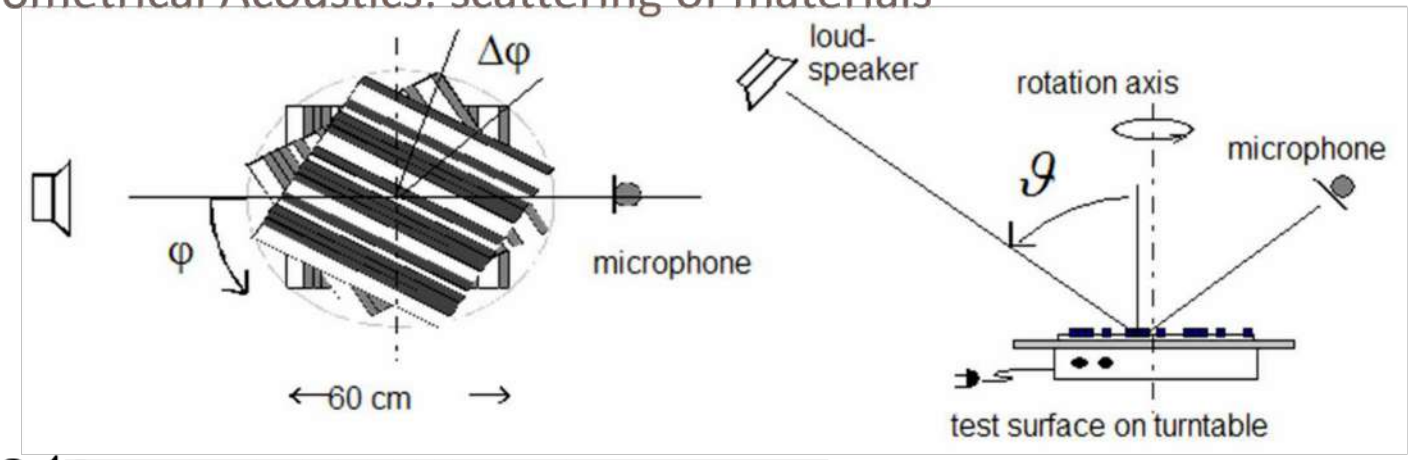


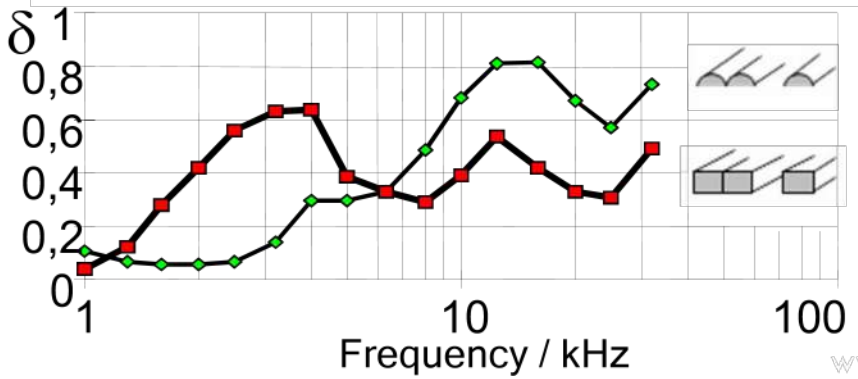
$f \langle\langle c/2a \qquad f \approx c/2a \qquad f \rangle\rangle c/2a$

c = Speed of sound f = Frequency a = Length of the scattering surface

PREDICTING REVERBERATION TIME

Geometrical Acoustics: scattering of materials





$$\delta = 1 - \frac{\left|\underline{R}_{specular}\right|^2}{1-\alpha}$$

δ = scattering coefficient

ϑ = loudspeaker tilt

α = random incidence absorption

PREDICTING REVERBERATION TIME

Geometrical Acoustics: scattering of materials

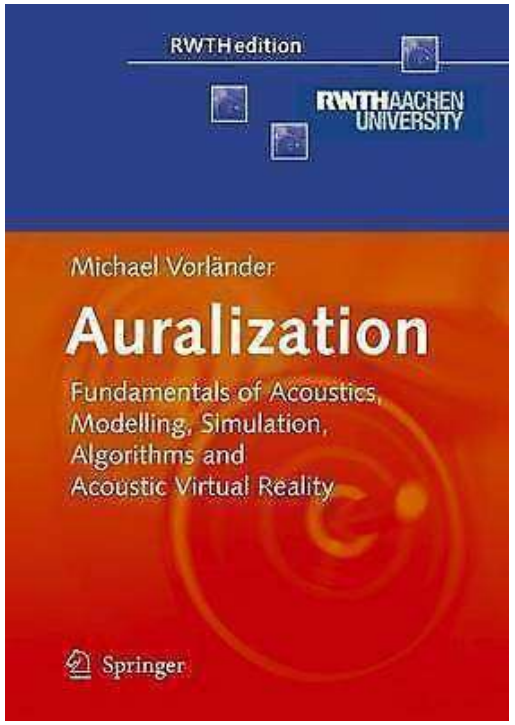
- Strongly affected by geometry of faces
- Manufacturer's data seldom found
- Measurements require laboratory for accurate results
- EASE software provides a scattering coefficient wizard

Generates coefficients based on material geometry

 University of Aachen – M. Vorländer

- Estimate them using AFMG Reflex

PREDICTING REVERBERATION TIME

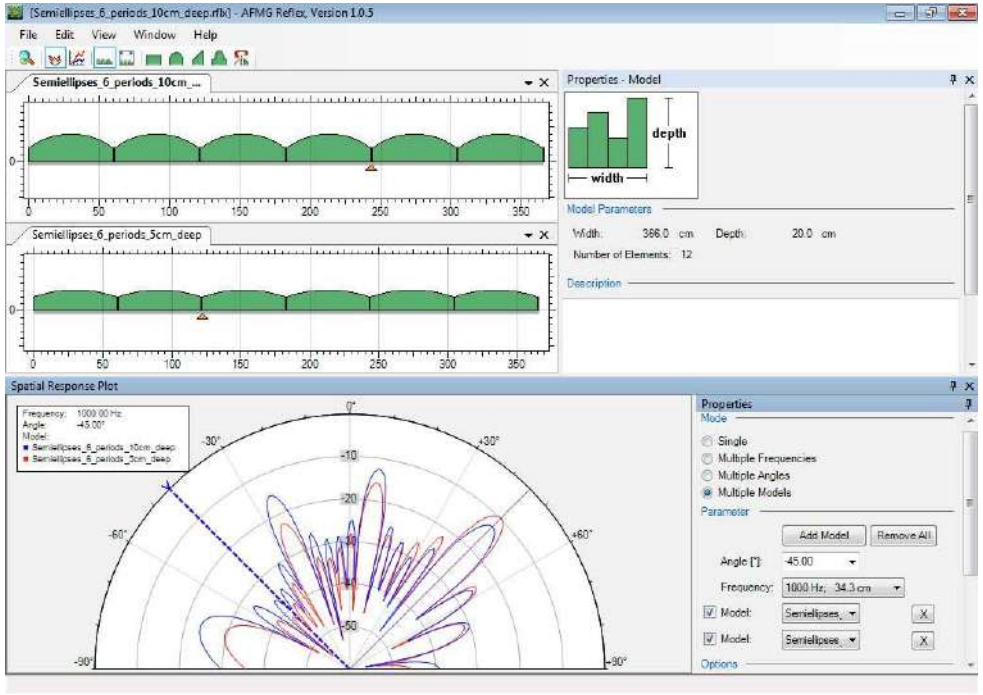


Auralization

PREDICTING REVERBERATION TIME

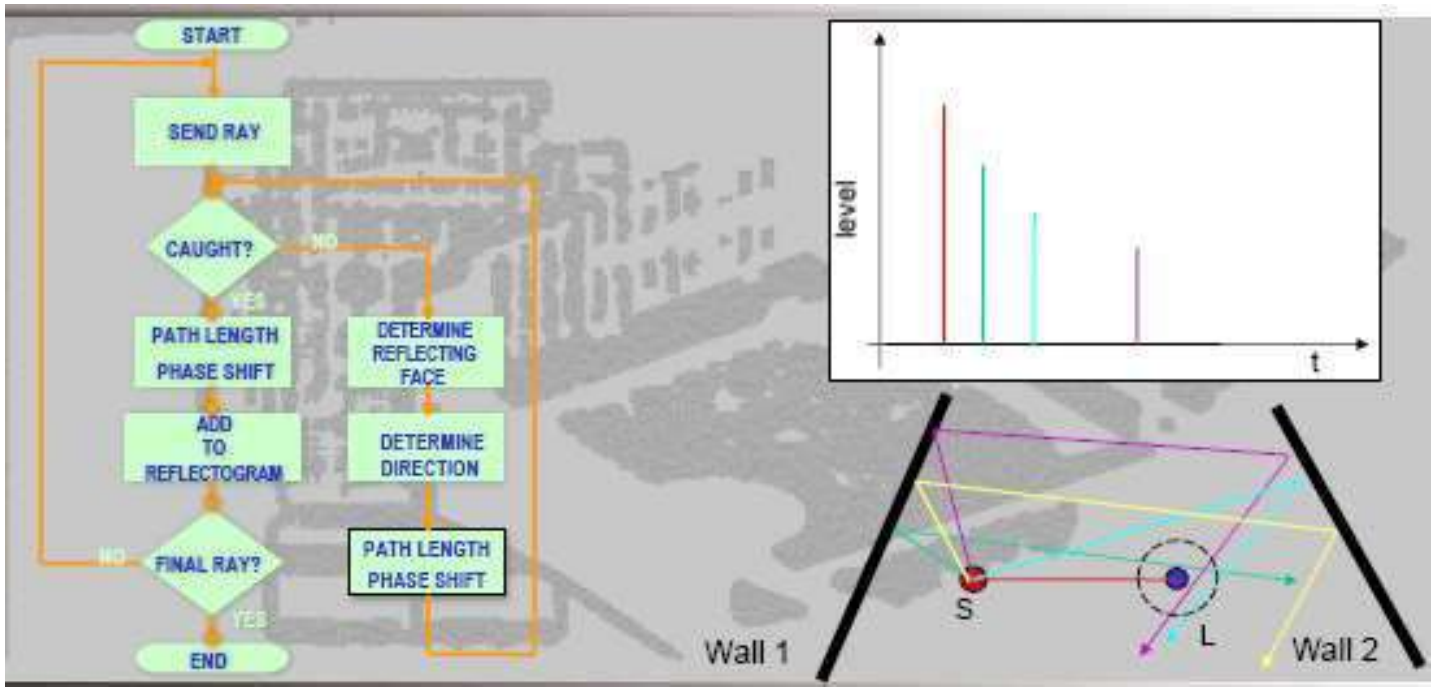
- M. Vorländer ‘Fundamentals of Acoustics,
Modelling, Simulation, Algorithms and Acoustic Virtual Reality’
“Auralization is the technique for creating audible sound files from numerical (simulated, measured, synthesized) data”

Geometrical Acoustics: scattering of materials – AFMG Reflex software



Geometrical Acoustics: calculation of energy from a sound source

PREDICTING REVERBERATION TIME



PREDICTING REVERBERATION TIME

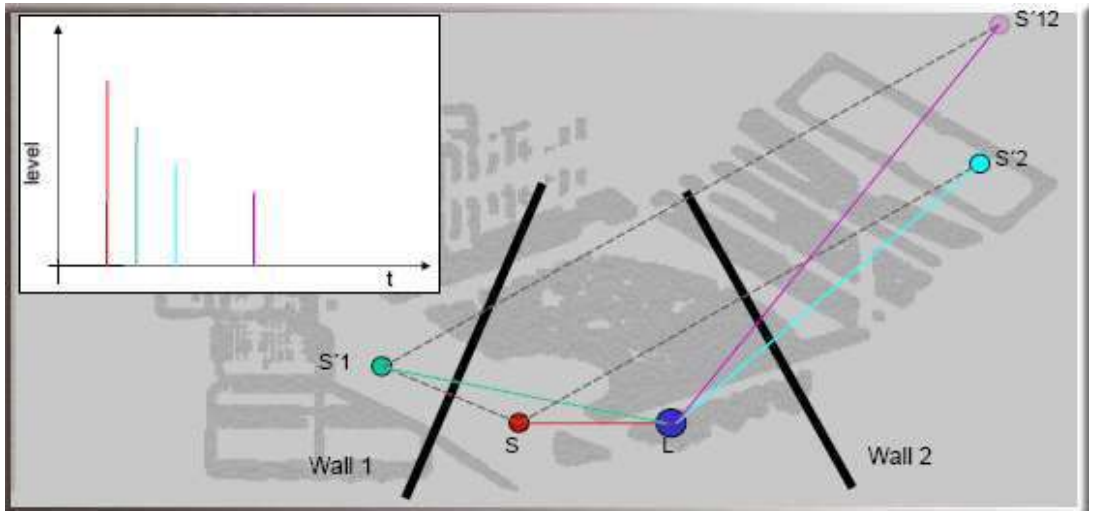
Geometrical Acoustics: calculation of energy from a sound source

The Mirror Image method assumes plane, lossy, pure geometrically reflecting surfaces, whose dimensions are large relative to the wavelength

Standard mirror image method used to proceed as follows:

- All image sources within a given time limit are determined
- Attenuation related to the image sources is applied (spreading loss + boundary absorption + air absorption)
- Contribution of real sources and images sources are added with phase information to build the sound pressure field at the investigation point

Geometrical Acoustics: calculation of energy from a sound source

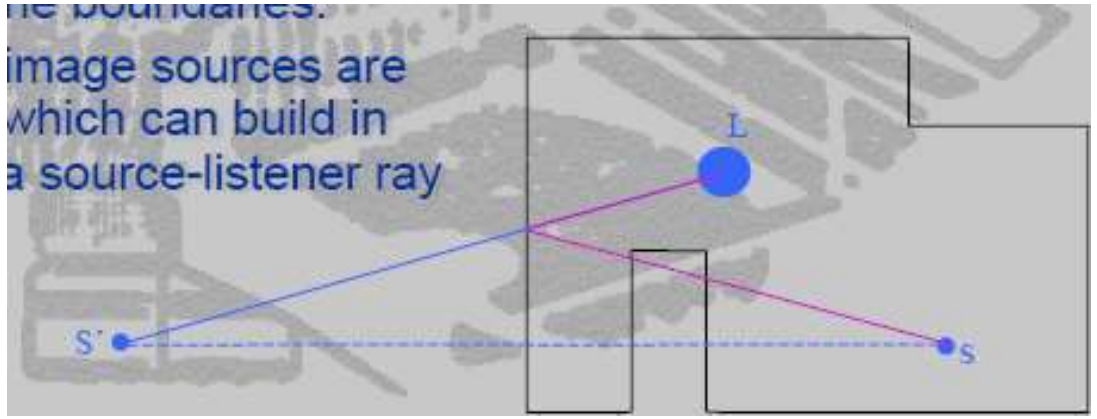


PREDICTING REVERBERATION TIME

Geometrical Acoustics: calculation of energy from a sound source

Potential image sources are determined by mirroring sources and their images about the boundaries

Actual image sources are those, which can build in-reality a source-listener array



Geometrical Acoustics: calculation of energy from a sound source

Ray tracing is used to locate valid mirror images:

- Classical ray tracing method is performed
- If the counting balloon catches a ray at the listener's location, then an actual mirror exists
- This actual mirror images is located by backtracking the captured ray

Interference effects can then be investigated, if the following are known:

PREDICTING REVERBERATION TIME

- Complex transfer function of air

Geometrical Acoustics: model elements

In the simulation model, the following four elements need to be properly modelled:

- Sources (loudspeakers)
- Boundaries (wall)
- Medium (absorption + scattering)
- Listeners

Geometrical Acoustics: modelling of sources

Modelling of sources must describe:

- Frequency-dependant radiated power
- Frequency-dependant directionality

PREDICTING REVERBERATION TIME

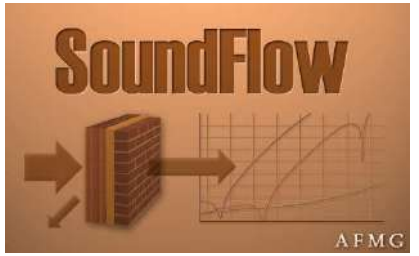
Directionality in ray tracing can be modelled in two ways:

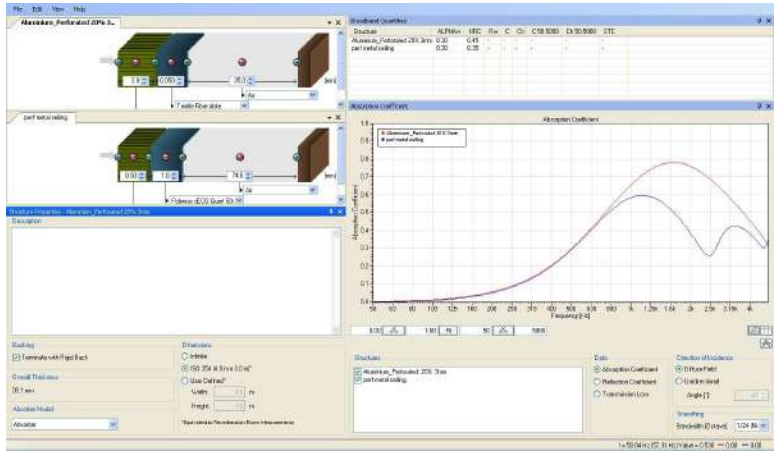
- Constant ray energy with varying spatial ray density
- Constant spatial ray density with varying ray energy

Geometrical Acoustics: modelling of boundaries

Boundaries need to be modelled:

- Geometrically – the simulator must be able to identify the boundaries and the points where rays are reflected





- Acoustically – the simulator must be fed by enough information about acoustical properties of the boundaries to properly model their reaction to incident energy

PREDICTING REVERBERATION TIME

Geometrical Acoustics: model absorption

more information, visit:

Reflex
AFMG

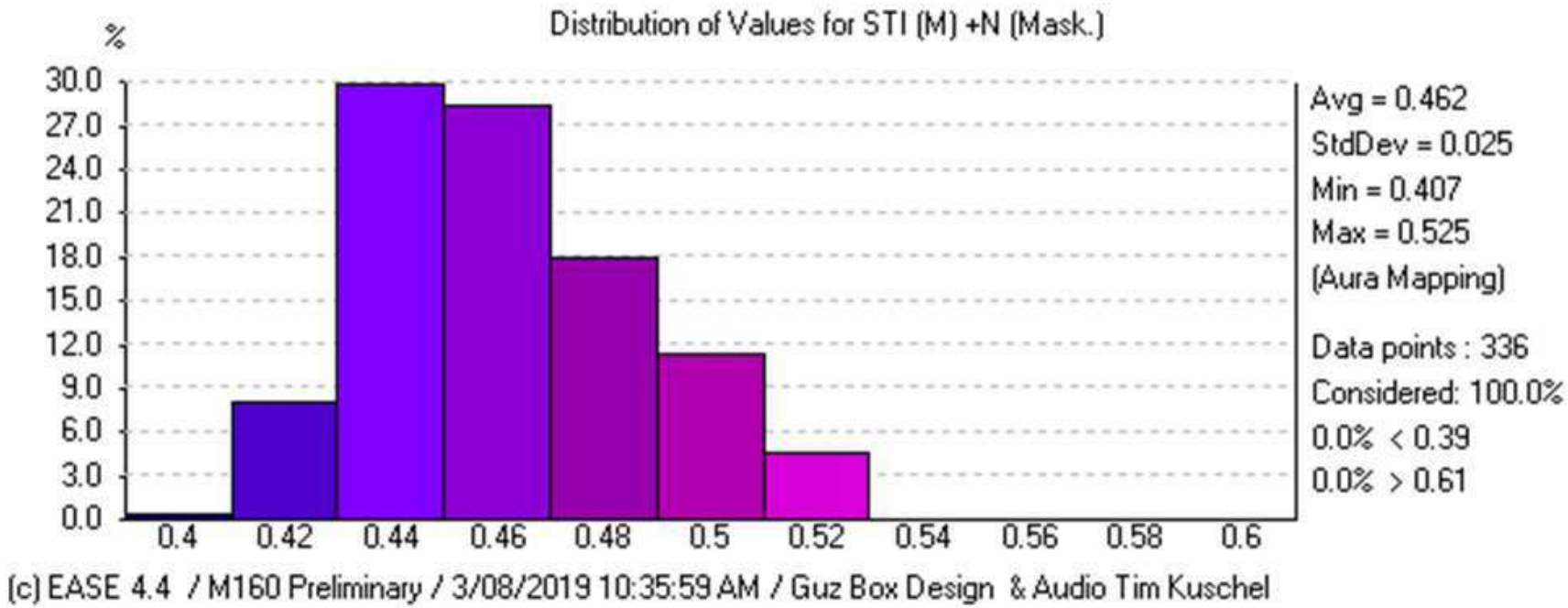
http://soundflow.afmg.eu/

Geometrical Acoustics: modelling scattering

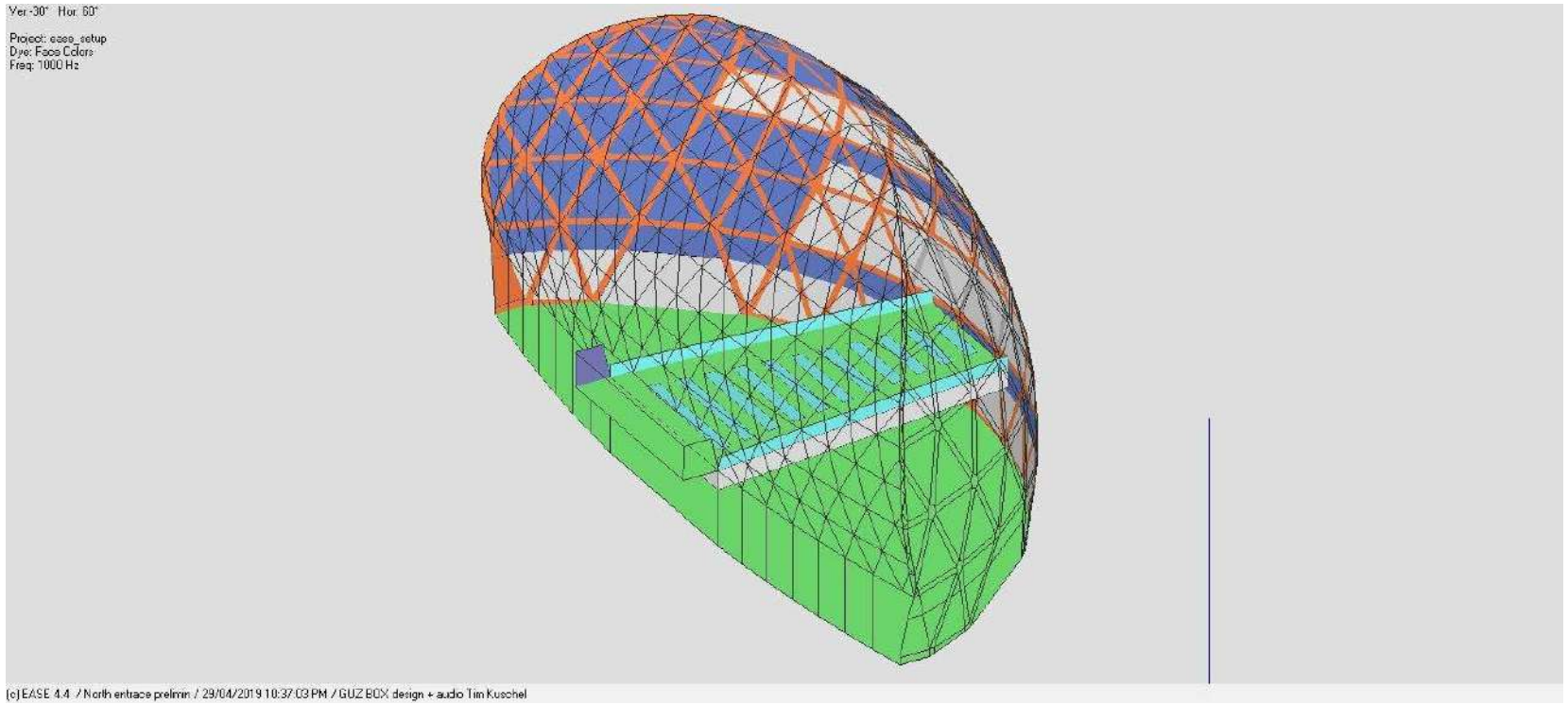
For more information, visit:
http://reflex.afmg.eu

PREDICTING REVERBERATION TIME

PREDICTING REVERBERATION TIME



PREDICTING REVERBERATION TIME



PREDICTING REVERBERATION TIME

VI. ACOUSTICAL NEWS

The International Commission for Acoustics(ICA)has announced that 2020 to be the International Year of Sound (IYS 2020) and recommending activities around the world for this event. I strongly advise our society members to recommend what sort of activities they would like for the IYS 2020. They can email them to me to: wsgan5@gmail.com

VI. ACOUSTICAL NEWS

International Year of Sound 2020

Importance of Sound for Society and the World

www.sound2020.org

PREDICTING REVERBERATION TIME

The board of the ICA is delighted to announce that the
International Year of Sound 2020 will be formally opened on

Friday 31 January 2020 at the

Grand Amphitheatre Sorbonne University, Paris.

Overvziew Pzlan

The ICA and La Semaine du Son (LSdS) have signed a Memorandum of Understanding and will cooperate to achieve international recognition of the goals of UNESCO Resolution 39 C/49 25 September 2017 on “The Importance of Sound in Today’s World: Promoting Best Practices” in the framework of the International Year of Sound 2020 (IYS 2020).

The IYS 2020 will comprise activities organised centrally by ICA, activities organized by La Semaine du Son and activities organized by the ICA Member Societies and International Affiliates. In this respect, the ICA is mobilizing its Member Societies and International Affiliates to arrange activities during 2020 that will promote best practices in sound.

ICA Central Activities

These will include at least:

- Official Opening on 31 January 2020.
- Production of a Video highlighting the importance of sound in all aspects of life. The video will be
- An International student competition on the importance of sound.
- Organization of Special thematic sessions in major International Conferences to be held in 2020.
- Hosting of the website www.sound2020.org
- Promoting member activities
- Creating a record of the activities These activities will be financially covered by the ICA budget and by sponsorship.

ICA Member Activities

ICA Member organisations are encouraged to host activities that highlight the importance of sound in our world and will promote best practices in sound.These activities may include National Conferences on Acoustics, thematic conferences and workshops related to sound, seminars, concerts and special events addressed to the public, and involvement of the media.The details of the outreach activity will be posted on the IYS 2020 website. The logo for IYS 2020 can then be used in the promotion and a short report will be provided as a record of that event.

These activities will be financially covered by the Member's budget

La Semaine du Son Activities

LSdS hosts weeks of sound throughout France as well as Belgium, Argentina and is expanding to other countries such as Lebanon and Japan. During 2020 these will be recorded as contributions to meet the goals of the IYS 2020 as well as the UNESCO

Resolution 39 C/49.More information on LSdS from www.sound2020.org

Founding Supporters

We are particularly grateful to our Founding Supporters (ASA, I-INCE, IIAV, EAA) who provided some seed funding which combined with ICA funding provided the necessary support to reach this stage.

Sponsorship

To reach our goal for the centrally funded activities sponsorship is required. Sponsors will receive extensive coverage from the website and from the centrally organised and nationally organised activities.

Sponsorship prospectus is available from www.sound2020.org

SOCIETY OF ACOUSTICS (SINGAPORE)

ICA EVENTS at a glance

HOST WEBSITE www.sound2020.org

OPENING 31JANUARY IN PARIS

VIDEO ON IMPORTANCE OF SOUND

INTERNATIONAL STUDENT COMPETITION

PROMOTE NATIONAL EVENTS

PROVIDE REPORT ON ALL ACTIVITIES

ICA MEMBER ORGANISATIONS

PLAN YOUR IYS 2020 EVENT

OUTREACH TO HIGHLIGHT

IMPORTANCE OF SOUND AND

PROMOTE BEST PRACTICES

POST THE DETAILS OF EVENT ON www.sound2020.org

RECEIVE THE IYS2020 LOGO PLUS GOLD SPONSOR LOGO

HOLD THE EVENT

PROVIDE SHORT REPORT

The road map to the IYS 2020

Importance of Sd
for Society and the World

Initiated by :

In cooperation with

www.sound2020.org

Founding members

2011 to 2019

It has taken considerable time to get this stage. In 2011 the ICA Board agreed to the concept of an International Year of Sound to be declared before the end of the decade. This was endorsed at the General Assembly in 2013. We spent some time following the same path as for the International Year of Light by seeking UNESCO and ultimately the UN approval. For various reasons that pathway became unachievable so in 2018 we established an agreement with the organisers of La Semaine du Son (LSdS) to work collaboratively to arrange an International Year of Sound in 2020. LSdS had been the primary force behind the UNESCO Resolution 39 C/49 25 September 2017 on “The Importance of Sound in Today’s World: Promoting Best Practices”. In 2019 and Memorandum of Agreement was signed between the ICA and LSdS. The IYS2020 becomes one of the outcomes of that resolution.

IYS 2020 Structure

Importance of Sd
for Society and Wor

Initiated by :

In cooperation with

www.sound2020.org.
Founding members

Liaison Committee: overview and coordination of the IYS 2020.
ICAMichael Taroudakis and Marion Burgess

LSdS Christian Hugonnet, Jean-Dominique

Polack and Nicolas Lounis

Steering Committee:

Encourage and coordination of central and

regional activities Coordinators:

Marion Burgess and Michael Taroudakis Regional responsibility:

Be seen Internationally

BECOME AN IYS2020 SPONSOR

GOLD SPONSORS

LOGO on all IYS2020 publicity

Other levels of Sponsorship available

PROSPECTUS FROM
www.sound2020.org

Europe/Africa:

Michael Vorländer, Antonino di Bella, Antonio Perez-Lopez Asia/Pacific:

Jeong-Guon Ih, Kohei Yamamoto Americas:

Mike Stinson, Fausto Rodrigues, Julio Cordioli

National Coordinators:

Representatives from all ICA Member Societies and International Affiliateswill be responsible for the coordination and the reporting of the national activities and the activities of the International Affiliates. The Member Societies and International Affiliates are requested to appoint their representative by the end of September 2019. Name to be sent to the ICA Secretary General, (ICASecGen@icacommission.org).

PREDICTING REVERBERATION TIME

Also our society is in the process of setting up the regional Singapore Chapter of the Acoustical Society of America(ASA).

VII. BID FOR FUTURE INTERNATIONAL CONFERENCES

The Society of Acoustics(Singapore) will be hosting the ICSV28 in Singapore from 25-29 July 2021 at the Marina Bay Sands Hotel.

Government Bodies

www.mom.gov.sg

www.nea.gov.sg

www.lta.gov.sg

Technical and Research Sites

Technical and Research Sites

Corporate Sites

www.metaultrasound.com

www.noisecontrols.com

(The Society welcomes interested parties to contribute relevant websites to the above e useful links. For more information, please contact us. Thank you.)

PREDICTING REVERBERATION TIME

Disclaimers

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President: Woon Siong Gan

E-Newsletter compiled by: Woon Siong Gan