Odeon
Room Acoustics Software

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Acoustical simulation of open-plan offices according to ISO 3382-3

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Outline

- Introduction
- ISO 3382's – ISO 3382 part 3
- Factors affecting acoustical performance
- Measurements
- Acoustical parameters
- Open-plan office example
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  - Screens
  - Background noise
- Conclusion

The ISO 3382 family

Acoustics -- Measurement of room acoustic parameters

- Part 1: Performance spaces
- Part 2: Reverberation time in ordinary rooms
- Part 3: Open plan offices

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Introduction

- ISO 3382-3: 2012 Acoustics — Measurement of room acoustic parameters — Part 3: Open plan offices
- New parameters, including:
  - Spatial sound distribution of the A-weighted sound pressure level of speech
    - Spatial decay rate of speech
  - Spatial sound distribution of the speech transmission index
    - Distraction distance
    - Privacy distance
  - Background noise level
- Computer simulations instead of measurements

Factors affecting acoustical performance according to 3382-3

- Layout of work stations
- Absorption
- Height of screens and storage units
- Background noise
- Degree of work station enclosure
- Distance between work stations
- Room dimensions

Measurements 3382-3

1. The office must be furnished, but unoccupied
2. Sound source should be omni directional
3. Sources and microphones are placed on work stations, height 1.2 m above floor
4. A measurement line is made from one source position and a number of receiver positions in different distances
5. Min. 4 receivers, recommended 6-10
6. At least two measurement lines should be used, and the results are averaged

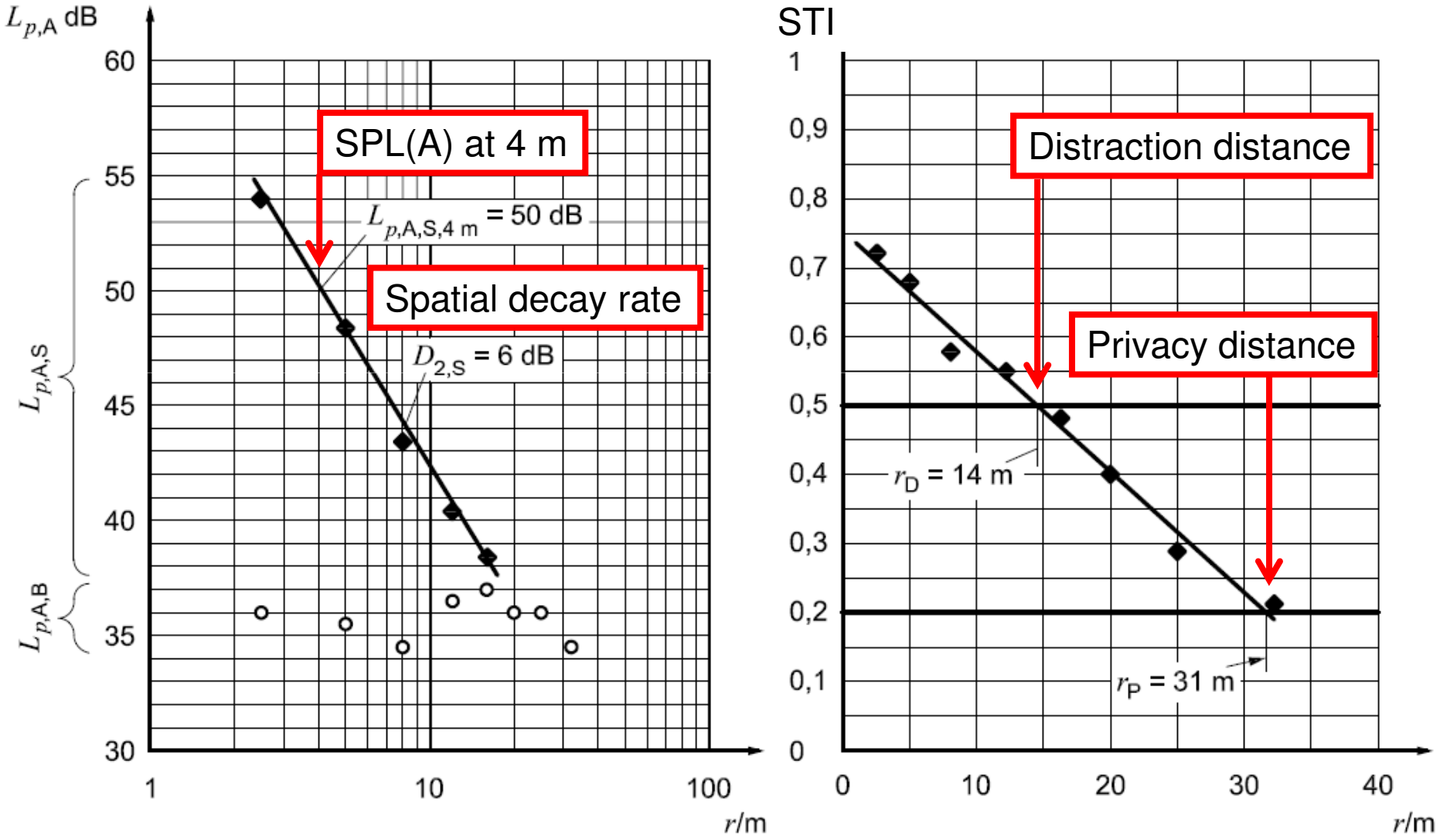
Calculations

Source power – normal effort unisex speech

At every measurement point:

- SPL(A) in octave bands, 125 – 8000 Hz
- Background noise in octave bands
- STI
  - The impulse response method is preferred (as Odeon)
  - Average of background noise is used for STI (as Odeon)

Spatial decay curves



Target values

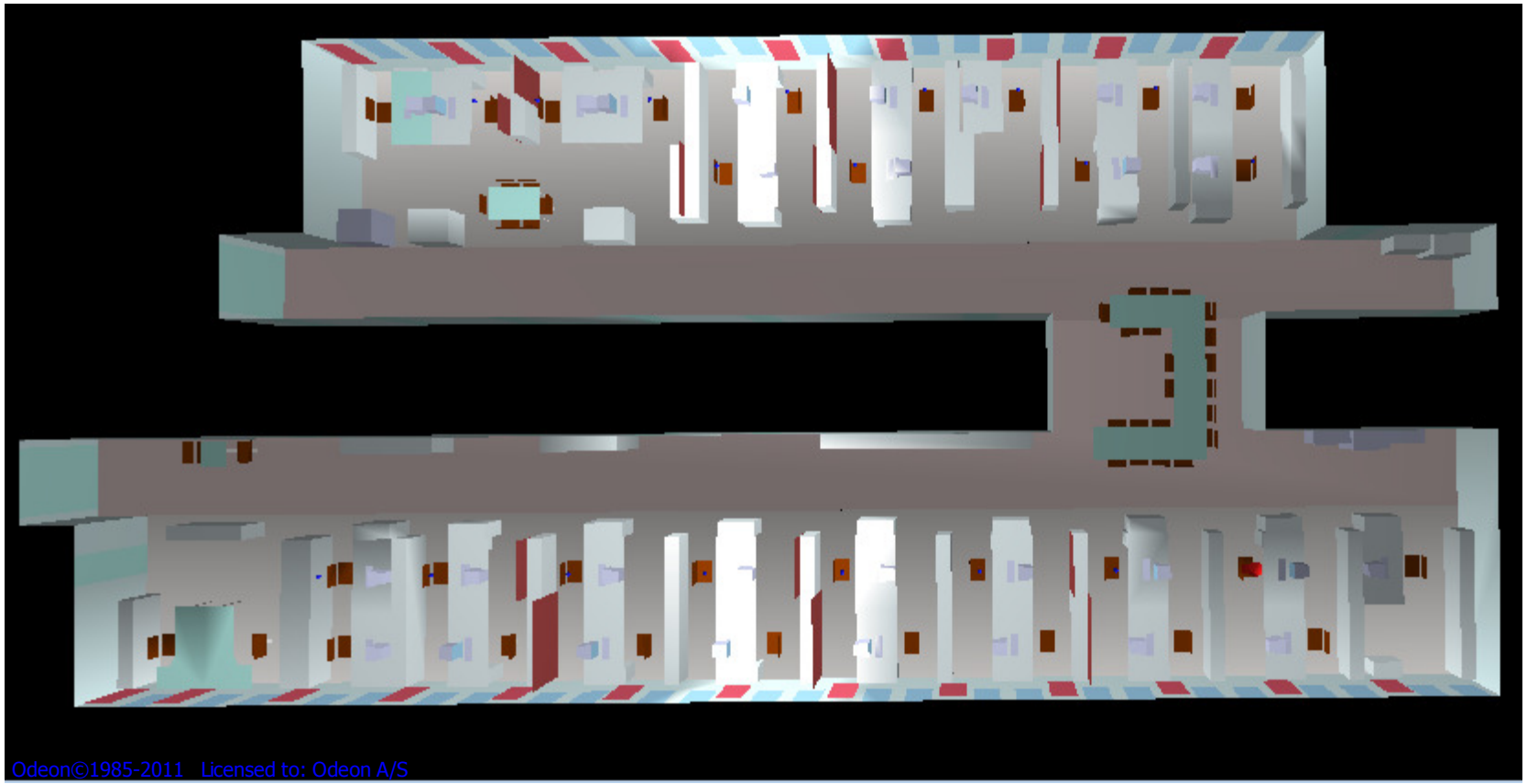
Parameter	Poor	Good
Spatial decay rate, $D_{2,S}$	<5 dB	>= 7 dB
SPL(A) at 4 metres, $L_{p,\,A,\,S,\,4\,m}$	> 50 dB	<= 48 dB
Distraction distance, r_D	> 10 m	<= 5 m

Simulating ISO 3382-3 in Odeon 12ß

- Model of room geometry fully furnished
- Full impulse response calculated (hybrid method)
- Diffraction over screens and storrage units etc. included
- Constant background noise easily included ($L_{p,B}$)
- SPL(A) and STI parameters can be predicted
- ISO 3382-3 quantities are automatically calculated from a selected number of receivers
- Average results from at least 2 measurement lines

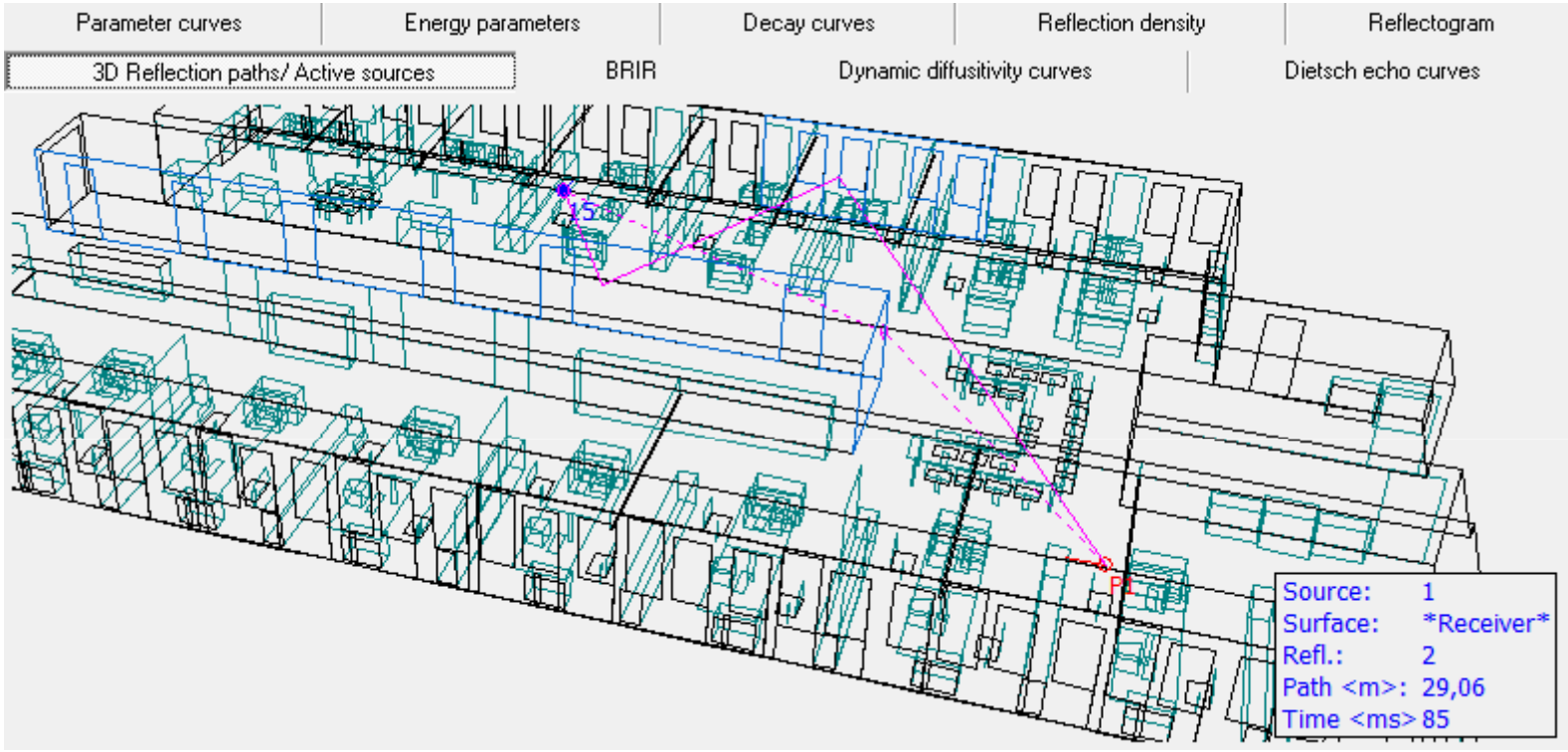
- Easy to include many workstations/receivers – use > 10?

Example office



View into the ODEON model

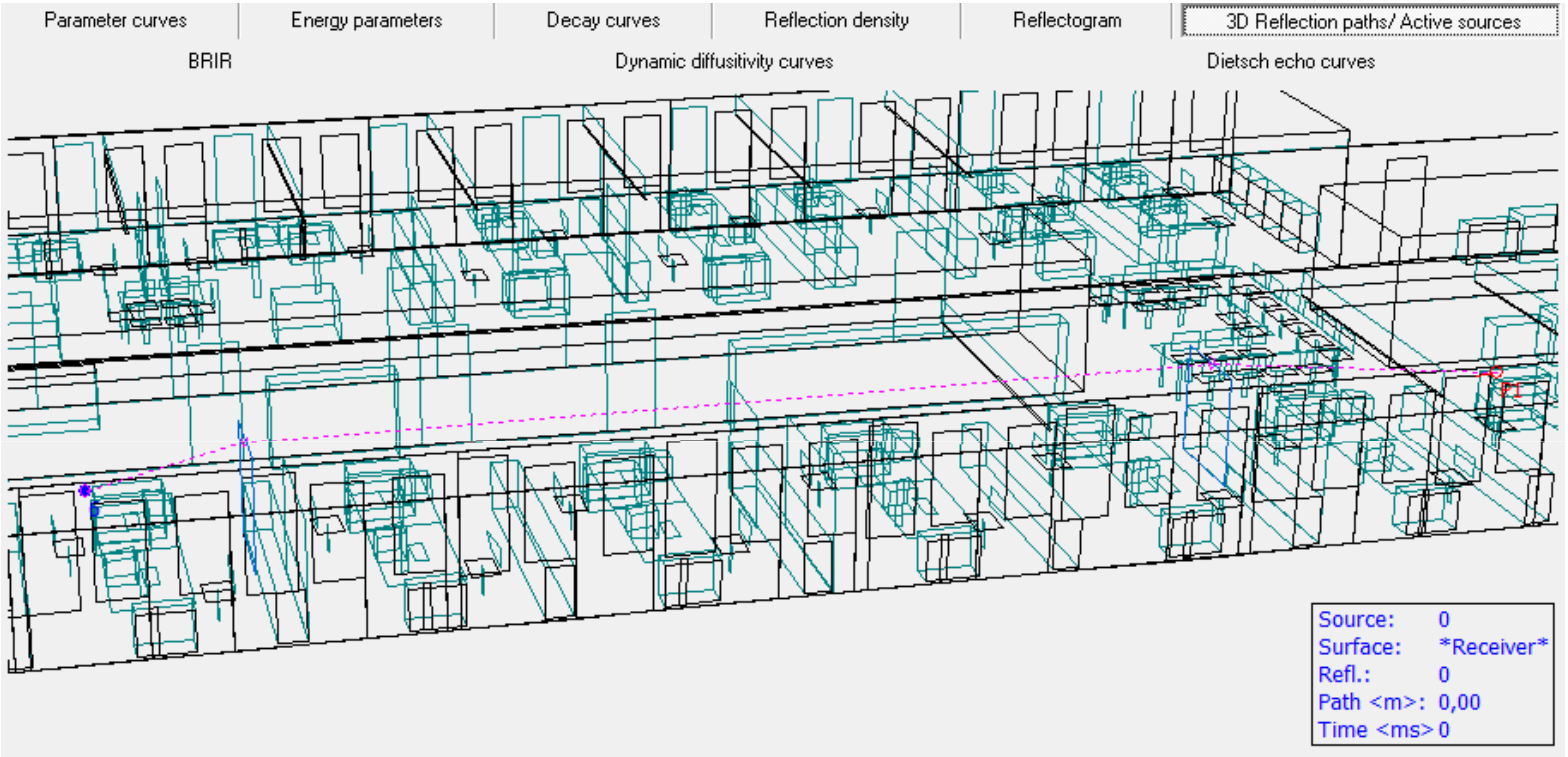
1-point diffraction



Diffraction

- Geometric path automatically detected
- Contribution calculated according to Allan D. Pierce

2-point diffraction

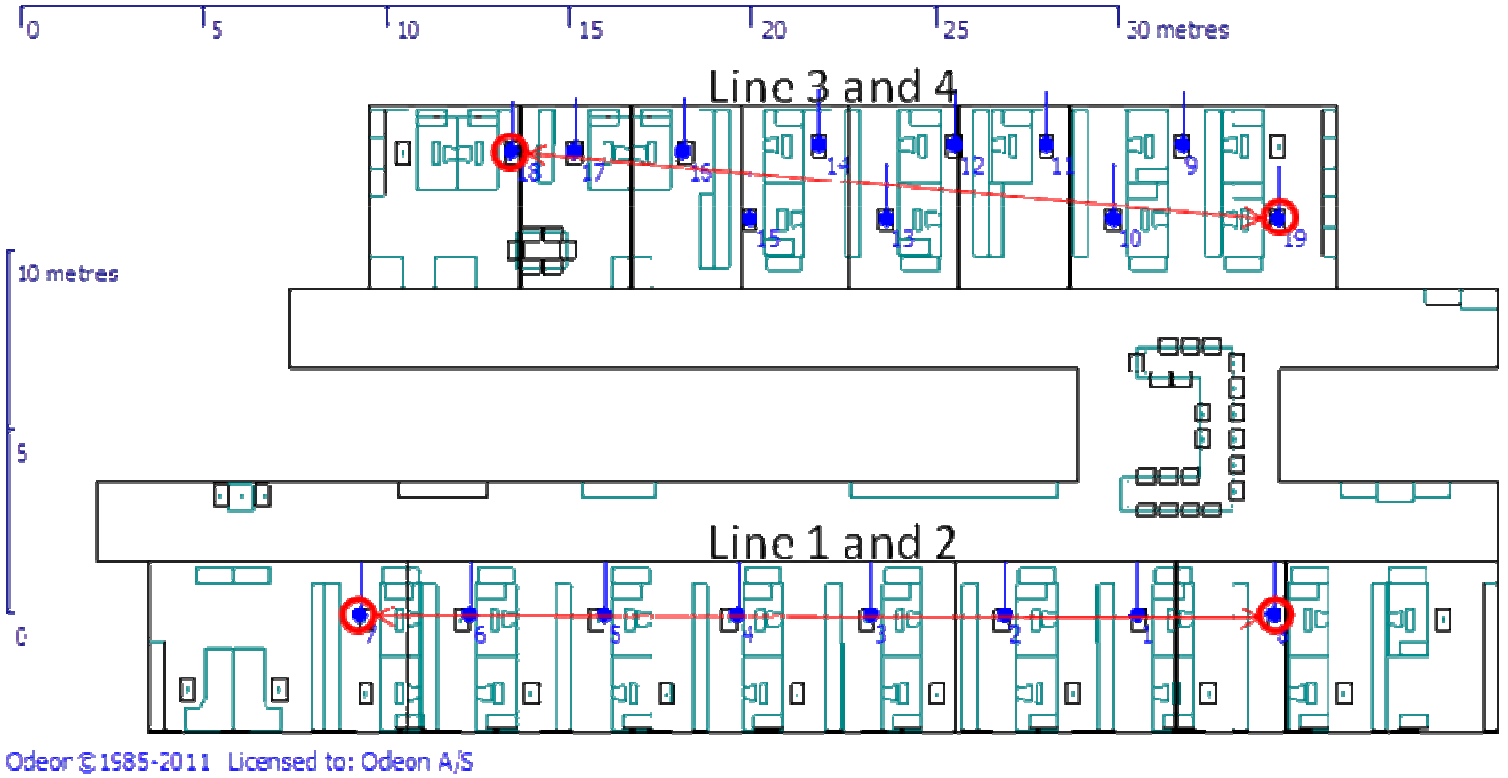


Diffraction

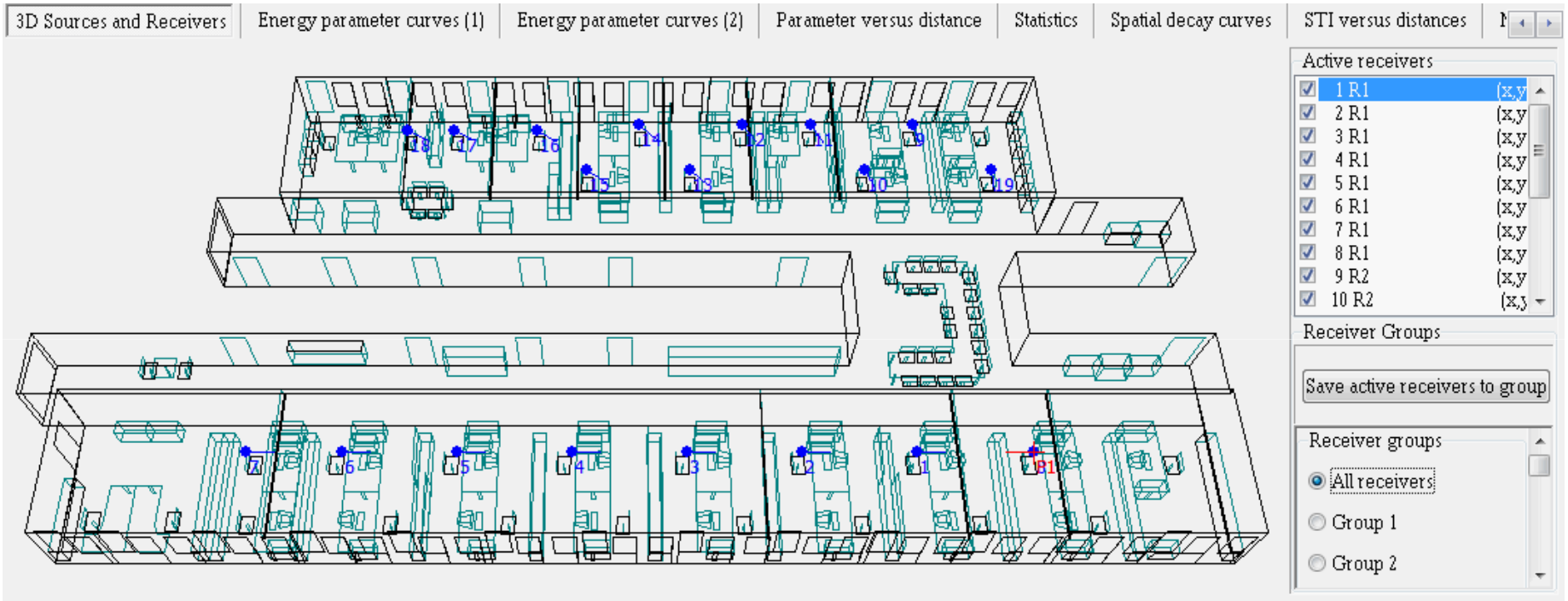
- Geometric path automatically detected
- Contribution calculated according to Allan D. Pierce

Measurement lines

- Lines 1 and 2 with 7 mic. positions
- Lines 3 and 4 with 10 mic. Positions



Selecting receivers in Odeon 12ß



Define /select a group of receivers for immediate display of

- $D_{2,S,}$, Lp,A,S, 4 m (and $SPL_{(A)}$ versus distance)
- r_D and r_P (and STI versus distance)

Single number quantities - Office 3

	Line 1	Line 2	Line 3	Line 4	Average
STI in nearest workstation	0,64	0,67	0,75	0,64	0,68
Distraction distance, r_D, in m	8,20	10,14	10,53	7,09	9,0
Privacy distance, r_P, in m	22,38	24,08	21,70	19,13	21,8
Spatial decay rate of A-weighted SPL of speech, $D_{2,S}$, in dB	6,05	6,11	6,74	5,12	6,0
A-weighted SPL of speech at 4 metres, $L_{p,A,S,4\ m}$, in dB	48,5	50,2	50,9	46,0	48,9
Average A-weighted background noise, $L_{p,A,B}$, in dB	38	38	38	38	38

Three office versions

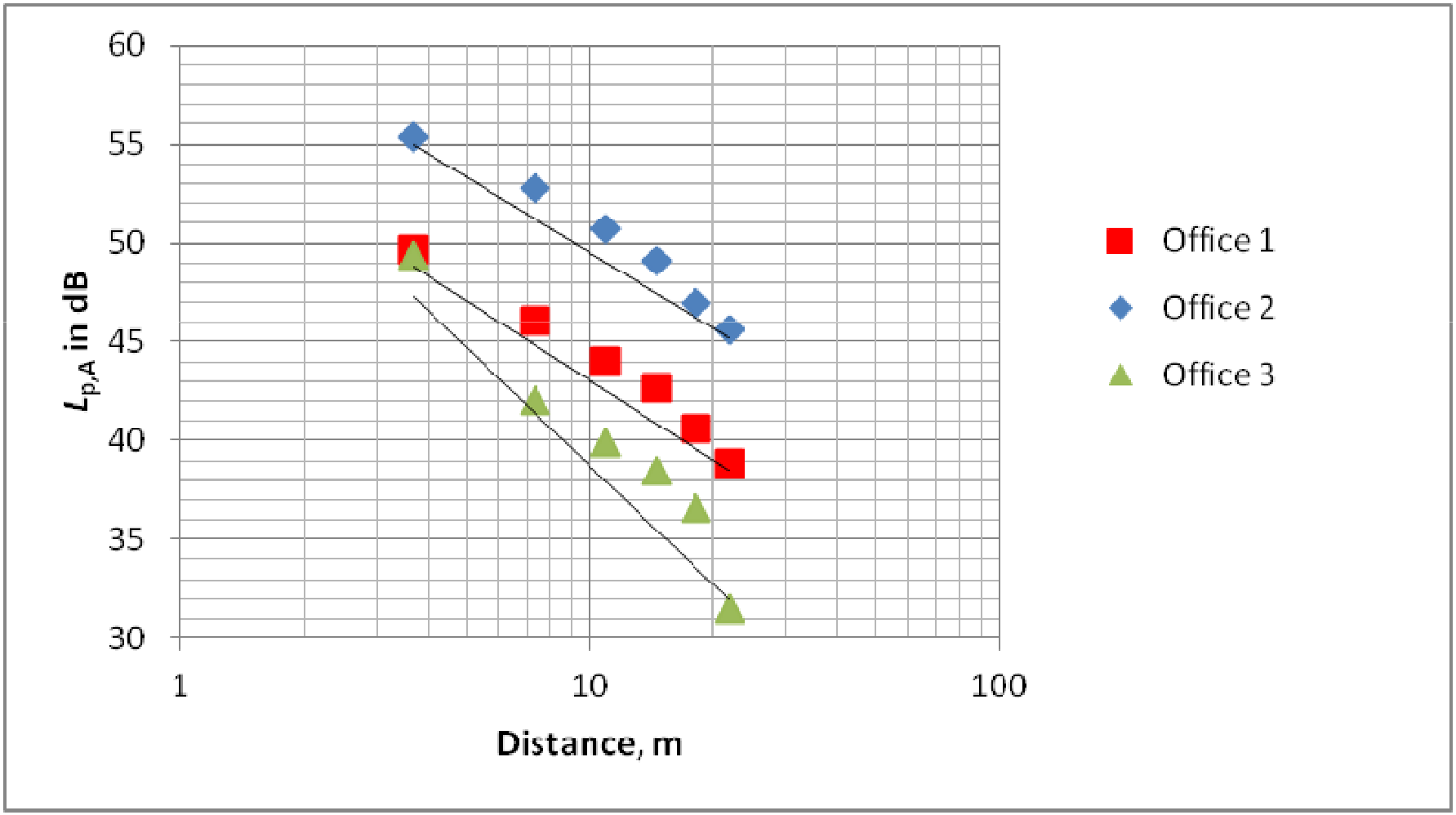
Office 1: As existing, absorption in ceiling

Office 2: Reflective ceiling

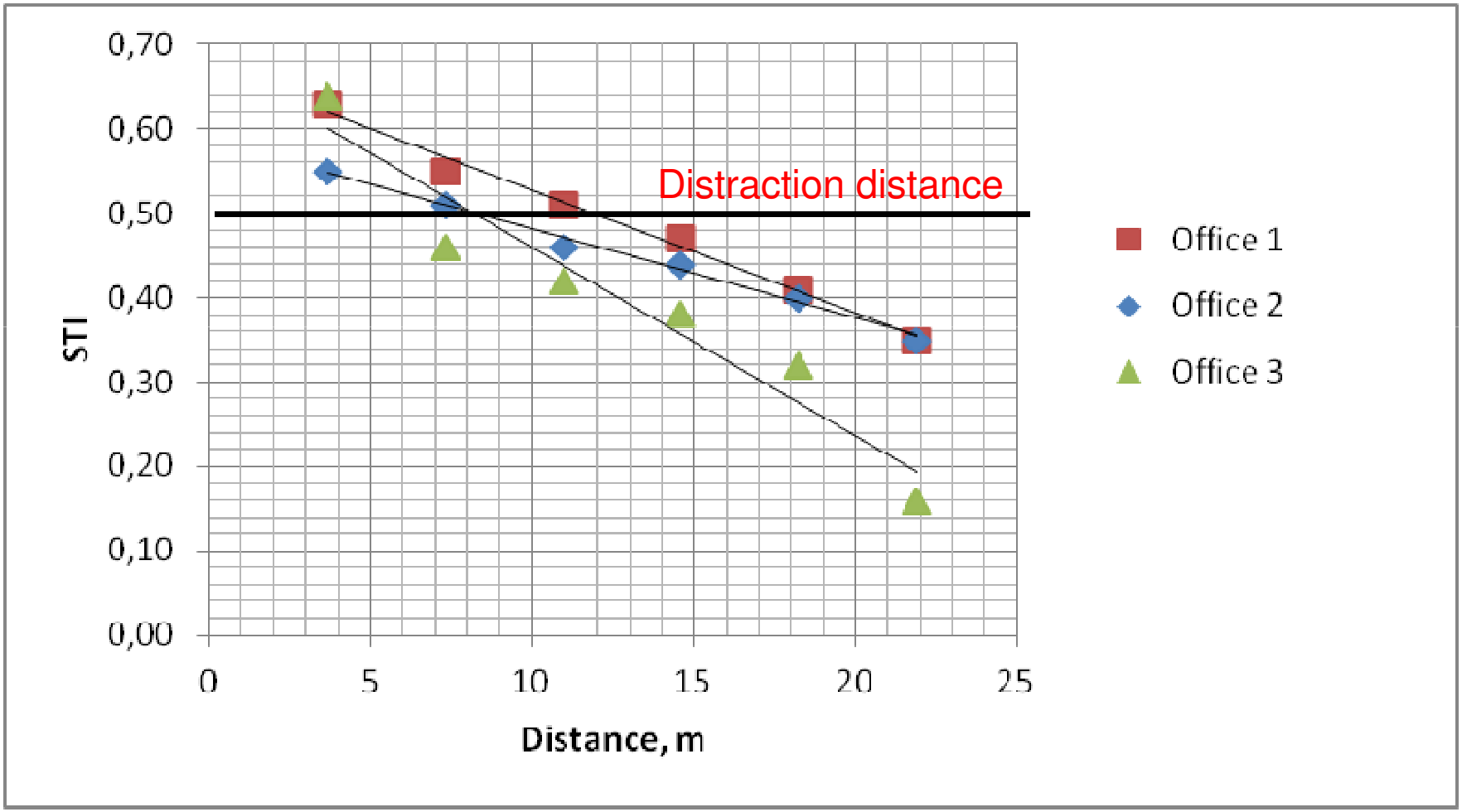
Office 3: As no. 1, plus absorbing baffles and 1.25 m screens

	Office 1	Office 2	Office 3
T_{20} (500 - 1000 Hz) in s	0,5	1,1	0,3
STI in nearest workstation	0,71	0,61	0,68
Distraction distance, r_D, in m	13,8	10,1	9,0
Privacy distance, r_P, in m	33,3	37,8	21,8
Spatial decay rate of A-weighted SPL of speech, $D_{2,S}$, in dB	4,4	3,8	6,0
A-weighted SPL of speech at 4 metres, $L_{p,A,S,4\ m}$, in dB	51,0	56,5	48,9
Average A-weighted background noise, $L_{p,A,B}$, in dB	38	38	38

Spatial distribution curves, $L_{p,A}$



Spatial distribution curves, STI



Variation of screen height

Office 3, Screen height	1,25 m	1,50 m	1,75 m
STI in nearest workstation	0,68	0,67	0,67
Distraction distance, r_D, in m	9,0	8,4	8,0
Privacy distance, r_P, in m	21,8	19,8	18,7
Spatial decay rate of A-weighted SPL of speech, $D_{2,S}$, in dB	6,0	6,6	7,1
A-weighted SPL of speech at 4 metres, $L_{p,A,S,4\,m}$, in dB	48,9	48,6	48,4
Average A-weighted background noise, $L_{p,A,B}$, in dB	38	38	38

Increasing the screen height means:

- r_D and r_P decrease
- $D_{2,S}$ increases

Variation of background noise

Average A-weighted background noise, $L_{p,A,B}$, in dB	40	45	50
STI in nearest workstation	0,64	0,54	0,40
Distraction distance, r_D, in m	7,1	2,5	-
Privacy distance, r_P, in m	19,1	14,0	8,6

Increasing the background noise means:

- r_D and r_P decrease
- STI in nearest workstation goes down

(Actually, r_D can be negative, i.e. no result)

Conclusion

- The new parameters behaves differently to
  - Absorption
  - Screens
  - Background noise
- Computer simulations can be used to evaluate alternative solutions
- In order to meet target values for good acoustic conditions – absorbing ceiling, 1.75 m screens and approx. 43 dB back ground noise is needed.
- More factors can be altered in new open plan office design