# 國家奈米元件實驗室之微動量測與模態識別

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## 摘　　要

高科技產業為台灣經濟之重要支柱。科技的進步常常導致微電子製程設備對微振動控制之嚴格要求。台灣在近二十年內興建了不少高科技廠房。雖然國內土木設計或顧問公司累積了多年承建高科技廠房的經驗，但這些公司尚無法獨立設計高科技廠房。其主要原因之一就是這些顧問公司對於潔淨室之微振動分析技術尚無法掌控。潔淨室裡針對振動較敏感儀器之設計技術仍須依賴國外顧問公司。

隨著國家奈米元件實驗室(NDL)的興建，本研究配合實驗室的籌建，針對實驗室之不同興建階段與不同地點進行微動量測與分析。伐式基礎減低環境微振。建築物對振動而言就像一低通濾波器，並且進而減低基礎之振動量。風扇與其他支援設備運作時相當的增加高頻振動量。最後建築物的自然振動頻率、阻尼比與模態經由微振量測透過次空間法被識別出來。水平兩方向的運動因為建築的極不對稱導致強烈藕合。全部共九個水平方向模態與四個垂直方向模態被識別出來。

# Ambient Vibrations of National Nano Device Laboratories and Their Modal Identification

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## Abstract

The hi-tech industry is the important pillar of the economy of Taiwan. The progress in technology usually results in strict request on vibration control for the microelectronics fabrication facilities. Many hi-tech factory buildings were built in Taiwan in last two decades. Although some of design or consultant companies in civil engineering have experienced the construction of high-tech fabs in these years, these companies are still not able to design the high-tech facilities alone. One of the main issues that make those domestic consultant companies unable to complete the whole design is the analysis of ambient vibration for the clean-room. The clean-room design for vibration-sensitive instruments still depends on foreign consultants.

As the construction for the building of National Nano Device Laboratories (NDL) was in progress, this work measured its ambient vibrations in the various construction stages and in different locations. The mat foundation decreases the ambient vibrations. A building acts like a low-pass filter for the vibrations and further decreases the vibrations at the basement. The operation of fans and other supporting equipment considerably increases high-frequency vibrations. Finally, the natural frequencies, damping ratios and mode shapes of the building are identified via a sub-space method from the ambient vibration measurement. The motions in two horizontal directions are strongly coupled because of the structural un-symmetry of the building. Totally, nine modes in horizontal motion and four vertical modes are identified.