



仿真
新
时代

2017 ANSYS 用户技术大会

中国·烟台

PCB及机箱设备EMC辐射分析

张伟 / 高级应用工程师

ANSYS 中国

传统EMC设计弊端



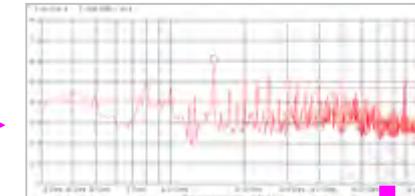
产品EDA开发



整机装配



EMC测试



测试超标



整机装配



重复多次整改，无法满足性能要求，严重耽误交付周期！



产品流改版



位测试



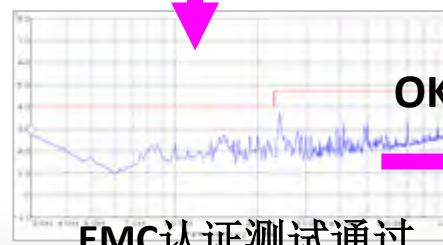
EMC测试



NO



EMC测试超标

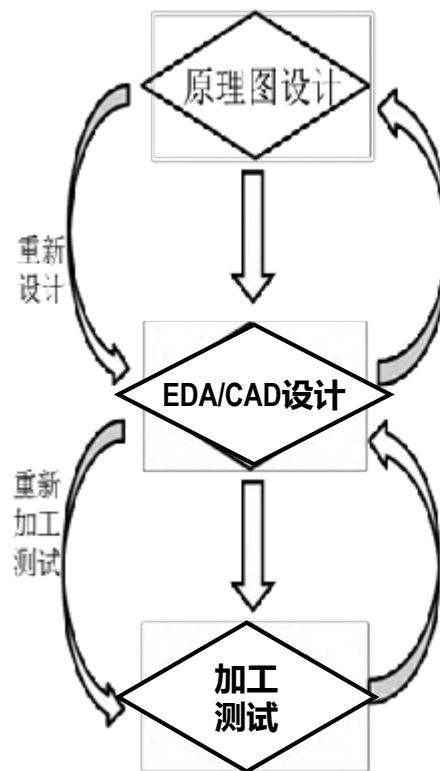


EMC认证测试通过

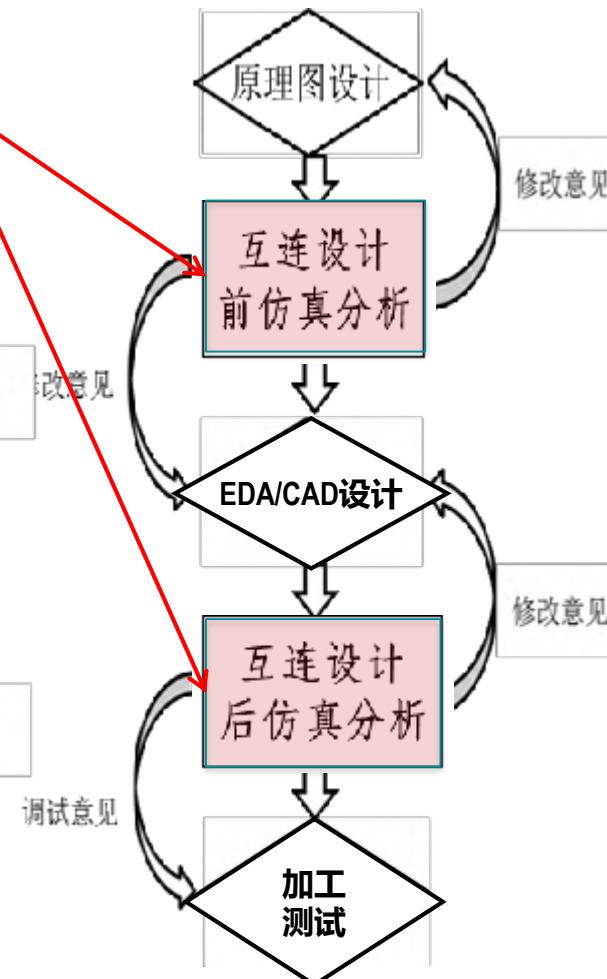


EMC设计新流程

虚拟仿真技术！

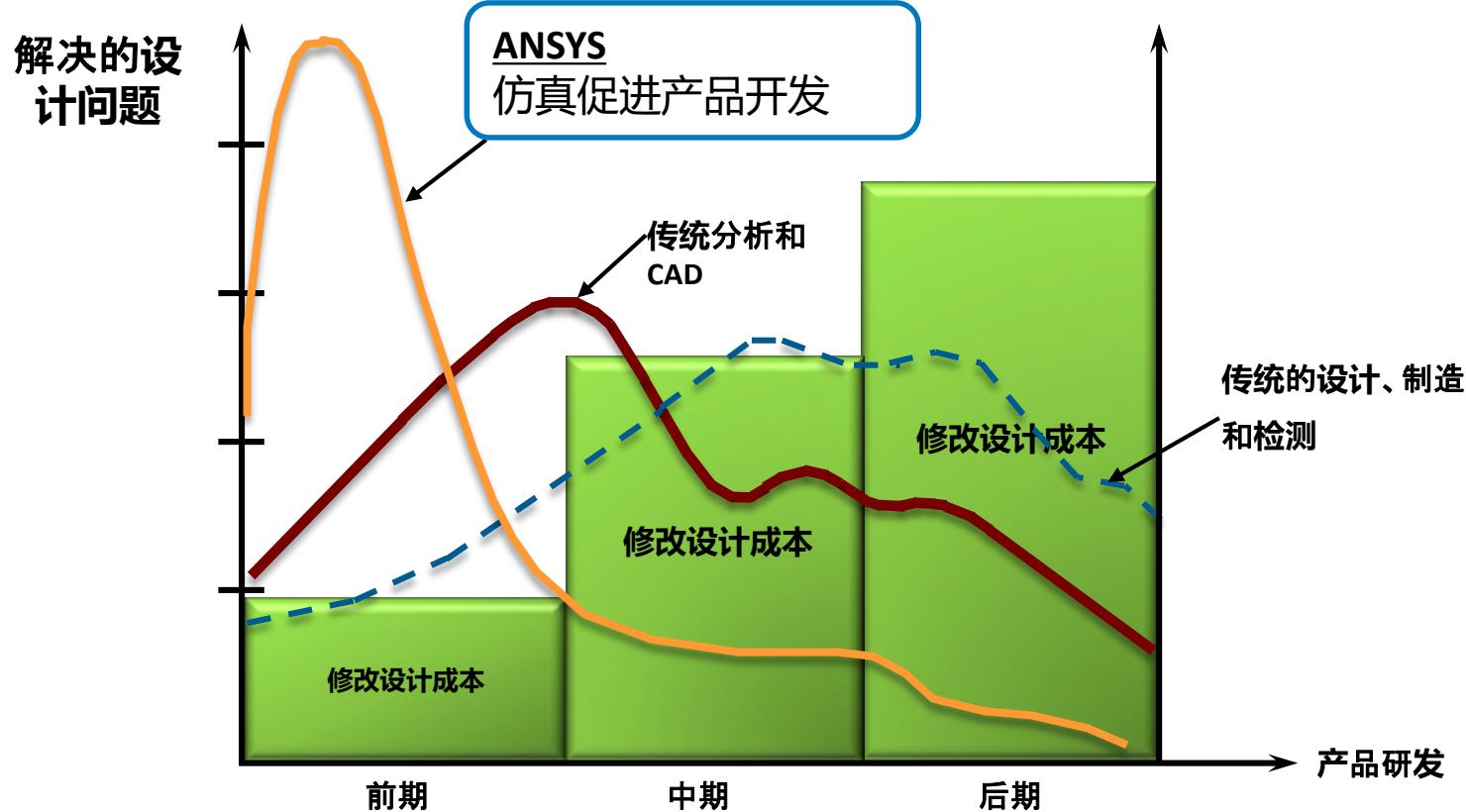


传统设计流程



新型设计流程

仿真技术对产品开发的影响



ANSYS EMC 分析解决方案



ANSYS低频EMC传导解决方案



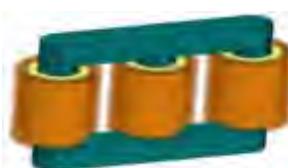
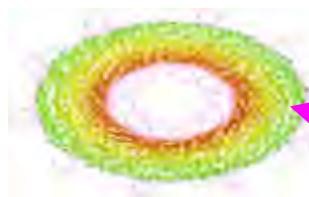
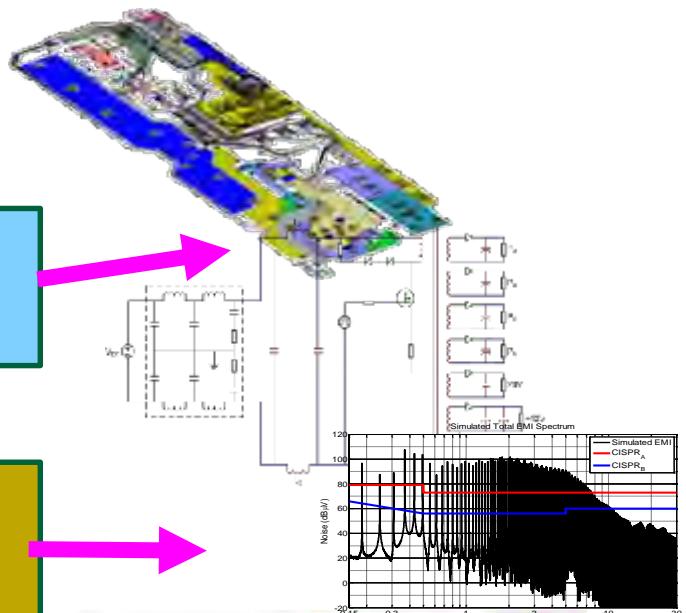
PExprt
电感、变压器快速设计
和方案优选

模型动态链接

Q3D
互连寄生参数

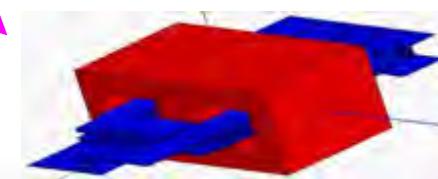
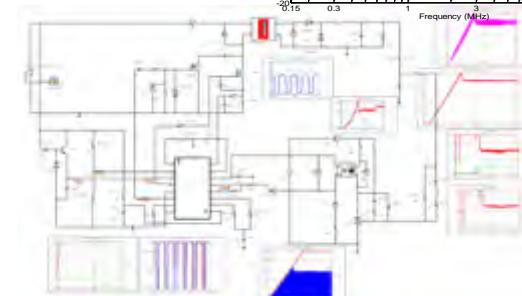
场路协同

Simplorer
机电系统电路
及传导干扰分析



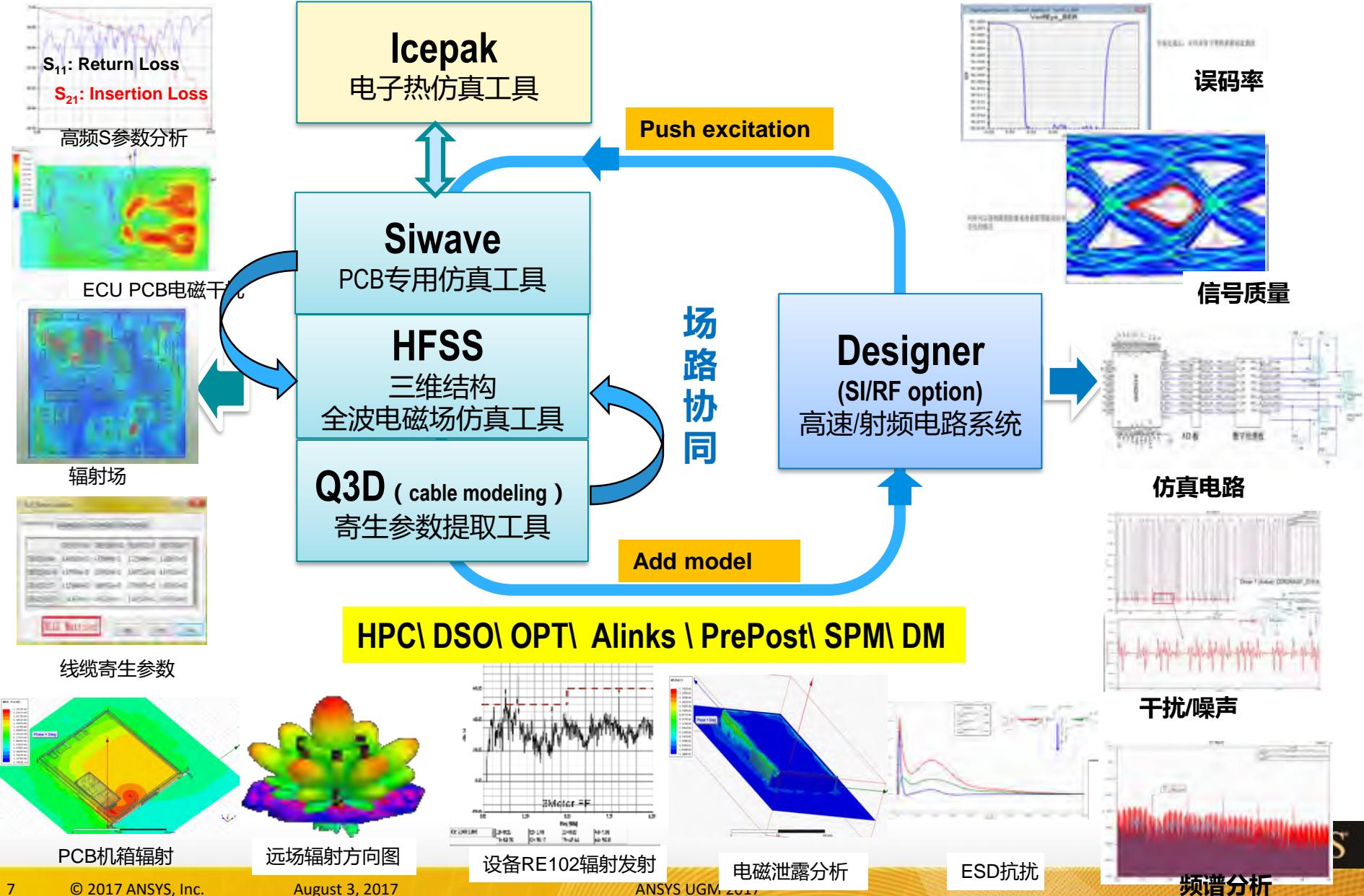
Maxwell
电感、变压器精确电磁性能分析、
参数计算和降阶模型提取

场路协同



ANSYS

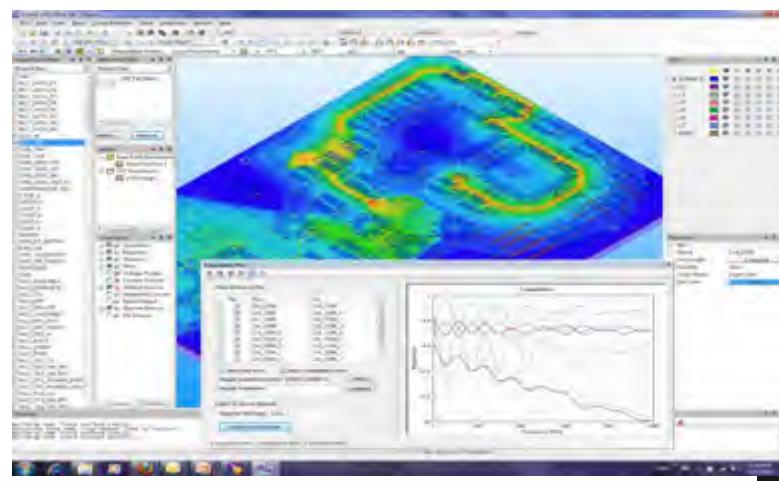
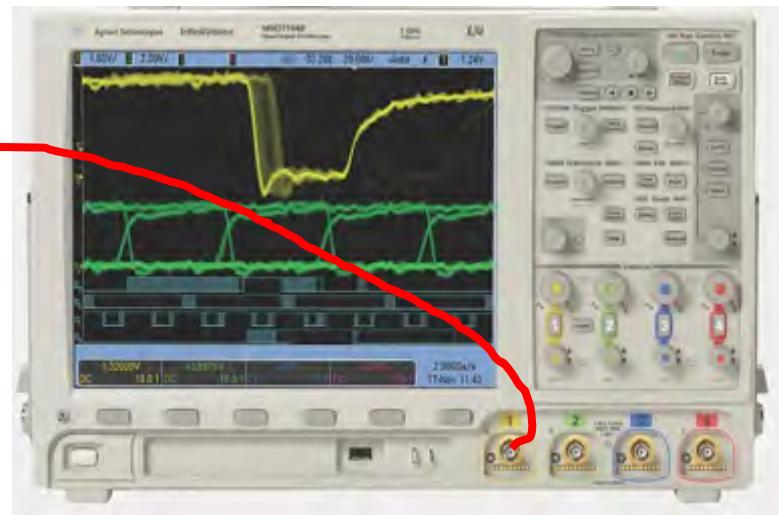
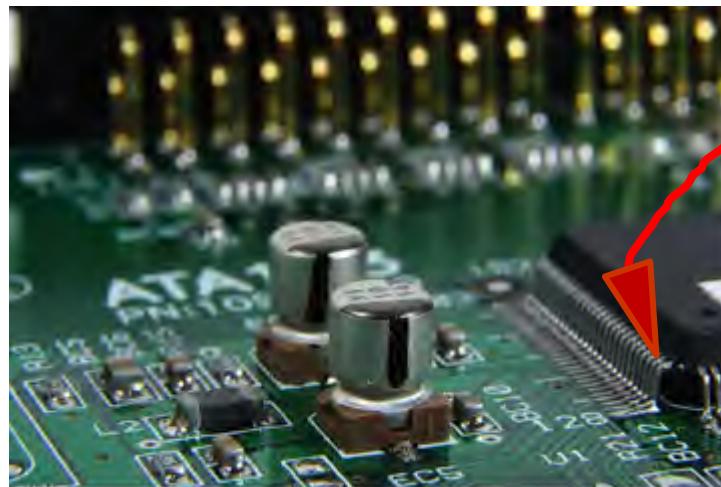
ANSYS 高频EMC辐射解决方案



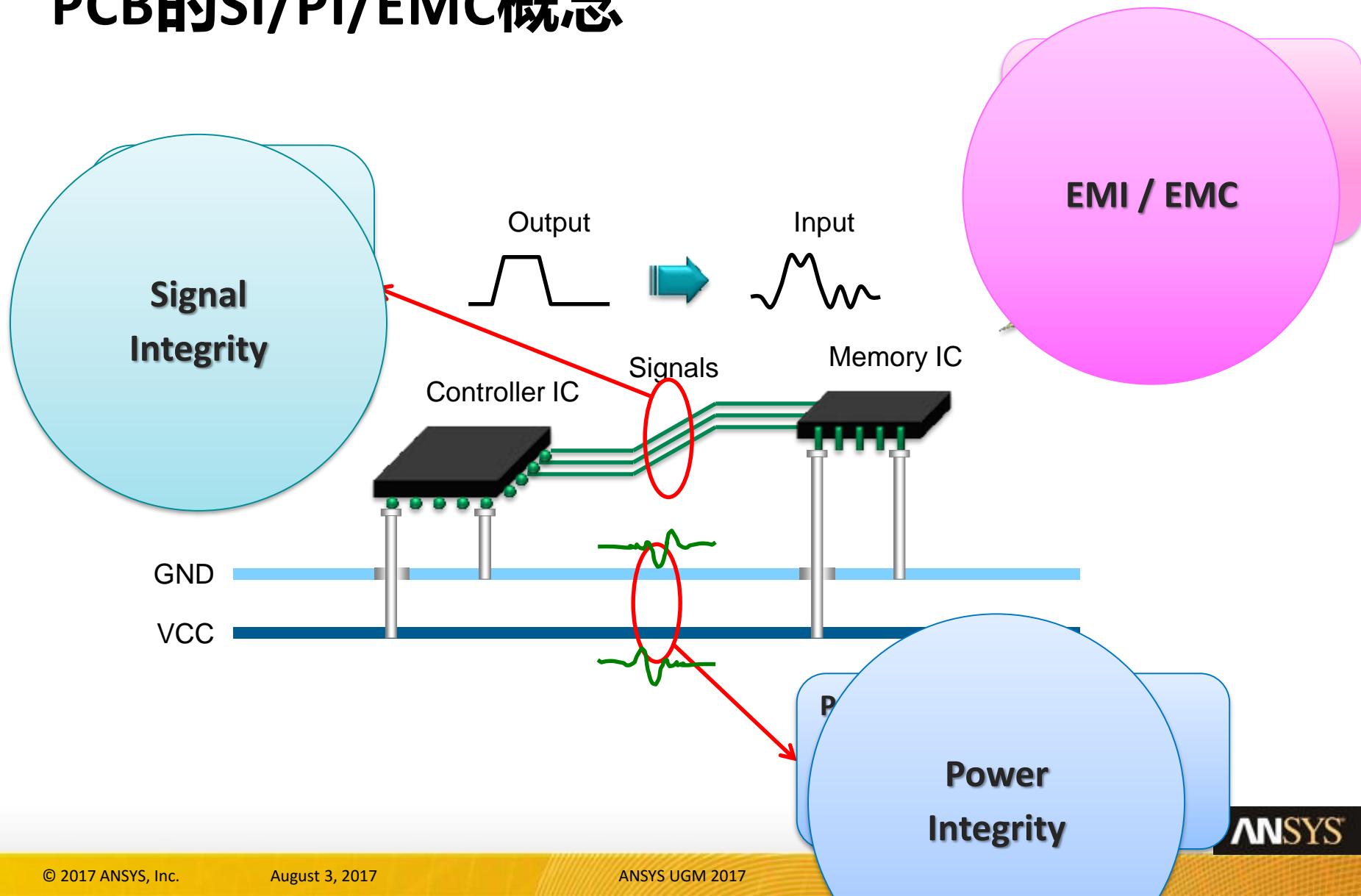
案例分析

1. 电路板信号、电源噪声辐射仿真
2. PCB线缆机箱设备的辐射发射仿真
3. 外界强电磁环境下设备的辐射受扰仿真

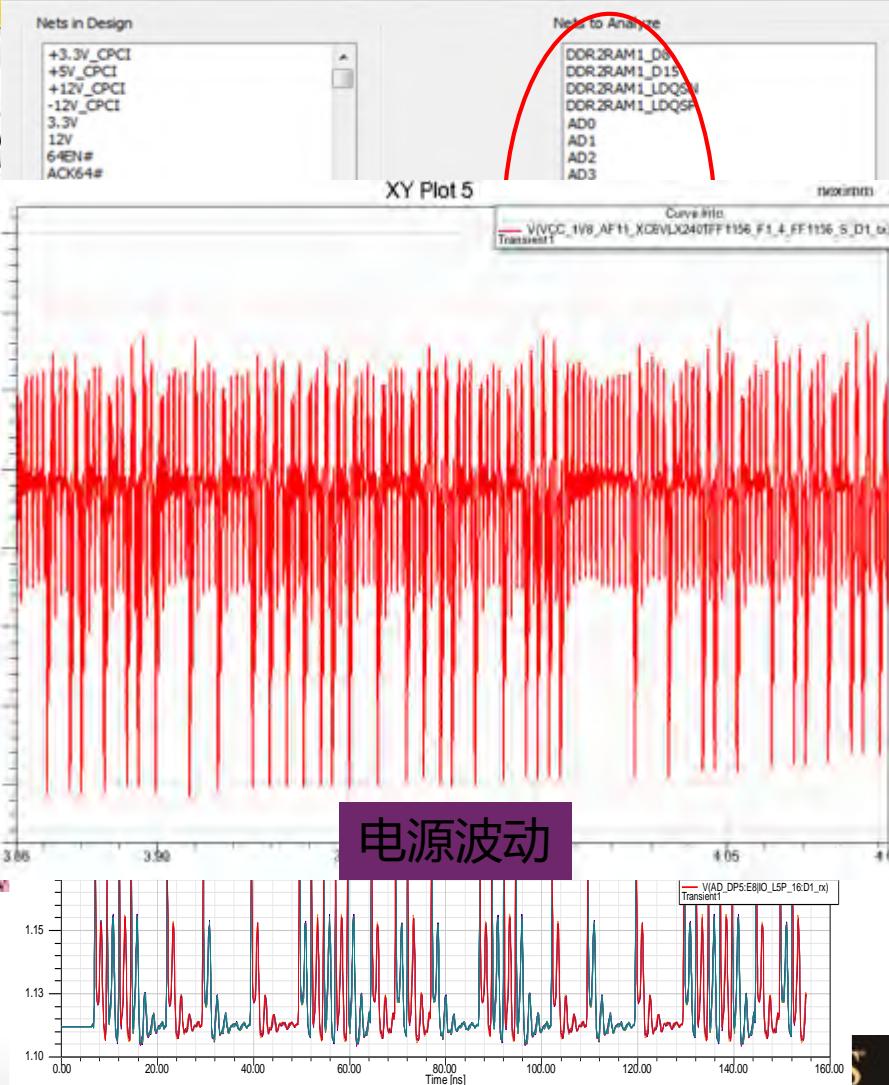
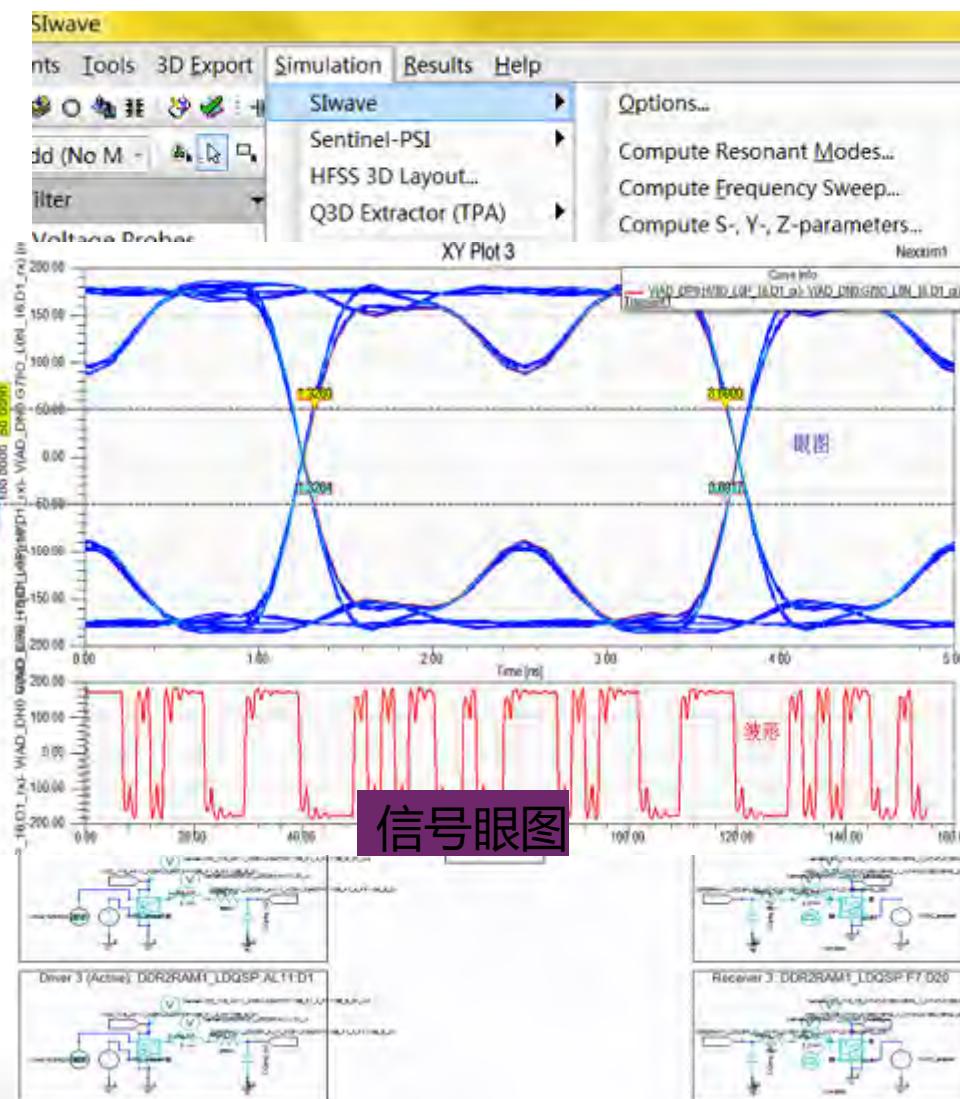
案例1：电路板信号电源噪声辐射



PCB的SI/PI/EMC概念

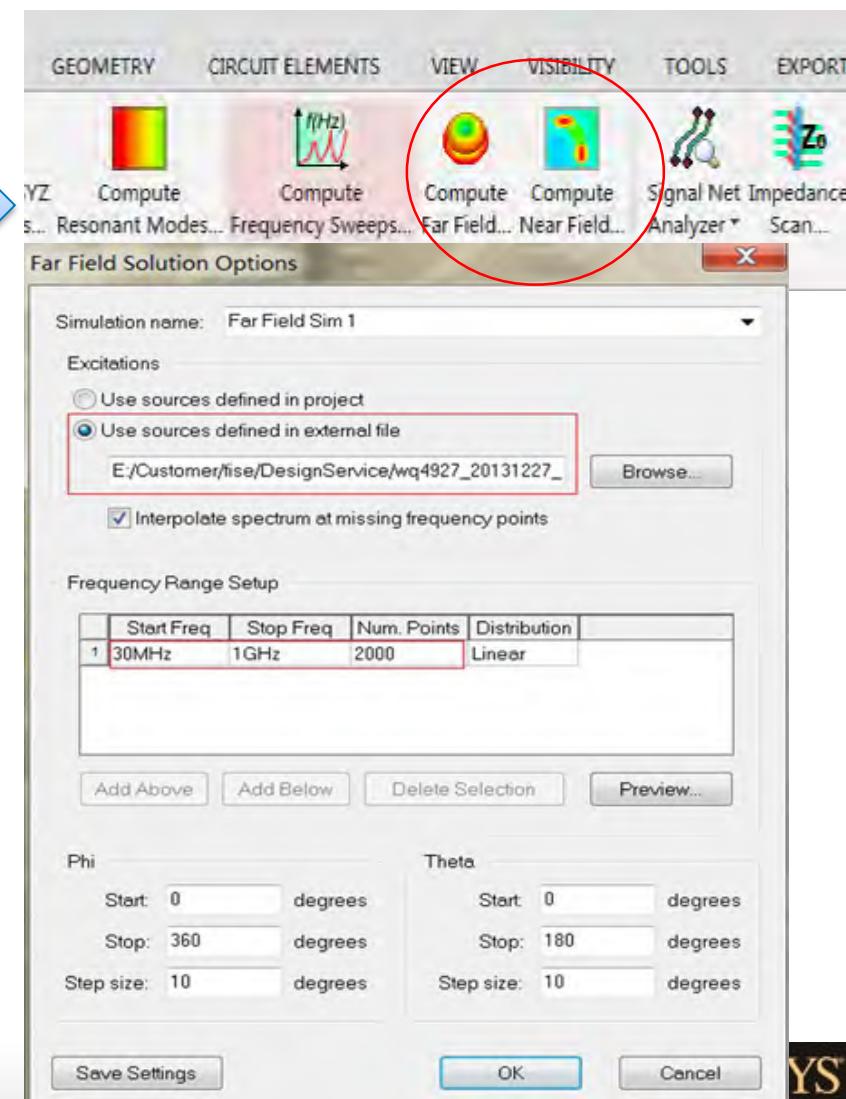
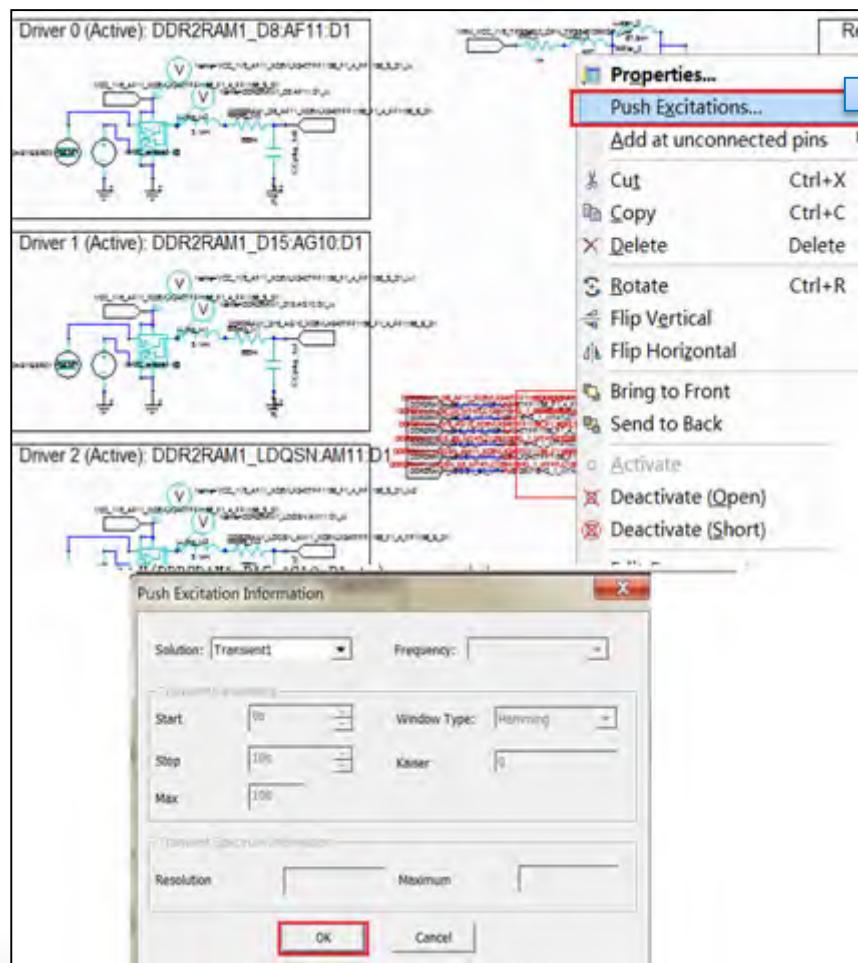


ANSYS PCB SI/PI/EMC分析

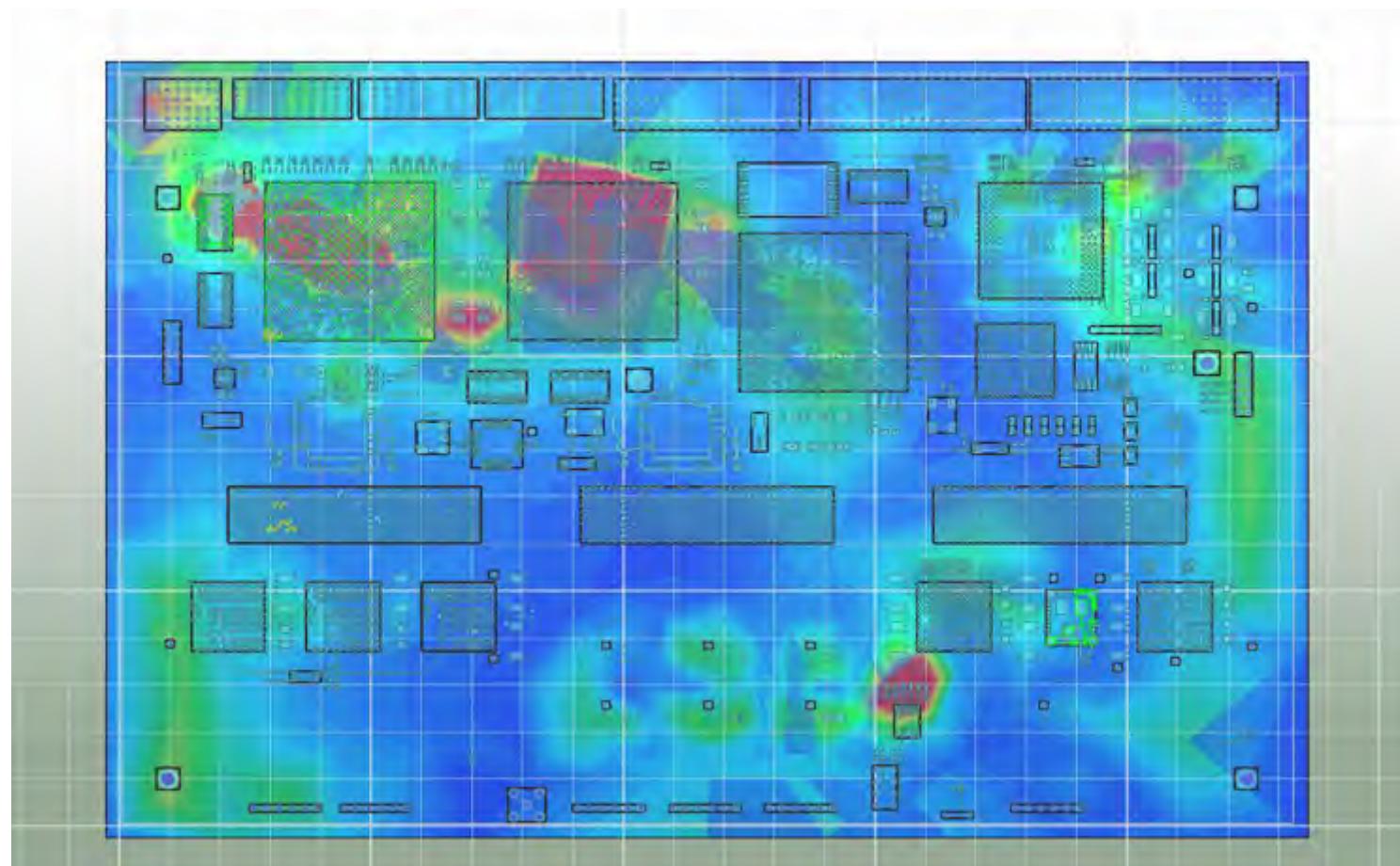


PCB辐射分析

SIwave与designer的场路协同



噪声辐射分析



近场辐射分布

电源阻抗自动优化

电源去耦网络阻抗自动优化模块，考虑电容容值，布局位置，焊盘等细节影响



PI Optimizer Wizard Step 3

Capacitors Selected for Optimization

Part Name	Ref. Des.	Val.
CC0603	C55	
CC0603	C56	
CC0603	C57	
CC0603	C58	
CC0603	C59	
CC0603	C60	
CC0603	C63	
CC0603	C64	
CC0603	C65	
CC0603	C66	
CC0603	C67	
CC0603	C68	
CC0603	C75	
CC0603	C77	
CC0603	C78	
CC0603	C79	
CC0603	C1	
CC0603	C11	
CC0603	C12	
CC0603	C13	
CC0603	C14	

本地电容

Impedance

实时显示Z11频响曲线

添加电容到优化对象

Vendor	Series	Part Name	Part	Capacitor	Value (F)	EIA Size	Cost (\$)	SRF (Hz)	S_min (dB)	ESR (ohms)	ESL (H)
Murata	ERB18	ERB1885C2E100JDX4		Add	1E-11	0603	0	1.9768E+09	-55.125	0.162879	6.48864E-10
Murata	ERB18	ERB1885C2E101JDX4		Add	1E-10	0603	0	6.0572E+08	-66.3535	0.0480067	6.88119E-10
Murata	ERB18	ERB1885C2E110JDX4		Add	1E-11	0603	0	1.86238E+09	-52.7218	0.227032	6.63924E-10
Murata	ERB18	ERB1885C2E120JDX4		Add	1E-11	0603	0	1.83092E+09	-56.7613	0.137515	6.23944E-10
Murata	ERB18	ERB1885C2E130JDX4		Add	1E-11	0603	0	1.70699E+09	-53.0636	0.191861	6.68703E-10
Murata	ERB18	ERB1885C2E150JDX4		Add	1E-11	0603	0	1.70043E+09	-56.5571	0.118976	5.84025E-10
Murata	ERB18	ERB1885C2E160JDX4		Add	1E-11	0603	0	1.56565E+09	-54.4661	0.169071	6.45848E-10
Murata	ERB18	ERB1885C2E180JDX4		Add	1E-11	0603	0	1.41206E+09	-58.0734	0.108668	7.05767E-10
Murata	FRR18	FRR1885C2F1R0CDX1		Add	1E-12	0603	0	42.0923	0.307204	0	

Assigned Candidate Models

Vendor	Series	Part Name
Murata	GRM18	GRM188R60J105ME47
Murata	GRM18	GRM188R60J474KA01
Panasonic	S-para	ECJ1VB1H393K
YUDEN	Standard_...	UNK107CH681
YUDEN	Standard_...	UNK107B103

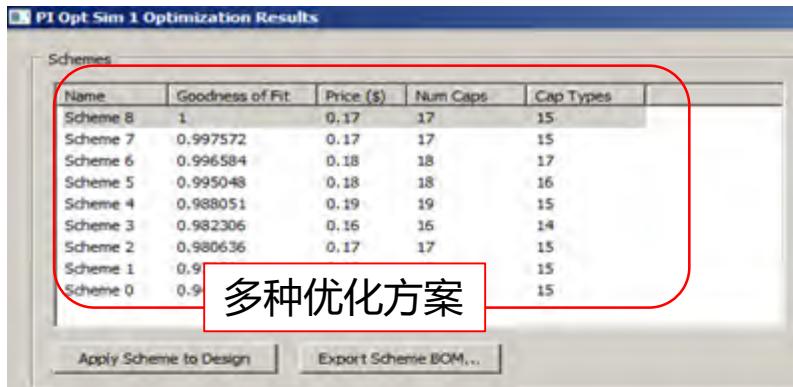
Filters

Vendor	Show	Series	Show	EIA Size	Show	Filter	Quantity	Min.	Max.
AVX	<input checked="" type="checkbox"/>	0201	<input checked="" type="checkbox"/>	01005	<input checked="" type="checkbox"/>	Value (F)	0	0.0015	
Kemet	<input checked="" type="checkbox"/>	0402	<input checked="" type="checkbox"/>	0201	<input checked="" type="checkbox"/>	SRF Range (Hz)	0	210375E+10	
Murata	<input checked="" type="checkbox"/>	0603	<input checked="" type="checkbox"/>	0306	<input checked="" type="checkbox"/>	S_min Range (dB)	-105.911	-7.97224	
Panasonic	<input checked="" type="checkbox"/>	0805	<input checked="" type="checkbox"/>	0402	<input checked="" type="checkbox"/>	ESR Range (ohms)	4.99788E-05	593486	
Samsung	<input checked="" type="checkbox"/>	1206	<input checked="" type="checkbox"/>	0508	<input checked="" type="checkbox"/>	ESL Range (H)	0	1.40NF	
TDK	<input checked="" type="checkbox"/>	ERB18	<input checked="" type="checkbox"/>	0603	<input checked="" type="checkbox"/>	Cost (\$)	0	0	
YUDEN	<input checked="" type="checkbox"/>	ERB21	<input checked="" type="checkbox"/>	0612	<input checked="" type="checkbox"/>				
		ERB32	<input checked="" type="checkbox"/>	0805	<input checked="" type="checkbox"/>				
		GCM16	<input checked="" type="checkbox"/>	1206	<input checked="" type="checkbox"/>				

电容库筛选

Remove Plot [Z11] Previous Next Cancel

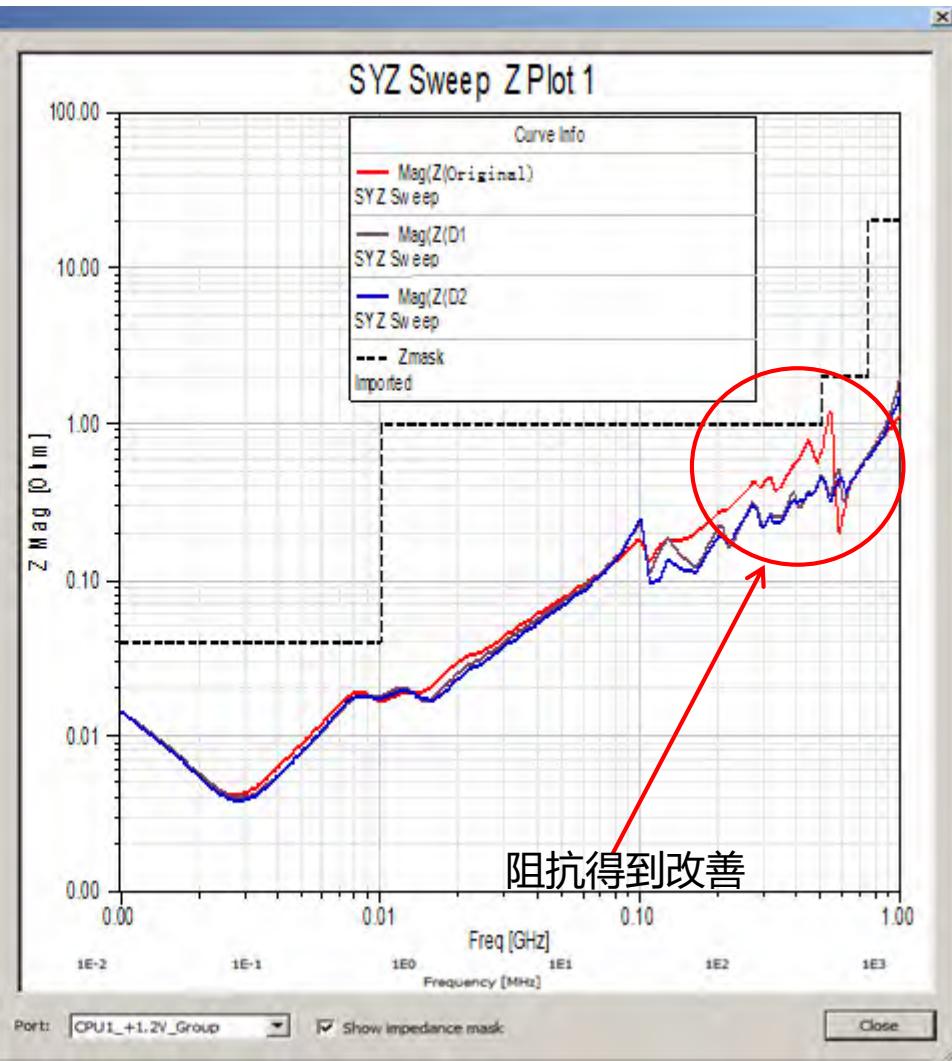
阻抗自动优化



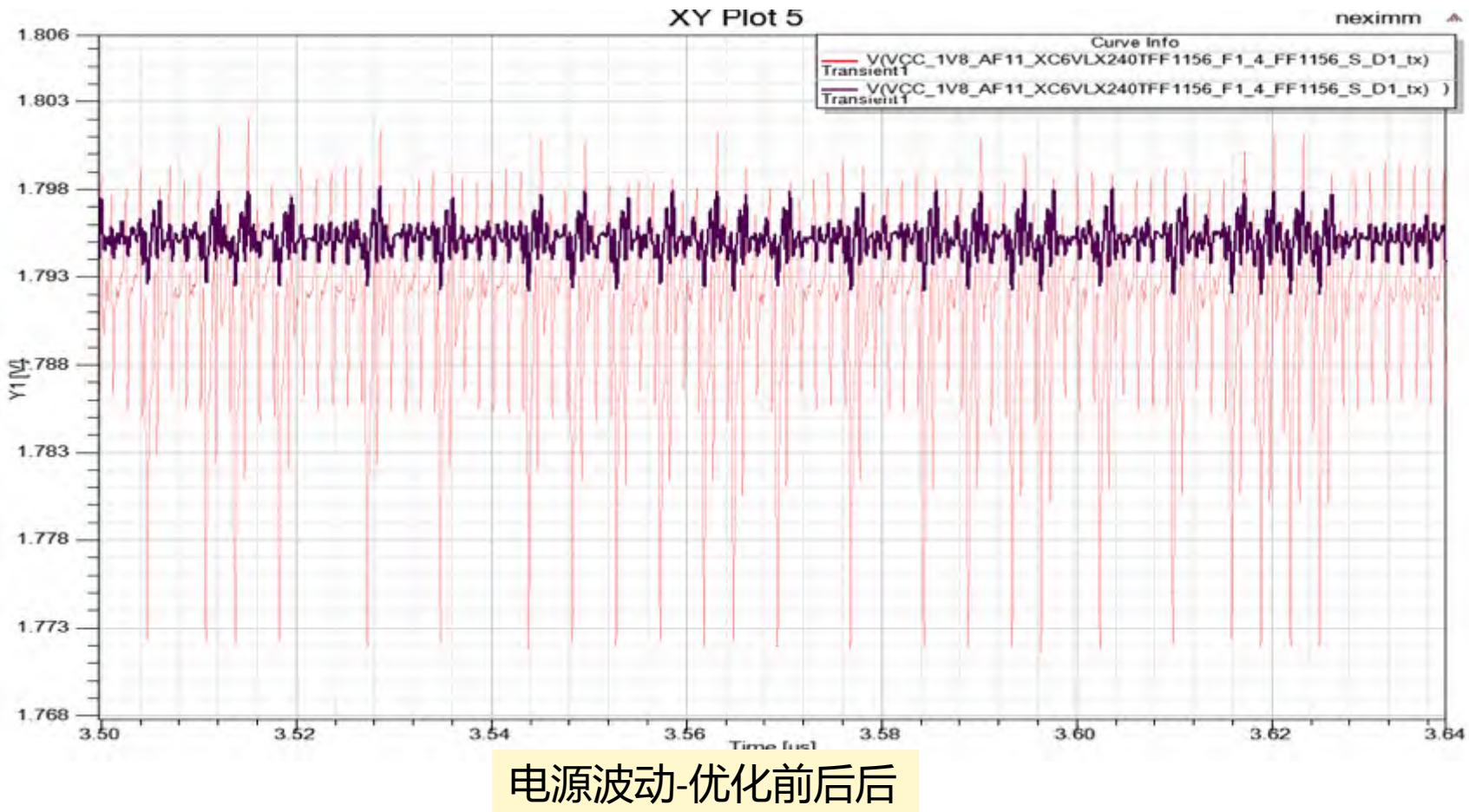
Capacitors Selected for Scheme 8

Capacitor	Value (F)	Vendor	Series	Part	Price (\$)
C1	(empty)				
C2	(empty)				
C3	1.6E-10	Murata	GRM18	GRM1885C1H161JA01	0.01
C4	(empty)				
C5	(empty)				
C6	(empty)				
C7	1E-09	Murata	GRM21	GRM216F51H1022A01	0.01
C8	1E-06	Murata	GRM21	GRM219R61A105KA01	0.01
C9	1E-06	Murata	GRM18	GRM188F51C105ZA01	0.01
C11	(empty)				
C12	(empty)				
C13	8.2E-11	Murata	GRM18	GRM1885C1H8203JA01	0.01
C14	1E-08	Murata	GRM18	GRM188R71H103KA01	0.01
C15	6.2E-11	Murata	GRM18	GRM1885C1H6203JA01	0.01
C16	6.2E-11	Murata	GRM18	GRM1885C1H6203JA01	0.01
C17	1E-10	Murata	GRM18	GRM1885C1H101JA01	0.01
C18	9.1E-11	Murata	GRM18	GRM1885C1H910JA01	0.01
C19	(empty)				
C20	(empty)				
C21	(empty)				
C22	2E-10	Murata	GRM18	GRM1885C1H201JA01	0.01
C43	(empty)				
C44	6.8E-11				

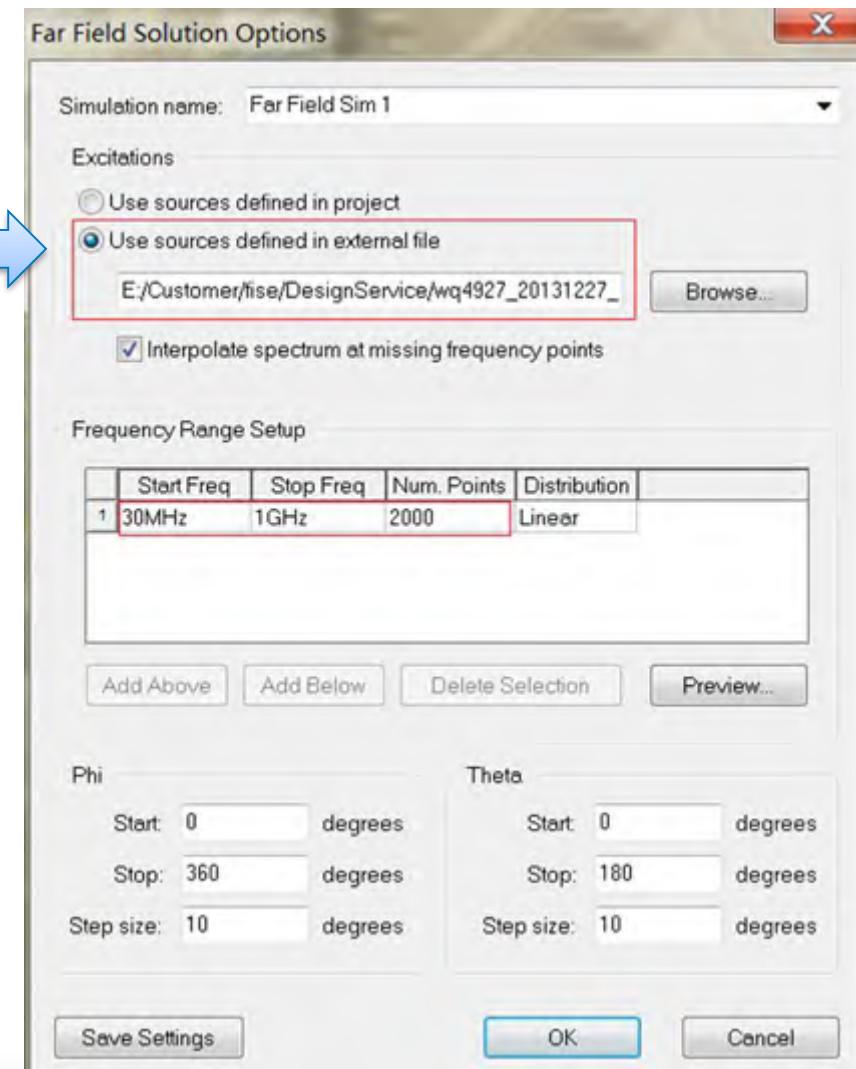
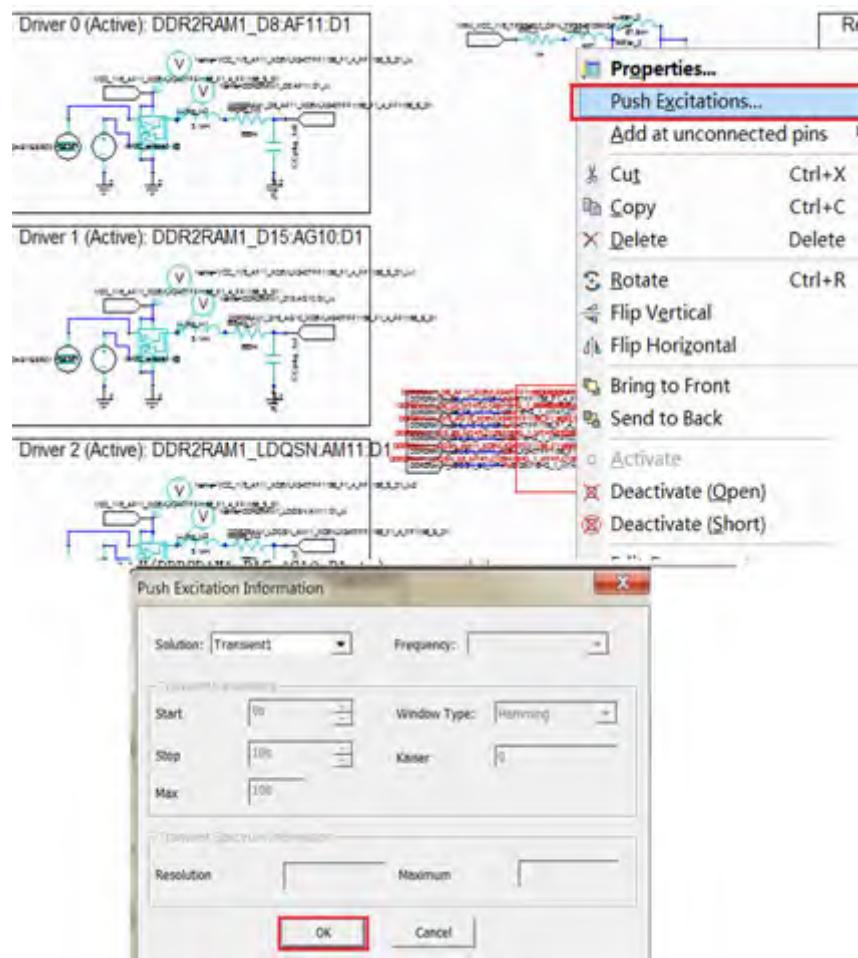
各个方案细节



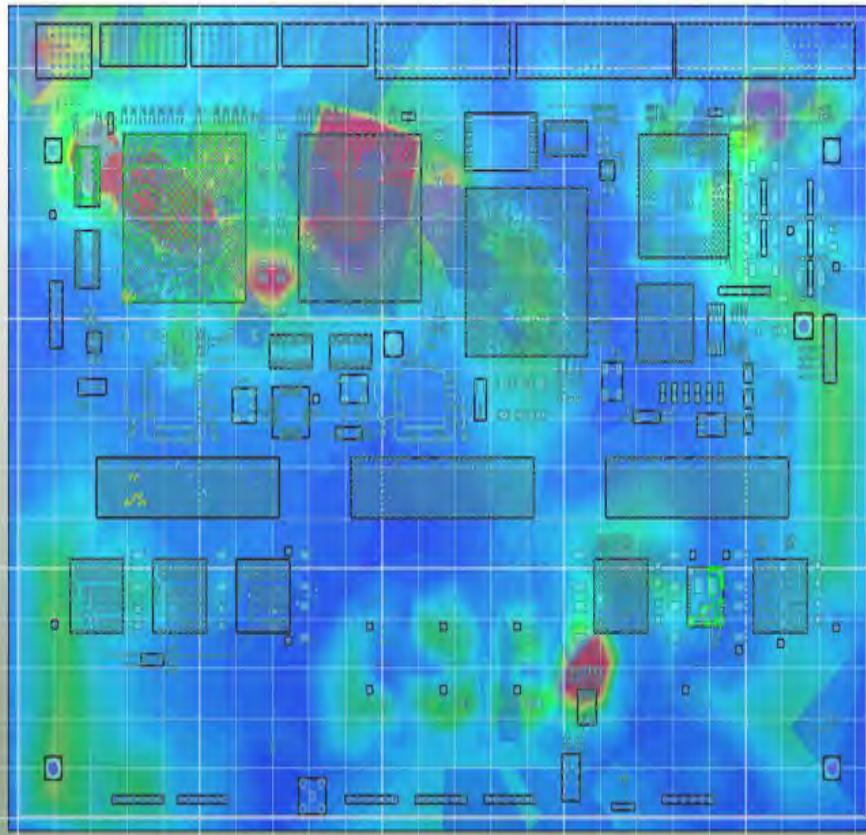
PCB时域电源抖动的改善



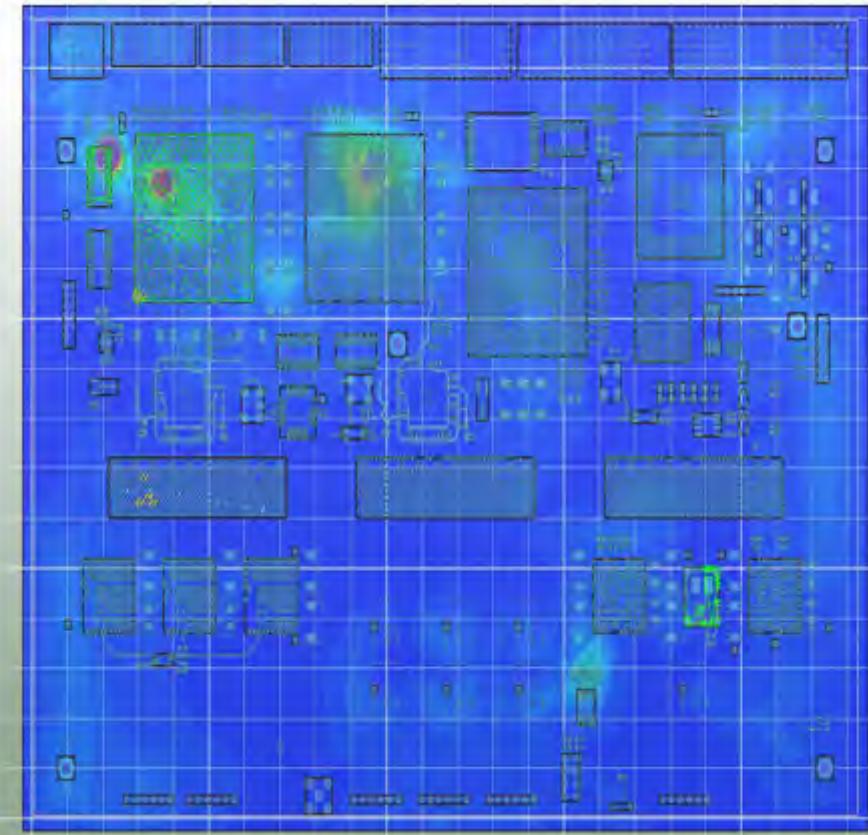
PCB对外辐射分析



PCB近场优化对比

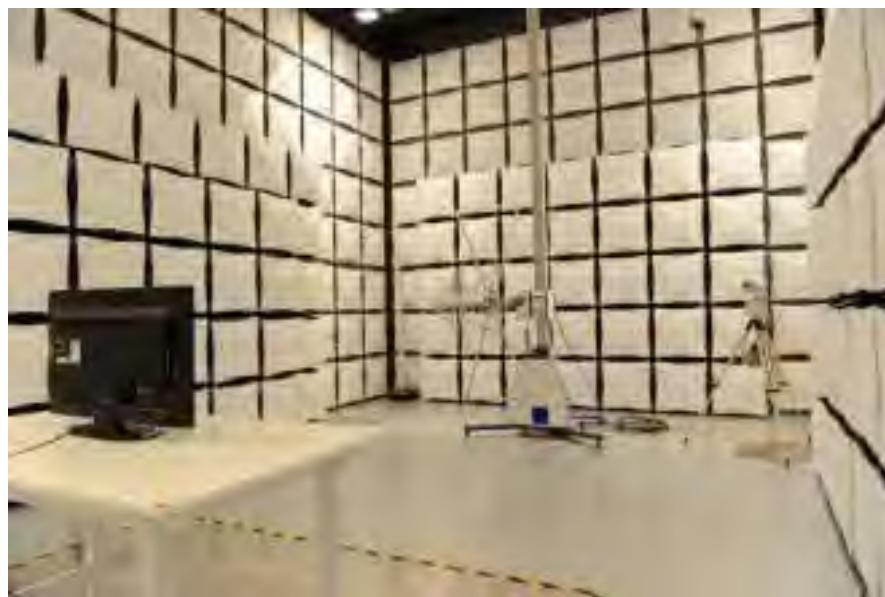


PCB电源优化前

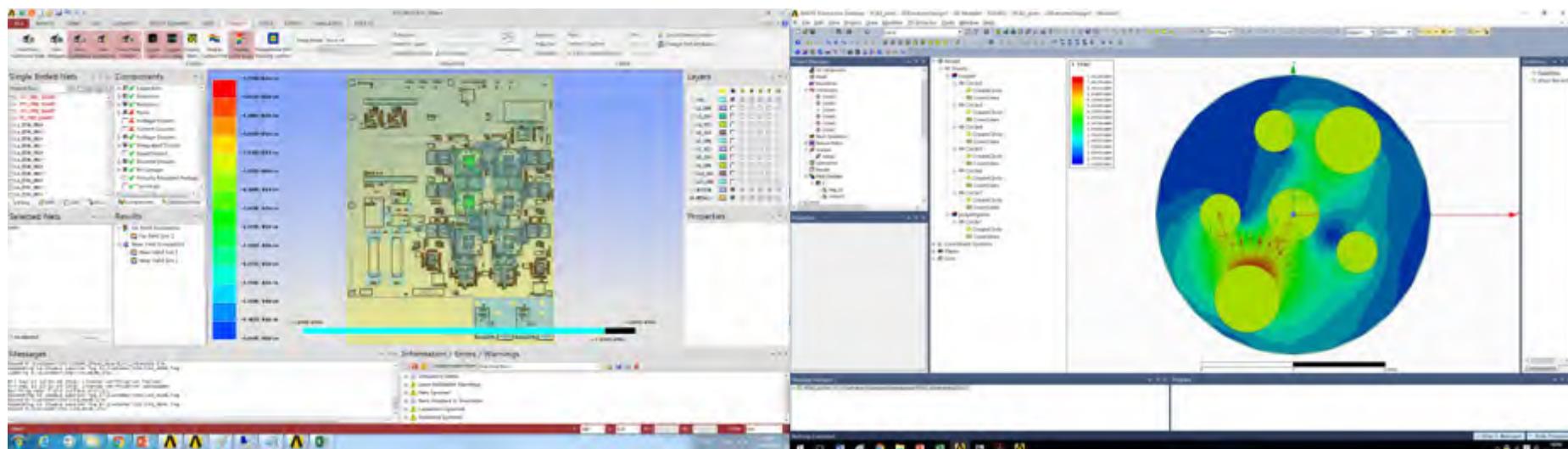


PCB电源优化后

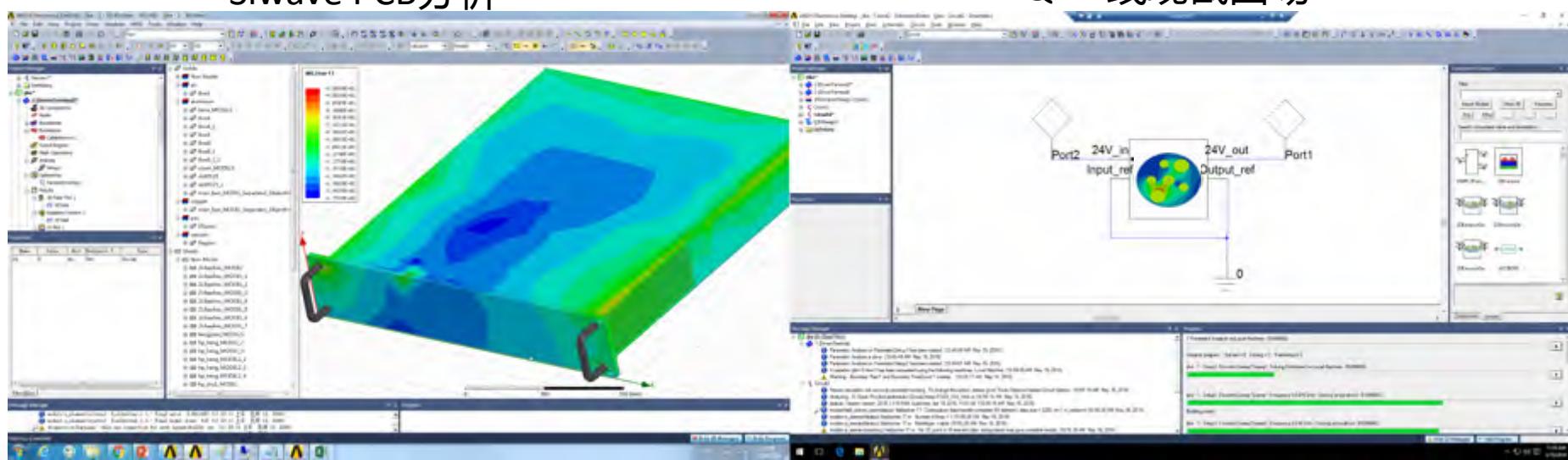
案例2：设备级（PCB线缆机箱）辐射发射



机箱联合PCB线缆的辐射分析



Siwave PCB分析

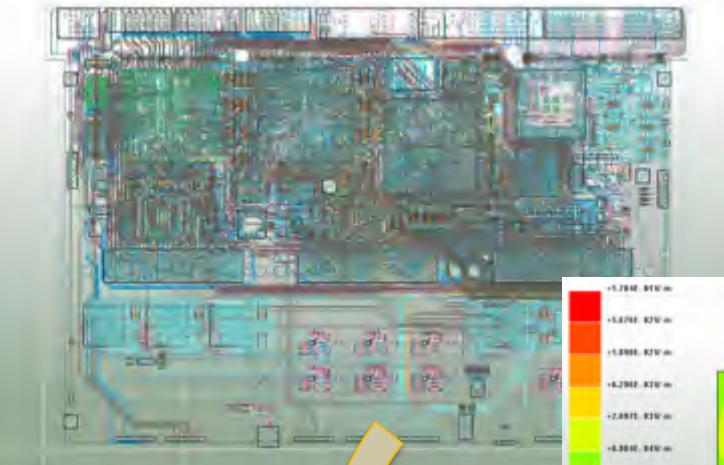


HFSS 设备三维电磁场

circuit 电路分析

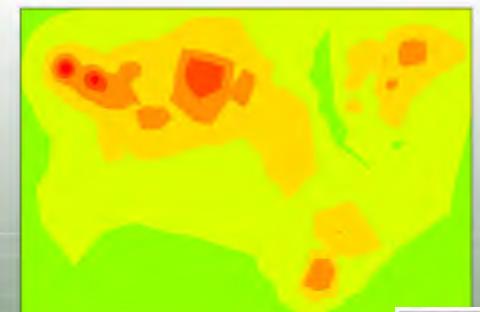
ANSYS

PCB机箱联合



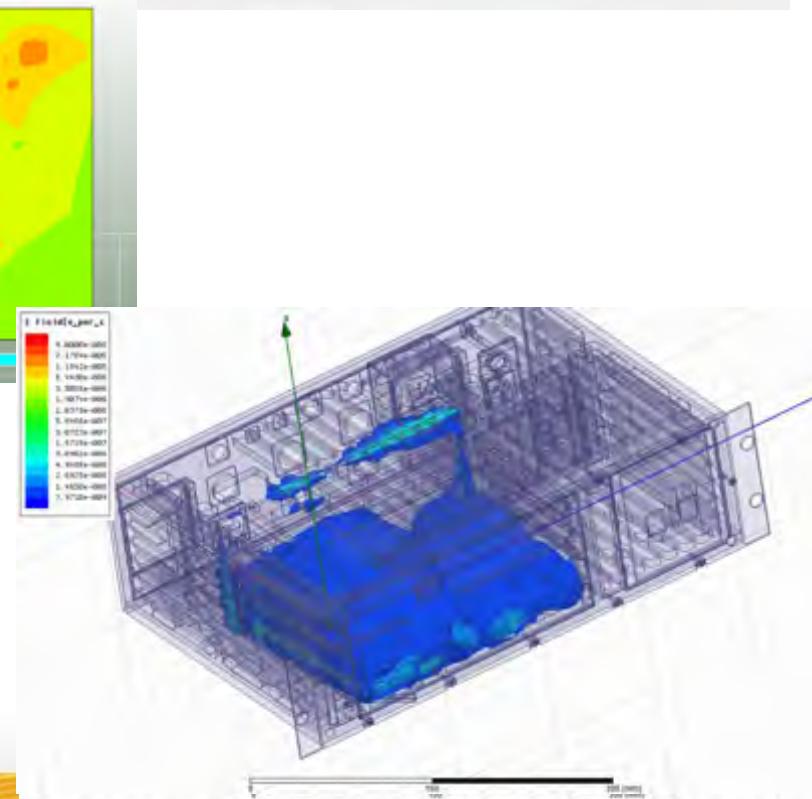
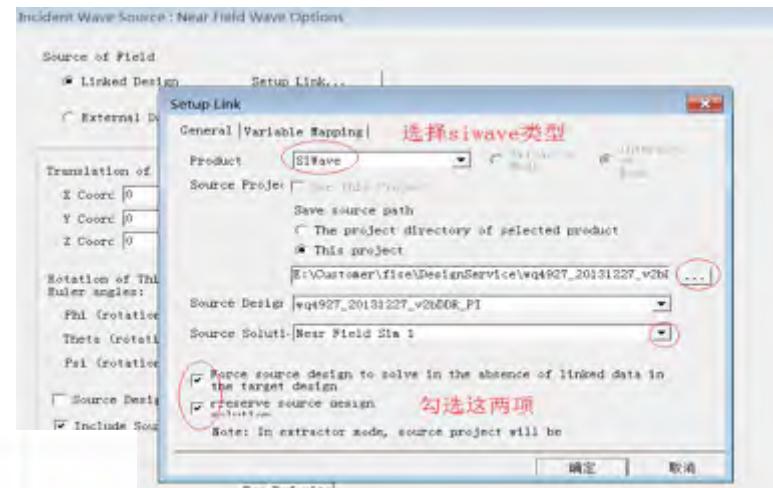
Siwave完成近场分析

+0.794E-01V/m
+0.670E-01V/m
+0.546E-01V/m
+0.422E-01V/m
+0.298E-01V/m
+0.174E-01V/m
+0.530E-02V/m
-0.232E-02V/m
-0.414E-02V/m
-0.596E-02V/m
-0.778E-02V/m
-0.960E-02V/m
-0.1142E-01V/m



HFSS连接Siwave近场数据

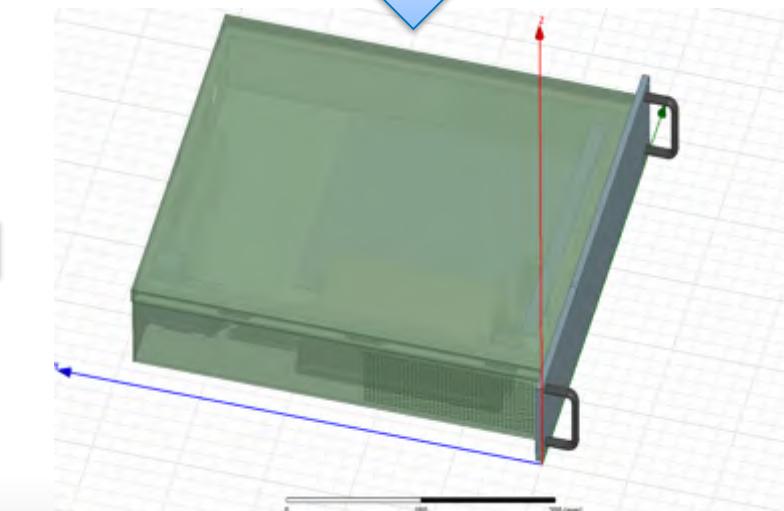
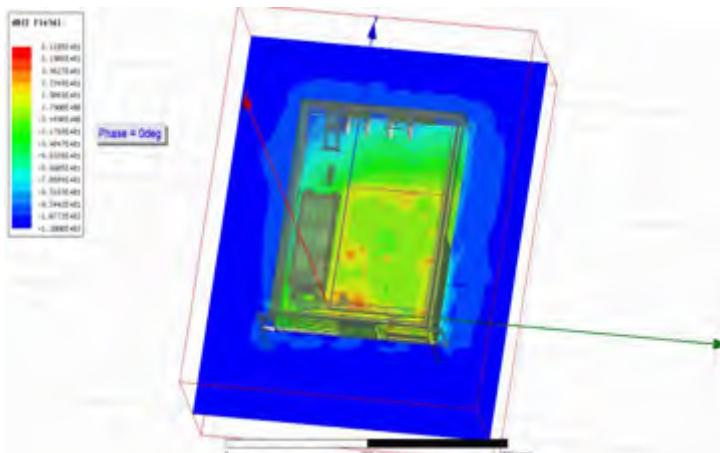
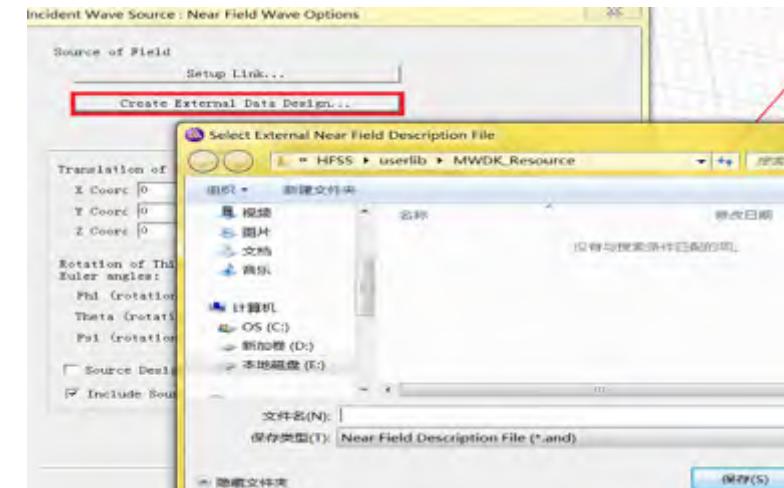
联合三维电磁场工具HFSS,可完成整设备的EMI分析



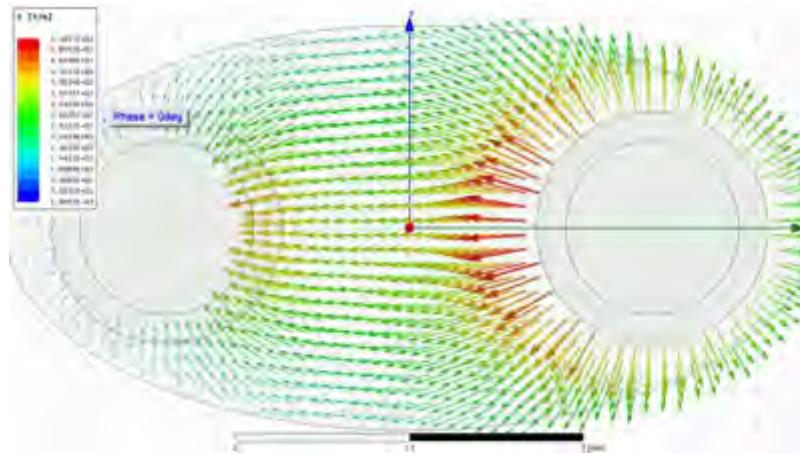
辐射数据多样化接口



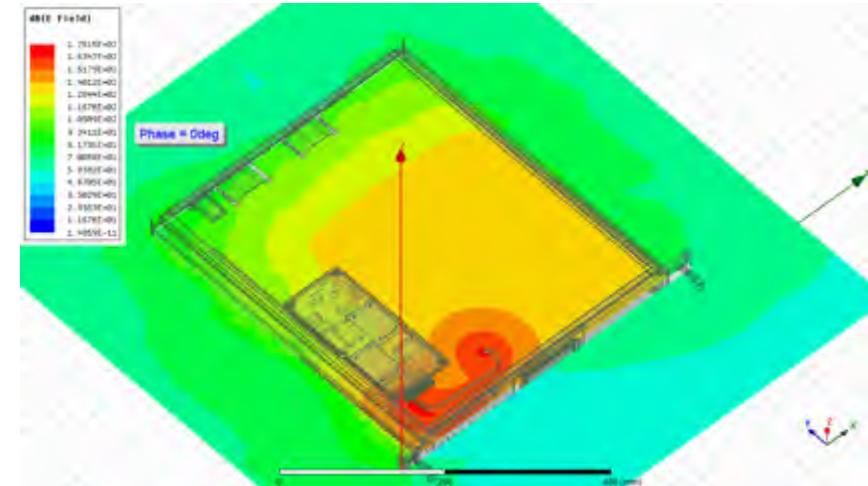
测试获得的辐射数据



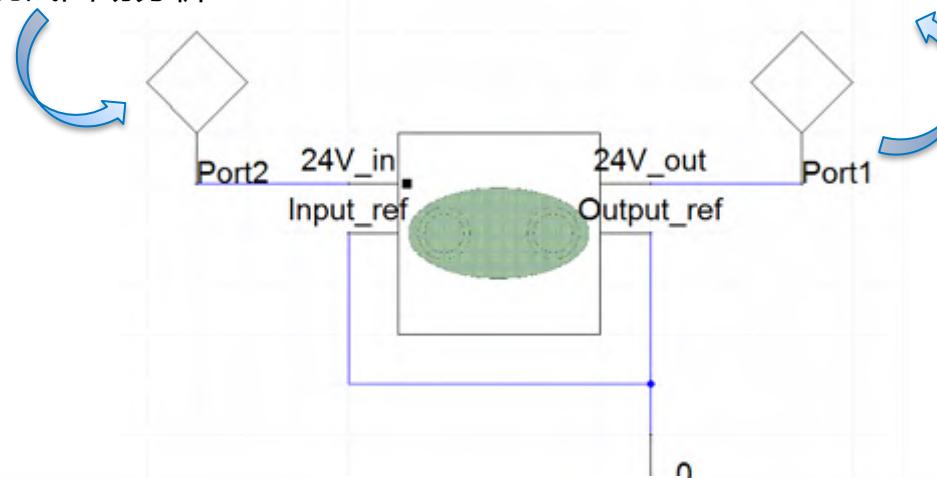
电缆辐射cable modeling技术



Q3D线缆截面场分析

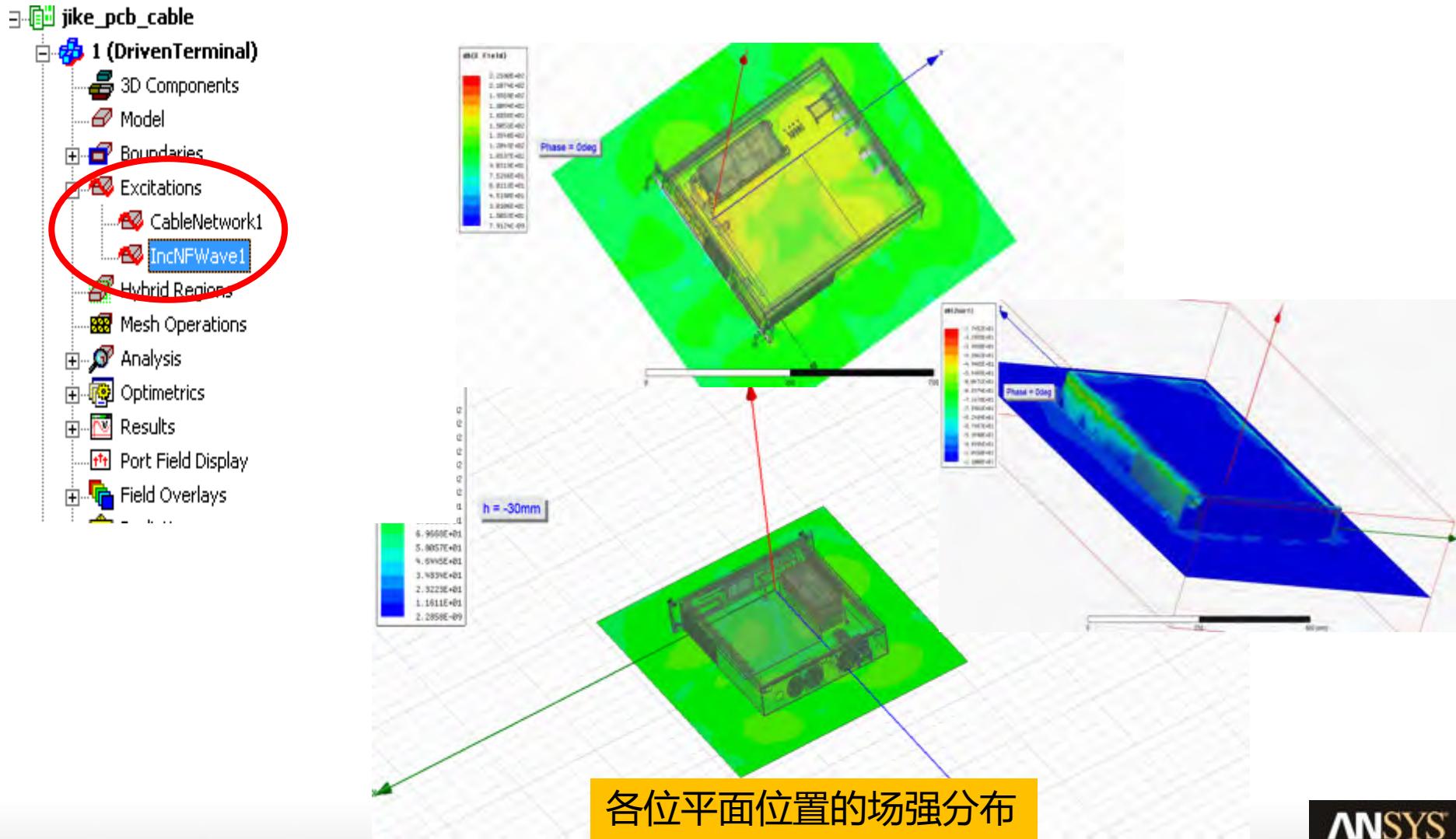


HFSS线缆敷设场

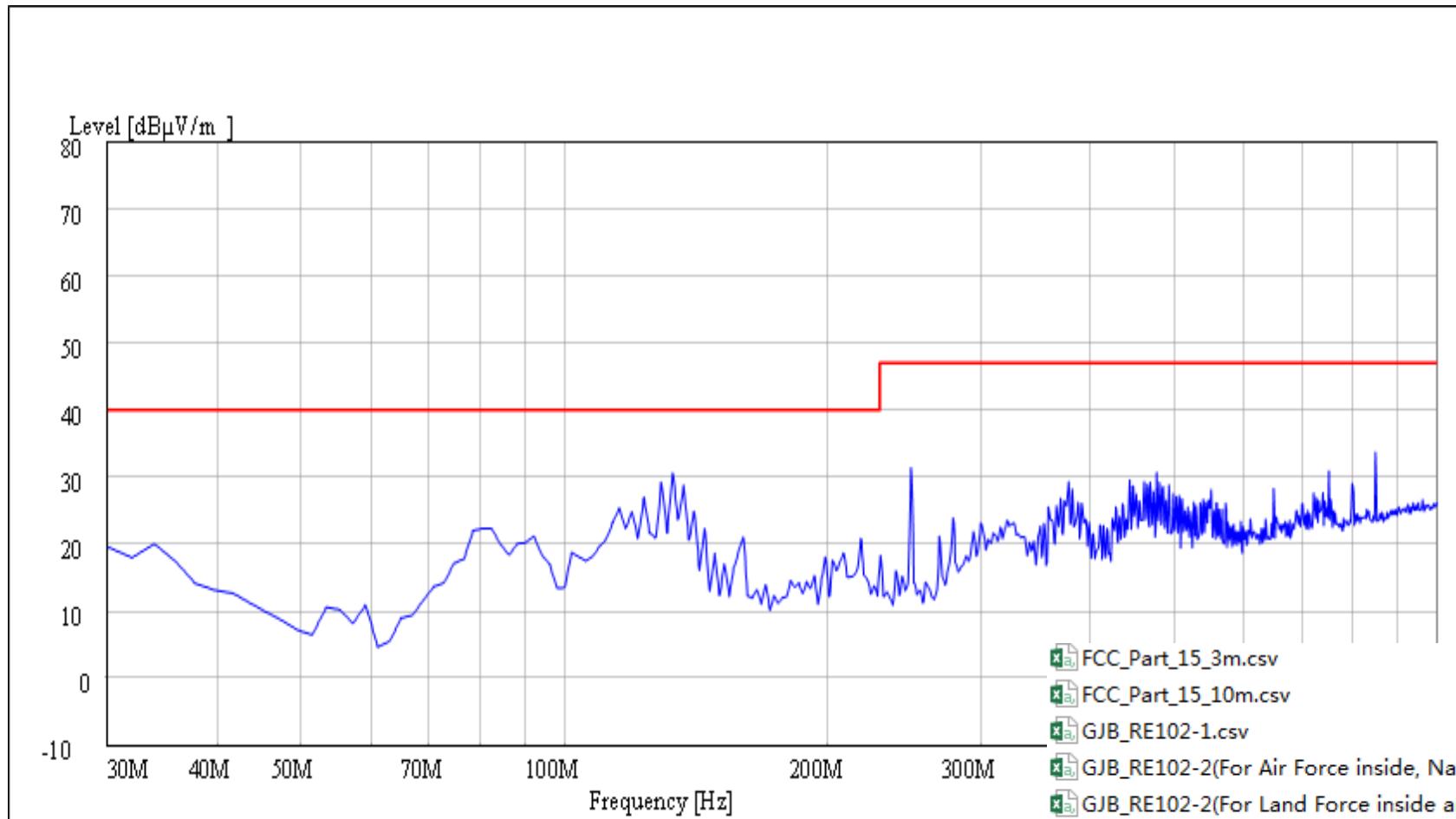


Circuit 电路噪声分析

PCB线缆机箱联合场分析



设备RE102辐射

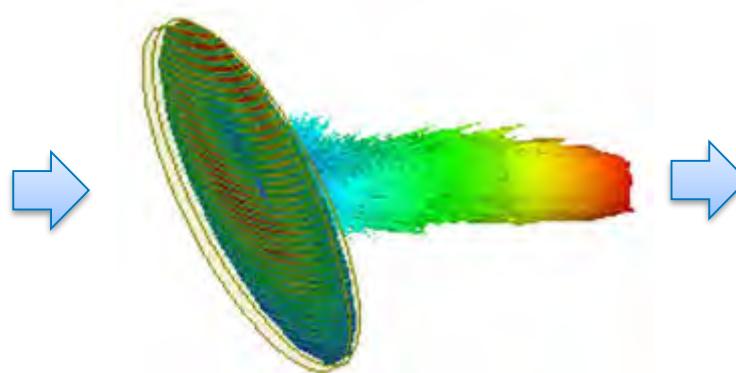


后处理结果-RE辐射发射曲线

案例3：外界强电磁环境下设备的辐射受扰



噪声源



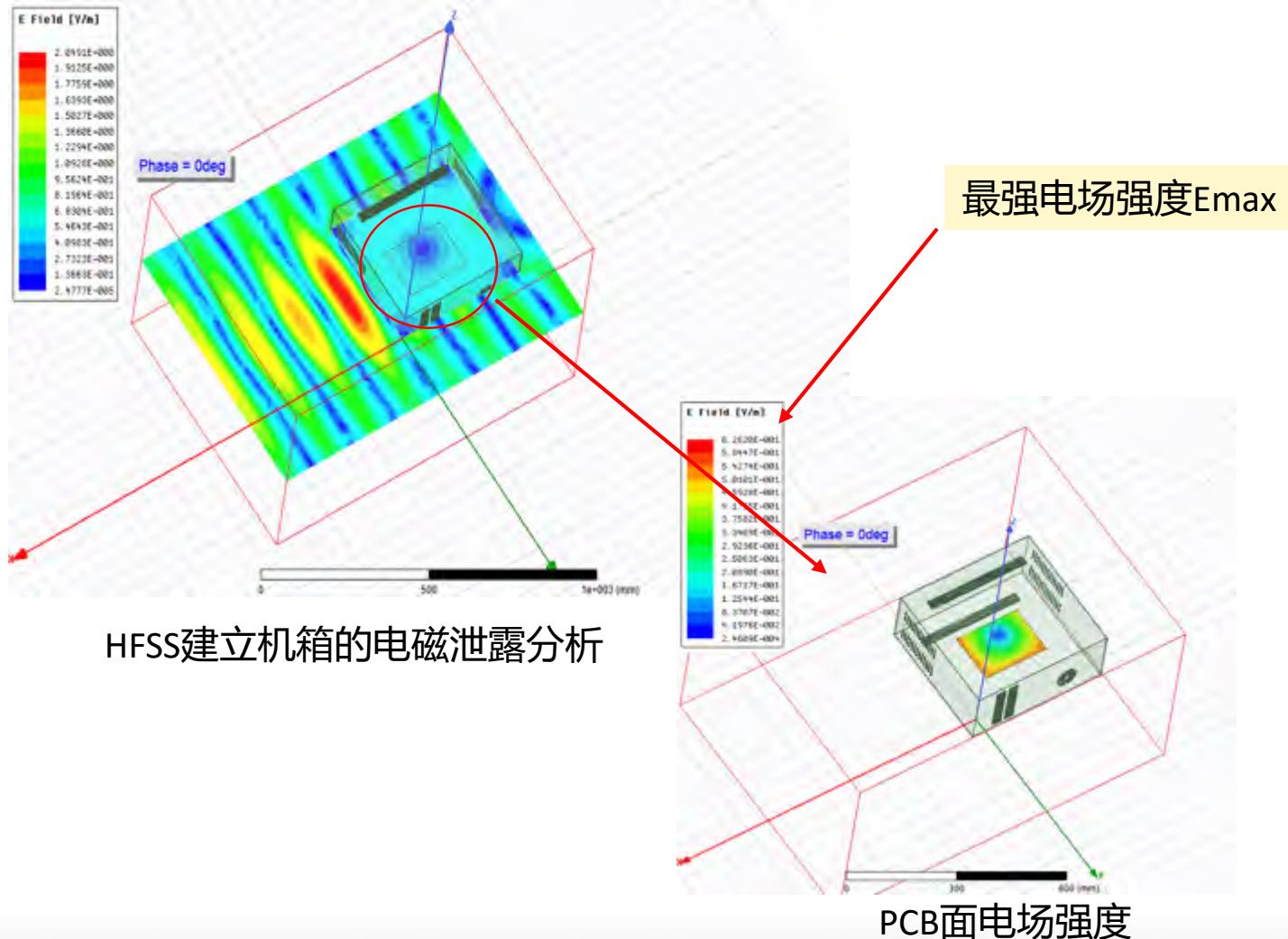
空间辐射



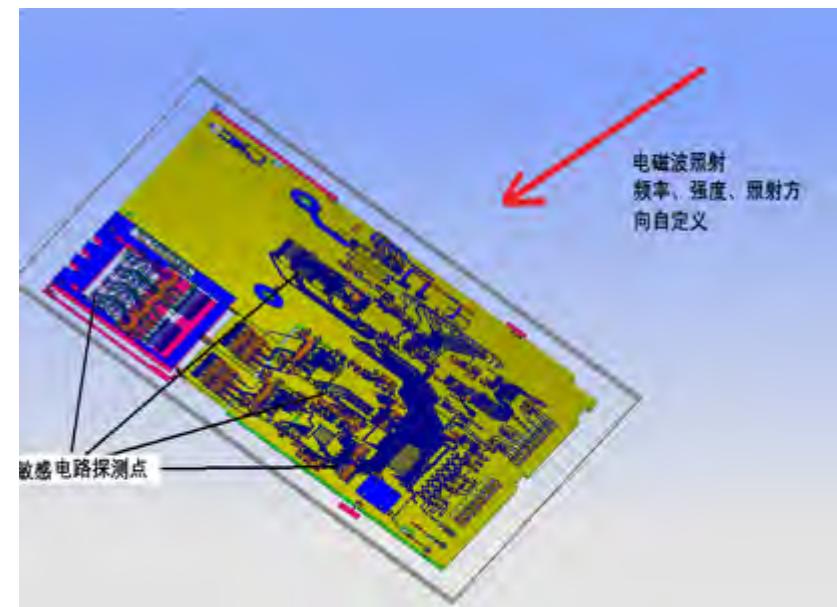
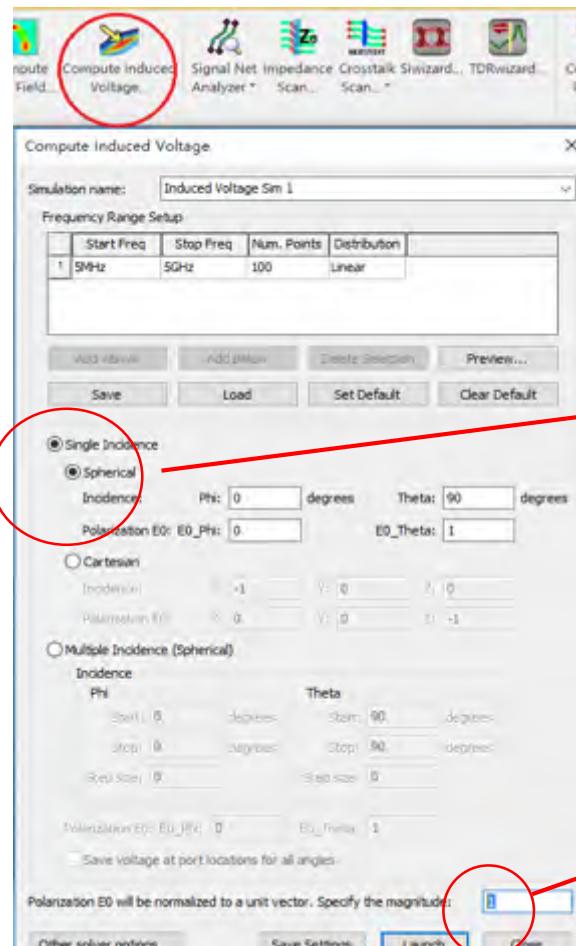
敏感设备

PCB电路耦合？线缆耦合？机箱屏蔽泄露？

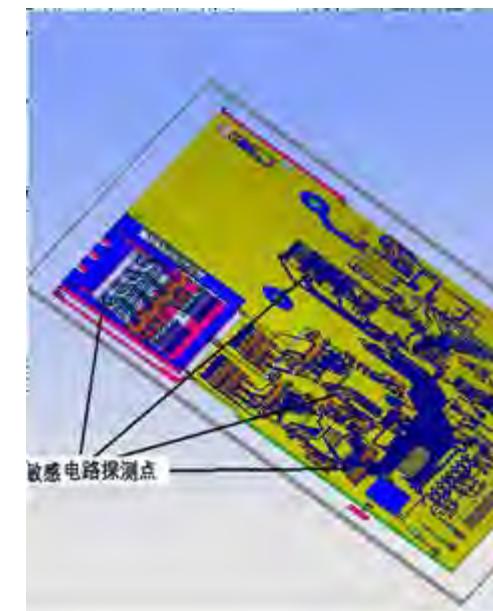
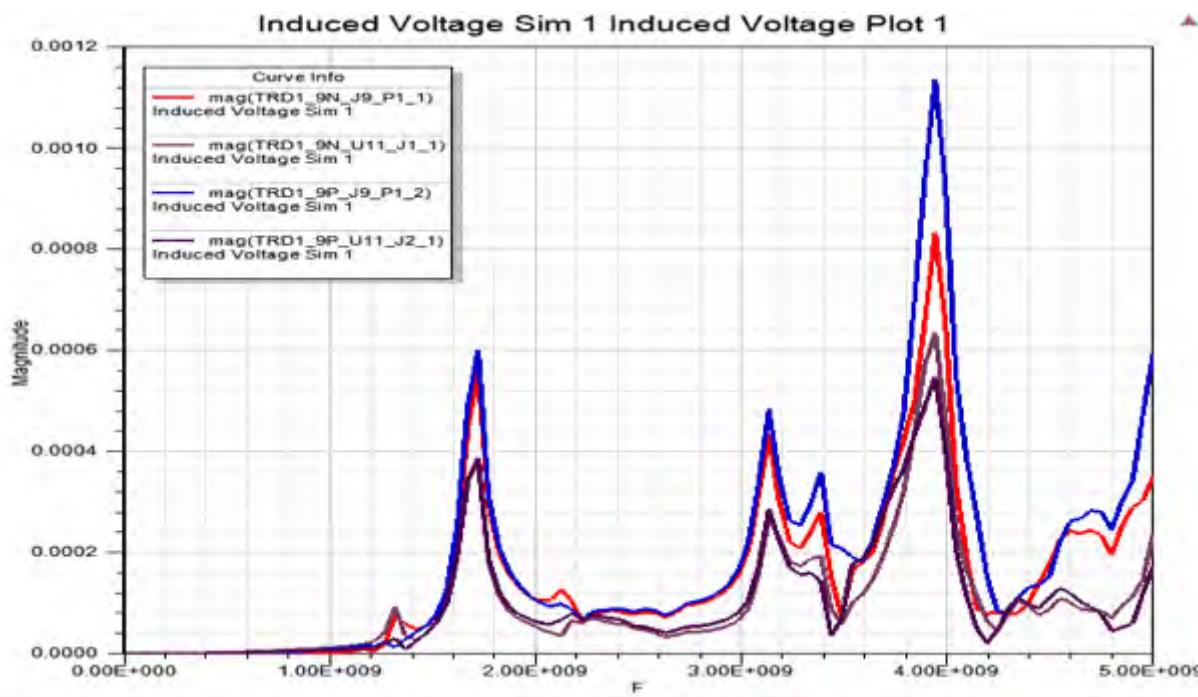
A: 通过PCB耦合噪声



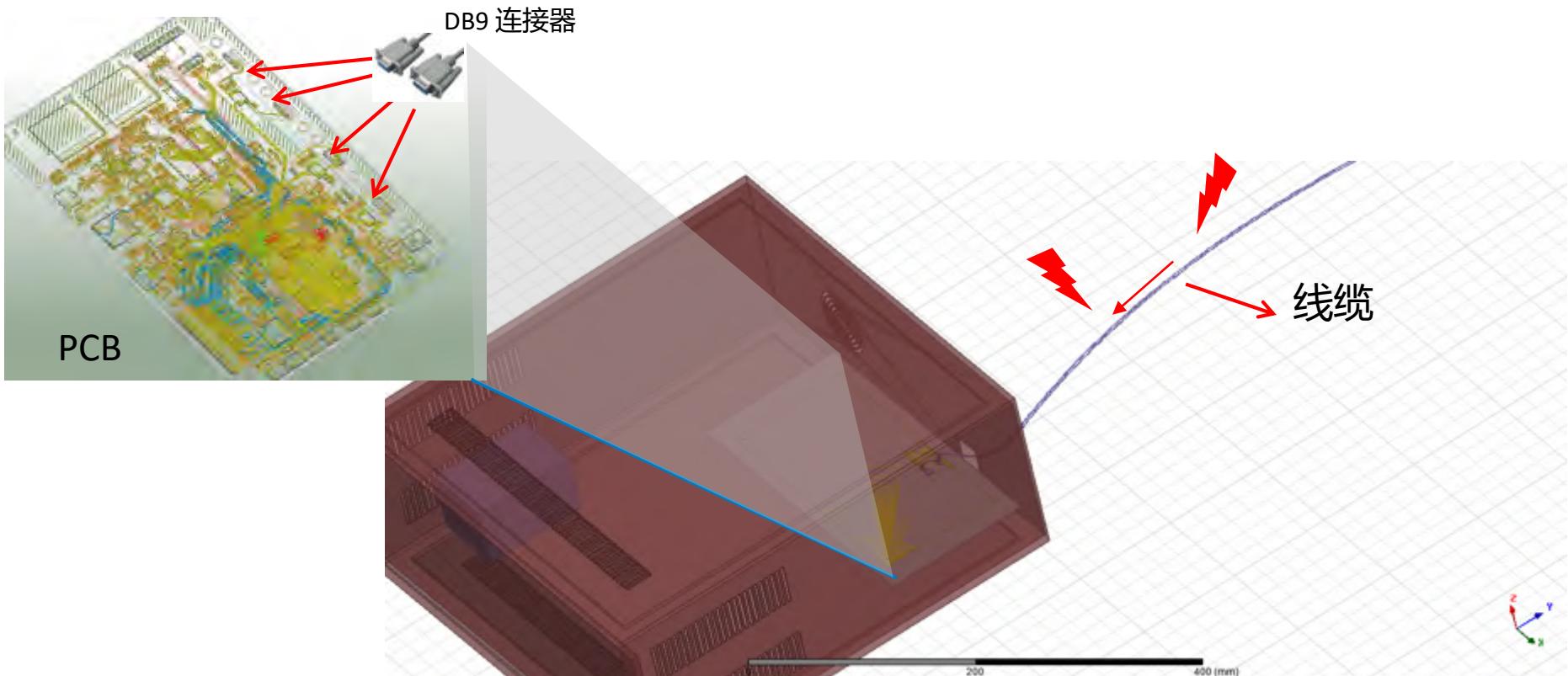
SIwave平面波照射分析



关键电路感应电压噪声

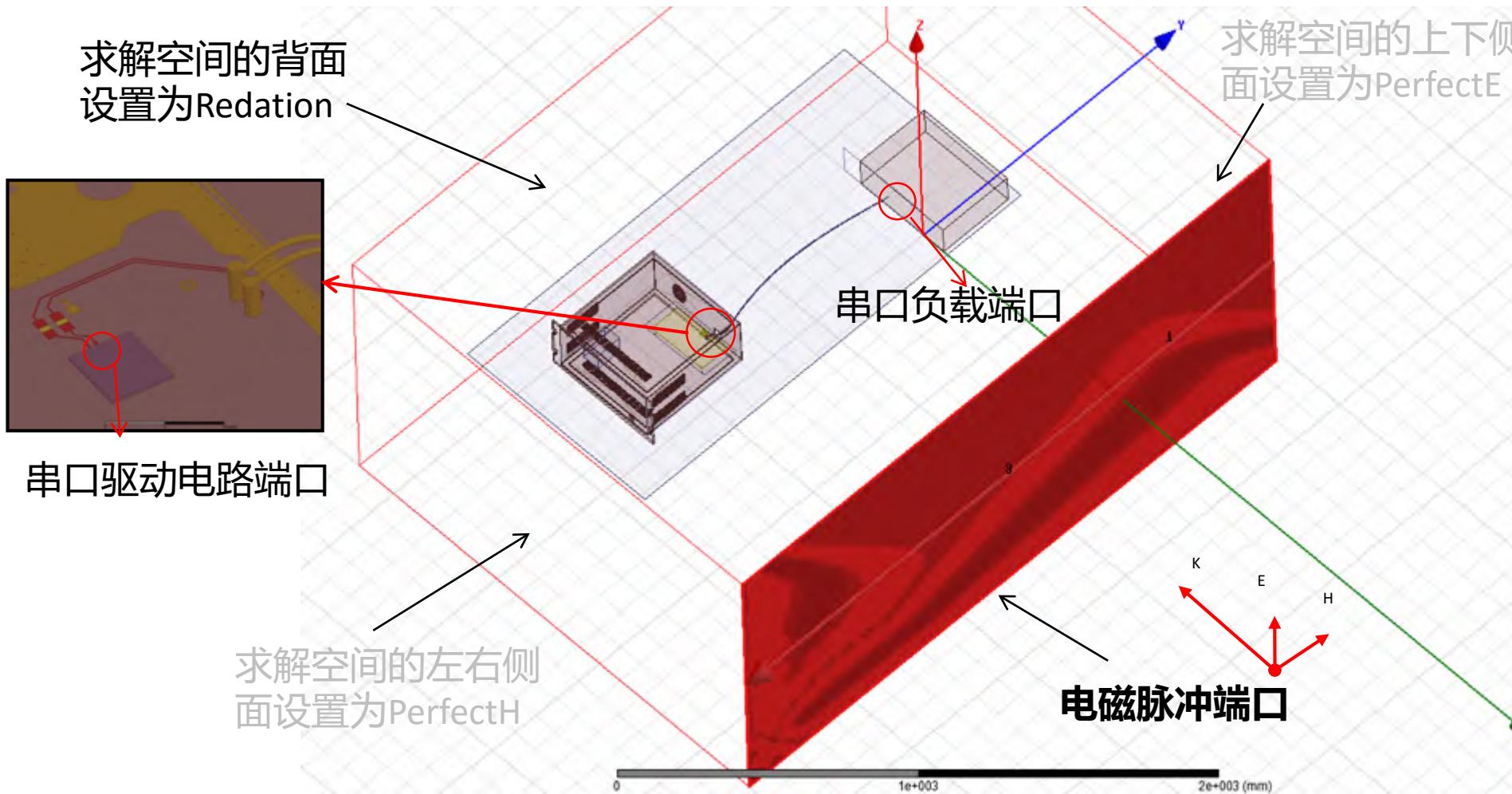


B: 通过线缆耦合噪声

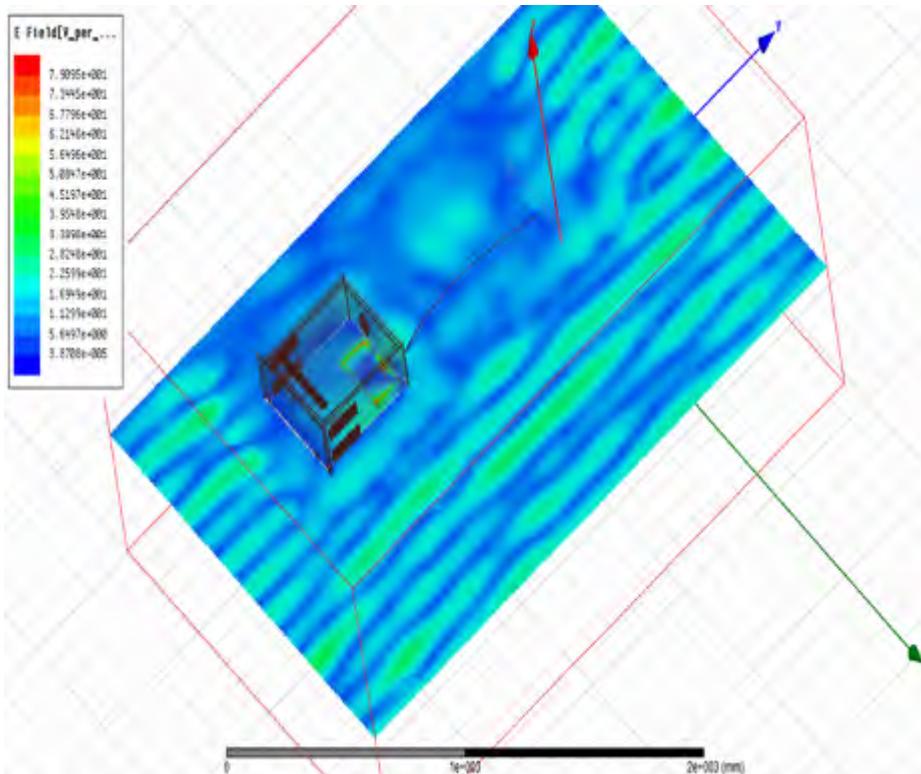


当在外界电磁波干扰的环境之下，线缆易形成天线效应，将不需要的电磁波能量接收下来，形成辐射干扰。

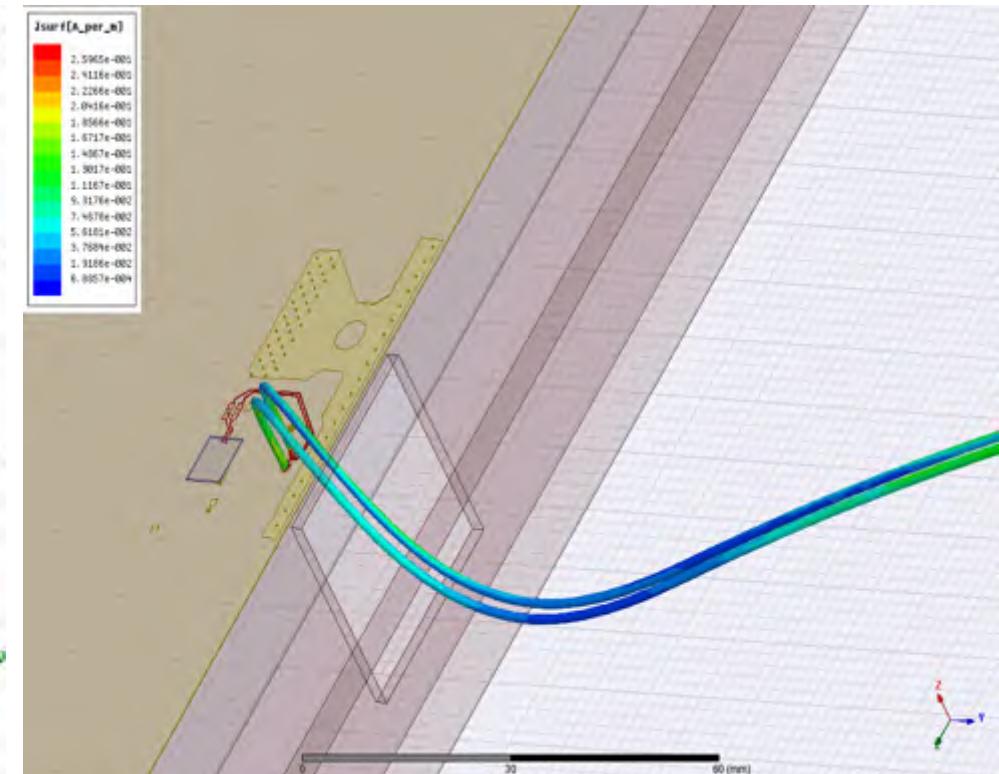
HFSS建立多端口模型



电磁波辐射场图

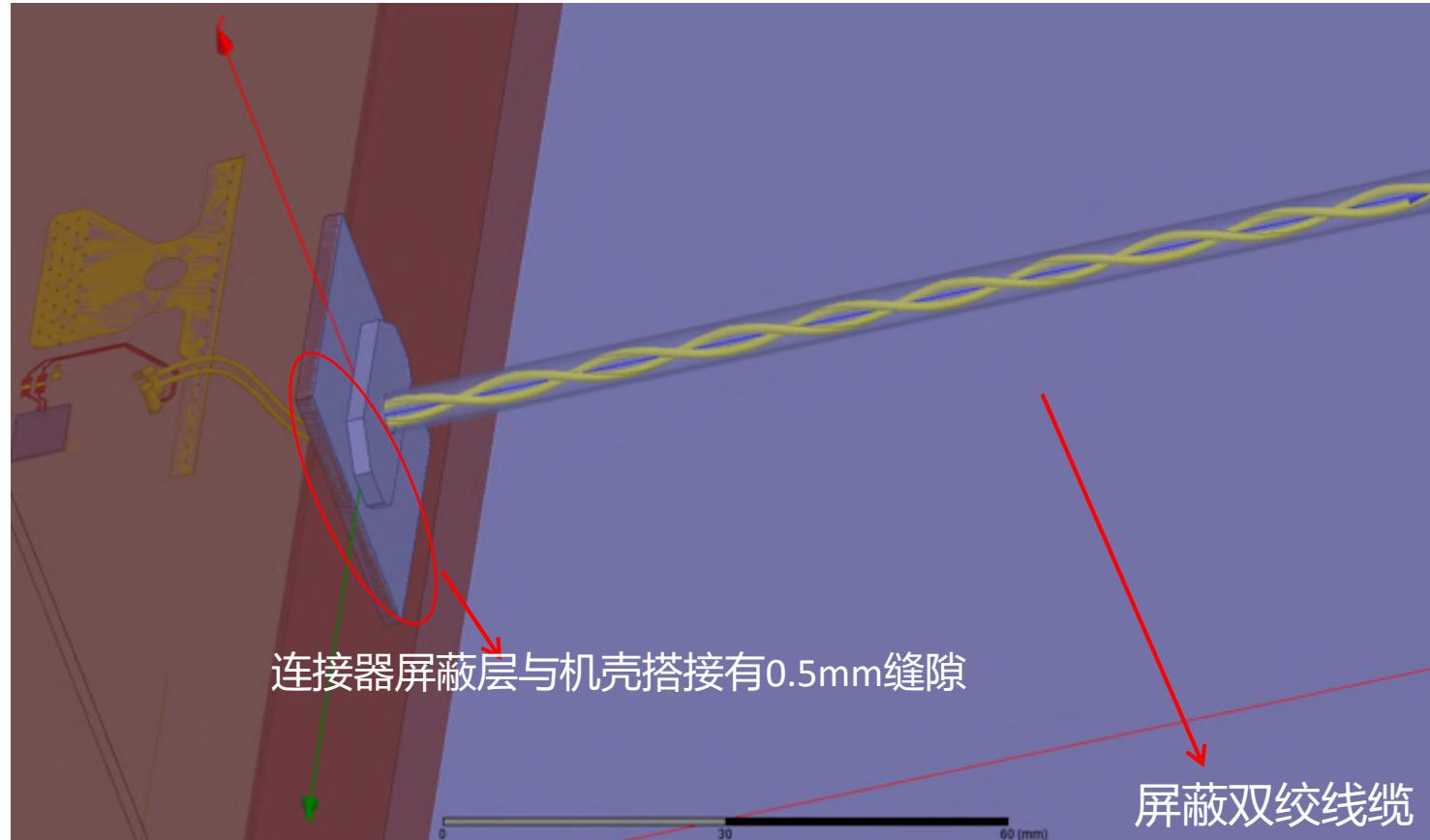


空间场分布



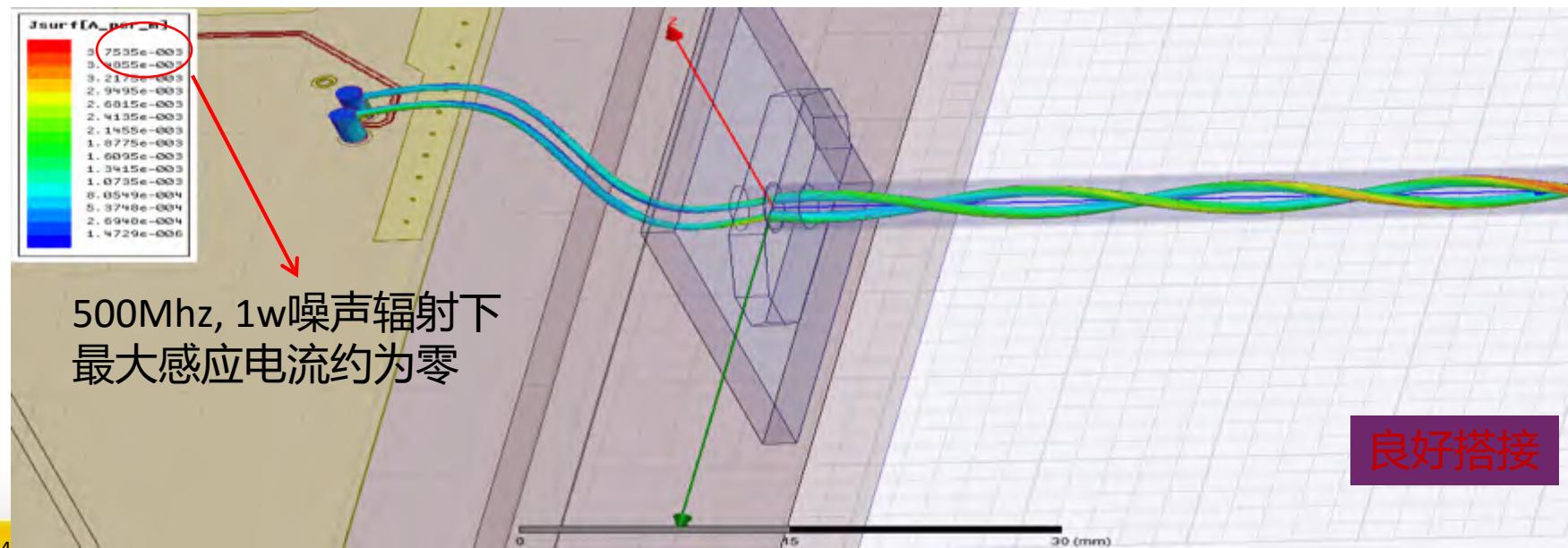
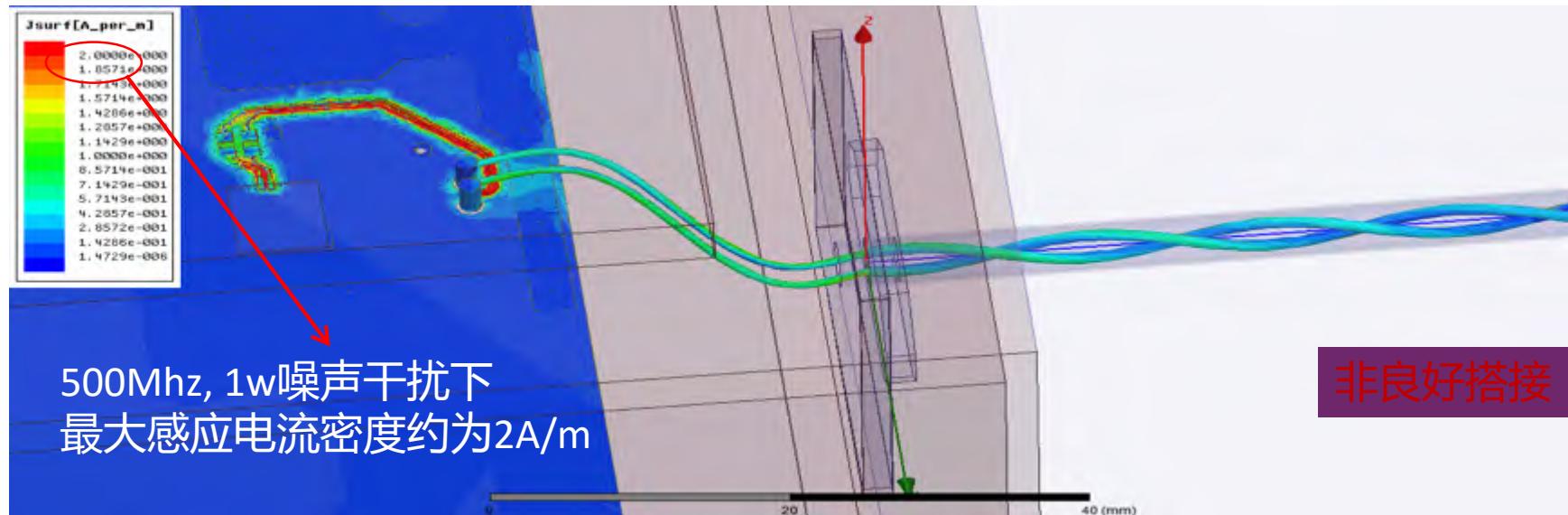
线缆感应电流

屏蔽线缆RS分析

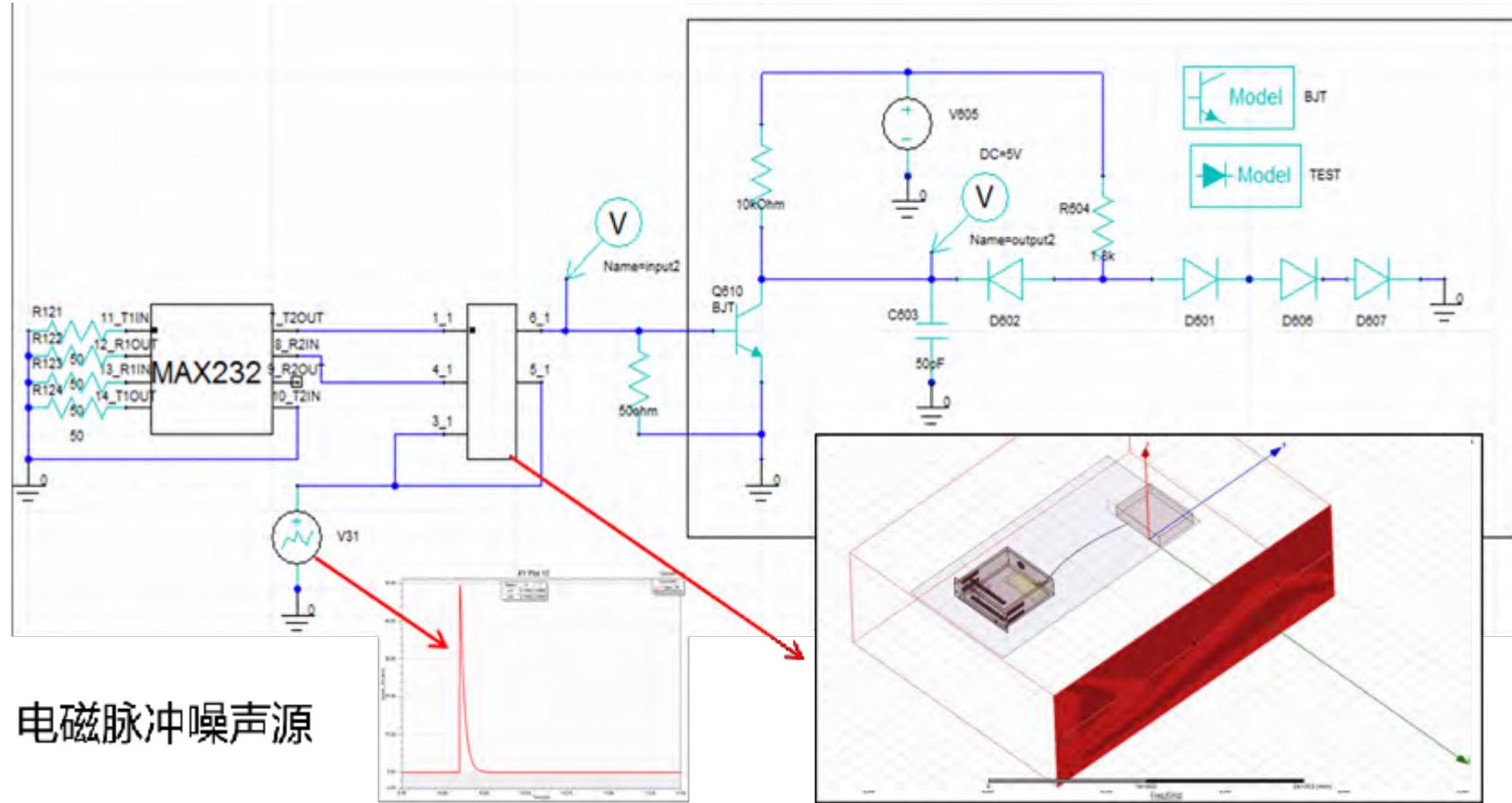


当屏蔽双绞线缆的屏蔽层没有和机壳形成良好搭接，将影响整个电路的抗干扰特性

RS485线缆感应电流

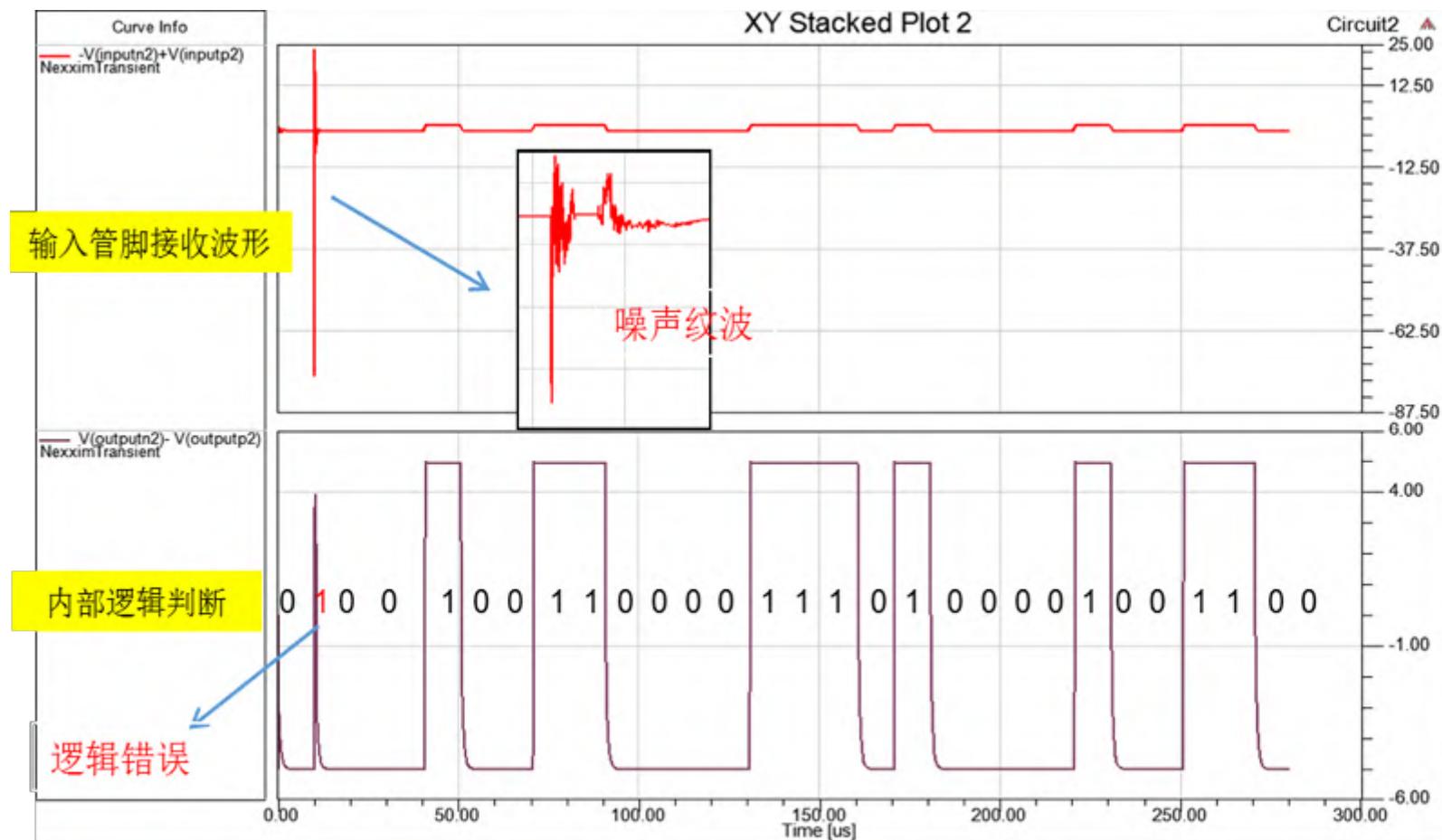


电路分析时域特征



电磁脉冲噪声源

时域干扰波形



由此可见，没有良好接地的双绞屏蔽线缆，收到外界高脉冲噪声的严重干扰，出现错误的逻辑判断；

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