ALTAIR

ALTAIR WINPROP/WRAP-场景建模与电波技术全新融合指导试验、雷达性能验证

焦金龙 / Altair 技术经理 / Aug 28, 2024

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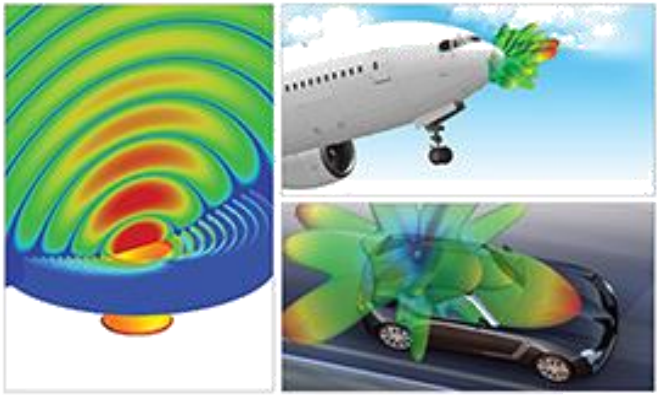

Altair WinProp
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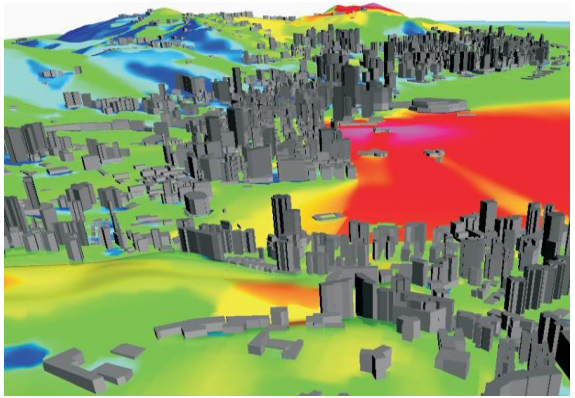

Altair WRAP
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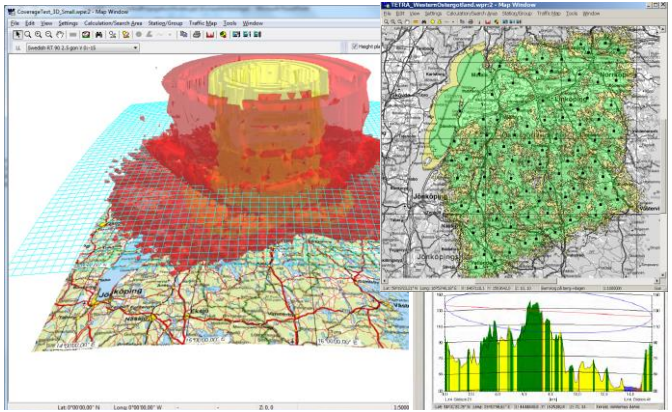

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Altair复杂场景建模与电波传播技术

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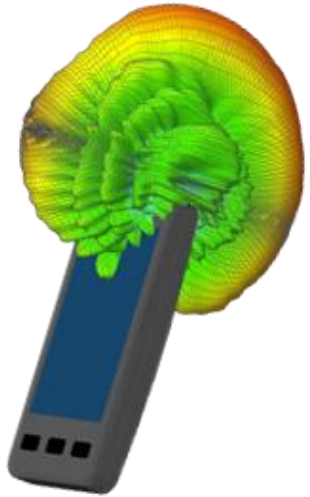
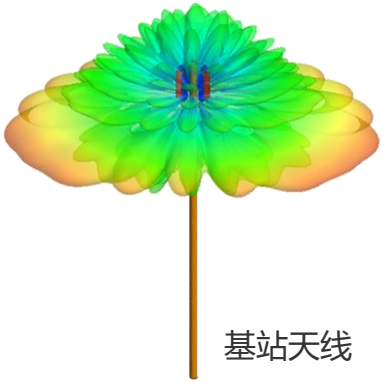
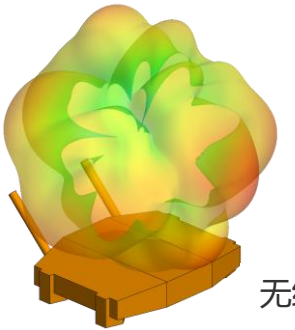
三维电磁场仿真



移动终端



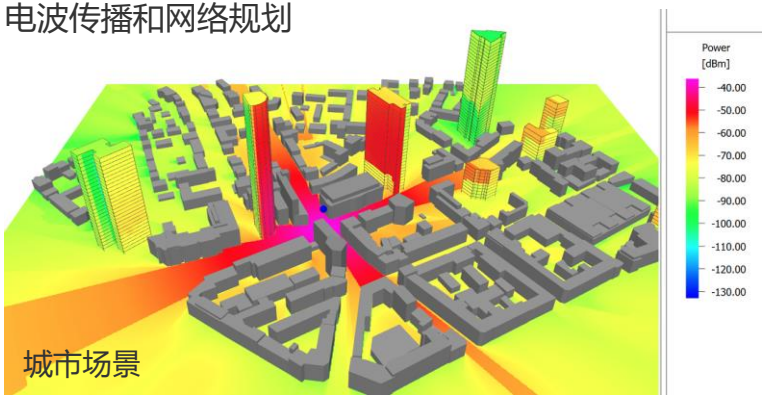
基站天线



无线路由器

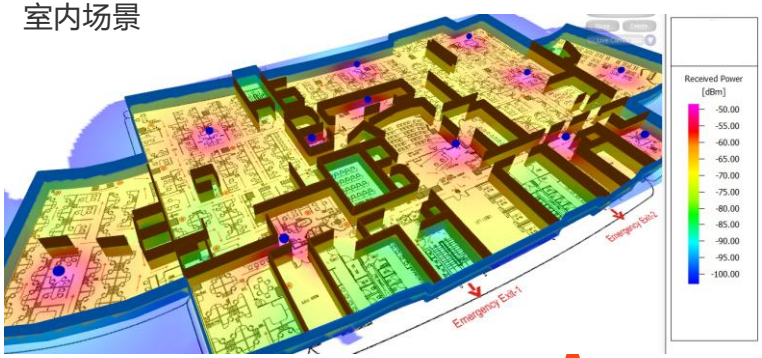
Altair WinProp

电波传播和网络规划



城市场景

室内场景



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Altair复杂场景建模与电波传播技术

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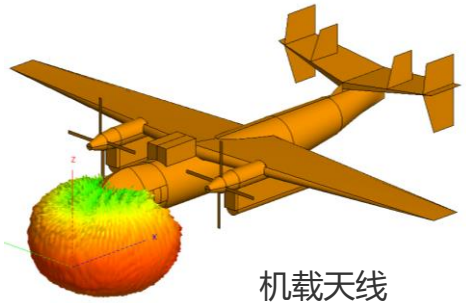
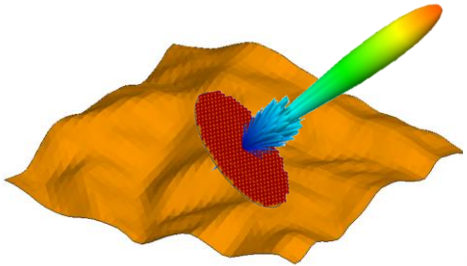
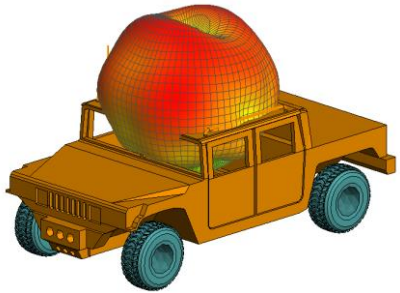
三维电磁场仿真



机载天线



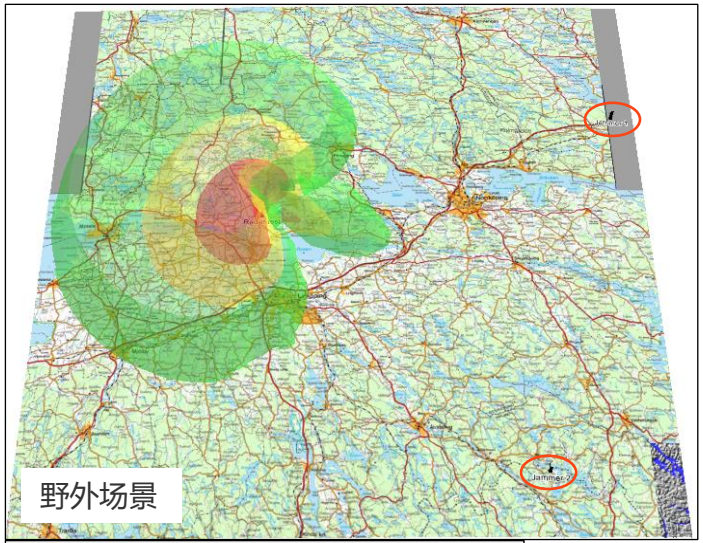
雷达天线

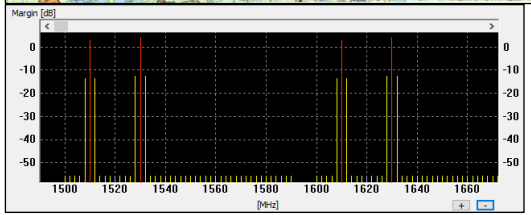


车机载天线

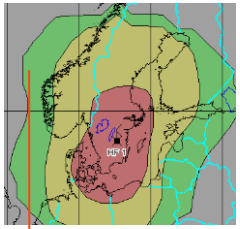
Altair WRAP

雷达覆盖和频谱管理



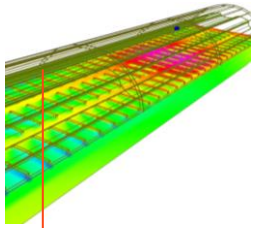


典型应用场景

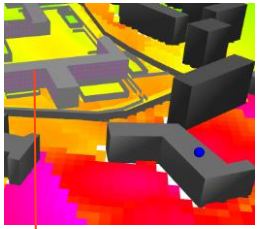


野外巨大场景下的无线覆盖（包含短波HF）

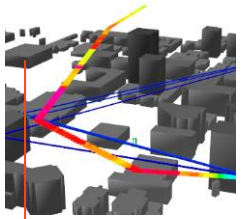
室内/城市无线网络规划



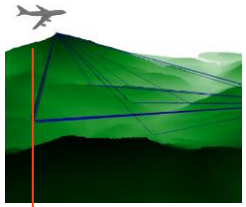
轨交或飞机舱室内的无线覆盖



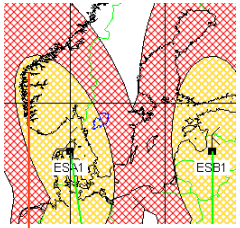
蜂窝移动网络或卫星信号干扰



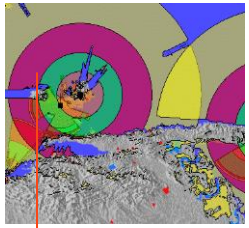
虚拟驾驶测试与飞行测试



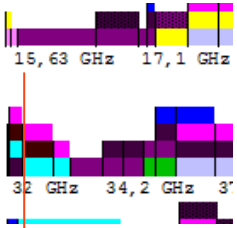
导航系统的多径衰落



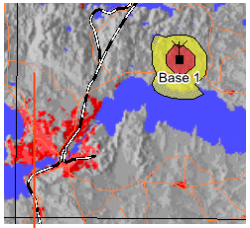
卫星无线覆盖



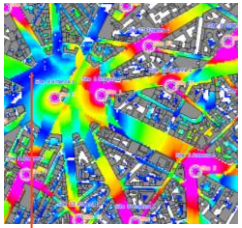
雷达覆盖



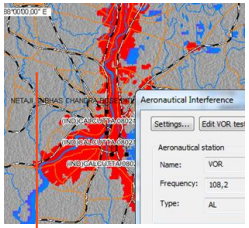
频谱管理



覆盖与成本优化



无线网络共存干扰



航空干扰协调

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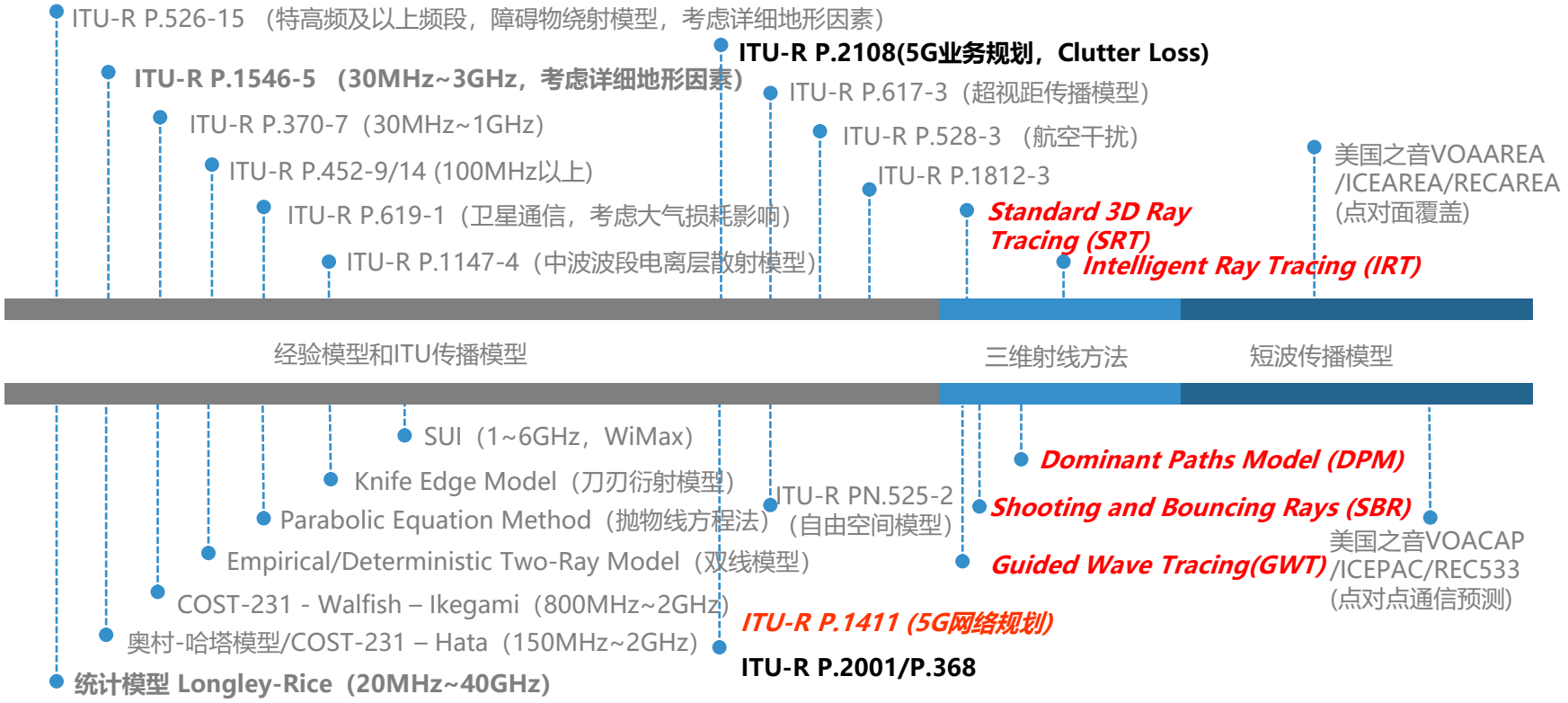
全面的电波传播模型



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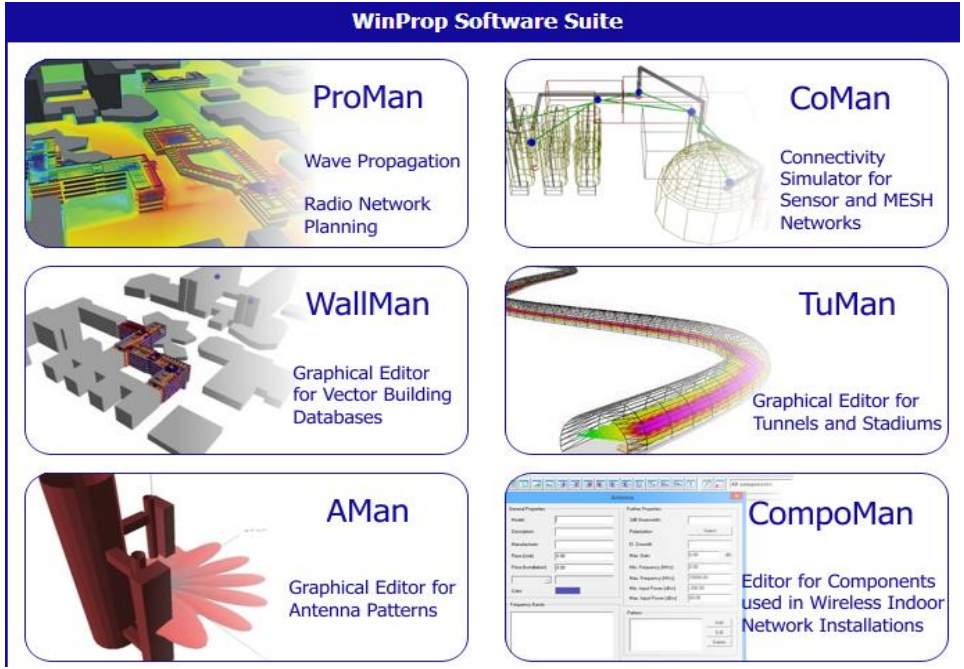
ALTAIR WINPROP 功能特色

WinProp的模块组成

- **WinProp的主要模块**
  - **AMan**：图形化天线编辑器
  - **WallMan**：城市、室内的数据库的图形化编辑器
  - **ProMan**：传播建模和无线网络规划工具
  - **API**：应用程序接口，支持二次开发定制

  - TuMan：隧道数据库的图形化编辑器
  - CoMan：网路连接分析工具



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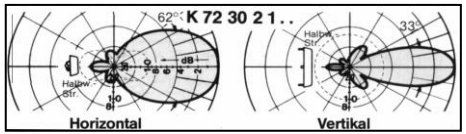
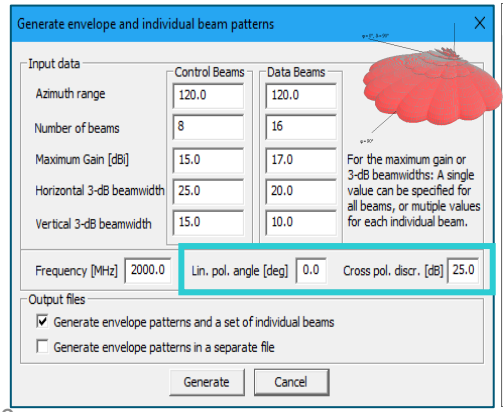
AMan – 雷达参数的建模

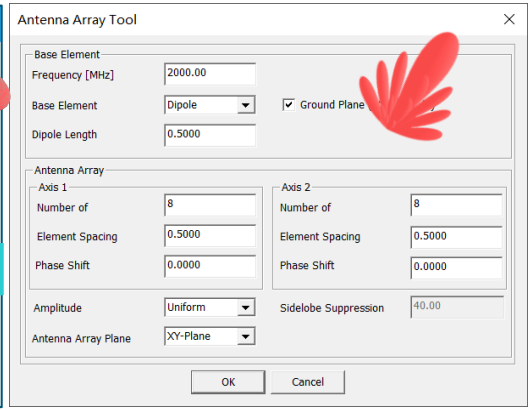
天线方向图

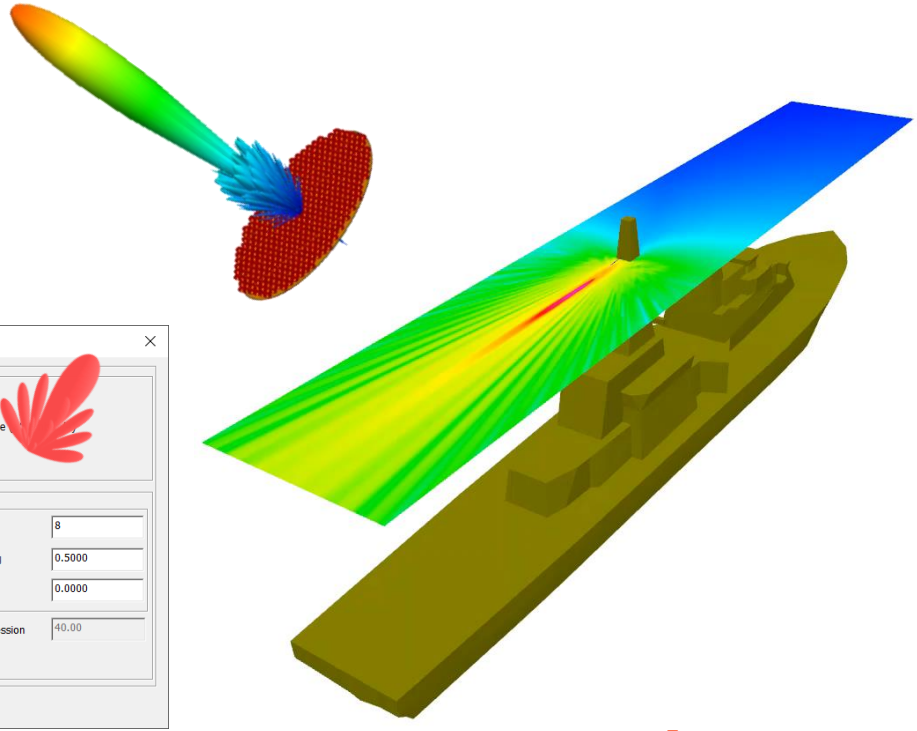
- 支持Feko仿真方向图的直接导入(.ffe文件)
- 可根据测试数据(两个主平面)插值获得



- **雷达天线综合工具（4G/5G/天线阵列等）**







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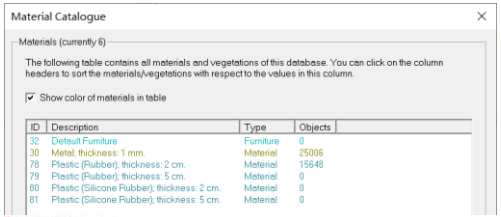
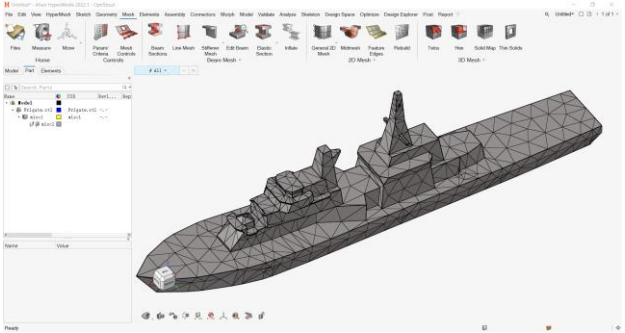
WallMan – 地图管理模块

矢量数据库

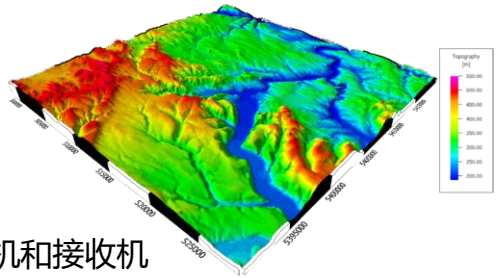
- 3D矢量数据库支持曲面结构
- **结合HyperMesh处理复杂平台模型**
- 可分区域设定模型材料

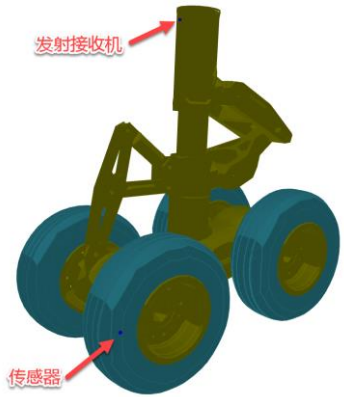


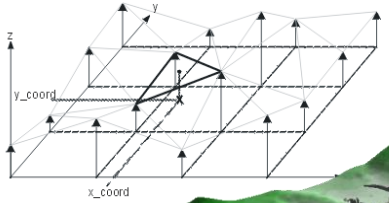


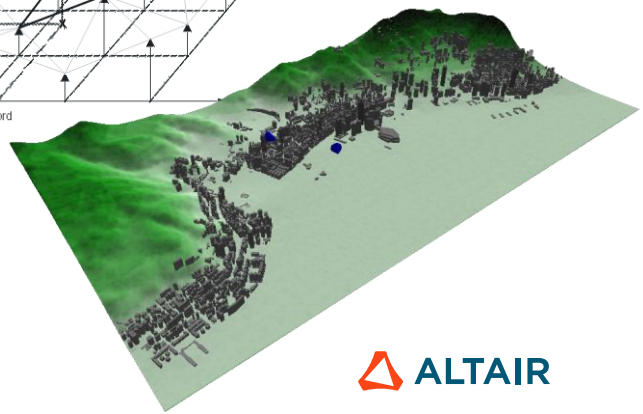
地形数据库

- 像素数据
- 分辨率 5...50m
- 根据地形移动建筑
- 根据地形移动发射机和接收机
- 以**三角形来拟合地形**









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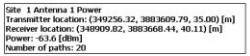
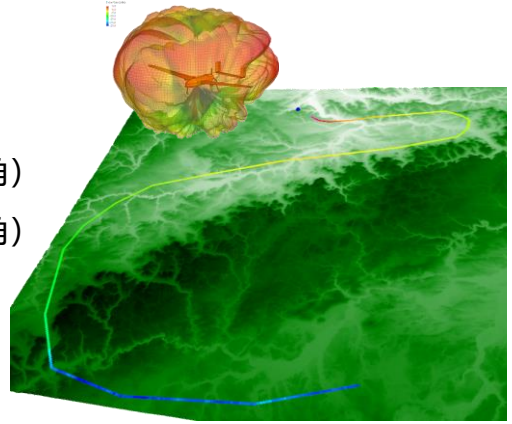
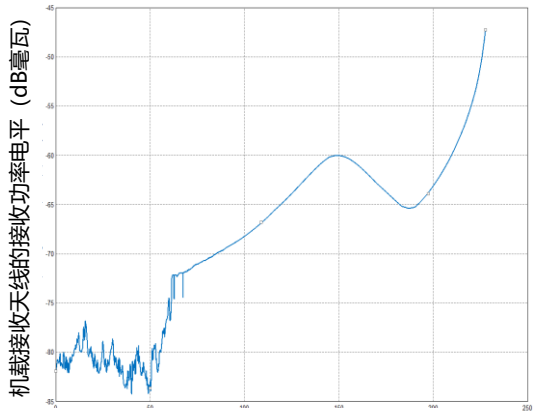
ProMan – 实际场景仿真

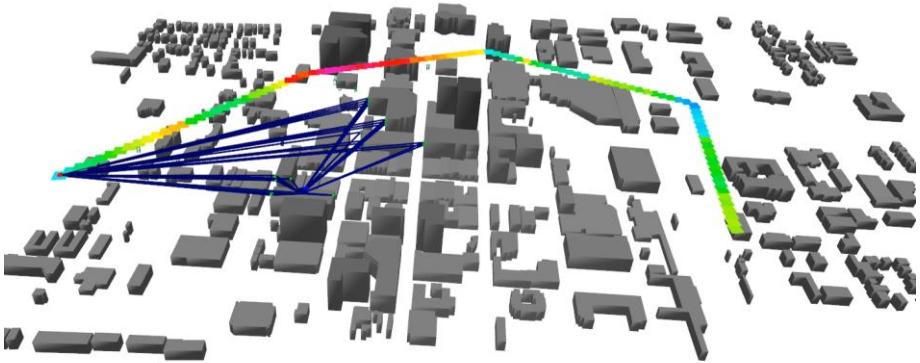
场景定义

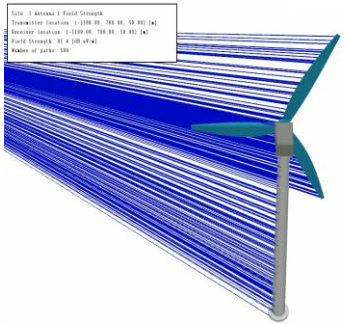
- 运动目标的雷达散射（平动、转动）
- 定义移动的发射机轨迹（位置、速度、姿态角）
- 定义移动的接收机轨迹（位置、速度、姿态角）

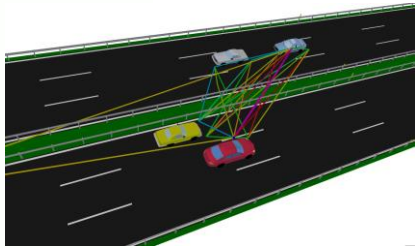












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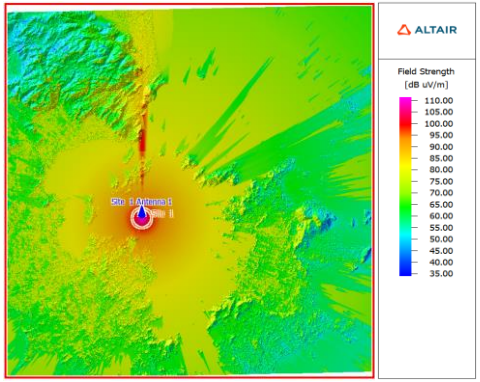
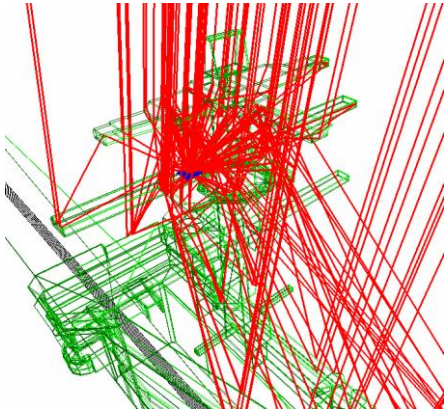
ProMan – 实际场景仿真

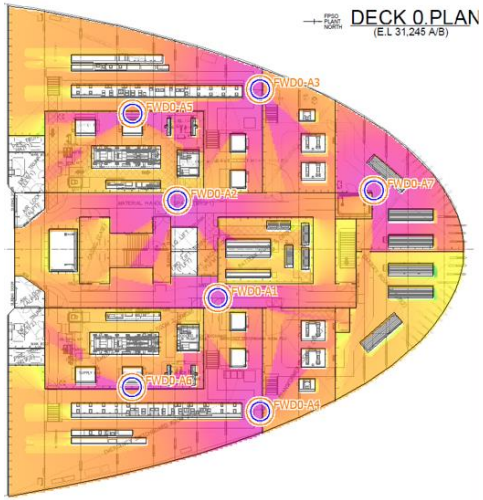
丰富的结果输出

- Received Power 接收功率
- Field Strength 场强
- Path Loss 路径损耗
- LOS Analysis 视距分析
- Data Rate 数据速率
- Throughput 吞吐量
- SNIR 信干噪比
- Ray Paths 射线路径

…







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WRAP功能特色

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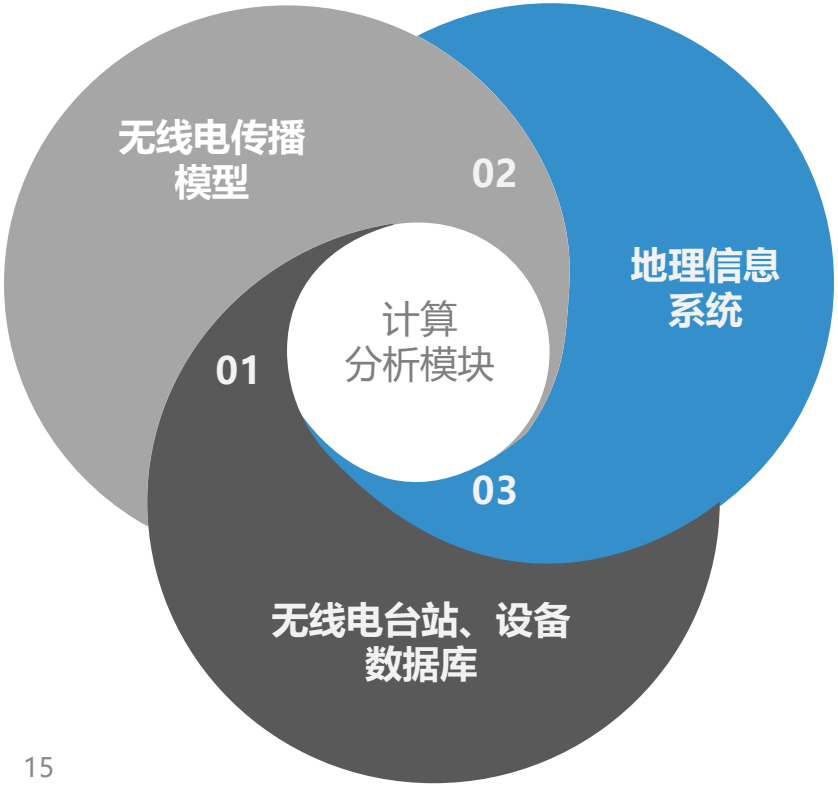
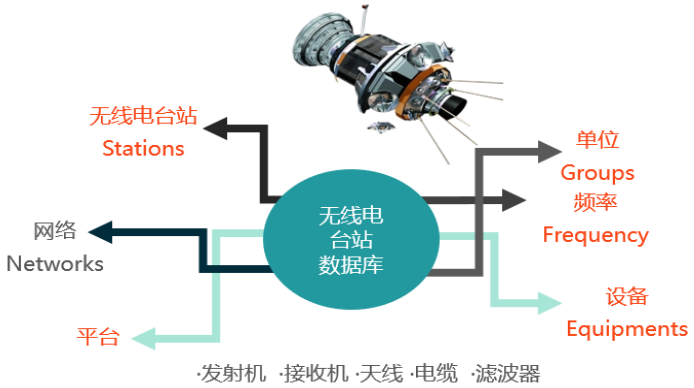
瑞谱(WRAP)软件架构

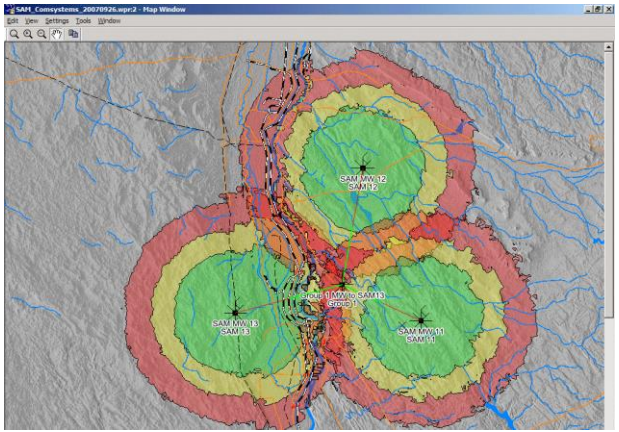




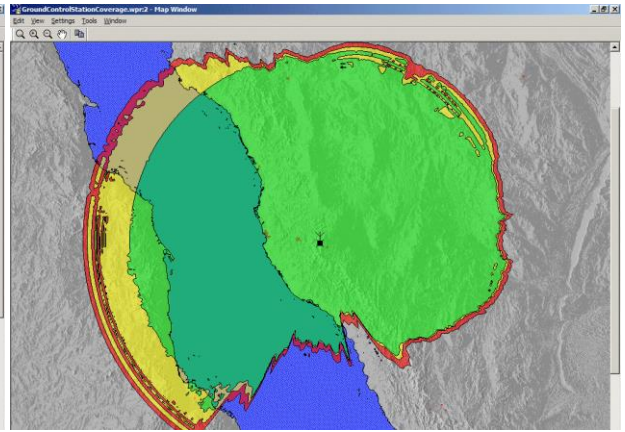
瑞谱(WRAP)软件计算模块			
无线电覆盖	雷达覆盖	覆盖范围比较	频率划分管理
干扰计算	覆盖范围优化	**航空干扰**	广播计算工具
同址干扰计算	**高频规划**	地球站协调	电信业务量
无线链路性能	**频率指配**	卫星网络协调	**点到对点通信**
频谱浏览	无线电网络管理	**障碍物管理** **风电干扰**	地图转换管理

典型功能一、无线电覆盖仿真

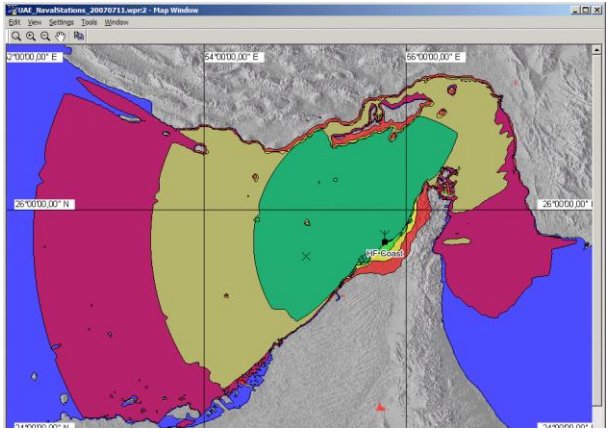
- 应用于无线电台站信号覆盖计算，可获得场强、功率通量密度、信号强度、接收功率、传输损耗、信干比等参数
- 从高频到5G，再到雷达和微波链路，可用于所有主要的军用和民用无线电系统



战场网络无线电的地对地覆盖



地面控制站对飞机的覆盖范围



海岸站地波覆盖

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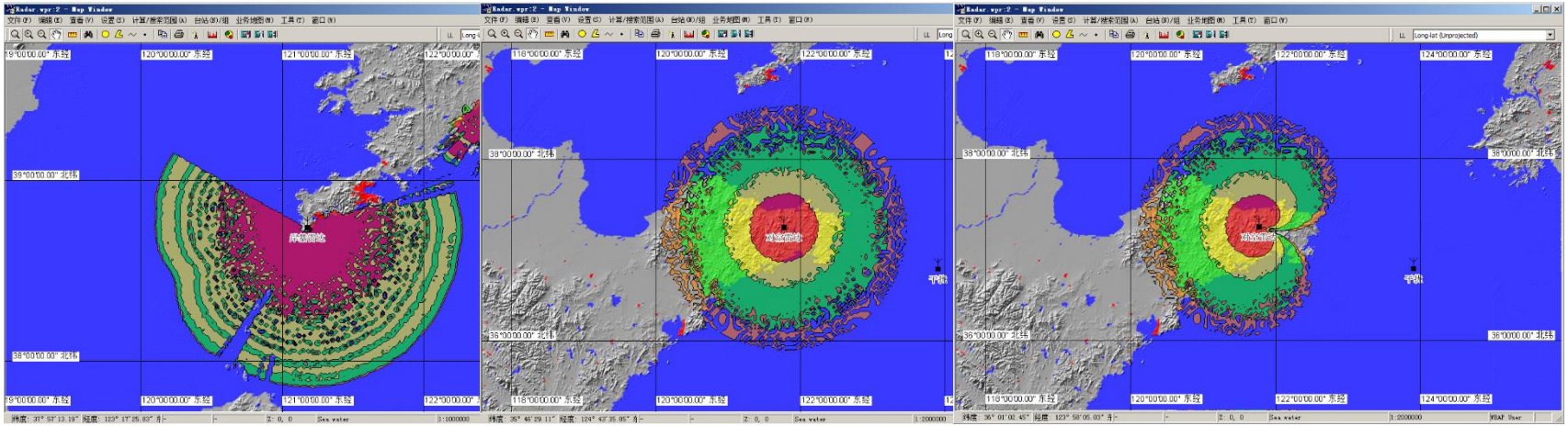
典型功能二、雷达探测仿真

- 利用雷达方程和地理信息数据，可计算雷达站地形遮蔽角、雷达探测高度，给定侦听概率计算雷达可探测到的 RCS，以及给定雷达目标RCS计算雷达的侦听概率
- 可考虑扫描天线，以及在干扰机存在下的雷达覆盖情况，提供二维和三维计算和显示



使用扫描天线　　固定雷达天线　　存在干扰机

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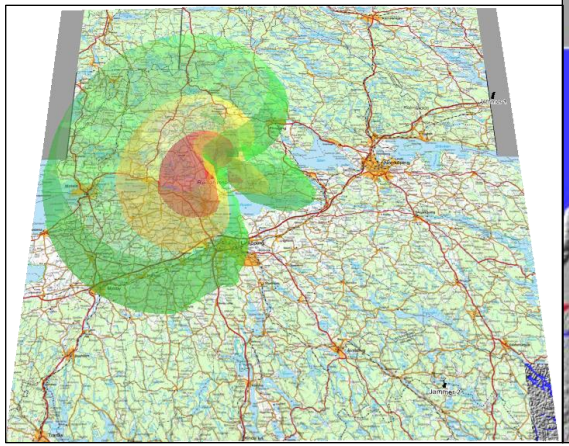
典型功能二、雷达探测仿真（干扰机）

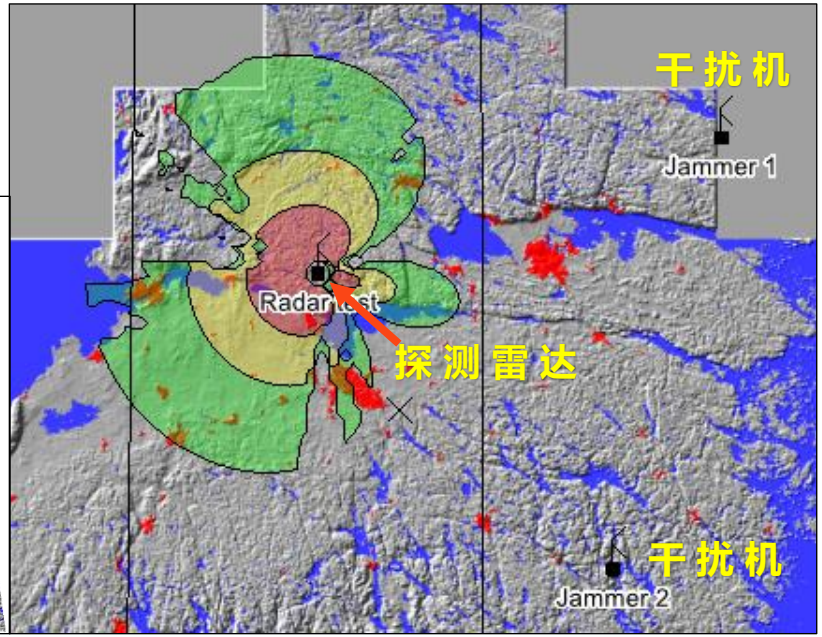
- 雷达可探测到目标的范围（在给定高度），绿、黄、红表示目标RCS分别为100平方米、10平方米、1平方米

- 干扰机具有不成比例的影响：

  干扰机功率 ~ $1/R^2$

  雷达探测 ~ $1/R^4$





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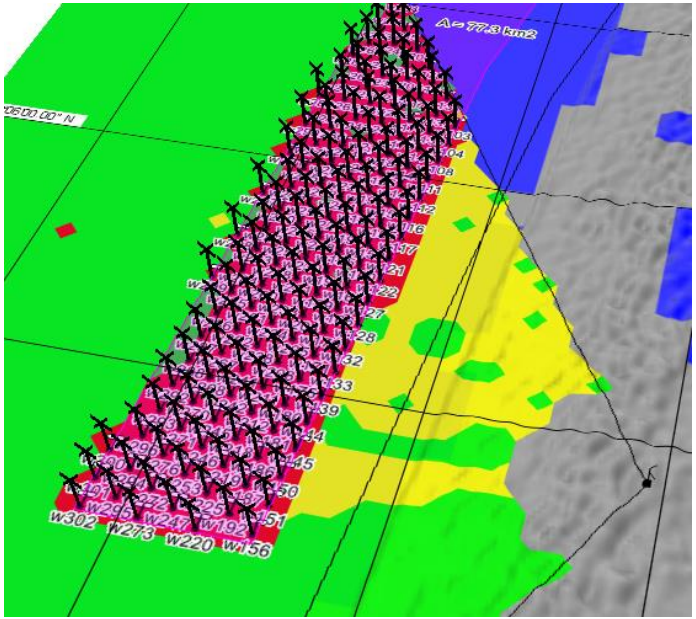
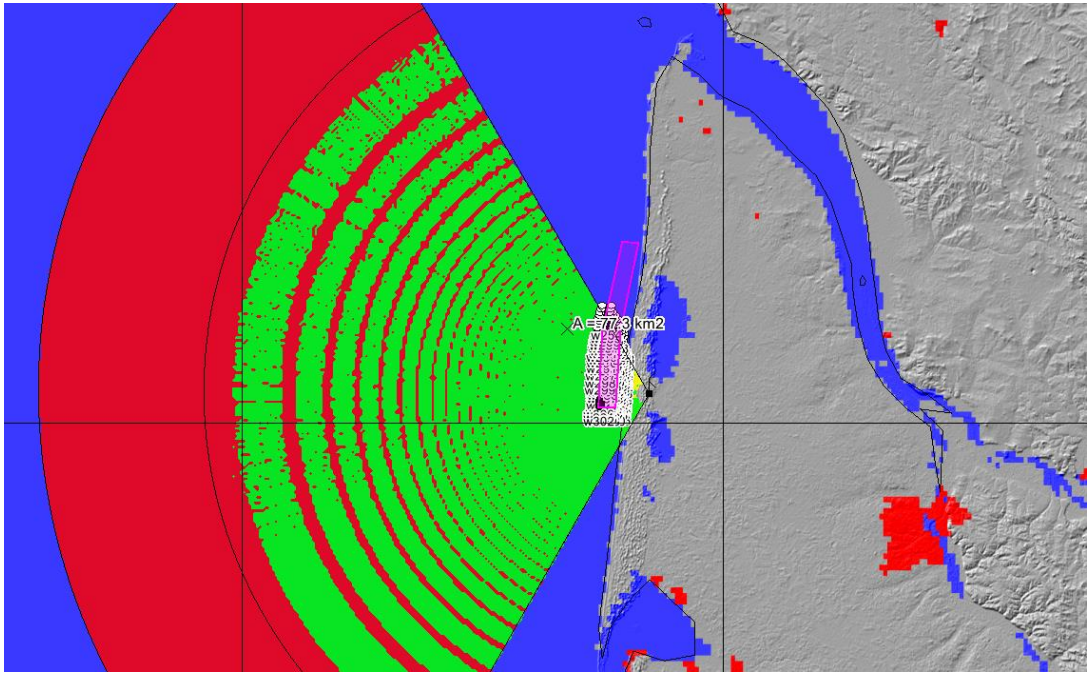
典型功能三、风电等障碍物管理

- 考虑风电及阵列等的遮挡
- 风电场对雷达探测有明显的影响，并会产生伪影目标.





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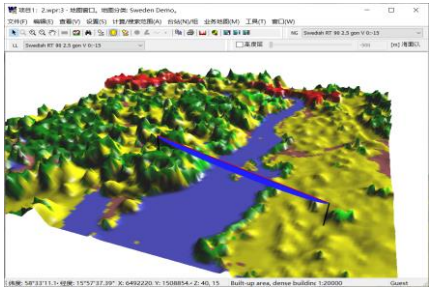
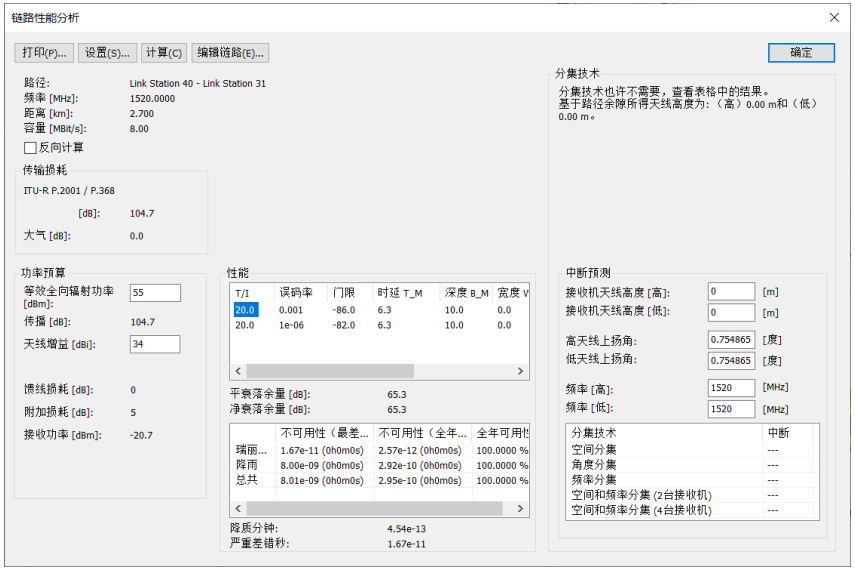
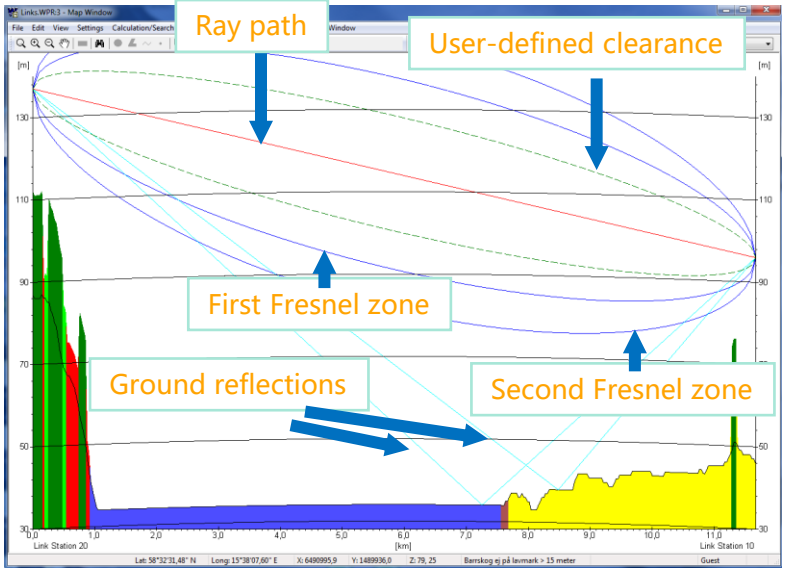
典型功能四、无线链路分析

- 计算微波链路的传输损耗、接收功率、衰落余量、中断概率等链路性能参数
- 提供剖面图显示







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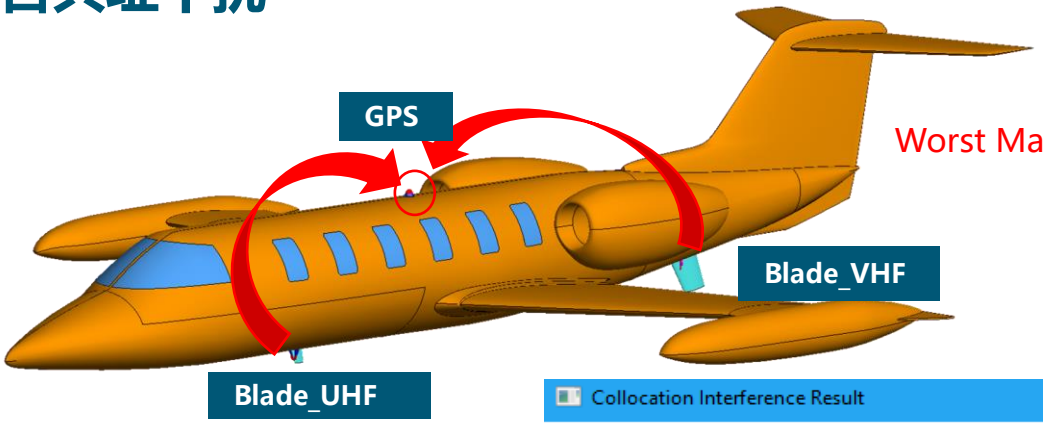
典型功能五、电大平台共址干扰

- **考虑多种干扰因素**
  - 同/邻信道干扰
  - 互调干扰
  - 谐波干扰
  - 阻塞干扰
  - 中频干扰
  - 镜频干扰
- 包括：跳频（Frequency hopping）,扩频（spread-spectrum）等



Worst Margin -19.9 dB

Collocation Interference Result

File Edit View Settings Frequencies Calculate

Receiver	f [MHz]	B [kHz]	Max block [%]	Total	Co/Adj
Blade_VHF	131.2850	250	0.0	1	1
Blade_UHF	315.0840	500	0.0	1	1
GPS_L1_Receiver	1575.4200	500	0.0	4	2

编辑组: Test1

主要 台站 耦合损耗矩阵 卫星网络 卫星轨道 符号

A\B	频率	Blade_UHF	Blade_UHF	GPS_L1_Receiver
Blade_UHF	131.2850 MHz	---	*8.4 **	*43.8 **
Blade_UHF	4.5000 GHz	*8.4 **	---	*74.5 **
GPS_L1_Rece...	1.5754 GHz	*65.4 **	*65.4 **	---

Feko计算的天线
多端口S参数矩阵

GPS_L1_Receiver (1575.4200 MHz)
- Co/Adjacent Channel Interference (2)
- Harmonic Interference (2)

同/邻信道干扰

Transmitter	f [MHz]	B [kHz]	EIRP [dBW]	Margin [dB]
Blade_VHF	131.2850	250	15.0	-18.4
Blade_UHF	315.0840	500	15.0	-2.4

GPS_L1_Receiver (1575.4200 MHz)
- Co/Adjacent Channel Interference (2)
- Harmonic Interference (2)

谐波干扰

Transmitter	f [MHz]	B [kHz]	EIRP [dBW]	Margin [dB]
Blade_UHF	315.0840	500	15.0	-19.9
Blade_VHF	131.2850	250	15.0	-4.2

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典型功能六、无线电频谱管理

主要应用

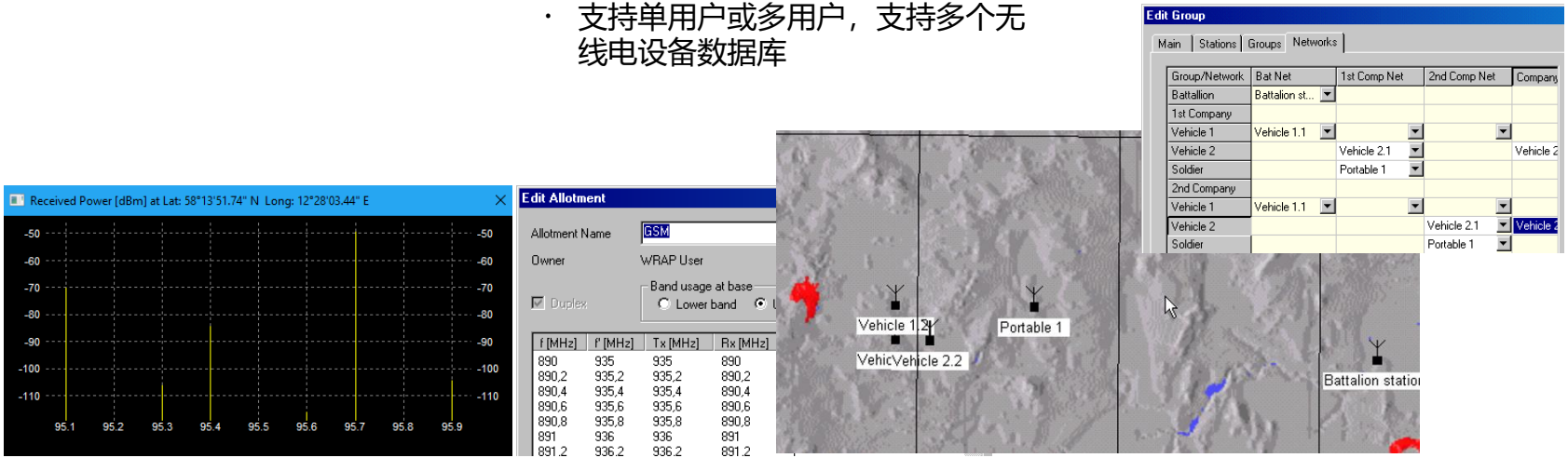
- 国家或国际民用与军用频率协调
- 集中管理和协调频率使用及分配
- 区域内的长期频率使用规划
- 演习等短期的频率使用管理

实施单位

- 电信或国防的中央频谱管理机构
- 区域的频率使用机构(例如：陆军、空军、海军等)
- 地方单位
- 支持单用户或多用户，支持多个无线电设备数据库

网络优化

- 规划设计无线电台和雷达系统，实现最佳的覆盖效果
- 自动频率指配，最大限度利用频谱资源，避让干扰信号



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新功能与典型案例

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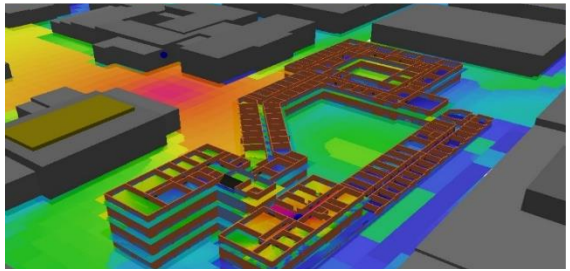
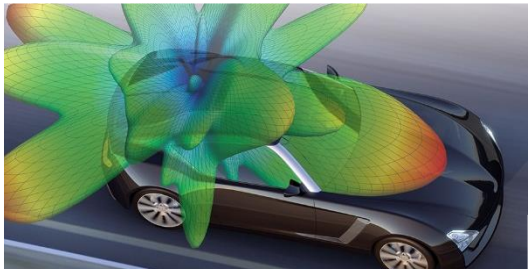
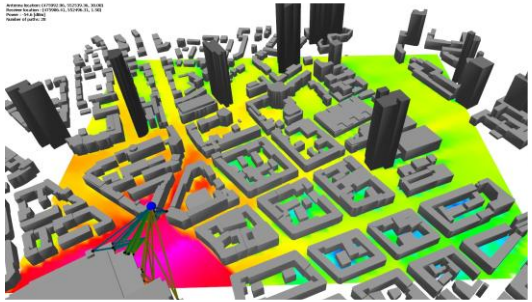
5G技术发展与仿真功能更新

构建新型工业产业园区网络

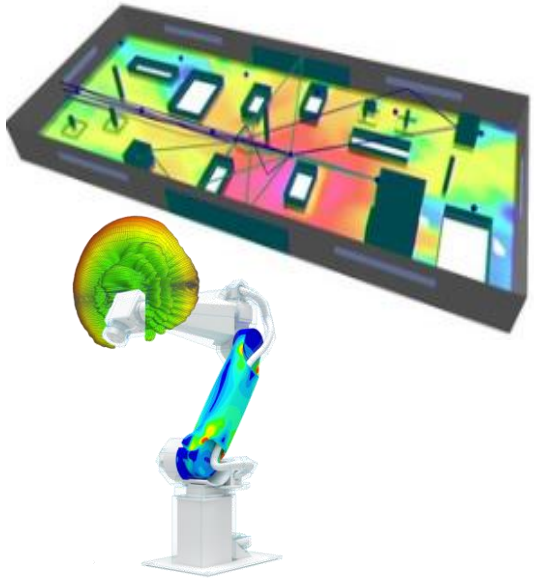


促进V2X技术发展与落地





加快5G天线和物联网基础设施建设



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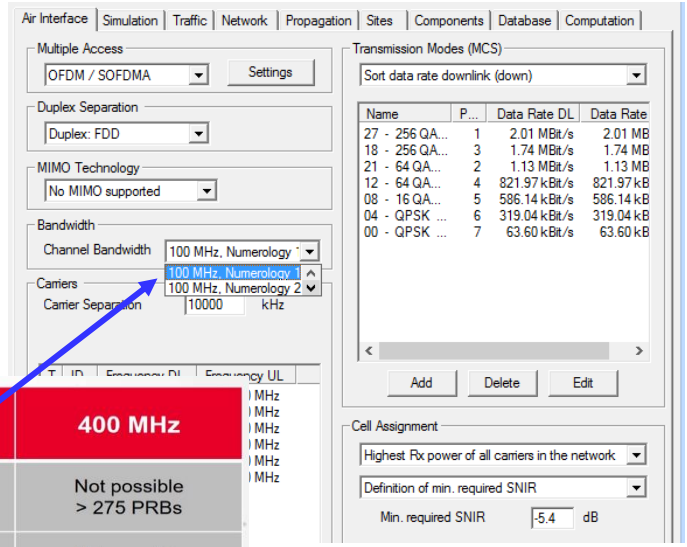
5G空中接口

网络规划

支持5G空口：μ=0，1，2，3，4，5，6

新增WiFi 6 (802.11ax)、WiFi 7 (802.11.be)



	Subcarrier Spacing / Slot Length	20 MHz	50 MHz	100 MHz	200 MHz	400 MHz
μ=0	15 kHz 1 ms	2048 FFT 1320 sc (110 PRBs) 30.72 Msps	4096 FFT 3300 sc (275 PRBs) 61.44 Msps	Not possible > 275 PRBs	Not possible > 275 PRBs	Not possible > 275 PRBs
μ=1	30 kHz 500 μs	1024 FFT 660 sc (55 PRBs) 30.72 Msps	2048 FFT 1644 sc (137 PRBs) 61.44 Msps	4096 FFT 3300 sc (275 PRBs) 122.88 Msps	Not possible > 275 PRBs	Not possible > 275 PRBs
μ=2	60 kHz 250 μs	512 FFT 324 sc (27 PRBs) 30.72 Msps	1024 FFT 816 sc (68 PRBs) 61.44 Msps	2048 FFT 1644 sc (137 PRBs) 122.88 Msps	4096 FFT 3300 sc (275 PRBs) 245.76 Msps	Not possible > 275 PRBs
μ=3	120 kHz 125 μs	Not possible < 20 PRBs	512 FFT 408 sc (34 PRBs) 61.44 Msps	1024 FFT 816 sc (68 PRBs) 122.88 Msps	2048 FFT 1644 sc (137 PRBs) 245.76 Msps	4096 FFT 3300 sc (275 PRBs) 491.52 Msps

Numerology	Subcarrier Spacing (kHz)	CP type	Supported for Data (PDSCH, PUSCH etc)	Supported for Sync (PSS,SSS,PBCH)	PRACH
N/A	1.25		No	No	Long Preamble
N/A	5		No	No	Long Preamble
0	15	Normal	Yes	Yes	Short Preamble
1	30	Normal	Yes	Yes	Short Preamble
2	60	Normal,Extended	Yes	No	Short Preamble
3	120	Normal	Yes	Yes	Short Preamble
4	240	Normal	No	Yes	
5	480	Normal	Yes	Yes	
6	960	Normal	Yes	Yes	

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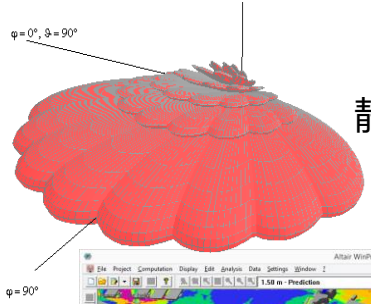
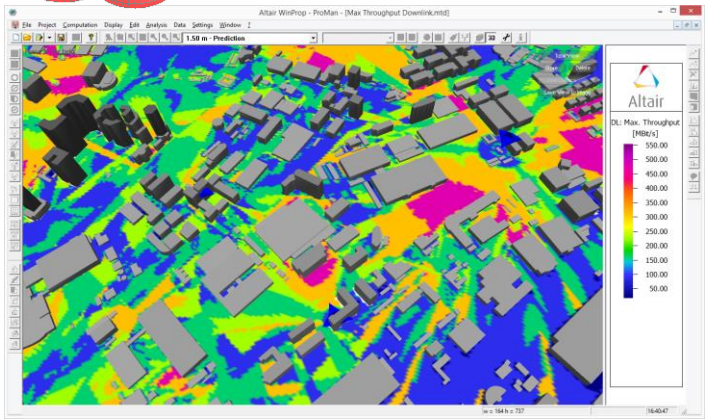
5G网络规划仿真

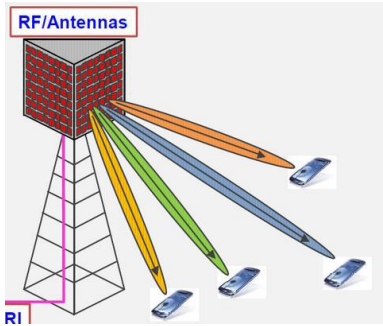
网络规划（5G波束形成）

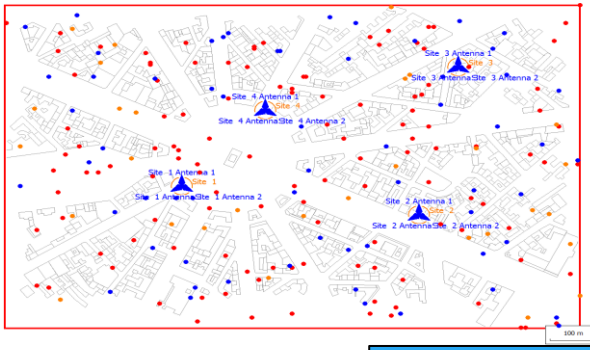


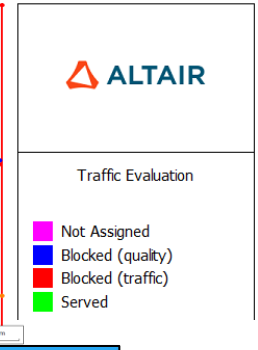
静态仿真



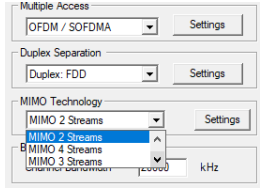
Monte-Carlo 仿真

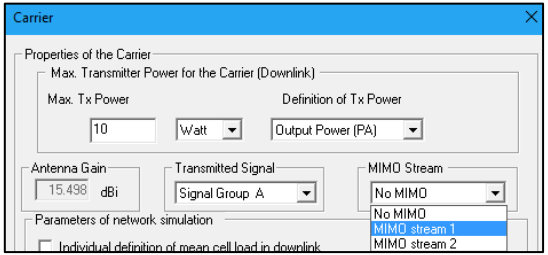


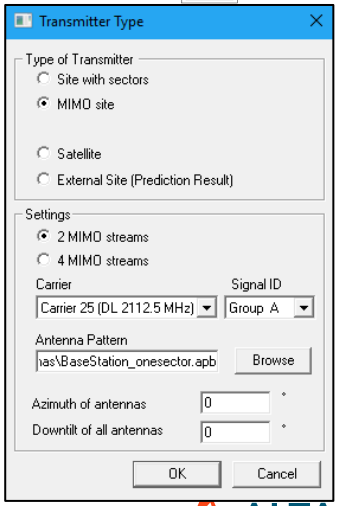




MIMO后处理







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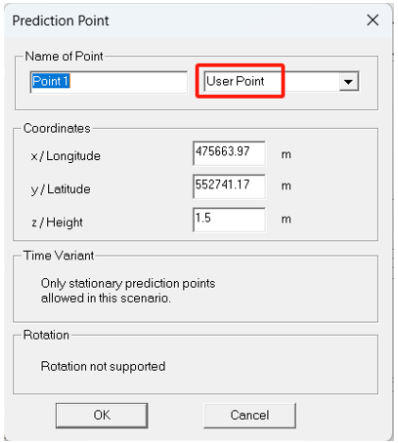
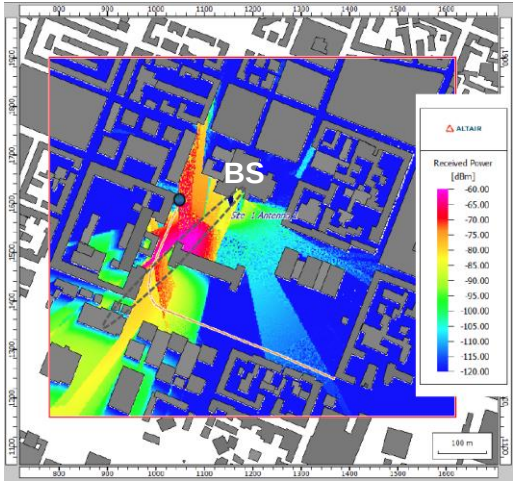
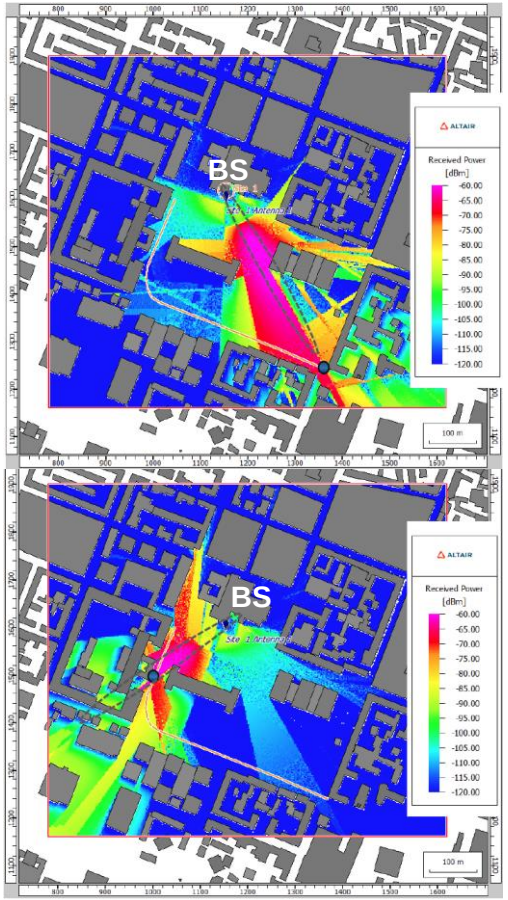
5G波束扫描

- 5G波束设计为N个方向固定的窄波束，通过波束扫描实现**动态小区覆盖**
- **用户设备**(UE) 在任意时刻由某个最佳波束服务，在软件中定义**User Point**，仅最佳波束被激活
- 如果UE移动，波束将**实时切换**







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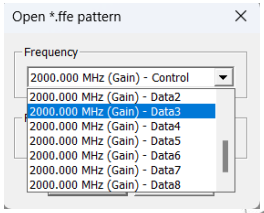
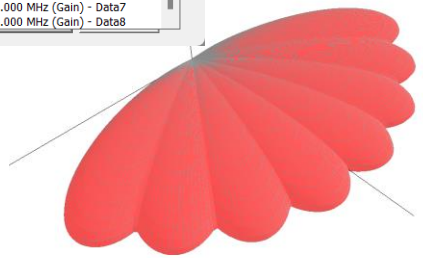
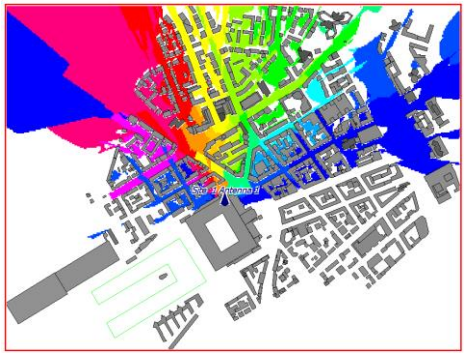
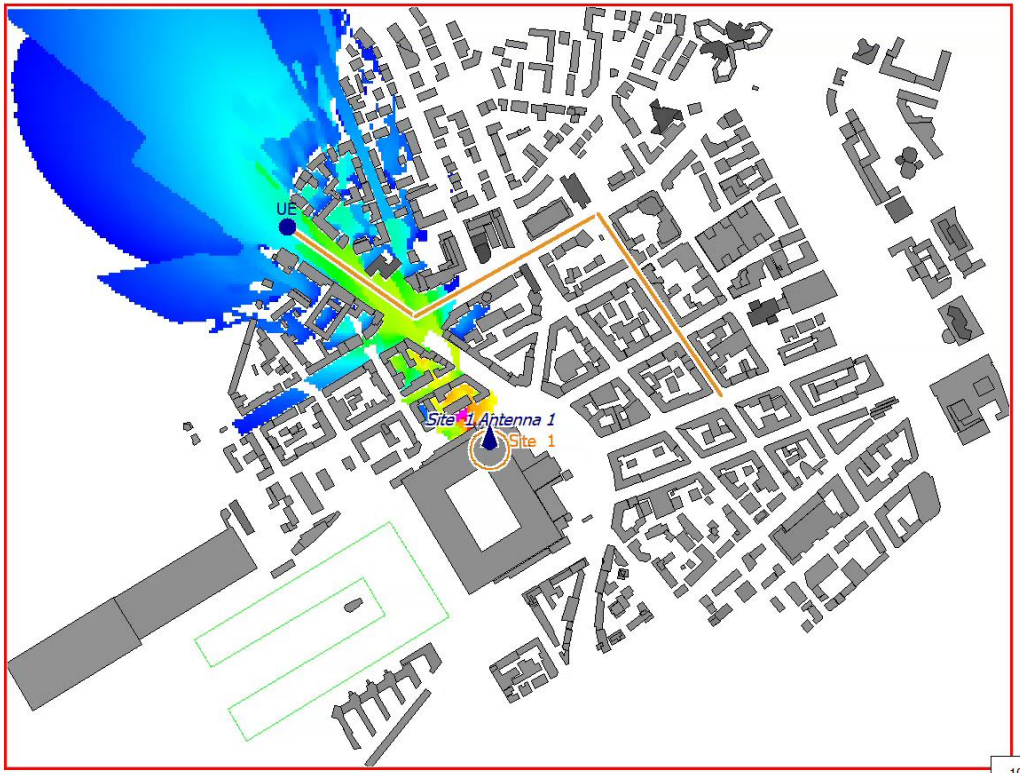
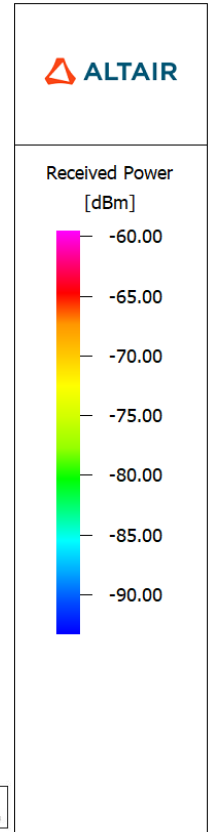
5G波束扫描











Data波束服务范围

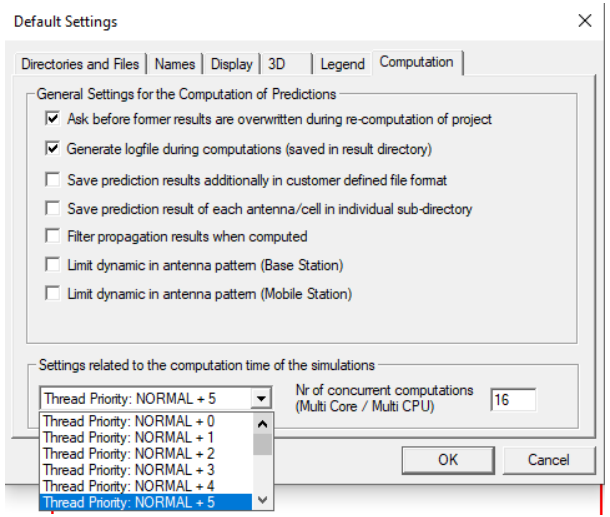
MPI 并行加速

- 全面支持MPI并行加速(SRT, IRT, SBR等)

测试算例：室内场景（3次射线作用）

线程数	时间（秒）	并行效率
1	14853	100%
16	956	96.9%
32	485	95.7%
48	330	93.8%
64	267	86.9%
96	190	81.4%

求解配置	时间（秒）	并行效率
1 节点 * 64 线程	22275.0	100 %
2 节点 * 64 线程	11216.0	99.3%
3 节点 * 64 线程	7694.0	96.5%



2. Run WinProp MPI as follows:

```
mpiexec -n number_of_mpi_processes path/to/WinPropCLI.impi -F path/to/project.net
 -A --multi-threading number_of_threads
```

For example:

```
mpiexec -n 2 D:/Programs/Altair/2024.0/feko/bin/WinPropCLI.impi -F  D:/home/user/
wt_qad/src/wp/validate/data/mpi-test/Conversion_xodr_idb/Conversion_xodr_idb.net
 -A --multi-threading 4
```

where *machinefile* contains the host details listed as follows:

```
host1
host2
```

It is also possible to specify the number of MPI processes to use per host as:

```
host1:2
host2:1
```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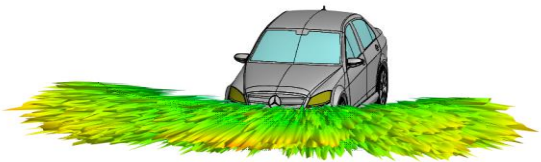
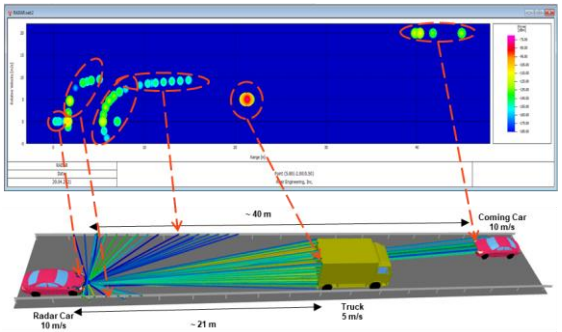
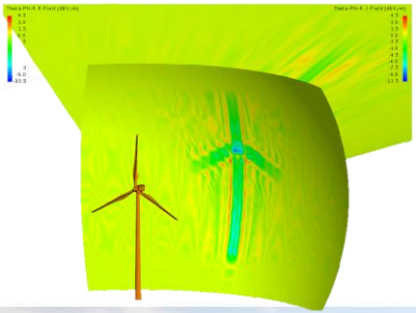
复杂目标散射场模拟与雷达探测

车联网典型场景模拟

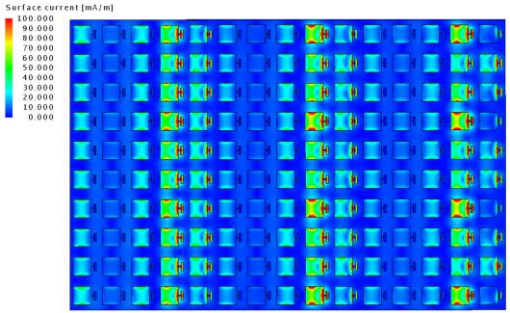


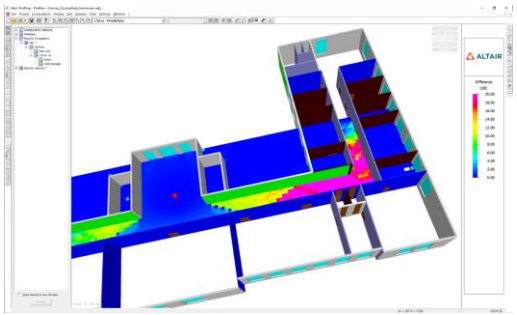


雷达风电干扰分析



可重构超表面（RIS）仿真-面向6G





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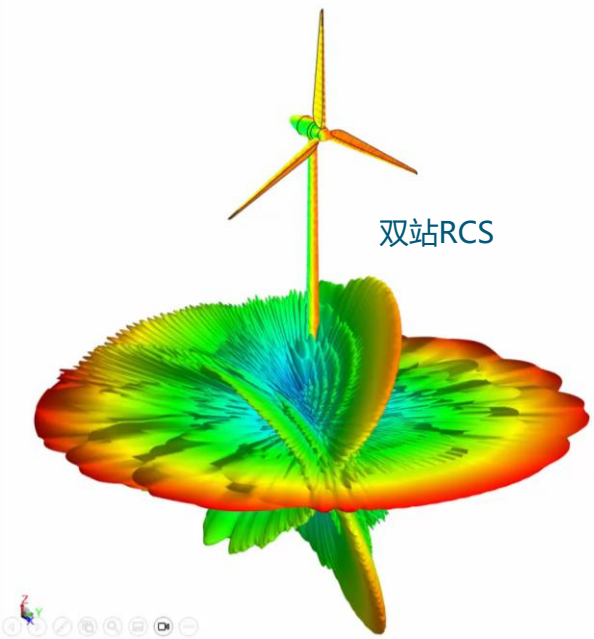
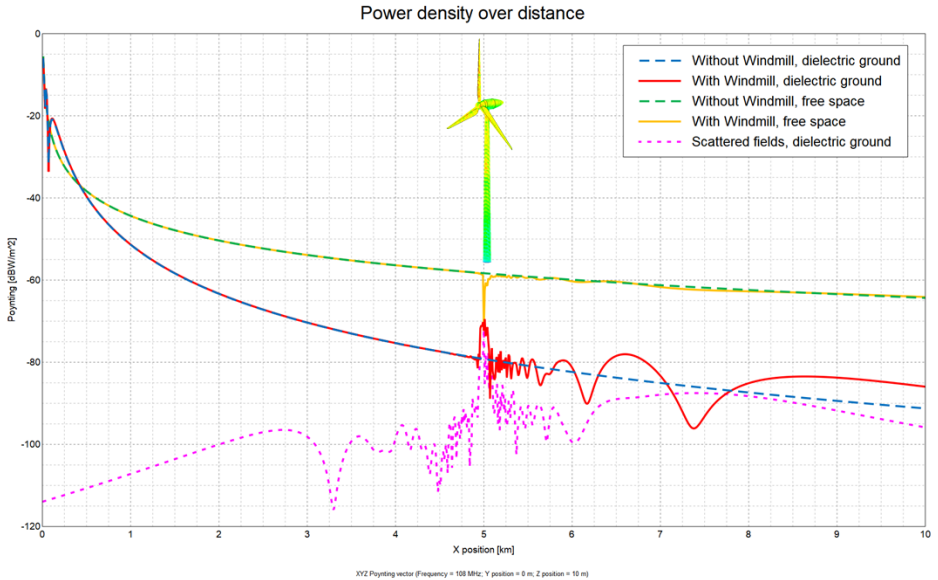
风机散射特性提取

- 仿真雷达工作频率下的风机散射特性





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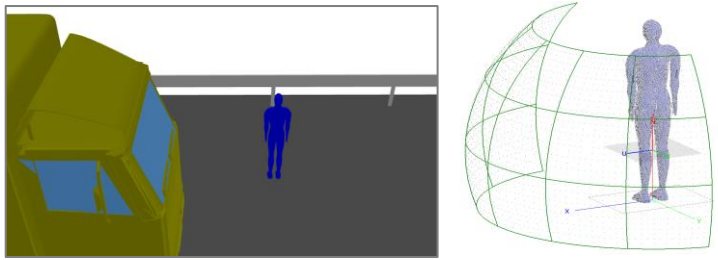
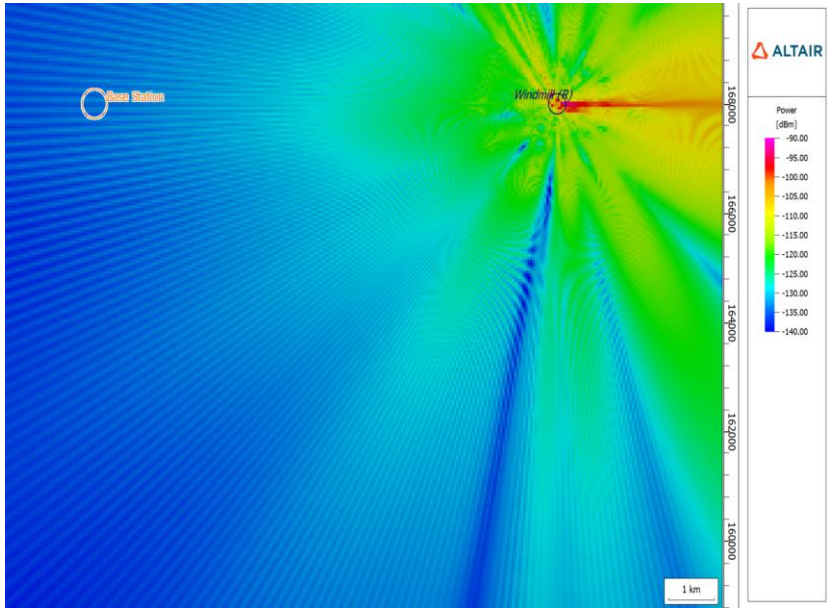
考虑目标的双站RCS

- 新增读取**双站RCS**数据模拟复杂目标散射
- 考虑真实场景，如地形、地貌
- ***当需要考虑更大的传播场景或考虑6G的可重构智能表面（RIS）时，此功能非常有用。***
- ***雷达行业***：模拟风机**前向散射**、**背散射**、**双站散射**区域特性，RCS由Feko计算得到，更精确
- ***扩展到汽车行业***：在V2X典型场景中模拟车辆、行人等目标



V2X场景仿真



风机在野外场景下的散射分析案例

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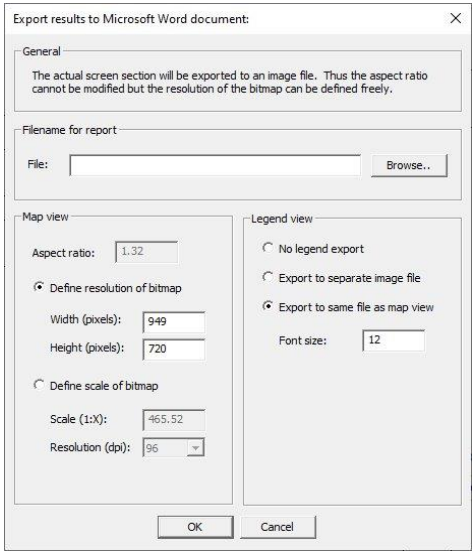
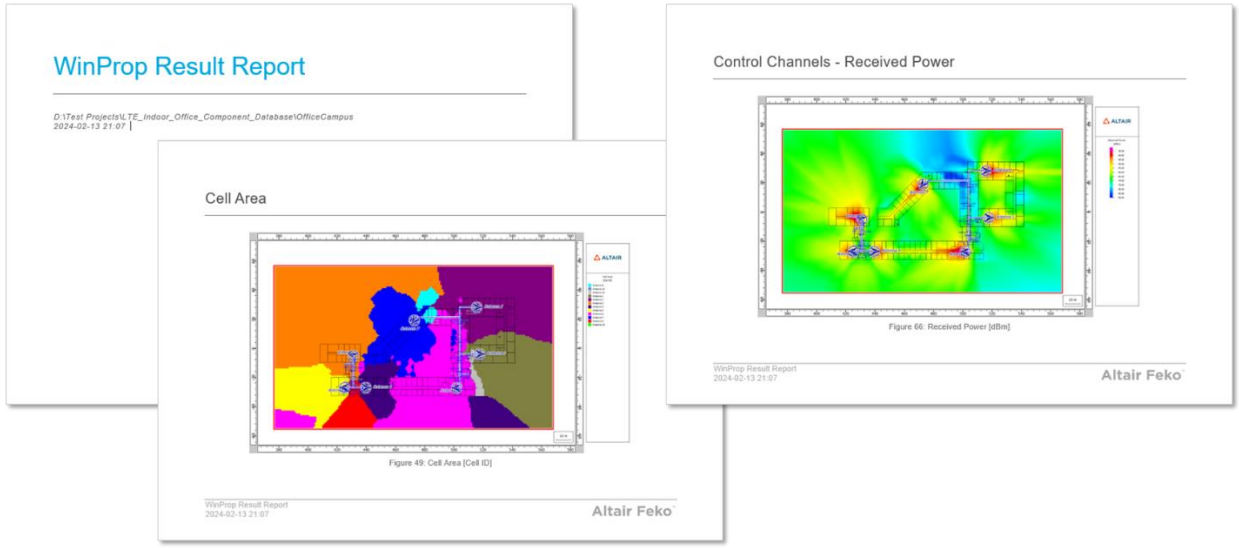
自动生成报告

- 支持批量导出图片或**生成Microsoft Word报告**





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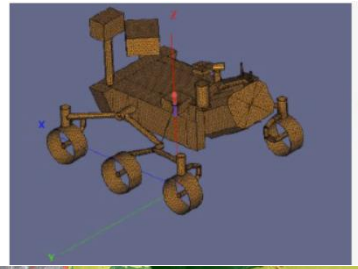
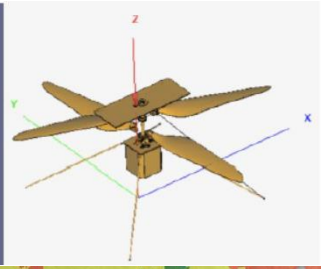
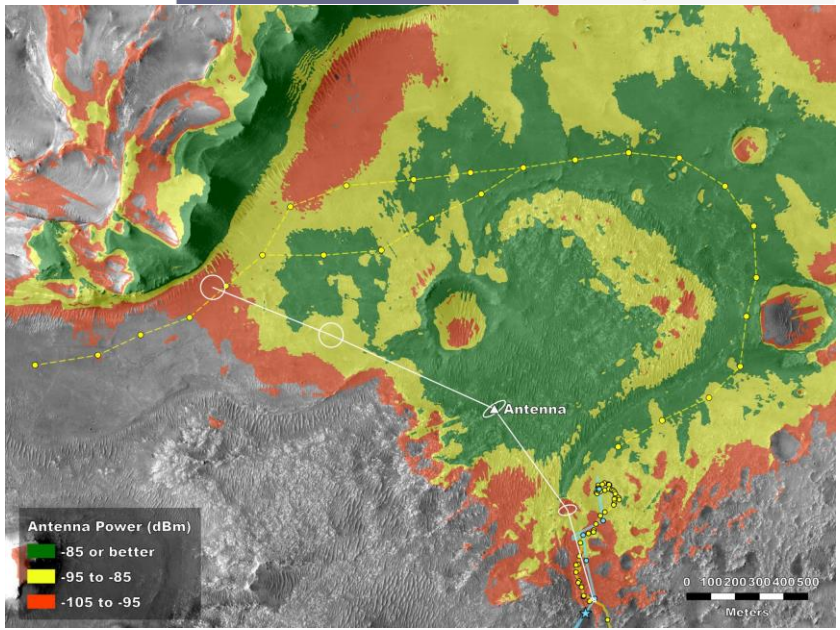
成功案例：火星上的虚拟飞行测试

- “毅力号”火星车与无人机通信链路分析
- 用于计算安全的飞行路径，避免无人机丢失信号
- 通过14条实际飞行路线的实验比对







Source and more information at: https://www.linkedin.com/posts/nacer-chahat-1133054b_telecom-marshelicopter-activity-6957998487007371264-jqPJ

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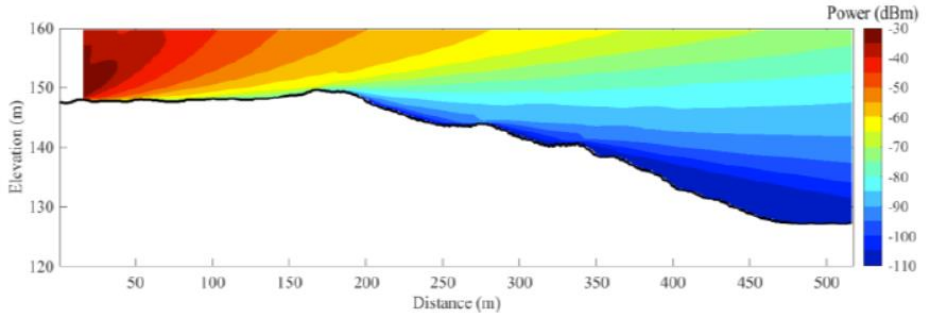
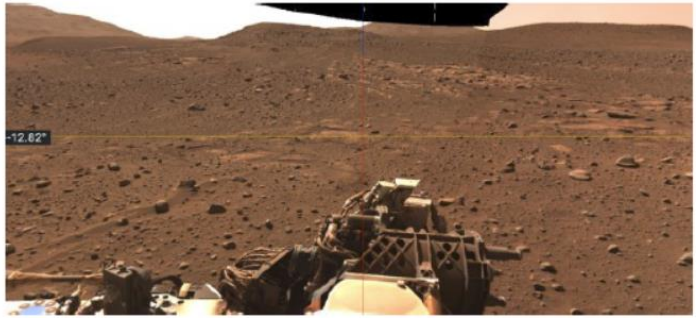
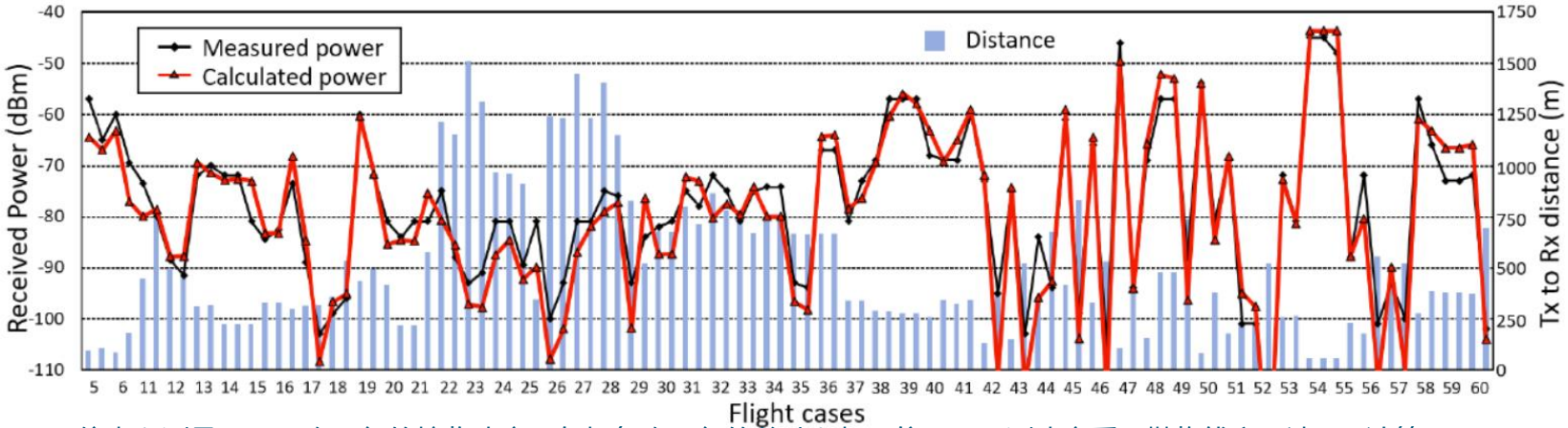
成功案例：火星上的虚拟飞行测试







仿真和测量 5至60次飞行的接收功率，包括每次飞行的着陆和起飞位置。预测功率采用抛物线方程法(PE)计算

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THANK YOU

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