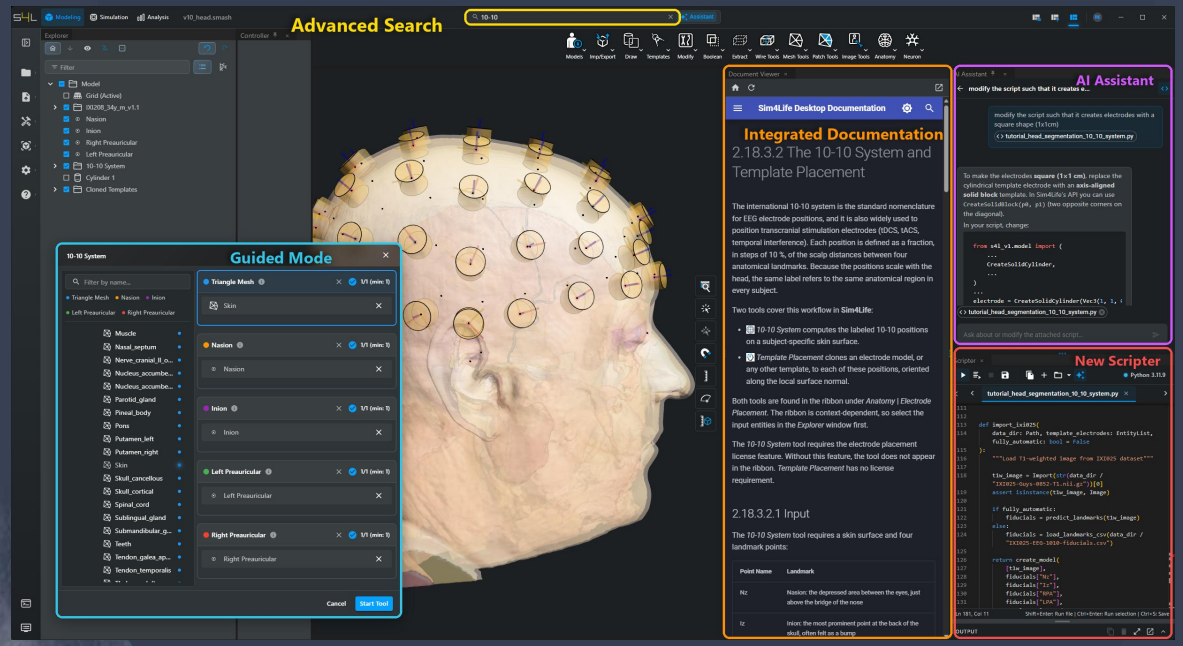
auden

sim4Life

Sim4Life 版本更新

- V10.0 B25335 桌面版

zurich med tech



https://sim4life.swiss/release-history/release-notes-v10-0-0

Sim4Life V10.0 更新亮點

- **統一操作介面:** Sim4Life.web 與桌面版應用程式採用全新且一致的操作介面，整合工具與技術文件搜尋功能，並支援鍵盤快速鍵及四種語言(英文、中文、韓文、西班牙文)

- **AI 助理與文字轉模擬:** 以淺顯易懂的語言描述任務需求，由 AI 助理自動撰寫用於模型建立、模擬設定或後處理的 Python 程式碼，並逐步說明各項操作流程

- **BraiNN 全腦網路模擬:** 利用全新開發的全腦模擬器，模擬大腦神經網路活動及刺激引發的腦電圖(EEG)反應，透過 GPU 加速，運算速度較傳統 CPU 模擬器快逾 90 倍，有效提升大規模參數探索與個人化模型擬合效率

- **ThermoReg 全身熱調節模型:** 採用結合 UTCI 與 Fiala 的熱調節模型，涵蓋出汗、顫抖及熱交換等生理調節機制，並整合電磁波與聲學能量沉積效應



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使用者介面(User Interface)

(1) 桌面版與網頁版採用全新且一致的操作介面 (包含整合搜尋框、引導式建模、Web 平台腳本環境和嵌入式文件...)



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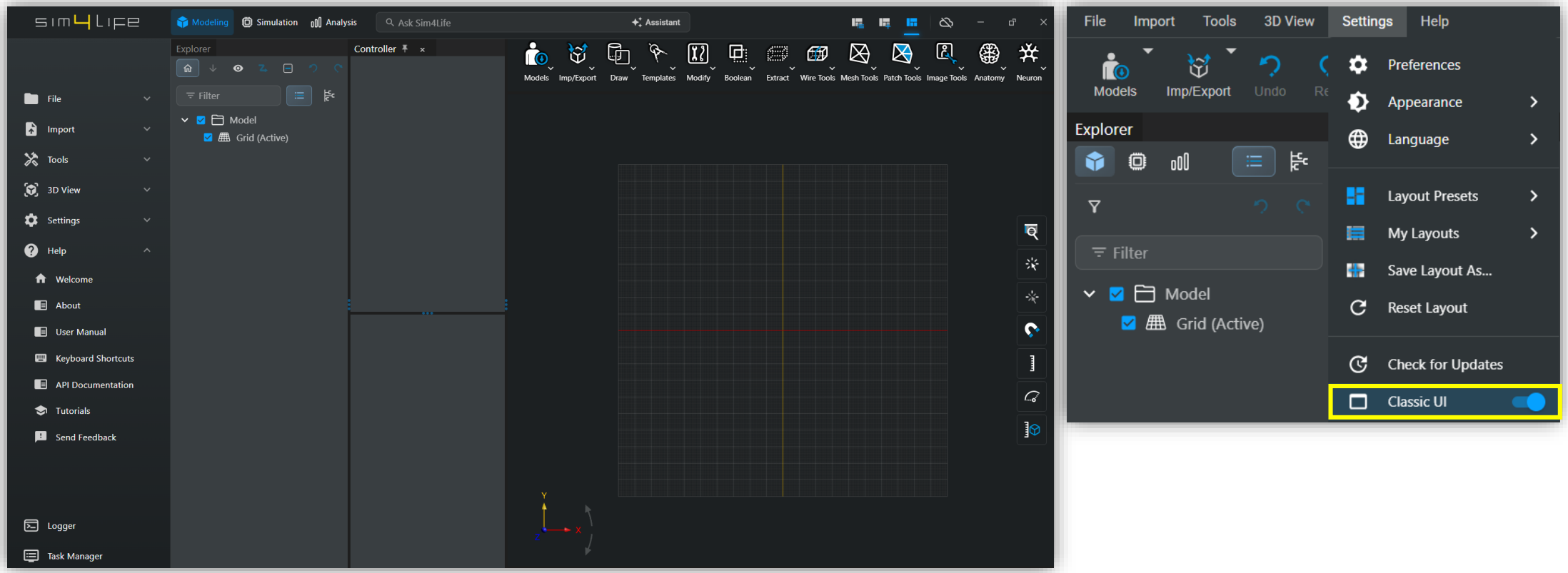
使用者介面(User Interface)

(2) Sim4Life Classic V10.0 可與 Sim4Life V10.0 並行安裝，並可隨時透過新版介面中的切換功能，還原為接近 Classic 版本的操作配置

Sim4Life_setup_10.0.0.25335.exe



Sim4Life web & V10.0 操作介面

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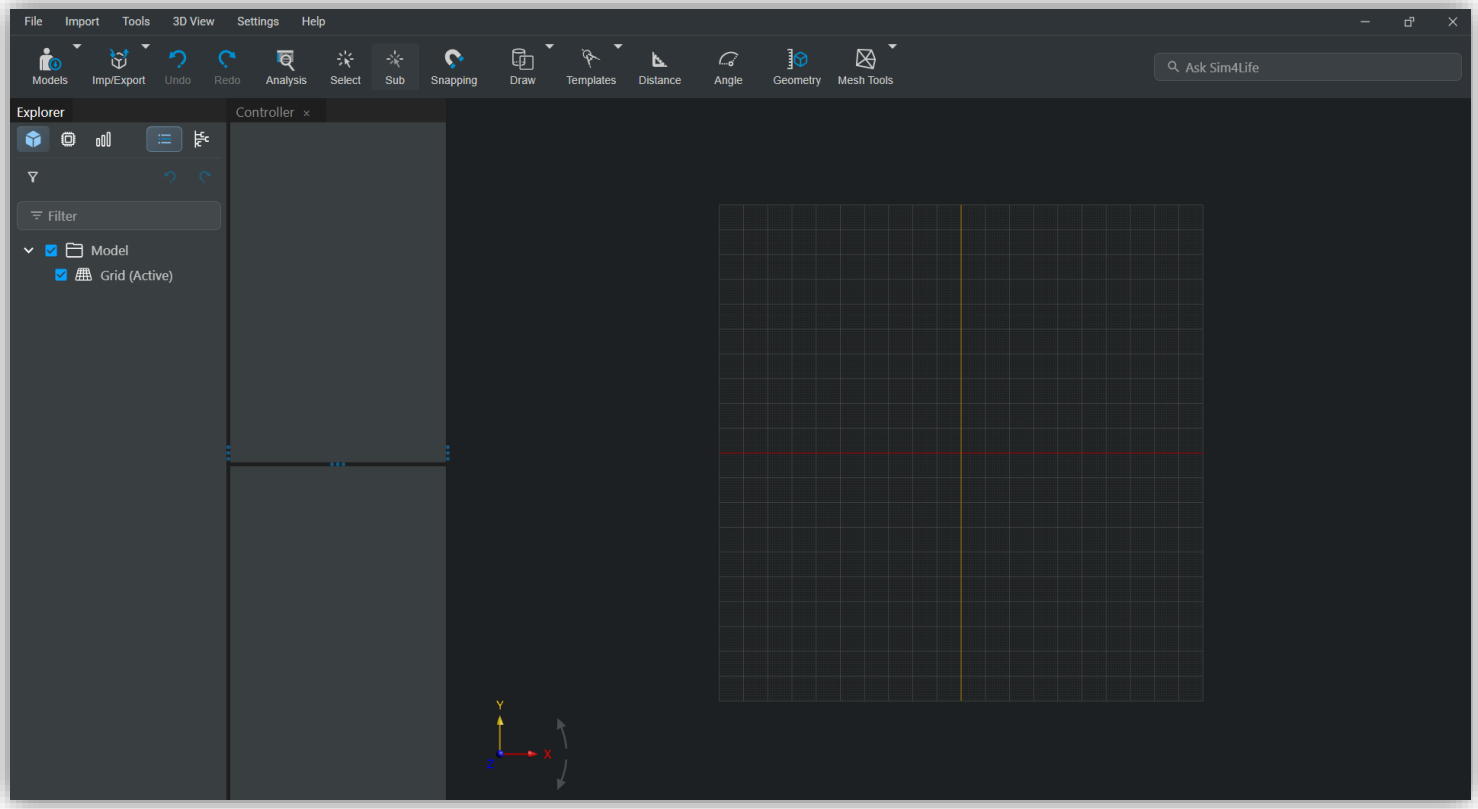
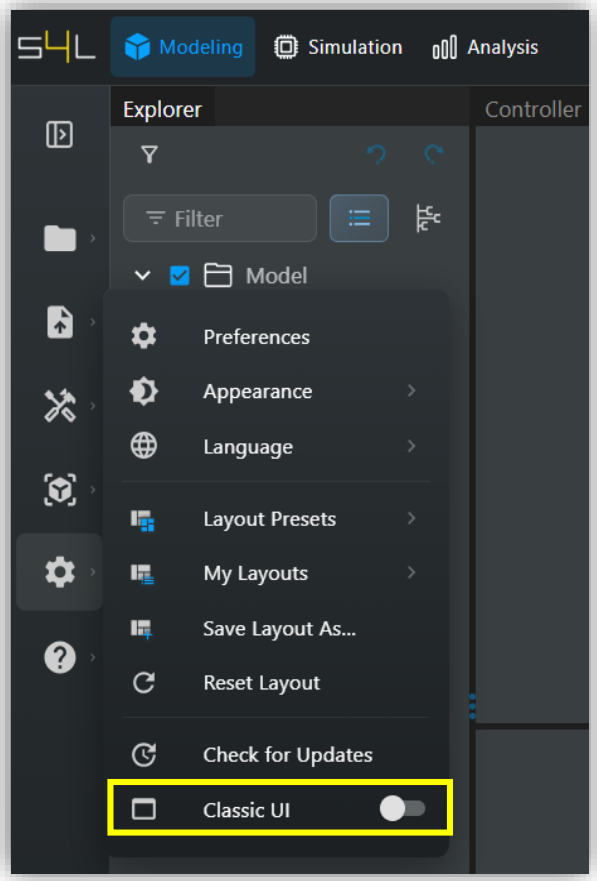
使用者介面(User Interface)

(2) Sim4Life Classic V10.0 可與 Sim4Life V10.0 並行安裝，並可隨時透過新版介面中的切換功能，還原為接近 Classic 版本的操作配置

Sim4LifeClassic_setup_10.0.0.25335.exe



Sim4Life Classic V10.0 操作介面



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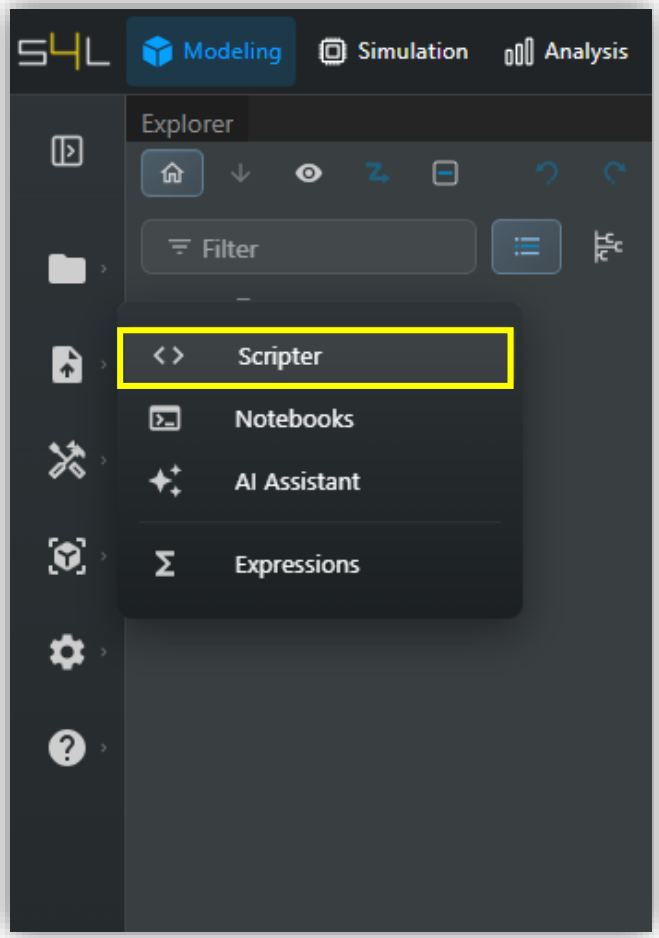
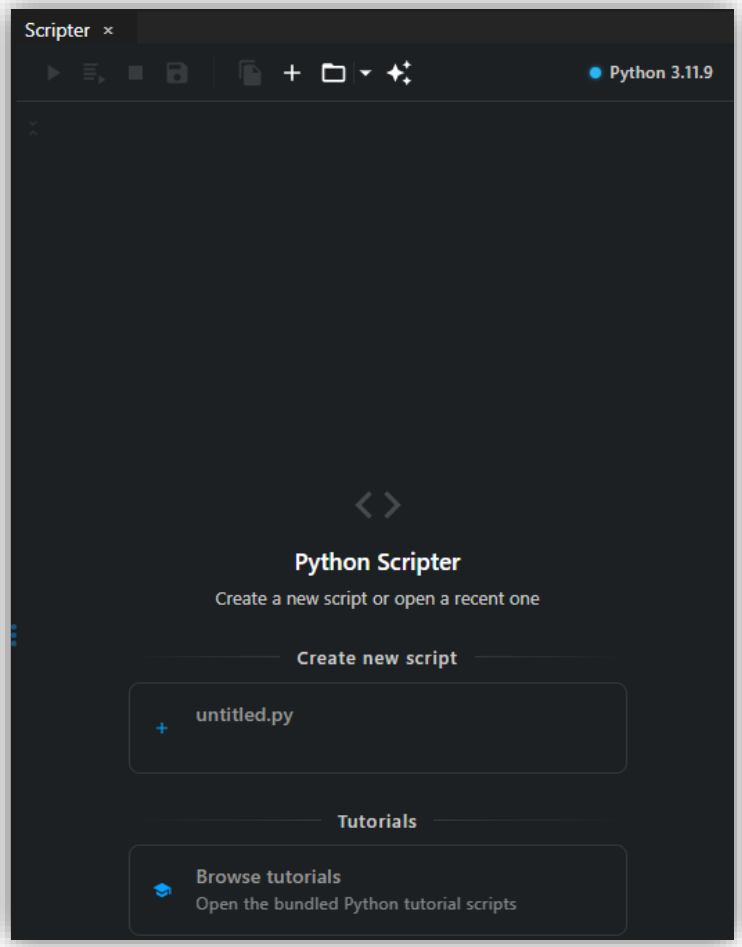
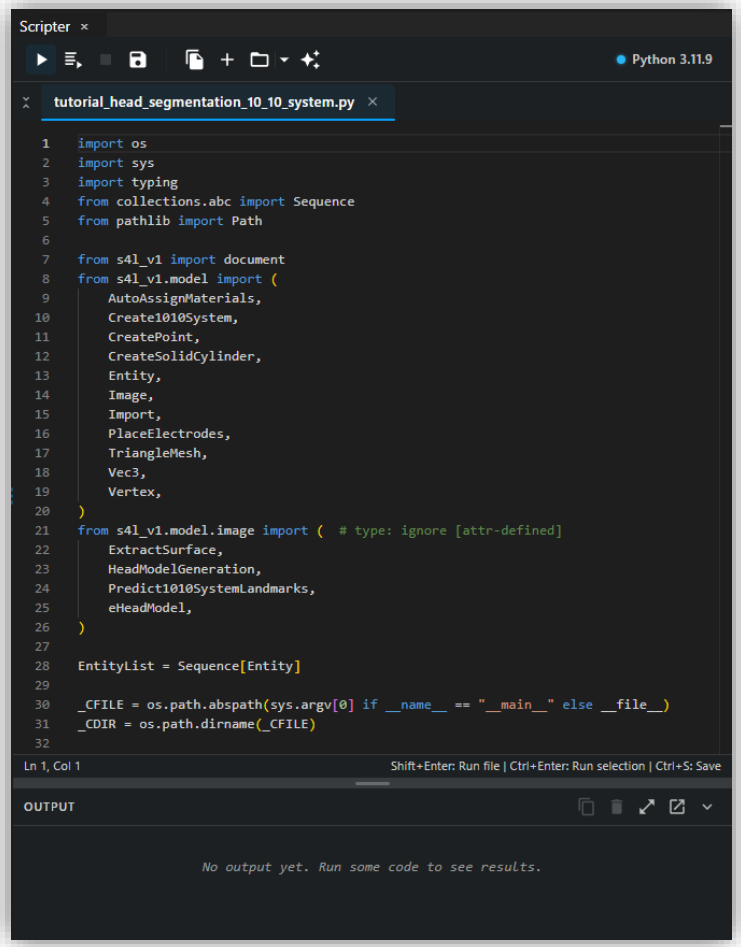
使用者介面(User Interface)

(3) 將網頁版的 Python 腳本編輯環境 Scripter 整合至桌面版，提供程式碼自動補全、語法高亮、另存新檔、腳本檔案拖放、輸出內容複製，以及直接存取教學與範例筆記本資料夾等功能







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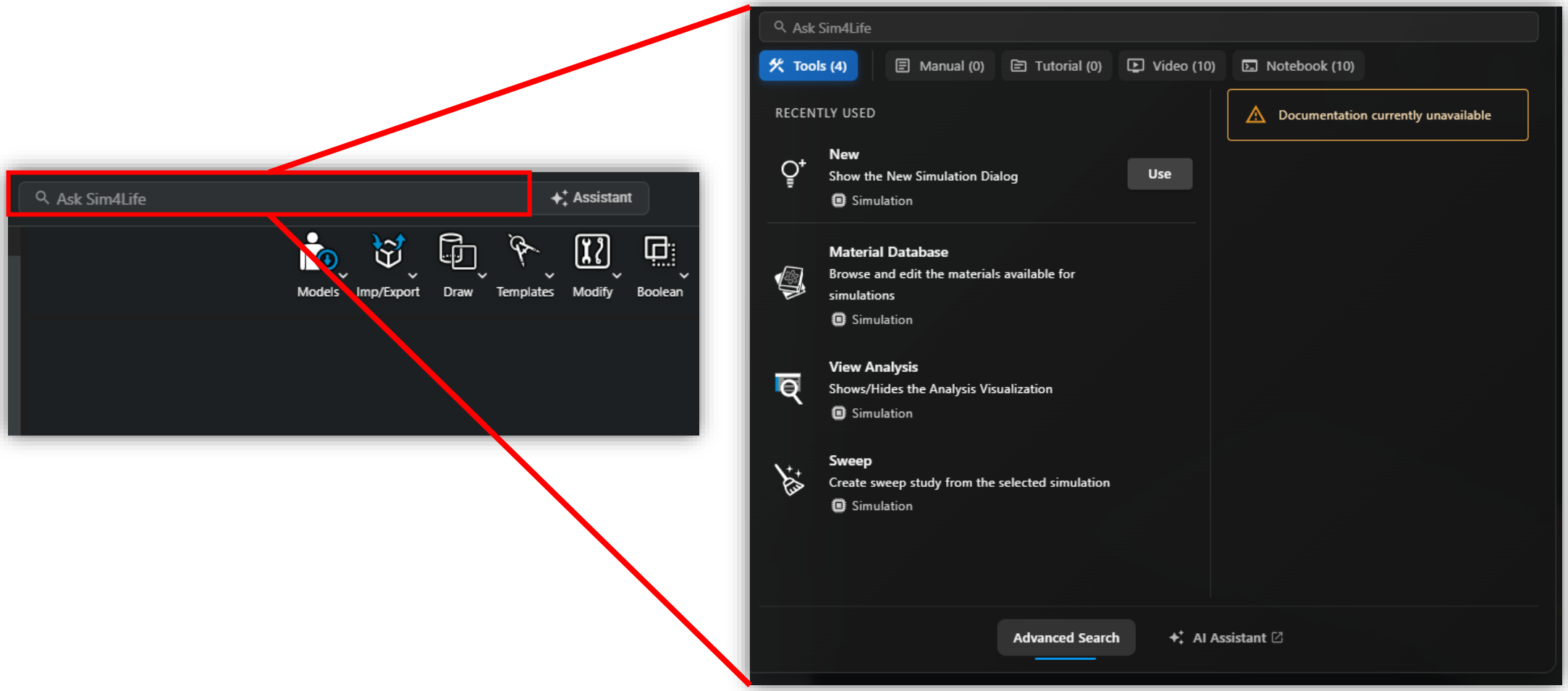
使用者介面(User Interface)

(4) 新增整合式搜尋功能，可跨工具、使用手冊及教學文件進行查詢



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使用者介面(User Interface)

(5) 新增歡迎首頁，整合快速入門工作流程、近期專案與腳本、教學文件、版本更新資訊及常用資源。相關內容與版本更新資訊皆安裝於本機，無須連接網際網路即可使用





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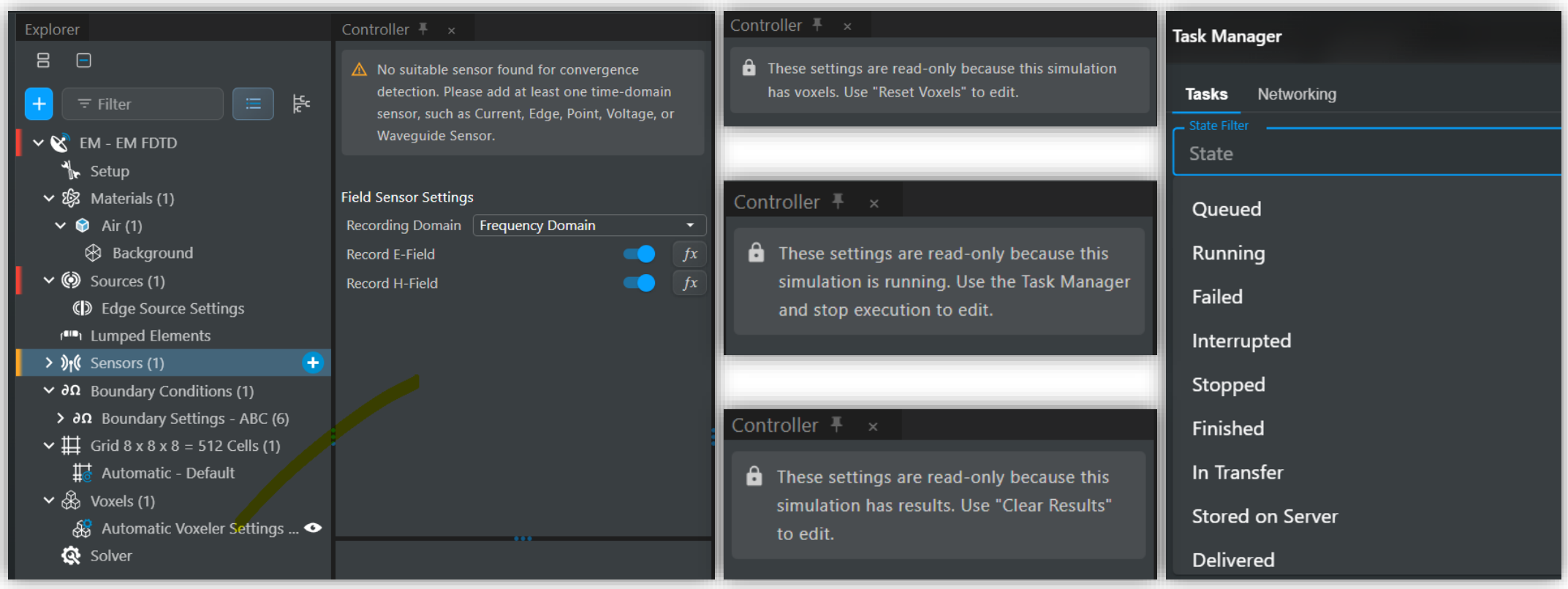
使用者介面(User Interface)

(6) 模擬樹狀結構中會直接顯示錯誤與警告訊息，並標示各工作流程步驟的執行狀態



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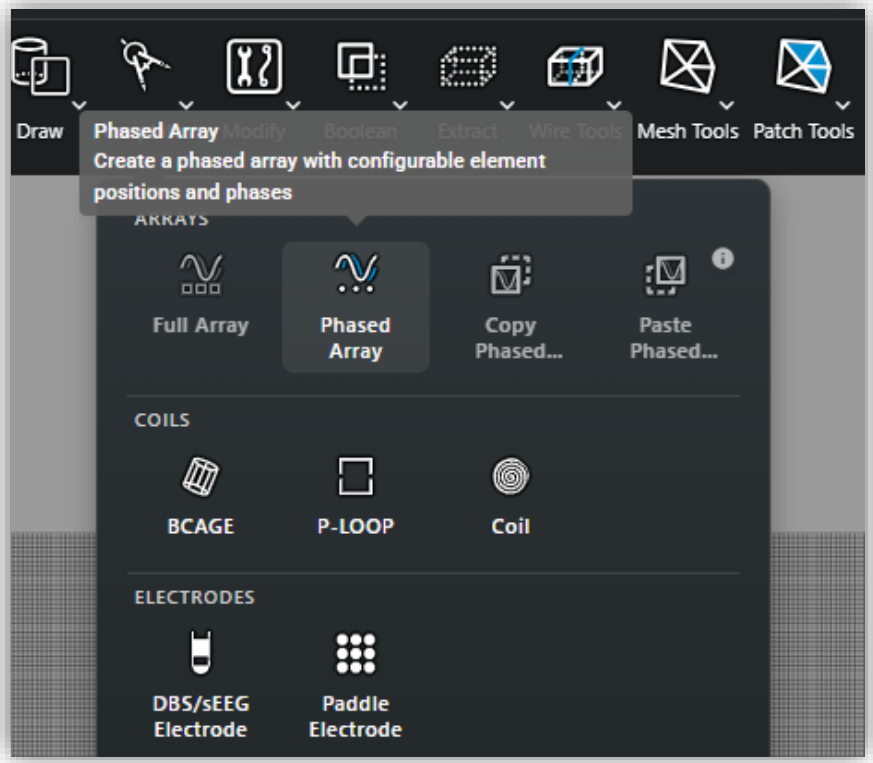
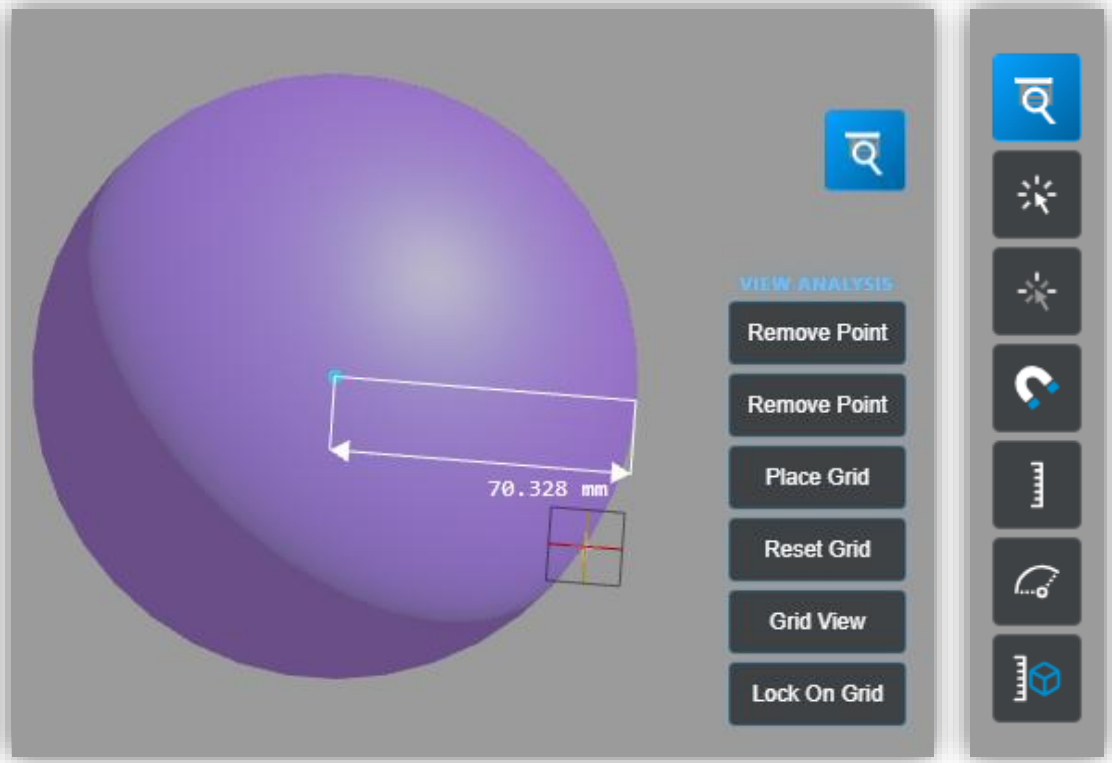
使用者介面(User Interface)

(7) 重新整理功能區與側邊欄配置，改善拖放操作的提示效果，並明確標示工具的鎖定狀態，例如: 已建立體素或模擬結果時的限制

(8) 提供更詳細的工具提示，並將相關說明文件整合至工具介面中，方便查閱







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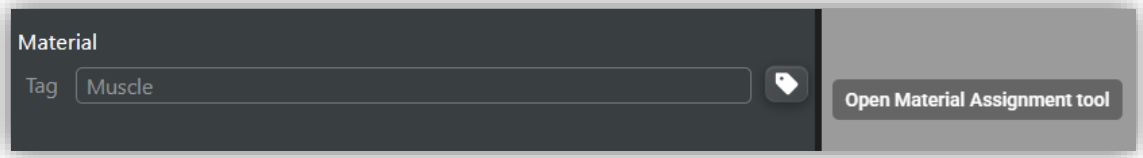
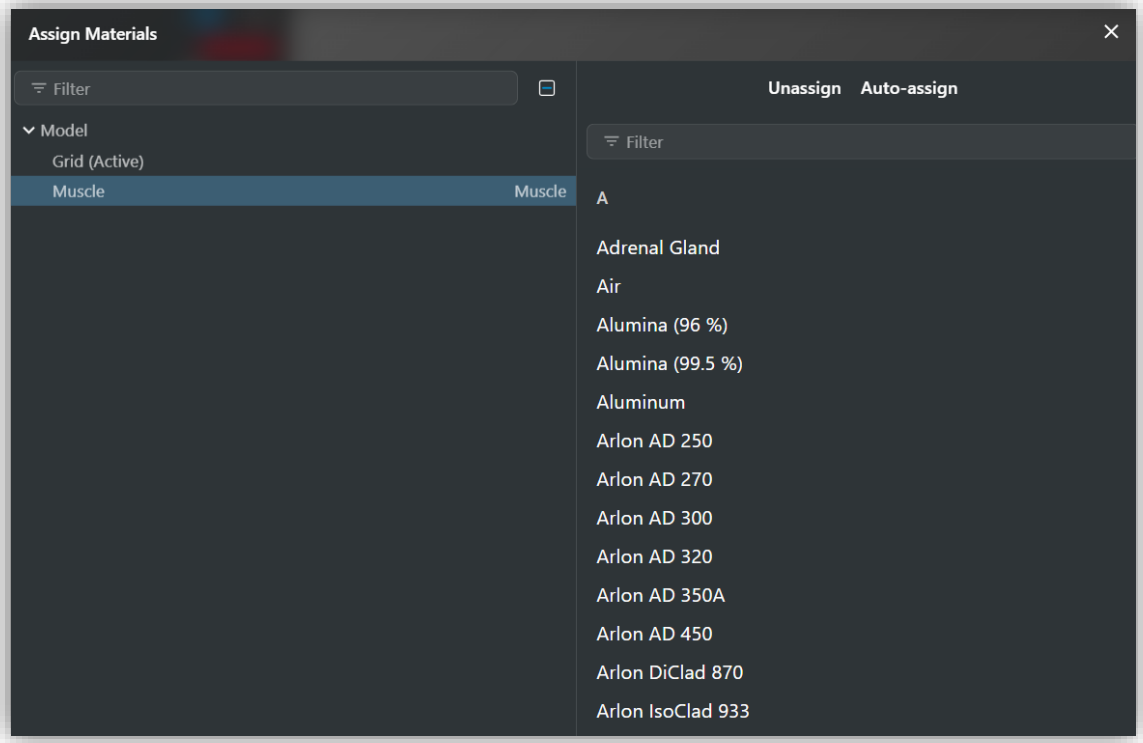
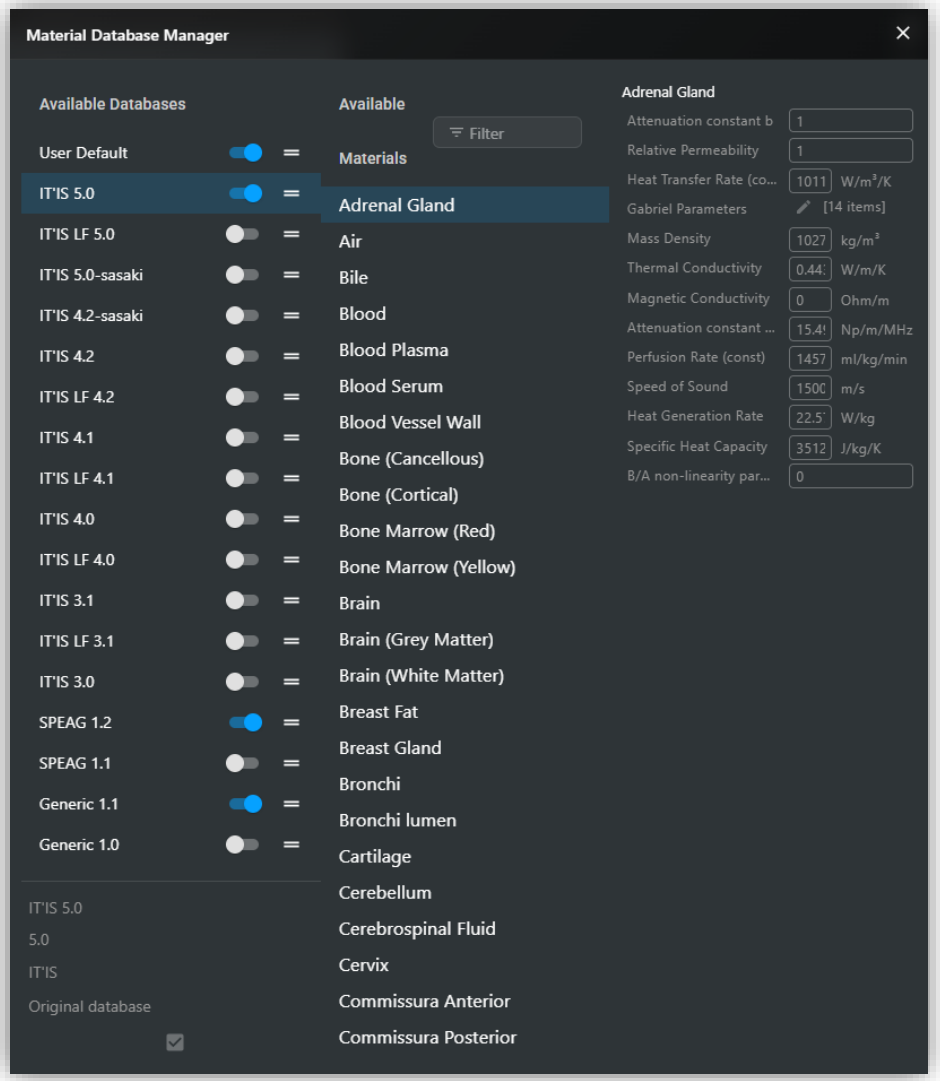
使用者介面(User Interface)

(9) 簡化材料設定介面: 除了頂層物件外，Assign Materials 工具現在也支援透過材料標籤(Material Tags)，將材料指定給非結構化網格的各個區域







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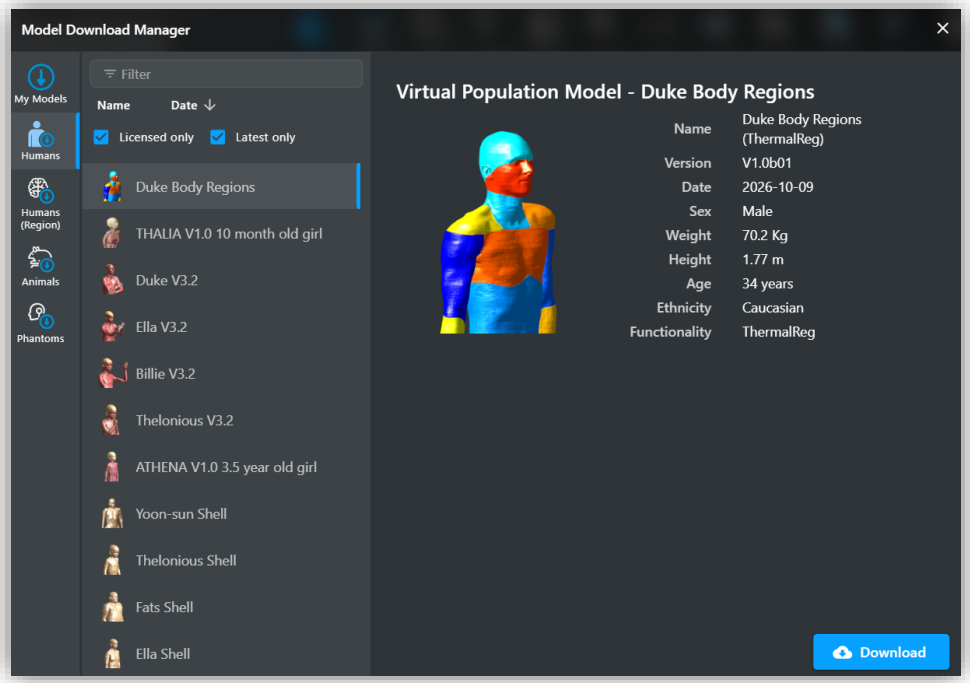
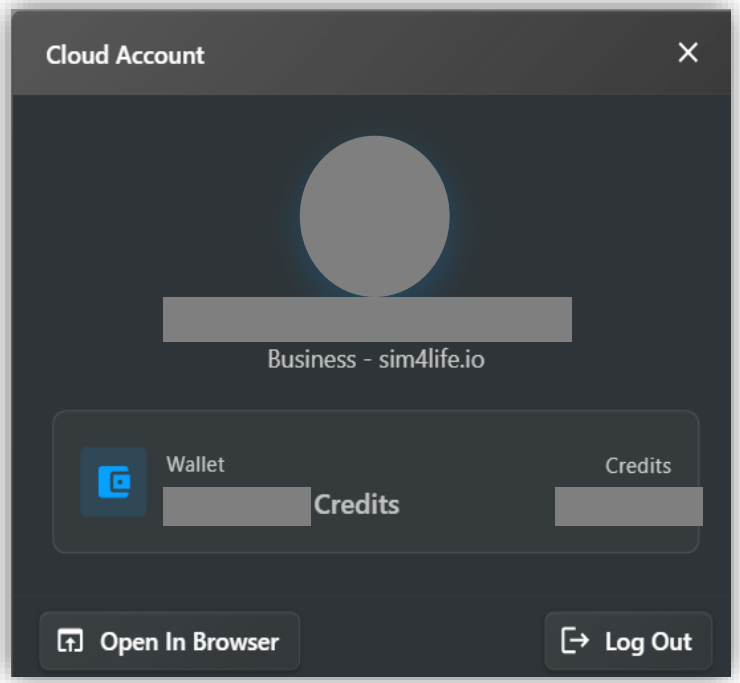
使用者介面(User Interface)

(10) Virtual Population 人體模型的下載管理器新增排序功能，且僅開放下載已取得授權的模型; 亦支援匯入本機儲存的模型



(11) 新增雲端點數顯示功能，並提供即將進行的系統維護與版本更新通知，同時加強雲端模擬執行狀態的資訊呈現



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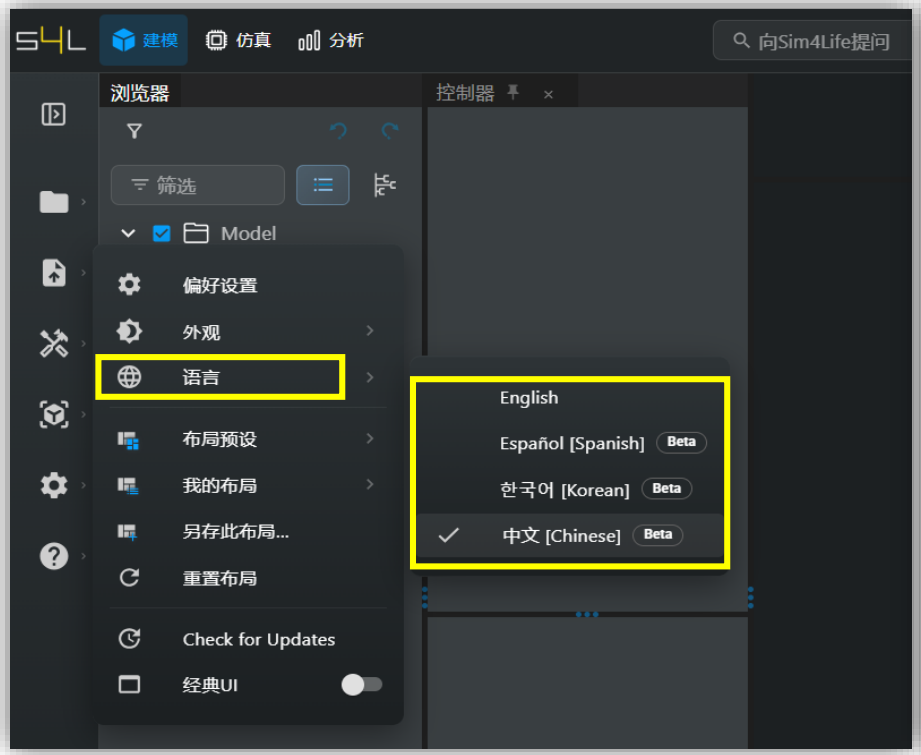
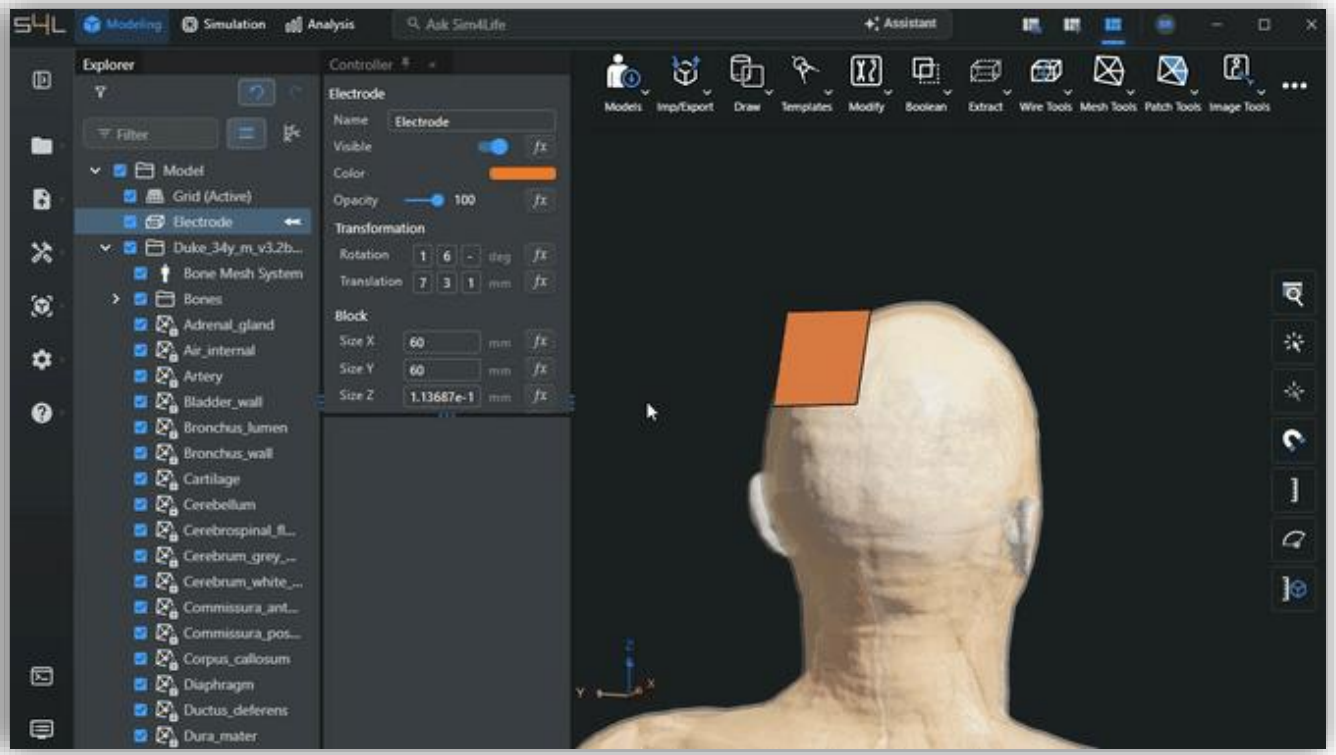
多語系支援(Localization)

- Sim4Life 支援英文、韓文、中文及西班牙文四種語言
- 透過 AI 輔助翻譯，完整涵蓋整體操作介面，包括功能選單、對話視窗、科學專業術語及錯誤訊息，提供一致且完整的多語系使用體驗





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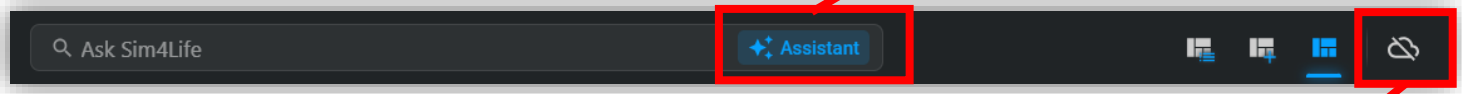
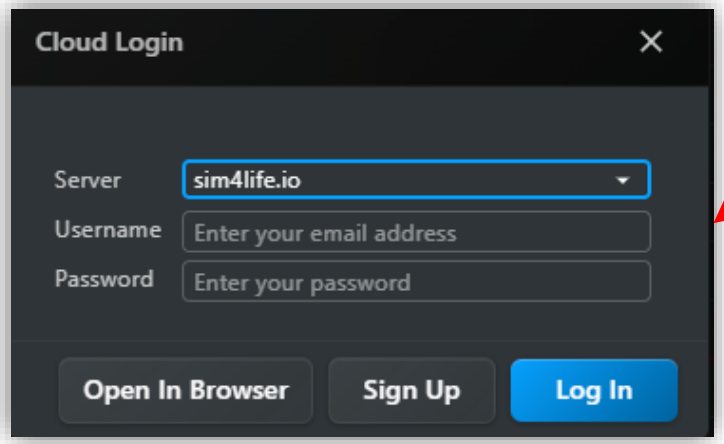
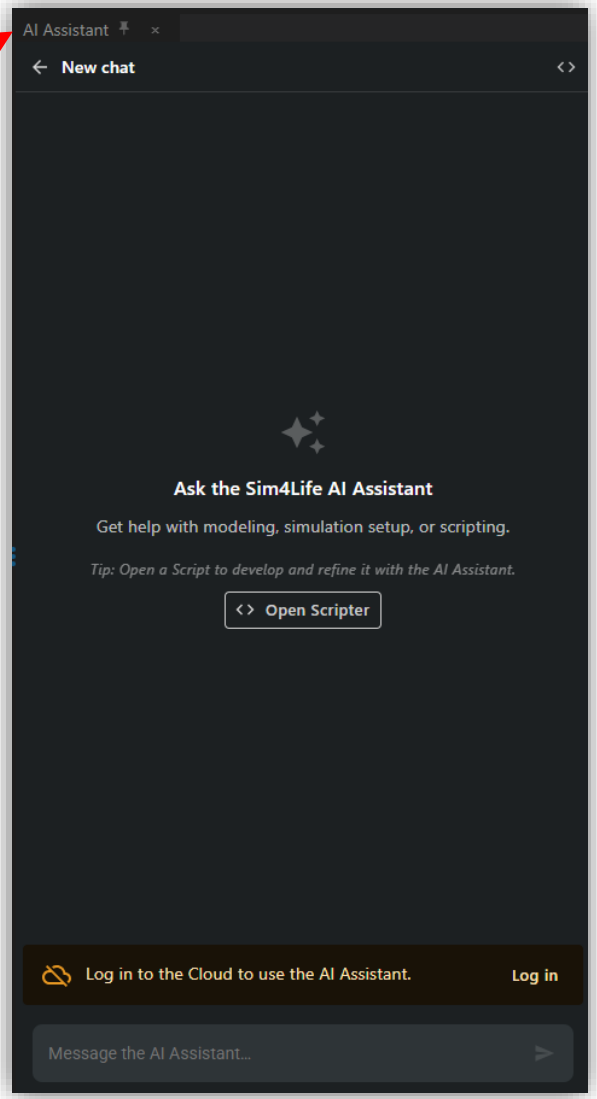
AI 助理與文字轉模擬

- AI 助理可依據自然語言指令，自動產生 Python 程式碼，應用於 CAD 建模、模擬設定與檢視，以及後處理作業
- 逐步說明程式執行流程，並支援檢視及編輯自動產生的程式碼
- 可於應用程式各處使用，包括 Scripter 腳本編輯器
- AI 助理無法使用時，系統會提供明確的提示訊息
- 桌面版須登入 Sim4Life 雲端帳戶才能使用







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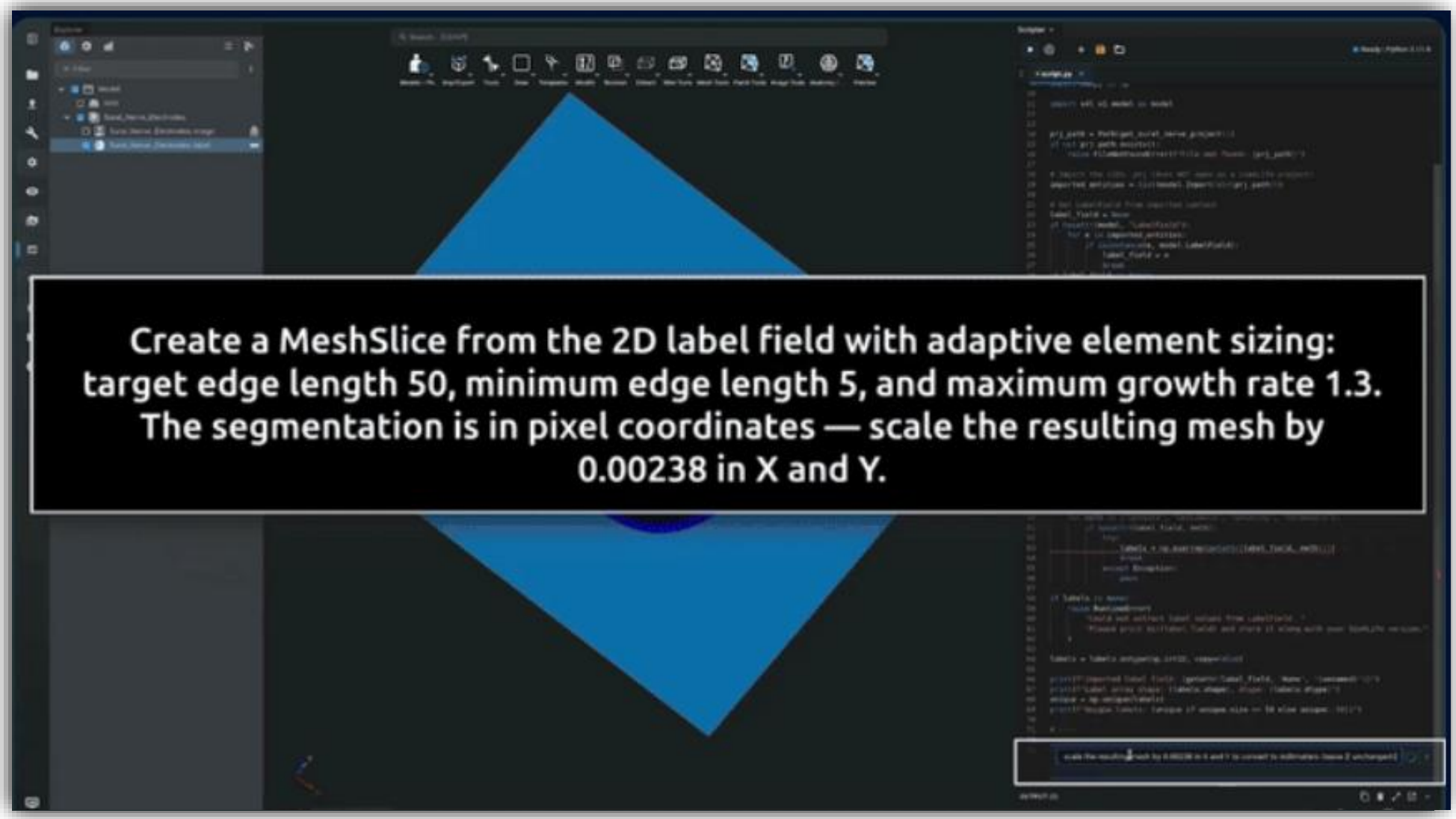
AI 助理與文字轉模擬



文字轉模擬應用: 周邊神經模型研究案例

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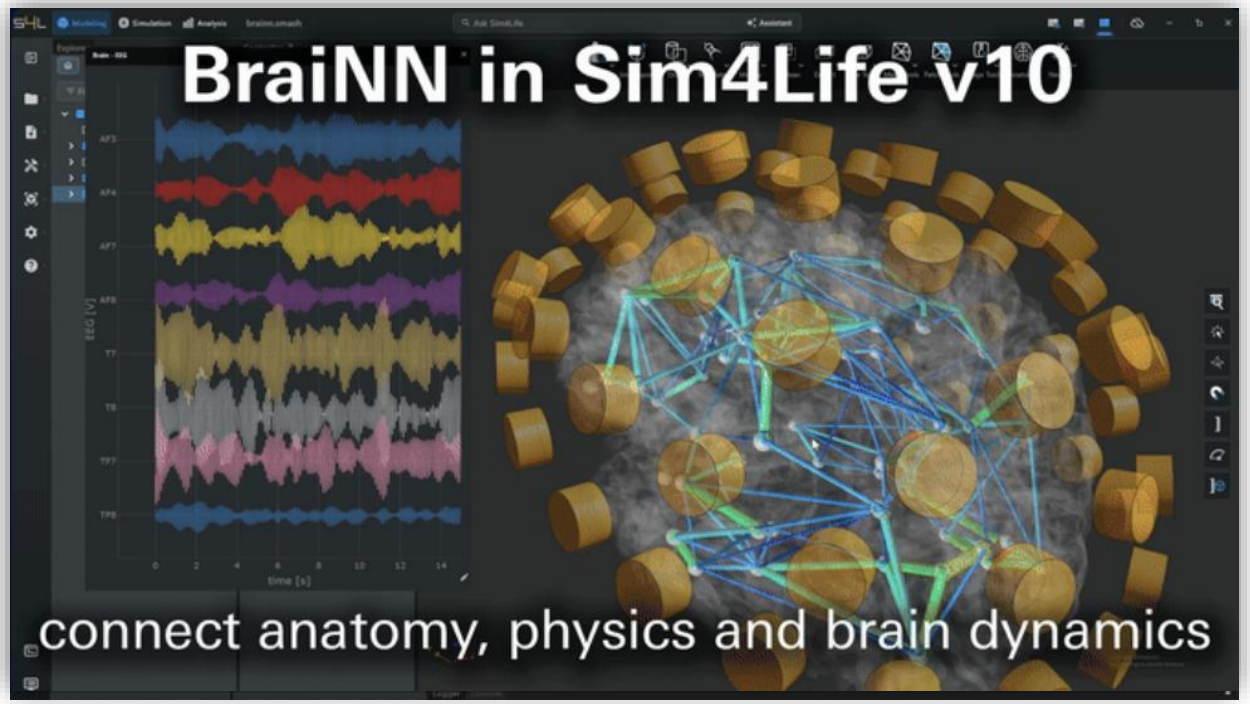
BraiNN: 全腦神經網路模擬

- 全新全腦模擬器，可建立以腦區或大腦皮質表面為基礎的神經質量模型網路，並利用低頻求解器計算的刺激電場驅動神經活動
- 透過相同頭部模型計算導程場(Lead Field)，將神經活動轉換為模擬頭皮腦電圖(EEG)訊號 (V10.0 版本中，電場誘發的輸入訊號為時間固定值)
- 採用 GPU 加速運算引擎，運算速度較常用的 CPU 全腦模擬器快數個數量級
- 支援確定性與隨機性求解器，並可調整突觸增益、神經網路耦合強度及雜訊程度
- 內建可直接執行的大腦與頭部模型，以及逐步操作教學; EEG 電極配置支援三種標準定位方式



Sim4Life V10.0 - 深入 BraiNN: 整合解剖結構、腦部動態、電磁場與腦電圖的一站式模擬流程

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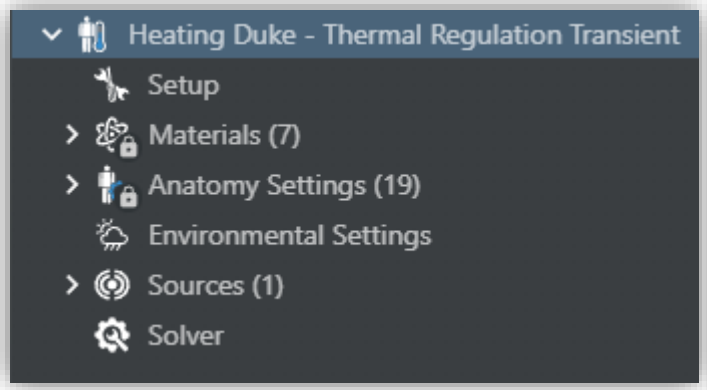
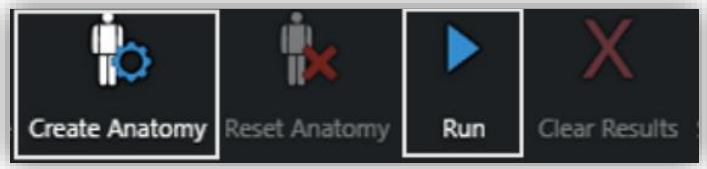
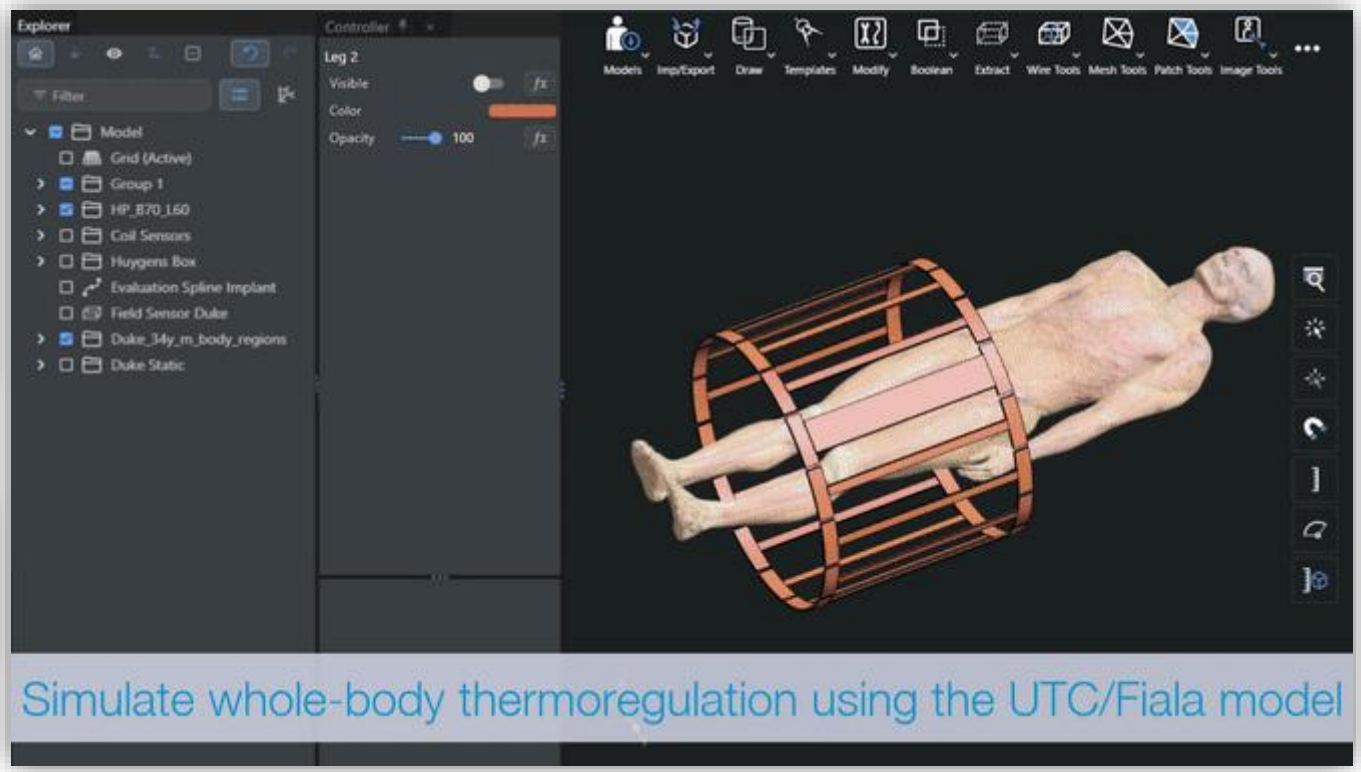
ThermoReg: 全身熱調節模擬

- 全新全身熱調節模擬器，採用 UTCI-Fiala 熱調節模型，可進行暫態與穩態分析
- 涵蓋主動生理調節機制，包括出汗、顫抖、血管舒縮及代謝產熱，以及人體與周遭環境之間的熱交換
- 可結合 Virtual Population Duke 人體模型及可下載的身體區域遮罩，進行電磁波與聲學能量沉積模擬的耦合分析







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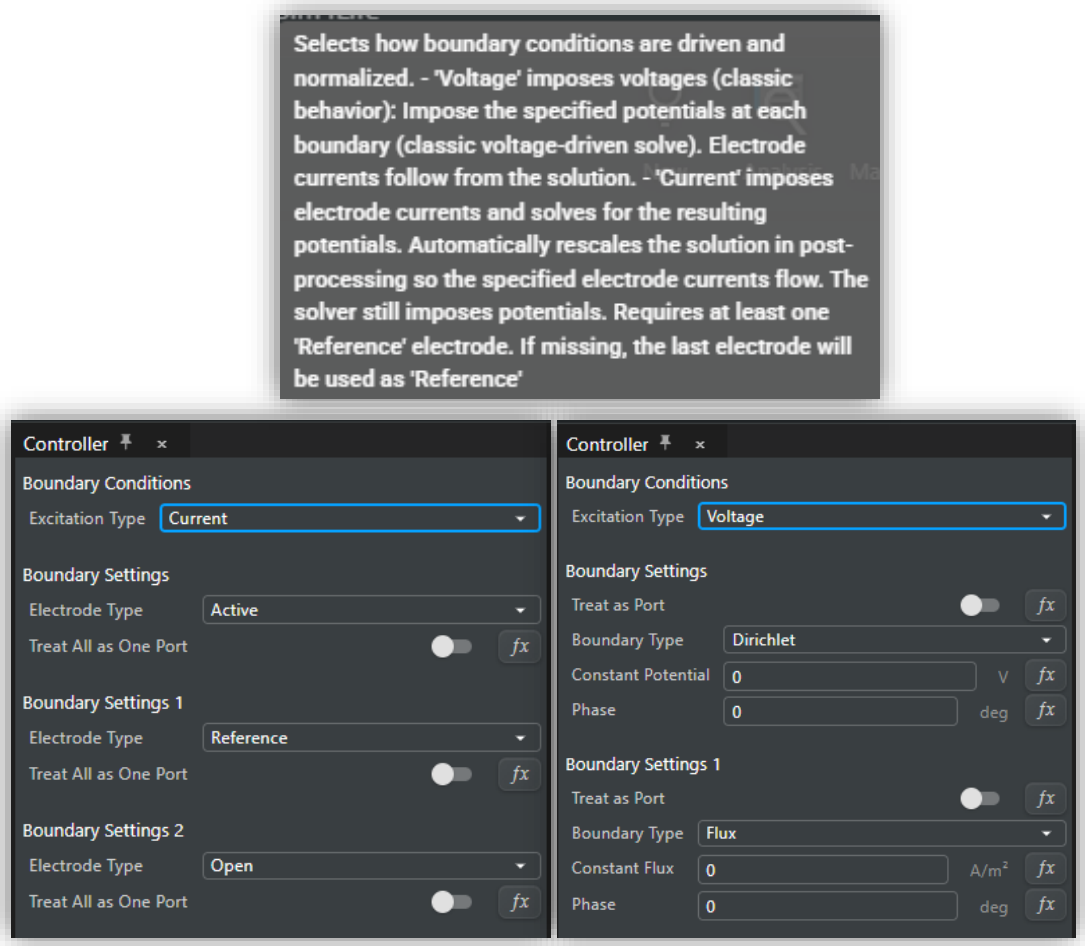
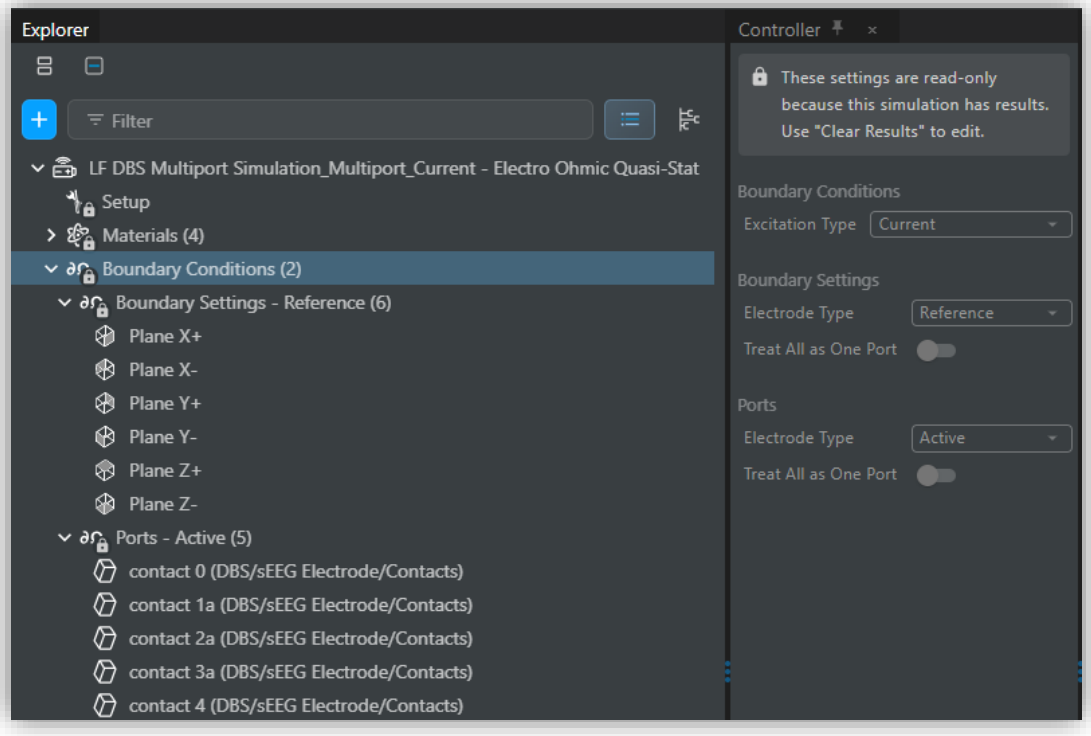
模擬(Simulation)

(1) 低頻求解器與多埠低頻模擬

- 放寬邊界條件的選擇限制(電壓/電流驅動模式)





邊界條件設置案例

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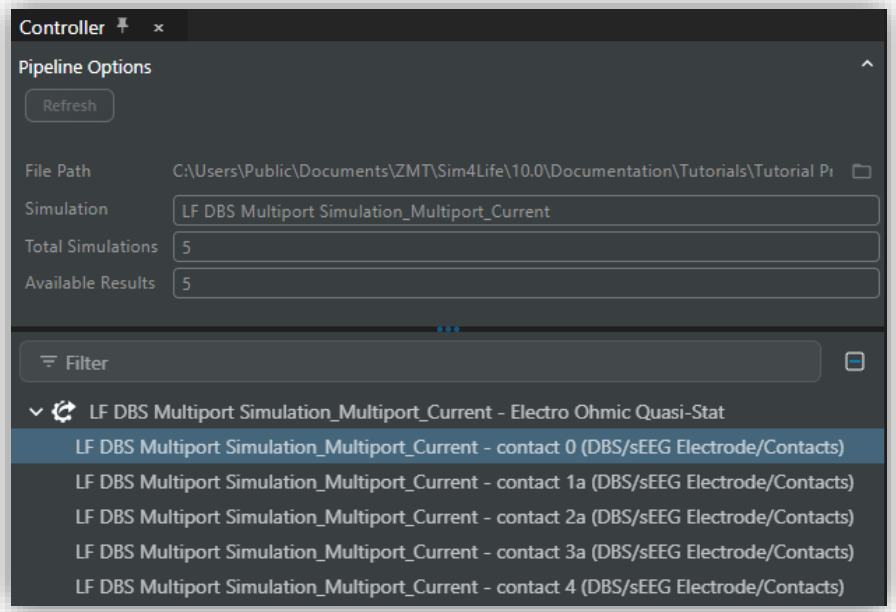
模擬(Simulation)

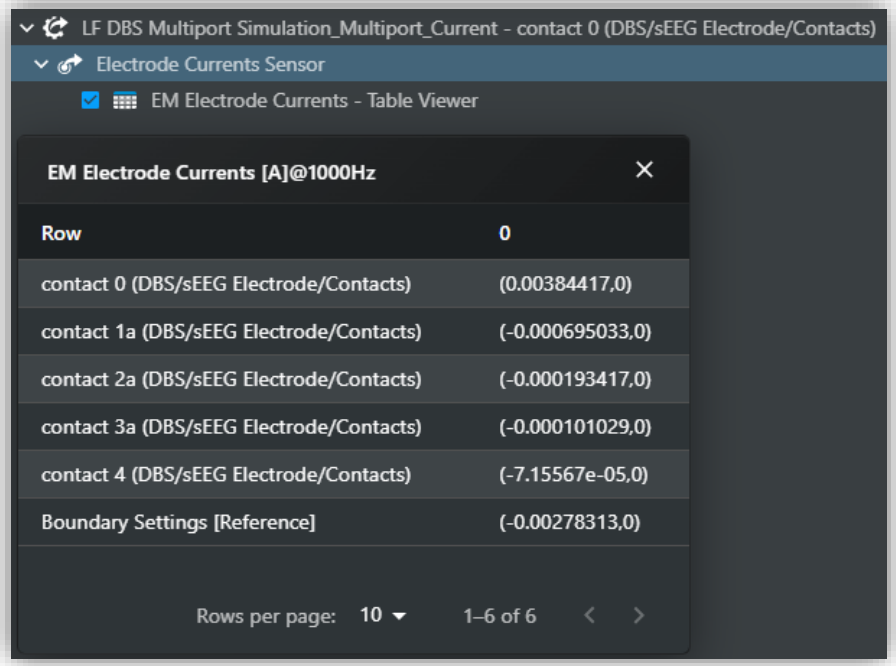
(1) 低頻求解器與多埠低頻模擬

- 可直接利用計算所得的電流通量建立導納/阻抗矩陣，加快後處理速度
- 新的通用電流歸一化器增強了邊界條件選擇的穩健性和靈活性



Port Simulation Extractor 可將多埠電磁低頻模擬中的各單埠基底模擬獨立擷取，並透過電極電流積分計算導納矩陣，以分析各埠之間的電流與電壓關係





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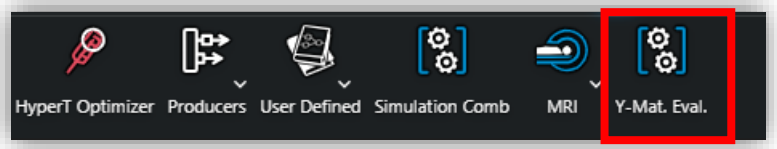
模擬(Simulation)

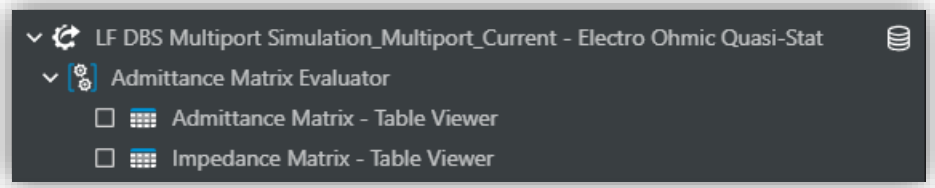
(1) 低頻求解器與多埠低頻模擬

- 可直接利用計算所得的電流通量建立導納/阻抗矩陣，加快後處理速度
- 新的通用電流歸一化器增強了邊界條件選擇的穩健性和靈活性





Admittance/Impedance Matrix Evaluator 可計算 EM LF 多埠模擬中各電極間的電氣耦合關係，透過導納矩陣與其反矩陣阻抗矩陣描述電極電壓與電流的關係(阻抗矩陣的計算須先定義參考電位，以確保矩陣可逆)



Admittance Matrix [Siemens]@1000Hz

Row	0	1	2	3	4
0	(0.00384417,0)	(-0.000695033,0)	(-0.000193417,0)	(-0.000101029,0)	(-7.15567e-05,0)
1	(-0.000695033,0)	(0.00293827,0)	(-0.000570518,0)	(-0.000137196,0)	(-7.54935e-05,0)
2	(-0.000193417,0)	(-0.000570518,0)	(0.00293803,0)	(-0.000573123,0)	(-0.000152218,0)
3	(-0.000101029,0)	(-0.000137196,0)	(-0.000573123,0)	(0.00293093,0)	(-0.00060556,0)
4	(-7.15567e-05,0)	(-7.54935e-05,0)	(-0.000152218,0)	(-0.00060556,0)	(0.00279204,0)

Rows per page: 10 1–5 of 5

Impedance Matrix [Ohm]@1000Hz

Row	0	1	2	3	4
0	(276.421,0)	(74.3219,0)	(38.1266,0)	(23.8392,0)	(16.343,0)
1	(74.3219,0)	(377.667,0)	(87.9465,0)	(42.852,0)	(26.2053,0)
2	(38.1266,0)	(87.9465,0)	(379.471,0)	(88.5705,0)	(43.2532,0)
3	(23.8392,0)	(42.852,0)	(88.5705,0)	(379.715,0)	(88.9539,0)
4	(16.343,0)	(26.2053,0)	(43.2532,0)	(88.9539,0)	(380.939,0)

Rows per page: 10 1–5 of 5

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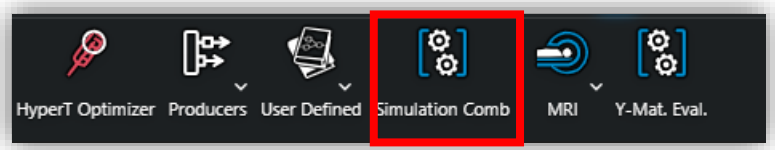
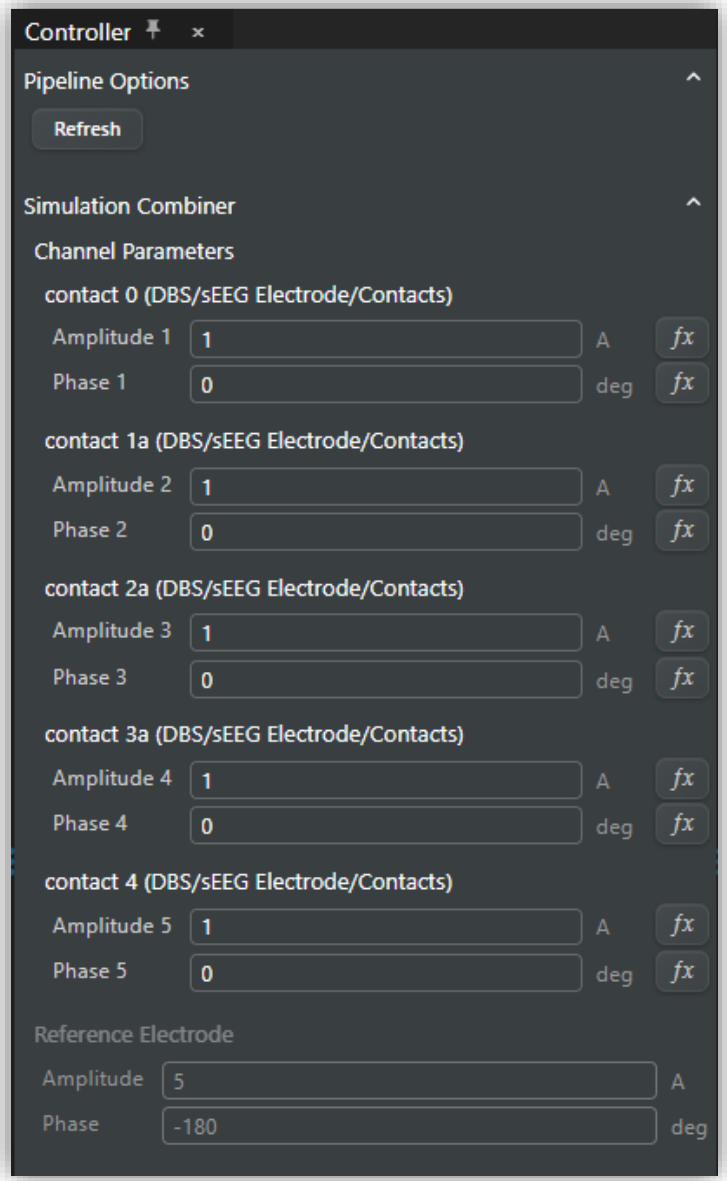
模擬(Simulation)

(1) 低頻求解器與多埠低頻模擬

- 可直接利用計算所得的電流通量建立導納/阻抗矩陣，加快後處理速度
- 新的通用電流歸一化器增強了邊界條件選擇的穩健性和靈活性



Simulation Combiner 可將多埠模擬中各單埠的場感測器結果整合為單一場結果，並依據電壓驅動或電流驅動模式設定各電極的振幅與相位，其中電流驅動模式的參考電極電流則依據電流守恆定律自動計算



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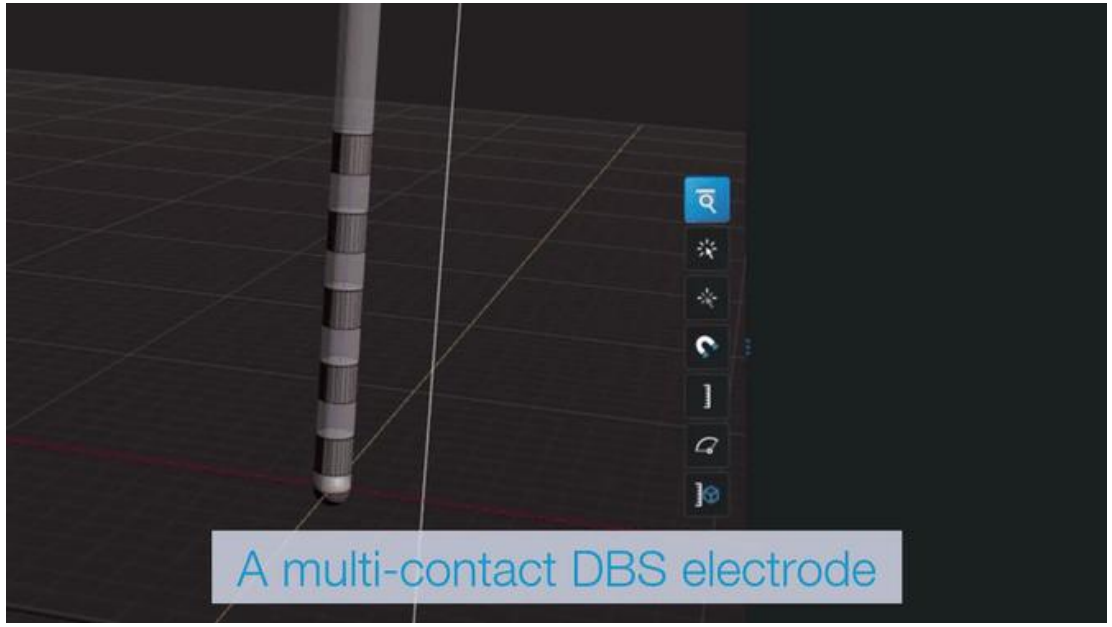
模擬(Simulation)

(1) 低頻求解器與多埠低頻模擬

- 針對電流或電壓驅動的多埠系統，自動計算導納矩陣，並直接將結果傳遞至耦合式電生理模擬與熱模擬，整個流程無須手動擷取資料或撰寫腳本
- 可透過參數掃描工具或 Python API，針對刺激閾值與溫升進行電極配置掃描及最佳化



案例示範: 使用 Python 進行多觸點電極最佳化

a. 透過 Python 控制多接點電極的最佳化流程，並結合電流控制多埠求解器(Current-controlled Multiport Solver)，可精確控制各電極接點的電流，並計算相應的電場分布

b. 透過耦合式電生理與熱模擬，可在最佳化過程中動態更新電場結果，提升整體運算效率與分析彈性

優勢

- 降低刺激閾值: 尋找能以較低刺激強度達成預期神經刺激效果的電極配置
- 降低峰值電流: 最佳化各電極接點的電流分布，以降低局部電流峰值
- 降低功率沉積: 減少組織中的功率沉積，進而降低潛在的熱效應

應用

- DBS 深部腦刺激
- SCS 脊髓刺激
- tES 經顱電刺激
- tIS 時域干涉電刺激

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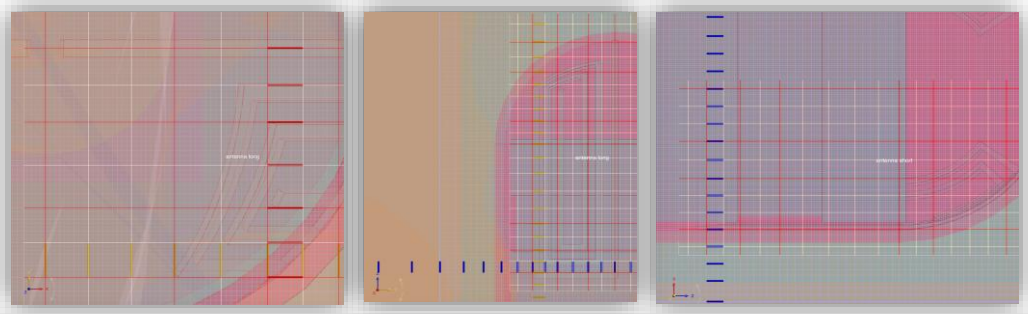
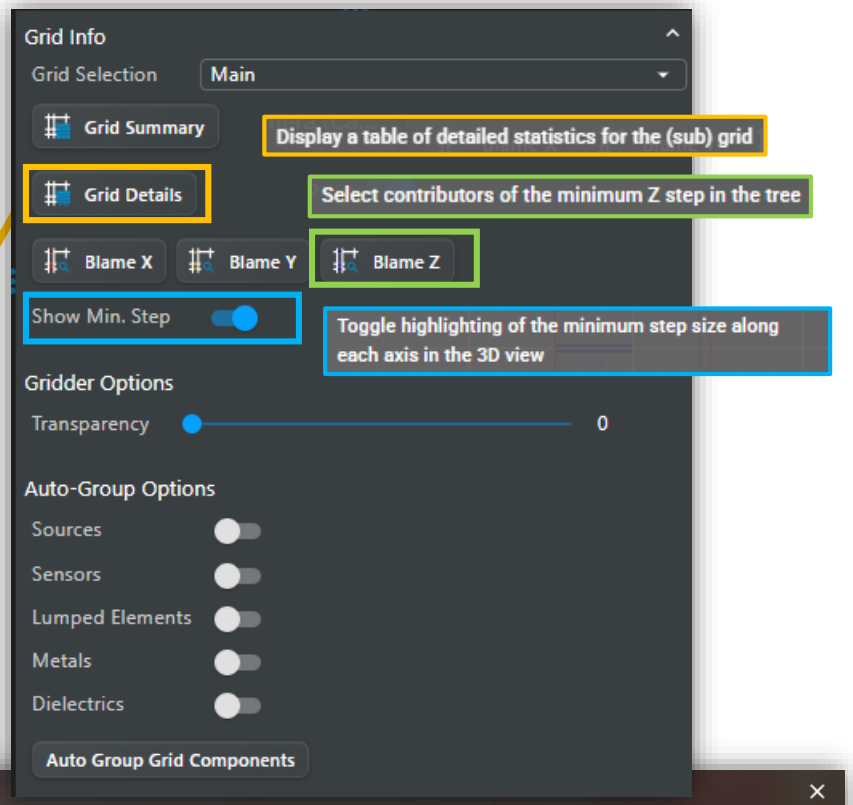
模擬(Simulation)

(2) 網格分割與體素化(Gridding and Voxeling)

- 顯示限制最大穩定時間步長的材料或物件，協助平衡模擬解析度與運算時間
- 支援在實體介面處進行選擇性的網格細化

Blame X (紅色步長)　Blame Y (黃色步長)　Blame Z (藍色步長)





Main Grid Details

Row	Name	Min. Step X [m]	Min. Step Y [m]	Min. Step Z [m]	Time Step [fs]	Automatic / Manual	Max. Step X [m]	Max. Step Y [m]	Max. Step Z [m]	Geom. Res. X [m]	Geom. Res. Y [m]	Geom. Res. Z [m]
	optical dome (Capsule)	0.568323	0.605025	1.082596	2515.627506	Automatic - Very Coarse	0.742641	1.330233	1.370899	20.923848	20.923848	20.923848
	Billie_V2_Gastrointestinal_System	0.568323	0.605025	0.599487	8353.946455	Automatic - Very Coarse	10.669984	10.141211	10.757330	5.502644	5.502644	5.502644
	CMOS camera (Capsule)	0.680012	0.646612	-	-	Automatic - Very Coarse	0.686858	0.928214	-	20.923848	20.923848	20.923848
	spacer (Capsule)	0.568323	0.605025	-	-	Automatic - Very Coarse	0.742641	1.330233	-	28.551600	28.551600	28.551600
	Billie_wholebody_shell_v2.0	0.568323	0.605025	0.599487	8351.092067	Automatic - Very	10.669984	10.141211	10.985534	5.492767	5.492767	5.492767

Rows per page: 10　1–10 of 13

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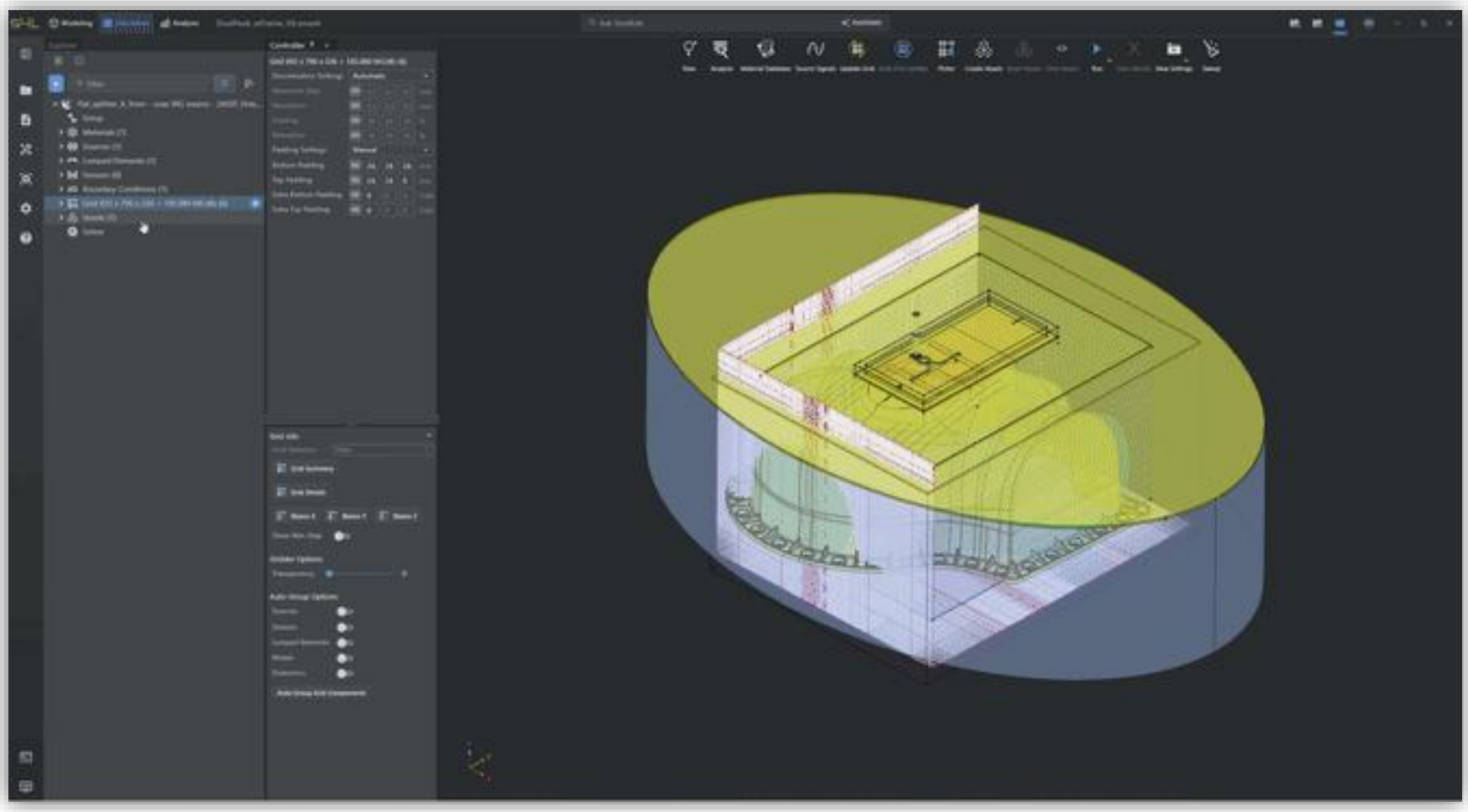
模擬(Simulation)

(2) 網格分割與體素化(Gridding and Voxeling)



網格控制工具演示: 辨識限制穩定時間步長的材質或物件

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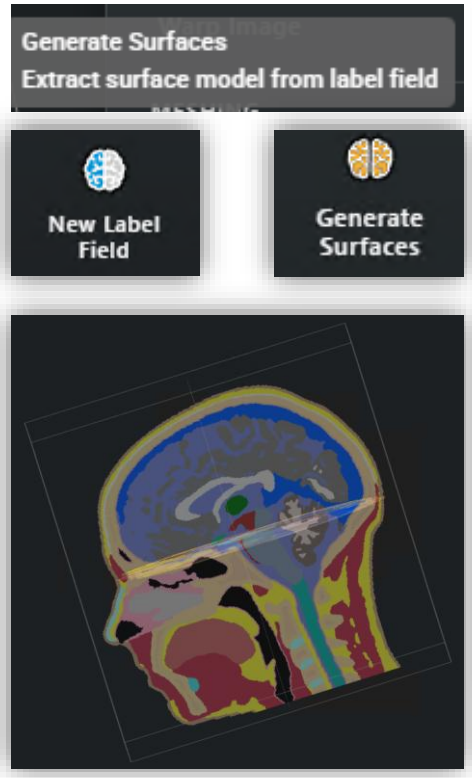
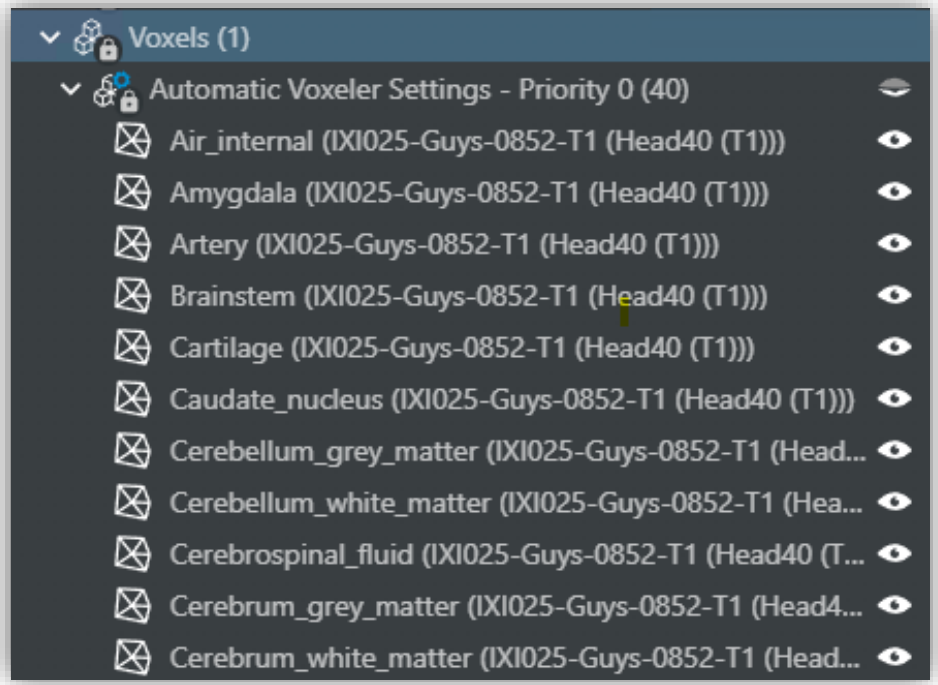
模擬(Simulation)

(2) 網格分割與體素化(Gridding and Voxeling)

- 支援匯入 AI 影像分割工具產生的標籤場，並轉換為可直接進行模擬的體素資料; 亦可加入植入物等其他物件並進行體素化







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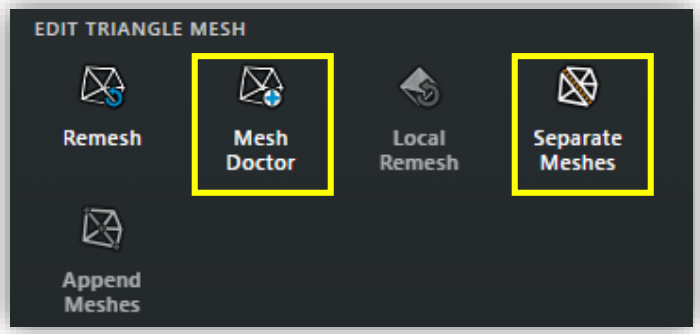
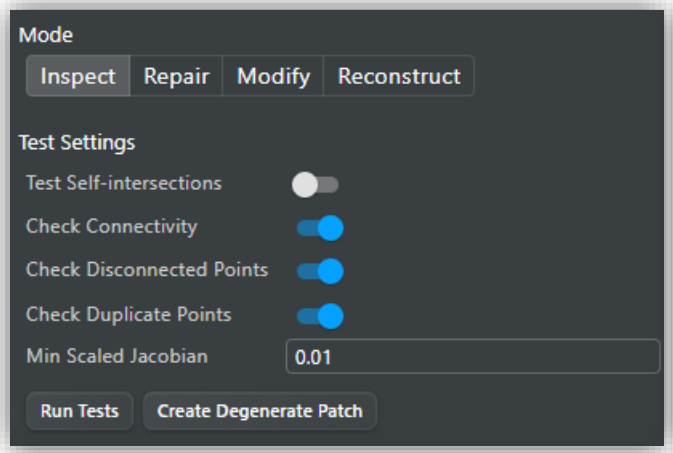
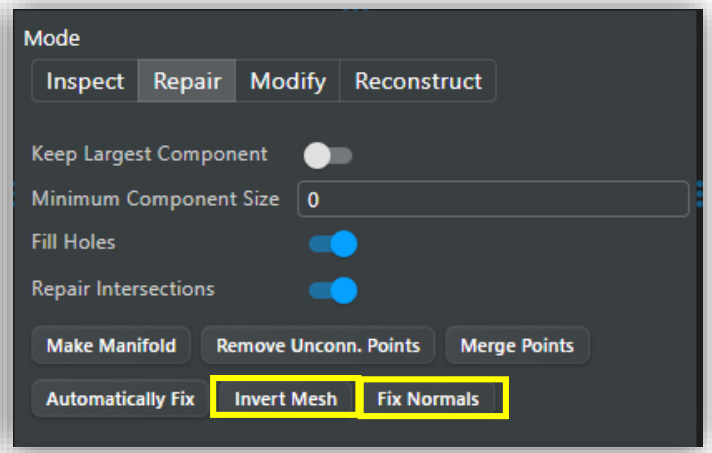
模擬(Simulation)

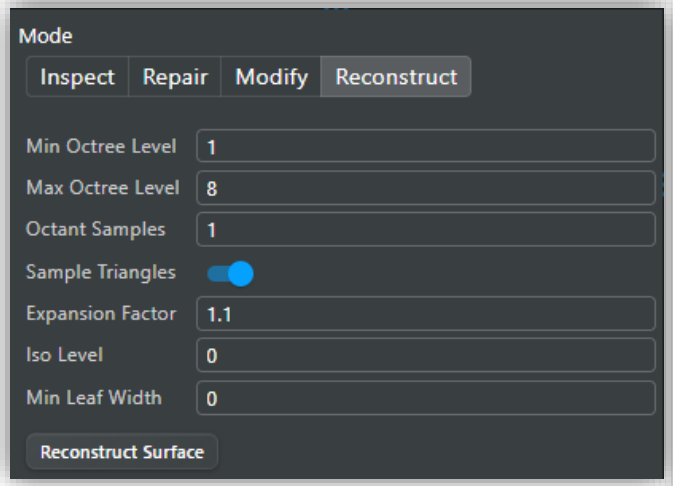
(3) 網格生成(Meshing)

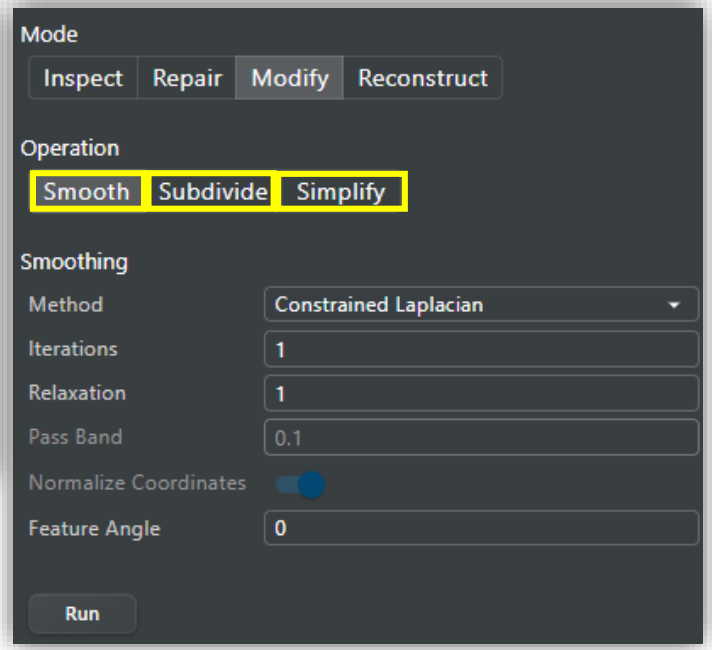
- Mesh Doctor 新增多項網格處理工具
  - ✓ 表面簡化(Simplify Surfaces)
  - ✓ 平滑(Smooth)
  - ✓ 細分(Subdivide)
  - ✓ 網格分離(Separate Meshes)
  - ✓ 網格反轉(Invert Mesh)
  - ✓ 法向量修正(Fix Normals)











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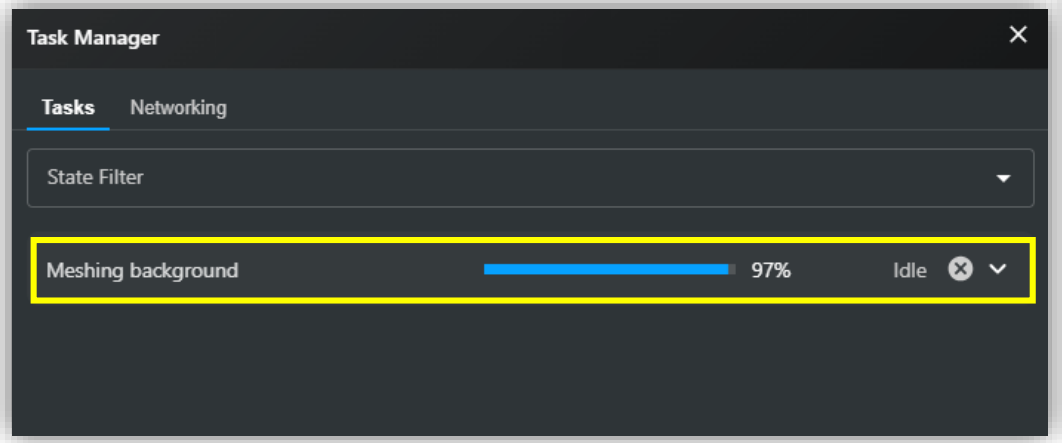
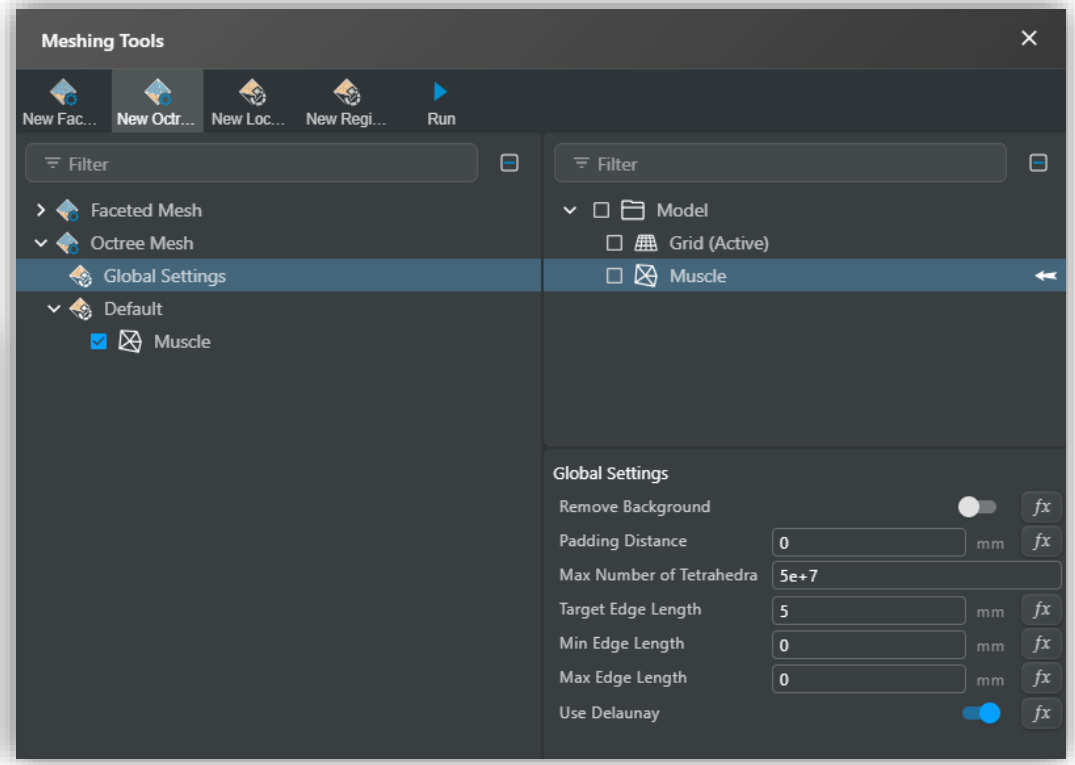
模擬(Simulation)

(3) 網格生成(Meshing)

- 八叉樹網格生成新增進度條
- 加快八叉樹網格生成作業的取消速度
  (網頁版及 V9.6.2 以後的桌面版本)





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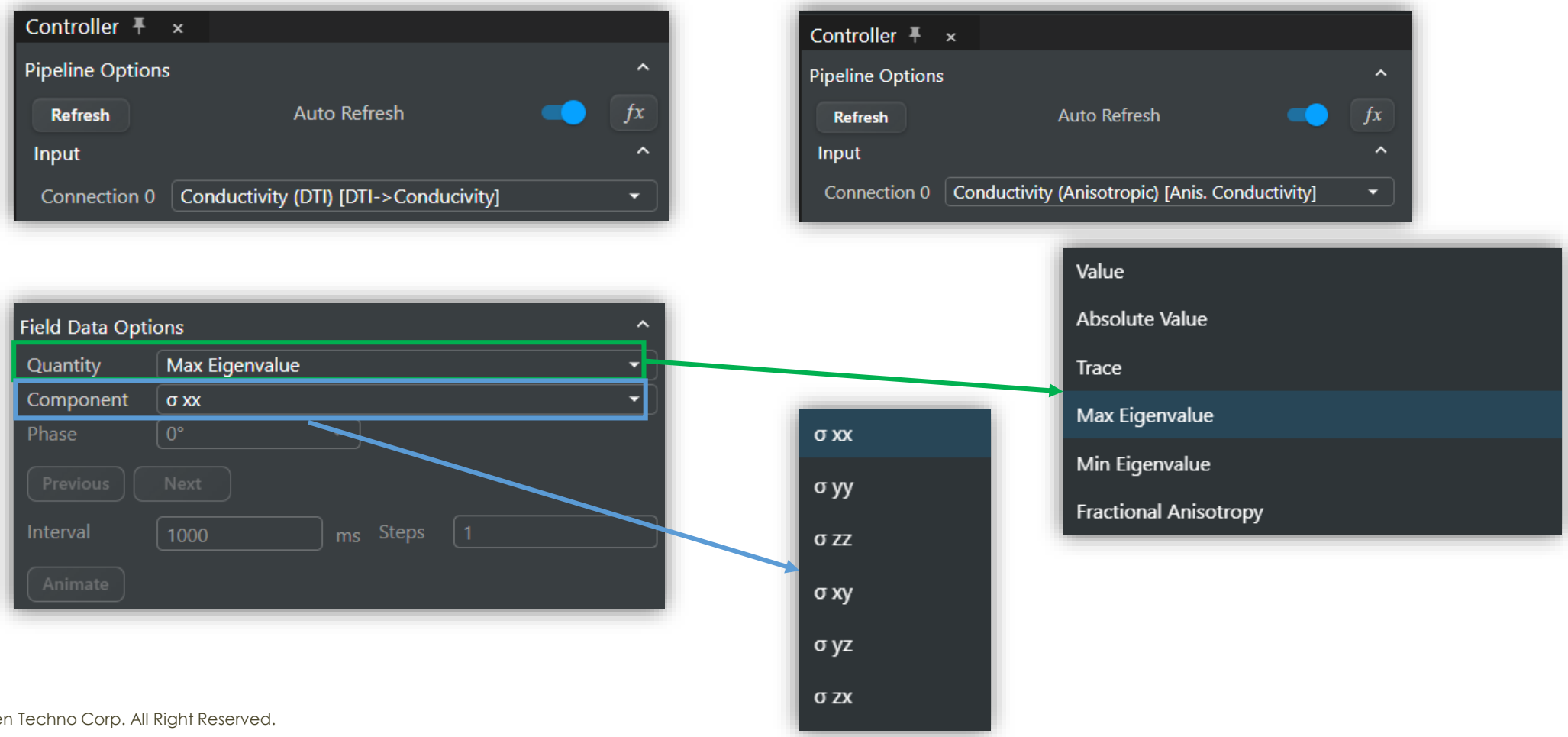
分析(Analysis)

(1) 視圖(Viewers)

- 檢視器新增對稱二階張量(如: DTI 或導電率張量)的特徵值與跡(Trace)等物理量顯示，取代原先的張量分量平方和



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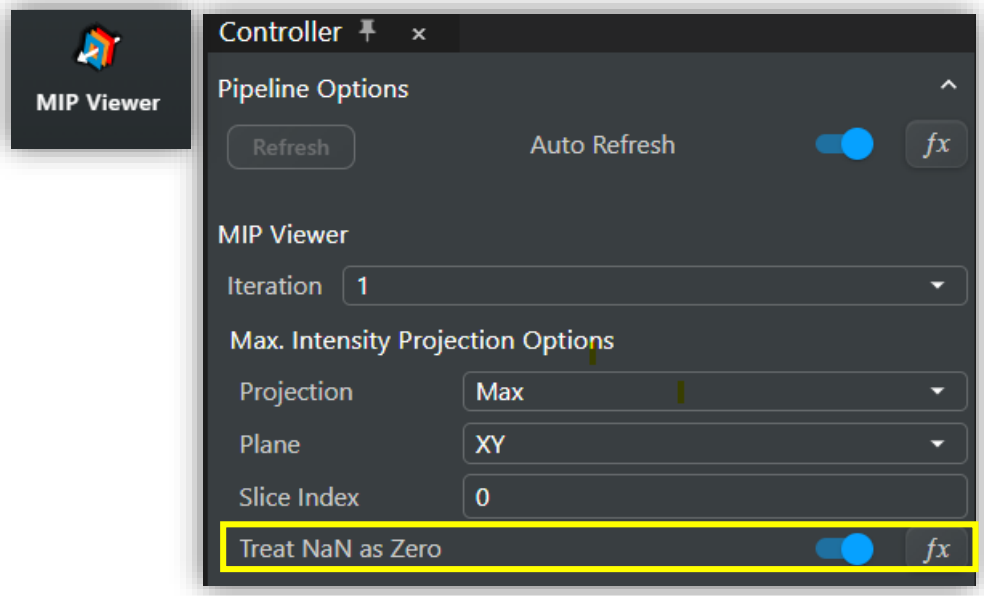
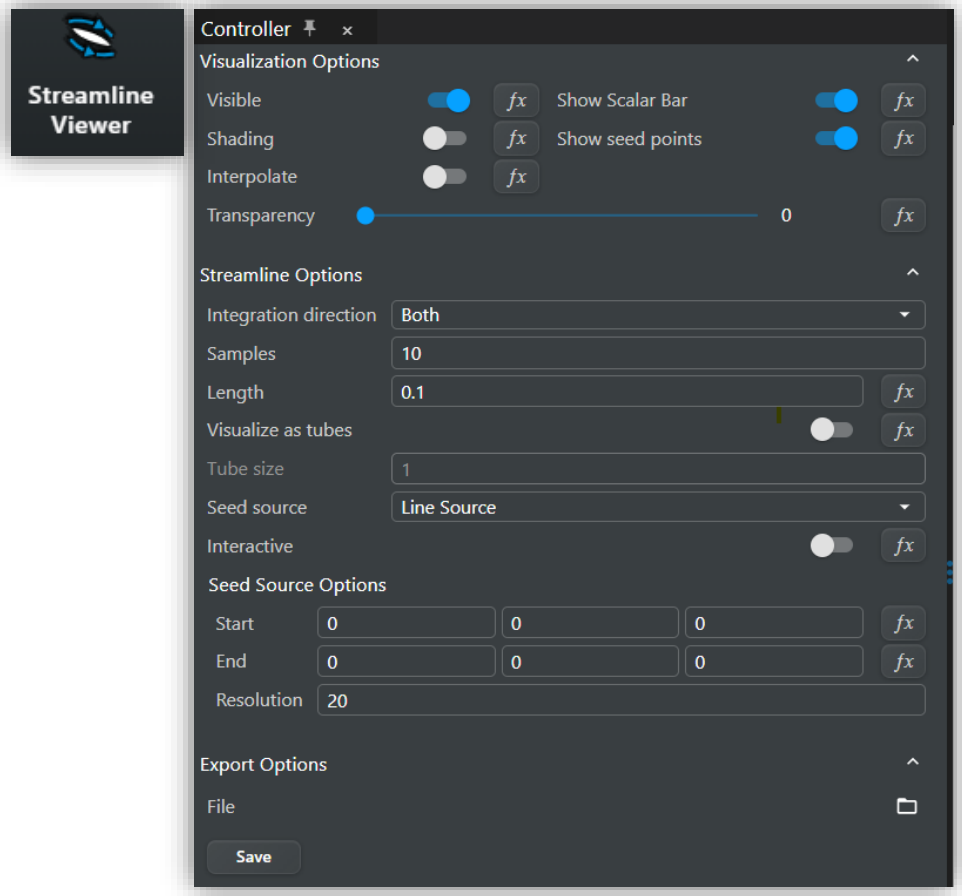
分析(Analysis)

(1) 視圖(Viewers)

- 最大強度投影(Maximum Intensity Projection, MIP)新增 NaN 值處理選項，可選擇保留 NaN 或視為零



- 改善流線檢視器(Streamline Viewer)的功能與效能



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分析(Analysis)

(2) 劑量工具(Dosimetry)

- 擴充並加速 Homogeneous psSAR 評估功能，符合 IEC/IEEE 62704-1 標準

2.16.7.10 Homogeneous psSAR [IEC/IEEE 62704-1 Draft] — Preview

Note

This algorithm is currently only offered as a preview pending finalization from the 62704-1 Joint Working Group.

This tool computes the peak spatial-average SAR for homogeneous phantoms using surface-conforming averaging volumes, per the latest IEC/IEEE 62704-1 draft. It is currently limited to surface evaluation.

Inputs of *Homogeneous psSAR [IEC/IEEE 62704-1 Draft] — Preview*:

- The SAR field as recorded by a field sensor from an *EM FDTD* simulation.
- A Working Coordinate System (WCS) defining the normal at the evaluation location.
- A triangulated surface grid representing the evaluation surface.

Properties of *Homogeneous psSAR [IEC/IEEE 62704-1 Draft] — Preview*:

- **Target mass**: the averaging mass.
- **Sampling step**: the resolution of the sampling cube.
- **Cutoff dB factor**: controls which triangles are used to compute the sSAR by limiting the evaluation to triangles that have local SAR within the specified dB range from the maximum
- **Frequency**: The frequency snapshot from the SAR field for which the averaging is performed

Outputs of *Homogeneous psSAR [IEC/IEEE 62704-1 Draft] — Preview*:

- **Peak Spatial SAR (psSAR) Results**: A summary of the psSAR and peak triangle geometry.
- **SAR on Peak Averaging Cube**: Non-averaged SAR field interpolated onto the peak averaging cube points (as used for the sSAR evaluation).
- **Avg sSAR on surface**: The averaged sSAR field on the evaluation surface. Now that only triangles within the cutoff dB will be displayed.
- **sSAR on surface**: the SAR field interpolated onto the evaluation surface.

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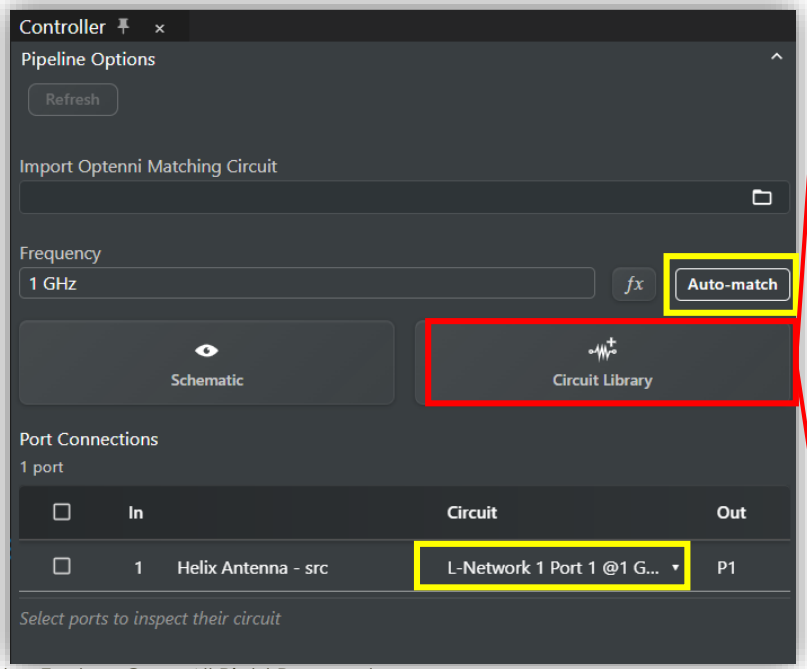
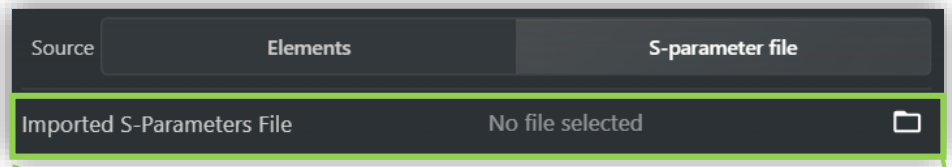
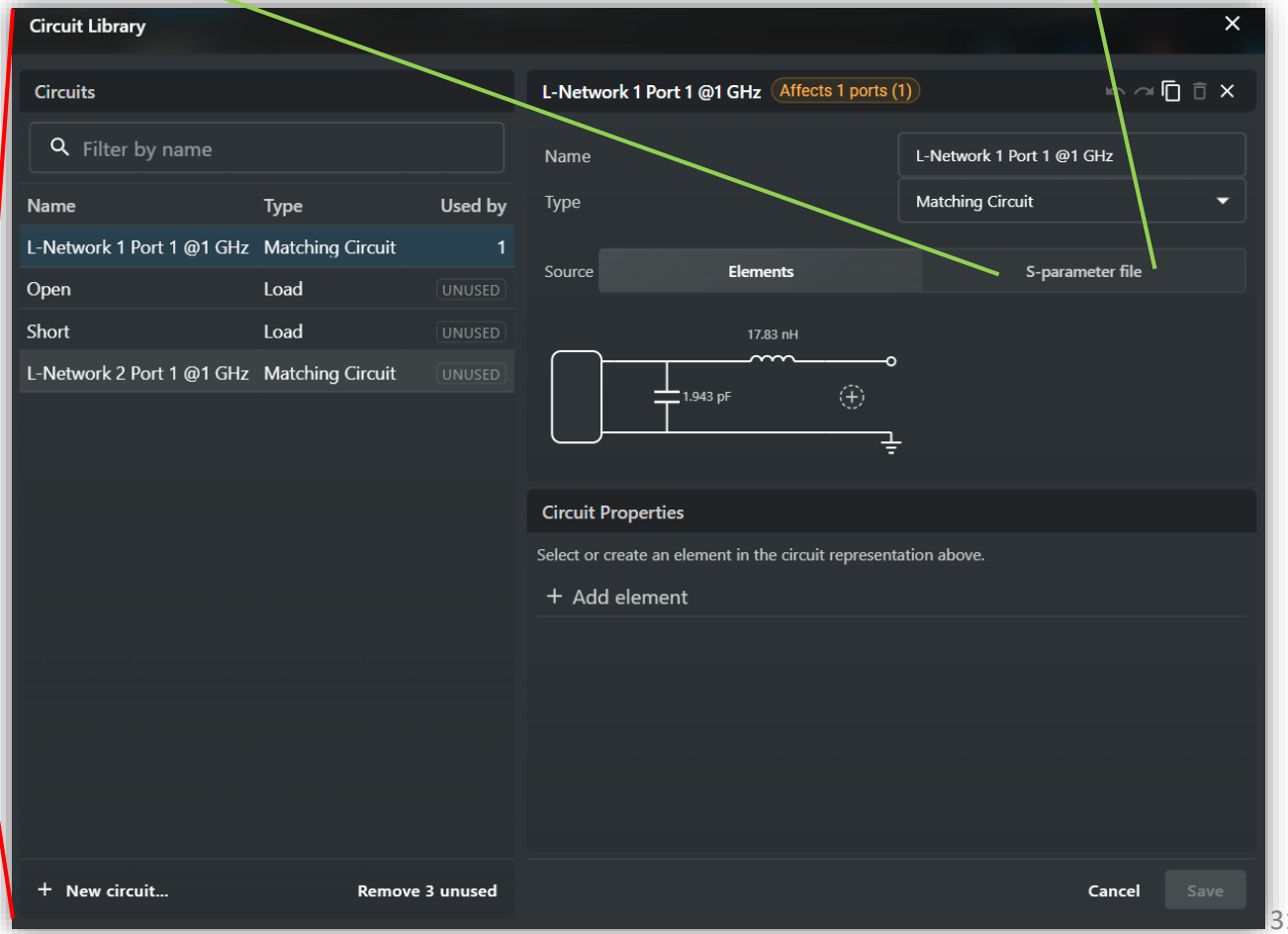
分析(Analysis)

(3) MATCH 電路匹配功能

- 自動匹配(Auto-match)可針對指定頻率下所有未連接的埠，一鍵自動產生匹配電路
- 電路庫(Circuit Library)可方便建立及重複使用負載與多元件匹配電路
- 支援一鍵匯入 Touchstone 檔案中的電路







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Python API

- 可透過 Python API 設定 NIfTI 影像切片的視覺化選項

mod s4l_v1.model.image

s4l model image API

API to the image modeling functionality

Classes:

- `CompositeTransform` – This class represents a sequence of 3d transformations.
- `Image` – This class represents a 3d image, i.e. a stack of image slices.
- `LabelField` – This class represents a 3D label field, i.e. a segmentation of an image into different labels/regions.
- `MetricOptions` – Object which stores the metric settings used by RegisterImages.
- `PyramidOptimizerOptions` – Object which stores the optimizer settings used by RegisterImages.
- `RegistrationOptions` – Object which stores the settings used by RegisterImages.
- `RegistrationStageOptions` – Object which stores the settings used by RegisterImages.
- `TransformOptions` – Object which stores the transform settings used by RegisterImages.
- `eHeadModel` – Enum to select the version of the head model model. 'head16' predicts 16 tissues, head30' predicts 30 tissues, etc.
- `eInterpolation` – Specify interpolation method to use for 'ResampleImage'.
- `eModality` – Enum to the image modality
- `eMorphologicalOperation` – Operation type

Functions:

- `AddLumen` –
- `AddSkin` – Add skin layer inside or outside selected tissue. The layer will be assigned the skin_label and skin_name.
- `BinaryThreshold` – Threshold an image. The background is assigned '0', the foreground is assign '1'.
- `BodyModelGeneration` – Segment trunc/body from medical image. The input image can be either an MRI or a CT image.
- `CopyPasteLabels` – Copy non-zero voxels from source to target. If merge_labels==True,
- `CreateMask` –
- `CropImage` – Crop image to user-specified extent
- `Difference` – Show difference in an image.
- `DistanceTransform` – Compute signed distance transform from specified 'foreground_label'
- `ExtractSurface` – Extract surface model from segmentation.
- `FindIslands` – Create mask image where islands smaller than a 'max_size' are assigned 'island_label'.
- `HeadModelGeneration` – Segment whole head model. The image list should contain either a T1-weighted MRI, or [t1_img, t2_img]. Previous versions can be called via the option 'version'.
- `ImportImage` – Import image from image file format.
- `ImportLabelField` – Import image as LabelField. The iSEG tissue list can be loaded
- `ImportVoxels` – Import voxels as LabelField from raw file with user-specified shape and spacing
- `ImportVoxelsWithDescriptor` – Import voxels as LabelField from raw file and ViP descriptor file
- `InterpolateTo` – Interpolate from a source image to the grid of a reference image.
- `LabelMorphologicalOperation` – Do morphological operation for specific labels in label_field (specified by list of names).
- `LabelVotingOperation` – Use neighborhood voting to re-assign labels. Only changes voxels with foreground value.
- `MapLabelField` –
- `MapLabelFieldToImage` – Map labels to values by providing a functor 'name_value_mapping' with the signature '(string)->float'.
- `MaskImage` – Mask an image provided a labelfield with identical dimensions and functor with
- `NewImageFrom` – Creates a new image or labelfield entity with the same structure, i.e., size, spacing, and transform.
- `PadImage` – Pad the image by specific number of pixels
- `Predict1010SystemLandmarks` – Predict the inion, nasion and pre-auricular points from a T1-weighted MR image.
- `RegisterImages` – Register two images (source and target) and compute a CompositeTransform
- `ResampleImage` – Re-sample an image. The shrink factors are used to scale the image spacing.
- `VoxelSurface` – Voxel surface as 'segmented' region in label field
- `WarpImage` – Given a source image and a CompositeTransform, compute the transformed source image.

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Python API

- 支援透過 Python API 設定非均質各向異性導電率

```
material_settings.ElectricProps.ConductivityAnisotropic = True
material_settings.ElectricProps.ConductivityInhomogeneous = True
material_settings.ElectricProps.ConductivityDataAnisotropic.DataOriginType =
material_settings.ElectricProps.ConductivityDataAnisotropic.DataOriginType.enum.Pipeline
```

```
attr s4l_v1.simulation.emlf.MaterialSettings.ElectricProps property

ElectricProps
```

```
'ConductivityAnisotropic',
'ConductivityAnisotropicProp',
'ConductivityDataAnisotropic',
'ConductivityDataIsotropic',
'ConductivityDiagonalElements',
'ConductivityDiagonalElementsProp',
'ConductivityInhomogeneous',
'ConductivityInhomogeneousProp',
'ConductivityOffDiagonalElements',
'ConductivityOffDiagonalElementsProp',
'ConductivityProp',
```

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效能提升

- 加快模擬運算速度，並提升大型模擬的擴展效能
- 大型專案開啟速度更快，大型結果資料集載入效率提升
- 加速 3D 視覺化渲染，並改善透明效果的呈現精確度

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主要問題修復(桌面版)

(1) 建模

- 修正複雜模型中，巢狀固定模型(Fixed Nested Model)的操作套用錯誤問題
- 修正建立樣條曲線(Spline)時，長度輸入框遮擋控制點捕捉功能的問題。
- 修正複製陰影實體(Shadow Entity)時發生的異常問題(例如: 將其作為參數化實體的輸入，包含 Unite 操作)
- 修正透過 Python API 在 Modeler 中擷取頂點時發生的錯誤
- 修正 ViP 模組中的 SplitWiresByContainment 功能異常
- 開放對實體表面區塊(Body Patches)使用 Edit Faceting (編輯多面化)功能
- 修正部分模型(例如: IXI025、ATHENA)下載失敗的問題

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主要問題修復(桌面版)

(2) 網格劃分(Meshing)

- 修正使用多面化網格劃分工具(Faceted Mesher)時，實體網格生成失敗的問題
- 修正 Mesh Slice 功能產生的三角形尺寸小於預期的問題
- 修正網格檢視器(Mesh Viewer)無法正確套用非結構化網格(Unstructured Mesh)所附帶的座標轉換(Transforms)的問題
- 修正多域網格(Multidomain Mesh)的單位與模型單位不一致的問題

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主要問題修復(桌面版)

(3) 模擬

- 修正透過工作管理員(Task Manager)終止多埠模擬(Multiport Simulation)時，所有連接埠的子工作(Sub-jobs)未同步停止的問題。現在終止模擬時，也會一併停止所有子工作
- 修正迭代式惠更斯模擬(Iterative Huygens Simulation)的設定對話框無法顯示的問題
- 修正 T-Neuro 中 Rat Estimator 的被動響應異常問題
- 在非結構化熱模擬的材料設定中，新增完美熱導體(Perfect Thermal Conductor)選項

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主要問題修復(桌面版)

(4) 後處理分析

- 修正低頻磁場求解器所產生的感應電場向量無法正確顯示的問題
- 修正遮罩篩選器(Mask Filter)計算平均比吸收率(Average SAR)時產生 NaN 結果，以及將已遮罩材料仍納入總質量計算的問題
- 修正停止執行中的均質模型峰值比吸收率(Homogeneous psSAR)評估後，演算法設定遭到鎖定、無法修改的問題
- 修正流線檢視器(Streamline Viewer)忽略頻率快照(Frequency Snapshot)選項，以及在不同檢視器之間複製參數時導顏色條(Colorbar)顯示異常的問題
- 修正 Sim4Life 在檢視器(Viewer)仍處於啟用狀態時關閉程式，可能導致程式當機的問題

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主要問題修復(桌面版)

(5) Python

- 修正 To Python 功能無法區分邊界平面(Boundary Plane)的正向(Plus)與負向(Minus)元件的問題
- 修正透過 Python API 重新命名模型物件後，模擬樹(Simulation Tree)中的名稱未同步更新的問題; 現在重新命名後，模擬樹會自動更新名稱
- 修正 Jupyter Notebook 中的程式碼儲存格執行順序錯亂的問題
- 修正個人化經皮脊髓電刺激(Personalized Transcutaneous Spinal Cord Stimulation)教學範例中缺少檔案的問題

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