ENGLISH VERSION

THE STATE OF THE ART OF THE ELECTROMAGNETIC SIMULATION FOR POWER, GROUNDING AND LIGHTNING PROTECTION SYSTEMS

SINT Ingegneria Srl

IS AN ITALIAN INDEPENDENT COMPANY AND HAS BEEN IN THE FIELD OF THE ENGINEERING DESIGN, SOFTWARE AND CONSULTING SINCE 1993.

AT THE MOMENT IN SINT INGEGNERIA THEY WORK 22 PEOPLE.

MAIN ACTIVITIES:

- DESIGN (ELECTRICAL AND MECHANICAL PLANTS)
- SOFTWARE (XGSLAB)
- CONSULTING (POWER, GROUNDING AND LIGHTNING SYSTEMS)

XGSLAB HISTORY:

- 1995 – 1997 GSA FOR INTERNAL USE (FORTRAN)
- 1997 – 2006 GSA WAS USED FOR CONSULTANCIES ACTIVITY
- 2006 – 2007 GSA COMMERCIAL VERSION (C)
- 2007 – 2011 GSA DIFFUSION IN MANY COUNTRIES
- 2012 – 2013 GSA_FD
- 2014 – 2015 XGSA_FD
- 2015 – 2016 XGSA_TD
- 2017 XGSLAB MULTILAYER
- 2018 – 2019 NETS
- 2020 …

XGSLAB (OR SHORTLY XGS) IS TODAY ONE OF THE MOST POWERFUL SOFTWARE OF ELECTROMAGNETIC SIMULATION FOR POWER, GROUNDING AND LIGHTNING PROTECTION SYSTEMS IN BOTH FREQUENCY AND TIME DOMAIN.

XGS IS USEFUL TO PROTECT HUMAN LIFE (PEOPLE AND WORKERS) AND INSTALLATIONS (PIPELINE AND TELECOMMUNICATION NETWORKS OR BUILDINGS) BUT THE APPLICATION RANGE IS SO WIDE THAN WE DISCOVER UNEXPECTED UTILIZATION.

XGS ESSENTIALLY CAN BE USED TO THE CALCULATION OF:

- GROUNDING SYSTEMS
- CATHODIC PROTECTION SYSTEMS
- ELECTROMAGNETIC FIELDS
- ELECTROMAGNETIC INTERFERENCES
- FAULT CURRENTS DISTRIBUTION
- LIGHTNING PROTECTION SYSTEMS

XGSLab SOFTWARE

IN THE WORLD

XGS COMPETITORS:

- CDEGS® (CANADA)
- CYME® (CANADA)
- ETAP® (USA)
- WinIGS® (USA)
- SKM® (USA)
- ELEK® (AUSTRALIA)

XGS IS THE ONLY TOOL MADE IN EUROPE.

CDEGS® IS THE ONLY TOOL COMPARABLE WITH XGS.

XGSLab SOFTWARE

XGS MODULES:

- GSA 

- GSA_FD 

- XGSA_FD 

- XGSA_TD 

- NETS 

- SRA (AUX)
- FA (AUX)

DATA ENTRY:

- REFERENCE STANDARD
- SOIL MODEL
- LAYOUT
- ENERGIZATION

REFERENCE STANDARD

XGS TAKES INTO ACCOUNT THE FOLLOWING STANDARDS:

- IEC STANDARD: IEC/TS 60479-1:2005 (EXPIRED)
- IEC STANDARD: IEC/TS 60479-1:2018
- EUROPEAN STANDARD: HD 637 S1:1999 (EXPIRED)
- EUROPEAN STANDARD: EN 50522:2010
- USA STANDARD: IEEE STD 80-2000 (EXPIRED)
- USA STANDARD: IEEE STD 80-2013

THE IEC STANDARDS ARE THE REFERENCE FOR MANY NATIONAL STANDARDS.

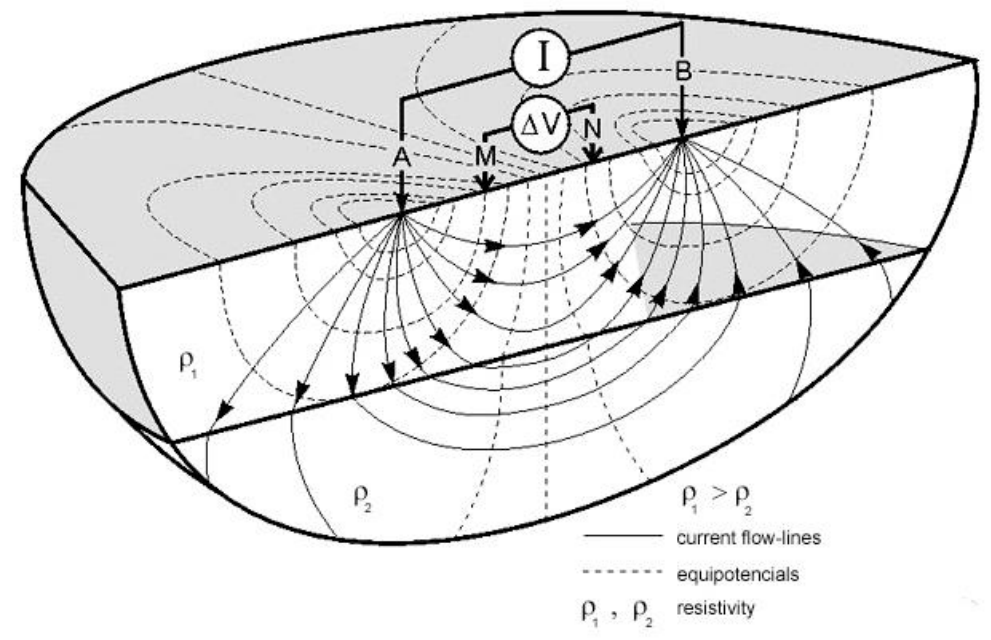
THE EN STANDARDS ARE USED IN MOST EUROPEAN COUNTRIES AND ACCEPTED IN SOME EXTRA EUROPE COUNTRIES (AS AFRICA AND FAR EAST).

THE IEEE STANDARDS ARE WIDELY USED IN USA AND ADOPTED IN SEVERAL OTHER COUNTRIES (AS IN SOUTH AMERICA, IN THE MIDDLE EAST AND AUSTRALIA). THEN XGS MAY BE USED IN MOST COUNTRIES OF THE WORLD.

SOIL MODELS

XGS SUPPORTS THE FOLLOWING SOIL MODELS:

- UNIFORM SOIL MODEL
- MULTILAYER SOIL MODEL
- MULTIZONE SOIL MODEL
- PRESENCE OF A THIN SURFACE MATERIAL LAYER



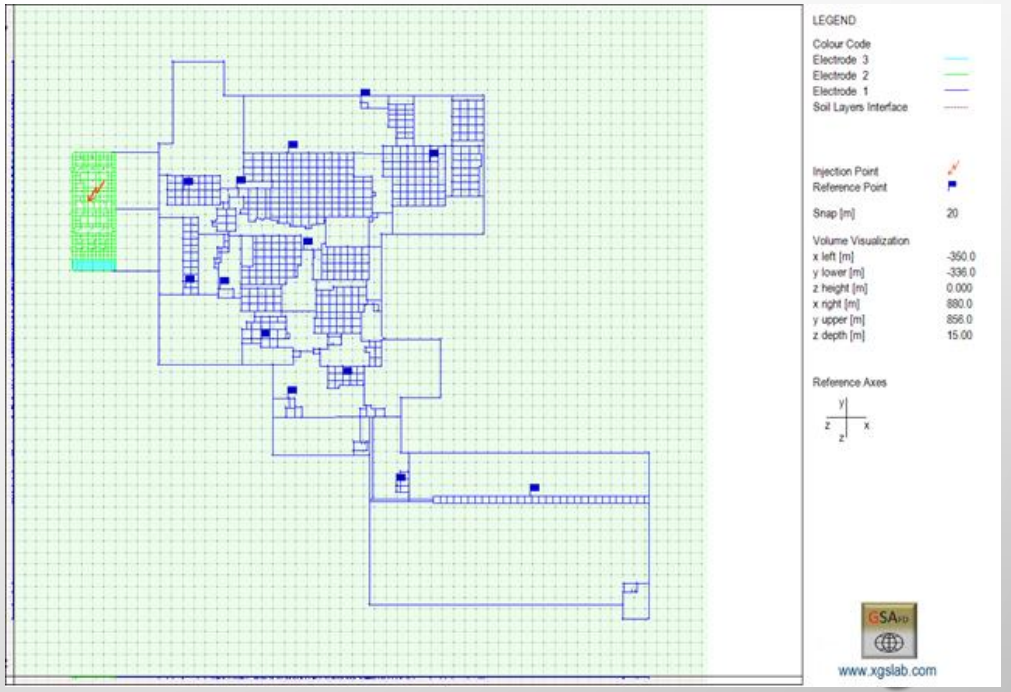
THE PARAMETERS OF THE SOIL MODEL CAN BE OBTAINED FROM THE SOIL RESISTIVITY MEASURES WITH WENNER AND SCHLUNBERGER METHODS.

LAYOUT

LAYOUT DATA INCLUDES ALL THE GEOMETRICAL AND PHYSICAL DATA OF THE CONDUCTORS NETWORK AND THEN:

- POSITION
- CONNECTIONS (*)
- PARTITION
- OUTER DIAMETER, CROSS SECTION AND COVERING THICKNESS
- MATERIALS PROPERTIES OF CONDUCTOR AND COVERING (*)

(*) EXCLUDED GSA



ENERGIZATION

- GSA REQUIRES ONLY THE INJECTION CURRENTS. IT IS NOT REQUIRED TO SPECIFY THE POSITION WHERE THE CURRENT ENTERS THE ELECTRODES BECAUSE GSA DOES NOT TAKE INTO ACCOUNT THE LONGITUDINAL CURRENT.
- GSA_FD REQUIRES INJECTION CURRENTS AND INJECTION POINT. MORE INJECTION POINTS FOR EACH ELECTRODE CAN BE TAKEN INTO ACCOUNT.
- IN BOTH CASES INJECTED CURRENT HAS TO BE SPECIFIED AS MAGNITUDE AND PHASE VALUES.

RESULTS AFTER MAIN CALCULATION

THE FOLLOWING RESULTS ARE AVAILABLE AFTER THE MAIN CALCULATION:

- GPR AND EARTHING IMPEDANCE (ALL MODULES)
- LEAKAGE CURRENTS DISTRIBUTION (ALL MODULES)
- POTENTIAL DISTRIBUTION (ONLY GSA_FD AND XGSA_FD)
- LONGITUDINAL CURRENTS DISTRIBUTION (ONLY GSA_FD AND XGSA_FD)
- ELECTROMOTIVE FORCE DISTRIBUTION (ONLY XGSA_FD)
- COVERING STRESS VOLTAGE DISTRIBUTION (ONLY XGSA_FD)
- COMPLEX POWER DISTRIBUTION (ONLY XGSA_FD)

RESULTS AFTER POST PROCESSING

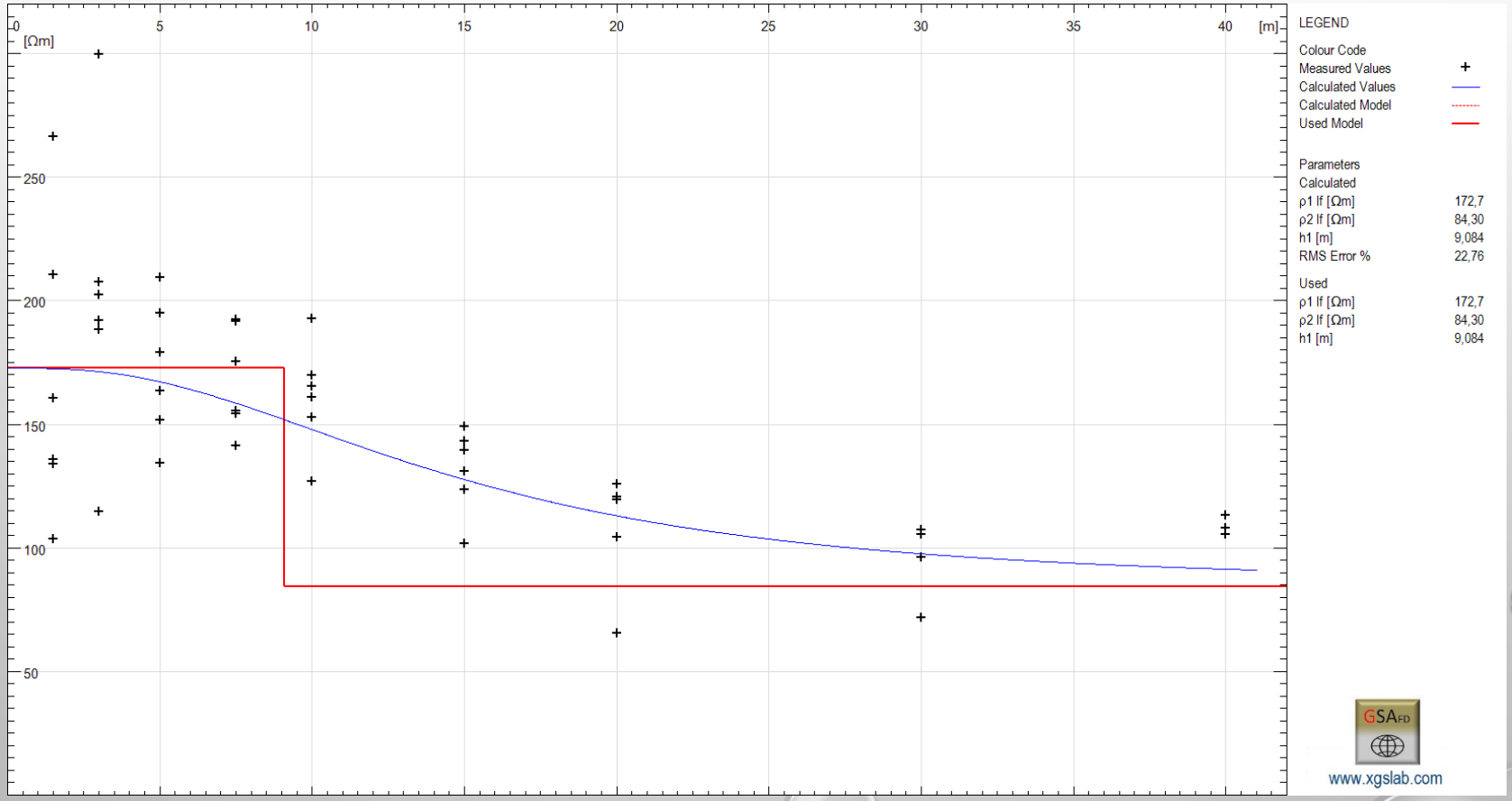
WITH A POST PROCESSING CALCULATIONS FOLLOWING ADDITIONAL RESULTS CAN BE OBTAINED:

- POTENTIAL DISTRIBUTION (ALL MODULES)
- TOUCH AND STEP VOLTAGES DISTRIBUTION (ALL MODULES)
- MAGNETIC FIELD DISTRIBUTION (ONLY GSA_FD AND XGSA_FD)
- ELECTRIC FIELD DISTRIBUTION (ONLY XGSA_FD)

THESE DISTRIBUTIONS CAN BE CALCULATED ALONG LINES OR ON AREAS.

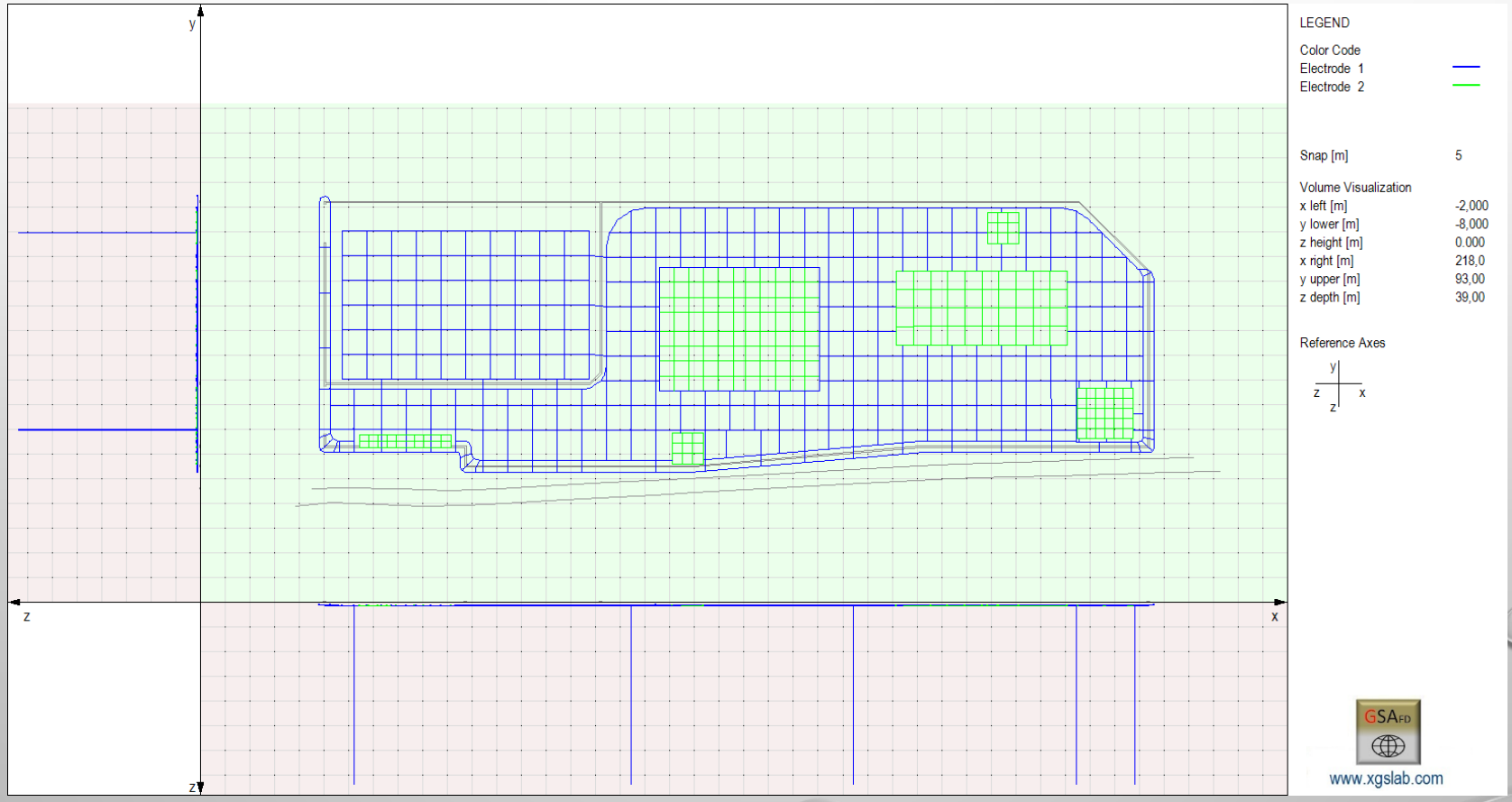
CASE A - SUBSTATION

Vn = 132 kV - If = 21 kA - tf = 0.5 s – EN 50522 Std
DOUBLE LAYER SOIL MODEL



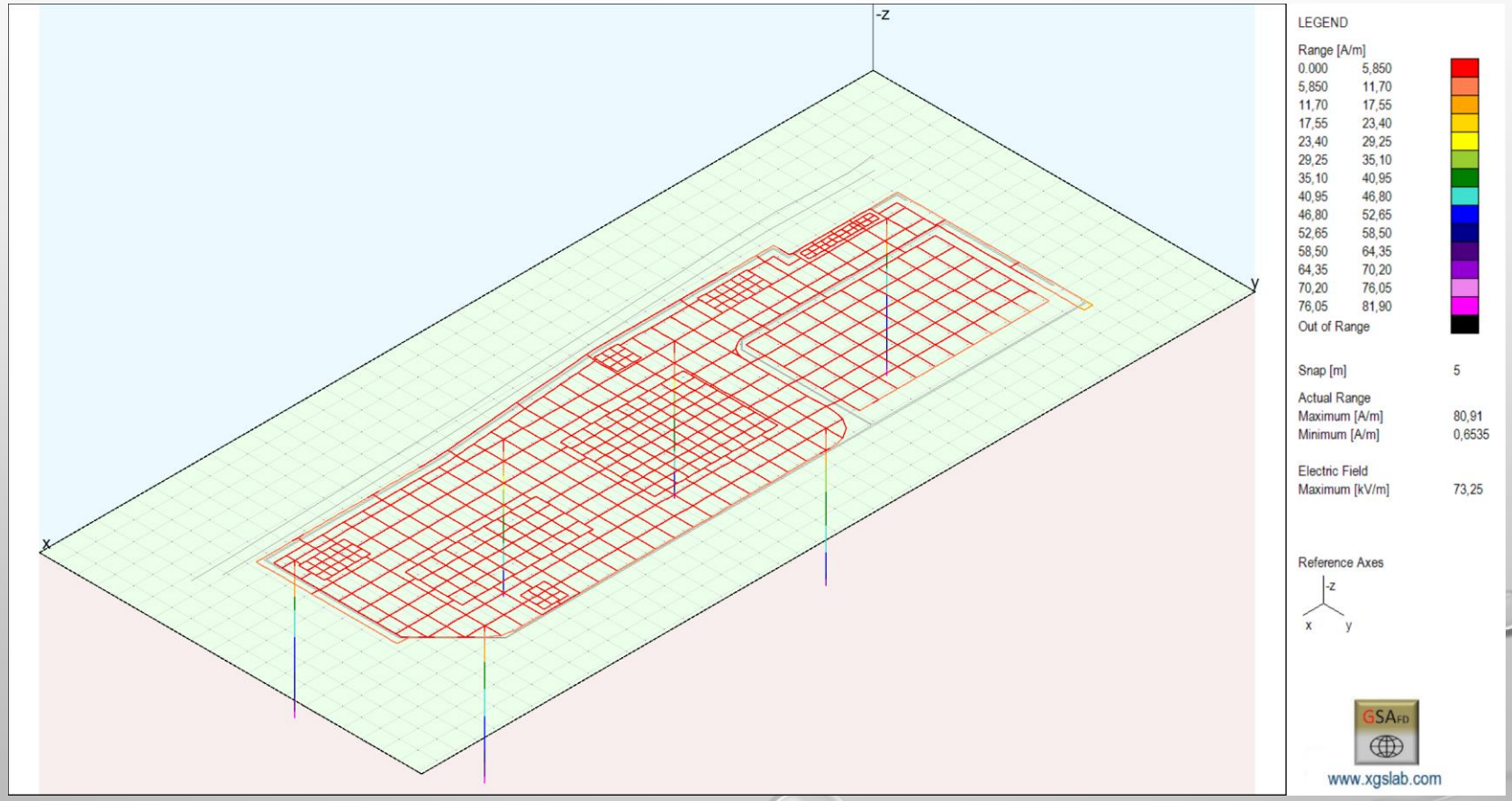
CASE A - SUBSTATION

GENERAL LAYOUT – BLUE INTENTIONAL, GREEN FOUNDATIONS



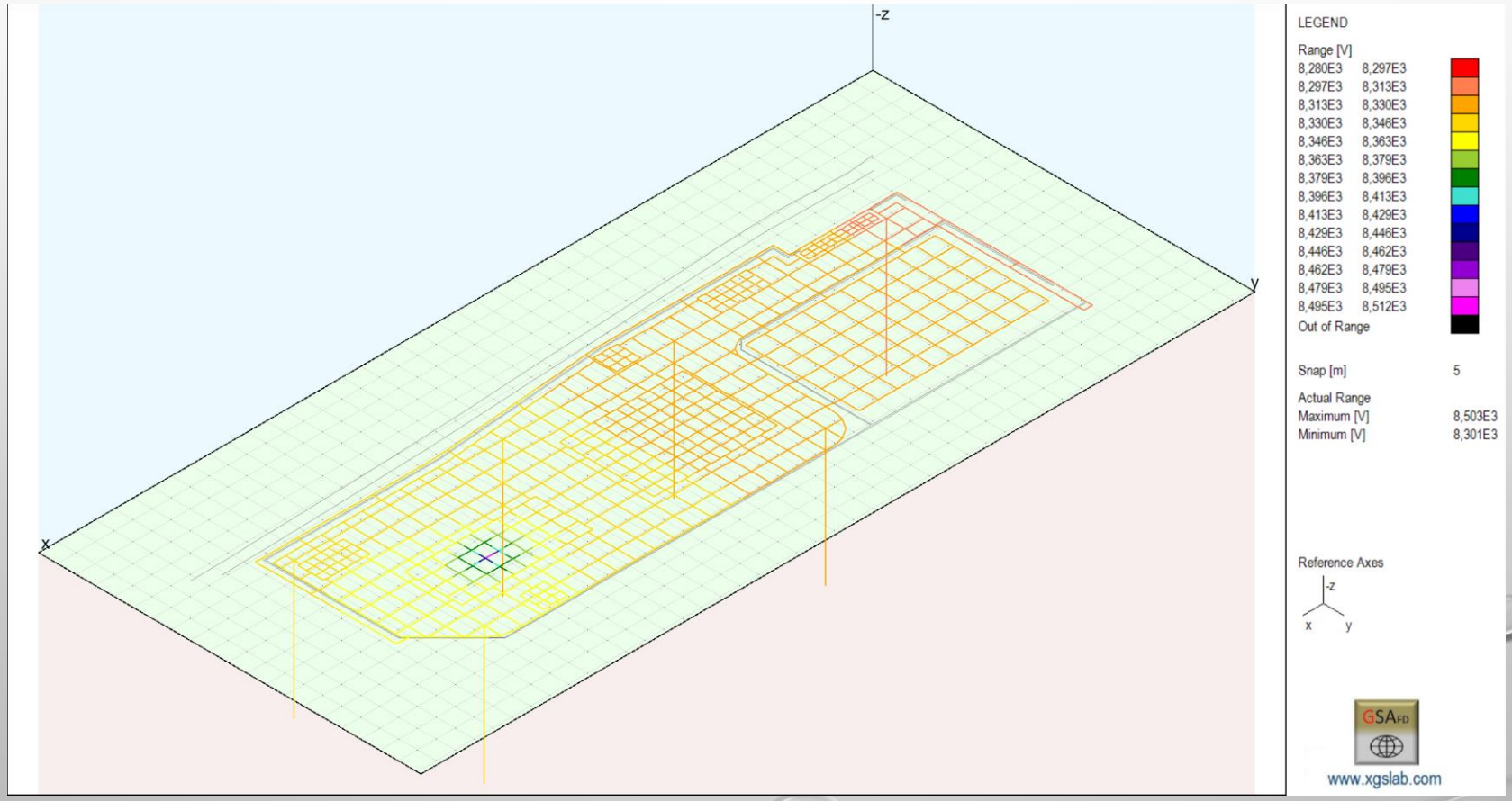
CASE A - SUBSTATION

SUBSTATION – LEAKAGE CURRENT DISTRIBUTION



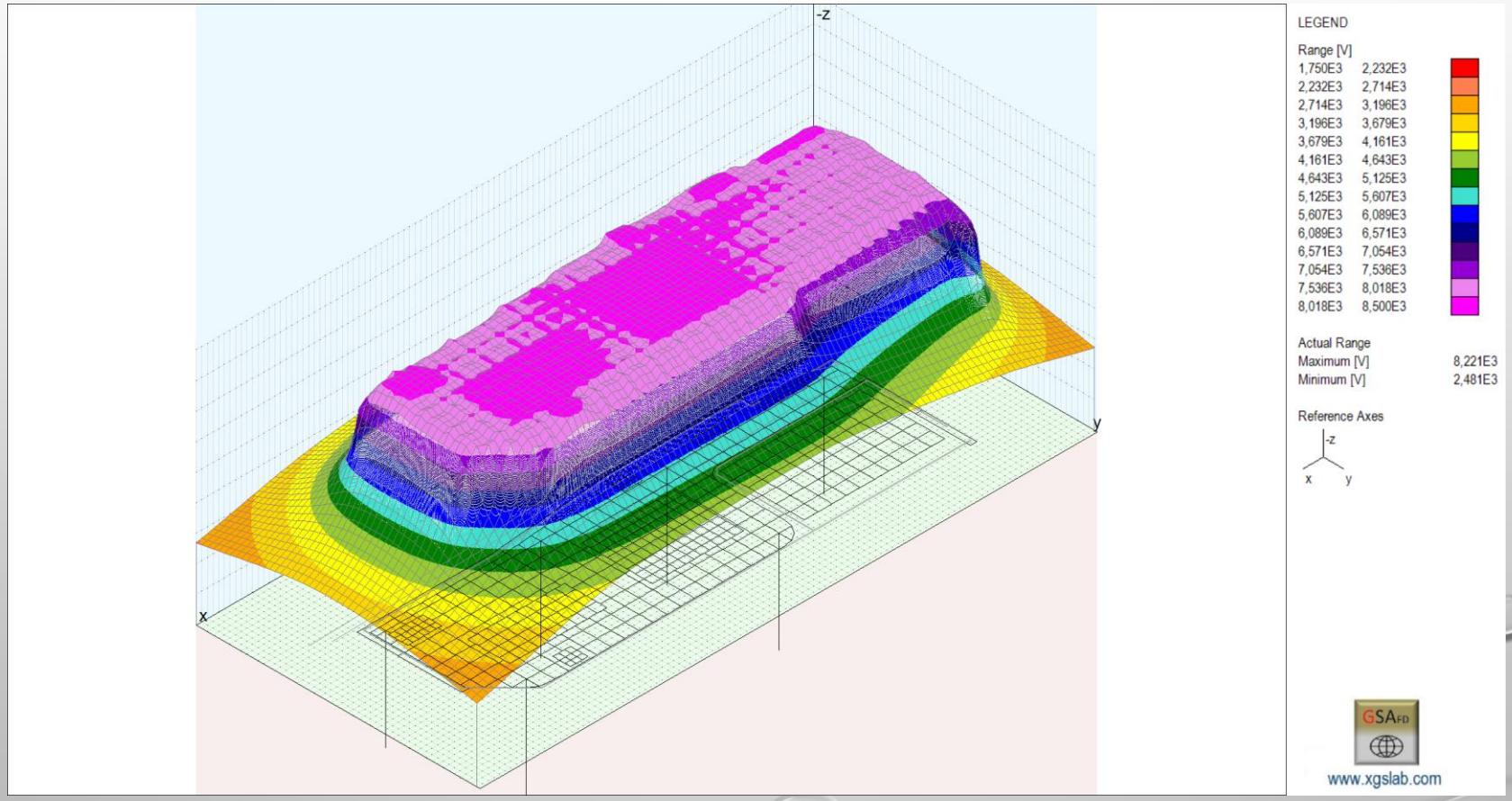
CASE A - SUBSTATION

SUBSTATION – POTENTIAL DISTRIBUTION



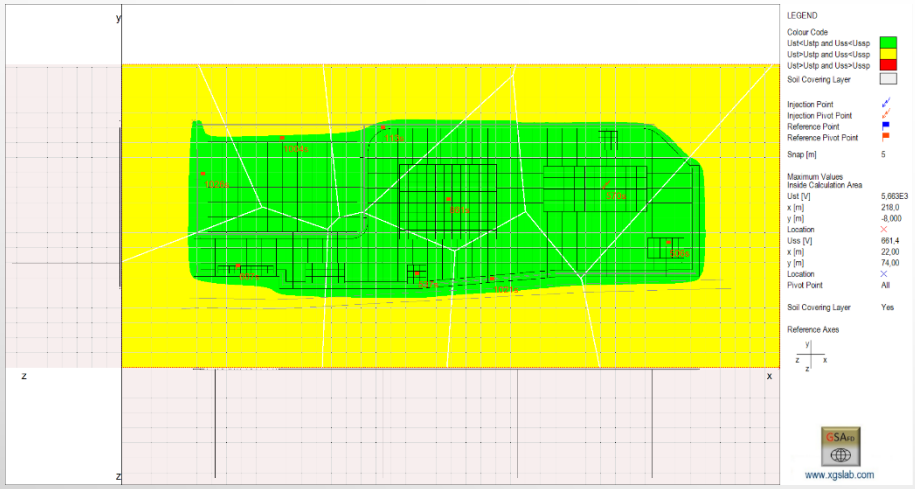
CASE A - SUBSTATION

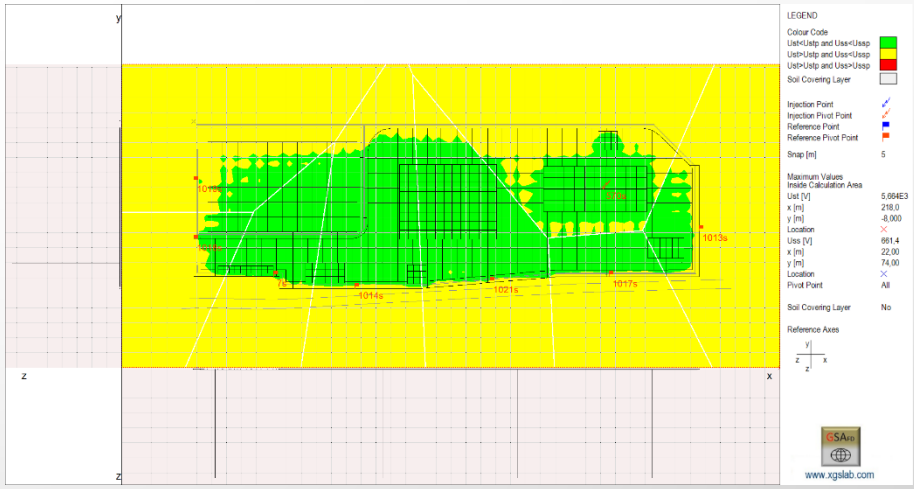
SUBSTATION – EARTH SURFACE POTENTIAL DISTRIBUTION

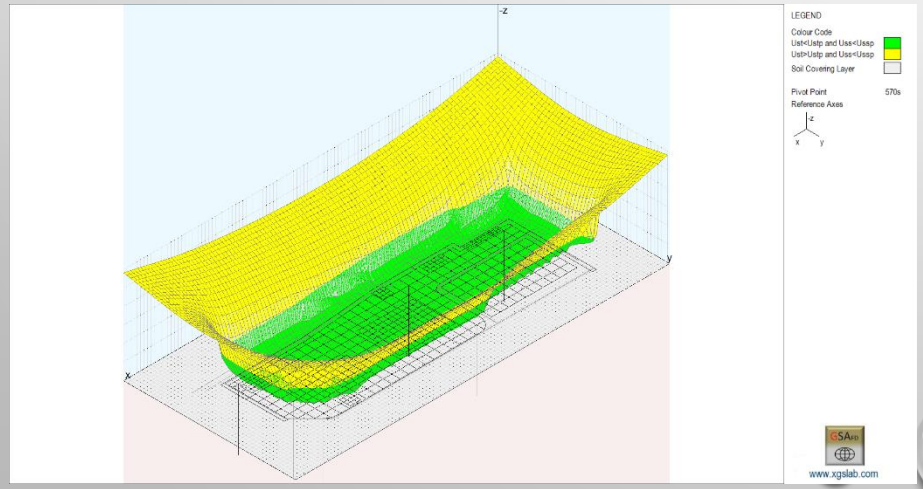


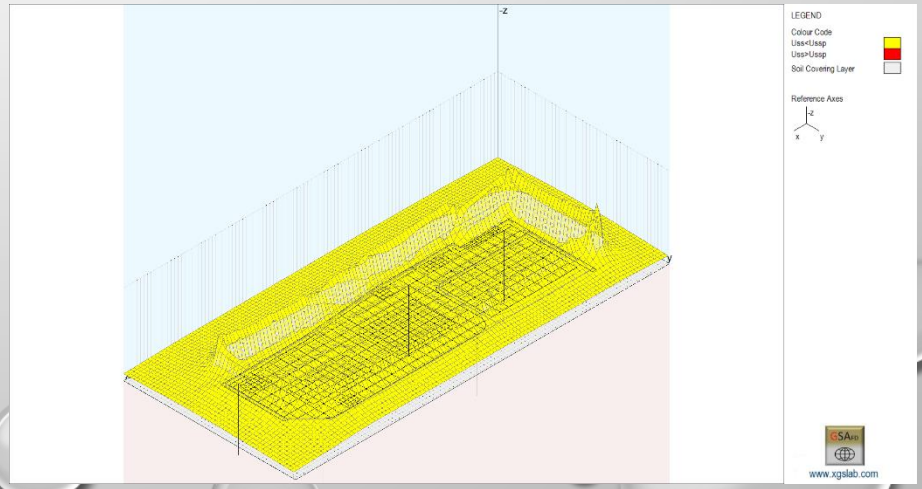
CASE A - SUBSTATION

SUBSTATION – TOUCH AND STEP VOLTAGES WITH/WITHOUT GRAVEL (5x5 m)



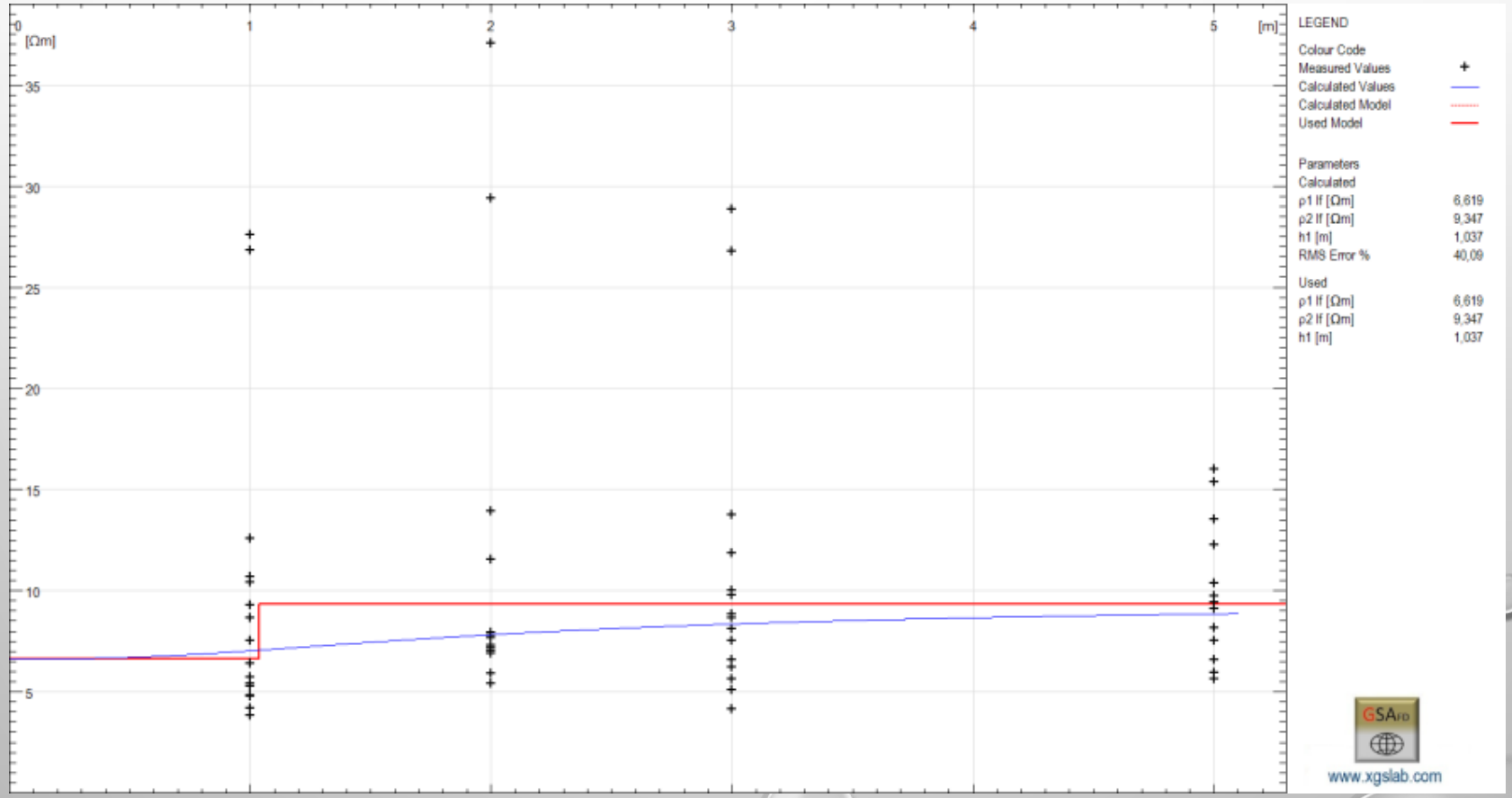






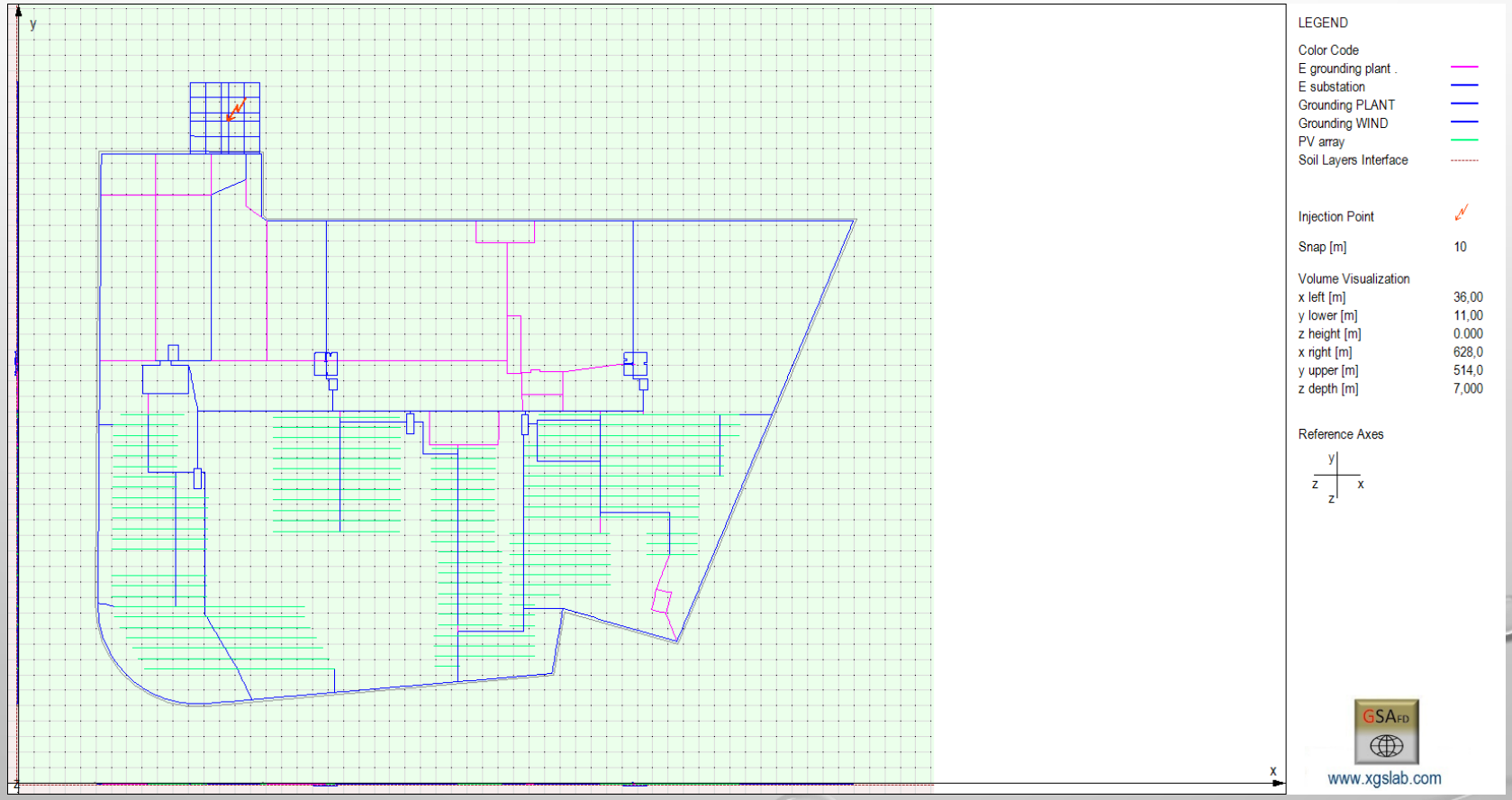
CASE B – PV+W POWER PLANT

Vn = 66 kV - If = 25 kA - tf = 1.0 s – EN 50522 Std.
DOUBLE LAYER SOIL MODEL



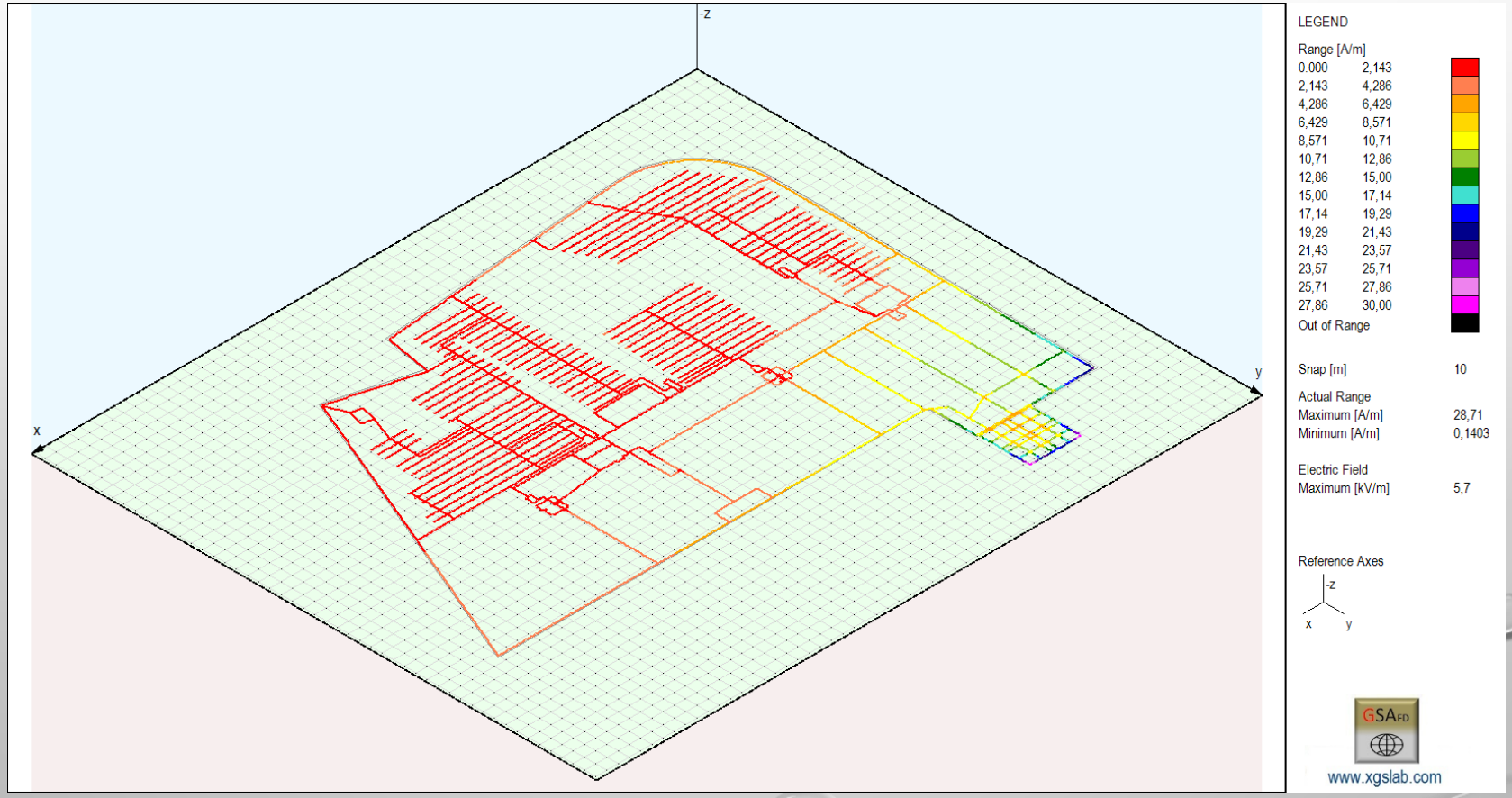
CASE B – PV+W POWER PLANT

GENERAL LAYOUT – BLUE + PINK INTENTIONAL, GREEN FOUNDATIONS



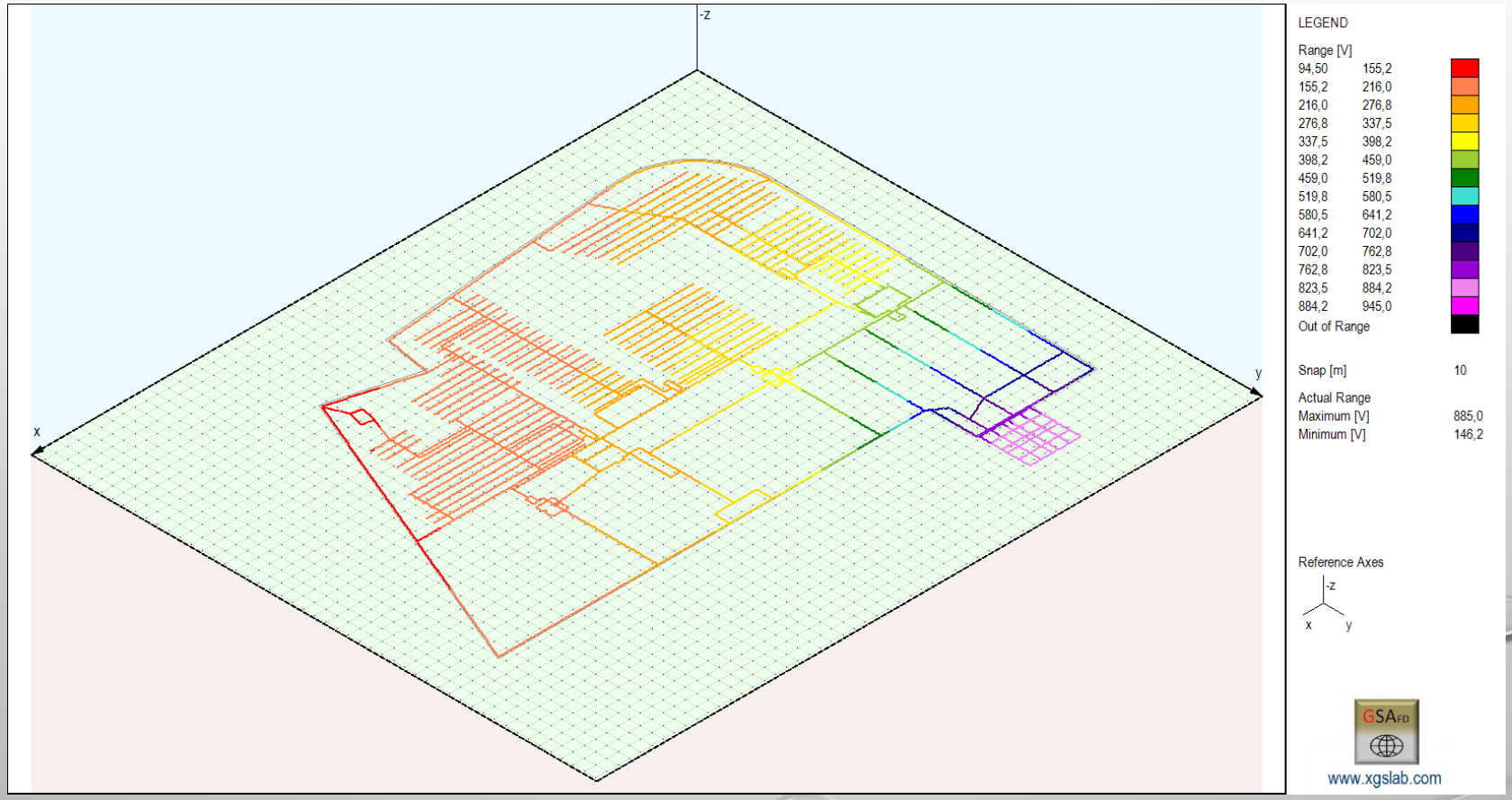
CASE B – PV+W POWER PLANT

SUBSTATION – LEAKAGE CURRENT DISTRIBUTION



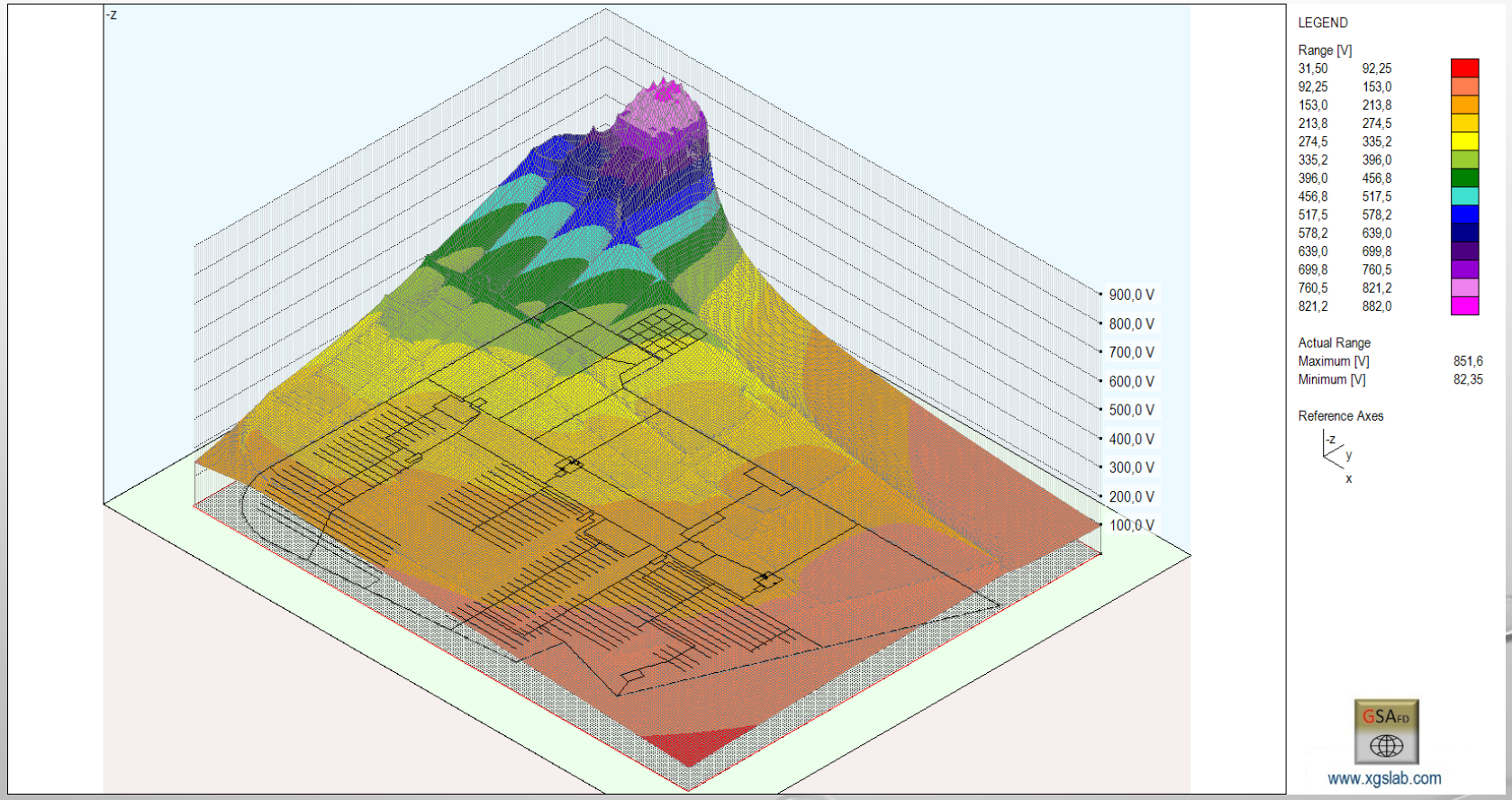
CASE B – PV+W POWER PLANT

SUBSTATION – POTENTIAL DISTRIBUTION



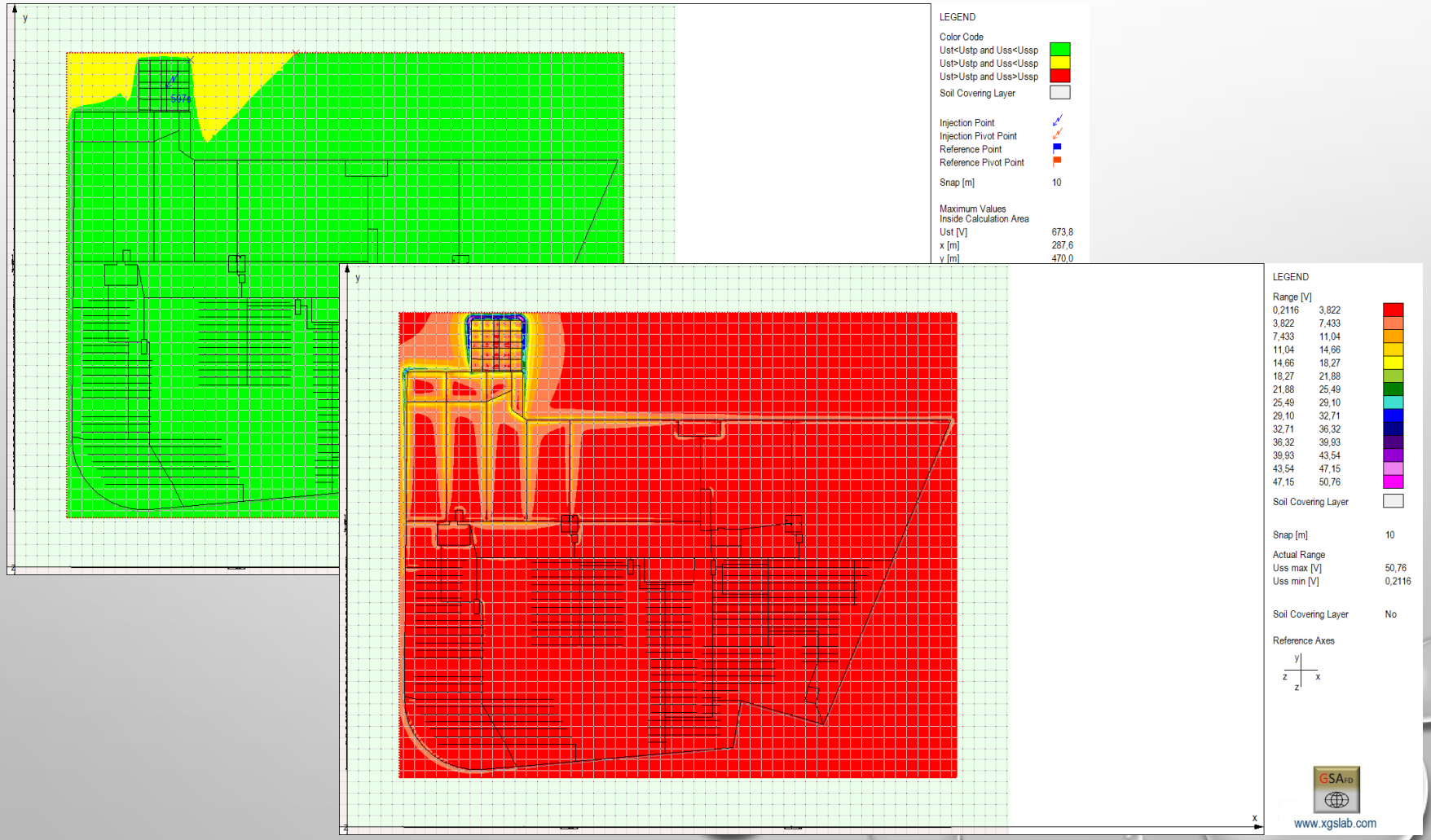
CASE B – PV+W POWER PLANT

SUBSTATION – EARTH SURFACE POTENTIAL DISTRIBUTION



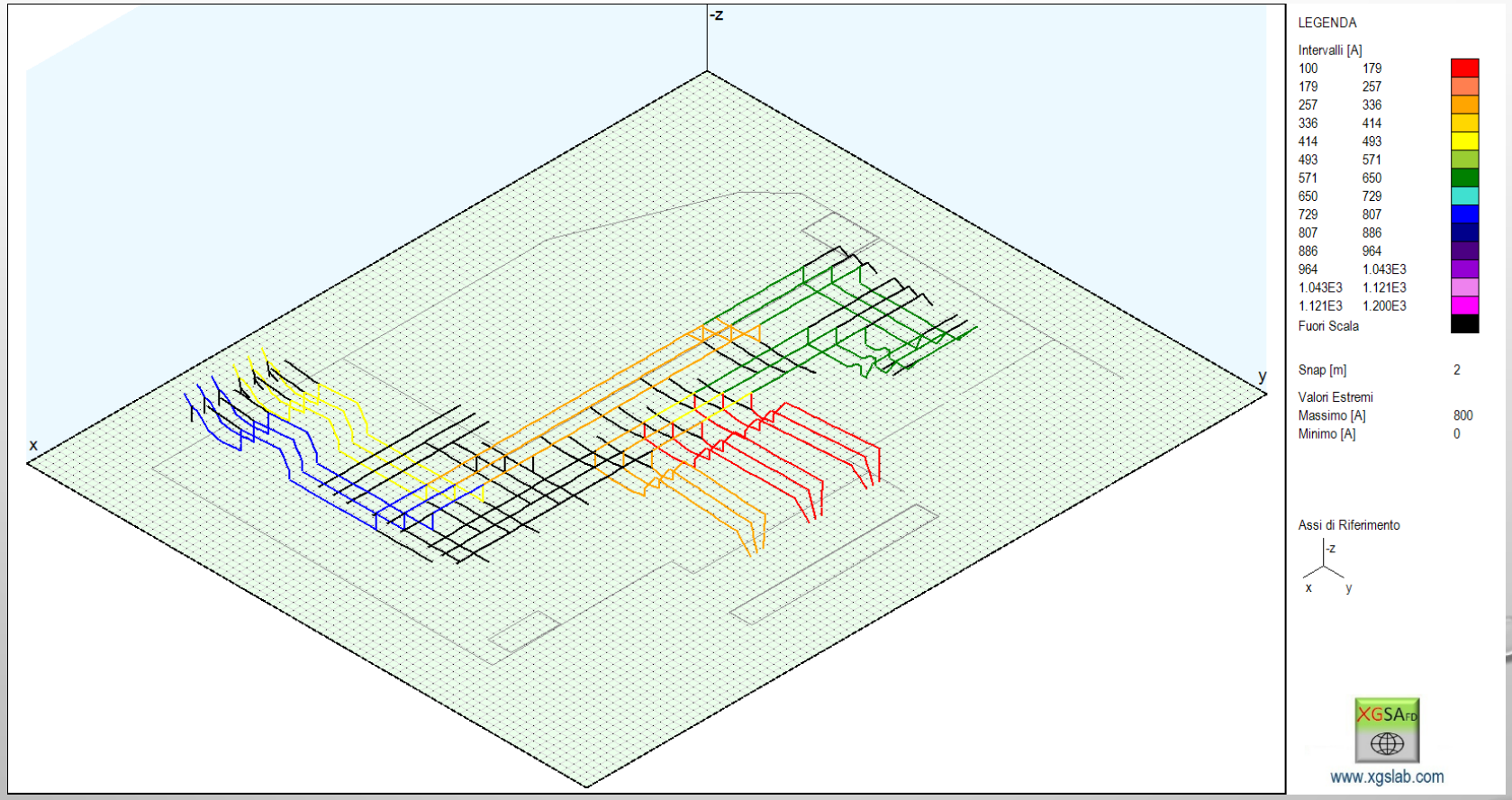
CASE B – PV+W POWER PLANT

SUBSTATION – TOUCH AND STEP VOLTAGES WITHOUT GRAVEL (5 X 5 m)



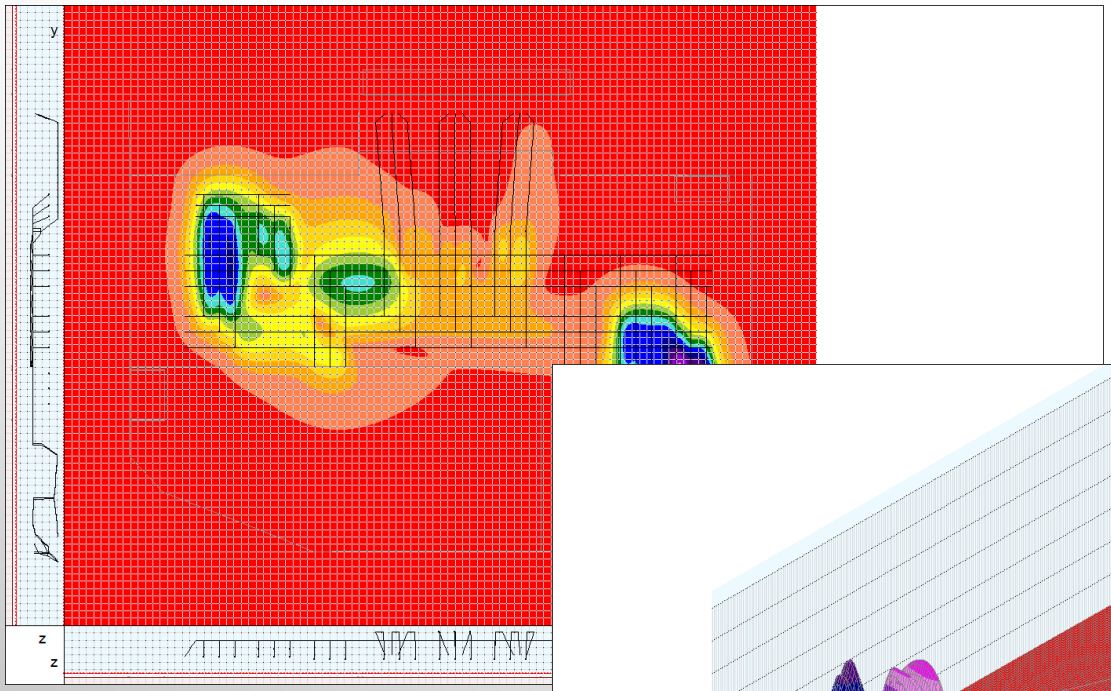
CASE C – EM FIELDS

Substation – Longitudinal current distribution



CASE C – EM FIELDS

SUBSTATION – MAGNETIC FIELD



LEGENDA

Intervalli [µT]

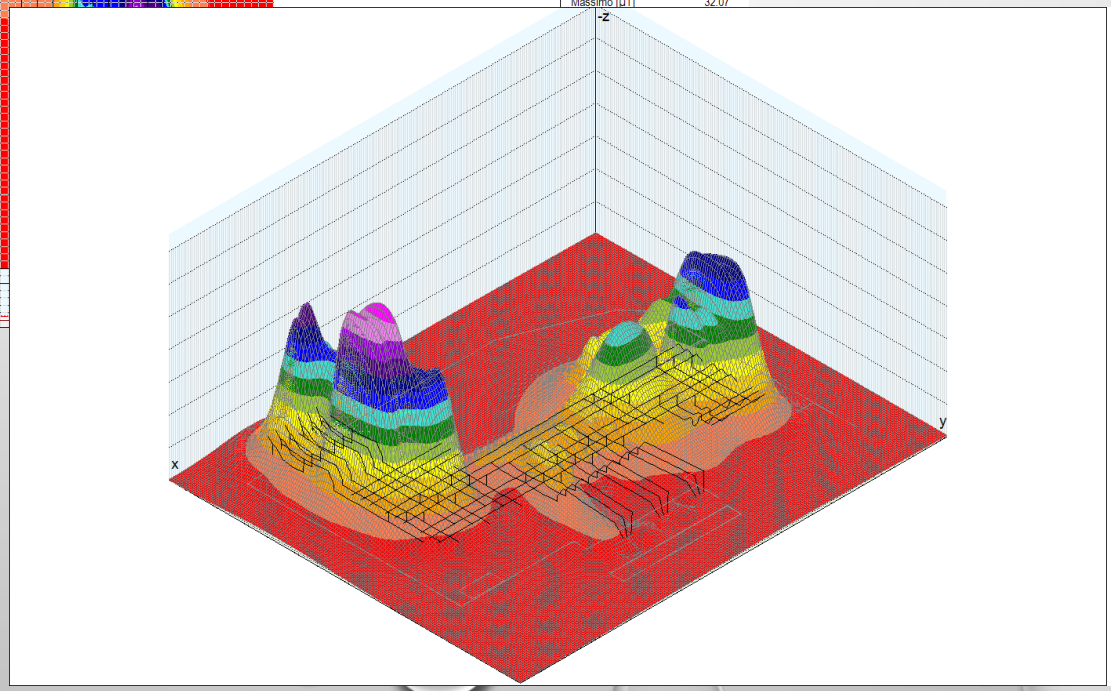
0	2.5
2.5	5
5	7.5
7.5	10
10	12.5
12.5	15
15	17.5
17.5	20
20	22.5
22.5	25
25	27.5
27.5	30
30	32.5
32.5	35

Superficie del suolo

Snap [m] 2

Valori Estremi

Massimo [µT] 32.07



LEGENDA

Intervalli [µT]

0	2.321
2.321	4.643
4.643	6.964
6.964	9.286
9.286	11.61
11.61	13.93
13.93	16.25
16.25	18.57
18.57	20.89
20.89	23.21
23.21	25.54
25.54	27.86
27.86	30.18
30.18	32.5

Valori Estremi

Massimo [µT] 32.07

Minimo [µT] 3.147E-2

Z calcolo [m] -1

Solo Normale No

Assi di Riferimento

-z
x y

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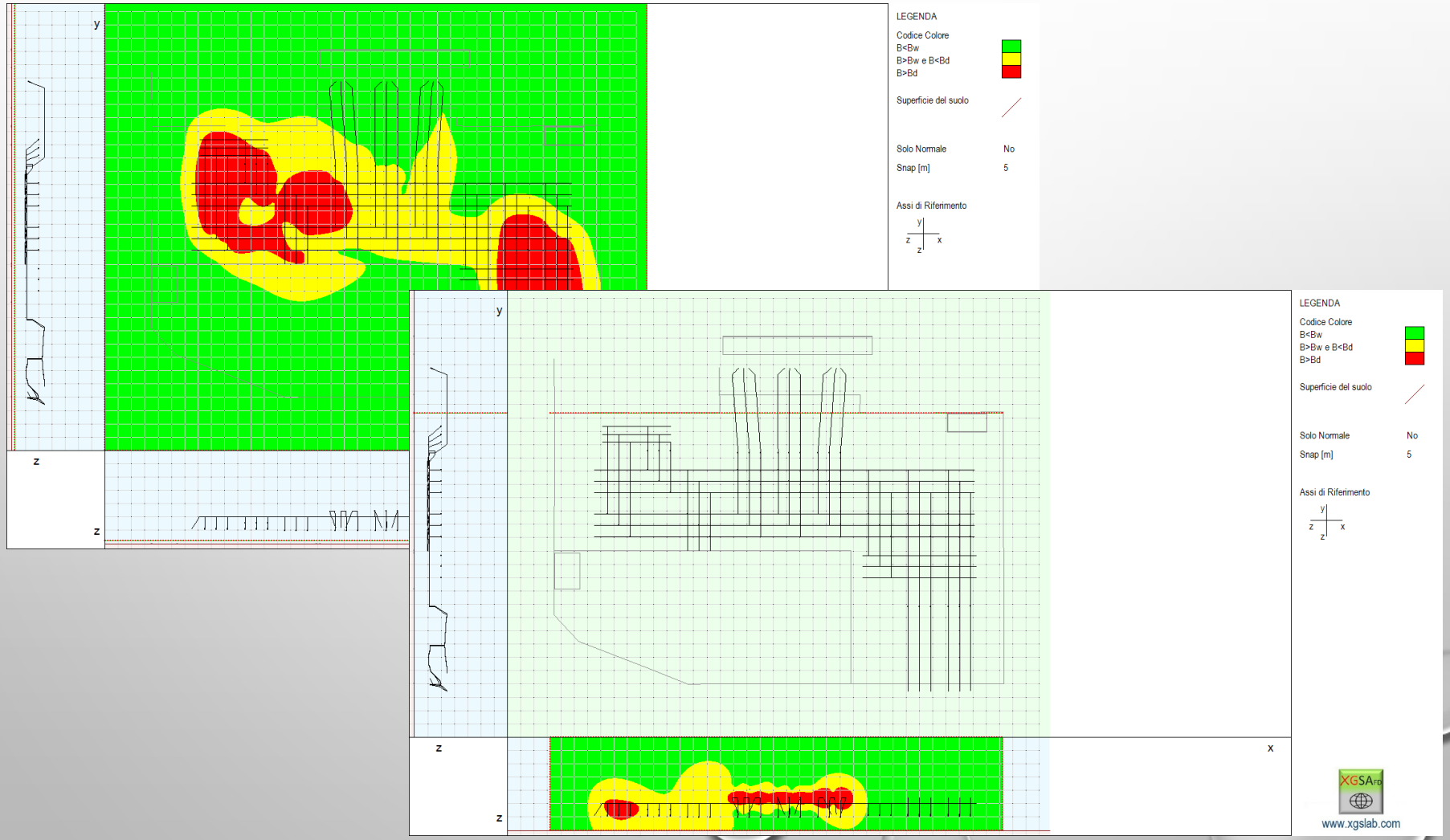
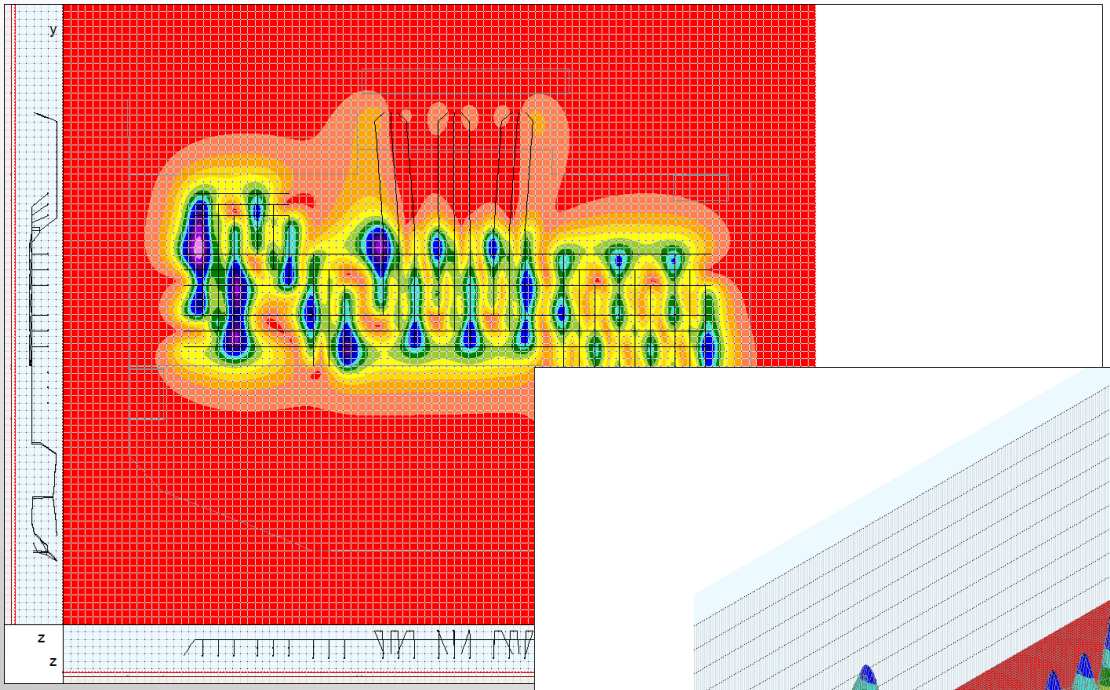
CASE C – EM FIELDS

SUBSTATION – MAGNETIC FIELD SAFE AREAS



CASE C – EM FIELDS

SUBSTATION – ELECTRIC FIELD



LEGENDA

Intervalli [V/m]

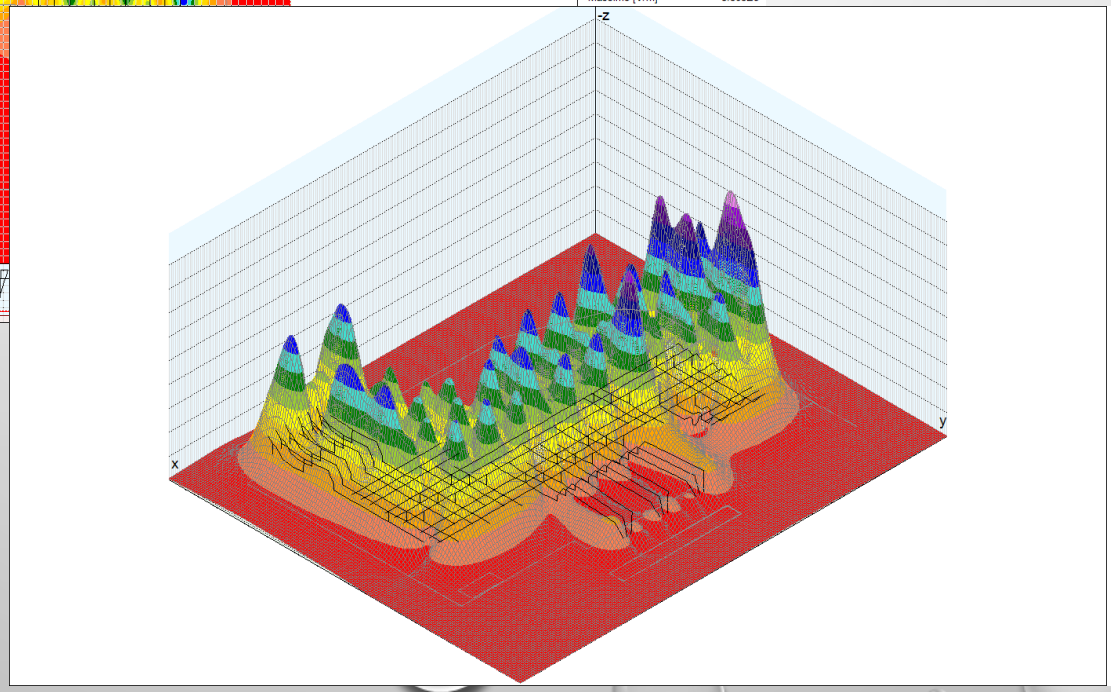
0	685.7
685.7	1.371E3
1.371E3	2.057E3
2.057E3	2.743E3
2.743E3	3.429E3
3.429E3	4.114E3
4.114E3	4.800E3
4.800E3	5.486E3
5.486E3	6.171E3
6.171E3	6.857E3
6.857E3	7.543E3
7.543E3	8.229E3
8.229E3	8.914E3
8.914E3	9.600E3

Superficie del suolo

Snap [m] 2

Valori Estremi

Massimo [V/m] 8.808E3



LEGENDA

Intervalli [V/m]

0	685.7
685.7	1.371E3
1.371E3	2.057E3
2.057E3	2.743E3
2.743E3	3.429E3
3.429E3	4.114E3
4.114E3	4.800E3
4.800E3	5.486E3
5.486E3	6.171E3
6.171E3	6.857E3
6.857E3	7.543E3
7.543E3	8.229E3
8.229E3	8.914E3
8.914E3	9.600E3

Valori Estremi

Massimo [V/m] 8.81

Minimo [V/m] 6.45

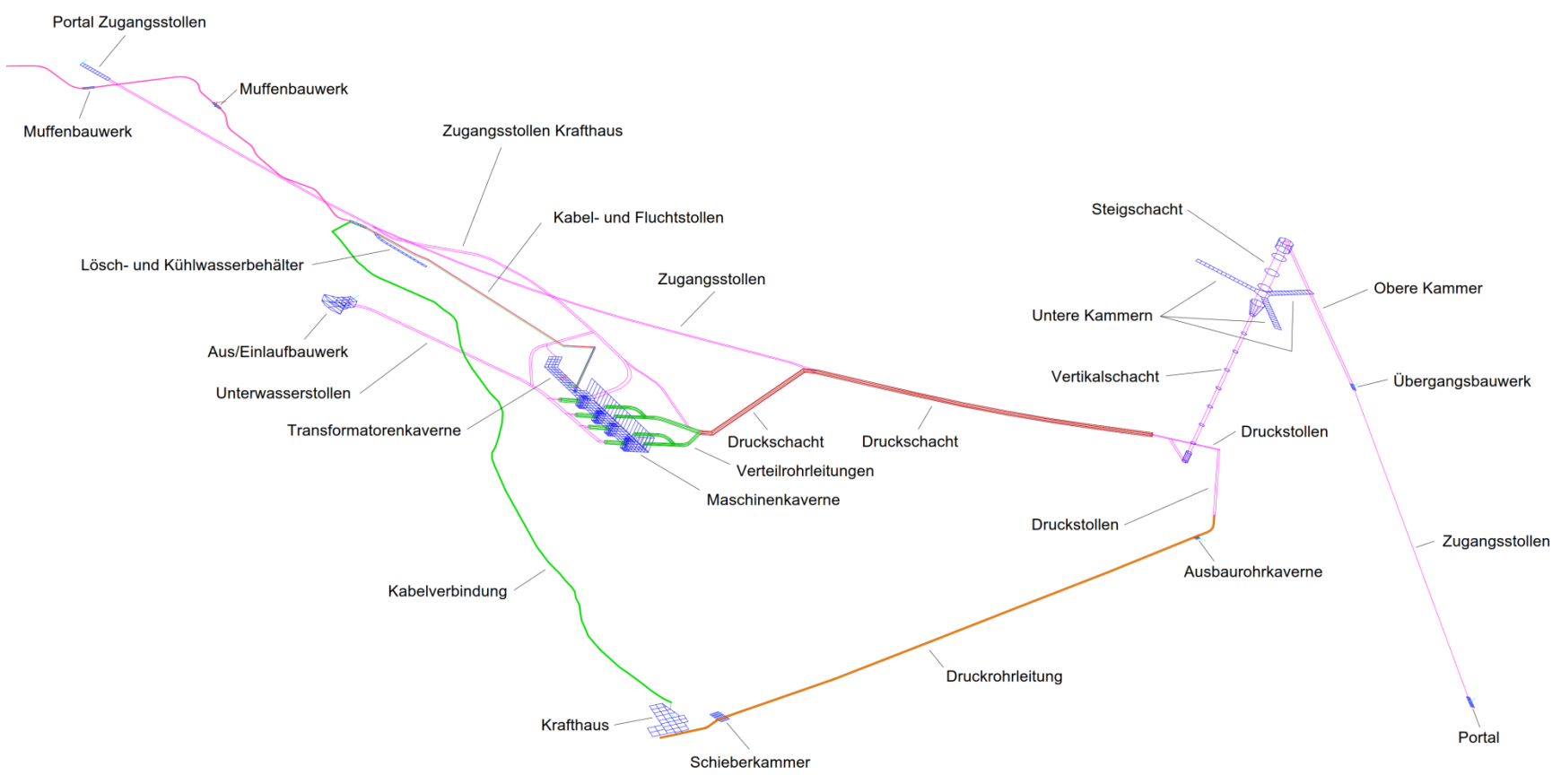
Z calcolo [m] -1

Solo Normale No

Assi di Riferimento

CASE D – HYDRO POWER PLANT

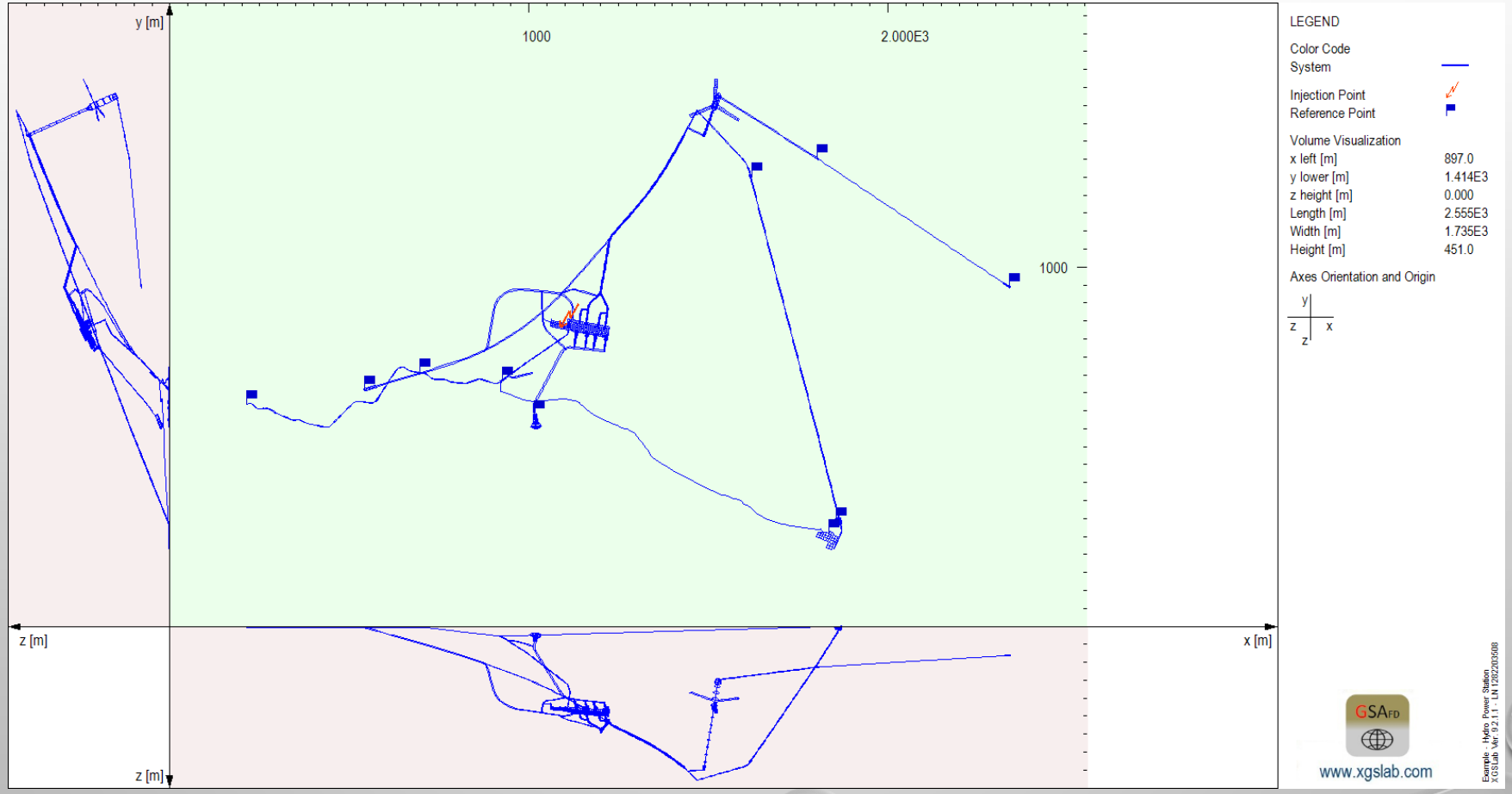
UNDERGROUND POWER STATION: PIPE FLOW TYPE, No 4 POWER UNITS
SINGLE PHASE TO EARTH FAULT CURRENT 300 A



CASE D – HYDRO POWER PLANT

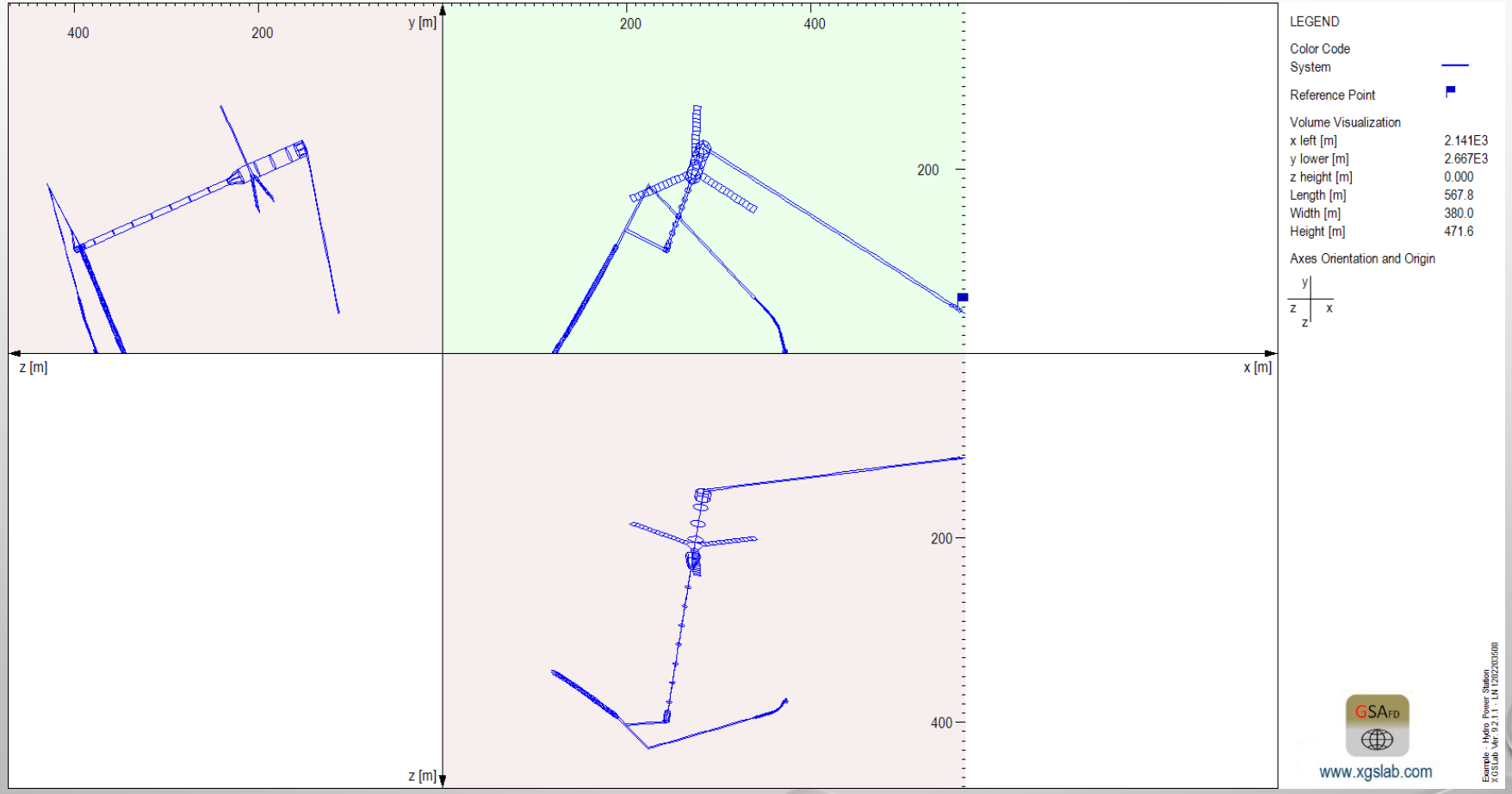
UNDERGROUND POWER STATION: PIPE FLOW TYPE, No 4 POWER UNITS

SINGLE PHASE TO EARTH FAULT CURRENT 300 A



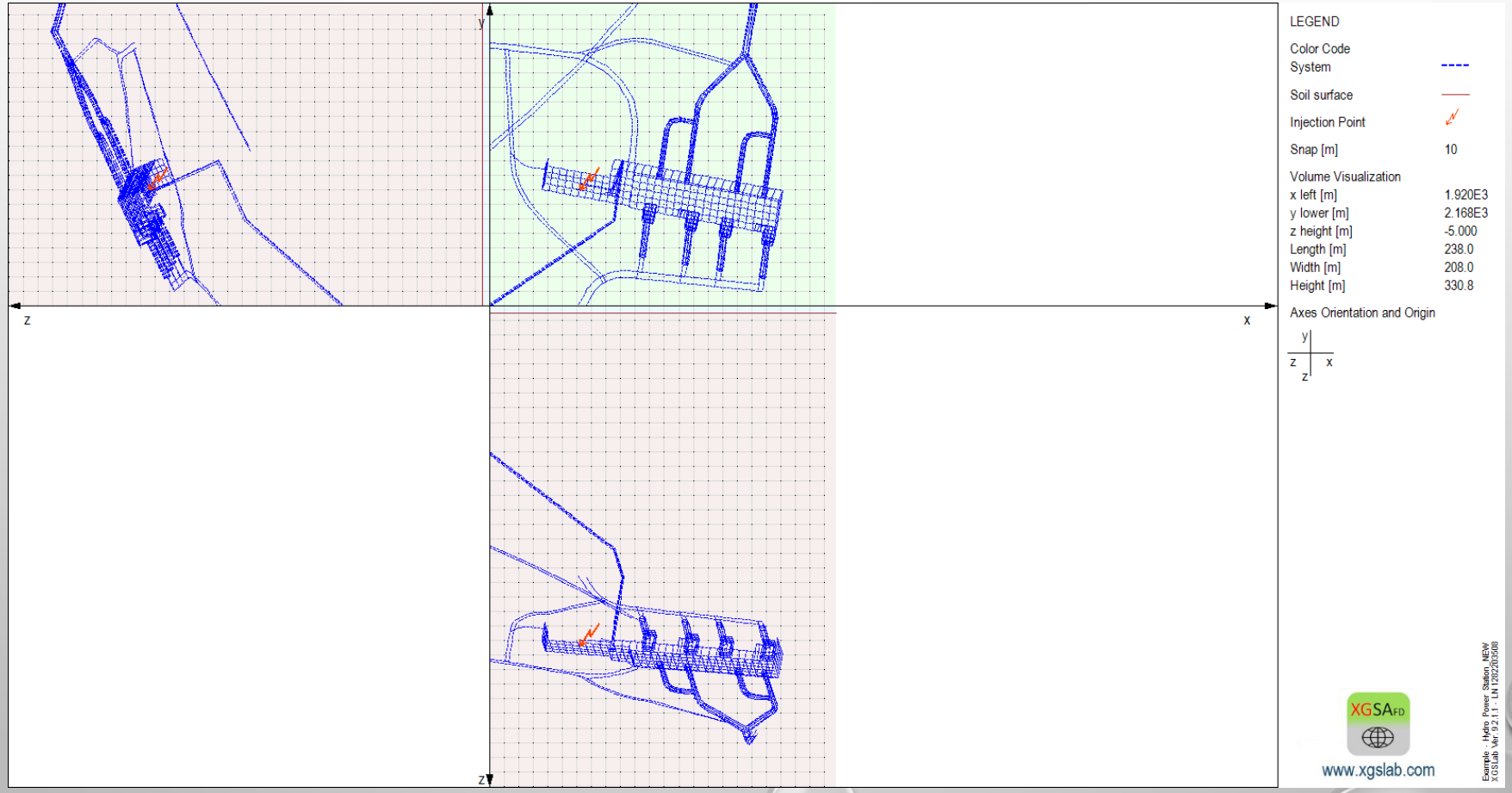
CASE D – HYDRO POWER PLANT

UNDERGROUND POWER STATION: DETAILS - INTAKE



CASE D – HYDRO POWER PLANT

UNDERGROUND POWER STATION: DETAILS – POWER PLANT CHAMBER

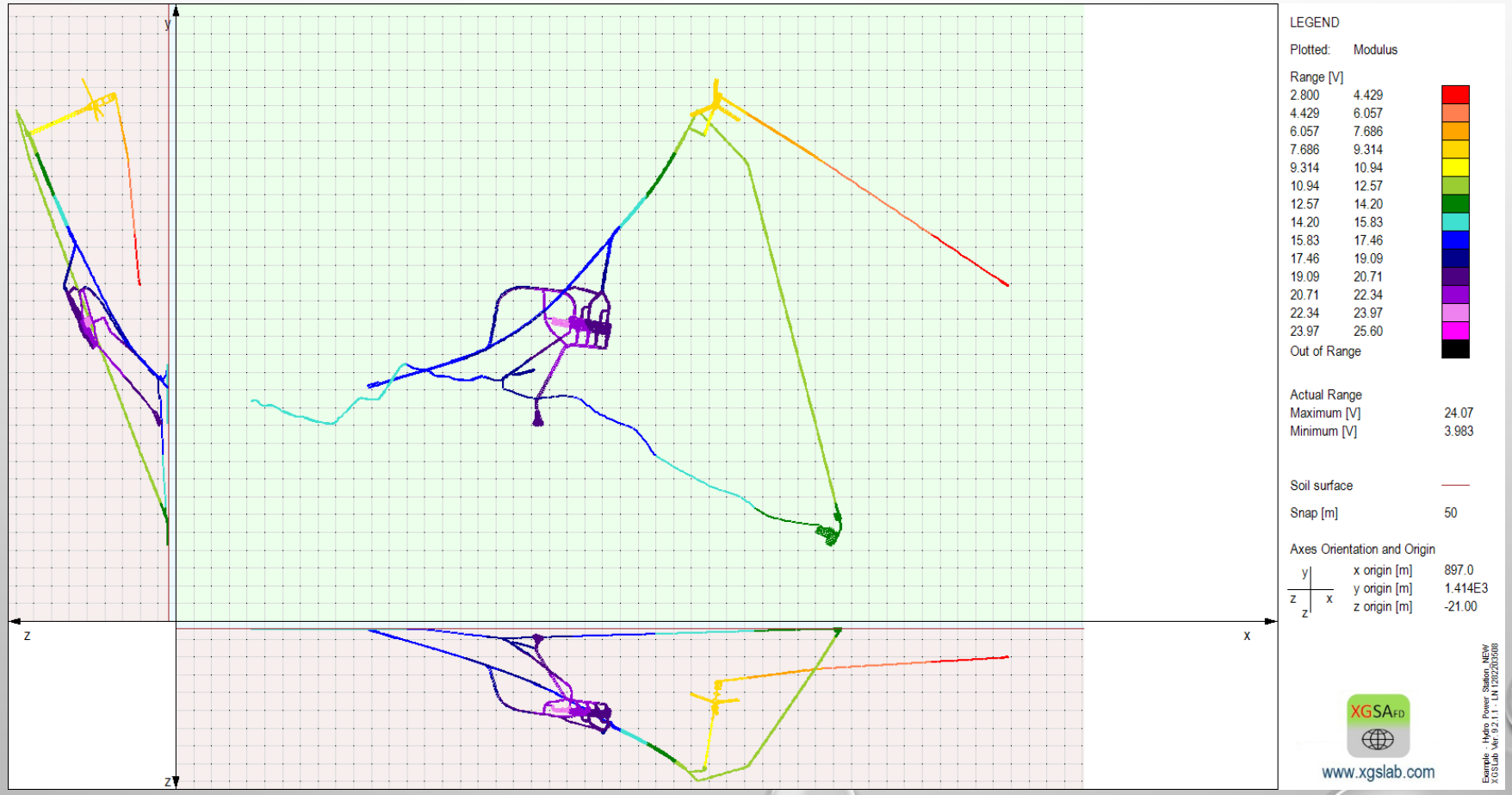


CASE D – HYDRO POWER PLANT

UNDERGROUND POWER STATION: RESULTS – LEAKAGE CURRENT DENSITIES

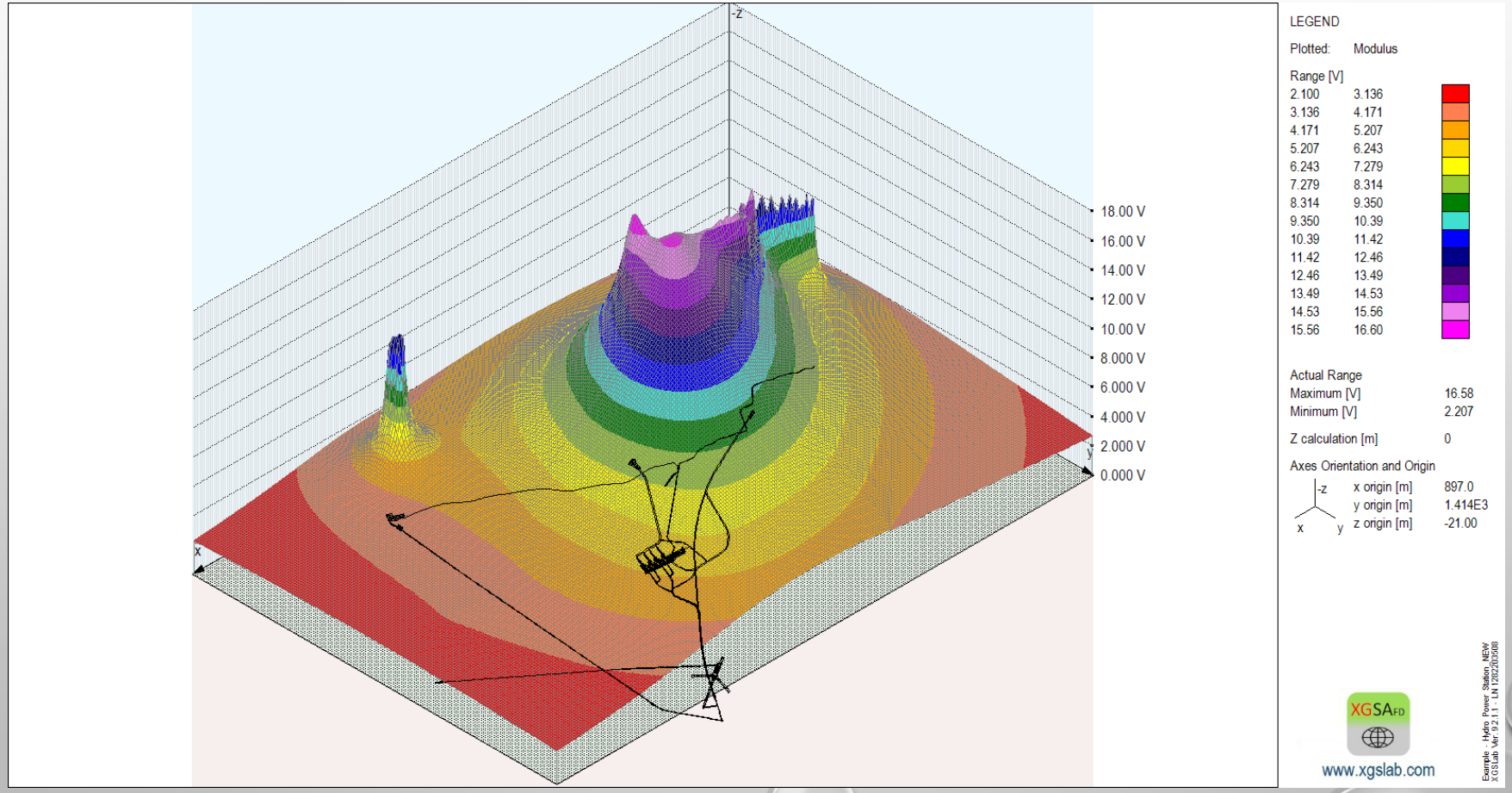
CASE D – HYDRO POWER PLANT

UNDERGROUND POWER STATION: RESULTS – POTENTIAL



CASE D – HYDRO POWER PLANT

UNDERGROUND POWER STATION: RESULTS – EARTH SURFACE POTENTIAL



GRAZIE PER L'ATTENZIONE!