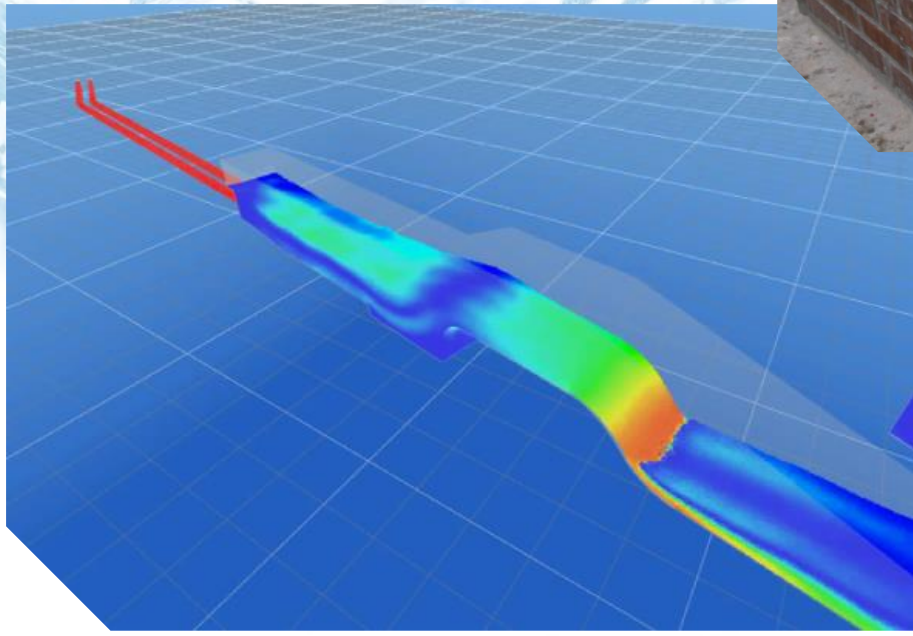




Loteta and Ebro Dams Bottom Outlets Design

Ángel Gassó Sánchez



CEDEX

Hydraulic structures design with SPHERIMENTAL

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- 1. Projects Presentation
- 2. Base model construction
- 3. Study of alternatives
- 4. Visualization and study of the SPH models
- 5. Comparison with the physical model

1. Projects Presentation

Loteta Dam



- Modern earth dam, built in 2008 and in operation.
- Bottom outlet current design within the dam body with a free flow channel.
- The project consists of the substitution of the channel with a pipe and the design of a stilling basin outside of the dam.

1. Projects Presentation

Ebro Dam

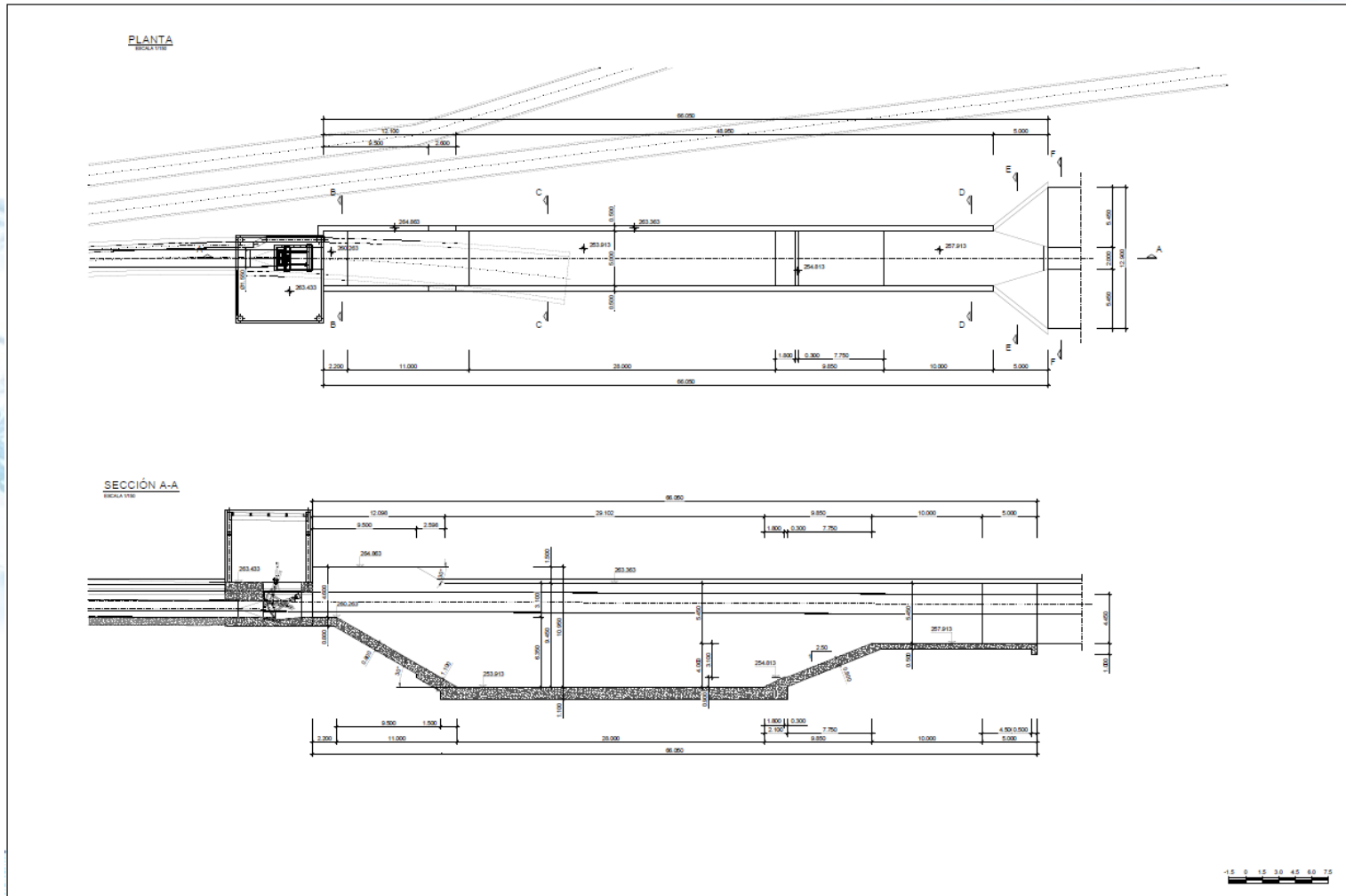


- Historical gravity dam, built in 1952 and in operation.
- Bottom outlet current design without specific stilling structure.
- The project consists of the design of a stilling basin and its return to the river.



2. Base model construction

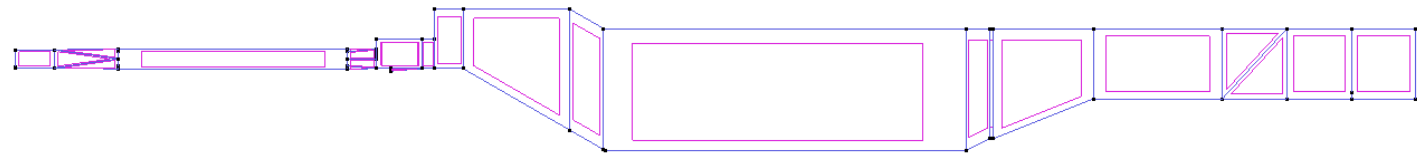
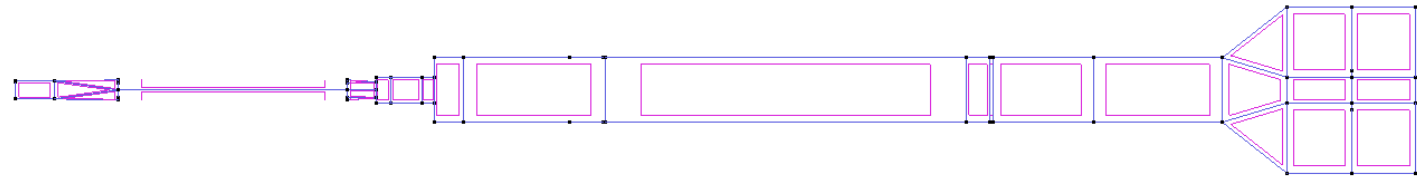
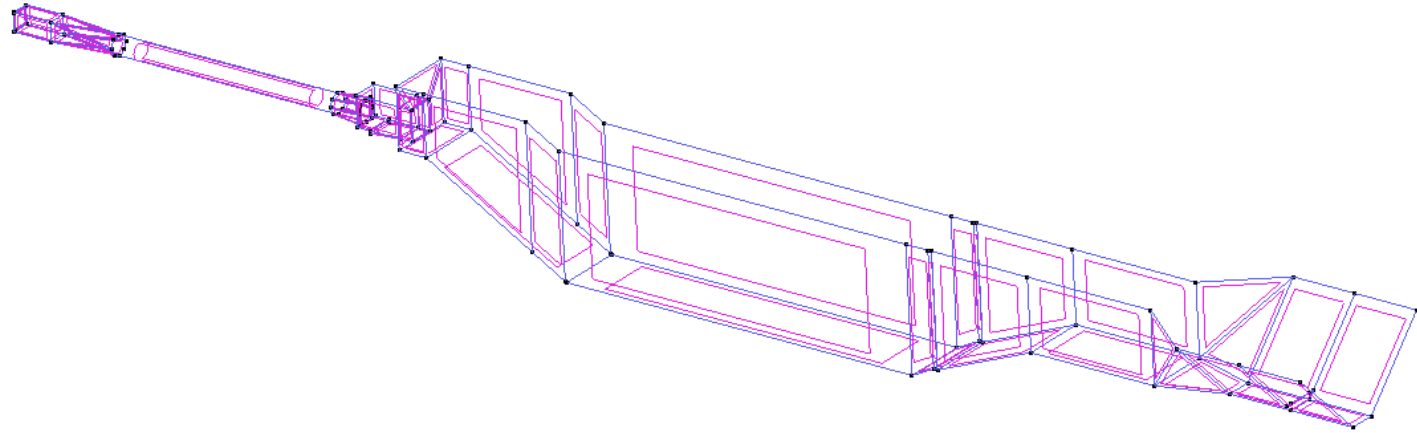
Loteta Dam





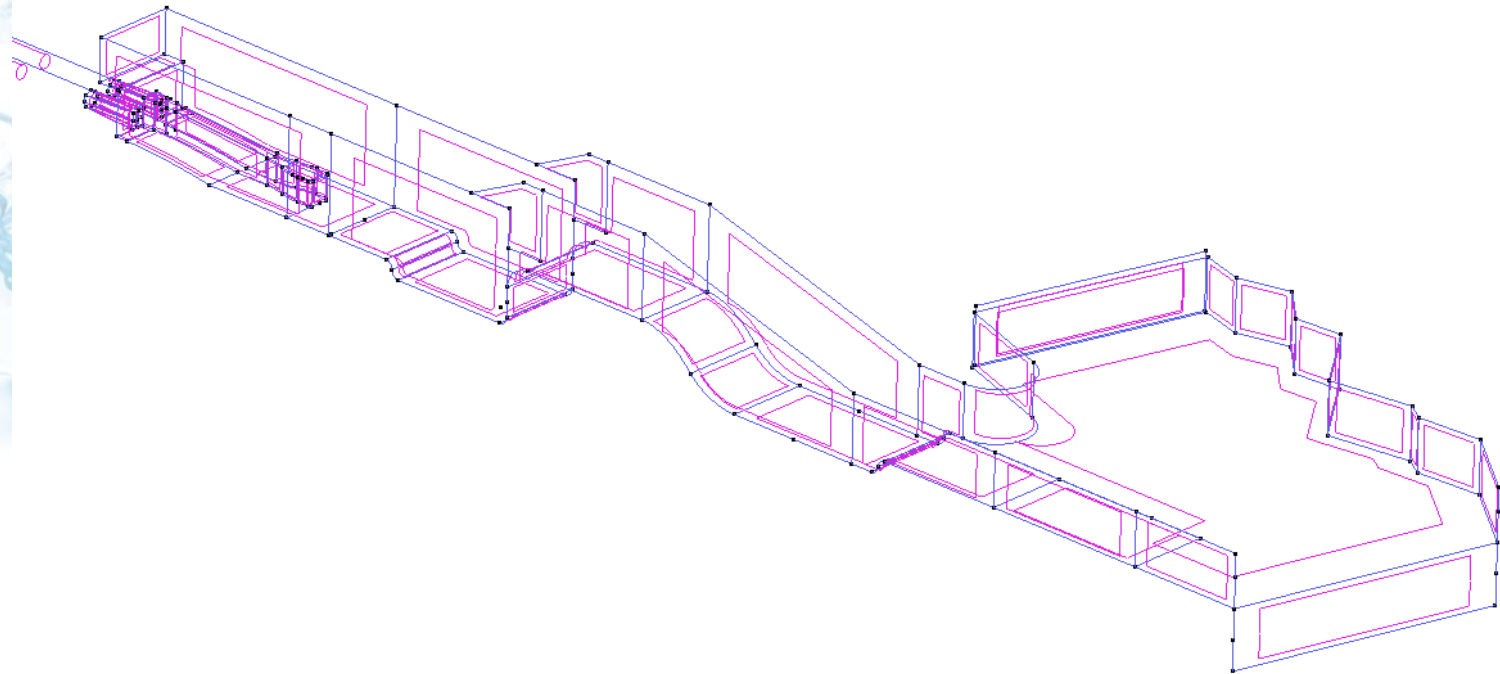
2. Base model construction

Loteta Dam



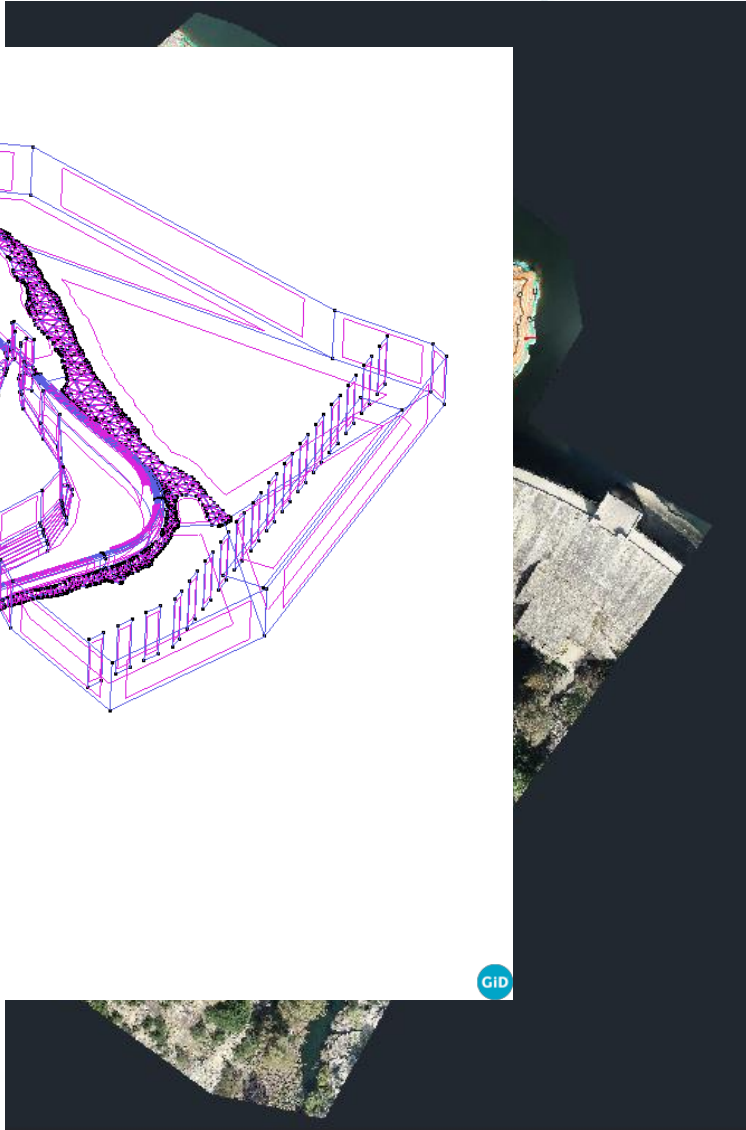
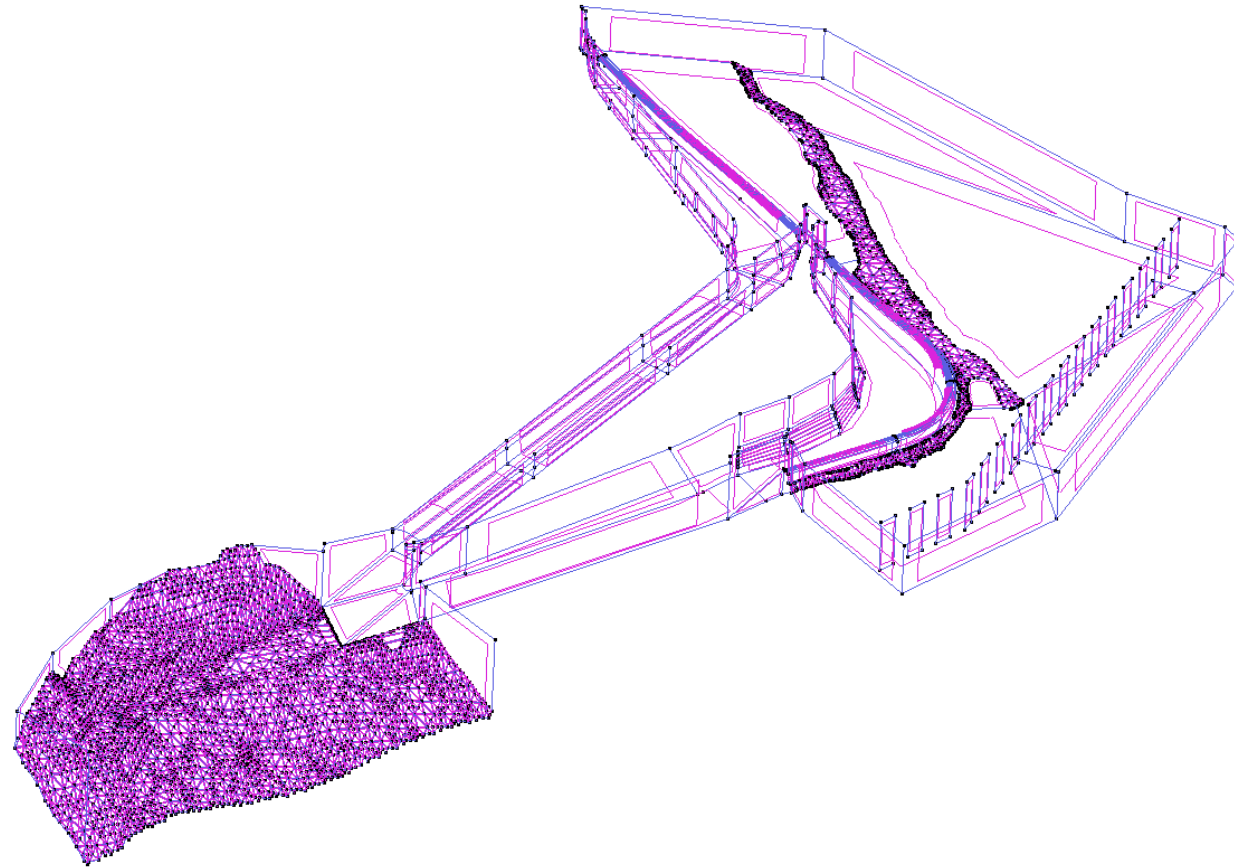
2. Base model construction

Ebro Dam



2. Base model construction

Jándula Dam Spillway

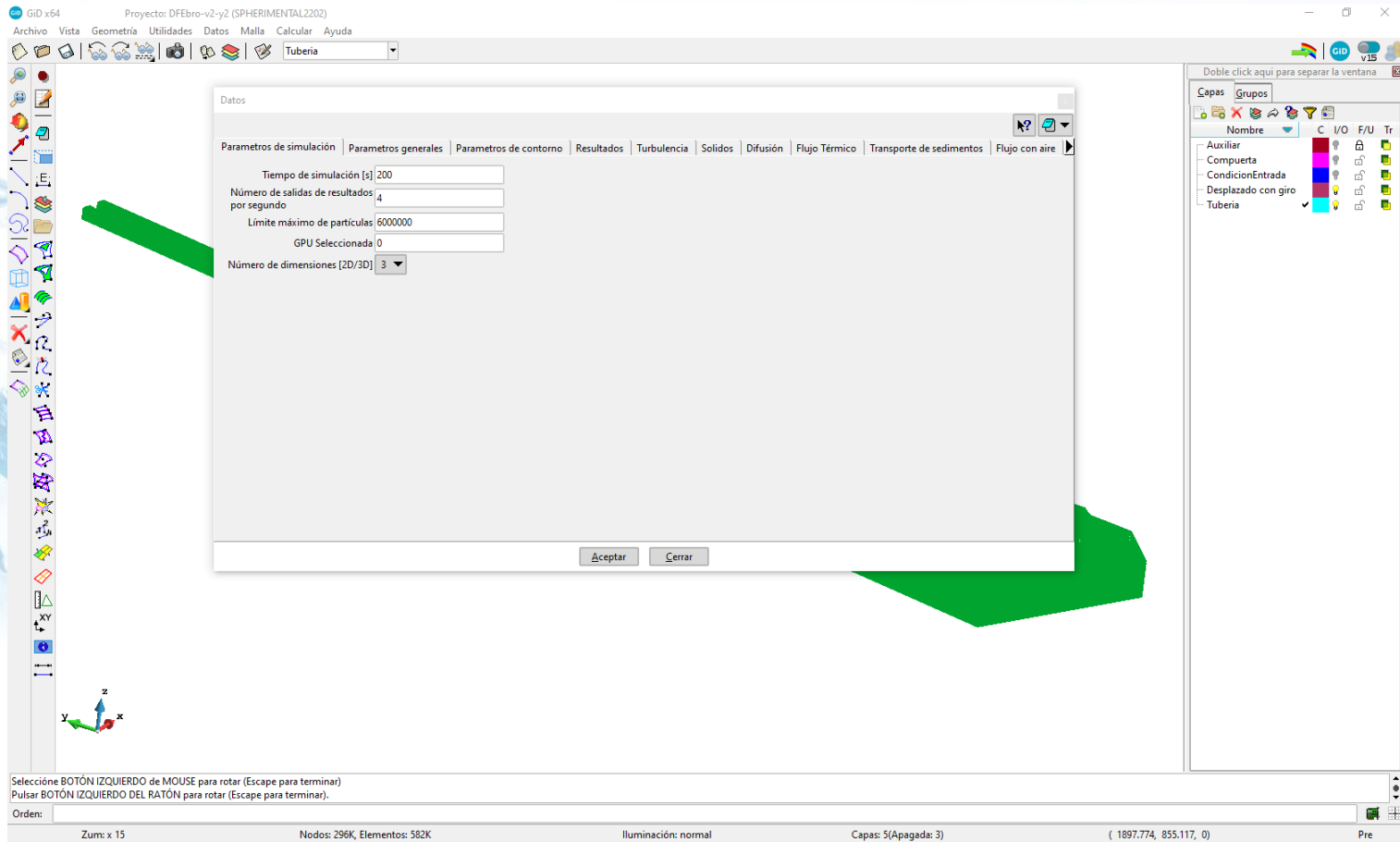


3. Study of alternatives

	Loteta Dam	Ebro Dam
Particle size	10 cm	10 cm
Mesh size	5 cm	5 cm
Boundary Particles	1,300,000	2,700,000
Fluid Particles	1,000,000	3,500,000
Simulation time	150 s	200 s
Outputs	4 per second	4 per second
GPU	NVIDIA GeForce RTX 3080	
Calculation time	6 hours	20 hours
Number of models studied	35	45

3. Study of alternatives

Input data



Proyecto: DFEbro-v2-y2 (SPHERIMENTAL2202)
 Archivo Vista Geometría Utilidades Datos Malla Calcular Ayuda
 Tubería

Datos

Parametros de simulación | Parametros generales | Parametros de contorno | Resultados | Turbulencia | Solidos | Difusión | Flujo Térmico | Transporte de sedimentos | Flujo con aire

Tiempo de simulación [s] 200
 Número de salidas de resultados por segundo 4
 Limite máximo de partículas 6000000
 GPU Seleccionada 0
 Número de dimensiones [2D/3D] 3

Aceptar Cerrar

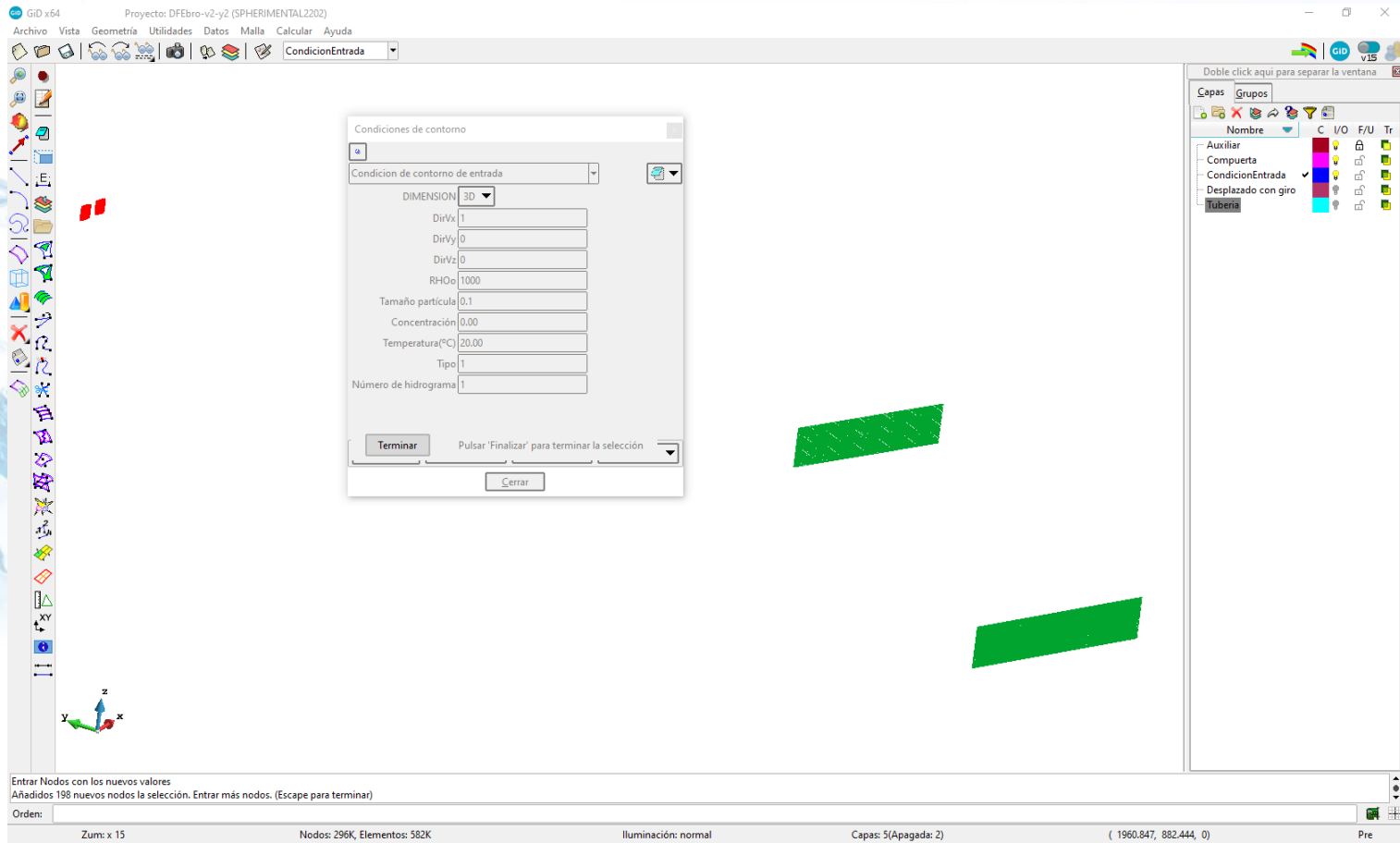
Capas Grupos
 Nombre C I/O F/U Tr
 - Auxiliar
 - Compuerta
 - CondiciónEntrada
 - Desplazado con giro
 - Tubería

Seleccióné BOTÓN IZQUIERDO de MOUSE para rotar (Escape para terminar)
 Pulsar BOTÓN IZQUIERDO DEL RATÓN para rotar (Escape para terminar).
 Orden:

Zum: x 15 Nodos: 296K, Elementos: 582K Iluminación: normal Capas: 5(Apagada: 3) (1897.774, 855.117, 0) Pre

3. Study of alternatives

Boundary Conditions



Entrar Nodos con los nuevos valores
 Añadidos 198 nuevos nodos a la selección. Entrar más nodos. (Escape para terminar)

3. Study of alternatives

Información de salida para 'current'

Numero de tarjetas CUDA disponibles: 2

GPU en uso: 0 NVIDIA GeForce RTX 3080

Total Global Mem: 12287 Mb

Compute Capability: 8.6

Número de partículas de fluido= 0

Número de partículas de contorno= 1335299

Número de celdas de búsqueda= 3281850

43	2.5149696E-02	5.9642148E-04	1000.516	1000.297	180	6.040000	34	25	0.000000
0.000000									
85	5.0199430E-02	5.9642148E-04	1000.516	1000.297	180	8.539000	35	25	0.000000
0.000000									
127	7.5249106E-02	5.9642148E-04	1000.516	1000.297	180	11.04000	38	26	0.000000
0.000000									

Log tiempo real Cerrar

3. Study of alternatives

Información de salida para 'current'

339536 0.000000	199.8250	5.9642148E-04	1004.739	998.6050	3506682	84806.63	154	103	23.69991
339578 0.000000	199.8500	5.9642148E-04	1005.063	998.3647	3506747	84820.88	154	103	23.69991
339620 0.000000	199.8749	5.4529868E-04	1004.899	998.4232	3506571	84835.13	154	103	23.69991
339663 0.000000	199.9002	5.9642148E-04	1004.898	998.2573	3506611	84849.72	154	103	23.69991
339705 0.000000	199.9248	5.9642148E-04	1004.898	998.1981	3506452	84863.97	154	103	23.69991
339748 0.000000	199.9500	5.9642148E-04	1004.883	998.2314	3506498	84878.53	154	103	23.69991
339791 0.000000	199.9752	5.9642148E-04	1004.977	998.2879	3506367	84893.08	154	103	23.69991
339833 0.000000	200.0000	5.9642148E-04	1004.824	998.5272	3506491	84909.34	154	103	24.90896

tiempo: 84909.46 interacciones/s= 2.5474189E+09

Log tiempo real Cerrar

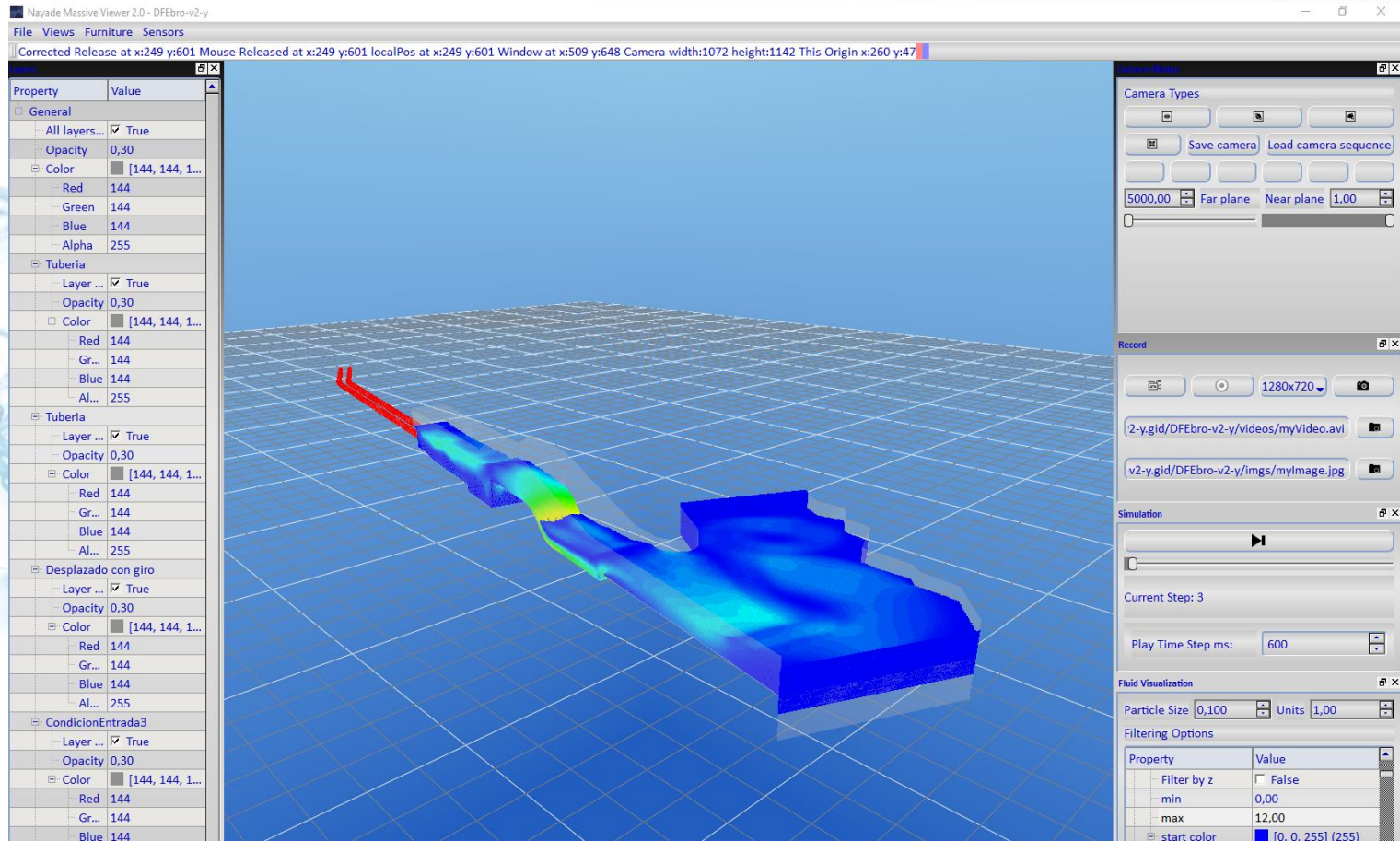
Time step

Fluid Particles

Outlet Flow

4. Visualization and study of the SPH models

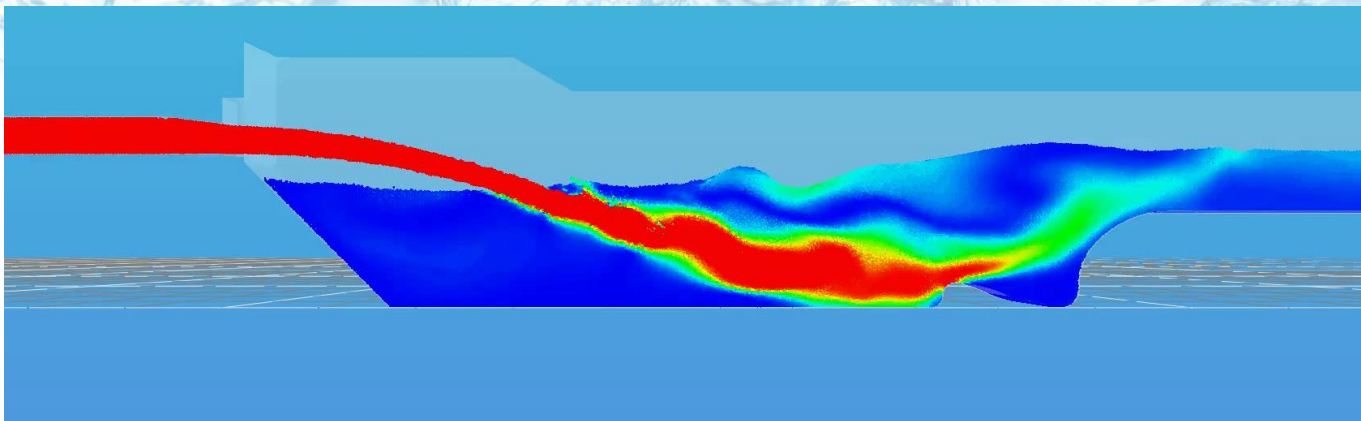
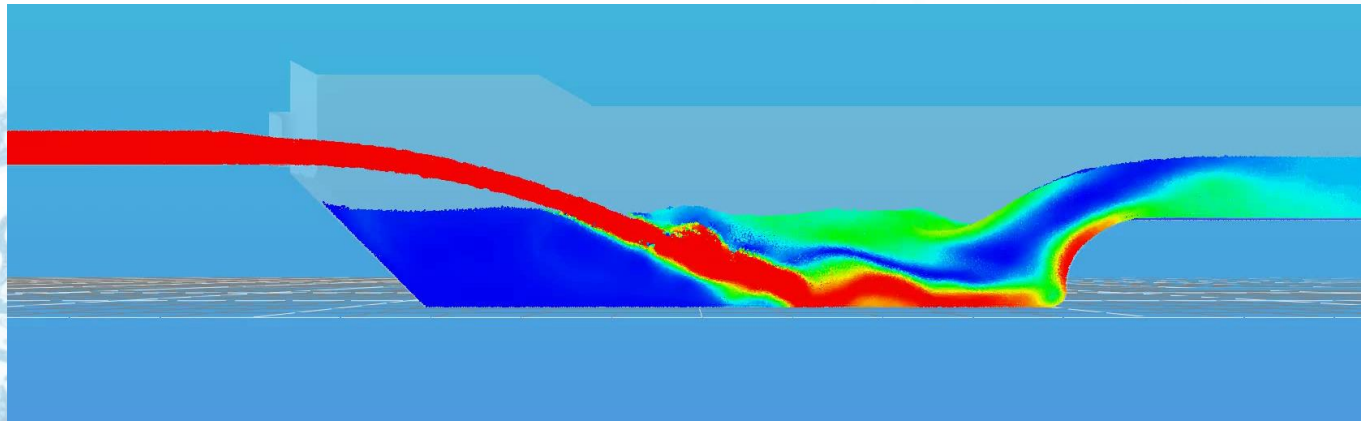
Nayade software



Quantitative analysis -> Visualization
 Qualitative analysis -> Queries

4. Visualization and study of the SPH models

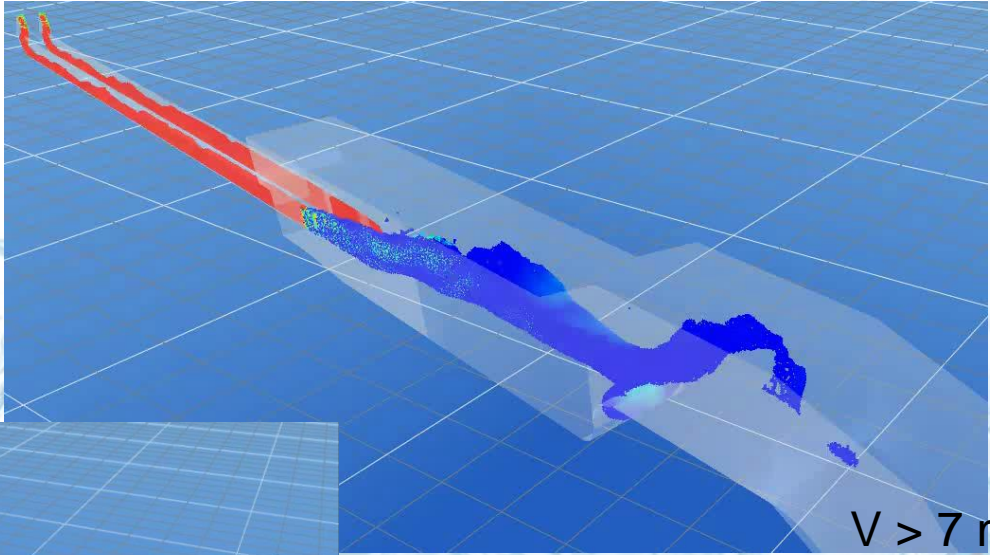
Loteta Dam weir behaviour



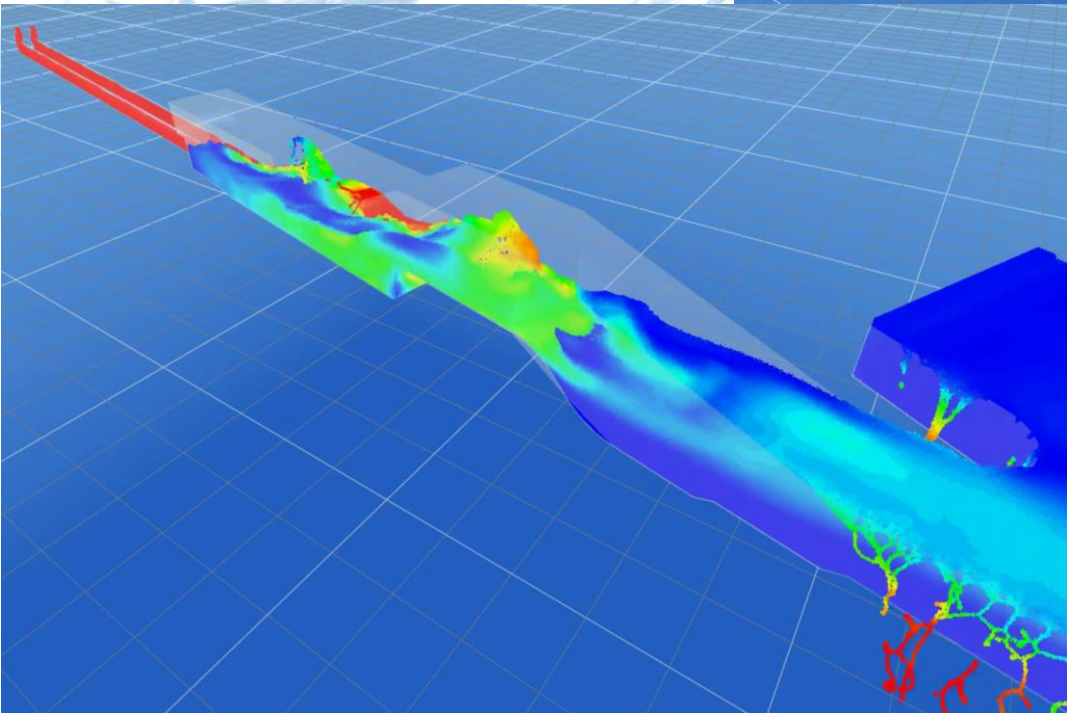
4. Visualization and study of the SPH models

Ebro Dam energy dissipation

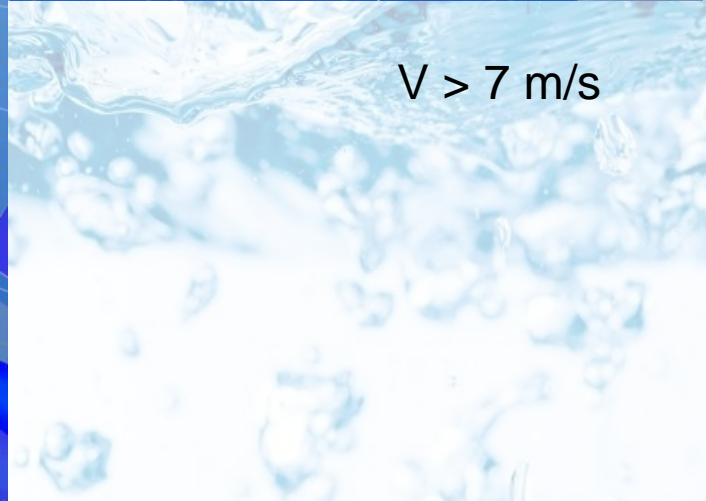
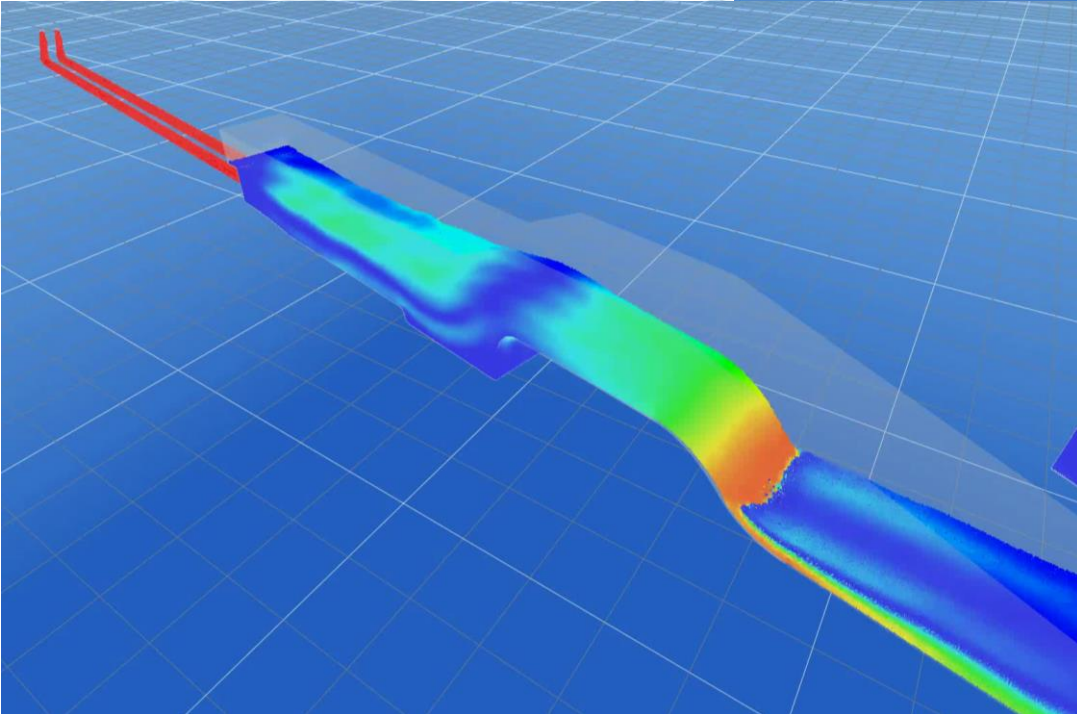
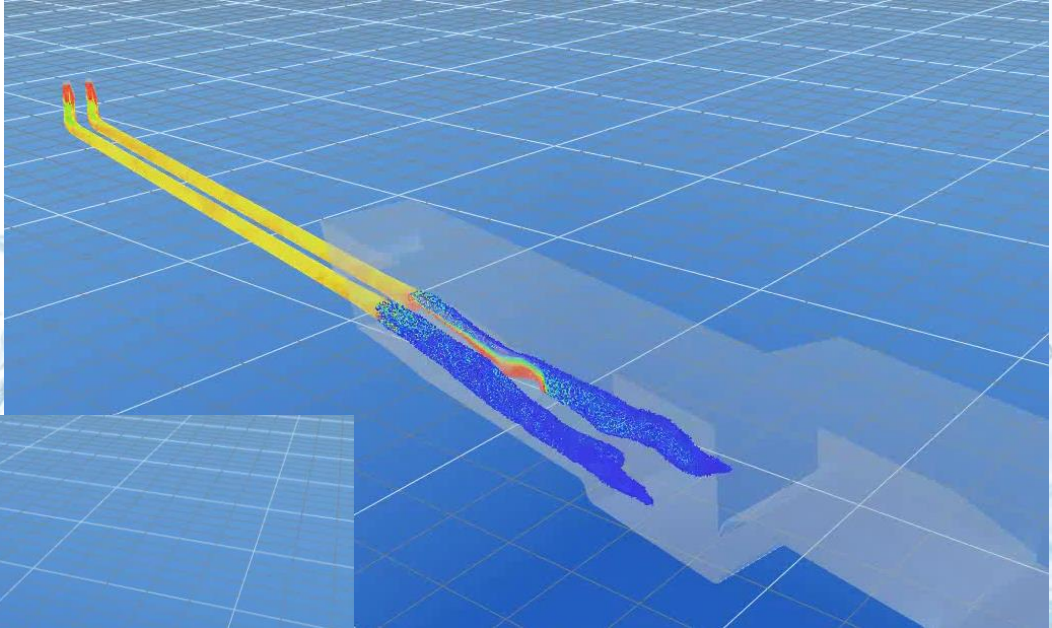
Centro de Estudios Hidrográficos



$V > 7 \text{ m/s}$

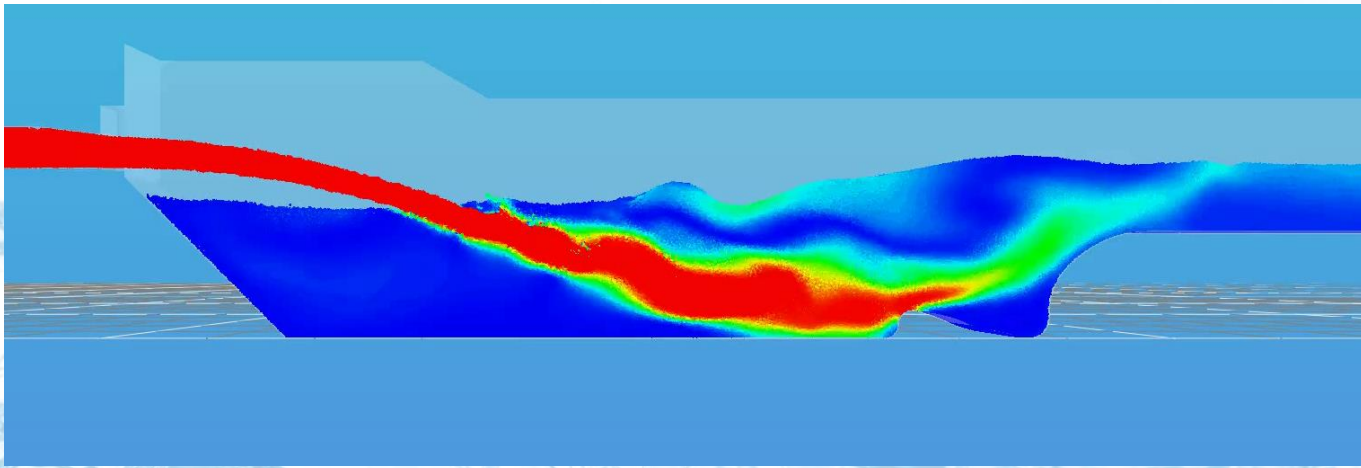


4. Visualization and study of the SPH models Ebro Dam energy dissipation



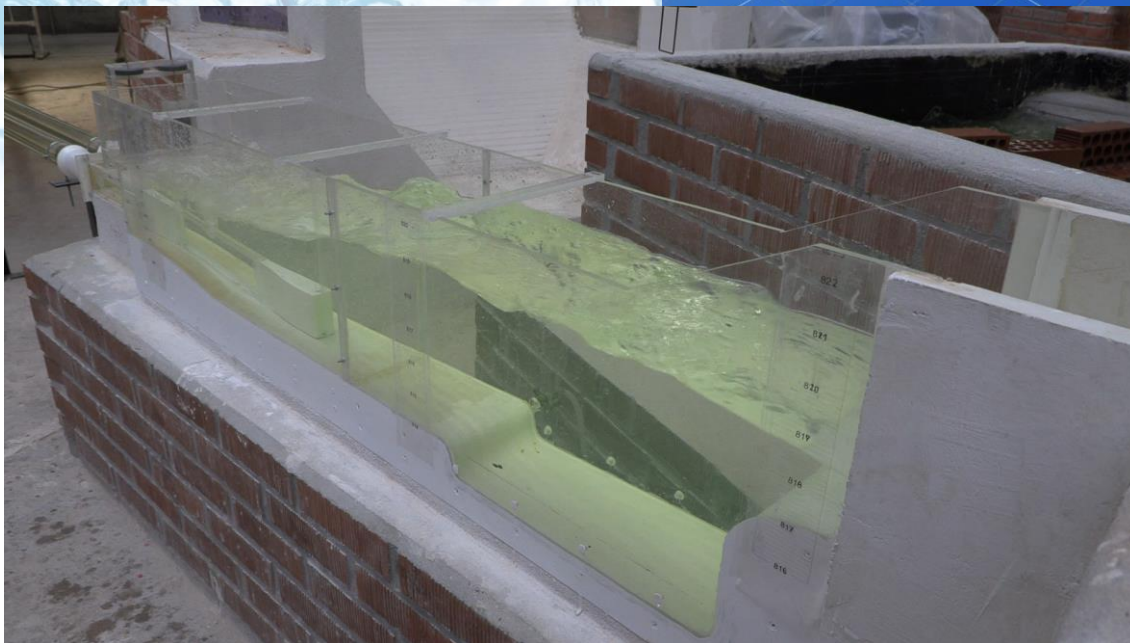
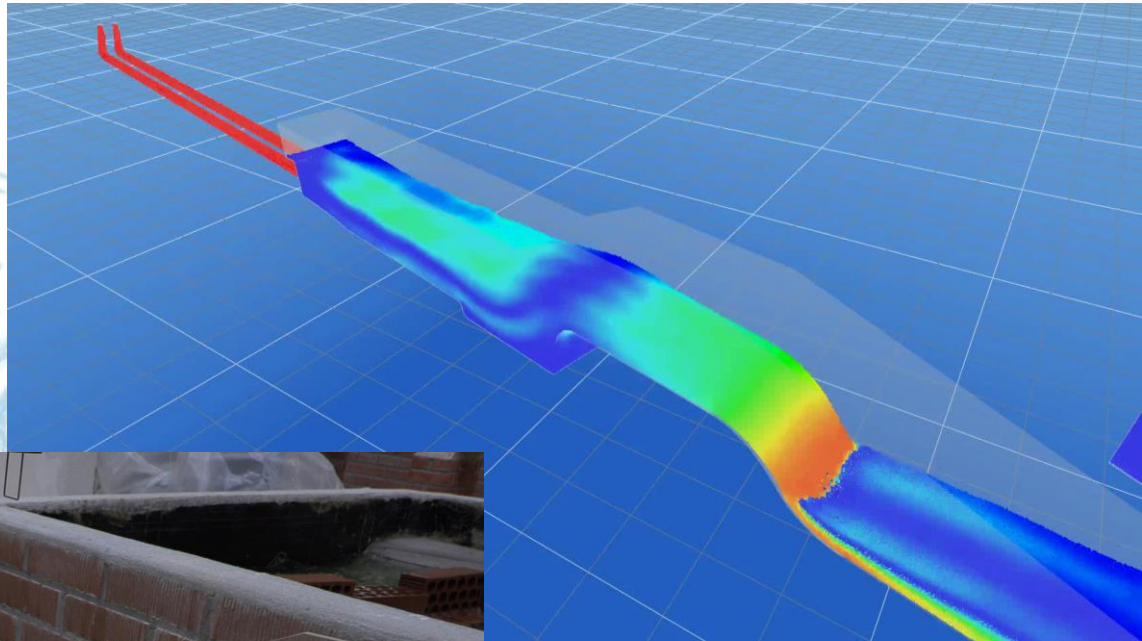
5. Comparison with physical models

Loteta Dam weir behaviour



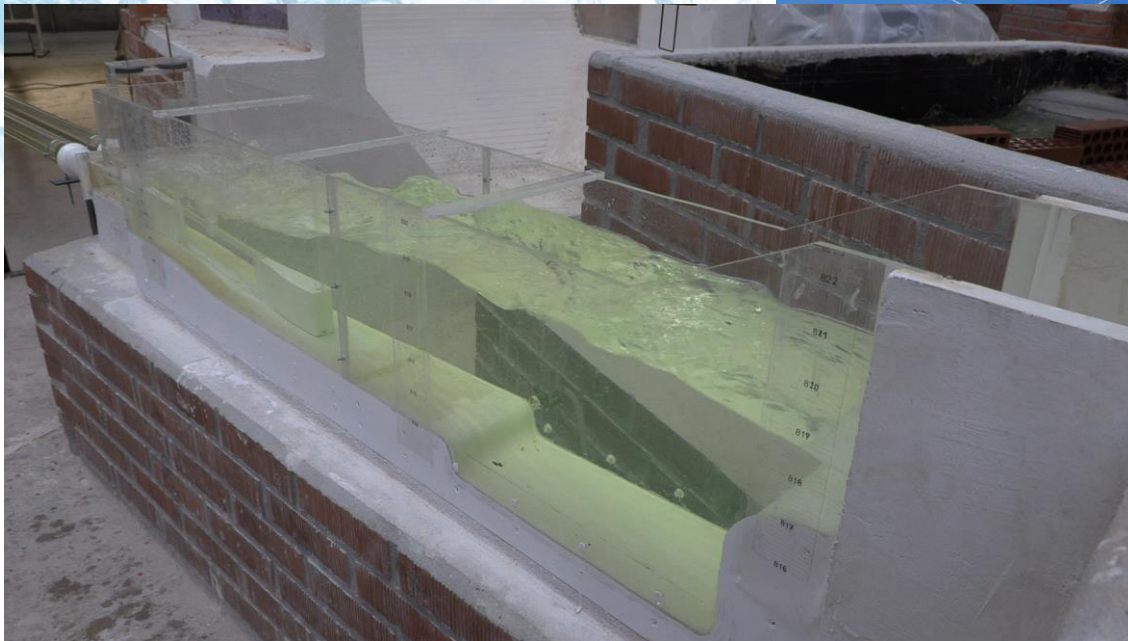
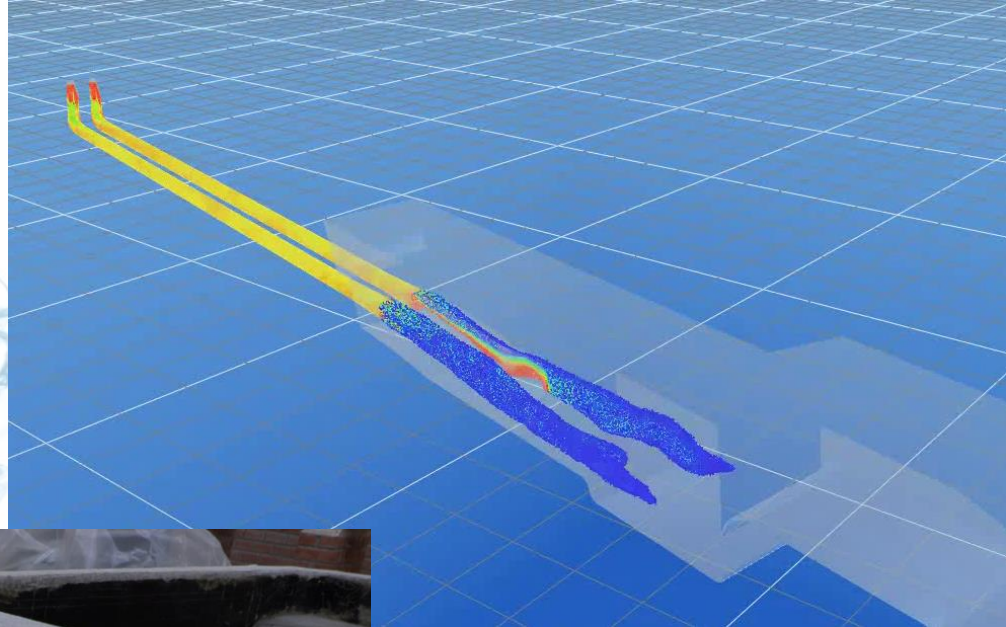
5. Comparison with physical models

Ebro Dam energy dissipation



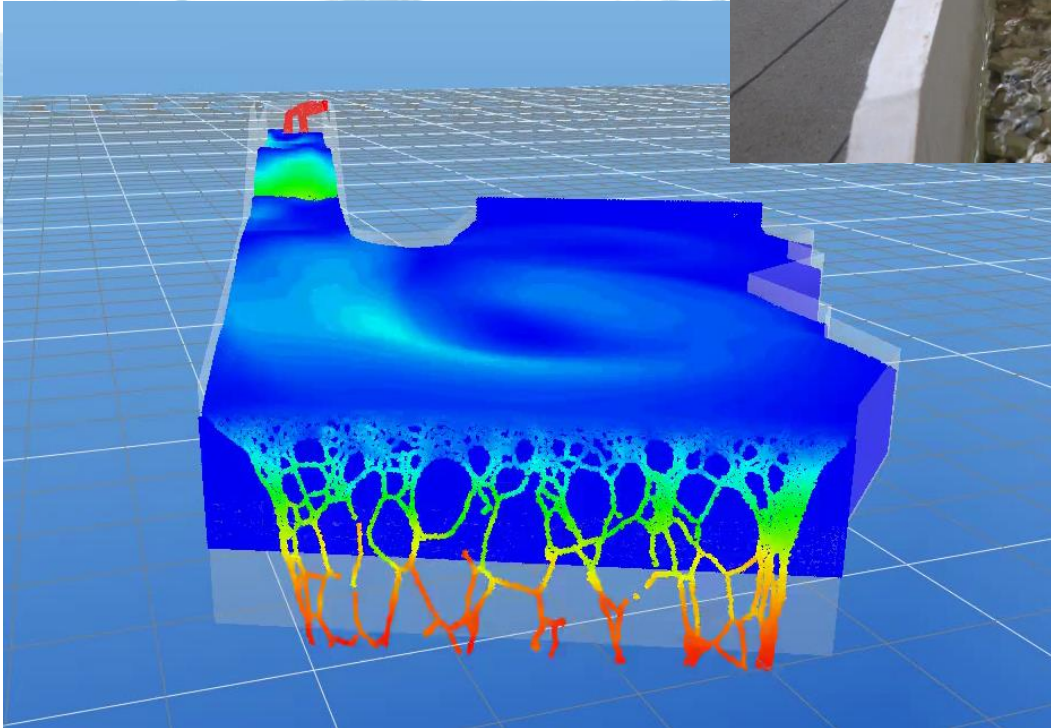
5. Comparison with physical models

Ebro Dam energy dissipation



5. Comparison with physical models

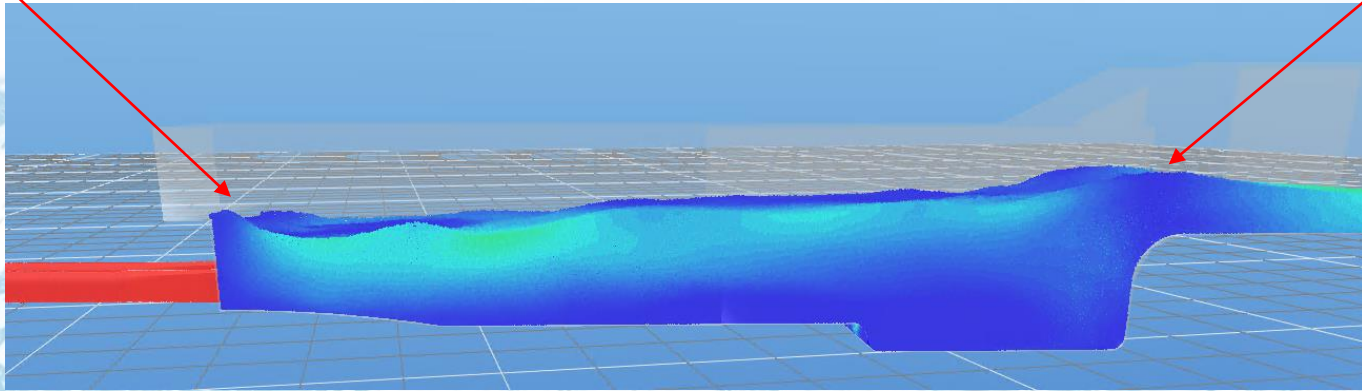
Ebro Dam river confluence



5. Comparison with physical models

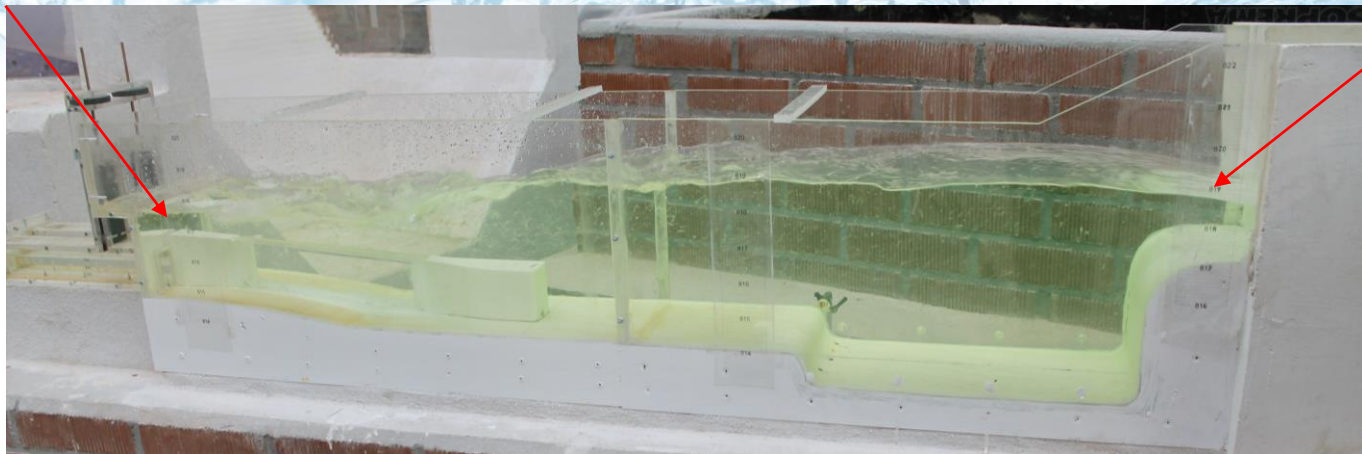
Ebro Quantitative analysis

Water level
817,1 m



Water level
818,7 m

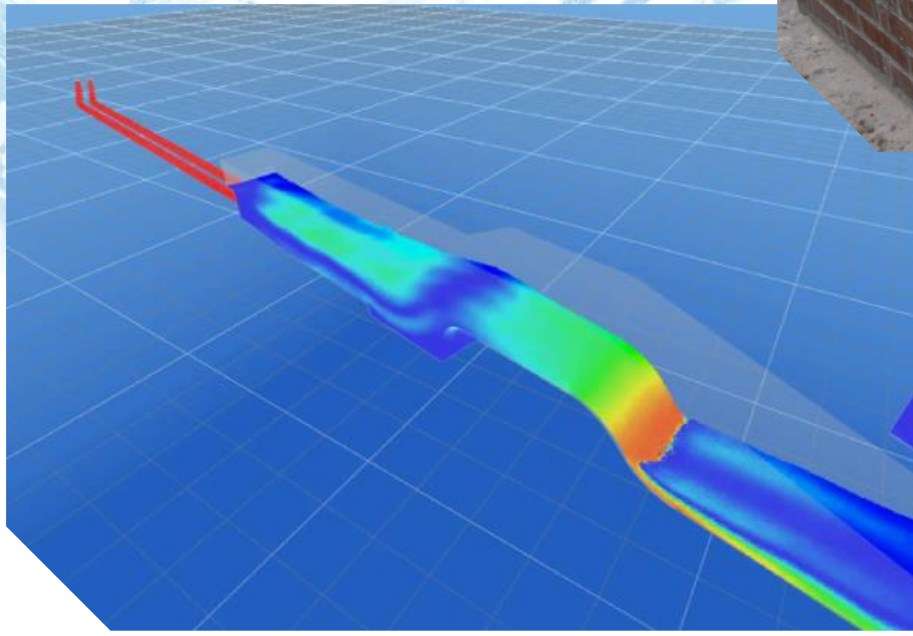
Water level
817,6 m



Water level
818,8 m



Conclusion



Thank you!
Ángel Gassó Sánchez
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