Voxel Based Reconstruction

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Concept

- The volume of LAr is subdivided in a regular 3D grid of Voxels
- Each voxel is assigned a weight, based on the likelihood of a photon originating from it
  - Calculated based on possible paths from photon hits and mask holes
  - Takes propagation time into account
- A 3D clusterization algorithm will then identify tracks based on contiguous high weight voxels

- Following slides are 2D instead of 3D

Motivation

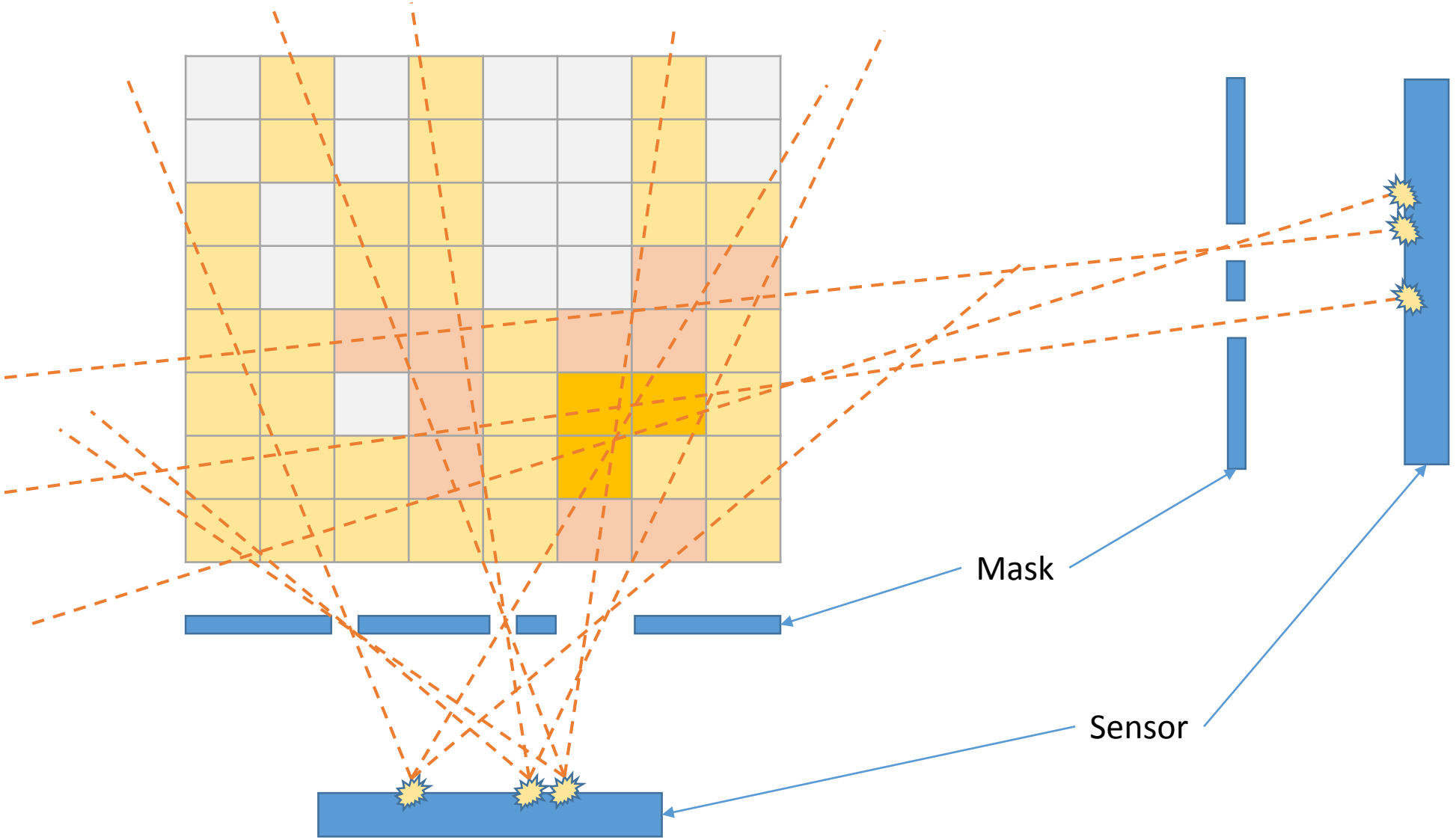
Pros:

- Combines different views with no concern for relative position
- May work even with one-two photons per pixel
- Uses photon timing explicitly
- Probability based, allows direct confidence level estimation

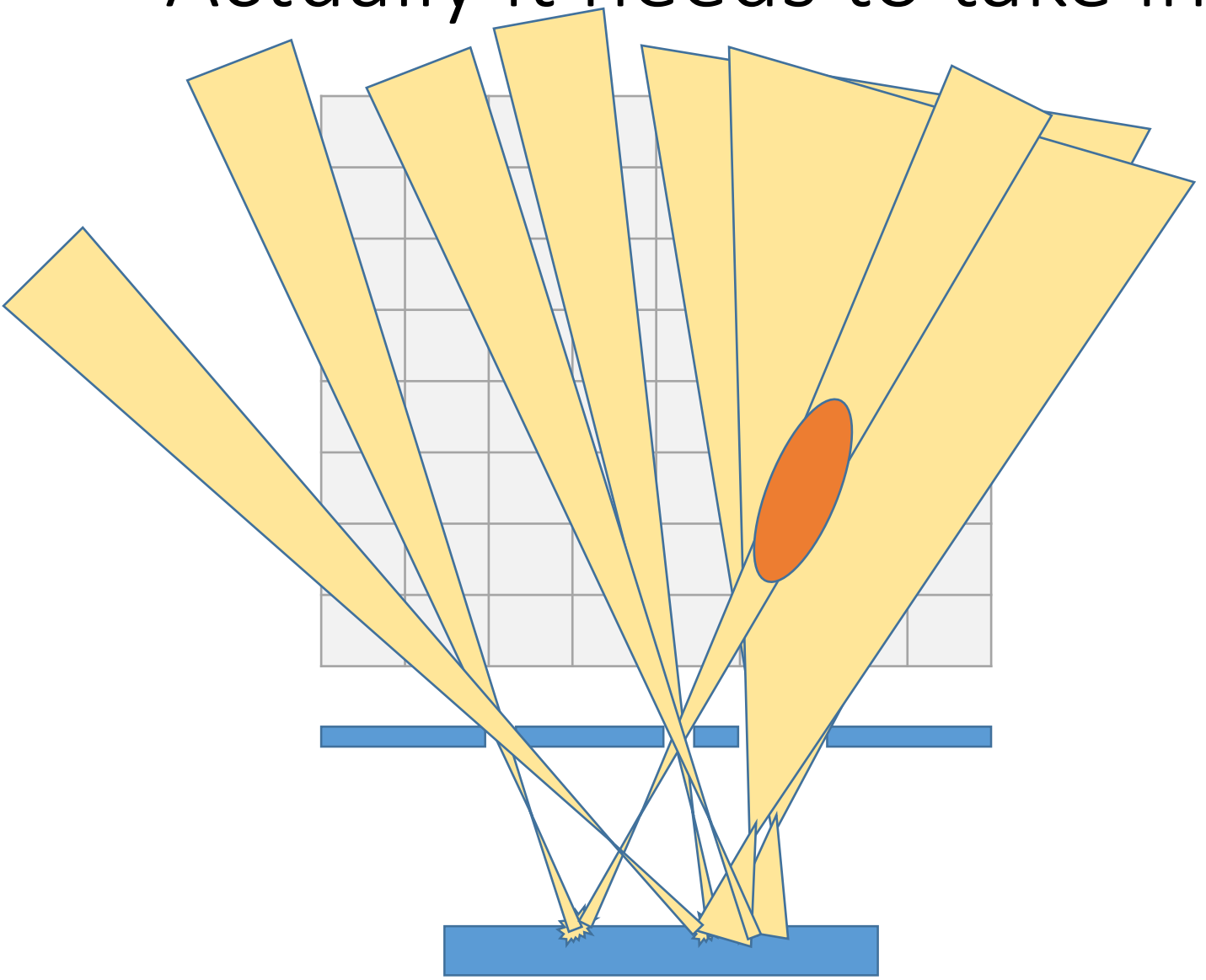
Cons:

- No strong theoretical background, so far
- Computationally intensive

Seen in 2D



Actually it needs to take into account sizes



Both pixels and mask holes have non negligible size

In 3D, each photon-hole combination projects out a `frustum`, defined by four planes

Weight calculation

For each voxel, photon, hole:

If voxel (centre) is inside of frustum, defined by a photon hit and a hole:

A = number of detected photons

σ = cross section of frustum at voxel

ϕ = time delay (measured time – theoretical time of flight from voxel)

$$w \mathrel{+}= \frac{A}{\sigma} e^{i\varphi}$$

Else do nothing

The scale of the problem

- Voxel Grid with ~1 cm resolution
  - 450k voxels in Meniscus

- Masks with O(100) holes
- Hit patterns with O(100) hits

- Several billion weight calculations

- GPU ready code (pyOpenCL): https://baltig.infn.it/sipmat/volumereco

Progress

DONE

- I convinced myself that the weight calculations can actually be done in a reasonable time

  ~ 1 Minute for each rank 17 mask on 16 core CPU

  (I did this first because I was very pessimistic at the start)

STARTED

- Import of realistic geometry

  Began working on importing latest geometry from V. Pia

- Import of simulated data

  Again from V. Pia

Outlook

STILL TO DO

- Implement reconstruction from voxels to actual tracks

  Maybe use Local Principal Curves algorithm, same as Genova?

- Develop statistical model to give realistic estimate of quality of result