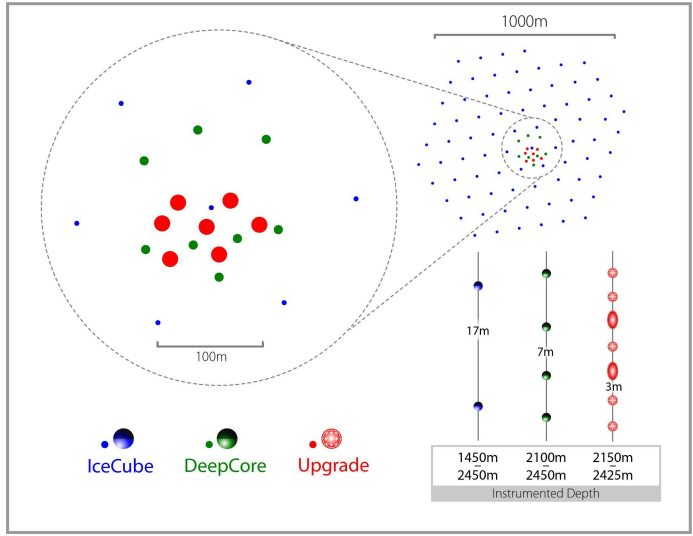


Reconstruction of Neutrino Events in IceCube using Graph Neural Networks

Martin Ha Minh (Technical University Munich) for the IceCube collaboration



The problem with low-energy reconstruction:

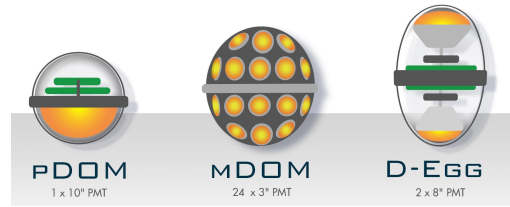
Many events
($\sim 10^7$ in final selection)



Long reconstruction
time per event
(~ 40 s)

IceCube Upgrade introduces more strings and new modules

→ Difficult for current algorithm!

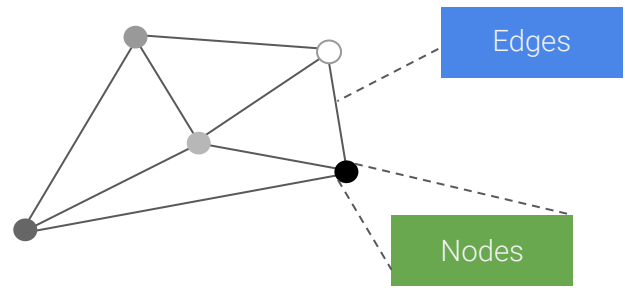


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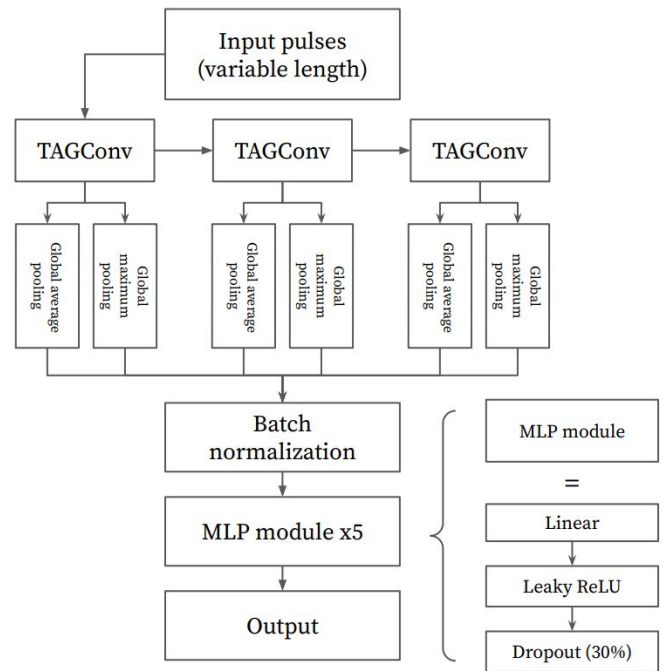
Graph neural networks:

- Representation of input information by nodes
 - connected by edges, based on their relationship
- Good to encode information with irregular shapes!



Our approach:

- IceCube events are lists of pulses
- Each event is a graph, each pulse is a node
- Connect nodes by k nearest neighbors by positional and temporal distance



SFB 1258



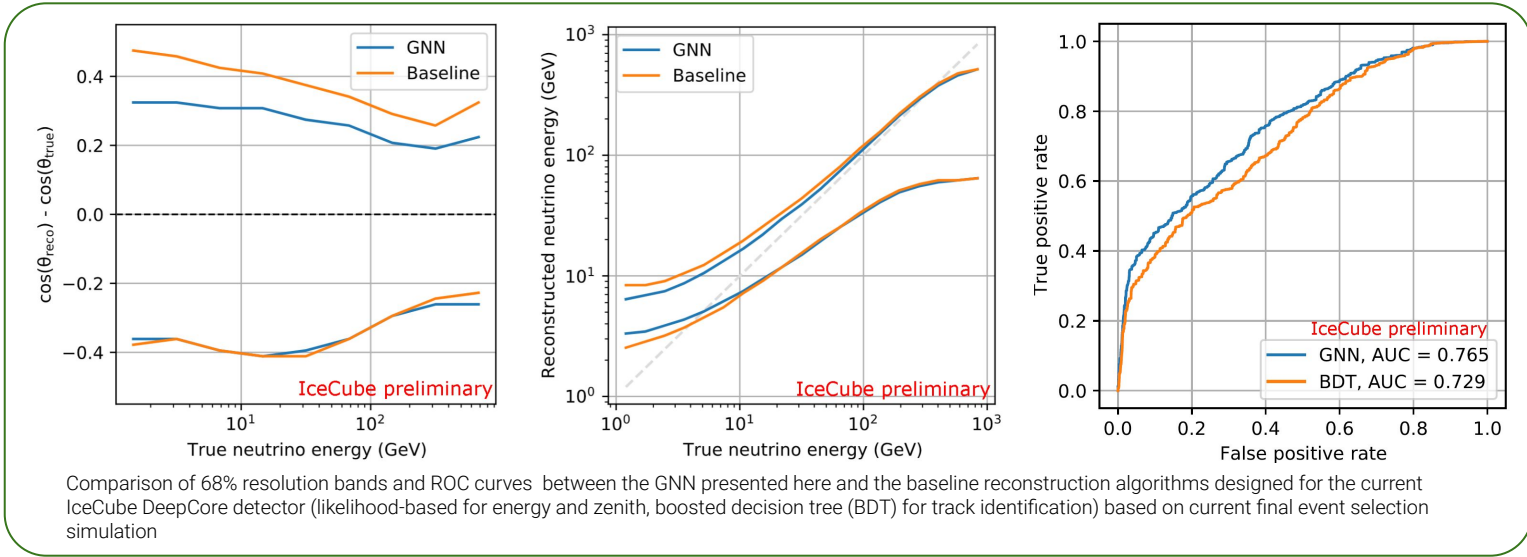
Deutsche Forschungsgemeinschaft
German Research Foundation



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IceCube DeepCore only



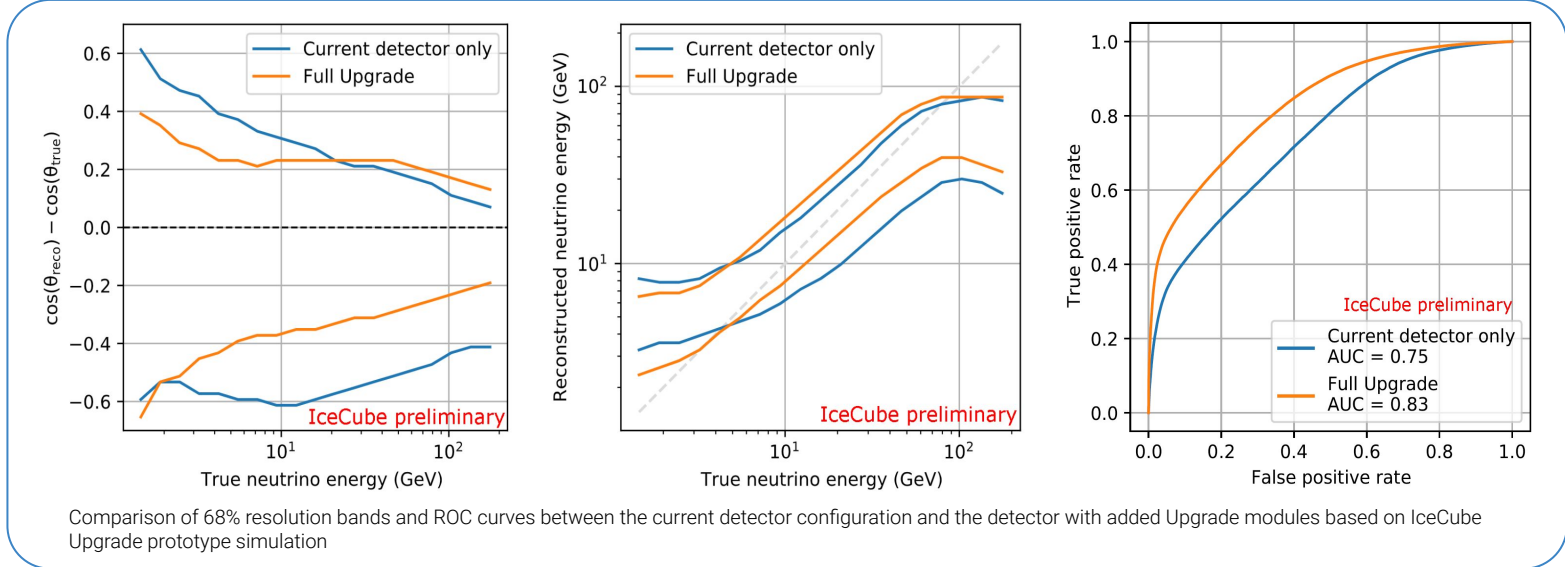
Application on current IceCube simulation:

- Improved resolution in all reconstructed parameters!
- Speedup of $\sim 10^4$!

Reconstruction of Neutrino Events in IceCube using Graph Neural Networks

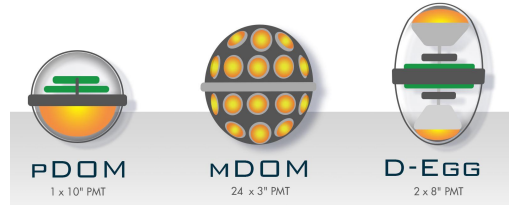
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IceCube Upgrade



Application on IceCube Upgrade

- Fully compatible without major modification to algorithm!
- Improvement of new strings and modules quantifiable!



Reconstruction of Neutrino Events in IceCube using Graph Neural Networks

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Summary:

Graph neural networks are

- Fast
($\sim 10^4$ times speedup)
- Flexible
(Applicable to both current IceCube and future IceCube Upgrade)
- Preserves the complete event information
- Resolution comparable or even better than baseline algorithms

Explore possibilities in event chain, e.g. event selection