

Update from Zagreb

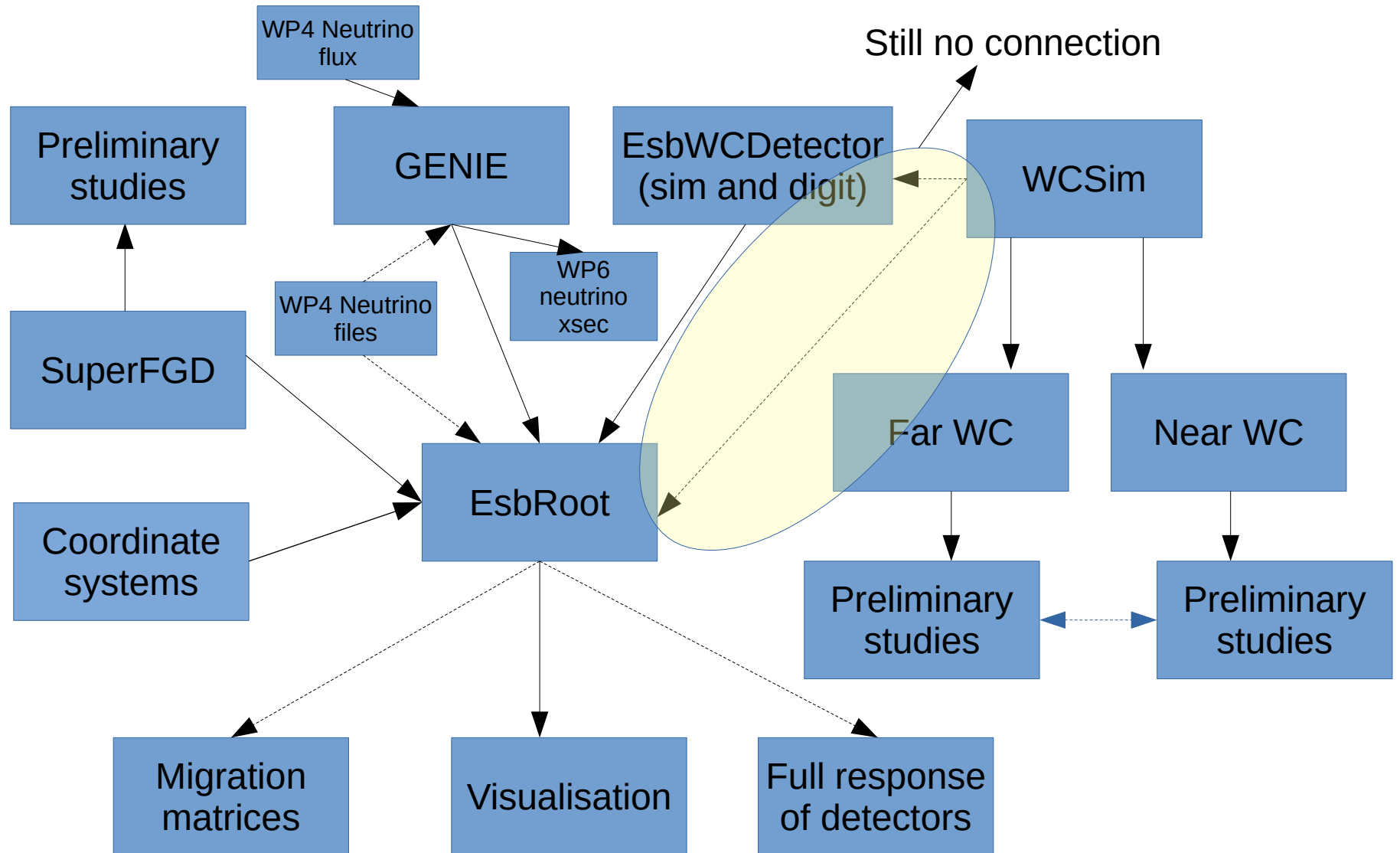
Budimir Kliček
IRB Zagreb

ESSnuSB/EuroNuNet annual meeting
22 October 2019, IRB, Zagreb

News since Strasbourg meeting

- Two software workshops + far detector meeting
- EsbRoot status
 - GitHub repository up and running
 - also keeping forks of external software (FairSoft, FairRoot, Genie, ...)
 - Doxygen page works
 - <https://essnusb.irb.hr/doxygen/>
 - Automatically updated with every commit to our GitHub repository
 - Master branch only
 - Genie integrated in to EsbRoot
 - more and more complex fluxes/geometries
 - Very advanced and beautiful visualisation of events
 - even movie-like visualisations in time
 - EsbRoot getting ready for physics
 - especially for FGD
- Using WCSim
 - WCSim used for studies of both ND and FD Water Cherenkov detectors
 - but, should be integrated in EsbRoot if we want the real thing

Things are starting to converge



New things since Pag WG meeting

- Software coordination
 - Using realistic neutrino spectrum in GENIE (Budimir)
 - Comparison between EsbRoot and WCSim (Peter, Jason)
 - FGD reconstruction (Georgi, Mariyan)
 - EsbRootView 2.0.0 (Guy)
- Far Detector
 - Further understanding of FD using WCSim (Olga)
 - Steps to implementing MEMPHYS geometry in WCSim (Mehmet, Gul)
- Flux measurement
 - Elastic scattering of neutrinos on electrons (Kaja)
 - Using emulsions could be a very interesting prospect (Fukuda-san)

Genie with realistic spectrum

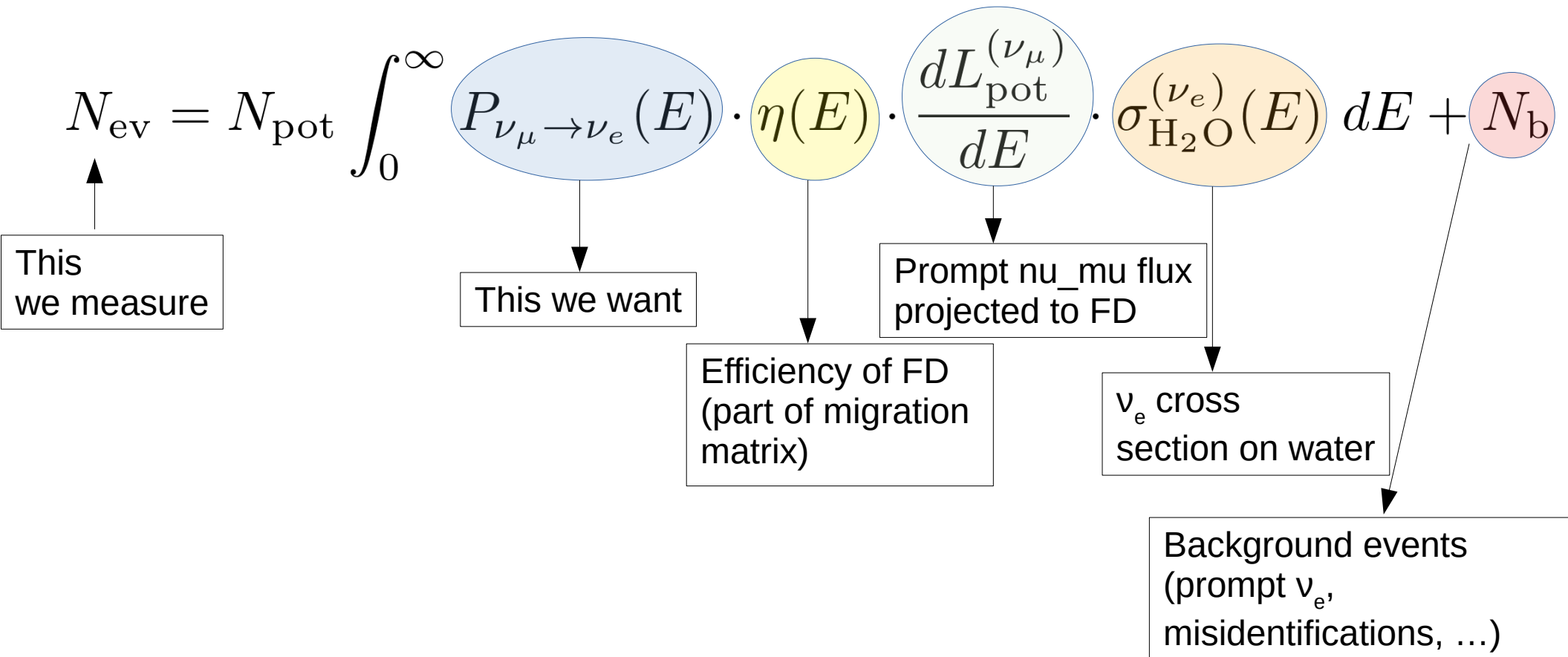
- Used old version of spectrum files (center of the beam)
<https://essnusb.eu/DocDB/private/ShowDocument?docid=342>
- Used vanilla Genie 3_00_04
 - not via EsbRoot
 - target is isotopically pure water
 - Production:
 - 96M ν_{μ} interactions
 - 10M ν_e interactions
 - Part of the production can be found at IRB cloud under:
Autumn_school/Genie_beamfiles

Plans for Zagreb

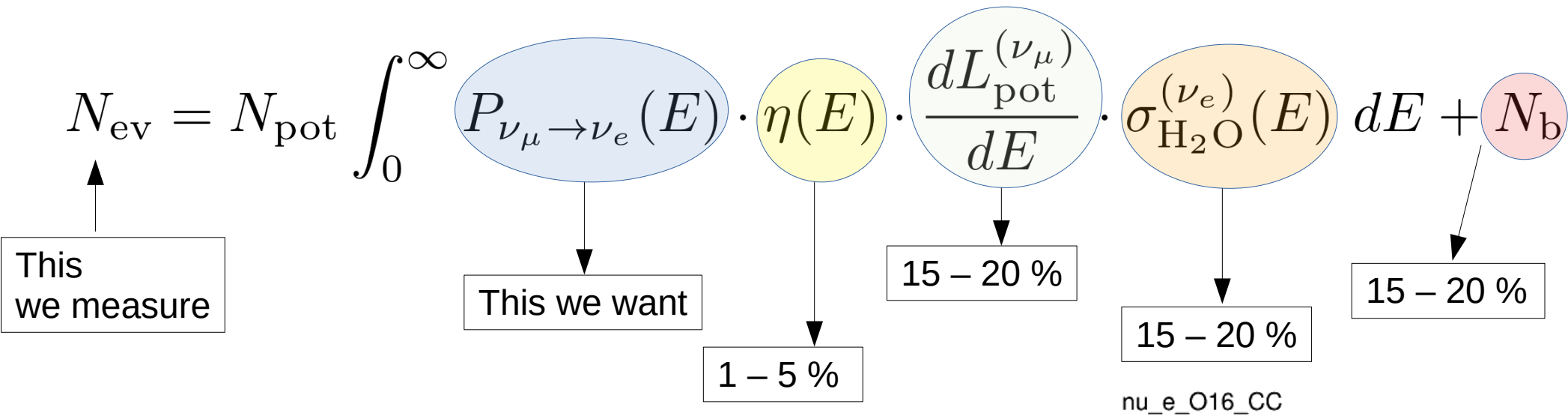
- Coordinate the EsbRoot development
- Work on FD (with Adana and Athens)
 - solve multi-ring problem
 - implement MEMPHYS geometry (IN PROGRESS)
 - evaluate various resolutions when shooting pure leptons (DONE)
 - neutrino migration matrices?
- Produce neutrino interactions in ND using neutrino list (realistic flux) from WG4
 - evaluate the difference wrt. central flux approximation
- Find ways to constrain flux at ND / FD sites using ESSnuSB's own future measurements
 - elastic scattering on electrons and more...

Constraints on flux and cross-sections

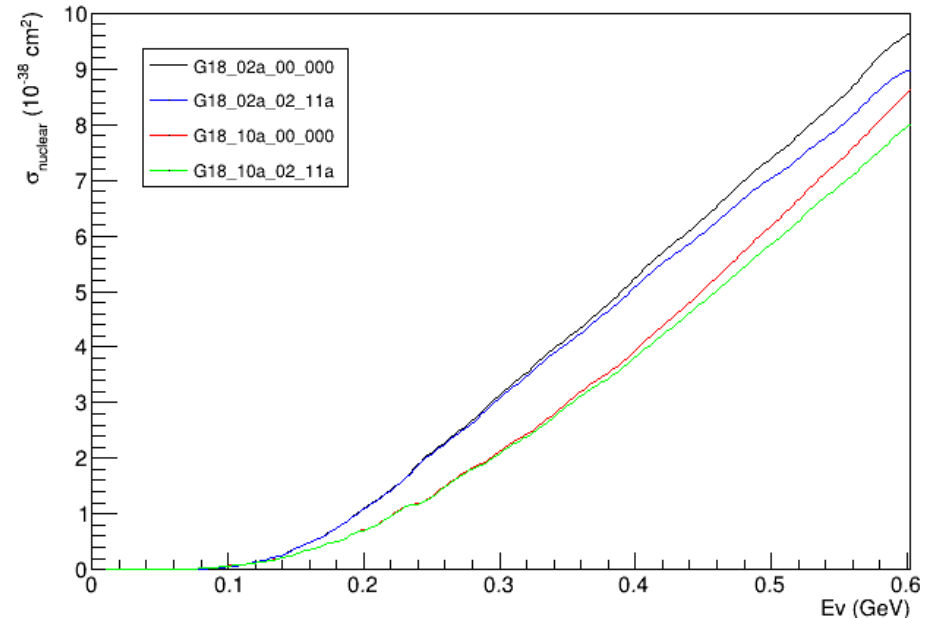
Signal at the far detector



Uncertainties at the far detector (personal educated guess)



This is without any constraints from near detector!



Uncertainties at the far detector (personal educated guess)

$$N_{\text{ev}} = N_{\text{pot}} \int_0^\infty P_{\nu_\mu \rightarrow \nu_e}(E) \cdot \eta(E) \cdot \frac{dL_{\text{pot}}^{(\nu_\mu)}}{dE} \cdot \sigma_{\text{H}_2\text{O}}^{(\nu_e)}(E) dE + N_b$$

This we measure

This we want

1 – 5 %

15 – 20 %

15 – 20 %

15 – 20 %

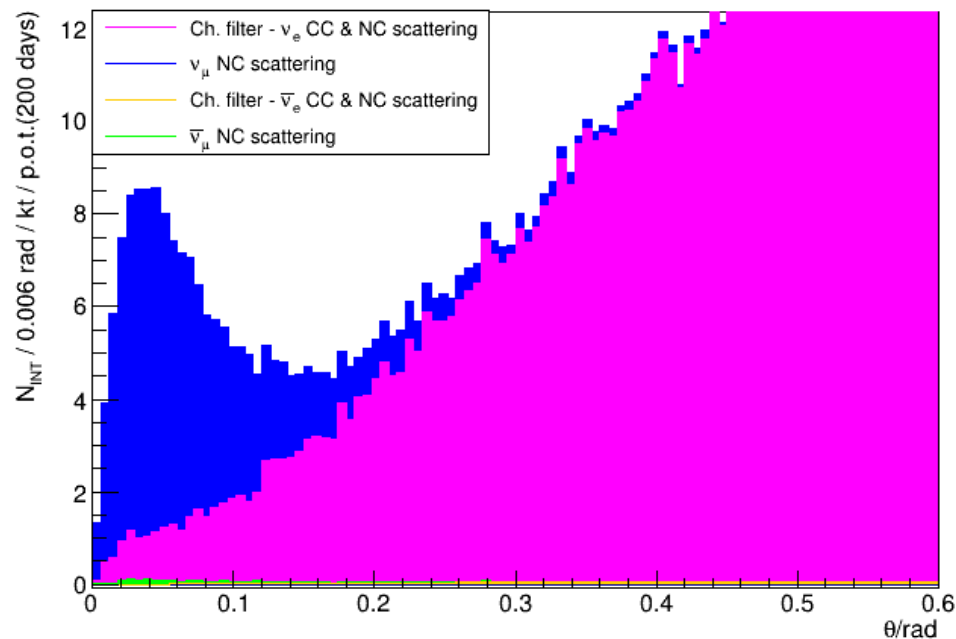
This is without any constraints from near detector!

Could be constrained by looking at ν_μ CC events at FD, but for this we need ν_μ xsec

Could be constrained by dedicated ND measurements and/or ENUBET type instrumentation of decay tunnel.

Measuring ν_μ xsec at near detector

- Measure ν_μ flux at ND using elastic scattering of neutrinos on electrons
 - cross-sections for this process can be calculated very precisely
- Measure ν_μ xsec using that flux
 - we can measure e.g. quasielastic cross-section of ν_μ on water



Plot by
Kaja Krhač

Conclusions

- We are progressing
- EsbRoot is getting ready for physics
 - but, there is still more work to be done
- Far detector evaluation is on-going
 - need to implement the MEMPHYS geometry to reproduce the previous results
 - the best would be to integrate WCSim to EsbRoot
 - we get neutrinos, CS, ... for free
- Interesting prospects to measure flux and cross-sections
 - elastic scattering of neutrinos on electrons at ND
 - emulsion detector
 - and more..

The end