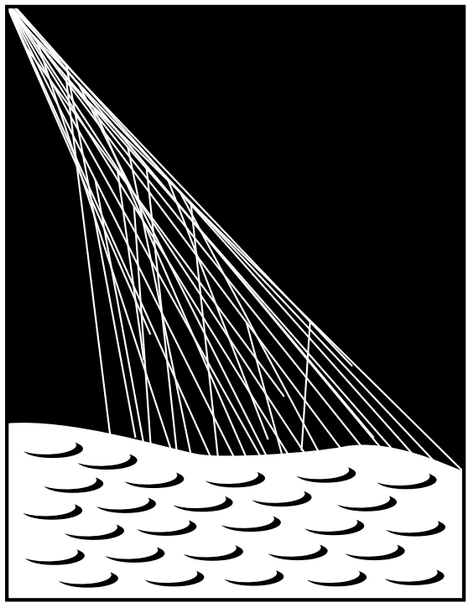


PIERRE AUGER OBSERVATORY

Update on the Continuous SD Neutrino Searches

Michael Schimp

April 2, 2020

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

BERGISCHE UNIVERSITÄT WUPPERTAL

Motivation

- Follow-up searches of LIGO/Virgo events running since 2019-04-01 (start of O3) on prod@Malargüe
  - SD neutrino analyses performed every 15 minutes
  - Scheme and details: Backup slides

- **Without coincidences:** Single neutrino candidate slightly above threshold in current Auger lifetime (~ 10 yr full SD equiv.) would be insignificant (expected background ~ 1 candidate)
  - Allow for more coincidences by continuous search with alerts to be sent out

- Avoid problems of actual unblinding by **not** looking at the distributions of sensitive quantities (e.g. trace properties) for non-candidate events (= pretty much all events)

Status

Set-up since 2019-10-17:

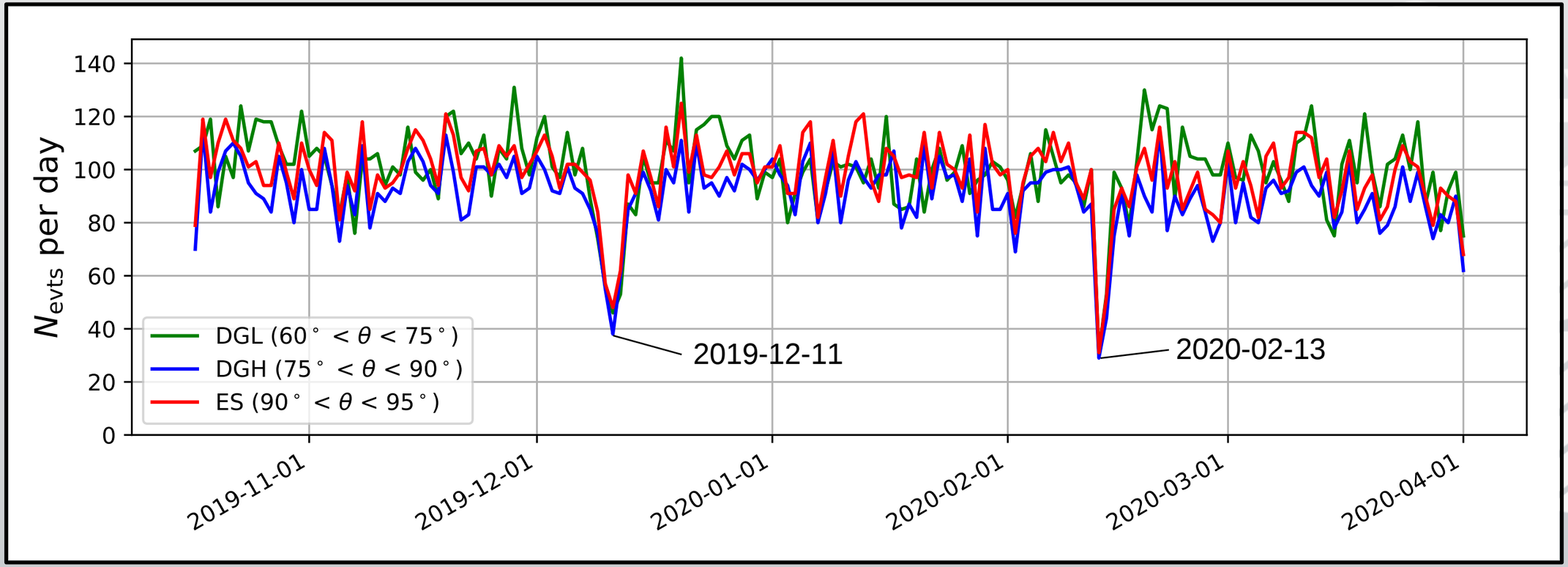
Existing routine running every 15 minutes on prod@Malargüe:

Alert us (Santiago + Wuppertal) in case event(s) fulfill neutrino criteria

- Independently trigger follow-up searches by others
- Tested and running without major issues
- Alert: Mail with event info and CDAS file containing candidate
- No alerts so far

Status — Event Rate

- Basic event selection (just inclination and quality cuts, neutrino analyses **not** applied)



- Very consistent behavior across angular ranges
- Reason for dips unknown

Upcoming

- Waiting for a candidate of course

- Rare occurrence of candidates, potential high impact of true signal
  - Won’t send out alerts/notices automatically, human vetting is **necessary**
  - Protocol/standard procedure after positive vetting?
    - **Be prepared**, no waste of time in case of interesting findings

- Suggestion (Jaime): Control plots of <AoP> and σ_{AoP} vs. time, in bins of 1 day (or 1 week, etc.) for different subsets (DGL/DGH/ES, or even finer)
  → Long term stability

Further ideas, suggestions, thoughts?

Other — Status of new neutrino CORSIKA simulations for SD

- DGL (zenith 60° – 75°)
  - New library (CORSIKA 7.7000, QGSJETII, FLUKA) soon to be completed
  - Lowest energies **already available** via iRODS, others coming soon (`/pauger/Simulations/libraries/schimp.neutrinos/CORSIKA_7.7000_QGSJETII-04_FLUKA`)
- DGH (zenith 75° – 90°)
  - Parameters for new CORSIKA library to be defined
  - Production request in preparation
- ES (zenith 90° – 95°)
  - Experimental phase:

    CORSIKA usable w/ workaround but no successful Offline SD simulation so far

Backup

Procedure of automatic LIGO/Virgo follow up

temporary SD file w/ events from current run (0..12 hours)

automatic
manual

prod@Malargüe

sd_online.root.nobackup

updated mostly every 15 min

standard neutrino reconstructions and analyses

Listener for GCN alerts

- Saves **GW event info** (basics + probability skymap)
- Looks for neutrino events in 90% CL region and period of [–500s..1day] among analyzed events (also “as they arrive”)
  - Communicates findings immediately

Event info (GCN)

LIGO/VIRGO Collaboration (LVC) open public alerts

(not live) BBH mergers: exposure + distance

sensitivity to UHEν flux (ICRC 2019)

Automatic mails to Auger neutrino people (Santiago, Wuppertal)

manual checking

BNS, mass gap, NSBH: send GCN notice after 24 h

Status of automatic LVC follow up

- ✔ Running stably & automatically

Premature termination due to COVID-19
(planned to run until 2020-04-30)

- O3: 2019-04-01 – 2020-03-27 with interruption (October 2019)
  - Large number and variety of interesting events, most likely origins:
    - 37 binary black hole (BBH) mergers
    - 6 binary neutron star (BNS) mergers
    - 5 neutron star black hole (NSBH) mergers
    - 4 mass gap events (>= 1 of merging objects between 3 and 5 solar masses)
    - 3 events classified to be of terrestrial origin
    - 24 retracted events (artifacts, noise, etc.)
  - ✔ All successfully received (as GCN notices) and processed