

Workshop on neutrinos@CERN  
CERN, 23-24 January 2025

## WRAP-UP & INTRODUCTION TO THE DISCUSSION

Claude Vallée  
CPPM Marseille

### Current & future CERN contributions to neutrinos:

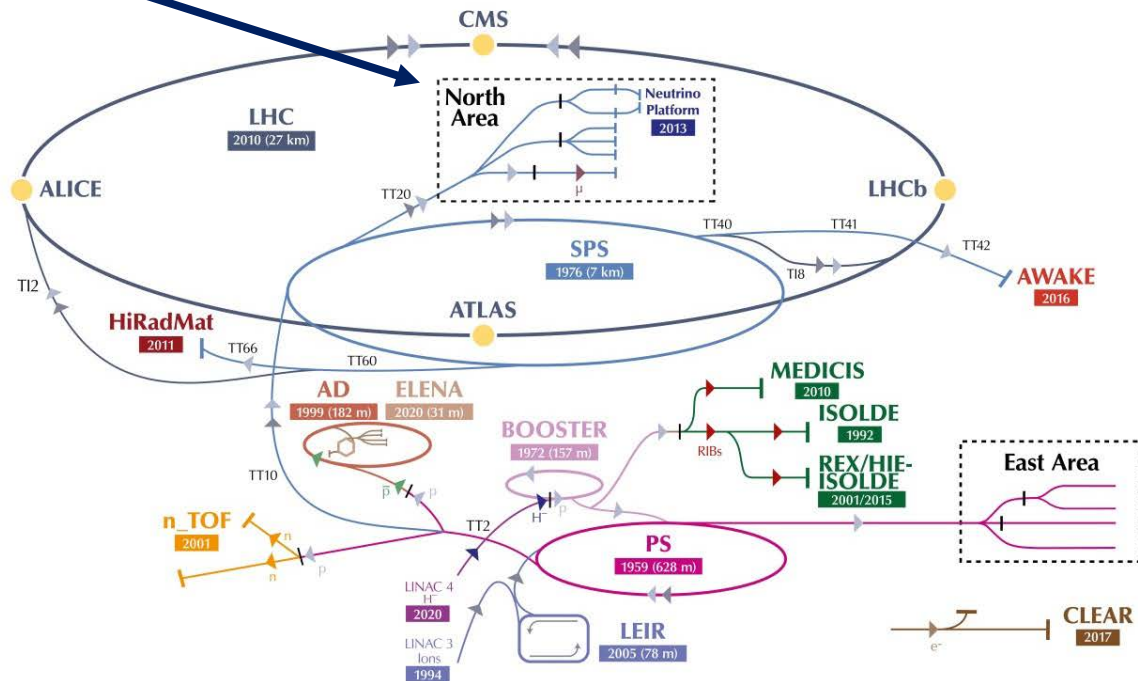
1. CERN inputs to external neutrino projects
2. CERN-specific neutrino physics
3. Some issues for decisions to come



# CURRENT CONTRIBUTIONS TO EXTERNAL NEUTRINO PROJECTS

## Neutrino beam control:

All beams: NA61/SHINE hadroproduction cross-sections and hadron production measurements with FNAL/JPARC neutrino beam replica targets



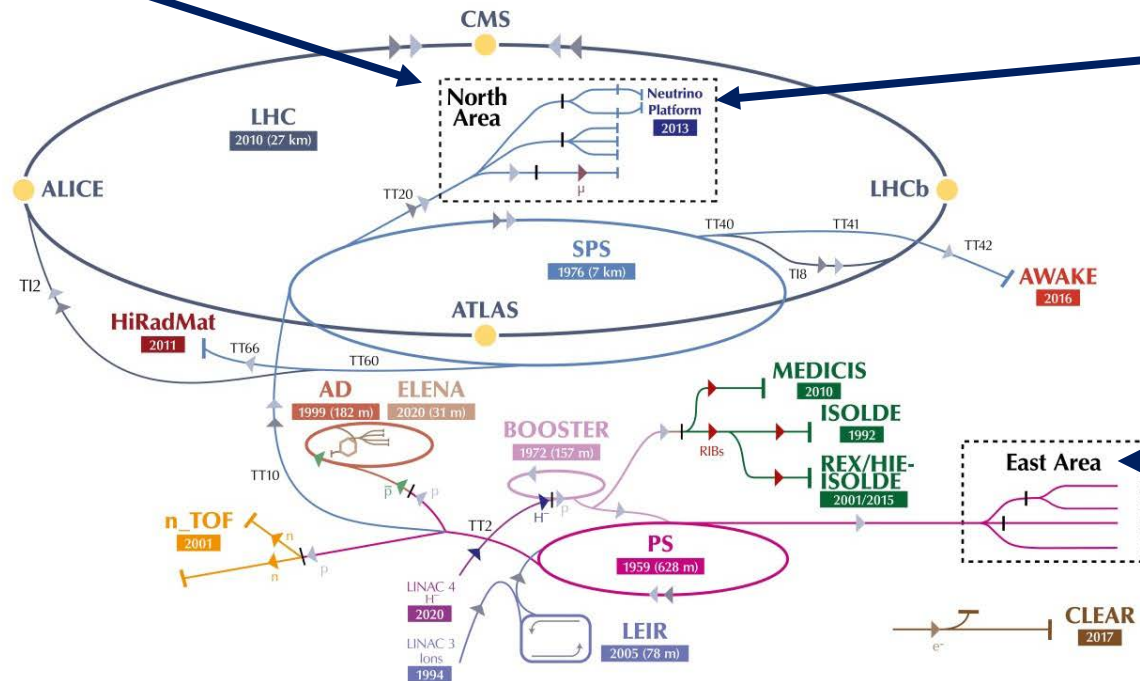
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## Neutrino detector technology and response:

- T2K: NP07 near detector
- DUNE: NP02 and NP04 far detector prototypes
- HK: NP08 for electronics  
WCTE detector prototype



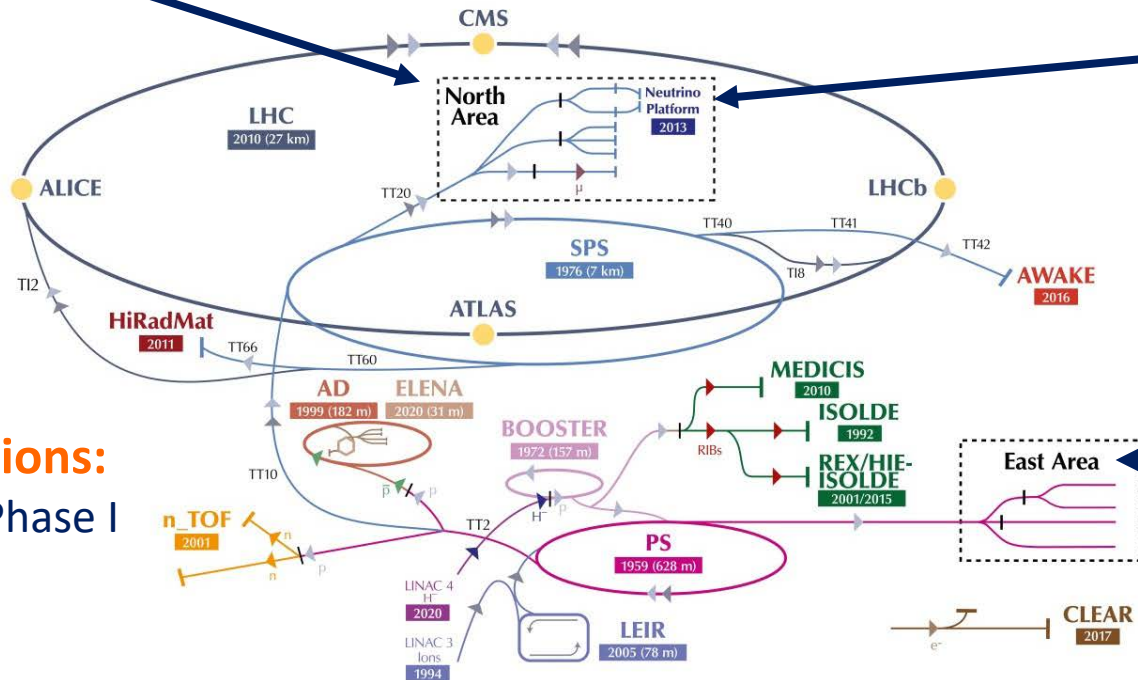
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## Neutrino interaction cross-sections:

NuSTORM@CERN studied by PBC Phase I



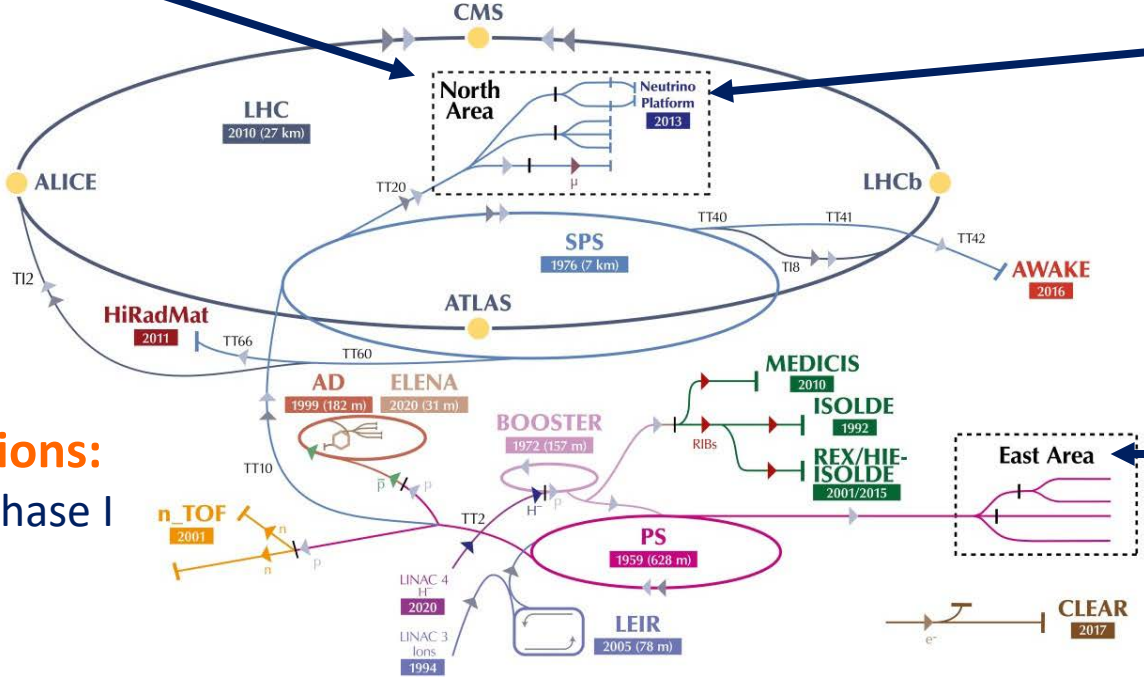
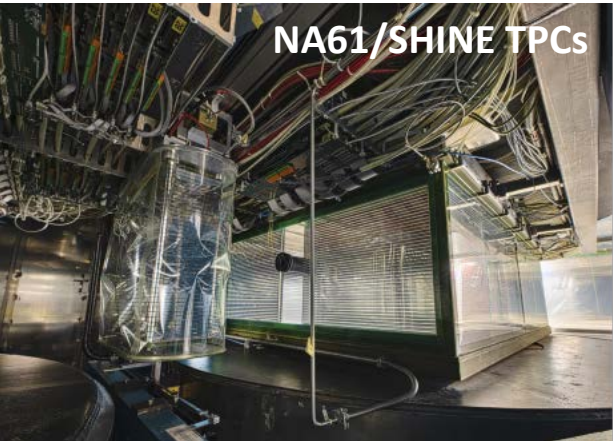
# FUTURE CONTRIBUTIONS TO EXTERNAL NEUTRINO PROJECTS

**Neutrino beam control:**

All beams: NA61/SHINE hadroproduction cross-sections and hadron production measurements with FNAL/JPARC neutrino beam replica targets  
 → *to be continued, additional low-E beam foreseen*

**Neutrino detector technology and response:**

- T2K: NP07 near detector → *completed*
- DUNE: NP02 and NP04 far detector prototypes → *new technologies (DUNE Phase II) + physics*
- HK: NP08 for electronics  
 WCTE detector prototype  
 → *data taking to be completed < LS3*



**Neutrino interaction cross-sections:**

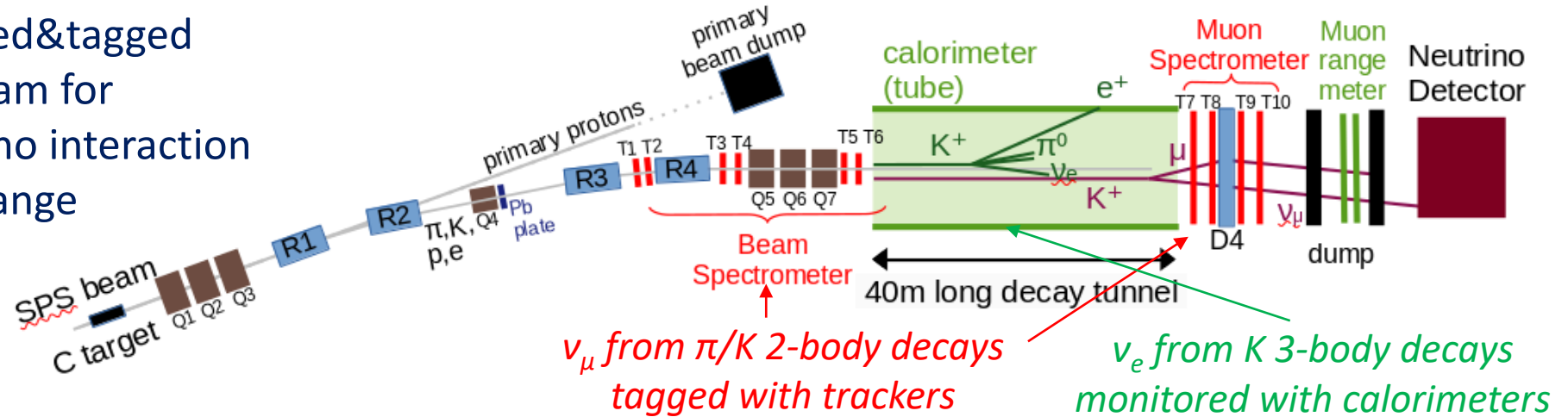
NuSTORM@CERN studied by PBC Phase I  
 → *SBN@CERN(ENUBET+NuTag) studied by PBC Phase II*

# FUTURE CONTRIBUTIONS TO EXTERNAL NEUTRINO PROJECTS cont'd

## SBN@CERN: a new facility under study for DUNE/HK

Medium-intensity monitored&tagged  
Short Baseline neutrino beam for  
%-level precision on neutrino interaction  
cross-sections in the GeV range

*Innovative  
slow extraction  
and focusing*

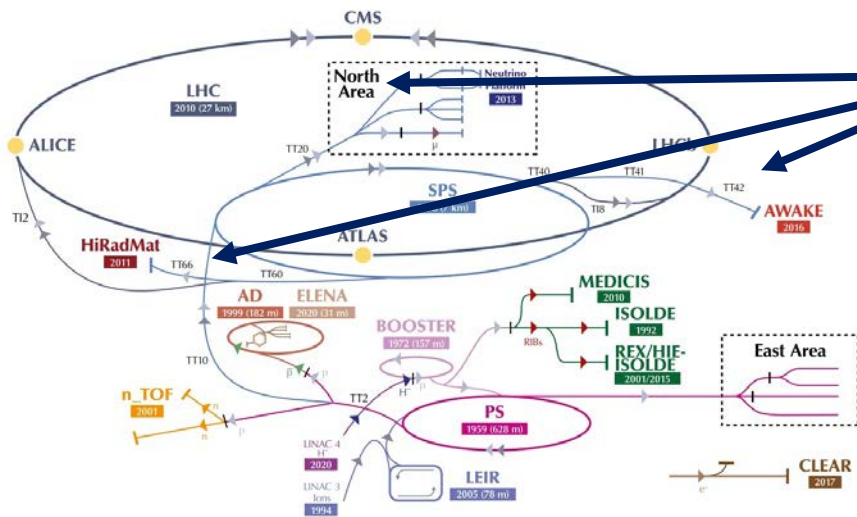
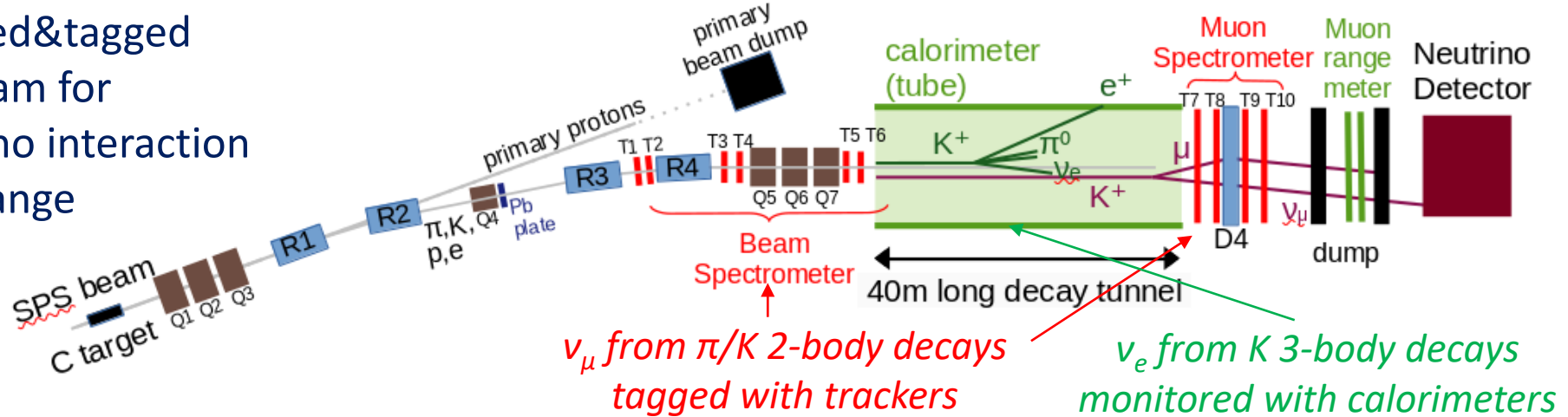


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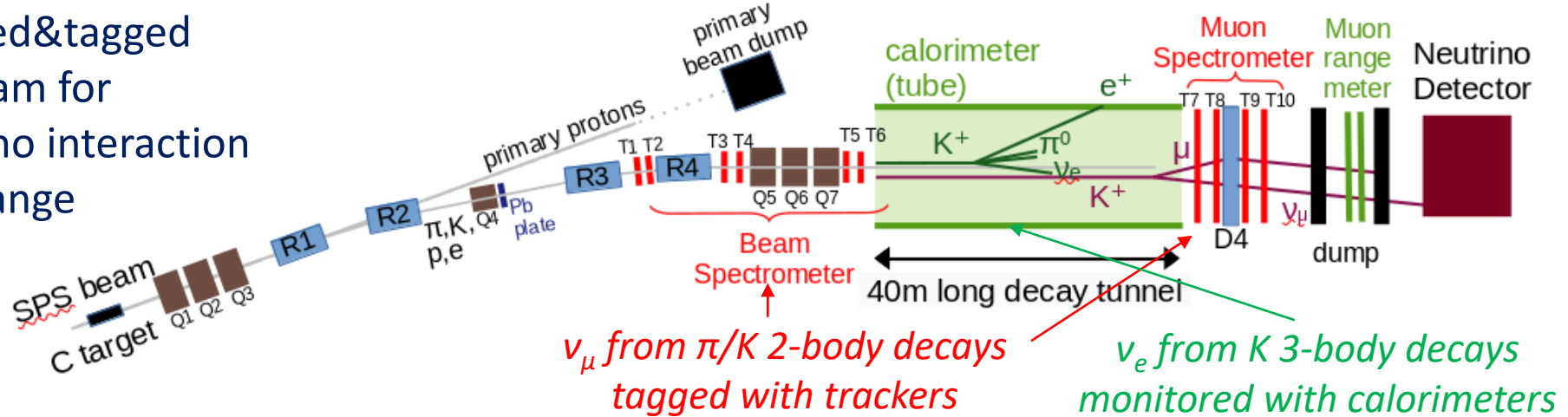


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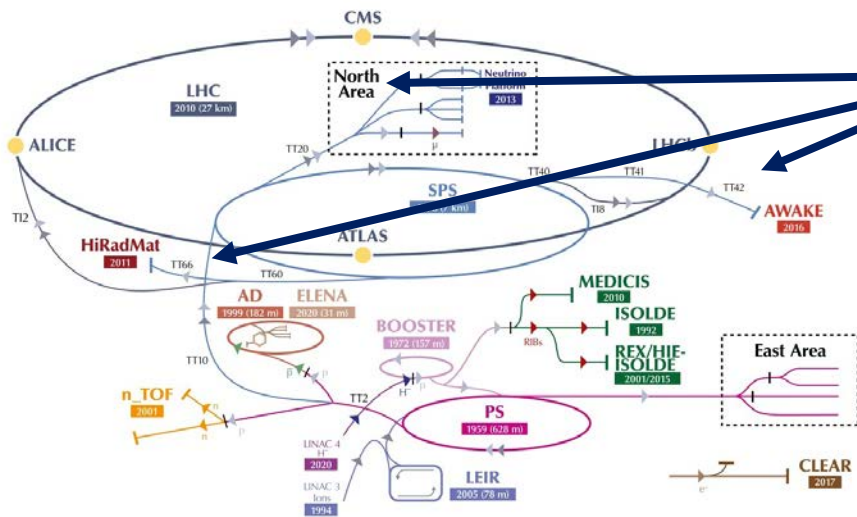
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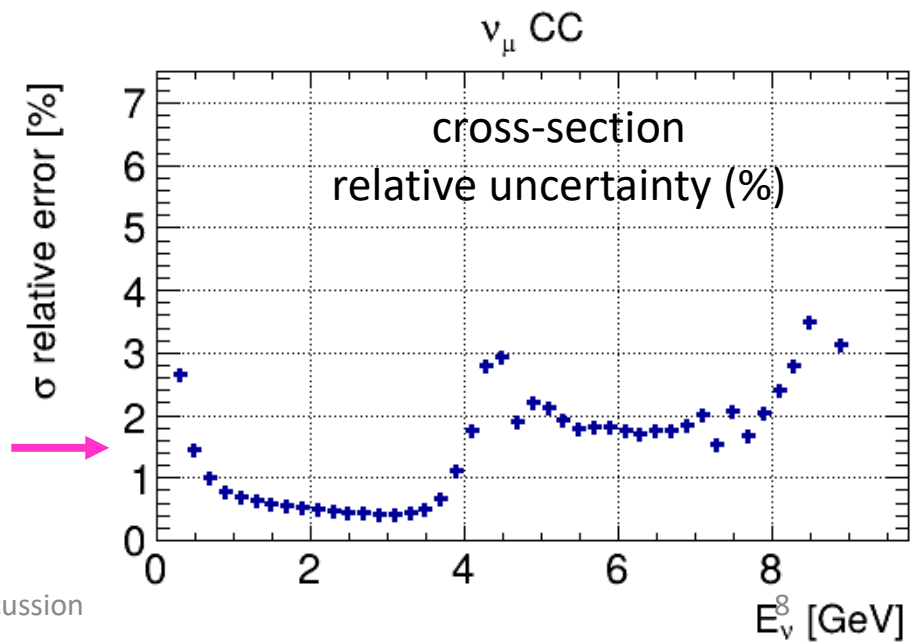
$\nu_\mu$  from  $\pi/K$  2-body decays  
tagged with trackers

$\nu_e$  from  $K$  3-body decays  
monitored with calorimeters



3 possible locations  
considered at CERN

Expect a strong reduction  
of a dominant systematics  
of DUNE/HK





## FUTURE CONTRIBUTIONS TO EXTERNAL NEUTRINO PROJECTS cont'd

*NB: the neutrino tagging technique may pave the way to a post-DUNE/HK sustainable high-precision LBL neutrino project in synergy with neutrino astronomy:*

- Huge size of deep-water detector over-compensates the moderate beam intensity
- Individual neutrinos measured at source → low-granularity Far Detector sufficient

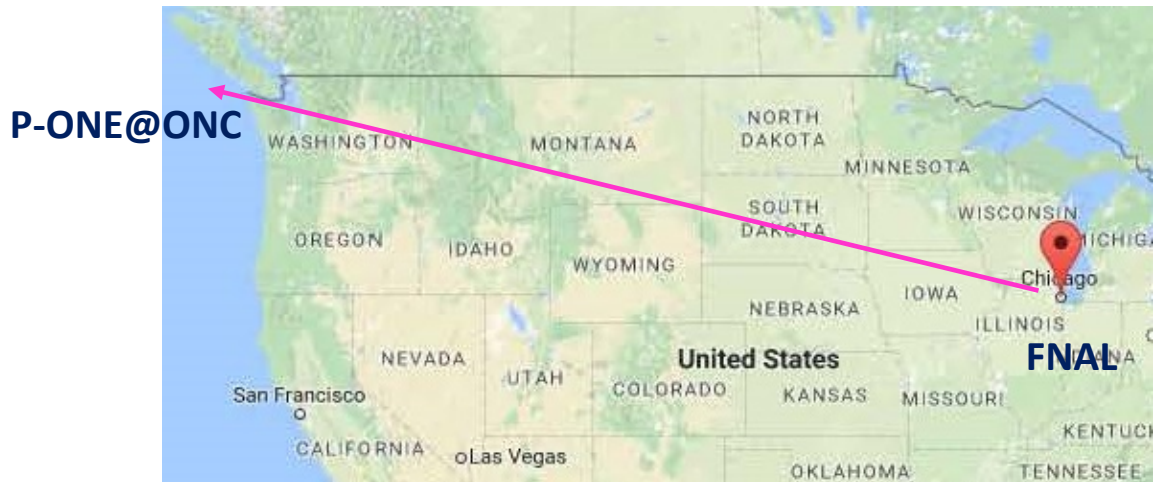
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Possible LBL configurations:

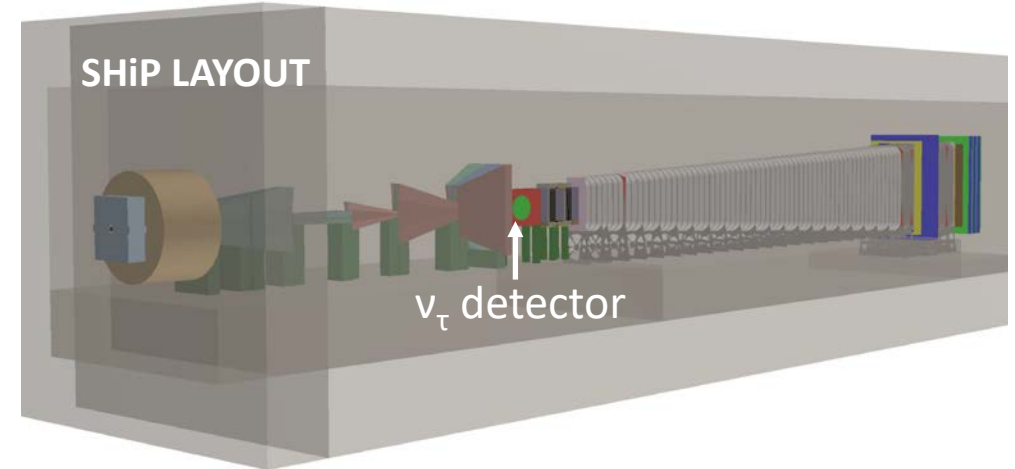
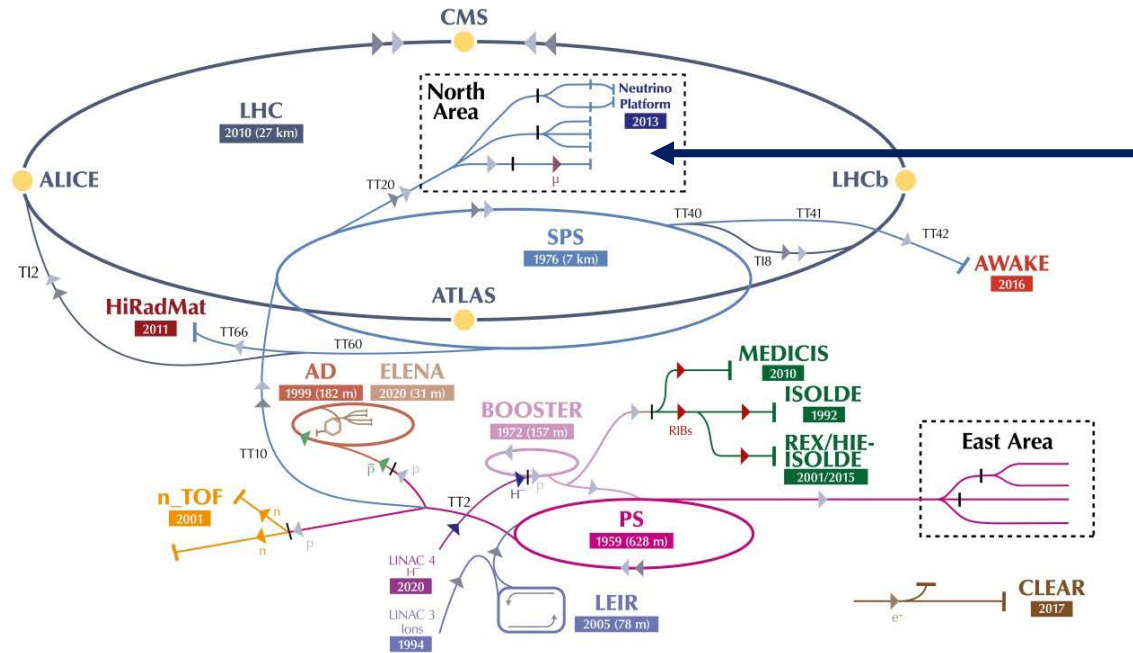
FNAL → P-ONE



CERN → KM3NeT



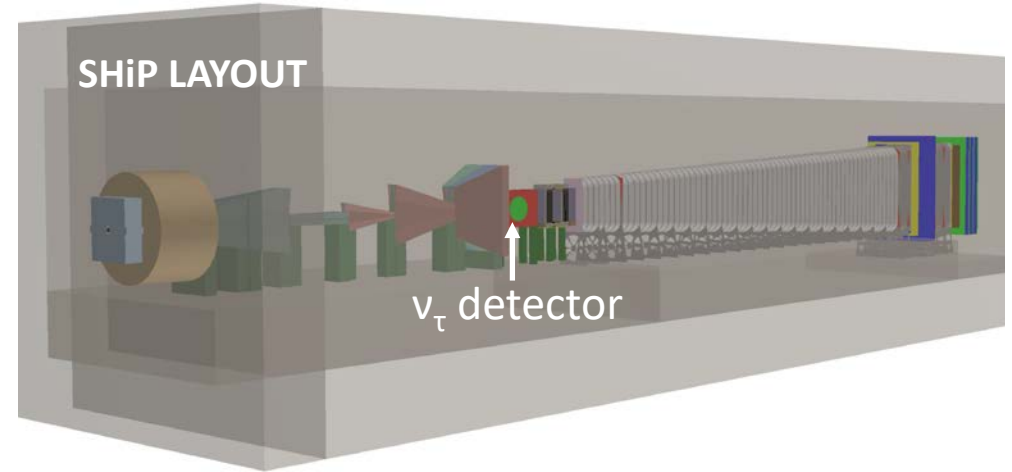
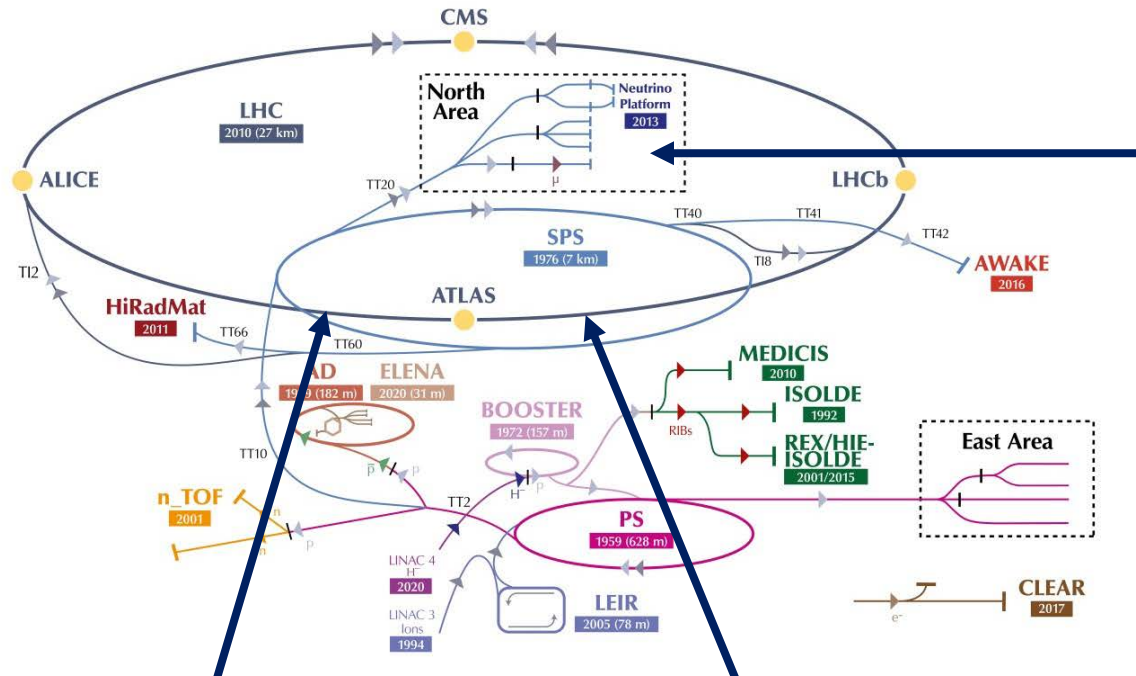
# CURRENT CERN-SPECIFIC NEUTRINO PHYSICS



## 10-100 GeV neutrinos @SPS

- DsTau  $\tau$ -neutrino production cross-section
- SHiP high-statistics  $\tau$ -neutrino measurements

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SND

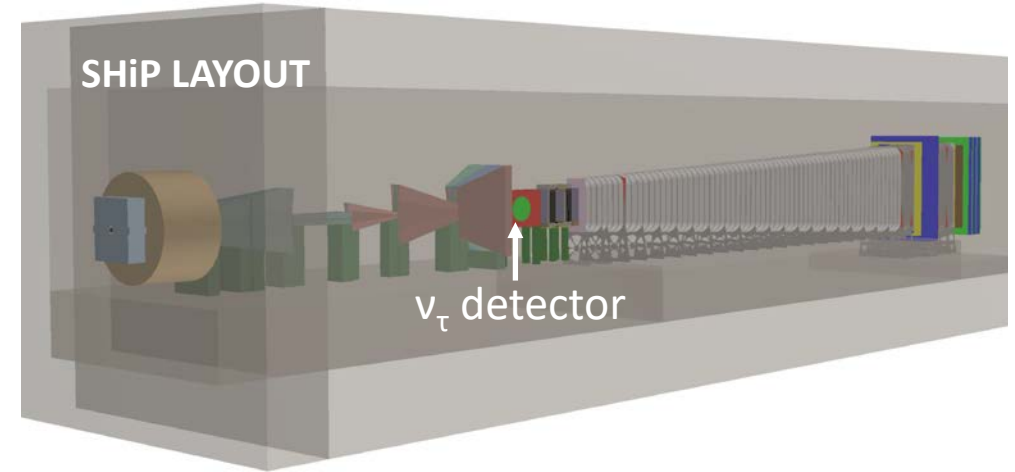
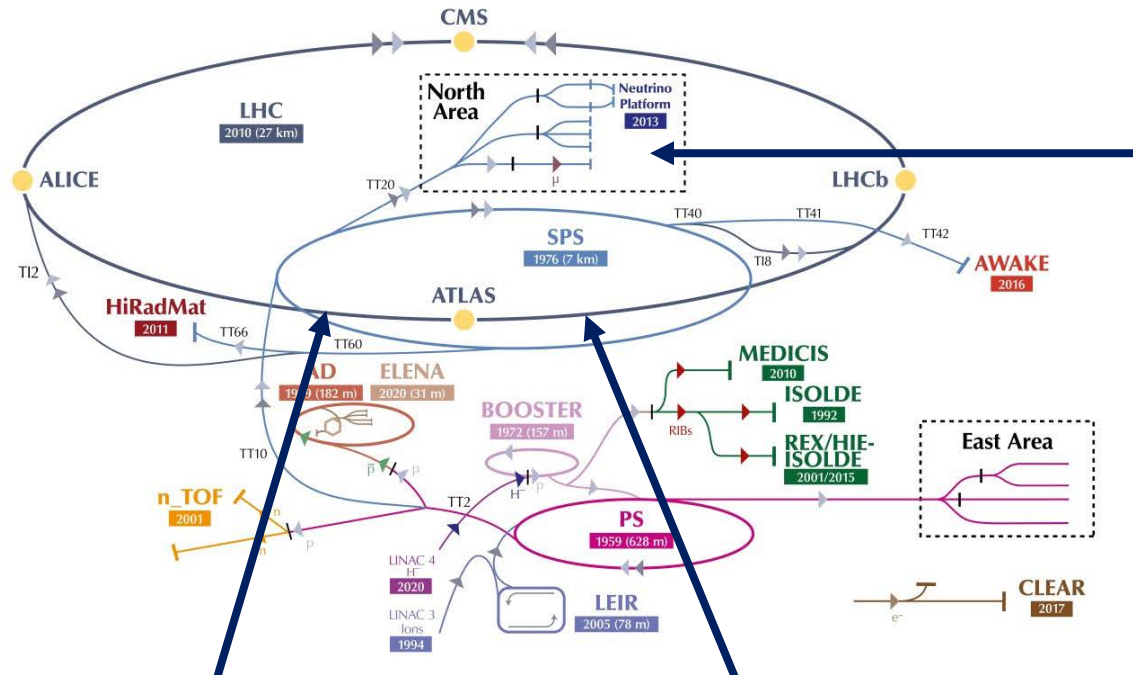


FASER

## TeV neutrinos @LHC:

- FASERv
- SND@LHC

# FUTURE CERN-SPECIFIC NEUTRINO PHYSICS



## 10-100 GeV neutrinos @SPS

- DsTau  $\tau$ -neutrino production cross-section  
→ *data taking completed, final results to come*
- SHiP high-statistics  $\tau$ -neutrino measurements  
→ *final design and construction to come*

## TeV neutrinos @LHC:

- FASERv → *upgrades foreseen for run 4 at present location*
- SND@LHC → *upgrades foreseen for HL-LHC at present location*  
→ *Forward Physics Facility studied by PBC Phase II*



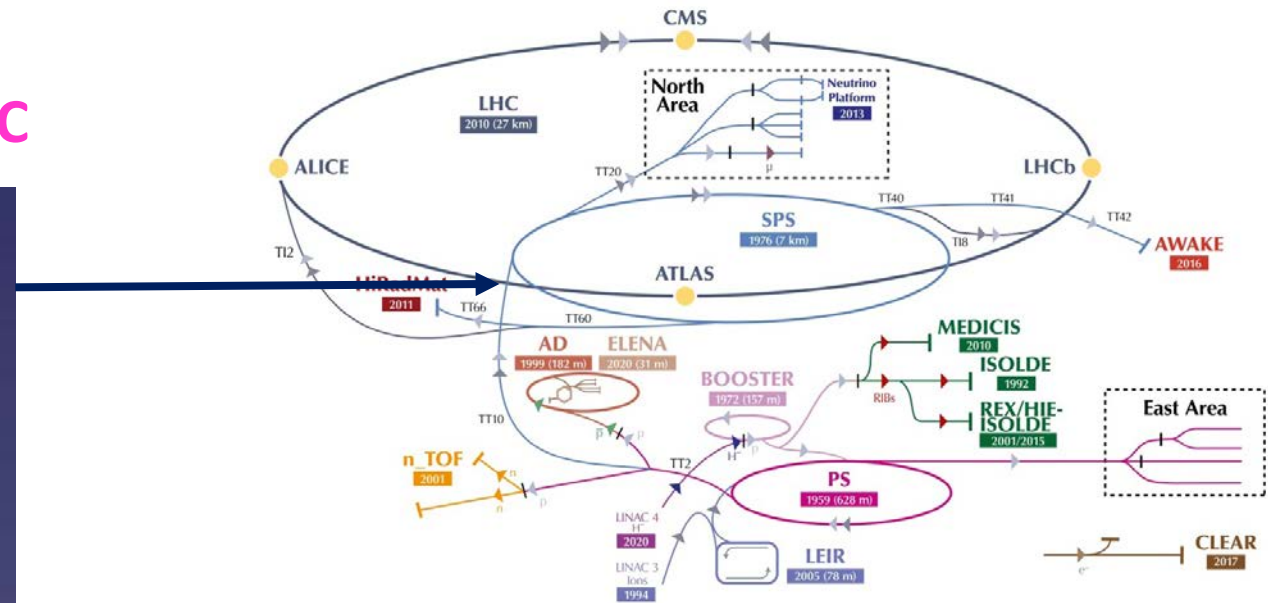
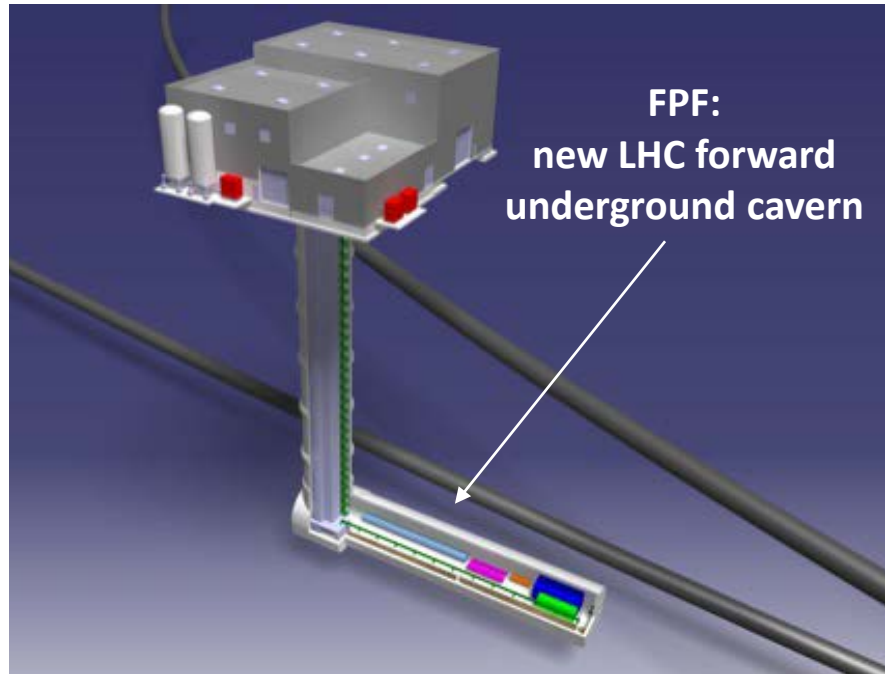
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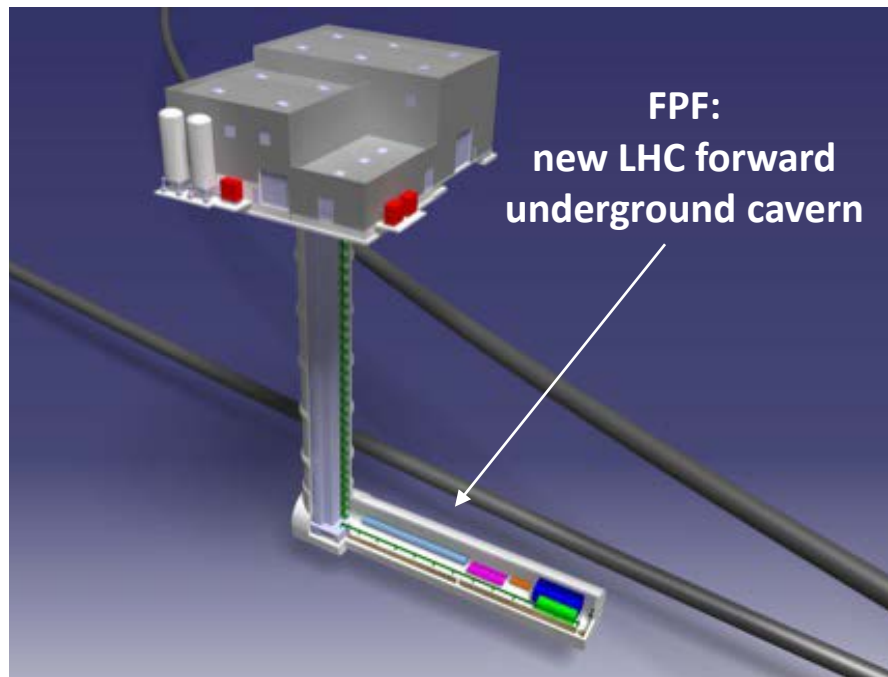
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Forward Physics Facility:  
a new facility proposed for HL-LHC

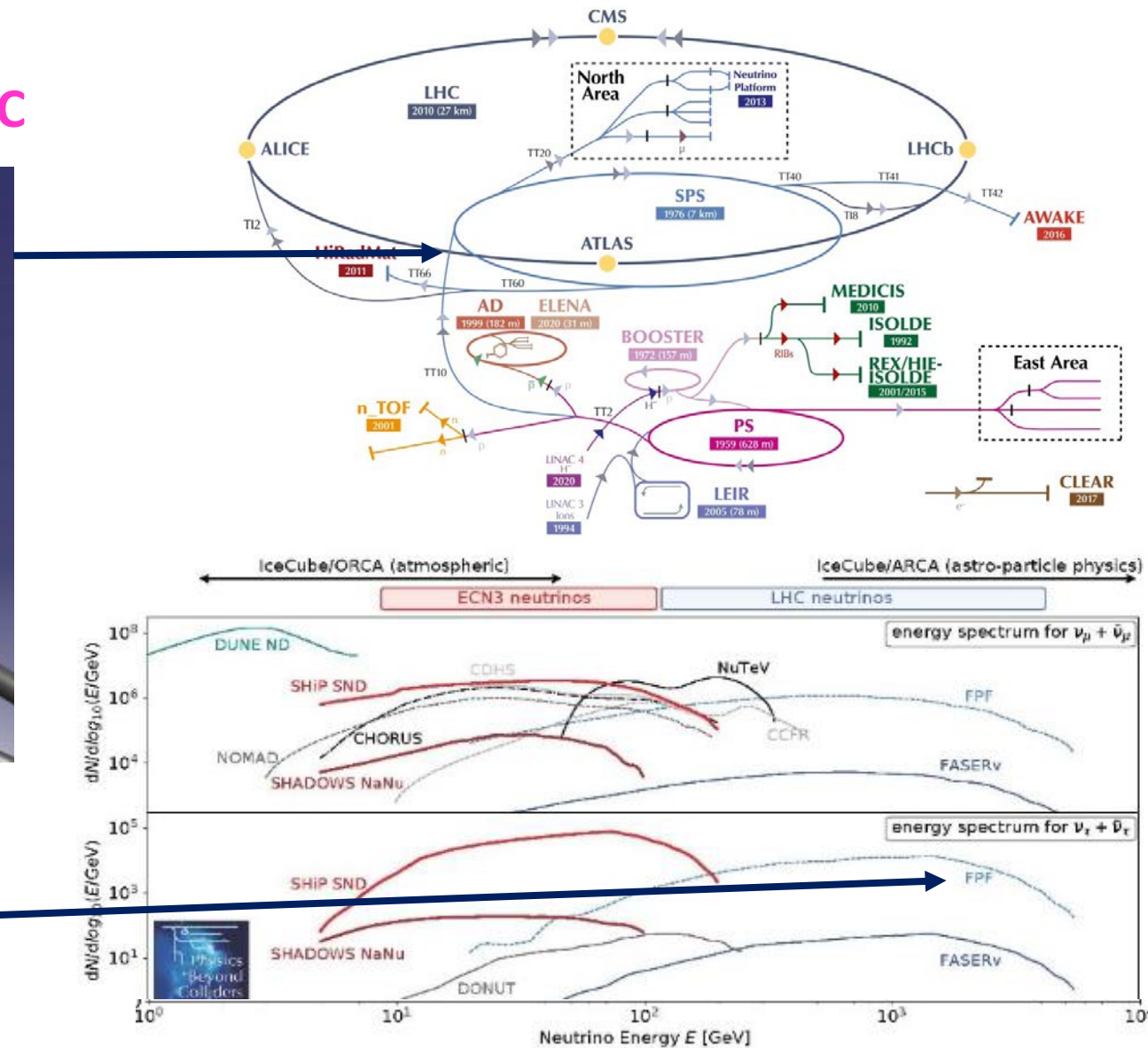


# FUTURE CERN-SPECIFIC NEUTRINO PHYSICS cont'd

Forward Physics Facility:  
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2 orders of magnitude more statistics  
expected in TeV-neutrino samples



# CERN FUTURE CONTRIBUTIONS TO NEUTRINOS

## SOME ISSUES FOR DECISIONS

*(personal view)*

### Neutrino detector technology and response:

- WCTE program completion @PS <LS3
- Future use of NP02 and NP04 LAr detector prototypes (technology ↔ physics)

### Neutrino interaction cross-sections:

- Final design of a cost-effective monitored&tagged SBL implementation @CERN
- Possible consideration of alternative locations with FNAL/JPARC

### Neutrino physics@CERN:

- Consolidation&quantification of the SHiP neutrino program and its fundamental reach e.g. for  $\tau$ -neutrinos
- Quantitative comparison of the TeV neutrino physics potential of a new dedicated LHC cavern compared to that of present locations and to the expected reach of the SHiP program.



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**THANKS AND LET'S DISCUSS!**