# Stato attività 2021 SHiP-SND e piani per il 2022 SND@LHC

# Stato attività SHIP

- ✓ 2020 Update of the European Strategy for Particles Physics
  Collaborazione SHiP : rallentamento nella preparazione del
  Technical Design Report

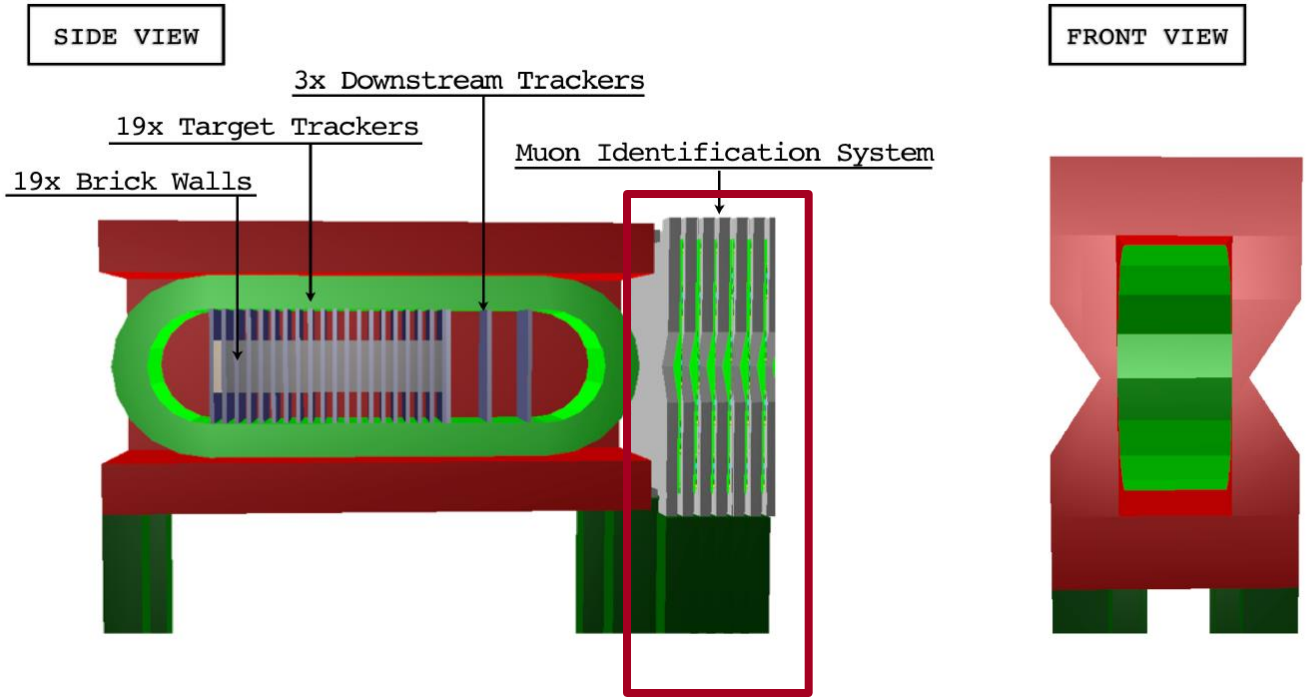
- ✓ Medium-Term Plan for the period 2020-2024
  *"Changes since the previous MTP"*
  *PBC activities are funded with an **increased budget of 3 MCHF/year** in this MTP (up from 1 MCHF/year). These resources will also be used to continue R&D and design studies (beam extraction and transfer, target system, radiation protection, etc.) for **a beam dump facility at the SPS**, so as to be ready to start construction before the end of the decade if a decision is taken on its implementation **by the time of the next ESPP update**.*

- ✓ 2 articoli pubblicati
  - *Sensitivity of the SHiP experiment to dark photons decaying to a pair of charged particles, Eur.Phys.J.C 81 (2021) 5, 451*
  - *Sensitivity of the SHiP experiment to light dark matter, JHEP 04 (2021) 199*

- ✓ 4 articoli in preparazione

# Scattering and Neutrino Detector (*SND*)

SHiP Progress Report
CERN-SPSC-2019-010 / SPSC-SR-248




**SND ν Physics potential**:

- first ever observation of anti- $\nu_\tau$
- $\nu_\tau$ and anti- $\nu_\tau$ physics with high statistics wrt the state of the art
- $\nu$ induced charm production studies
- $\nu_f$ cross sections measurements

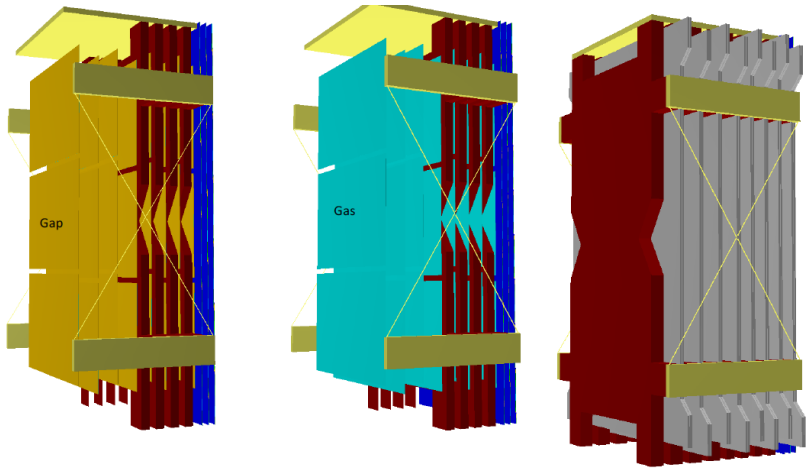
***Bari Group***

**M. De Serio Project Leader dell'Upstream Muon Detector e membro del Techical Board**

# attività SND @ Bari

***Task per il Muon ID system:***
***Design del Muon ID system, Struttura meccanica degli RPC , Elettronica , DAQ***

***Design del Muon ID system***
Analisi Monte Carlo dedicata alla ottimizzazione del design del Muon ID system

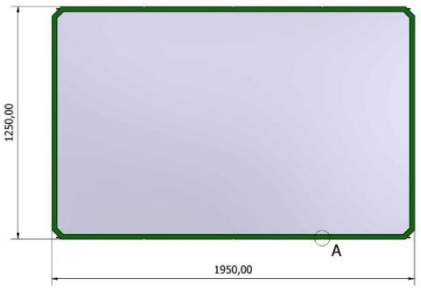


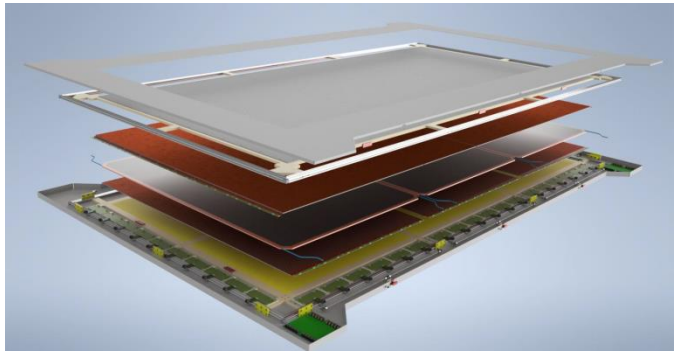

***Struttura meccanica degli RPC***

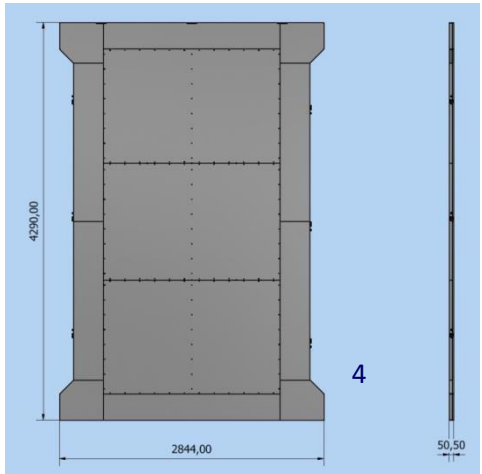
Ottimizzazione della struttura → **completata**

V. Valentino, CAD meccanico INFN Bari

Costruzione del prototipo della struttura e test di sospensione → **to do**



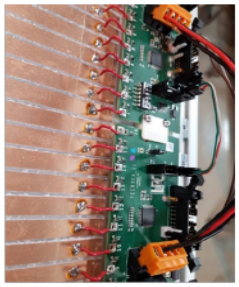


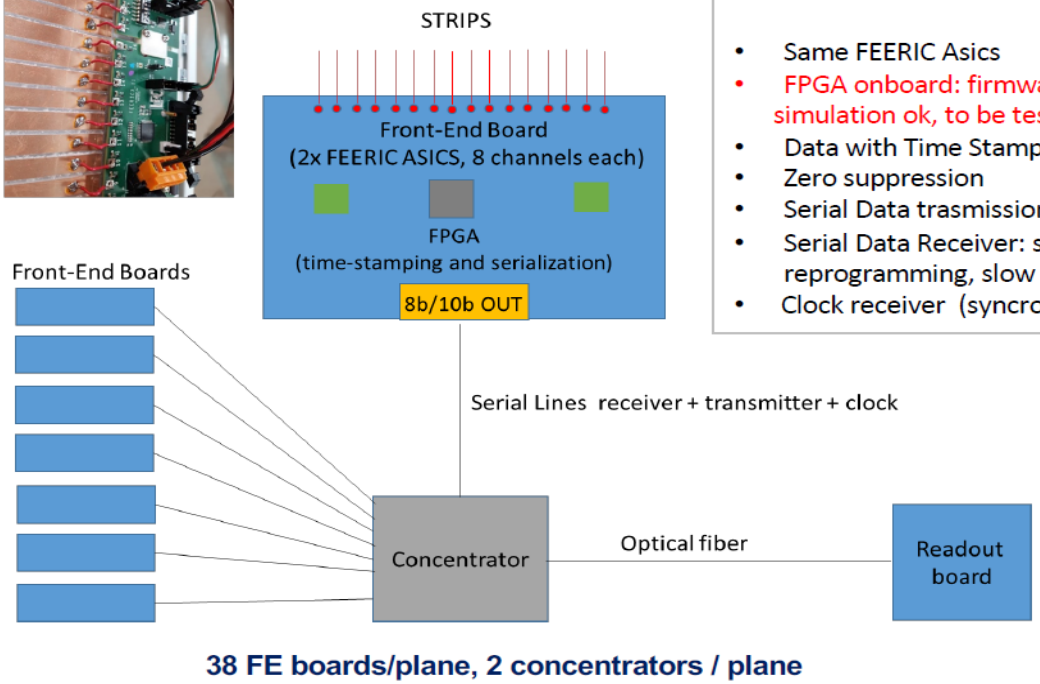
# attività SND @ Bari

***Tasks per il Muon ID system:***
***Design del Muon ID system, Struttura meccanica degli RPC , Elettronica , DAQ***

G. De Robertis, CAD elettronico INFN Bari

L. Congedo






**NEW Front end board**

- Same FEERIC Asics
- FPGA onboard: firmware ready, simulation ok, to be tested
- Data with Time Stamp @160MHz
- Zero suppression
- Serial Data trasmission (8b/10b)
- Serial Data Receiver: self trigger, FPGA reprogramming, slow control
- Clock receiver (syncronization)

**38 FE boards/plane, 2 concentrators / plane**

Full simulation of the FPGA project, including the simulation of the DAQ, performed

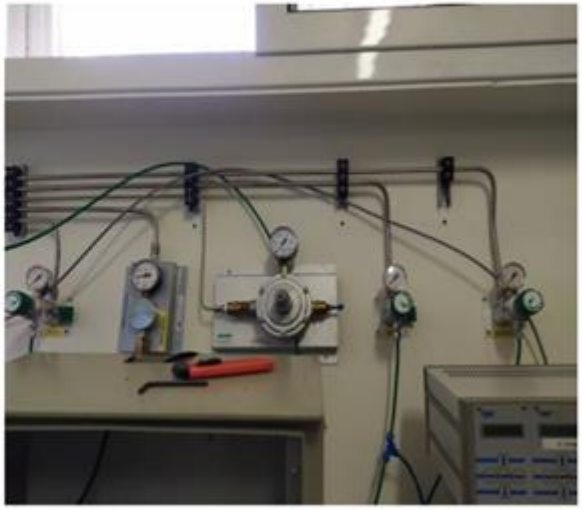
**production of prototype boards with new FPGA → DONE!**

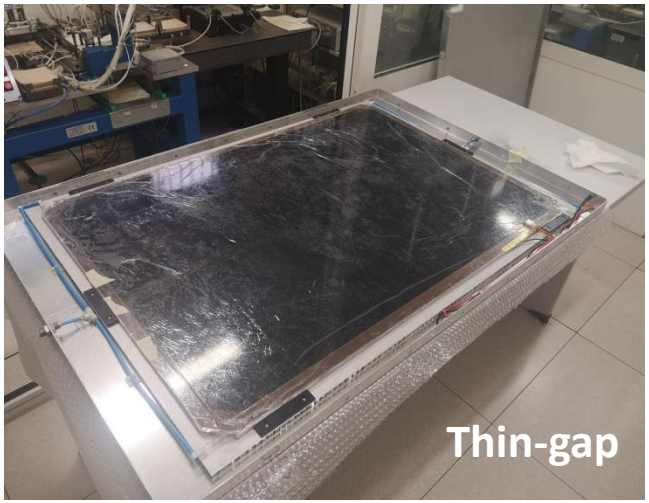
**test of the prototype boards → on going …**

# R&D @ Bari

C. Pastore M. Franco e S. Martiradonna,
Officina meccanica INFN Bari

## LAB RPC BARI




- **R&D** sull'uso di **miscele** di gas **eco-compatibili** (GREEN/GRANT 73) → **ON-GOING**

- **R&D** con **gap** di **spessore ridotto** rispetto agli attuali 2mm, per ottimizzare le performance con miscele freon-free e condizioni di lavoro ad alto rate (LHC-like). A Bari, l'attività è portata avanti in **sinergia** con CMS e, in particolare, in collaborazione con G. **Iaselli** e G. **Pugliese** → **ON-GOING**

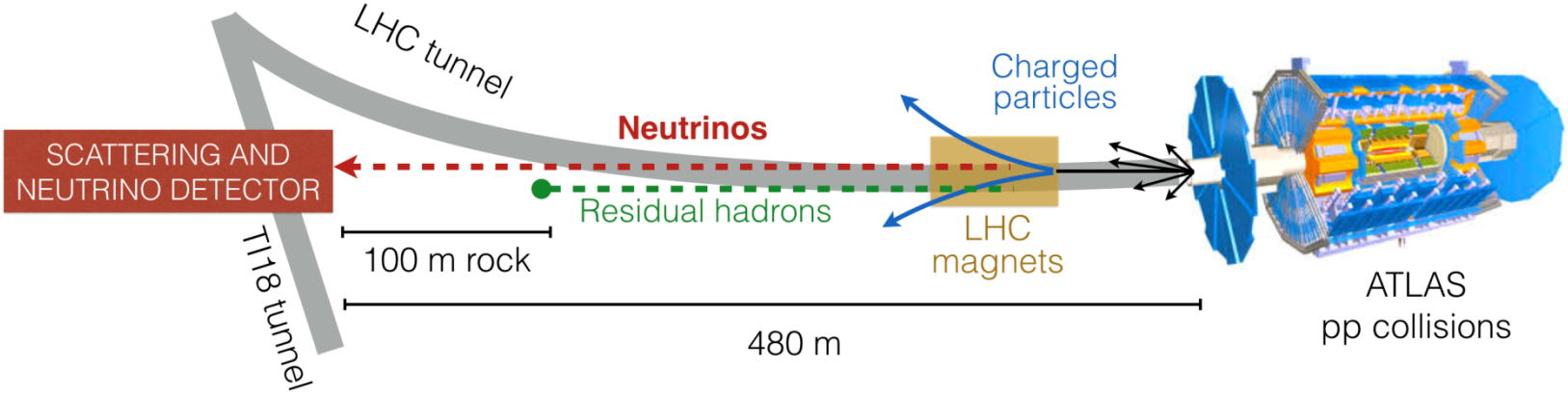
- Esposizione a raggi cosmici del rivelatore instrumentato con gap sottili per **performance test** → **READY TO START**

# *Scattering and Neutrino Detector operating at the LHC*

- ✓ EoI per SND@LHC sottomessa a febbraio 2020
  *"heavy flavor production at large rapidities*
  *neutrino production at high energies"*
  [arXiv:2002.08722 ; CERN-LHCC-2020-002 ; LHCC-I-035 ; LHCC-I-035]

- ✓ SND@LHC Technical Proposal sottomesso il 24 febbraio 2021
  https://cds.cern.ch/record/2750060/files/LHCC-P-016.pdf

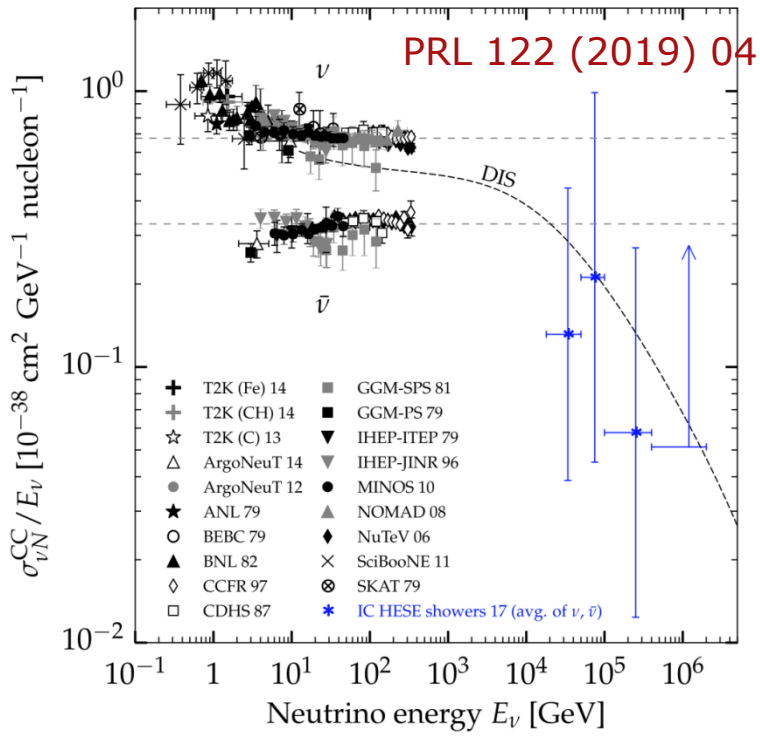
- ✓ **Approval March 2021, start with Run3 (Feb.2022)**



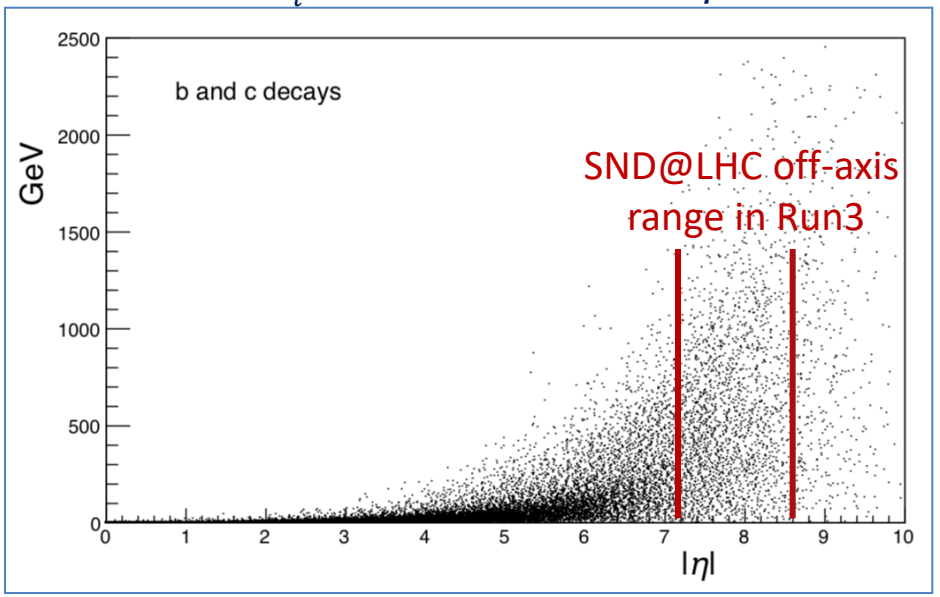
# SND@LHC

a very compact detector for high-energy neutrinos

PRL 122 (2019) 041101




$\nu_\tau$ ~5% for 6.5< $\eta$ <9



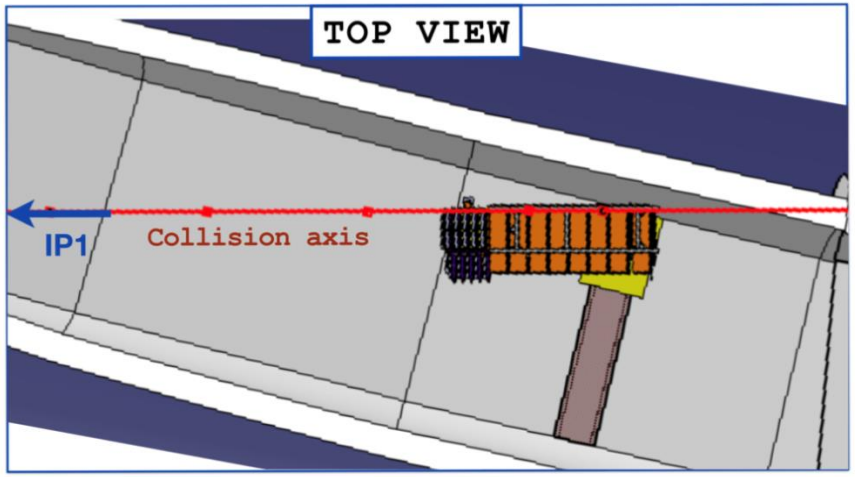

Journal of Physics G 46 (2019) 115008

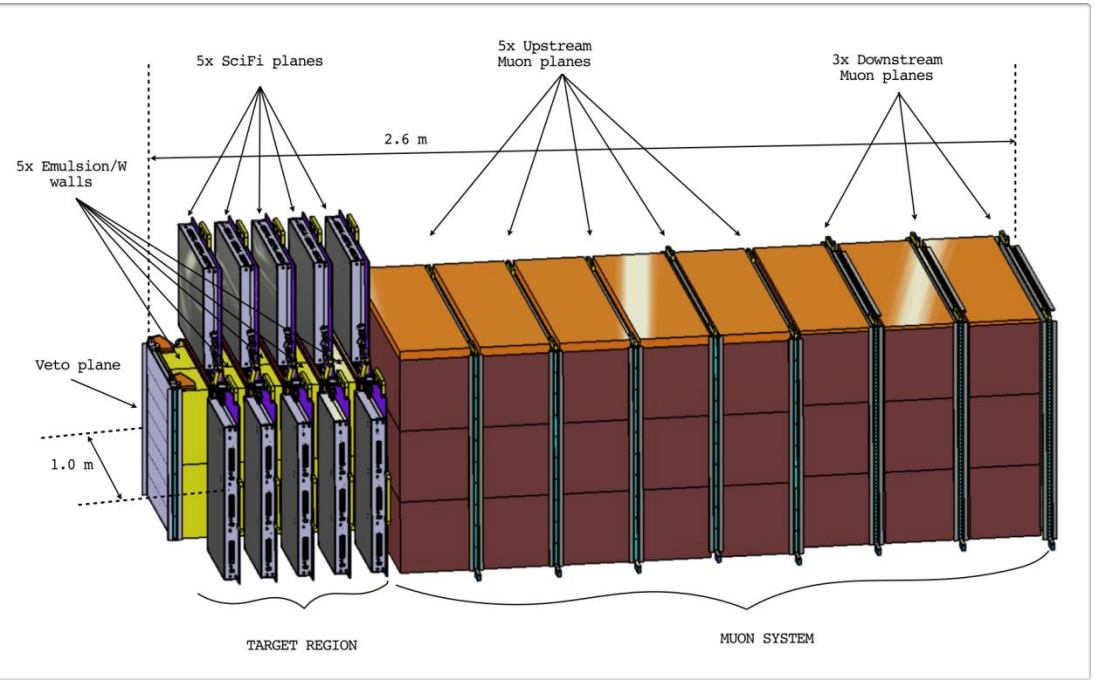
CERN is unique in providing energetic **ν** (from LHC) and measure pp → **ν**X in an unexplored domain

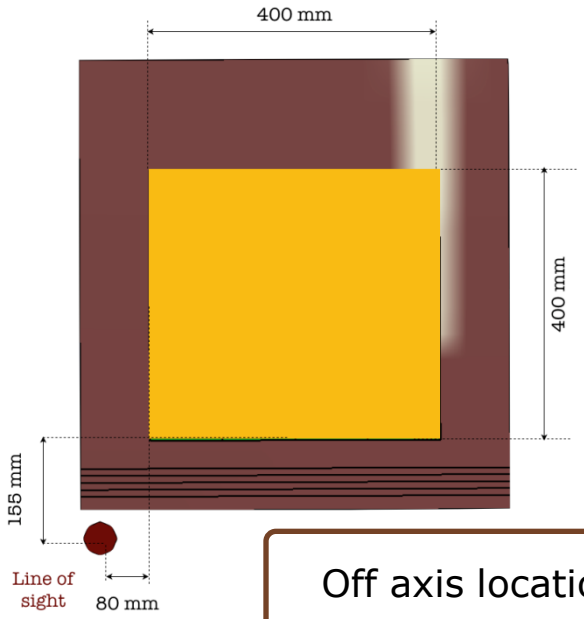
# SND@LHC

## a very compact detector for high-energy neutrinos

- Angular acceptance: 7.2< $\eta$ < 8.6
- Target material: Nuclear Emulsion + Tungsten
- Target mass: 830 kg
- Surface: 390x390 mm$^2$




Off axis location


# SND@LHC

**expectation at 150 fb$^{-1}$**

| Flavour | Neutrinos in acceptance ⟨E⟩ [GeV] | Neutrinos in acceptance Yield | CC neutrino interactions ⟨E⟩ [GeV] | CC neutrino interactions Yield | NC neutrino interactions ⟨E⟩ [GeV] | NC neutrino interactions Yield |
|---|---|---|---|---|---|---|
| $\nu_\mu$ | 130 | $1.9 \times 10^{12}$ | 452 | 606 | 480 | 182 |
| $\bar{\nu}_\mu$ | 133 | $1.7 \times 10^{12}$ | 485 | 248 | 480 | 93 |
| $\nu_e$ | 339 | $2.2 \times 10^{11}$ | 760 | 182 | 720 | 54 |
| $\bar{\nu}_e$ | 363 | $2.0 \times 10^{11}$ | 680 | 97 | 720 | 35 |
| TOT | | $4.0 \times 10^{12}$ | | 1133 | | 364 |

broad **neutrino physics** programme

| Measurement | Uncertainty Stat. | Uncertainty Sys. |
|---|---|---|
| $pp \to \nu_e X$ cross-section | 5% | 15% |
| Charmed hadron yield | 5% | 35% |
| $\nu_e/\nu_\tau$ ratio for LFU test | 30% | 22% |
| $\nu_e/\nu_\mu$ ratio for LFU test | 10% | 10% |
| NC/CC ratio | 5% | 10% |

In addition, SND@LHC can explore a large variety of **Beyond Standard Model (BSM) scenarios** describing Hidden Sector

# attività 2022

**Anagrafica 2022**:
M. De Serio (20%), R.A. Fini (20%), A. Marrone (10%), M. Pappagallo (10%), A. Pastore (20%), S. Simone (20%)

- Completamento della attività di R&D sul Muon ID system per SHiP
- Completamento dei test dei prototipi per l'elettronica
- Completamento dei test del rivelatore instrumentato con gap sottili
- Rate e Longevity test @GIF++
- Handling (al CERN) delle emulsioni nucleari utilizzate nel bersaglio attivo per la misura SND@LHC

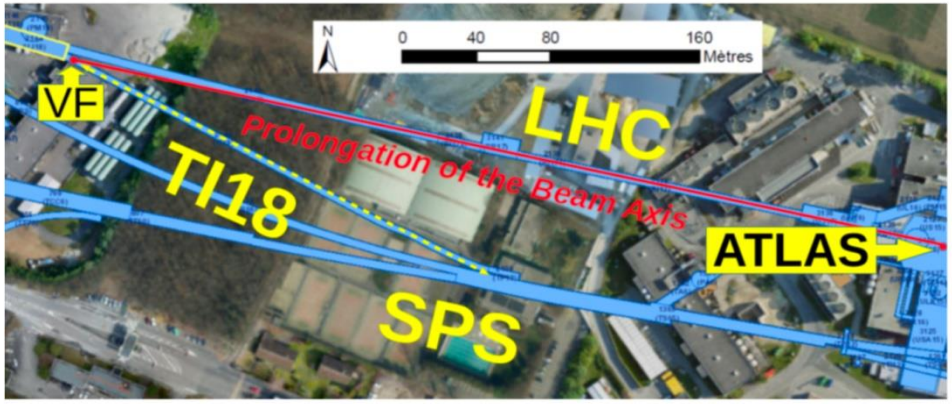
**Richieste Servizi**: **congiunte a LHCb**

Coinvolgimento del personale tecnico nei seguenti ambiti:

- Handling (al CERN) delle emulsioni nucleari utilizzate nel bersaglio attivo per la misura SND@LHC
- Gestione e sviluppo del software di controllo per slow control e DAQ

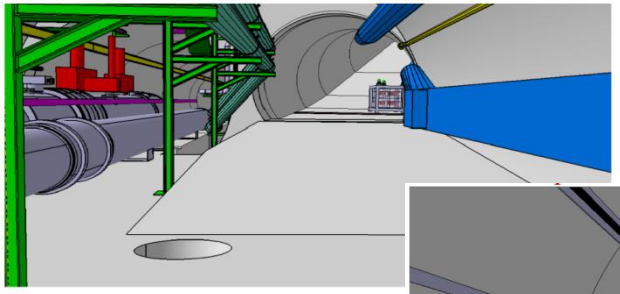

# Backup

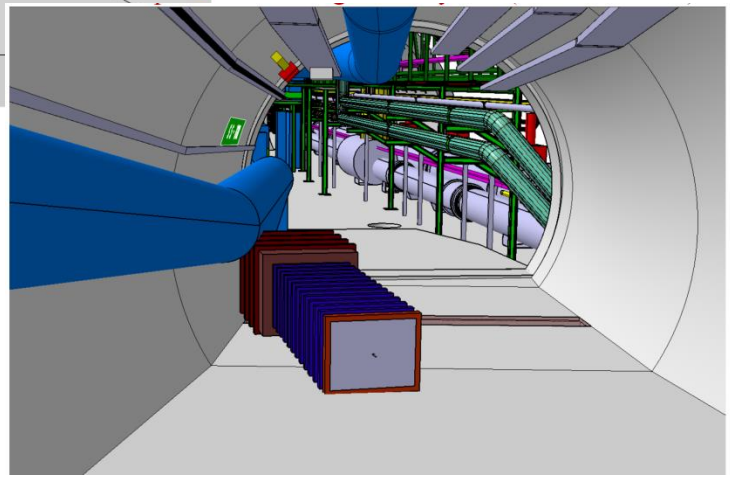
# SND@LHC




Detector at TI18 tunnel

TI18, Pablo Santos Diaz, EN





# SND@LHC - schedule

**SND INSTALLATION PLANNING v0.9**