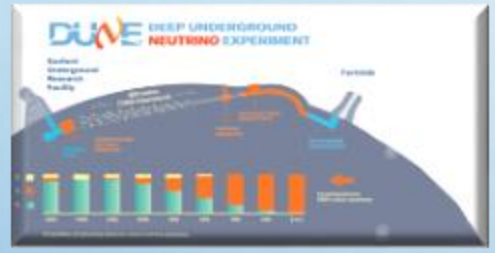
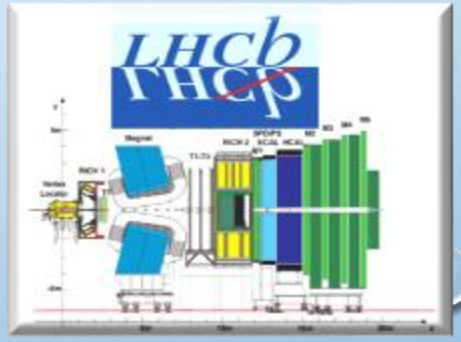
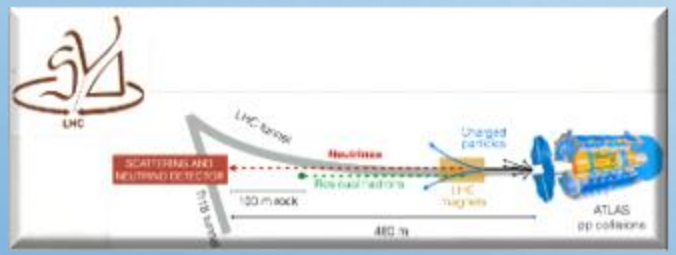
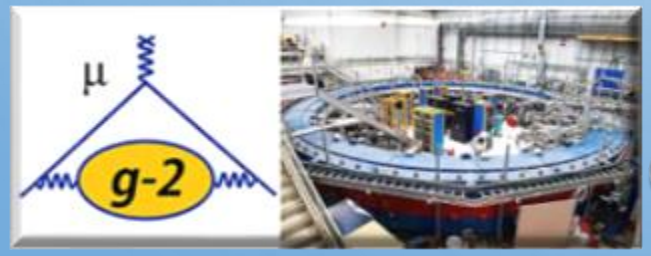
RIUNIONE DI GRUPPO 1
SEZIONE DI NAPOLI

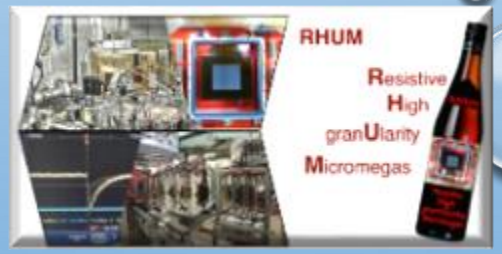
16/01/2024











Riunione Gruppo 1 - Napoli

Indico page

Thursday 16 Jan 2025, 09:00 → 19:00 Europe/Rome

2G26

Francesco Alessandro Conventi (Istituto Nazionale di Fisica Nucleare)

Description La riunione di Gruppo 1 si terrà in aula 2G26.

Link zoom: https://cern.zoom.us/j/68194851871?pwd=AbJcvBqjYDRig6QH0HsSp2o7FFa95c.1

09:00 → 09:30 **DUNE** 30m

Speakers: Francesco Di Capua (Università Federico II di Napoli), Francesco Di Capua (Istituto Nazionale di Fisica Nucleare)

DUNE_GR1-Napoli-...

09:30 → 10:00 **HYPER_K** 30m

Speaker: Gianfranca De Rosa (Istituto Nazionale di Fisica Nucleare)

HyperK-Gr1-160120...

10:00 → 10:30 **SND@LHC/SHIP** 30m

Speaker: Antonia Di Crescenzo (Istituto Nazionale di Fisica Nucleare)

2025_01_15_Neutri...

10:30 → 11:20 **Lightning talks (I)**

- 10:30 **Search for neutrino interactions in the emulsion target** 8m
  Speaker: Fabio Alicante
  20250116_FA.pdf
- 10:40 **Design of the magnet for the detector upgrade** 8m
  Speaker: Daniele Centanni (Istituto Nazionale di Fisica Nucleare)
  2025_01_16_DCent...
- 10:50 **Neutrino astronomy for multi-messenger studies in Super-Kamiokande** 8m
  Speaker: Aurora Langella (Istituto Nazionale di Fisica Nucleare)
  Presentazione_Gr1...
- 11:00 **HK mPMT electronics overlook** 8m
  Speaker: Alessandro Di Nola (Istituto Nazionale di Fisica Nucleare)
  alessandro_electro...

11:20 → 11:40 Coffe break 20m

11:40 → 12:10 **Comunicazioni del coordinatore** 30m

Speaker: Francesco Alessandro Conventi (Istituto Nazionale di Fisica Nucleare)

Slides_riunione_CS...

12:10 → 12:40 **CMS** 30m

Speakers: Alberto Orso Maria Iorio (Istituto Nazionale di Fisica Nucleare), Orso Maria Iorio

CMS Status 2024-5...

12:40 → 14:00 Lunch Break 1h 20m

14:00 → 14:30 **ATLAS** 30m

Speaker: Francesco Cirotto (Istituto Nazionale di Fisica Nucleare)

14:30 → 15:00 **FCC** 30m

Speaker: Marcello Campajola (Istituto Nazionale di Fisica Nucleare)

15:00 → 15:30 **Lightning talks (II)**

- 15:00 **Muon system: Run 2 studies and GEM ME0 Upgrade at CMS** 8m
  Speaker: Leonardo Favilla
  LFavilla_GR1_1601...
- 15:09 **Small Pad MicroMegas R&D for Future Colliders** 7m
  Speaker: Simone Pema
  Lightning talk Simo...
- 15:17 **Highlights dal Test Beam per il calorimetro elettromagnetico di IDEA al CERN** 7m
  Speaker: Lucrezia Borriello (Istituto Nazionale di Fisica Nucleare sezione Napoli)
  Lightning talks Lucr...
- 15:24 **Attività di simulazione per FCC** 6m
  Speaker: Antonio D'Avanzo (Istituto Nazionale di Fisica Nucleare)
  FCC_simulation_Gr...

15:30 → 16:00 **NA62** 30m

Speaker: Marco Mirra (Istituto Nazionale di Fisica Nucleare)

16:00 → 16:30 **BELLE2** 30m

Speaker: Guglielmo De Nardo (Istituto Nazionale di Fisica Nucleare)

16:30 → 16:50 **GMINUS2** 20m

Speaker: Michele Iacovacci (Istituto Nazionale di Fisica Nucleare)

MI Stato di g-2 al Fe...

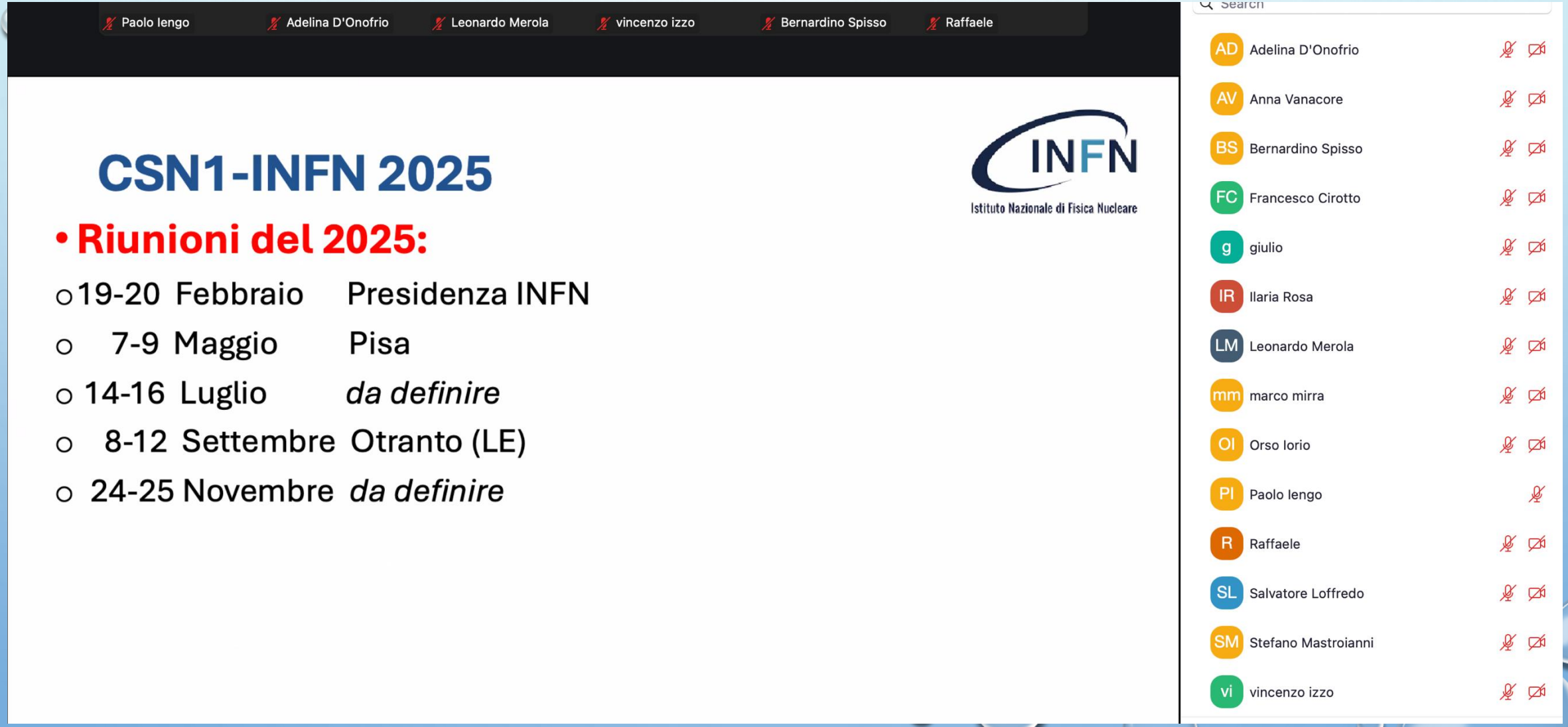
16:50 → 17:05 **PADME** 15m

Speaker: Paolo Iengo (Istituto Nazionale di Fisica Nucleare)

17:05 → 18:20 **Lightning talks (III)**

- 17:05 **Validation of DUNE Photon Detection System with ProtoDUNE data** 8m
  Speaker: Gabriel Botogoske
- 17:15 **Misura di B—>tau nu a Belle II** 10m
  Speaker: Giovanni Gaudino (Istituto Nazionale di Fisica Nucleare)
  250116-tv-Gaudino...
- 17:25 **Search for K+ → μ+ ν A', A' → e+ e-** 10m
  Speaker: Ilaria Rosa (Istituto Nazionale di Fisica Nucleare)
  KmunuA_Gruppo1...
- 17:35 **Misura BR K -> pi nu nu in NA62** 10m
  Speaker: Renato Fiorenza (INFN Napoli)
  Fiorenza_2025-01-1...

COMUNICAZIONI DEL COORDINATORE



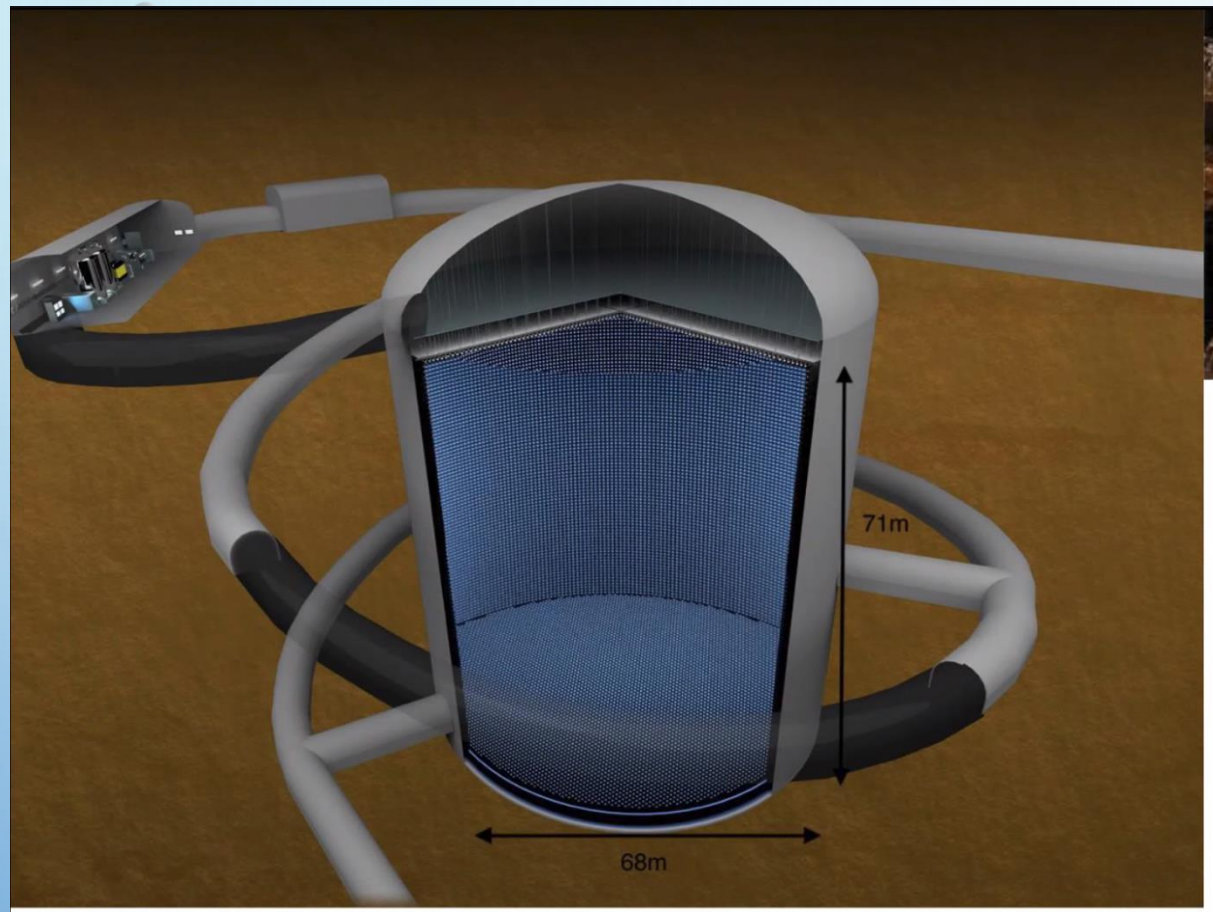
DUNE

DUNE activities in Naples

Main involvment in the Photon Detection System

- Characterization of the PDS module (Megacell)
- PDE of SiPMs at cryogenic temperatures
- European site for evaporation of the wavelength shifter
- Active participation to ProtoDUNE (analysis and simulation)
- Proposal for a new design for Far Detector 3
  - Simulation and perfomance study
  - In situ R&D small prototypes

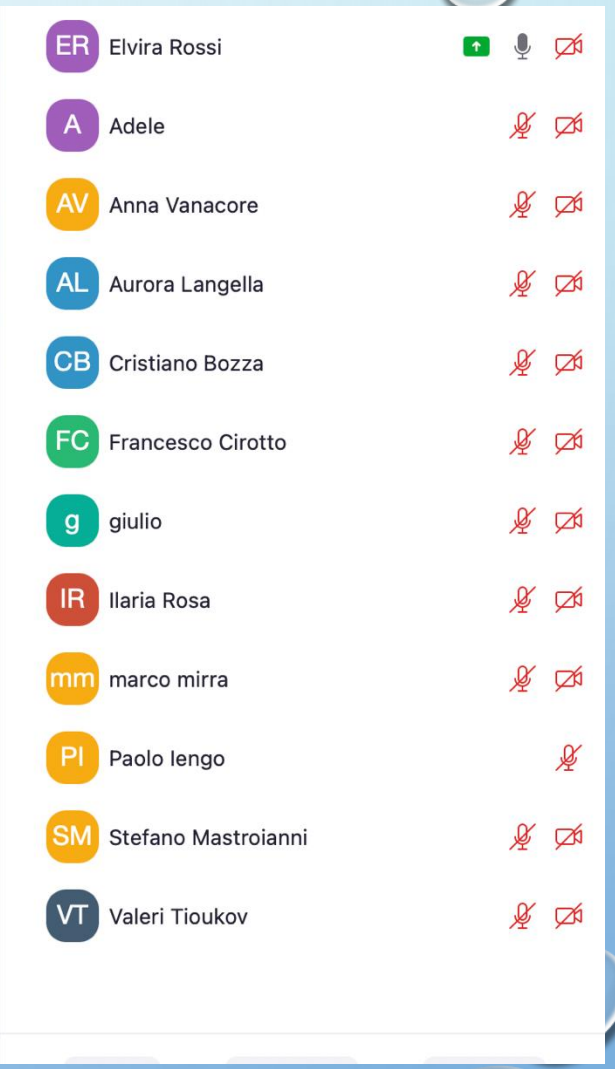
HYPER-K T2K SUPER-K



Hyper-K
T2K
Super-K

Hyper-Kamiokande T2K SUPER SK

Gianfranca De Rosa
Per il gruppo Hyper-K di Napoli

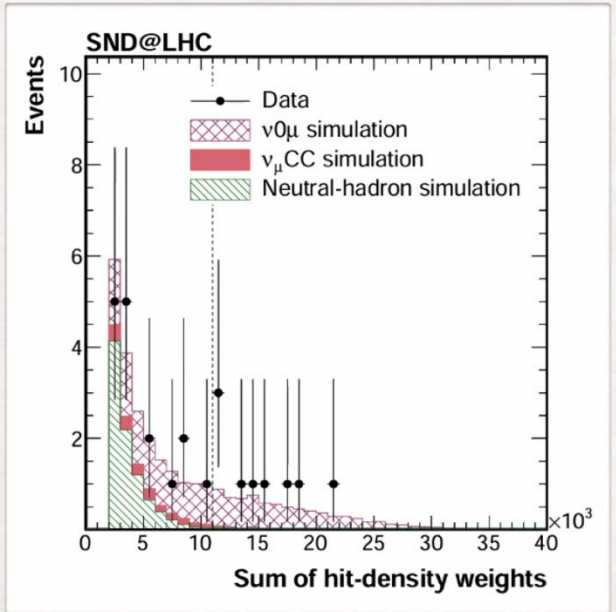


SND@LHC/SHIP

0μ NEUTRINO OBSERVATION

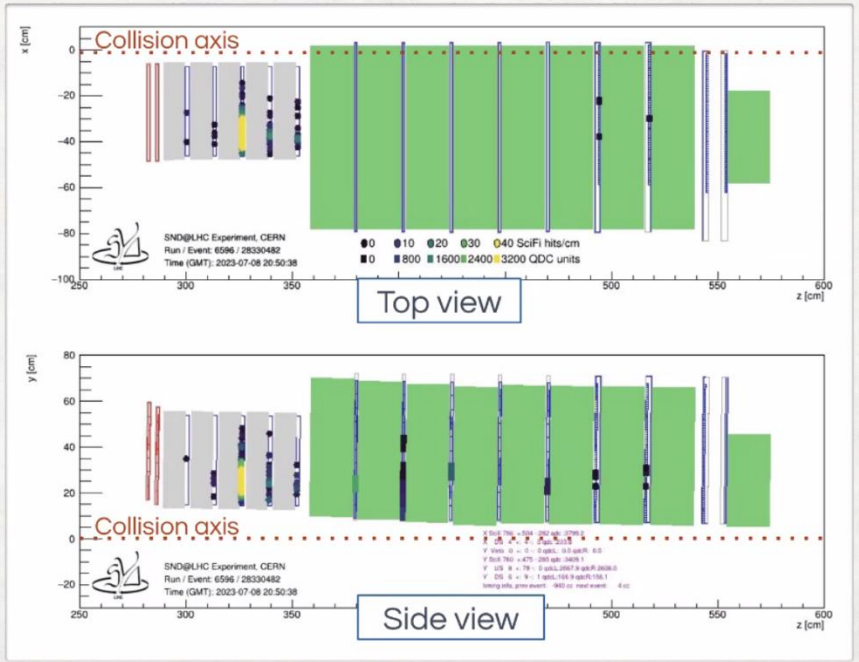
Submitted to PRL
arXiv:2411.18787

- First observation of neutrino interactions without a muon in the final state based on **2022-2023** data
- **9** observed **0μ ν-candidates**
- Observation significance **6.4σ**
- Evidence for **ν_e interactions** at 6.4σ



Observation of collider neutrinos without final state muons with the SND@LHC experiment

- Display of a 0μ ν-candidate event



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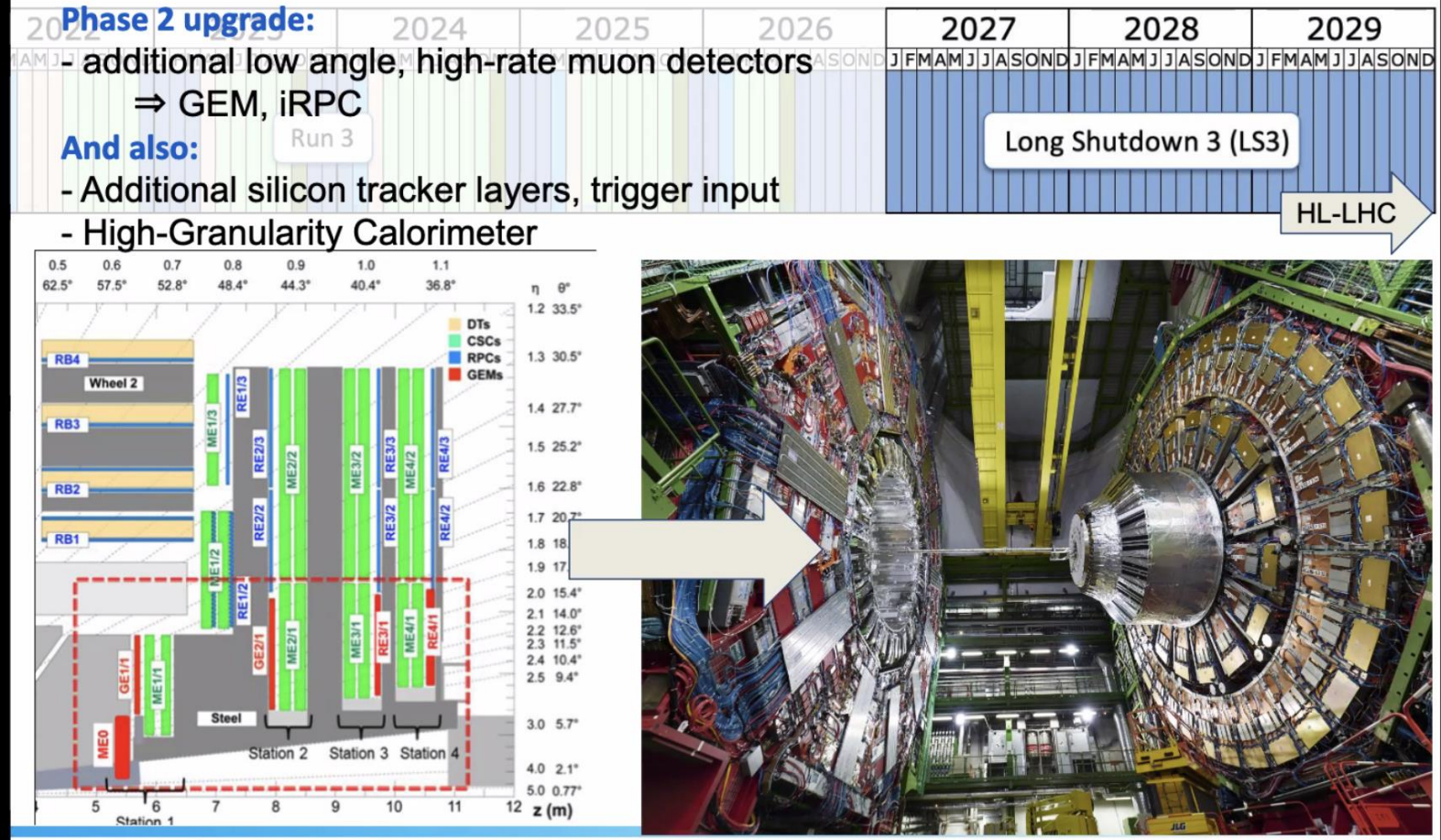
AD Adelina D'Onofrio
AL Aurora Langella
CB Cristiano Bozza
FC Francesco Cirotto
g giulio
IR Ilaria Rosa
mm marco mirra
OI Orso Iorio
PI Paolo Iengo
SM Stefano Mastroianni
VT Valeri Tioukov
vi vincenzo izzo

CMS

Looking forward

Phase 2 upgrade:
- additional low angle, high-rate muon detectors
  ⇒ GEM, iRPC

And also:
- Additional silicon tracker layers, trigger input
- High-Granularity Calorimeter



Alberto Orso Maria Iorio

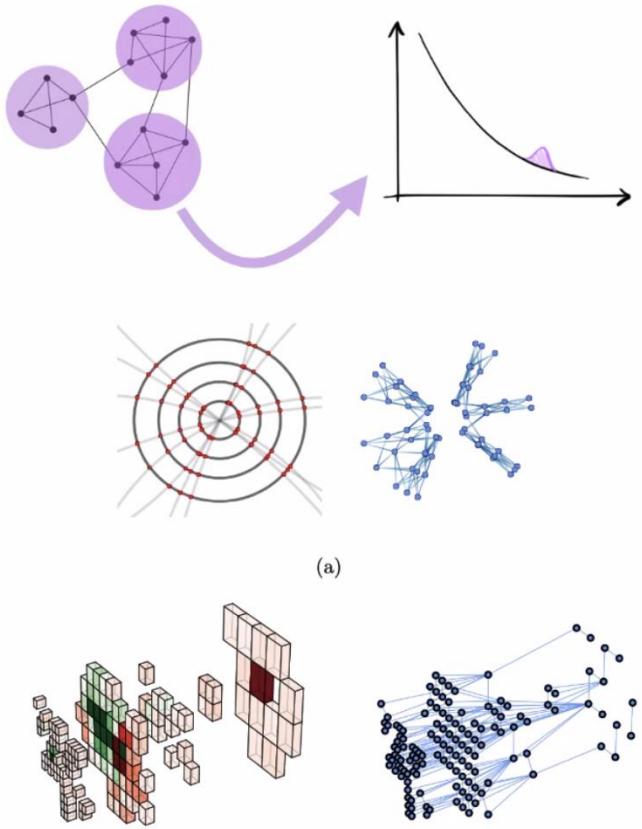
5

- ER Elvira Rossi
- vi vincenzo izzo
- AD Adelina D'Onofrio
- BS Bernardino Spisso
- FC Francesco Cirotto
- g giulio
- LM Leonardo Merola
- mm marco mirra
- OI Orso Iorio
- PI Paolo Iengo
- SL Salvatore Loffredo
- VD Vincenzo Del Piano
- R Raffaele

ATLAS

GRAPH ANOMALY DETECTION FOR NEW PHYSICS SEARCHES

- Graph-structured data are ubiquitous across science, engineering, and many other domains
  - ↪Used to describe and analyze relations and interactions
  - ↪Can encapsulate object or event information
  - ↪Can be employed in particle physics!
- Our strategy: **to represent jets as graphs and then apply machine learning to build an anomaly detection algorithm**
  - ↪Targeting heavy resonance searches with hadronic final states in Run-3
  - ↪Exploit event-based graphs to detect anomalies
- Jet information can be used as input features for neural network architectures.
  - ↪A significant improvement in performances can be achieved by employing a set of features with basic information (**low-level**) such as information coming directly from the detectors.
  - ↪Jet constituents represent challenging input features to achieve this goal

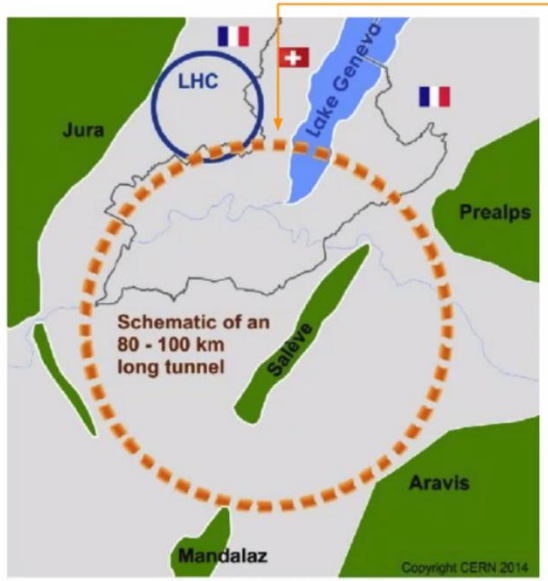


FCC

The FCC integrated program

The 2020 European Strategy concluded that an **e+e− Higgs factory is the highest priority next collider**.

➔ In 2021 CERN has launched the international **Future Circular Collider (FCC)** feasibility Study



FCC is a comprehensive long-term programme maximising physics opportunities:

- **stage 1 (FCC-ee): an Higgs factory, electroweak and top factory at highest luminosities**
- **stage 2 (FCC-hh)**: as natural continuation at energy frontier (~100 TeV)

intensity frontier

↓

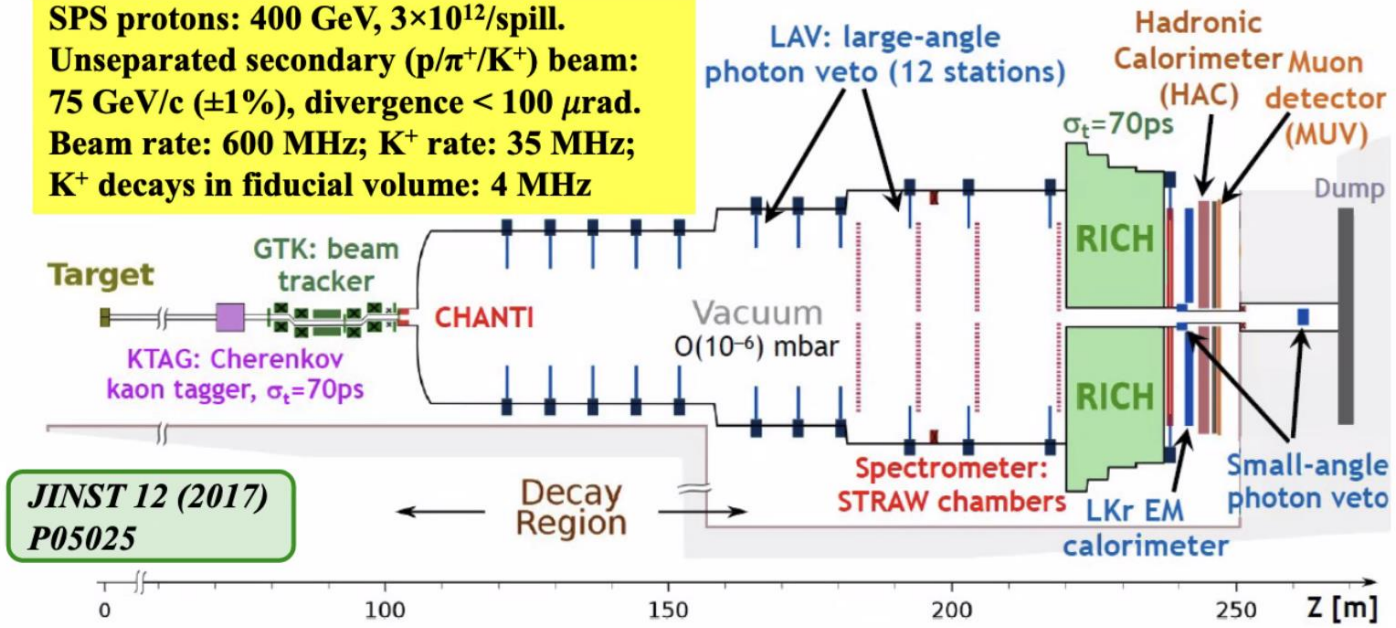
energy frontier

Both sharing same technical infrastructures

NA62

Beamline and detector

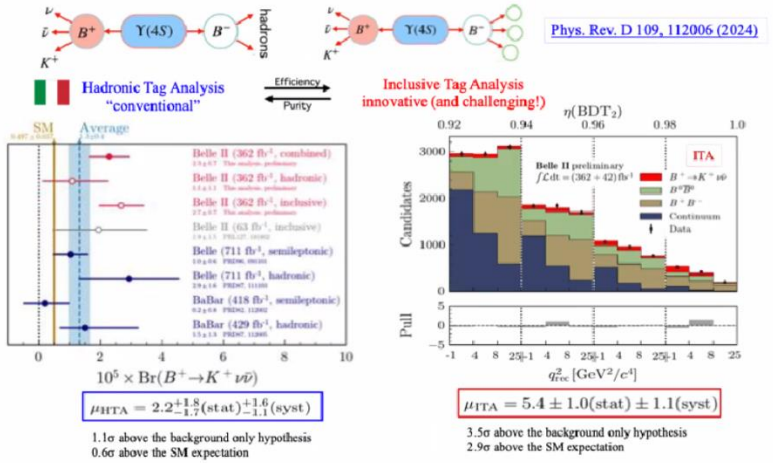
SPS protons: 400 GeV, 3×10^{12}/spill.
Unseparated secondary ($p/\pi^+/K^+$) beam:
75 GeV/c (±1%), divergence < 100 μrad.
Beam rate: 600 MHz; K^+ rate: 35 MHz;
K^+ decays in fiducial volume: 4 MHz



- ✓ **Excellent time resolution:** $\mathcal{O}$(100 ps) to match beam and daughter particle information
- ✓ **Kinematics:** rejection of main K modes 10^{-4} via kinematics reconstruction
- ✓ **PID capability (RICH+LKr+MUV):** $\mathcal{O}(10^{-7})$ muon suppression for 15GeV < p < 35 GeV
- ✓ **High-efficiency photon veto:** 10^{-7} rejection of π^0 for $E(\pi^0) > 40$ GeV

BELLE2

Evidence for B → K ν ν



$\mu_{\mathrm{HTA}} = 2.2^{+1.8}_{-1.7}(\mathrm{stat})^{+1.6}_{-1.1}(\mathrm{syst})$

1.1σ above the background only hypothesis
0.6σ above the SM expectation

$\mu_{\mathrm{ITA}} = 5.4 \pm 1.0(\mathrm{stat}) \pm 1.1(\mathrm{syst})$

3.5σ above the background only hypothesis
2.9σ above the SM expectation

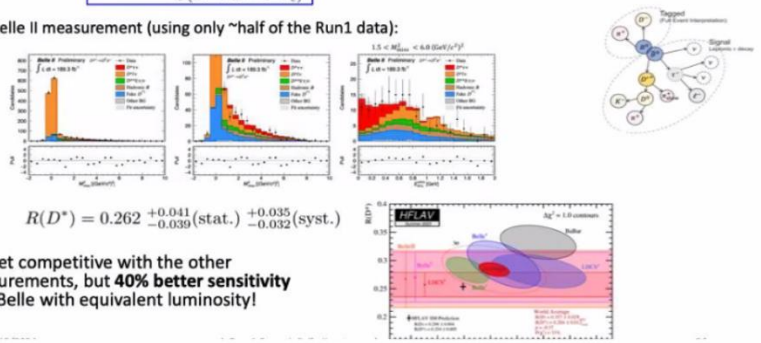
R(D*) measurement at Belle II

- Long-standing ~3σ anomaly in Flavor Physics:

Phys. Rev. D 110, 072020 (2024)

$$R(D^{(*)}) = \frac{\mathcal{B}(\overline{B} \to D^{(*)}\tau^-\bar{\nu}_\tau)}{\mathcal{B}(\overline{B} \to D^{(*)}\ell^-\bar{\nu}_\ell)}$$

- First Belle II measurement (using only ~half of the Run1 data):



$$R(D^*) = 0.262\ ^{+0.041}_{-0.039}(\mathrm{stat.})\ ^{+0.035}_{-0.032}(\mathrm{syst.})$$

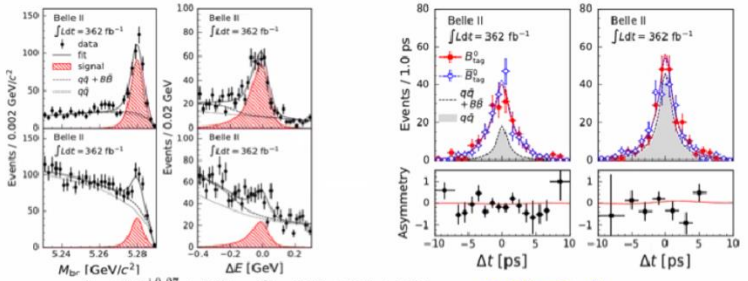
- Not yet competitive with the other measurements, but **40% better sensitivity** than Belle with equivalent luminosity!

Time dependent $B^0 \to K_S\,\pi^0\,\gamma$

- The SM predicst that the photon is ~100% right(left)-polarized for B^0 ($\bar{B}^0$) decays;

arXiv:2407.09139, accepted by PRL

- Any significant CP violation would be a sign of new physics;



$S = 0.00^{+0.27}_{-0.26} \pm 0.03\,, \quad C = 0.10 \pm 0.13 \pm 0.04$ for $K^{*0} \to K_S\,\pi^0$

$S = 0.04^{+0.45}_{-0.44} \pm 0.10\,, \quad C = -0.06 \pm 0.25 \pm 0.09$ for nonresonant $K_S\,\pi^0$

World leading precision!

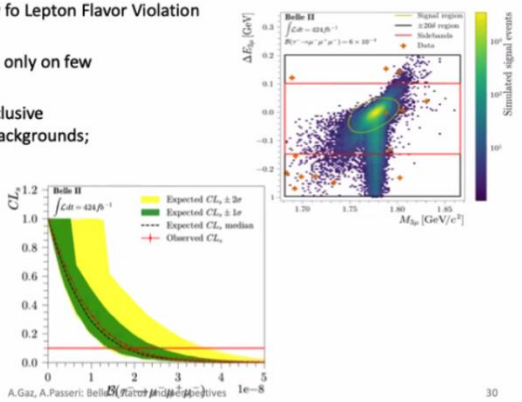
Search for LFV in τ → μμμ decays

JHEP 09 2024, 062 (2024)

- Belle II will dominate the sensitivity fo Lepton Flavor Violation searches in the coming years;
- Competition with hadron machines only on few channels, most notably τ → 3μ;
- Compared to Belle/BaBar: more inclusive analysis and better control of the backgrounds;
- World leading upper limit!

Most stringent limit to date

	UL at 90% C.L. on $\mathcal{B}(\tau \to 3\mu)$
ATLAS	3.8×10^{-7} ($\mathcal{L} = 20.3\ \mathrm{fb}^{-1}$)
LHCb	4.6×10^{-8} ($\mathcal{L} = 3.0\ \mathrm{fb}^{-1}$)
CMS	2.9×10^{-8} ($\mathcal{L} = 131\ \mathrm{fb}^{-1}$)
Belle	2.1×10^{-8} ($\mathcal{L} = 782\ \mathrm{fb}^{-1}$)
BaBar	3.3×10^{-8} ($\mathcal{L} = 486\ \mathrm{fb}^{-1}$)
Belle II	1.9×10^{-8} ($\mathcal{L} = 424\ \mathrm{fb}^{-1}$)



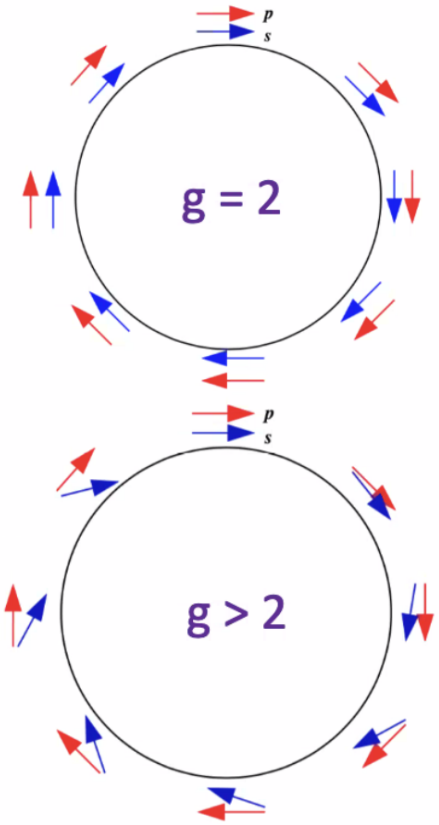
GMINUS2

Perché un anello di accumulazione con B uniforme?

- Il muone con momento **p** (freccia rossa) e spin **s** (freccia blu) subisce la rivoluzione del ciclotrone e la precessione di spin in un campo magnetico B (si assume che **s** e **p** siano perpendicolari a B)
- La differenza tra le velocità angolari della precessione di spin ω_S e rivoluzione ciclotrone ω_c è

$$\vec{\omega}_a = \vec{\omega}_s - \vec{\omega}_c = -\left(\frac{g_\mu - 2}{2}\right)\frac{q\vec{B}}{m} = -a_\mu \frac{q\vec{B}}{m}$$

- Se g = 2 esattamente, i vettori di spin e momento rimarrebbero bloccati insieme → $\omega_a = 0$
- Invece lo spin precede più velocemente e, alle condizioni del Fermilab, fa una rotazione aggiuntiva di 12° per giro. Dopo circa 30 giri si riallinea all'impulso.



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IR Ilaria Rosa
PI Paolo Iengo
SM Stefano Mastroianni
vi vincenzo izzo

PADME

https://agenda.infn.it/event/44906/contributions/252628/attachments/130296/193854/20250116-PADMEGr1NA.pdf

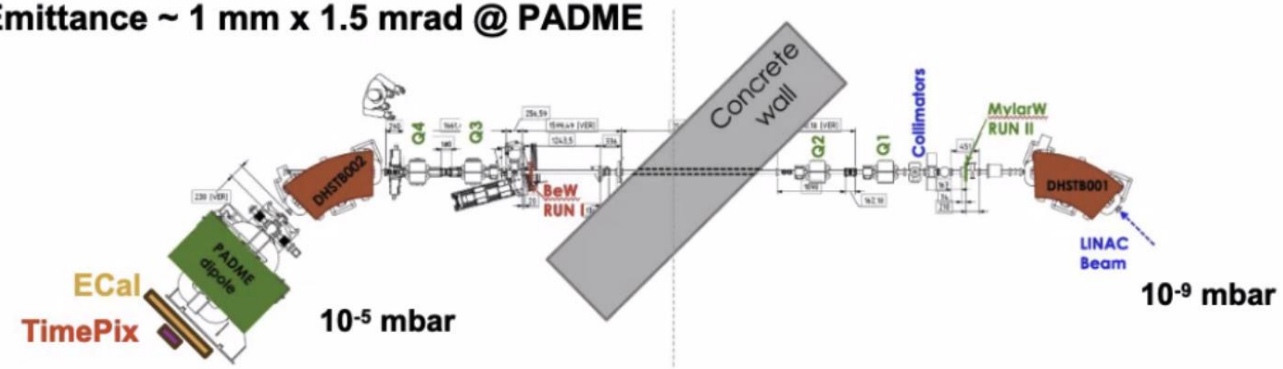
Positron Annihilation into Dark Matter Experiment (PADME)

Positrons from the DAFNE LINAC up to 550 MeV, O(0.5%) energy spread

Repetition rate up to 49 Hz, macro bunches of up to 300 ns duration

Intensity must be limited below ~ 3 × 10^4 POT / spill against pile-up

Emittance ~ 1 mm x 1.5 mrad @ PADME



Past operations:

Run I e^- primary, target, e^+ selection, 250 μm Be vacuum separation [2019]

Run II e^+ primary beam, 125 μm Mylar™ vacuum separation, 28000 e^+/bunch [2019-20]

Run III dipole magnet off, ~3000 e^+/bunch, 47 scan points $s^{1/2}$ ~ 17 MeV [2022]

- er elvira rossi (me)
- PI Paolo Iengo
- ER Elvira Rossi
- BS Bernardino Spisso
- FD Francesco Di Capua
- g giulio
- IR Ilaria Rosa
- P Paolo
- SM Stefano Mastroianni
- vi vincenzo izzo

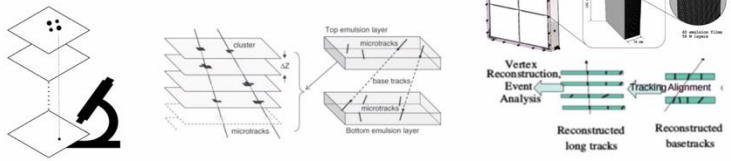
LIGHTNING TALKS

SPEAKER: FABIO ALICANTE

Emulsion Data reconstruction in SND@LHC

1. Emulsion films scanning (online cluster processing).
2. Correct microscope stage effects.
3. Link two layers of each emulsion film.
4. Align consecutive films.
5. Reconstruct tracks and vertices.

} Local effects and corrections!



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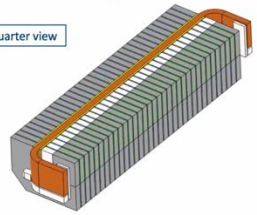
IR Ilaria Rosa
mm marco mirra
OI Orso Iorio
PI Paolo Iengo
SM Stefano Mastroianni
VT Valeri Tioukov
vi vincenzo izzo

Speaker: Daniele Centanni

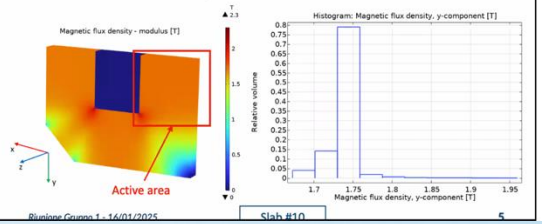
Electromagnetic design of the magnet

- ✓ Low power consumption
- ✓ Magnetised iron slabs
- ✓ Coil mass compliant with contraints on the crane maximum load
- ✓ Vertical 1.75 T uniform magnetic field
- ✓ High field homogeneity in the active region

Quarter view



Magnet feature	Value
Cross section [m²]	1.151 x 0.8
Iron length [m]	1.964
Total length [m] (including coil)	2.267
Reference magnetic flux density [T]	1.75
Magnetomotive force [kAturns]	13.0
Conductor size [mm²]	23 x 23
Current density [A/mm²]	0.89
Electrical power [kW]	1.19
mass (copper + resin) [tons]	0.87
+s.steel mass – single slab [tons]	0.327
Overall mass (iron + coil) [tons]	12.0



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OI Orso Iorio
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VT Valeri Tioukov
vi vincenzo izzo

Speaker: Aurora Langella

Astrophysical neutrino sources

Several astrophysical objects are suggested as sources of neutrinos, mainly those which are considered or confirmed to be cosmic rays acceleration sites (hadronic processes). Some of these are:

Core collapse supernovae (CC-SNe). First confirmed transient source of neutrinos (SN1987A)

Supernova remnants (**SNRs**) with shocks accelerating cosmic rays.

Binary systems involving compact objects producing jets and accreting matter (e.g. **BNS mergergers, Microquasar**).

Pulsar wind nebulae (**PWNe**) powered by rapidly spinning neutron stars.

Most of these sources are particularly interesting for multi-messengers astrophysics.

AL Aurora Langella
ER Elvira Rossi
AD Adelina D'Onofrio
FC Francesco Cirotto
FD Francesco Di Capua
g giulio
OI Orso Iorio
PI Paolo Iengo
SM Stefano Mastroianni
VT Valeri Tioukov
vi vincenzo izzo

Speaker: Alessandro Di Nola

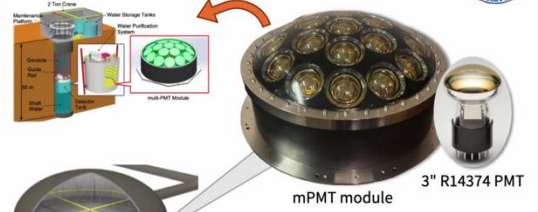
Photodetectors

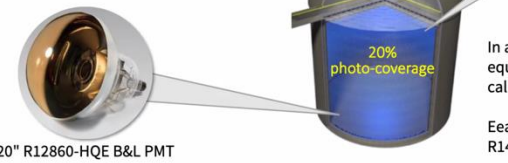
Hyper-Kamiokande will be instrumented with **20,000** 20'' photomultipliers

The PMT used are the newly developed Hamamatsu R12860

PMT improvements compared to the previous ones used in SK:
- higher pressure resistance
- double detection efficiency
- half time&charge resolutions

mPMTs will be the only photodetectors in IWCD





20" R12860-HQE B&L PMT

In addition to the 20'' PMTs, Hyper-K will be equipped with **808 multi-PMT optical modules** called mPMTs

Eeach mPMT is equipped with 19 Hamamatsu R14374 PMTs

ER Elvira Rossi
AD Adelina D'Onofrio
AL Aurora Langella
FC Francesco Cirotto
FD Francesco Di Capua
g giulio
OI Orso Iorio
PI Paolo Iengo
SM Stefano Mastroianni
vi vincenzo izzo

Speaker: Leonardo Favilla

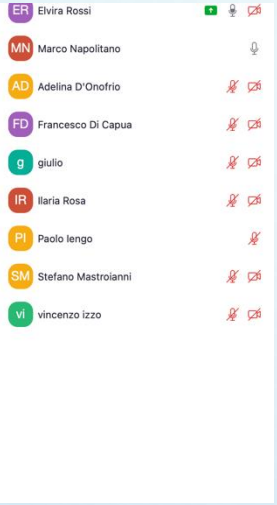
The Phase-2 Upgrade of the CMS Muon Detectors

- The muon system is challenged by high particle rates in the forward region of the CMS detector
  - Inst. Lumi: $2\times10^{34}cm^{-2}s^{-1}$ (LHC) → $5\div7.5\times10^{34}cm^{-2}s^{-1}$ (HL-LHC)
  - Pileup: 60 (LHC) → 140 ÷ 200 (HL-LHC)
  - Several upgrades taking place to handle such a harsh environment → link to CMS-TDR-016
- Main purpose:
  - $|\eta| < 2.4$ → Enhance identification and triggering capabilities
  - $|\eta| > 2.4$ → Extend muon identification and triggering
- Three new GEM detectors:
  - LS2: GE1/1 ($1.5 < |\eta| < 2.2$)
  - LS3: GE2/1 ($1.6 < |\eta| < 2.4$) & ME0 ($2.0 < |\eta| < 2.8$)
- CMS Napoli group involved in:
  - GE1/1 operation
  - GE2/1 and ME0 construction & commissioning
  - High-Voltage Power System design & mantainance

16/01/2025

L. Favilla - INFN Group 1

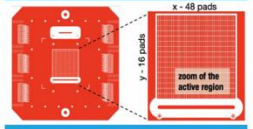
1



SPEAKER: SIMONE PERNA

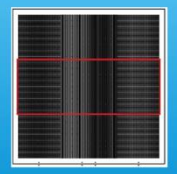
Test-Beam

DLC-20



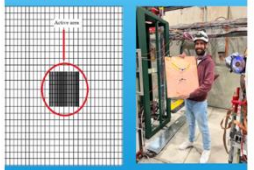
- 768 pad di dimensioni 1x3 mm^2.
- Gap drift a 7 mm.
- Gap ampl a 128 µm.

Paddy-400



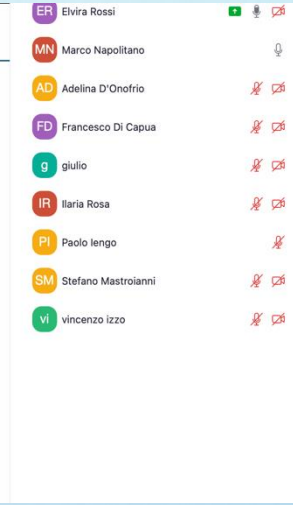
- 4800 pad di dimensioni 1x8mm^2 .
- Gap drift a 5 mm.
- Gap ampl a 128 µm.

Paddy-2000



- Area Attiva: 50cmx40cm
- Ha pad di dimensioni 1x8 mm^2 nella zona centrale e 10x10 mm^2 nella zona periferica.
- Gap drift di 6 mm.
- Gap ampl di 150 µm.

4



Speaker: Lucrezia Borriello

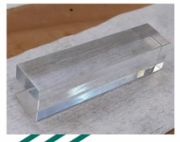
Dual Readout with Crystals

- Include in the IDEA detector design an additional layer of homogeneous material for the Calorimeter that allows to improve the energy resolution

IDEA calorimeter baseline
Cherenkov and Scintillation fiber based
σ_E/E (EM) ~13%/√E
σ_E/E (HAD) ~31%/√E

Calorimeter homogeneous medium=crystal
σ_E/E (EM) ~3%/√E
σ_E/E (HAD) ~30%/√E

- discriminating the Cherenkov signal from the Scintillation signals inside different crystal samples:

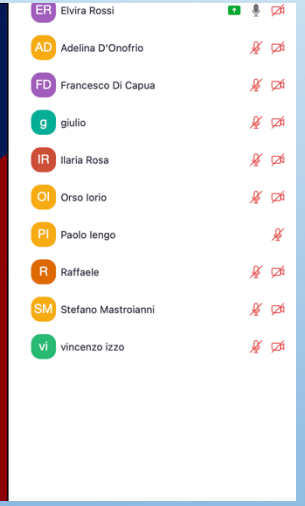


Cherenkov signal: prompt
Scintillation signals: longer

	time	spectrum
Cherenkov	fast	$1/\lambda^2$
Scintillation	slow	peaked

2

Lucrezia Borriello-INFN Napoli



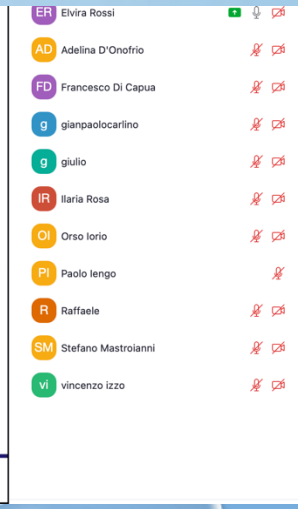
Speaker: Antonio D'Avanzo

WHAT: SIMULATING CRYSTALS RESPONSE IN GEANT4

- Study of the expected response of crystals for dual-readout electromagnetic calorimeter at FCC-ee
  - Simulation of scintillation/cerenkov light detection with SiPMs
- Fully customizable simulation of test beam setup in July 2024
  - Provided with optical photons tracing, crystal rotation and several materials
  - Able to reproduce data taking configurations to compare with data
  - Built with Geant4 toolkit on INFN IBISCO cluster in Naples

GEANT4
A SIMULATION TOOLKIT

2

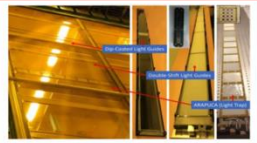


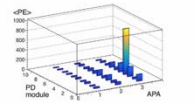
Speaker: Gabriel Botogoske

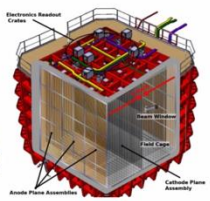
Proto-DUNE HD @CERN

Proto-DUNE SP

→0.42 kton fiducial LAr
→ 6 APAs



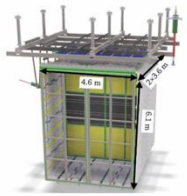




Successful

Proto-DUNE HD

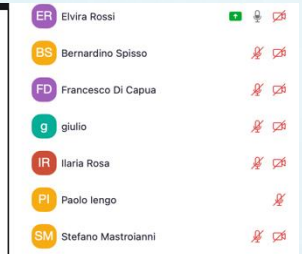
→0.28 kton fiducial LAr
→ 4 APAs
→Moved to X-ARAPUCA



– 2 different WLS and SiPMs(Hamamatsu and FBK)

APA 1- Full streaming mode
APA 2-4: Self Trigger mode

6

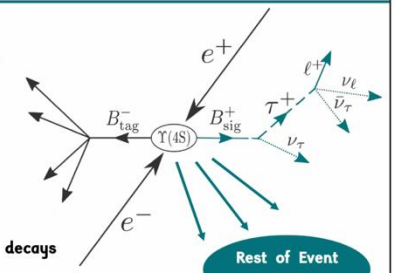


Speaker: Giovanni Gaudino

Event Selection and dataset

One B meson is fully reconstructed using a multivariate algorithm, Full Event Interpretation (FEI) with Hadronic Tagging.

1. $O_{FEI} > 10^{-2}$
2. $-0.15 < \Delta E = E_B^* - \sqrt{s}/2 < 0.1\ GeV$
3. $M_{bc}c^2 = \sqrt{s/4 - (p_B^* c)^2} > 5.27\ GeV$



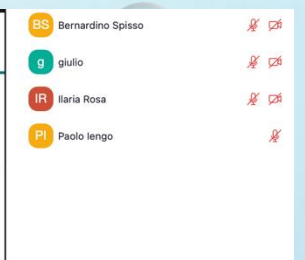
Backgrounds
$e^+e^- \to q\bar{q}$
$e^+e^- \to \tau^+\tau^-$
$e^+e^- \to B^+B^-$
$e^+e^- \to B^0\bar{B}^0$

Signal is searched through τ decays

1. $\tau^+ \to e^+\nu_e\bar{\nu}_\tau$
2. $\tau^+ \to \mu^+\nu_\mu\bar{\nu}_\tau$
3. $\tau^+ \to \pi^+\bar{\nu}_\tau$
4. $\tau^+ \to \rho^+\bar{\nu}_\tau$ with $\rho^+ \to \pi^+\pi^0$

- 0 Extra Tracks
- Extra Clusters clean-up

2025, January 16 — Giovanni Gaudino



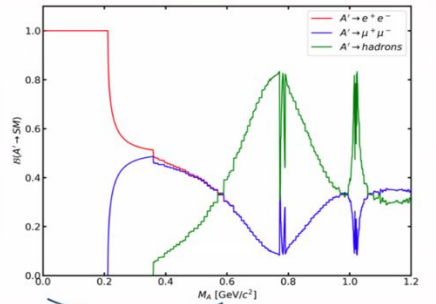
Speaker: Ilaria Rosa

Dark photon: a detailed view

- New vector field F′μν symmetric under a new U(1) symmetry feebly interacting with the SM fields
- A minimal extension to the SM: kinetic mixing with the SM hypercharge

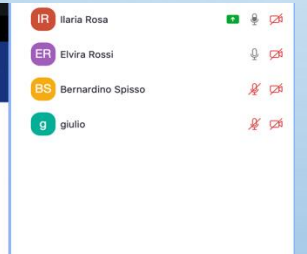
$$-\frac{\epsilon}{2}F'^{\mu\nu}B_{\mu\nu}$$

M(A′) and ε are free parameters



Decay width dominated by lepton antilepton final states for M(A′)< 700 MeV

2

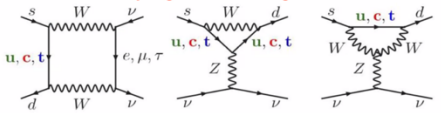


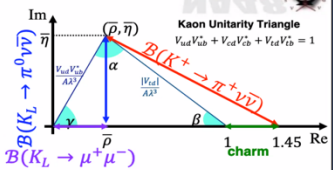
Speaker: Renato Fiorenza

$K \to \pi\nu\bar{\nu}$: Precision test of the SM

NA62

SM: Z-penguin & box diagrams





- $\mathcal{B}(K \to \pi\nu\bar{\nu})$ **highly suppressed** in SM
  - GIM mechanism & maximum CKM suppression $s \to d$ transition: $\sim \frac{m_t}{m_W}|V_{ts}^* V_{td}|$
- Theoretically clean ⇒ high precision SM predictions, high sensitivity to BSM
  - Dominated by short distance contributions
  - Hadronic matrix element extracted from $\mathcal{B}(K \to \pi l\nu)$ decays via isospin rotation

Decay Mode BR	SM [Buras et al. EPJC 82 (2022) 7, 615]	SM [D'Ambrosio et al. JHEP 09 (2022) 148]	Experimental Status
$\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu})$	$(8.60 \pm 0.42) \times 10^{-11}$	$(7.86 \pm 0.61) \times 10^{-11}$	$(10.6^{+4.1}_{-3.5}) \times 10^{-11}$ (NA62)
$\mathcal{B}(K_L \to \pi^0\nu\bar{\nu})$	$(2.94 \pm 0.15) \times 10^{-11}$	$(2.68 \pm 0.30) \times 10^{-11}$	$< 2.2 \times 10^{-9}$ (KOTO)

INFN

Differences in SM calculations from choice of CKM parameters: [Eur.Phys.J.C 84 (2024) 4, 377]

NA62 (2016–18 data): [JHEP 06 (2021) 093]
KOTO (2021 data): arXiv:2411.11237

SSM

2