SHADOWS

Search for **H**idden **A**nd **D**ark **O**bjects **W**ith the **S**PS

Italy:
INFN-Bologna
Universita' di Bologna
INFN-Ferrara
INFN- Frascati
INFN- Napoli
INFN-Roma1
INFN-Roma3

(1) *CERN, European Organization for Nuclear Research, CH-1211 Geneva 23, Switzerland*
(2) *INFN, Sezione di Napoli, Napoli, Italy*
(3) *Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*
(4) *INFN, Sezione di Ferrara, Ferrara, Italy*
(5) *INFN Laboratori Nazionali di Frascati, Frascati (Rome), Italy*
(6) *INFN, Sezione di Roma III, Roma, Italy*
(7) *Johannes Gutenberg Universitat Mainz, Mainz, Germany*
(8) *INFN, Sezione di Bologna, Bologna, Italy*
(9) *Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany*
(10) *PARTREC and University of Groningen, Groningen, The Netherland*
(11) *INFN, Sezione di Roma III, Roma, Italy*
(12) *University of Freiburg, Freiburg, Germany*
(13) *Charles University, Prague, Czech Republic*
(14) *Royal Holloway, University of London, UK*
(15) *INFN, Sezione di Roma1, Roma, Italy*
(16) *University of Bologna, Bologna, Italy*

SHADOWS-LNF

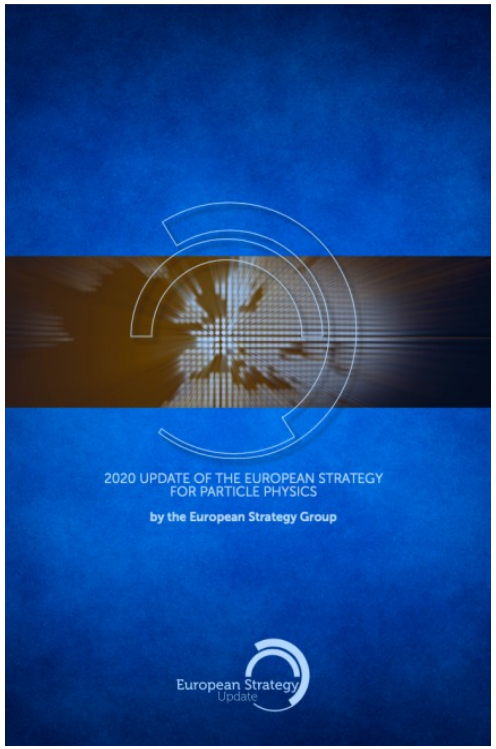
Alessandro Calcaterra
Paolo Ciambrone
Giulietto Felici
Luca Foggetta
Gaia Lanfranchi
Tommaso Napolitano
Alessandro Paoloni

E l'insostituibile aiuto di:
Alessandro Balla
Maurizio Gatta
Giuseppe Papalino

LNF – Gruppo 1 meeting – 20 september 2023

European Strategy for Particle Physics recommendations

https://cds.cern.ch/record/2721370/files/CERN-ESU-015-2020%20Update%20European%20Strategy.pdf

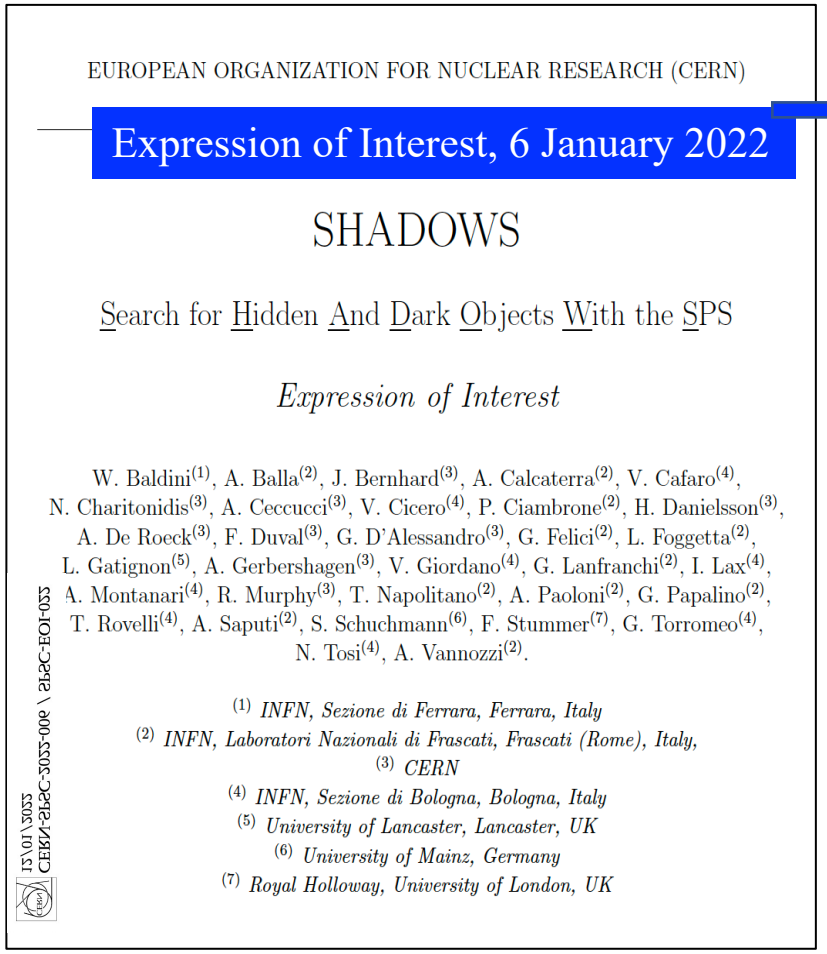


4. Other essential scientific activities for particle physics:

- *a) The quest for dark matter and the exploration of flavour and fundamental symmetries are crucial components of the search for new physics.*
- *This search can be done in many ways, for example through precision measurements of flavour physics and electric or magnetic dipole moments, and searches for axions, dark sector candidates and feebly interacting particles.*
- *There are many options to address such physics topics including energy-frontier colliders, accelerator and non-accelerator experiments. A diverse programme that is complementary to the energy frontier is an essential part of the European particle physics Strategy.*

SHADOWS can explore low-mass (< 5 GeV) NP with very feeble couplings becoming a main player in the future CERN diversity programme.

SHADOWS: 20 very intense (and exciting) months..



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

Expression of Interest, 6 January 2022

SHADOWS

Search for Hidden And Dark Objects With the SPS

Expression of Interest

W. Baldini[1], A. Balla[2], J. Bernhard[3], A. Calcaterra[2], V. Cafaro[4], N. Charitonidis[3], A. Ceccucci[3], V. Cicero[4], P. Ciambrone[2], H. Danielsson[3], A. De Roeck[3], F. Duval[3], G. D'Alessandro[3], G. Felici[2], L. Foggetta[2], L. Gatignon[5], A. Gerbershagen[3], V. Giordano[4], G. Lanfranchi[2], I. Lax[4], A. Montanari[4], R. Murphy[3], T. Napolitano[2], A. Paoloni[2], G. Papalino[2], T. Rovelli[4], A. Saputi[2], S. Schuchmann[6], F. Stummer[7], G. Torromeo[4], N. Tosi[4], A. Vannozzi[2].

[1] *INFN, Sezione di Ferrara, Ferrara, Italy*
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[7] *Royal Holloway, University of London, UK*

15\01\2022 CERN-SPSC-2022-030 \ SPSC-EOI-033

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

Letter of Intent, 4 November 2022

SHADOWS

Search for Hidden And Dark Objects With the SPS

Letter of Intent

M. Alviggi[1], S. Bachmann[2], W. Baldini[3], A. Balla[4], M. Biglietti[8], V. Büscher[11], A. Calcaterra[4], V. Cafaro[5], N. Charitonidis[6], A. Ceccucci[6], V. Cicero[5], P. Ciambrone[4], H. Danielsson[6], M. Dellapietra[1], A. De Roeck[6], F. Duval[6], G. Felici[4], T. Ferber[7], L. Foggetta[4], M. Gatta[4], A. Gerbershagen[13], V. Giordano[5], S. Hansmann-Menzemer[2], P. Iengo[1], M. Iodice[8], K. Jakobs[9] M. Klute[7], K. Köneke[9], M. Koval[10], G. Lanfranchi[4], A. Laudrain[11], I. Lax[5], B. Leverington[2], P. Lichard[6], K. Massri[6], A. Montanari[5], R. Murphy[6,12], T. Napolitano[4], F. Neuhaus[11], L. J. Nevay[6] A. Paoloni[4], G. Papalino[4], U. Parzefall[9], S. Ritter[11], T. Rovelli[5,14], A. Saputi[3], B. Schmidt[6], M. Schott[11], H.C. Schultz-Coulon[2], G. Sekhniaidze[1], F. Stummer[6,12], G. Torromeo[5], N. Tosi[5], U. Uwer[2], M. van Dijk[6], A. Vannozzi[4], R. Wanke[11], C. Weiser[9], P. Wertelaers[6], T. Zickler[6]

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[3] *INFN, Sezione di Ferrara, Ferrara, Italy*
[4] *INFN, Laboratori Nazionali di Frascati, Frascati (Rome), Italy,*
[5] *INFN, Sezione di Bologna, Bologna, Italy*
[6] *CERN*
[7] *Karlsruhe Institute of Technology, KIT, Germany*
[8] *INFN, Sezione di Roma III, INFN, Italy*
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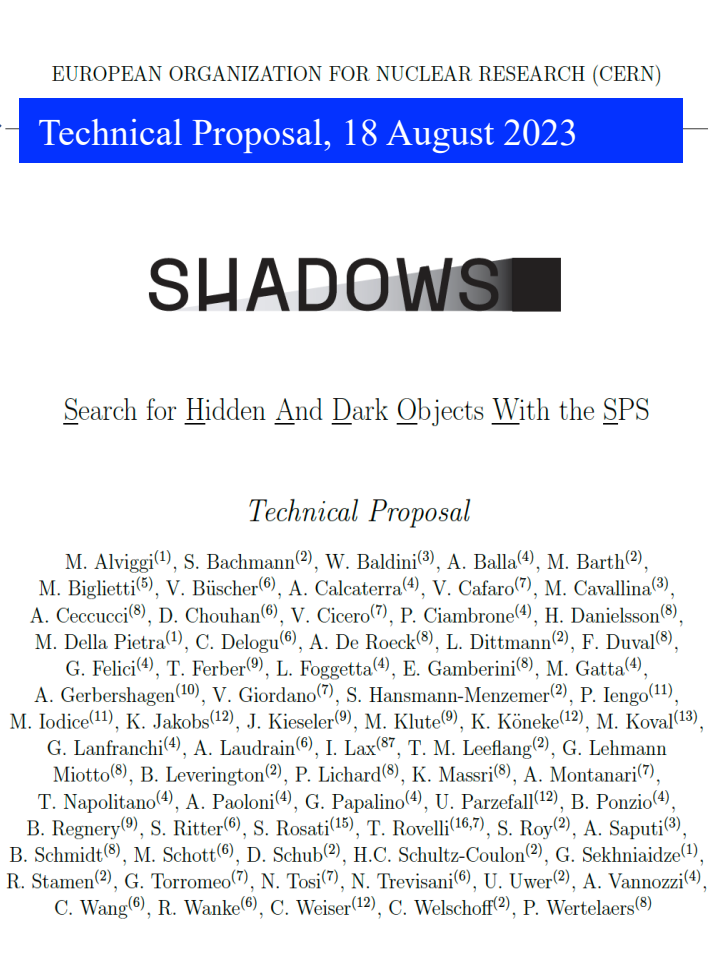
[13] *PARTREC and University of Groningen, Groningen, The Netherland*
[14] *University of Bologna, Bologna, Italy*

CERN-SPSC-2022-030 / SPSC-I-256
04/11/2022



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

Technical Proposal, 18 August 2023

SHADOWS

Search for Hidden And Dark Objects With the SPS

Technical Proposal

M. Alviggi[1], S. Bachmann[2], W. Baldini[3], A. Balla[4], M. Barth[2], M. Biglietti[5], V. Büscher[6], A. Calcaterra[4], V. Cafaro[7], M. Cavallina[3], A. Ceccucci[8], D. Chouhan[6], V. Cicero[7], P. Ciambrone[4], H. Danielsson[8], M. Della Pietra[1], C. Delogu[6], A. De Roeck[8], L. Dittmann[2], F. Duval[8], G. Felici[4], T. Ferber[9], L. Foggetta[4], E. Gamberini[8], M. Gatta[4], A. Gerbershagen[10], V. Giordano[7], S. Hansmann-Menzemer[2], P. Iengo[11], M. Iodice[11], K. Jakobs[12], J. Kieseler[9], M. Klute[9], K. Köneke[12], M. Koval[13], G. Lanfranchi[4], A. Laudrain[6], I. Lax[87], T. M. Leeflang[2], G. Lehmann Miotto[8], B. Leverington[2], P. Lichard[8], K. Massri[8], A. Montanari[7], T. Napolitano[4], A. Paoloni[4], G. Papalino[4], U. Parzefall[12], B. Ponzio[4], B. Regnery[9], S. Ritter[6], S. Rosati[15], T. Rovelli[16,7], S. Roy[2], A. Saputi[3], B. Schmidt[8], M. Schott[6], D. Schub[2], H.C. Schultz-Coulon[2], G. Sekhniaidze[1], R. Stamen[2], G. Torromeo[7], N. Tosi[7], N. Trevisani[6], U. Uwer[2], A. Vannozzi[4], C. Wang[6], R. Wanke[6], C. Weiser[12], C. Welschoff[2], P. Wertelaers[8]

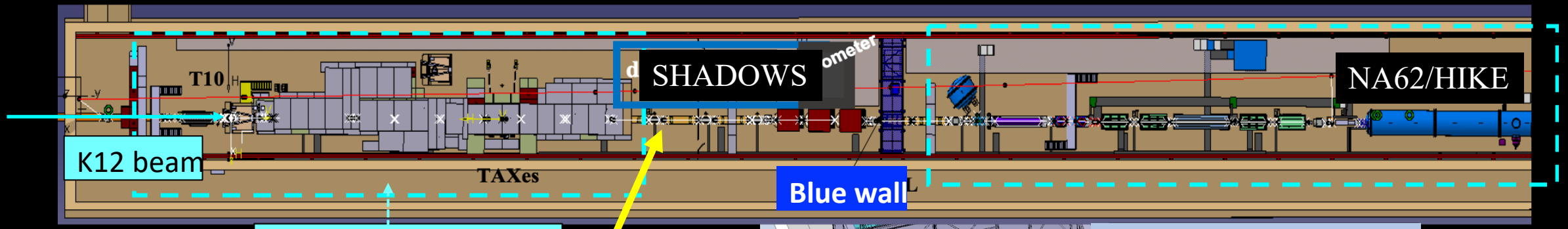
From the Expression of Interest (Jan 22) ⟶ Proposal (Aug. 23)
the collaboration almost tripled (82 collaborators, 16 institutions)


NA62 in ECN3
Blue wall
Beam
~ 150 m

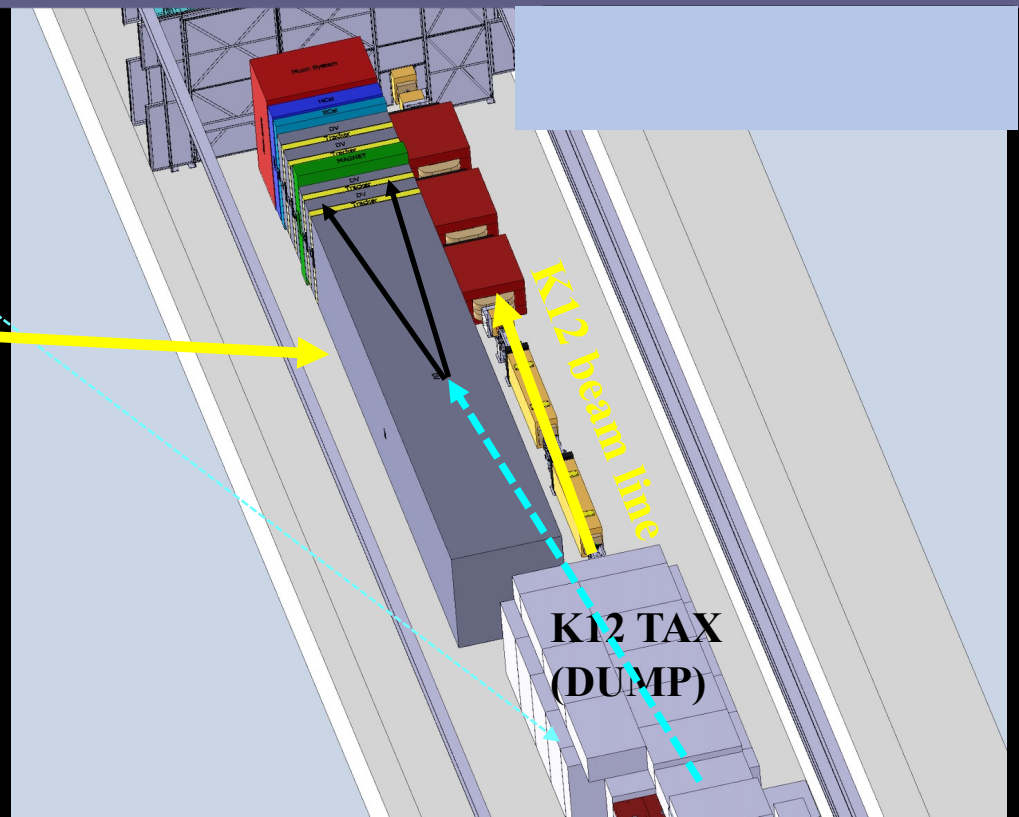
SHADOWS in ECN3 (North Area)

Letter of Intent submitted to the SPS Committee beginning of November

https://cds.cern.ch/record/2839484/files/SPSC-I-256.pdf



SHADOWS in the target area

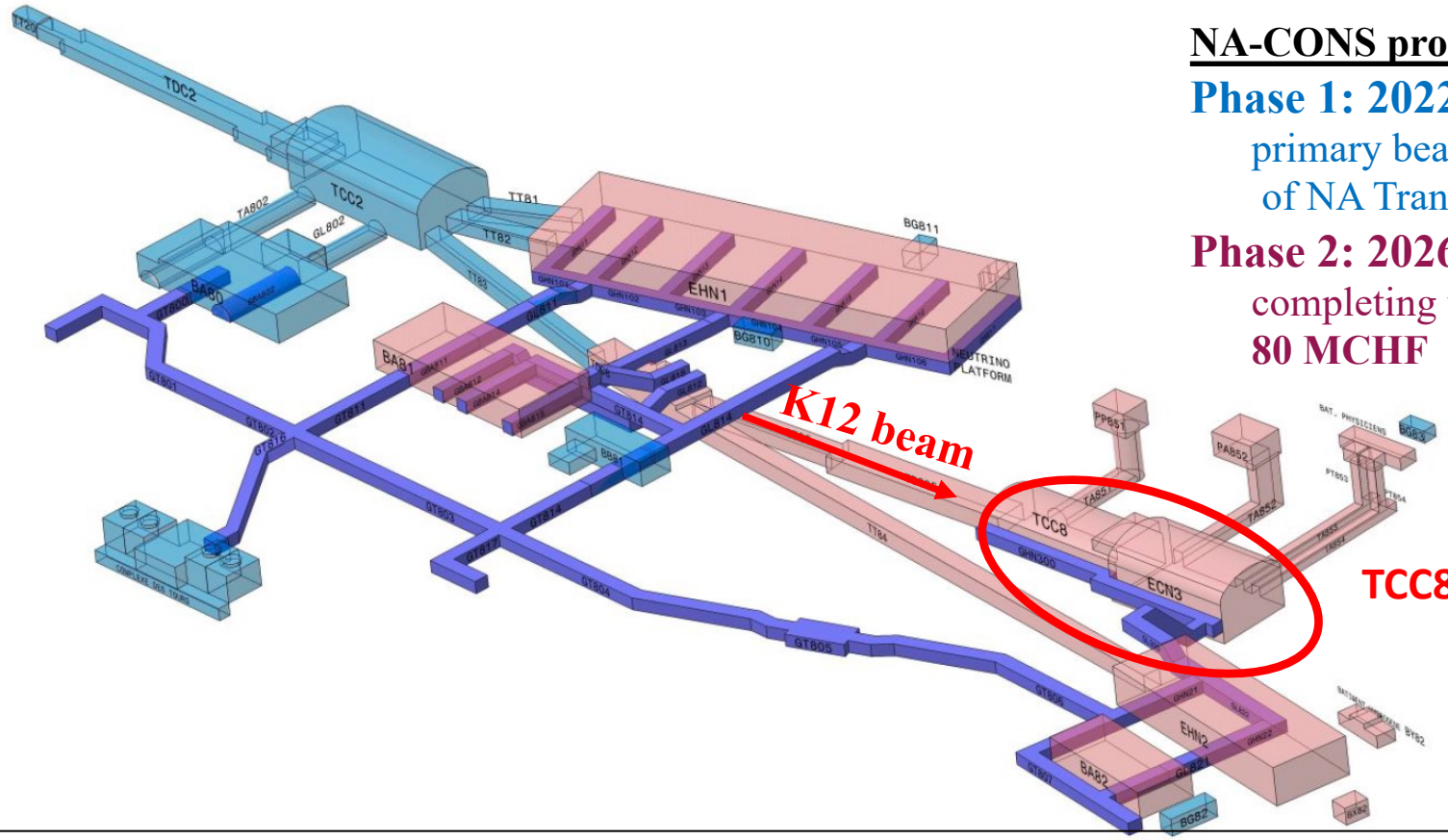


SHADOWS Conceptual Layout

A spectrometer of about 2.5x 2.5 m^2 transverse area
~1 m off-axis from beam line
20 m long decay volume,
starting ~10 m downstream of the dump

The high-intensity K12 beam line

Fully compatible and synergistic with the (already funded) North-Area Consolidation Programme:



TCC8+ECN3 complex

NA-CONS programme:

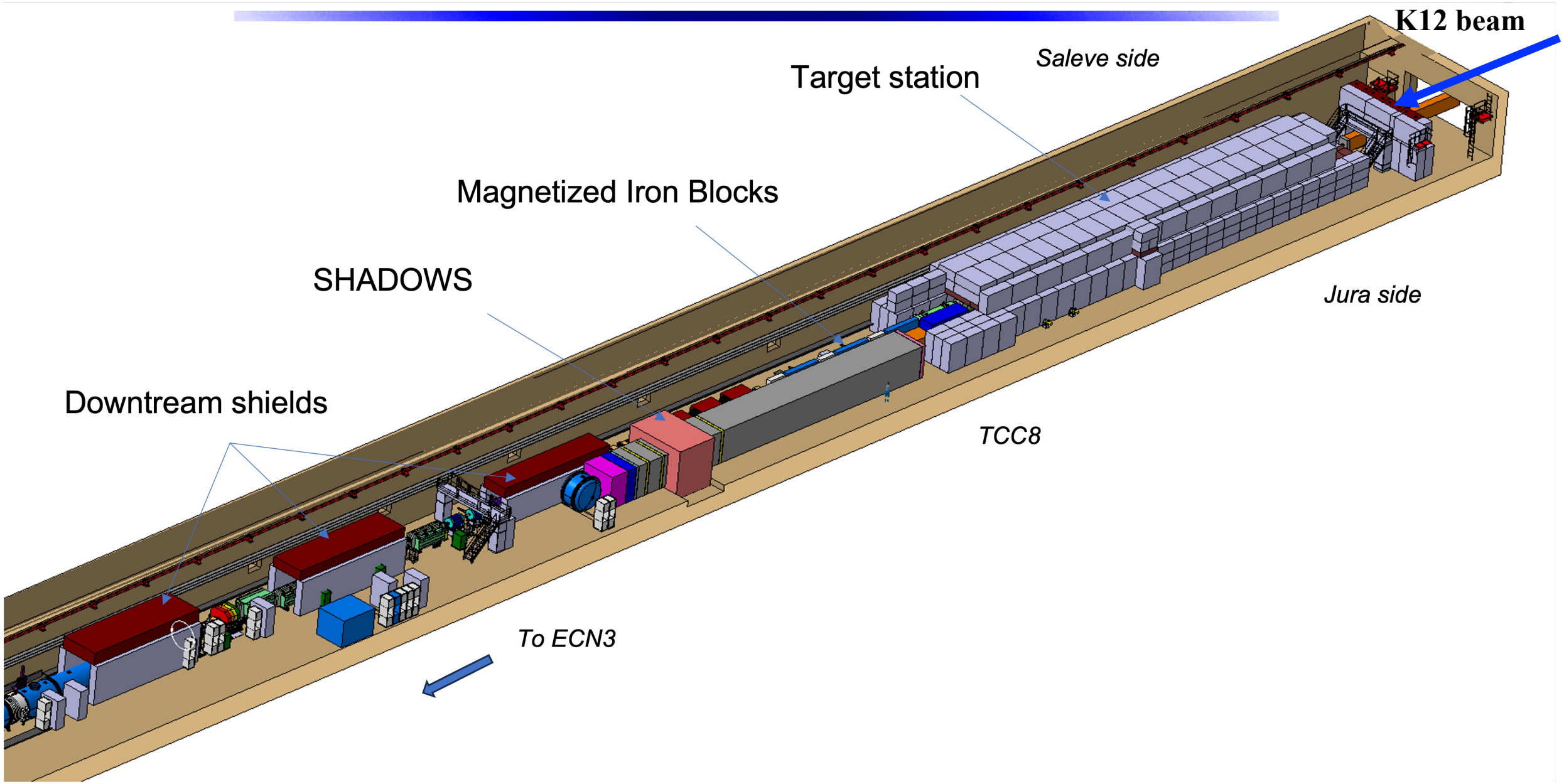
Phase 1: 2022–2028 (up to end LS3),
primary beam areas TT20, TDC2, TCC2 and initial section of NA Transfer Tunnels. **20 MCHF**

Phase 2: 2026–2034 (up to end LS4),
completing the consolidation of the secondary beam areas.
80 MCHF

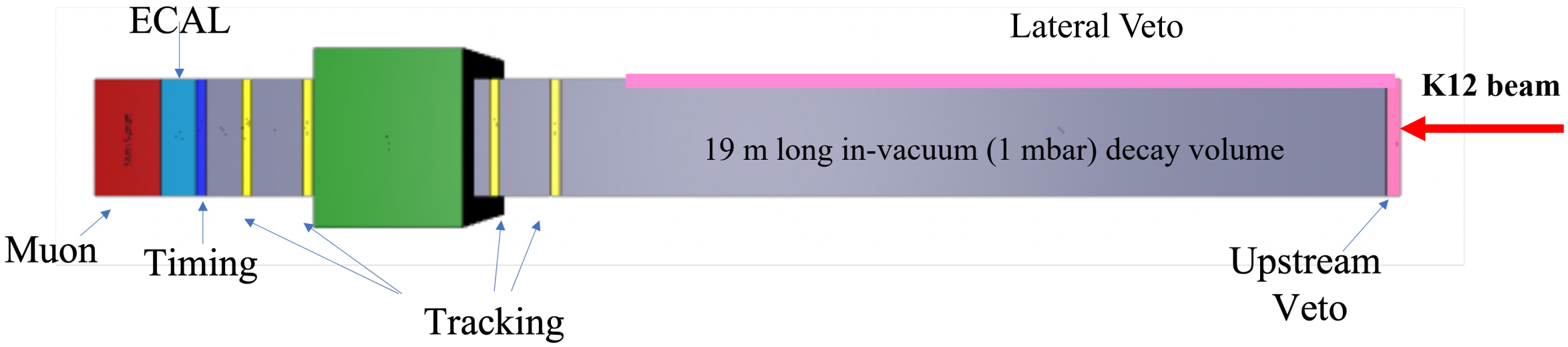
5×10^{19} protons-on-target (pot), with 4.8 sec long spills, can be delivered to ECN3 in 4 integrated years with a dedicated beam delivery for ECN3, and shared cycles to EHN1 and EHN2.
This annual yield is **fully compatible with the current North Area operation.**

additional (14 + 50) MCHF asked to CERN Management for upgrade of the beamline + area

SHADOWS in the TCC8 tunnel



The Detector



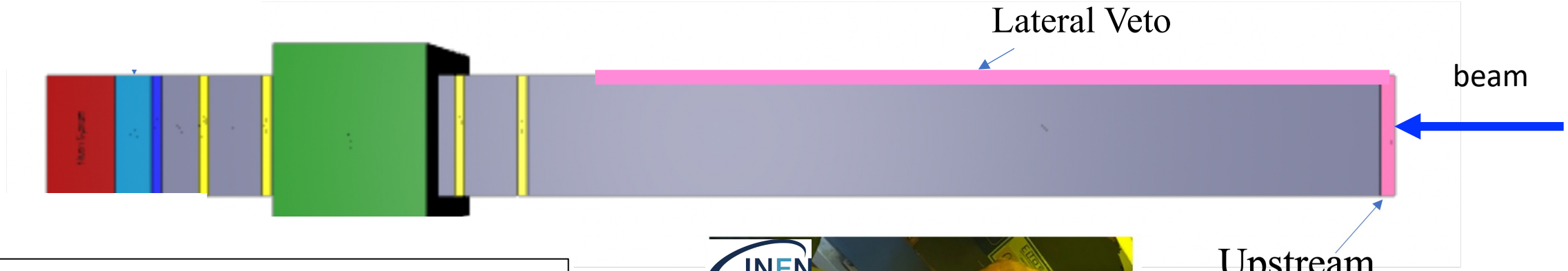
SHADOWS must be able to reconstruct and identify most of the visible final states of FIPs decays

Scalar portal	$\ell^+\ell^-,\ \pi^+\pi^-,\ K^+K^-$
Pseudo-scalar portal	$\ell^+\ell^-,\ \gamma\gamma,\ \pi^+\pi^-,\ K^+K^-$
Vector portal	$\ell^+\ell^-, \pi^+\pi^-, K^+K^-$
Fermion (neutrino) portal	$\ell^\pm\pi^\mp, \ell^\pm K^\mp, \ell^\pm\rho^\mp(\rho^\mp \to \pi^\pm\pi^0), \ell^+\ell^-\nu$

Standard spectrometer, with 19m long in-vacuum decay volume, excellent tracking system, high resolution timing layer, ECAL with pointing capability, muon system and efficient vetoes

The Detector: Upstream & Lateral Veto

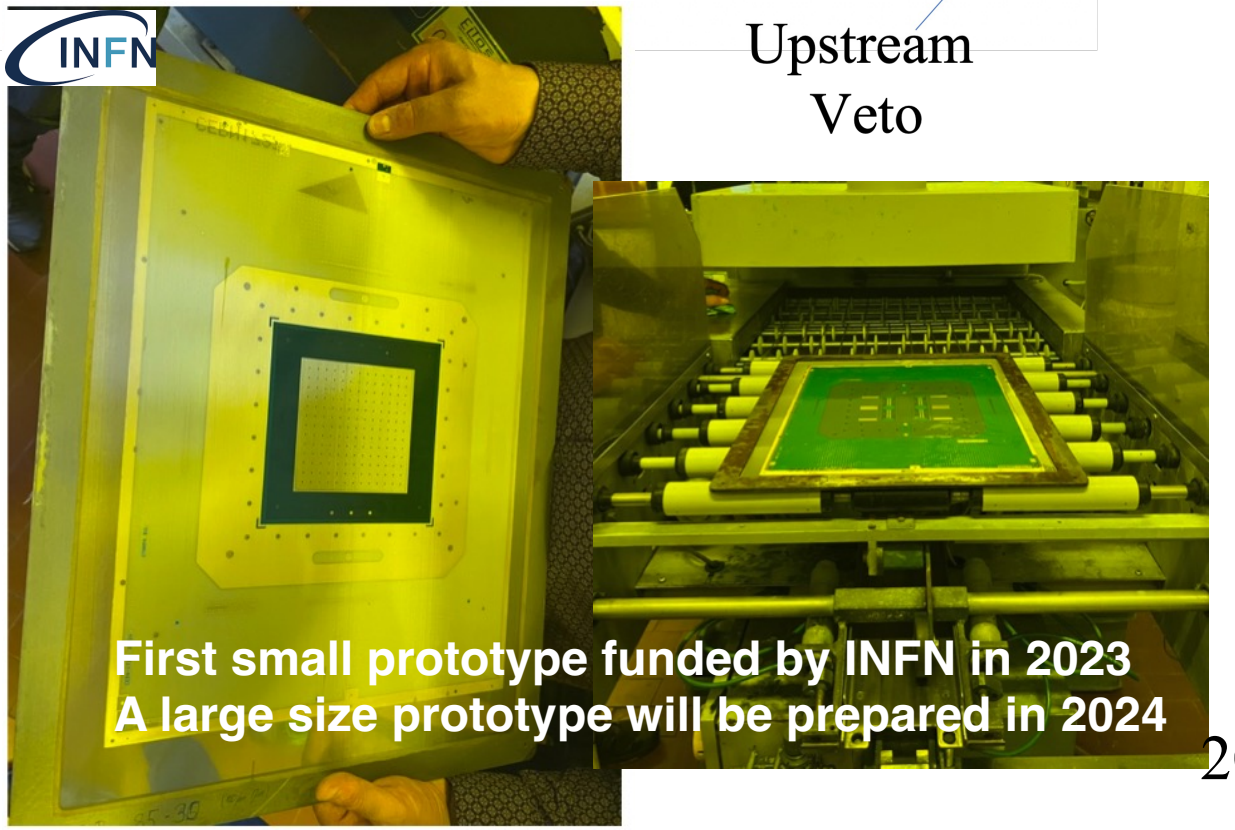
Institutes:
INFN-Roma3, INFN-Naples
Expertise:
ATLAS new small wheels.



Goal:
veto muons that enter the decay vessel escaping the MIB system

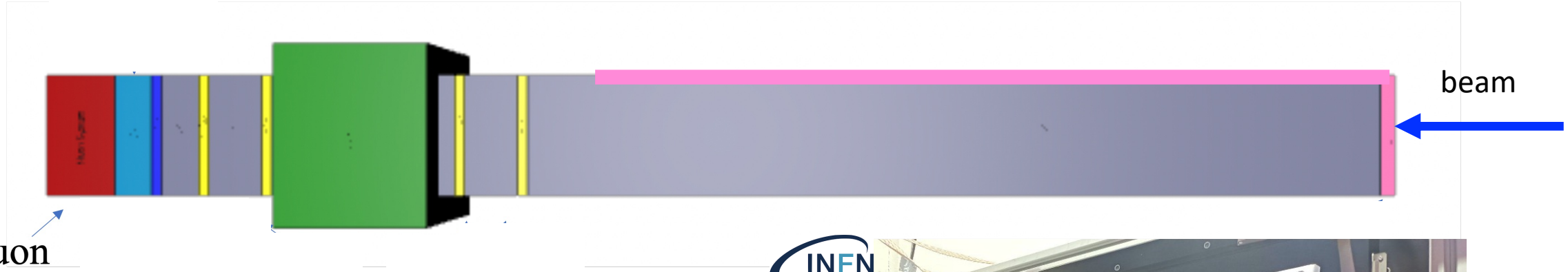
Technology:
Double layer of micromegas detectors:
- efficiency > 99.8%
- space resolution: o(1) mm
- time resolution: o(10) ns
- rate capability: up to 10 MHz /cm2

Requirements fully satisfied.



The Detector: Muon System

Groups: INFN-LNF, INFN-Bologna, INFN-Ferrara
Expertise: LHCb muon system, CMS muon system



Goal:
identify muons and reduce muon combinatorial background via timing measurement.

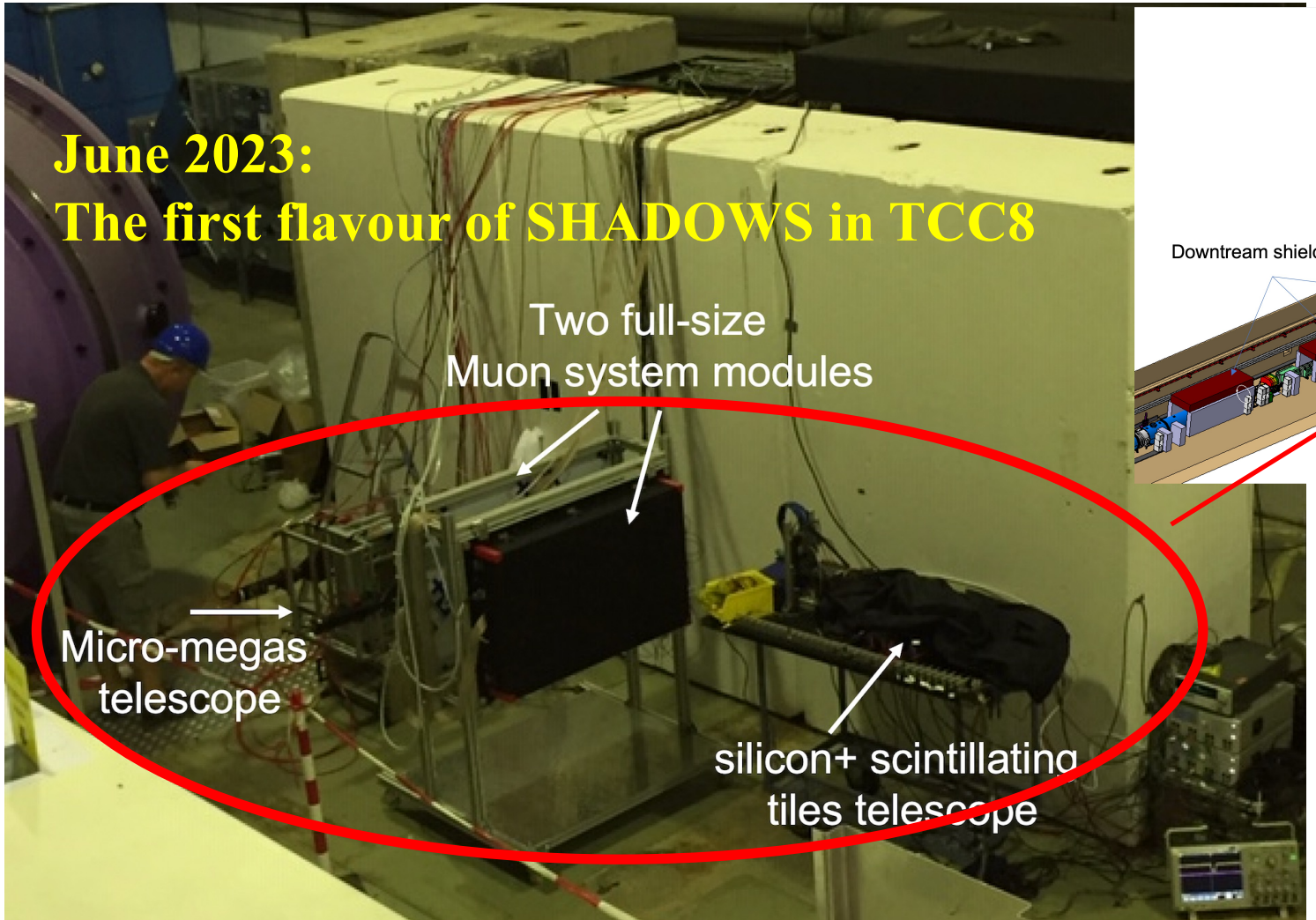
Technology:
3 stations of scintillating tiles with direct sipm readout
Interleaved by iron filters. Measured 250 ps resolution per station.

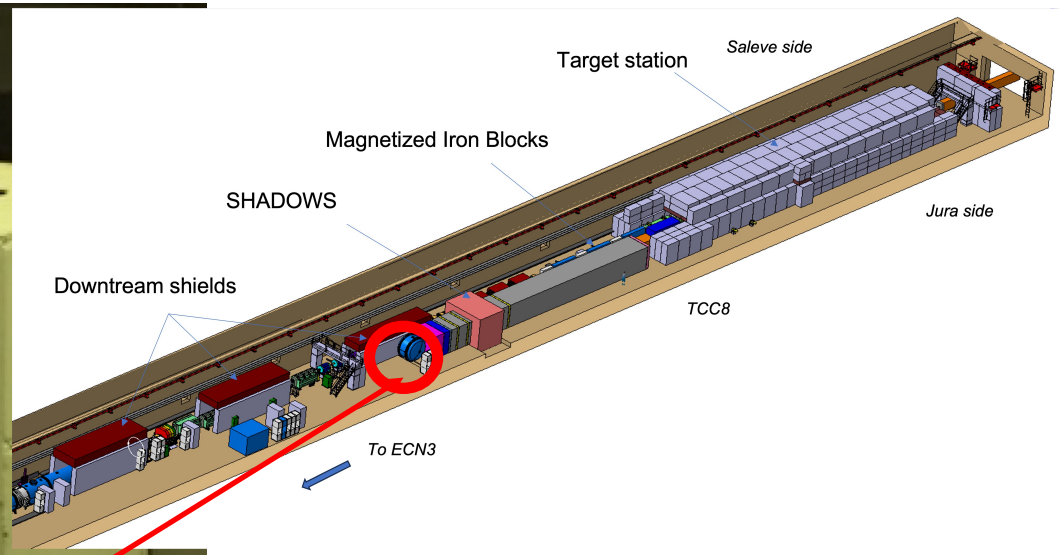
Two full-size modules already funded by INFN in 2023 and used to measure the off-axis muon flux in ECN3 during the June 2023 campaign (see later).

Requirements fully satisfied.

Validation of the simulated *off-axis* muon flux with SHADOWS prototypes

Measurement performed in June 2023 with NA62 operated in beam-dump mode at nominal beam intensity.
Effort partially funded via EUROLABS European Grant.





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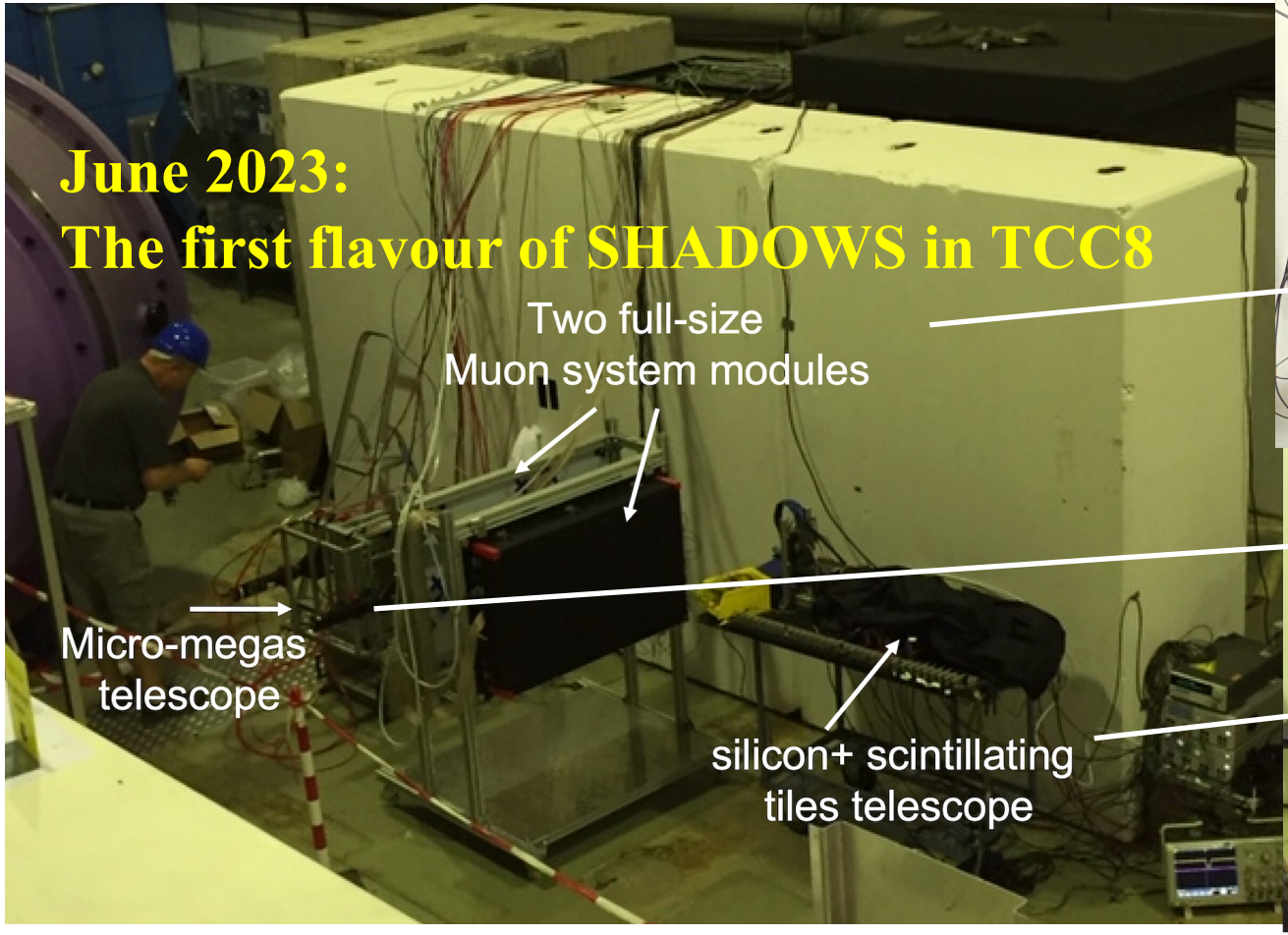
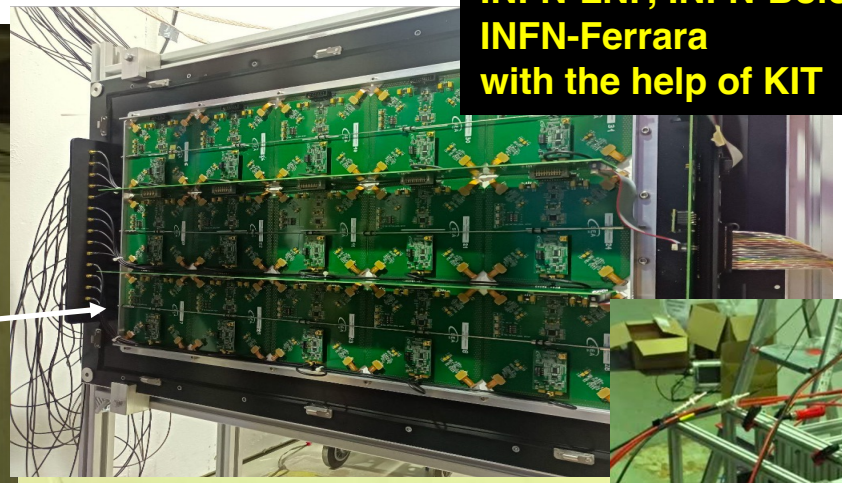
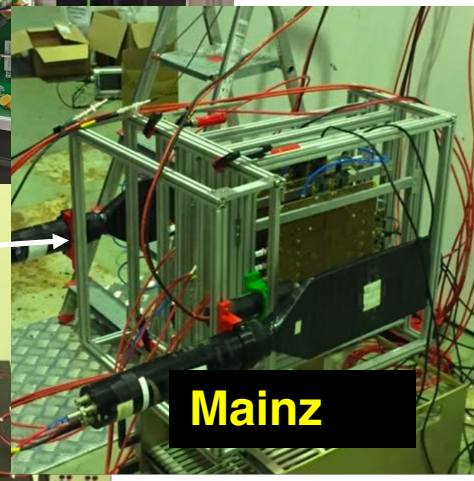
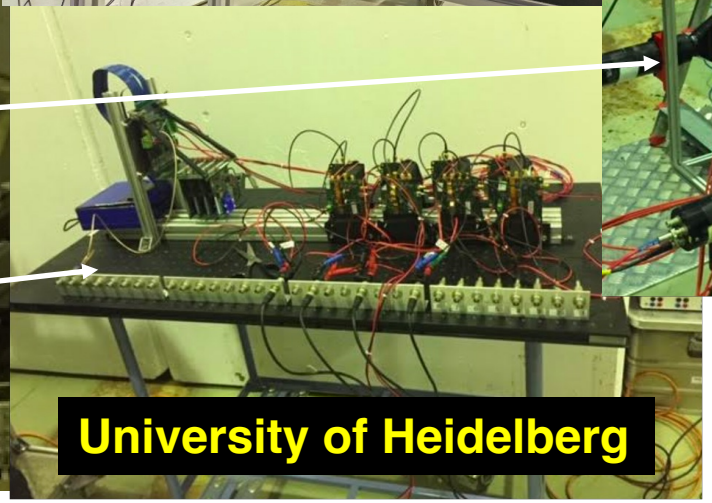




INFN-LNF, INFN-Bologna,
INFN-Ferrara
with the help of KIT

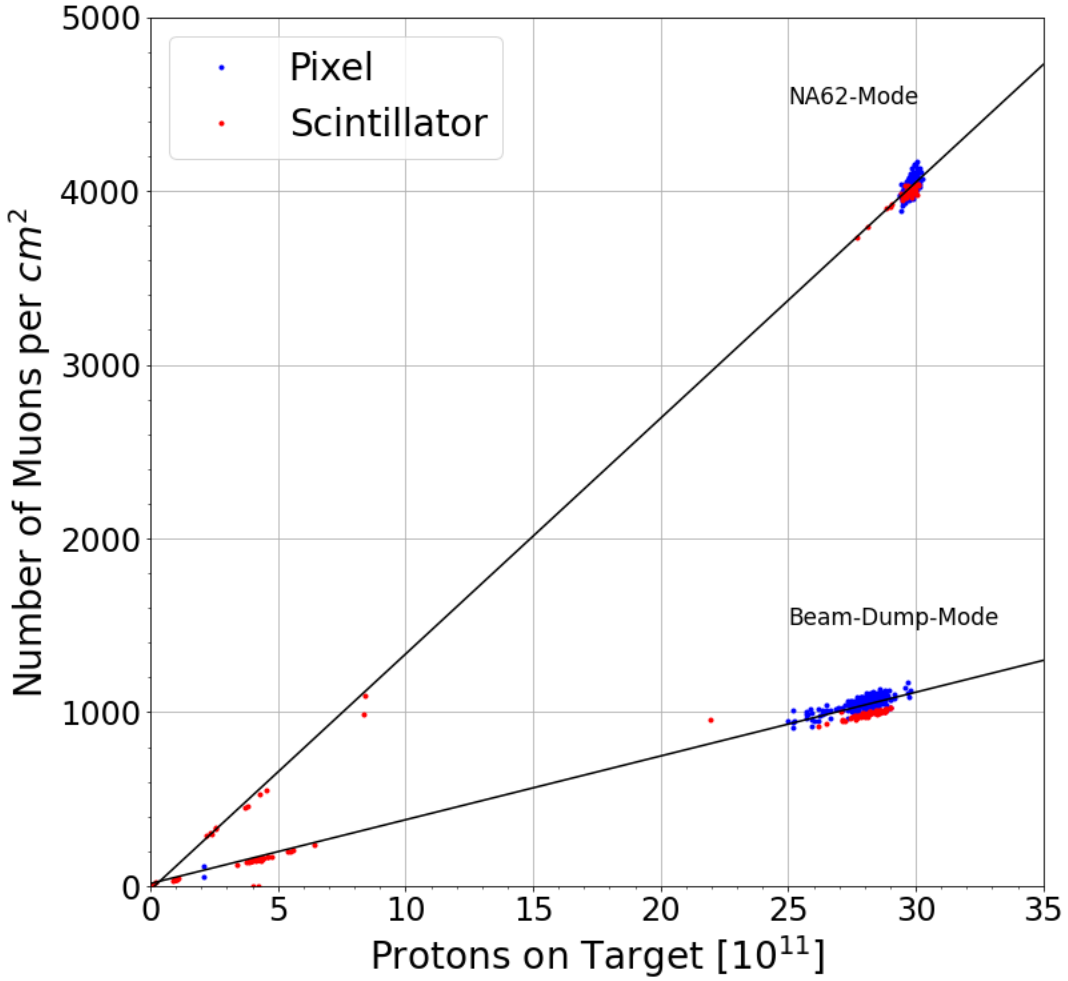


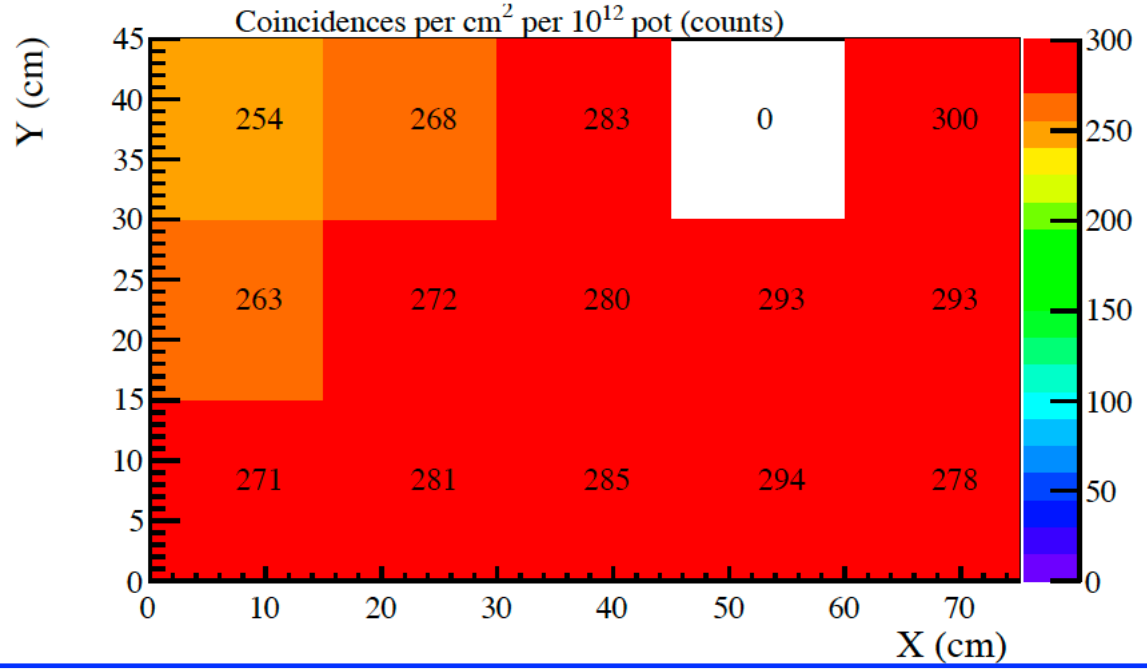
Mainz



University of Heidelberg

Validation of the simulated *off-axis* muon flux with SHADOWS prototypes





Results from data: 250-300 counts/cm^2/10^{12} pot

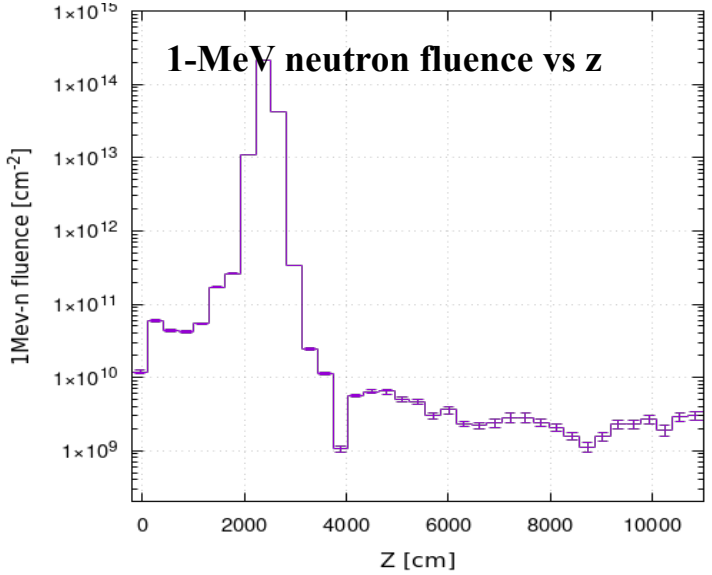
Results from simulation (rescaled): 260 ± 20 counts/cm2/10^{12} pot

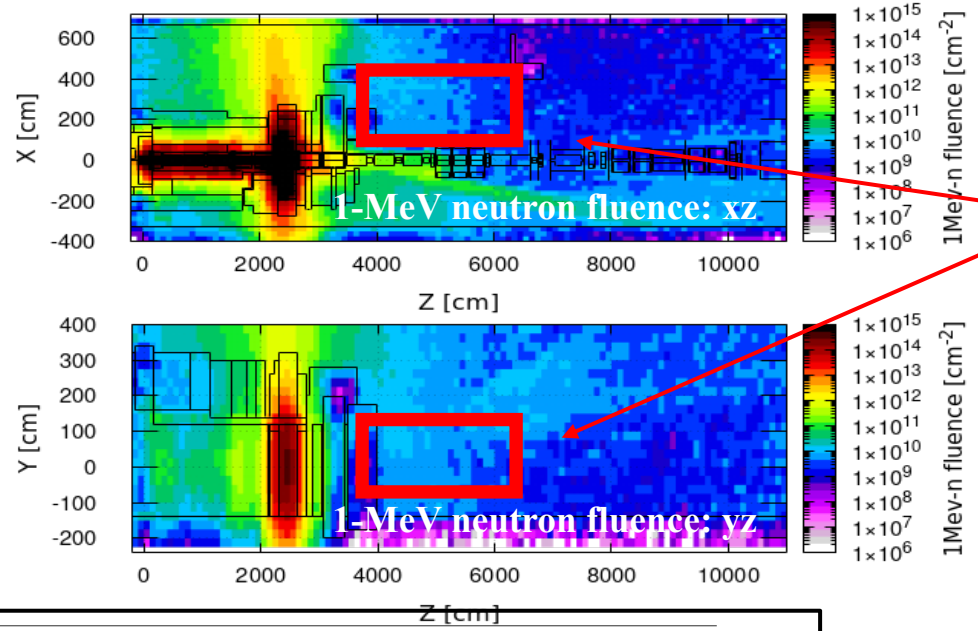
Excellent agreement between the results obtained with (very different) detectors gives reliability of the measurement.
Off-axis measurements confirmed the on-axis ones. Simulation is now fully validated.

Target station: Radiation Levels

C. Ahdida, L. Esposito, S. Niang, E. Nowack
CERN PBC ECN3 Task Force

1-MeV equivalent neutron fluence, high energy hadron fluence and thermal neutron fluence evaluated with a detailed FLUKA simulation in SHADOWS area





SHADOWS location

Quantity	Detector location	R2E safe
Total Ionising Dose (Gy)	0.1-1 per year	< 10
1-MeV neutron equivalent fluence (cm^{-2})	10^{9-10} per year	$< 10^{11}$
High-Energy Hadron eq. fluence (cm^{-2}year^{-1})	few 10^{9}	$< 3 \times 10^{6}$
Th. neutron eq. fluence (cm^{-2}year^{-1})	$< 5 \times 10^{10}$	$< 3 \times 10^{7}$

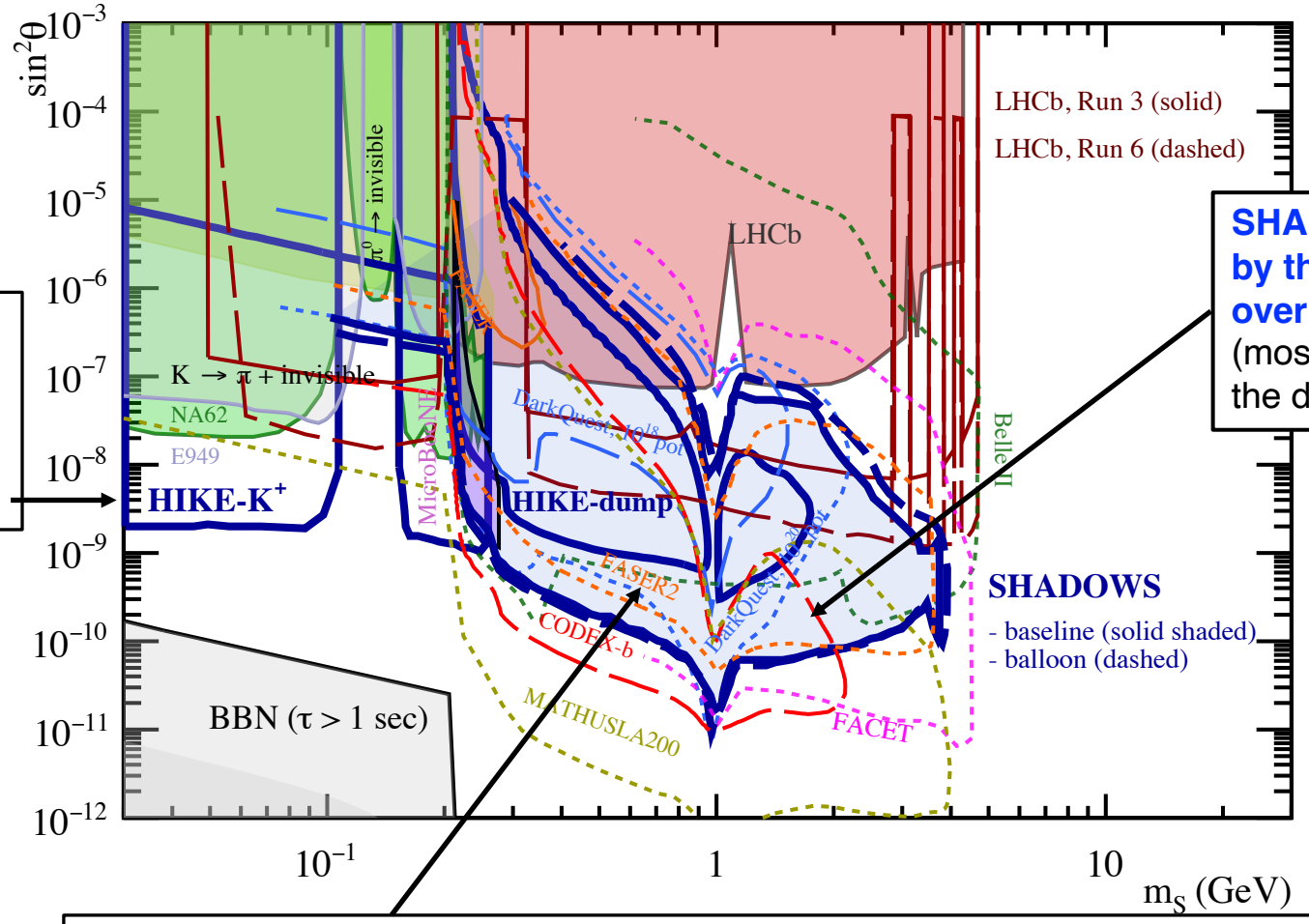
Radiation levels are not a show-stopper in the very-close-to-dump SHADOWS location

Radiation- tolerant electronics will have to be used in proximity of the SHADOWS detector

Dedicated alchoves with iron/concrete shielding far from the dump for the off-detector electronics.

Physics sensitivity: Light Dark Scalar mixing with the Higgs

(mediator of sub-GeV DM interacting with SM particles; candidate for relaxion mechanism, etc.)



SHADOWS is fully complementary to HIKE-phase 1 in kaon mode, that improves by about one order of magnitude below the kaon mass.

SHADOWS can improve by three orders of magnitude over the existing bounds (mostly from LHCb) between the di-muon threshold and ~4 GeV.

Given the extremely low background, **the contour plot can be interpreted as discovery plot.**

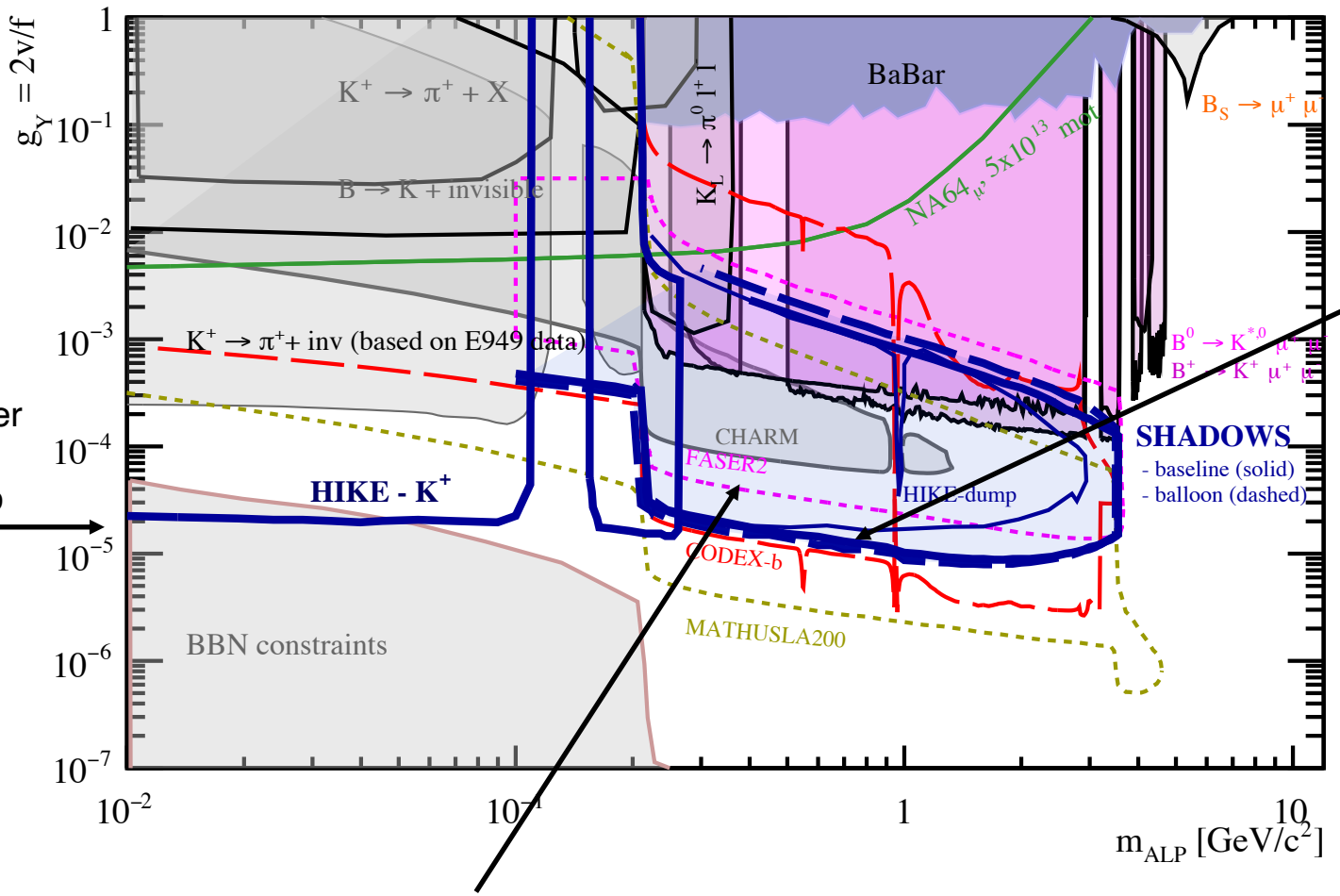
SHADOWS can cover a larger area in the (still uncharted) parameter space **than: DarkQuest; LHCb Run3 & Run 4 (upgrade 1); LHCb Run 6 (upgrade 2); CODEX-b; FASER2** at the Forward Physics Facility.

Worldwide landscape from FIPs2022 Proceedings, arXiv:2305.01715, accepted by EPJC

Physics sensitivity: ALPs with fermion couplings

Axions/ALPs in the MeV-GeV range are possible solution to the strong-CP problem

SHADOWS is complementary to HIKE-phase 1 in kaon mode, that can improve by about one order of magnitude the current bound below the K mass, and fill the gap down to BBN.



SHADOWS can improve by two orders of magnitude over the existing experimental bounds (LHCb) between the di-muon threshold and ~ 4 GeV.

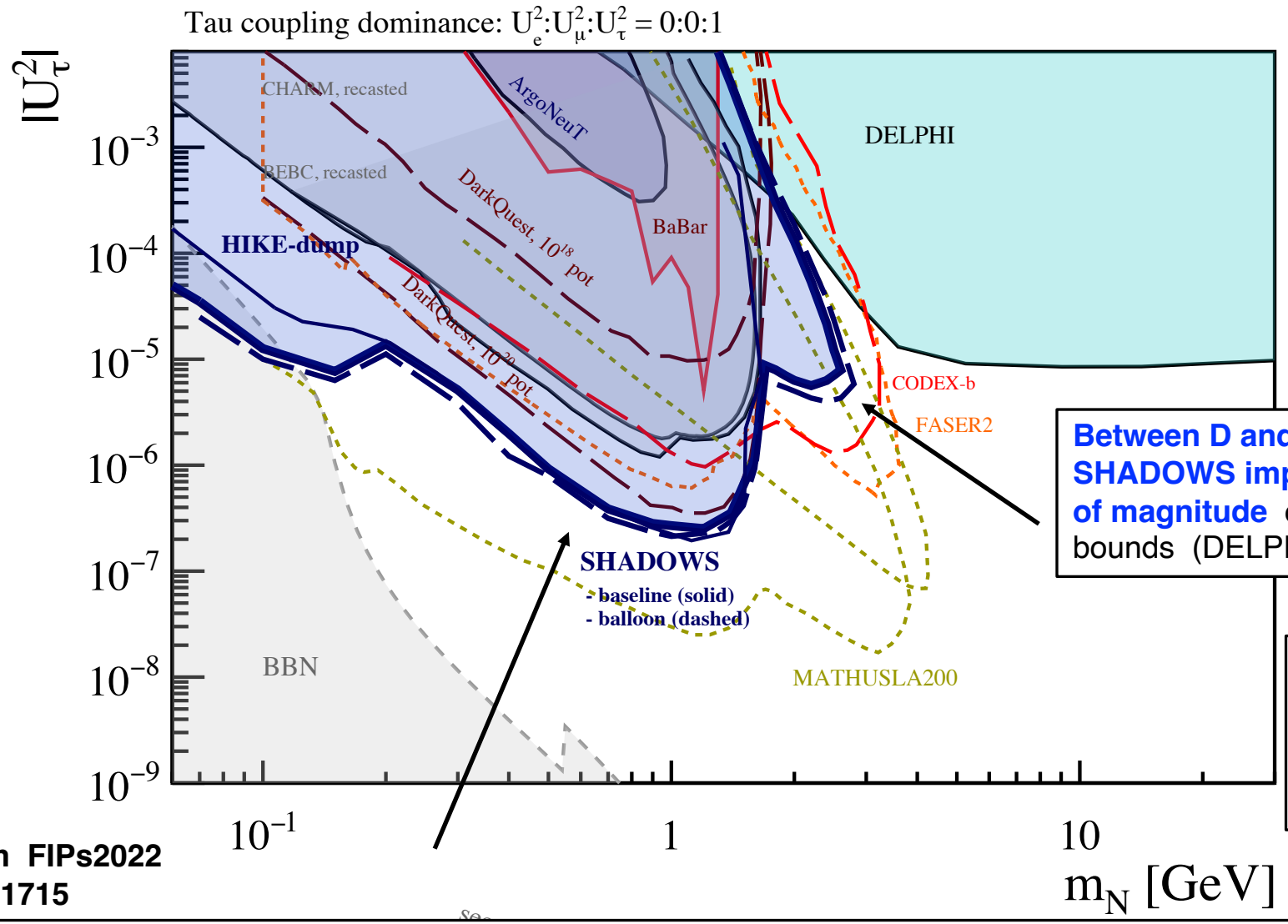
Given the extremely low background, **the contour plot can be interpreted as discovery plot.**

SHADOWS can cover a larger area than:
FASER2 at the Forward Physics Facility; and is very similar to CODEXb with the full data set at the end of the HL-LHC (3 ab^{-1}).

Worldwide landscape from FIPs2022 Proceedings, arXiv:2305.01715, accepted by EPJC

Physics sensitivity: HNL with tau couplings

Possible solution to the origin of the neutrino masses and matter-antimatter asymmetry



Between D and B thresholds SHADOWS improves by two orders of magnitude over the existing experimental bounds (DELPHI)

Given the extremely low background, **the contour plot can be interpreted as discovery plot.**

Worldwide landscape from FIPs2022 Proceedings, arXiv:2305.01715

Up to D threshold SHADOWS improves by two-four orders of magnitude over the existing experimental bounds (ArgoNeut & BaBar) and is better than DarkQuest, CODEX-b and FASER2.

Project Schedule

<table>
<tr><th>2023</th><th>2024</th><th>2025</th><th>2026</th><th>2027</th><th>2028</th><th>2029</th><th>2030</th><th>2031</th></tr>
<tr><td colspan="3">NA62 Run</td><td>LS3</td><td>LS3</td><td>LS3</td><td>ECN3/HI Installation/ commissioning</td><td>ECN3/HI Installation/ commissioning</td><td>ECN3/HI run</td></tr>
<tr><td>Proposal</td><td>TDR</td><td>TDR</td><td>TDR/PRR</td><td>Production</td><td>Production</td><td>Production/ Installation</td><td>Installation/ Pilot Run</td><td>SHADOWS run</td></tr>
<tr><th>2032</th><th>2033</th><th>2034</th><th>2035</th><th>2036</th><th>2037</th><th>2038</th><th>2039</th><th>2040</th></tr>
<tr><td>ECN3/HI run</td><td>LS4</td><td></td><td colspan="4">ECN3/HI Run</td><td>LS5</td><td></td></tr>
<tr><td>SHADOWS run</td><td>consolidation</td><td>SHADOWS run</td><td>SHADOWS run</td><td>SHADOWS run</td><td>SHADOWS run</td><td>SHADOWS run</td><td>consolidation</td><td>SHADOWS run</td></tr>
</table>

If approved, SHADOWS will be ready to start data taking in 2030 and collect $5x10^{19}$ pot by 2040.

(SHADOWS run beyond 2040 will depend on the compatibility with HIKE-phase 2)

Project Organization: preliminary groups interest

Table 41. Preliminary group interests for SHADOWS sub-detectors and activities.

Item	Technology	Interested groups
MIB system	magnetized iron blocks	CERN, LNF-INFN
Upstream Veto	Micromegas	INFN (Rome3, Naples)
Decay Vessel	in-vacuum	CERN
Dipole Magnet	warm	CERN
Tracker	Straws	Heidelberg
Timing Layer	scintillating bars	Freiburg
ECAL	StripCal	Mainz, KIT
Muon	scintillating tiles	INFN (LNF,Ferrara, Bologna)
Software		INFN-Rome 1, Prague
TDAQ		CERN
NaNu		Mainz/Bonn

All detectors/activities have groups involved. Still a lot of room for new groups/collaborators.

Project Organization: preliminary cost estimate

Table 40. Preliminary cost estimate of SHADOWS sub-detectors and magnets. The cost of the NaNu experiment is reported in the last row.

Item	Technology	Cost (M€)
MIB system	magnetized iron blocks	0.992
Upstream Veto	Micromegas	0.860
Decay Vessel	in-vacuum	1.0
Dipole Magnet	warm	2.57
Tracker	Straws	1.624
Timing Layer	scintillating bars	0.180
ECAL	StripCal	0.980
Muon	scintillating tiles	1.111
TDAQ		0.250
Total SHADOWS		**9.567**
Total NaNu		**2.840**

Cost uncertainty C3 class:
(-(10-20)%, +(10-30)%)

The relative small-medium size (and cost) makes SHADOWS feasible and realistic in the short timescale
(start production in three years from now, production lasting only two years)

SHADOWS Timeline

- ✓ **Submission of the Expression of Interest to the SPSC the 7 January 2022**
- ✓ **Submission of the Letter of Intent to the SPSC the 22 November 2022**
- ✓ **Submission of the Proposal to the SPSC the 18 August 2023**
- ✓ **Project presentation at the SPSC Open Session on September 5th 2023**
- ✓ https://indico.cern.ch/event/1303571/
- ✓ **Q&A session with the SPSC at the SPSC closed session on September 6th**

- ➢ **October 31st: Submission to CDS and to the SPSC of the final version of the Proposal**
- ➢ **21-22 November: SPSC Recommendations about SHADOWS (and HIKE)**
- ➢ **December: Final decision from the CERN Research Board.**

Hence:

By Christmas this year we will know whether we are approved or not.

CSN1, riunione di bilancio a Napoli 11-15/09

Gruppo I — **Bilancio 2024** — Nascondi Esperimenti

Rich	Esperimento	MISS Ass	MISS SJ	CON Ass	CON SJ	ALTRICONS Ass	ALTRICONS SJ	SEM Ass	SEM SJ	TRA Ass	TRA SJ	PUB Ass	PUB SJ	LIC-SW Ass	LIC-SW SJ	MAN Ass	MAN SJ	INV Ass	INV SJ	APP Ass	APP SJ	SPSERVIZI Ass	SPSERVIZI SJ	Parz Ass	Parz SJ	TOT	Antic	DIF
675.5	AMBER	223.5	9.5	86.5												4.0		25.0	5.0	6.0	90.0	44.0	43.5	389.0	148.0	**537.0**	0.0	**138.5**
6186.5	ATLAS	920.0	495.0	615.0	5.0											1.5						425.5	923.0	1962.0	1423.0	**3385.0**	497.0	**2801.5**
1271.0	BELLE2	584.5	58.5	85.5						2.0						8.0							220.0	680.0	278.5	**958.5**	0.0	**312.5**
853.0	BESIII	282.5	60.0	35.0	245.5	1.5				8.5				1.0				5.0		9.0	22.0			342.5	327.5	**670.0**	0.0	**183.0**
1458.5	CALC1-TIER1																							0.0	0.0	**0.0**	0.0	**1458.5**
8696.5	CMS	1178.0	668.5	727.0																		529.5	1511.0	2434.5	2179.5	**4614.0**	1118.0	**4082.5**
4881.5	DUNE	192.5	97.0	131.0	170.0	41.0				21.5								61.5	100.0	977.0	7.0	45.0	80.0	1469.5	454.0	**1923.5**	0.0	**2958.0**
4556.0	FASE2_ATLAS			54.5	53.5					4.0	3.0					2.0		44.0	53.0	537.0		13.5	13.5	655.0	123.0	**778.0**	9.0	**3778.0**
4738.5	FASE2_CMS			56.0	71.5						4.0							5.5	11.0	1978.0		2.0	2.0	2041.5	88.5	**2130.0**	0.0	**2608.5**
224.5	GMINUS2	40.5	40.5	10.5	40.0	2.0																		53.0	80.5	**133.5**	0.0	**91.0**
405.0	ICAR_US	92.5	52.5	31.0		6.0				13.0						12.0			3.5	47.5	5.0	40.0	30.0	242.0	91.0	**333.0**	0.0	**72.0**
440.0	IGNITE	20.0		180.0	225.0										10.0									200.0	235.0	**435.0**	0.0	**5.0**
0.0	KLOE																							0.0	0.0	**0.0**	0.0	**0.0**
2571.0	LHC-b	560.0	301.5	154.0							10.0											376.5	327.0	1090.5	638.5	**1729.0**	0.0	**842.0**
74.5	LHCf	27.0	17.5	4.5							5.0											5.0	3.0	36.5	25.5	**62.0**	0.0	**12.5**
0.0	LUXE																							0.0	0.0	**0.0**	0.0	**0.0**
480.0	MEG	182.5	46.0	76.5														7.0			20.0			266.0	66.0	**332.0**	0.0	**148.0**
0.0	MUEDM																							0.0	0.0	**0.0**	0.0	**0.0**
851.0	MUONE	35.0	3.0	65.0	10.0					5.0										132.0	529.0			237.0	542.0	**779.0**	0.0	**72.0**
776.0	NA62	460.5	7.0	57.0						2.0				2.0								182.0		703.5	7.0	**710.5**	0.0	**65.5**
92.0	PADME	32.0	15.0	13.0	15.0																			45.0	30.0	**75.0**	0.0	**17.0**
875.5	PMU2E	243.0	42.0	23.5	148.5		11.0			5.0										218.0		20.0		509.5	201.5	**711.0**	0.0	**164.5**
432.0	RD_FCC	167.0	144.5	18.0	20.0														10.0					185.0	174.5	**359.5**	0.0	**72.5**
464.0	RD_FLAVOUR			197.5	140.0					2.0								8.5	40.0		15.0			208.0	195.0	**403.0**	0.0	**61.0**
604.5	RD_MUCOL	116.5	73.0	71.5	17.0																21.0			188.0	111.0	**299.0**	25.0	**305.5**
0.0	SELDOM_TWOCRYST																							0.0	0.0	**0.0**	0.0	**0.0**
0.0	SHADOWS																							0.0	0.0	**0.0**	0.0	**0.0**
527.5	SNDLHC	238.5		40.5																24.0		193.5		496.5	0.0	**496.5**	0.0	**31.0**
0.0	UA9																							0.0	0.0	**0.0**	0.0	**0.0**
0.0																								0.0	0.0	**0.0**	0.0	**0.0**
42134.5	Totale Esperimenti	5596.0	2131.0	2733.0	1161.0	50.5	11.0			63.0	22.0			3.0	10.0	27.5		156.5	222.5	3928.5	709.0	1876.5	3153.0	14434.5	7419.5	**21854.0**	1649.0	**20280.5**
68.5	KLOE	11.0		21.0												26.0					5.0			58.0	5.0	**63.0**	0.0	**5.5**
58.0	SHADOWS		24.0		34.0																			0.0	58.0	**58.0**	0.0	**0.0**
67.0	UA9	7.0	12.0	4.5																		30.0		41.5	12.0	**53.5**	0.0	**13.5**

sigle sotto dotazione presenti a LNF

1111.0	Totale Esp. Dot.	169.0	92.5	56.5	77.5	5.0				2.0	12.0			1.0		56.5	5.0	22.5	37.0	31.0	36.5	30.0		373.5	260.5	**634.0**	0.0	**477.0**
1946.0	Totale Dotazioni	797.5		403.0				46.0				51.0						608.5						1906.0	0.0	**1906.0**	**0.0**	**40.0**
	Fondo Indiv.		314.0		50.0														50.0		92.0		100.0			**606.0**		
45191.5	TOTALE	6876.5	2223.5	3242.5	1238.5	55.5	11.0	46.0		65.0	34.0	51.0		4.0	10.0	84.0	5.0	837.5	259.5	4051.5	745.5	2006.5	3153.0	17320.0	7680.0	25000.0	1649.0	20191.5
		9100.0		4481.0		66.5		46.0		99.0		51.0		14.0		89.0		1097.0		4797.0		5159.5		25000.0				