5 Luglio 2023

Preventivi 2024
Gruppo IV

Francesco Sanfilippo

CSN4

Iniziative Specifiche di Gruppo IV

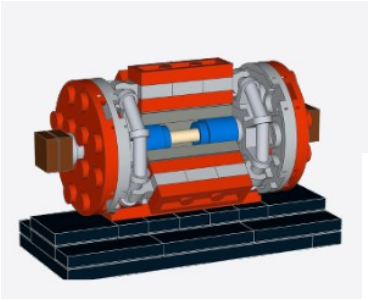
Sigla	FTE	Responsabile
SPIF	10.25 → 7.3	~~Giuseppe Degrassi~~ Davide Meloni
LQCD123	5.55 → 6.40	Francesco Sanfilippo
GSS	3	Dario Francia
TOTALE	**16.7**	Diminuzione per chiusura INDARK

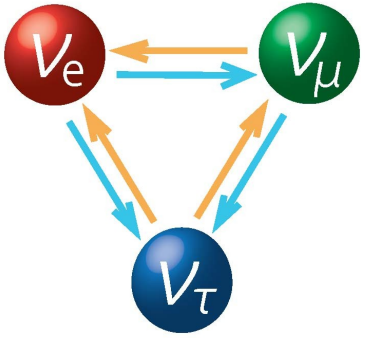
Descrizione	Impegni	Disp. Teorica
Strumenti tecnico-speci	3.075,56	412,73
Rimborso per viaggio e	5.569,94	430,06
Indennità di missione	1.192,42	3.585,58
Acquisto di servizi per	200,00	22,00
Altri servizi diversi n	300,00	0,00
Attrezzature scientific	26.811,94	24,76
	37.149,86	**4.475,13**

+ 1 Postdoc Gr IV (SPIF) coming in October (Joao Penedo)

SPIF @ RMIII

- Phenomenology for present and future colliders
- Flavor physics bounds to BSM
- Neutrino physics



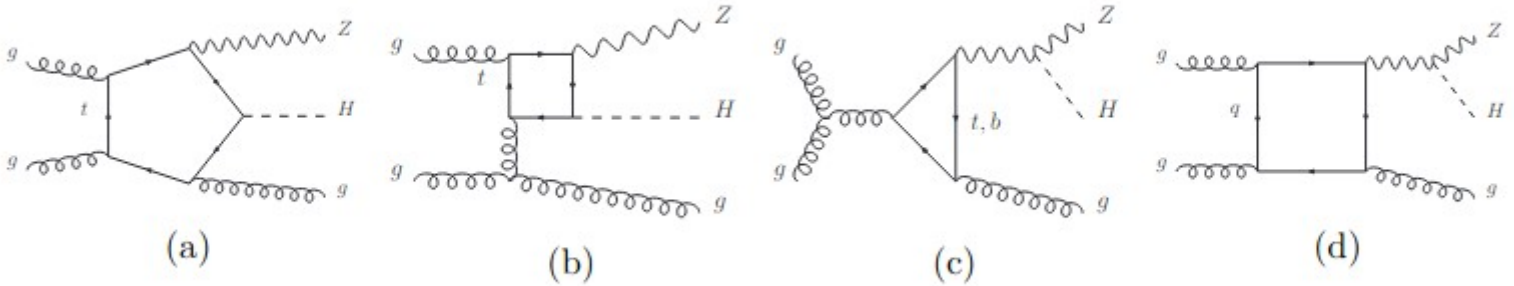


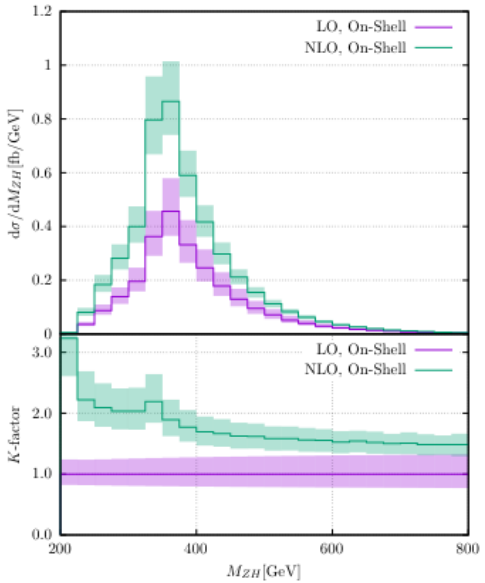
Degrassi	Giuseppe	Associato	100%
Simula	Silvano	Staff	20%
Greco	Mario	Senior	*
Giarnetti	Alessio	Dottorando	100%
Marciano	Simone	Dottorando	100%
Ciuchini	Marco	Staff	80%
Franceschini	Roberto	Associato	90%
Lubicz	Vittorio	Associato	20%
Meloni	Davide	Associato	100%
Tarantino	Cecilia	Associato	20%
Ronca	Jonathan	Assegnista	100%

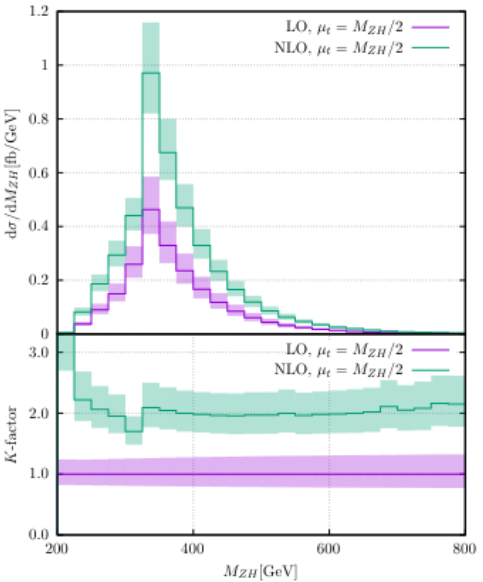
On the NLO QCD Corrections to Gluon-Initiated ZH Production

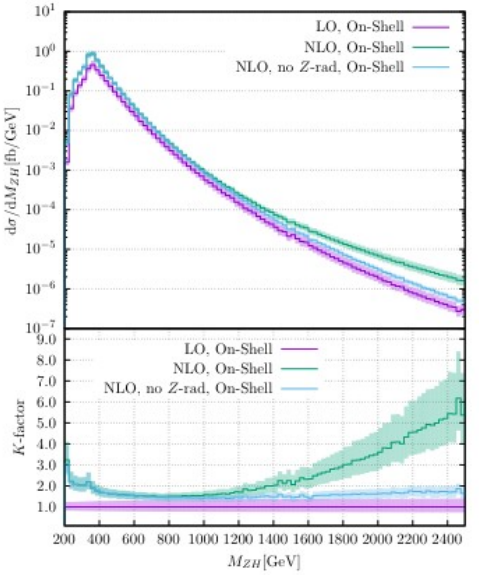
Giuseppe Degrassi[a,b*], Ramona Gröber[c†], Marco Vitti[b‡] and Xiaoran Zhao[b§]

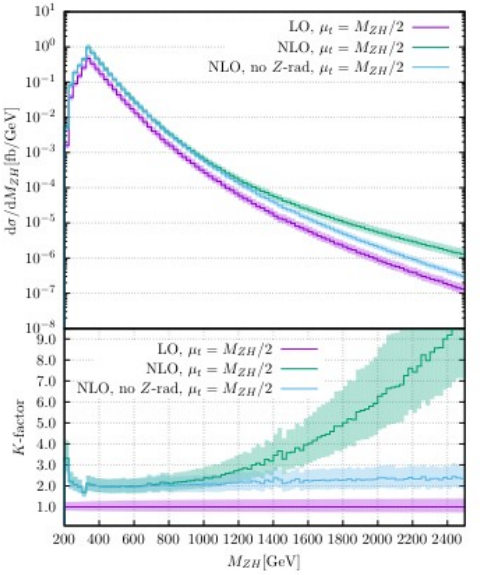
arXiv:2205.02769v2











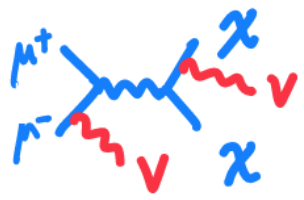
R.Franceschini Activity

- done
  - top quark mass at LHC with B-hadrons (2212.03929 with Maryland and Santa Barbara)
  - muon collider physics and WIMPs (2212.11900 with Xiaoran Zhao (Roma 3))
  - Belle II Axion Like Particles (upcoming arXiv with Francesca Acanfora (GGI & Roma 3 PhD) Alessio Mastroddi (Roma 3 PhD) and Diego Redigolo (CERN, INFN FI)
- current
  - W mass at muon collider (includes Jonathan Ronca (Roma3))
  - $Zh + X$ at muon collider and FCChh (with INFN LNF and CERN)
  - t and W precision mass measurements to spot light new physics (with Maryland, LNF, CERN)
- coordination of ECFA group on direct search of new physics at the Higgs/Top/Electroweak e^+e^- factory
- PRIN 2022 with Pisa, Padova, INFN on dark matter, flavor and future colliders

R.Franceschini Activity

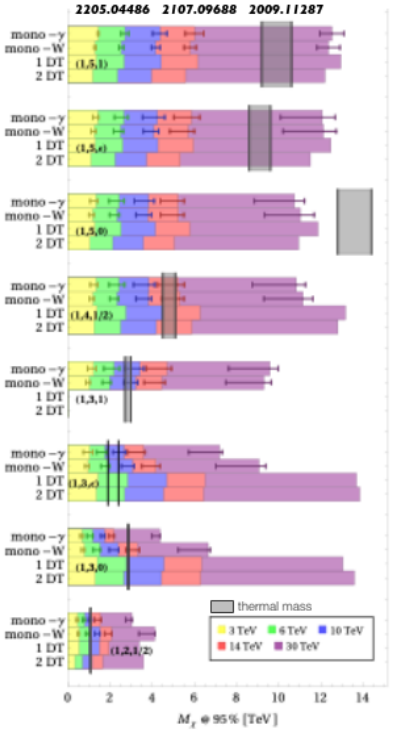
Search for EW Dark matter at $\mu\mu$ collider

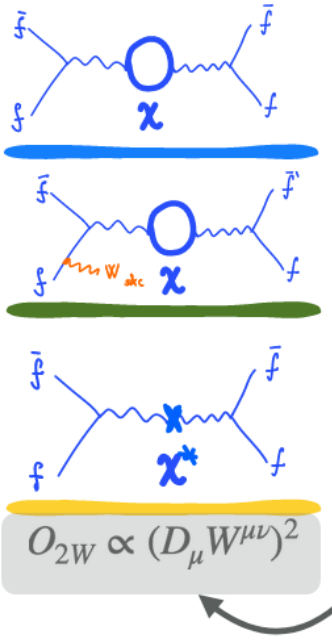
- Xe signal of heavy WIMP opens the chase from 1 TeV to fraction of PeV mass
- most solutions to open issues of the SM require new EW particles



Large χ mass needs CoM energy!

Weak radiation yield the most constraining channel "mono-W"

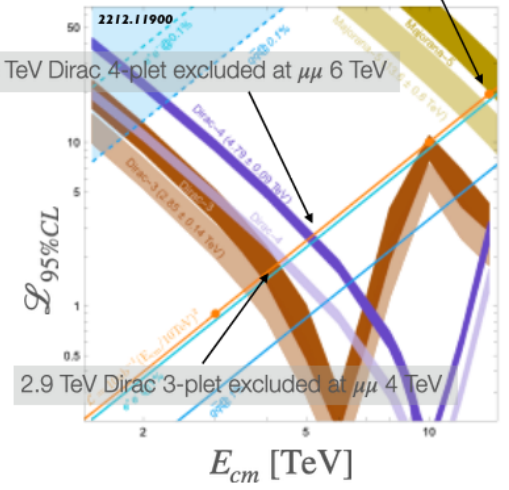


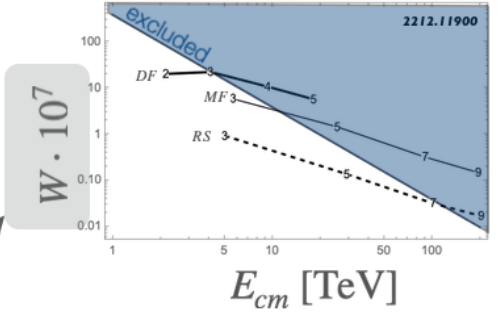


14 TeV Majorana 5-plet excluded at $\mu\mu$ 14 TeV

4.8 TeV Dirac 4-plet excluded at $\mu\mu$ 6 TeV

2.9 TeV Dirac 3-plet excluded at $\mu\mu$ 4 TeV





D. Meloni – Flavor Problem in Neutrino Physics

Awarded of the Horizon 2020: ESSnuSB plus - Roma Tre University node
New Physics in the neutrino sector at the future facility ESSnuSB in Sweden

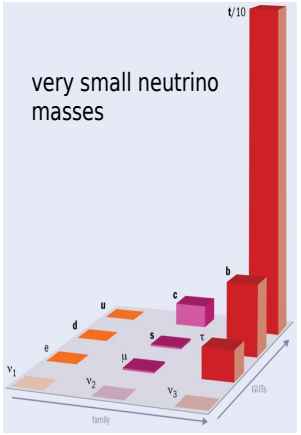
Collaborators:
- Alessio Giarnetti (postdoc),
- Simone Marciano (PhD),
- Matteo Parriciatu (borsista);
- Joao Penedo (Postdoc Gruppo IV, from October)

Publications:
- P.B.Denton, A.Giarnetti and D.Meloni, JHEP 02 (2023)
- G.Arcadi, S.Marciano and D.Meloni, Eur. Phys. J. C 83 (2023)

Preprints:
- S.K.Agarwalla, S.Das, A.Giarnetti, D.Meloni and M.Singh, [arXiv:2211.10620 [hep-ph]]
- D.Meloni and M.Parriciatu, [arXiv:2306.09028 [hep-ph]].

The Flavor Problem

Mass hierarchies



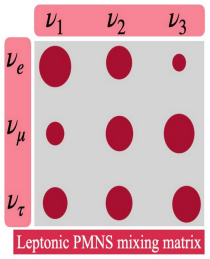
$$m_d \ll m_s \ll m_b, \quad \frac{m_d}{m_s} = 5.02 \times 10^{-2},$$

$$m_u \ll m_c \ll m_t, \quad \frac{m_u}{m_c} = 1.7 \times 10^{-3},$$

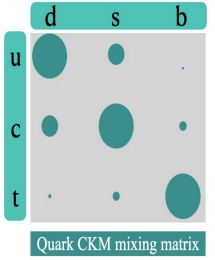
$$\frac{m_s}{m_b} = 2.22 \times 10^{-2}, \quad m_b = 4.18 \text{ GeV};$$

$$\frac{m_c}{m_t} = 7.3 \times 10^{-3}, \quad m_t = 172.9 \text{ GeV};$$

Fermion mixing



all mixing are large but the 13 element



almost a diagonal matrix

Suggested solutions

* Smallness of neutrino masses:

See-saw

$$\mathcal{M} = \begin{bmatrix} m_M^L & m_D \\ m_D & m_M^R \end{bmatrix}$$

$$m_{light} \sim \frac{m_D^2}{M_M^R}$$

No clue on mixing !

* Hierarchical Pattern

Froggatt-Nielsen mechanism

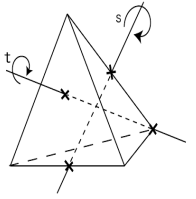
$$L \sim \overline{\Psi}_L H \Psi_R \left(\frac{\theta}{\Lambda}\right)^n$$

Too many O(1) coefficients

Works better for small mixing

* mixing angles

elegant explanation:
non-Abelian
discrete flavour symmetries



Complicated scalar sector

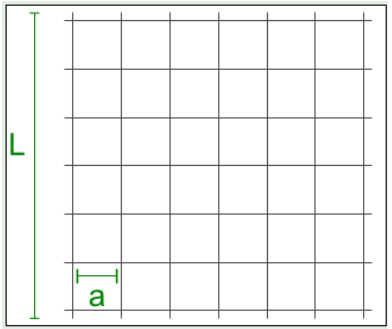
Working hard to find a reliable solution!

LQCD123 @ RMIII

NPQCD calculations of hadronic matrix elements

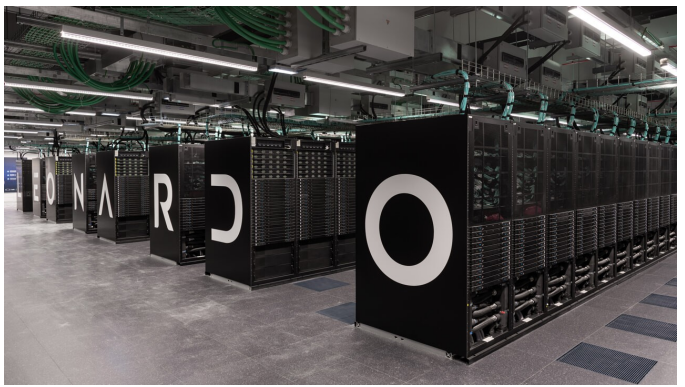
Inclusive decays via Inverse Laplace Problem

- QED effects in spectrum and decay
- Precision below % for selected observables



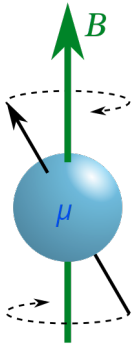
Sanfilippo	Francesco	Staff	100%
Simula	Silvano	Staff	70%
Martinelli	Guido	Senior	50%
Melis	Aurora	Borsa Gr IV	100%
Lubicz	Vittorio	Associato	80%
Di Palma	Roberto	Dottorando	100%
Tarantino	Cecilia	Associato	80%
Gagliardi	Giuseppe	Assegnista	100%

4.5k€ per missioni nel 2022

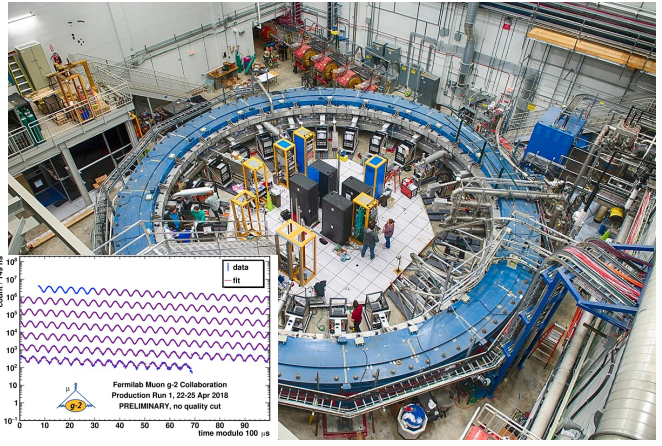


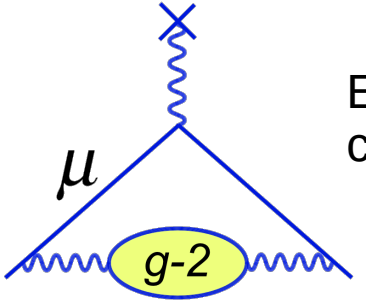
2 Prin 2021 awarded: V.Lubicz (University RM3, PI) and S.Simula (INFN RM3, PI @Torino)

The g $_\mu$ -2 puzzle

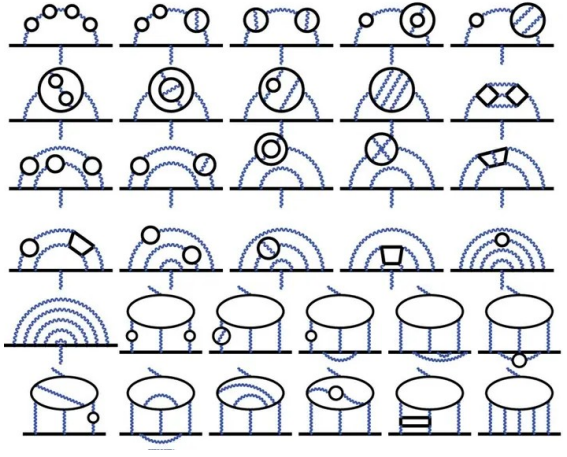


Extremely precise measurement



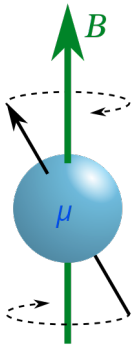


Extremely precise calculation...



More than 4σ discrepancy with theory!

The g $_\mu$ -2 puzzle



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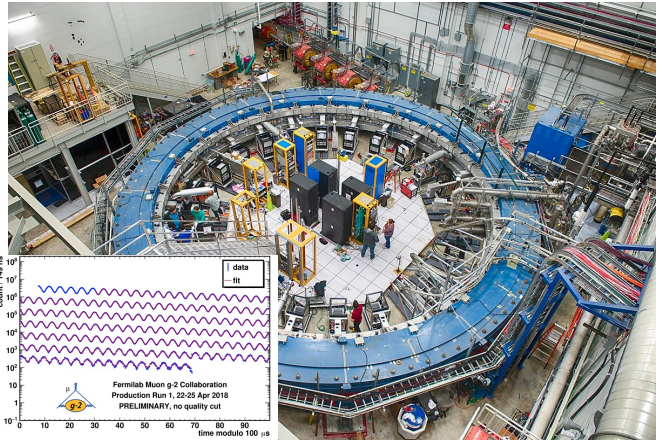

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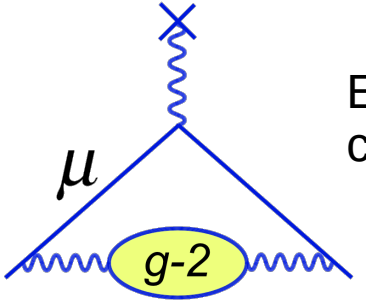
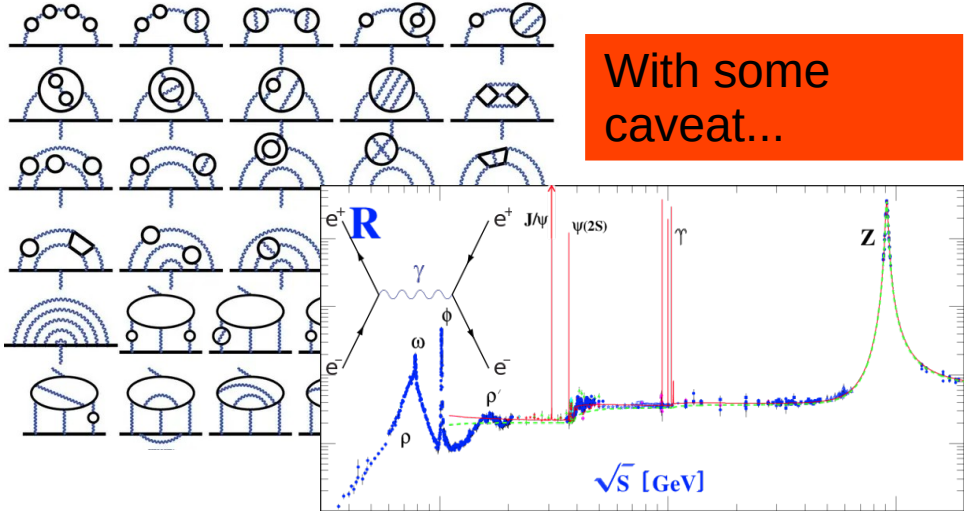


Extremely precise calculation...

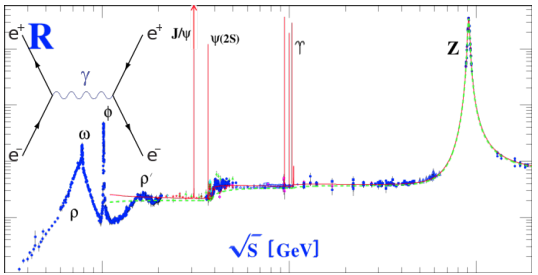


With some caveat...

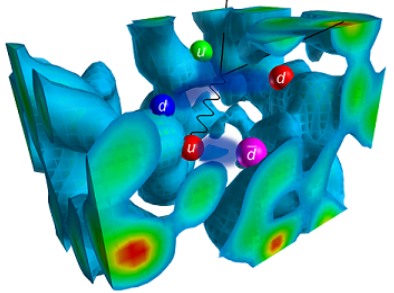
So far, experimental R-Ratio in place of leading hadronic contribution

Lattice came in - The “new” g $_{\mu}$ -2 puzzle

DISPERSIVE PREDICTION



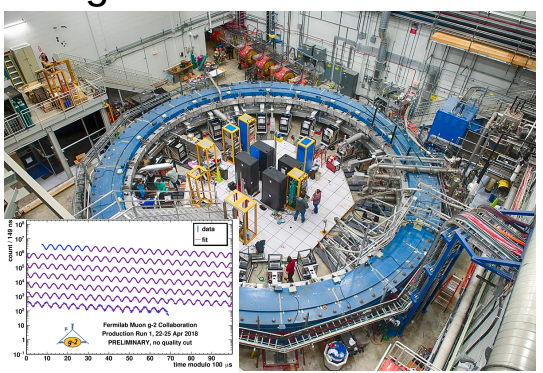
LATTICE CALCULATION



4.2σ DISAGREEMENT

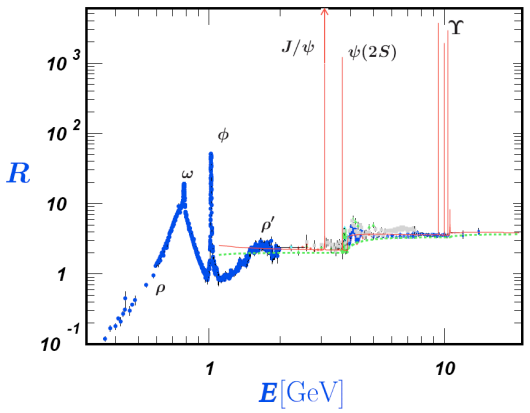
1.5σ “AGREEMENT”

g-2 EXPERIMENT



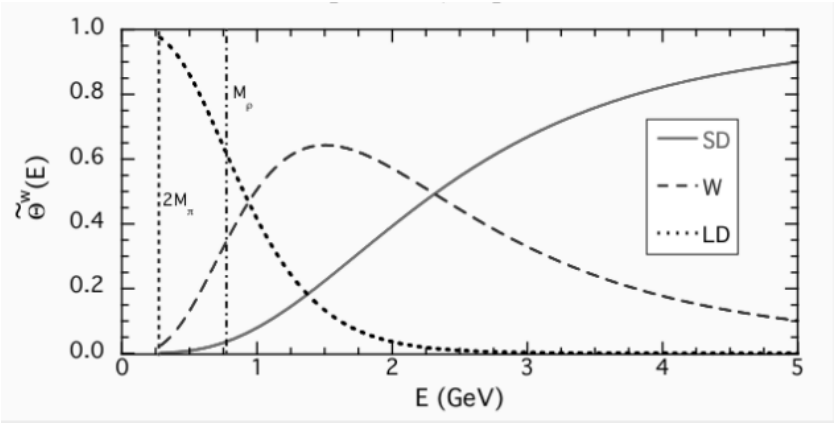
BMW coll.
Nature 593
(2021) 51

Do we know precisely R(E)?



Partial contribution of R(E) to g-2

“Energy Window observables”



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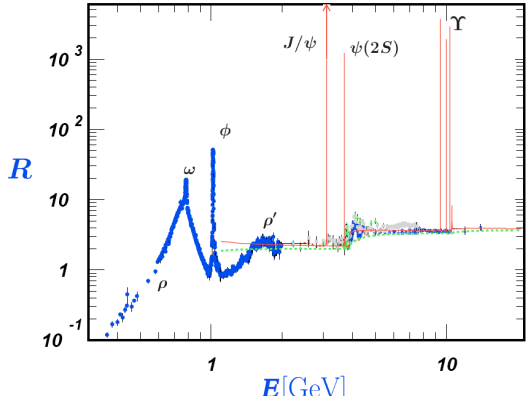

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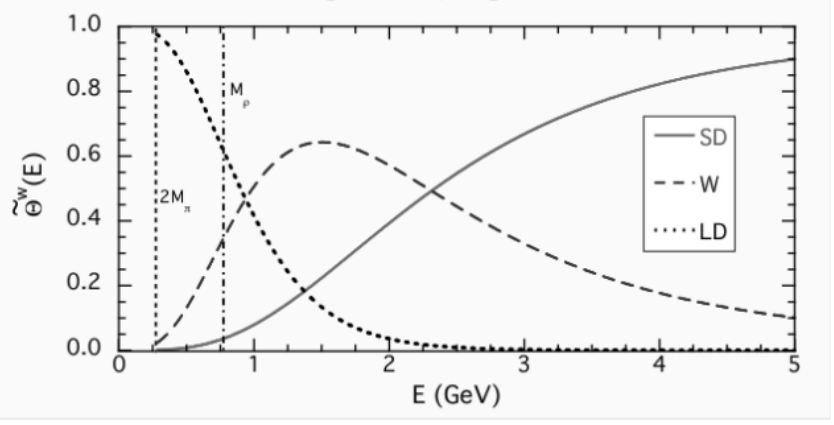
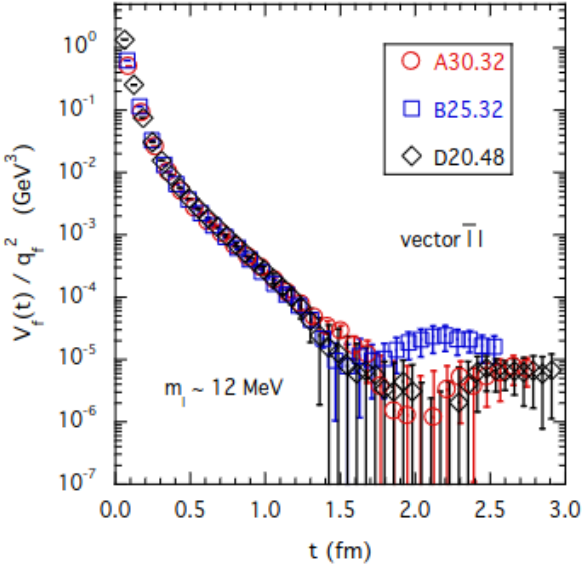
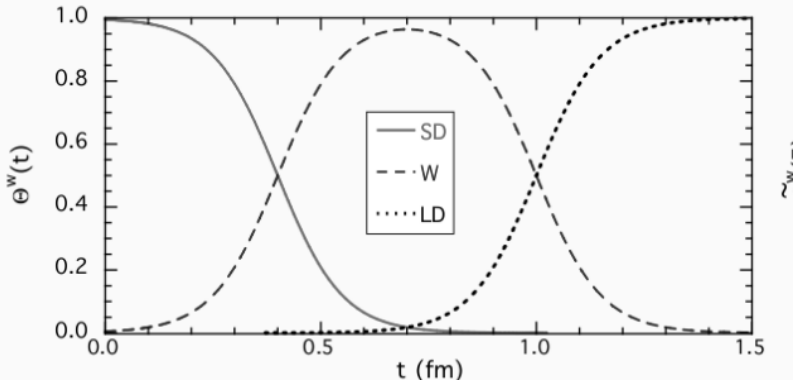


Three different contributions can be computed on the lattice from different times of the correlator: SD = Short Distance, W=(intermediate) Window, LD=Long Distance





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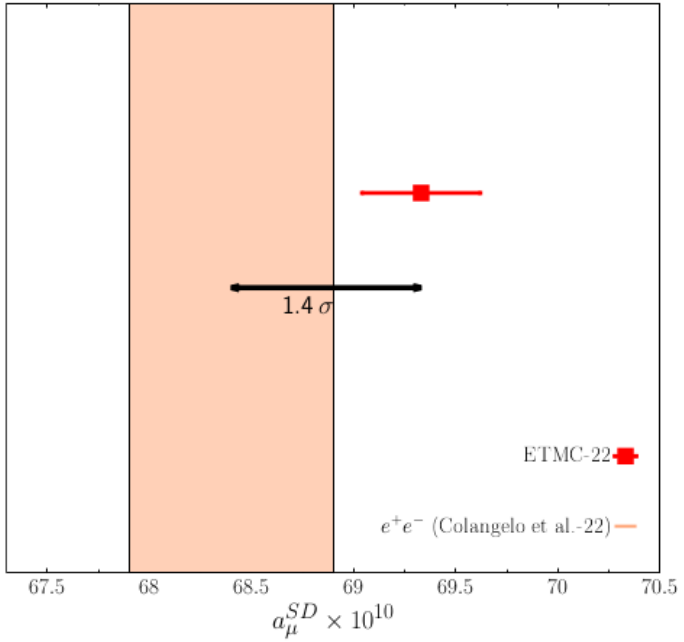

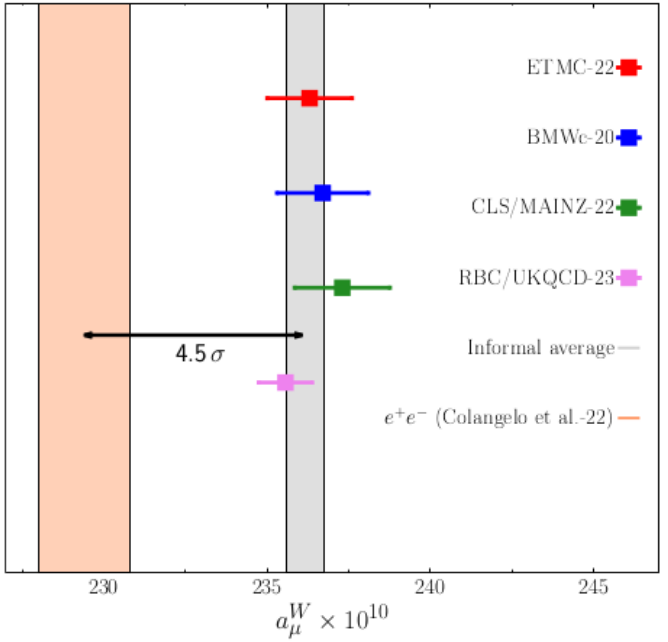

- R(E) computed on the lattice disagrees with experiment at ~1 GeV energies
- Agreement at large energies (and likely at very small energies)

[ETM collaboration, Phys.Rev.D 107 (2023) 7, 074506] 97 citations on INSPIRE!

Can we compute precisely R(E)?

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Infamous No-go theorem [L.Maiani, M.Testa Phys.Lett.B 245 (1990) 585-590]

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In Minkowski spacetime $$C(t) = \int_{E_0}^{\infty} e^{-iEt} R(E) E^2 dE$$ Inverse Fourier Transform

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Inverse Fourier Transform

On the lattice we are forced to change $t \longrightarrow i\tau$

In Euclidean spacetime

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Inverse Laplace Transform

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Can determine “easily” *R(E₀)* at threshold energy by taking $\tau \longrightarrow \infty$

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In Euclidean spacetime $$C(\tau) = \int_{E_0}^{\infty} e^{-E\tau} R(E) E^2 dE$$ Inverse Laplace Transform

Can determine “easily” *R(E₀)* at threshold energy by taking $\tau \longrightarrow \infty$

So far, it was considered **impossible** to determine hadron properties above threshold, beside special cases, from lattice simulations

Solve the Inverse Laplace transform numerically

Old ideas studied in Geophysics:
[G.E Backus and F.Gilbert, 1968]

Determine a “smoothed” inverse Laplace transform

$$R(E) \rightarrow R_{\Delta}(E) = \int \Delta(E-x)R(x)dx$$

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Adaptation to Particle physics needed: implement a method to fix the smoother Δ

[M.Hansen, A.Lupo, N.Tantalo, PRD 99 2019]

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[M.Hansen, A.Lupo, N.Tantalo, PRD 99 2019]

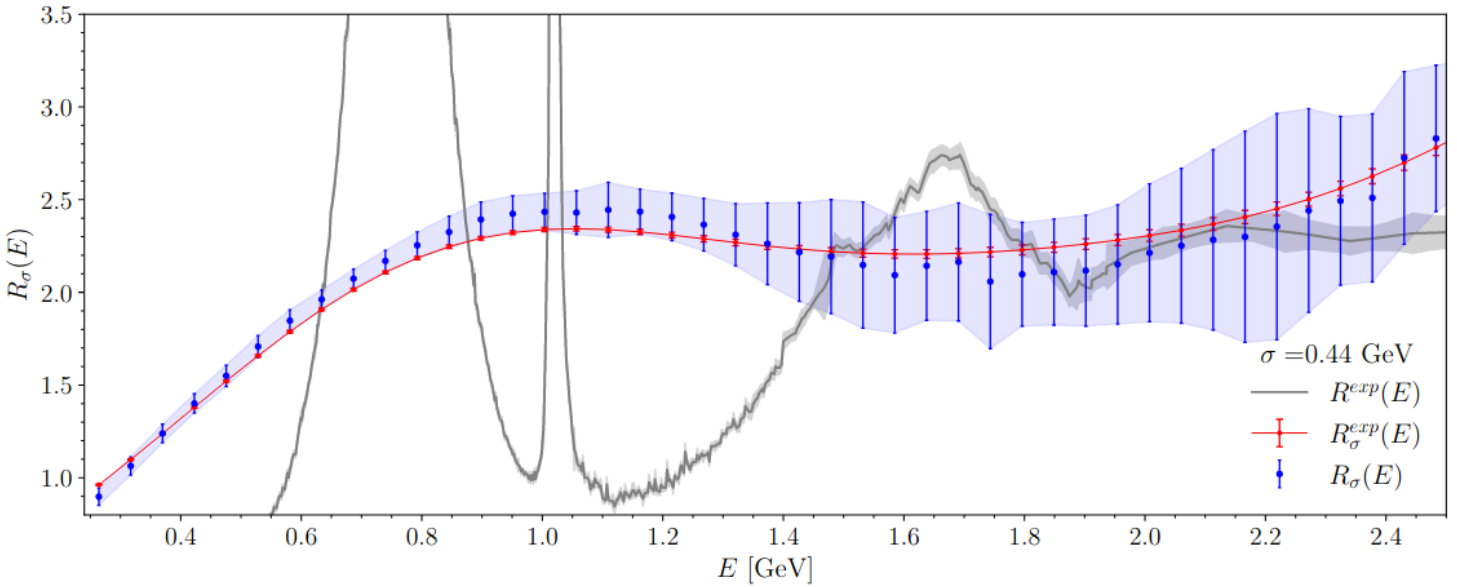
Smoothed inverse Laplace transform $R_\Delta^{teo}(E)$ can be compared with smoothed $R_\Delta^{exp}(E)$

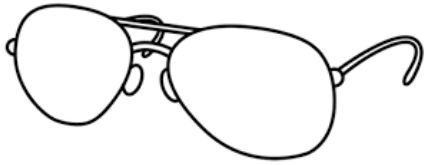
Proof-of-concept calculation with Δ of size ~440 MeV

"Probing the Energy-Smeared R-Ratio Using Lattice QCD", Phys.Rev.Lett. 130, 2023

Comparison of R(E) smoothed over ~440 MeV

"Probing the Energy-Smeared R-Ratio Using Lattice QCD", Phys.Rev.Lett. 130, 2023





- At these details level, no discrepancy visible yet
- More statistics needed to increase the resolution
- Applied to EuroHPC call, 4M Gpu Hours on Leonardo? Stay tuned

Same idea applied to radiative decays

arXiv:2306.07228

Spectral-function determination of complex electroweak amplitudes with lattice QCD

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Dipartimento di Fisica and INFN, Università di Roma "Tor Vergata", Via della Ricerca Scientifica 1, I-00133 Roma, Italy

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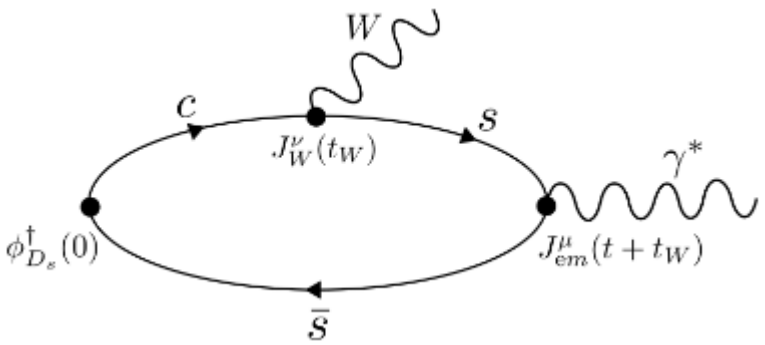
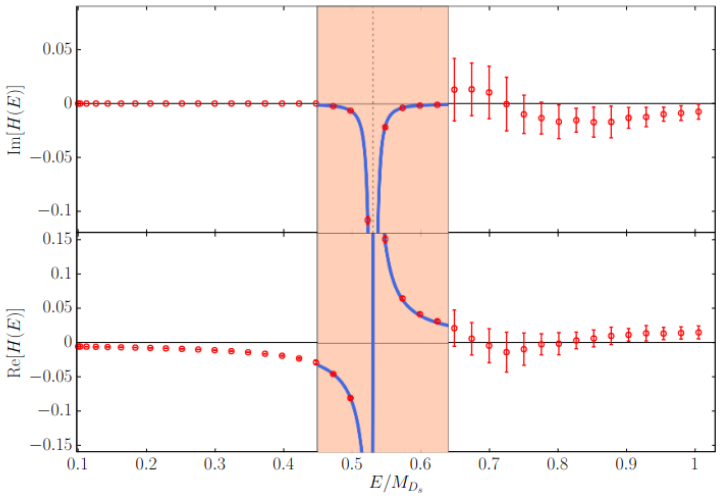
V. Lubicz
Dipartimento di Matematica e Fisica, Università Roma Tre and INFN, Sezione di Roma Tre, Via della Vasca Navale 84, I-00146 Rome, Italy

(Dated: June 13, 2023)





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Big Data and Quantum Computing

Fondato con PNRR, guida INFN INAF

Kick off meeting 26 nov 2022

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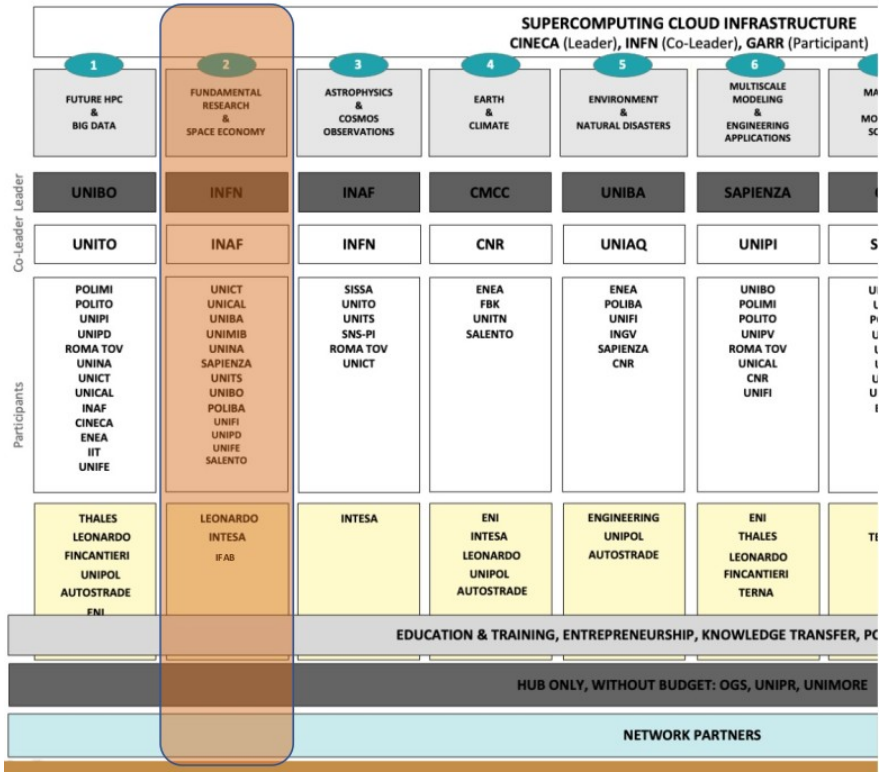

	Nome	Sezione	Mesi Uomo/Anno (per 3 anni)	% FTE
1	Tommaso Boccali	INFN Pisa	3.0	25.0%
2	Simone Gennai	INFN MIB	4.0	33.3%
3	Pia Astone	INFN Roma1	4.0	33.3%
4	Lucia Silvestris	INFN Bari	4.0	33.3%
5	Stefano Piano	INFN Trieste	3.0	25.0%
6	Lucio Anderlini	INFN Firenze	3.0	25.0%
7	Stefano Bagnasco	INFN Torino	4.0	33.3%
8	Leonardo Cosmai	INFN Bari	3.0	25.0%
9	Daniele Spiga	INFN Perugia	3.0	25.0%
10	Alessandro De Salvo	INFN Roma1	2.0	16.7%
11	Vincenzo Vagnoni	INFN Bologna	3.5	29.2%
12	Giuseppe Andronico	INFN Catania	3.0	25.0%
13	Giovanni Mazzitelli	INFN Frascati	1.0	8.3%
14	Silvio Donato	INFN Pisa	3.0	25.0%
15	Andrea Celentano	INFN Genova	1.5	12.5%
16	Michele Pepe	INFN MIB	4.0	33.3%
17	Francesco Sanfilippo	INFN Roma3	3.0	25.0%
18	Valerio Ippolito	INFN Roma1	3.0	25.0%
19	Domenico Elia	INFN Bari	3.0	25.0%

FS Partecipa con il 25% su WP 2 e 4

WP2: Design and development of science-driven tools and innovative algorithms for Theoretical Physics

WP4: porting of applications to GPUs

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Attività e prestazioni del centro

- ~ 15 tra borse di dottorato ed RTDA
  alle sedi universitarie membre del centro

- Use cases finanziati con tempo di
  calcolo su nuove facilities @Tecnopolo
  Testbed, prototipazione, porting

- Scuola di formazione su GPU
  →dedicato ai membri del centro

- Formazione su uso di FPGA
  in medio futuro

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Open call presentata da FS per attività di sviluppo di codici QCD+QED su GPU

Richiesto 1 RTDA – sotto valutazione

Spoke 2 - Cascade Call for Basic Research Activities: Call 1 ***"Development of a GPU library for massively parallelized simulations of QCD and QCD+QED on the lattice"***

Reference WPs/Tasks: Spoke 2 / WP1 / Task XXX

Scientific PI(s): TBD

Allocated funds: 150-200 kEuro

Expected Duration: 24 Months

Objectives: The applicant is requested to participate in the activities of Spoke 2 / WP1 / Task XXX, by realizing a library to perform massively parallelized lattice simulations of QCD and QCD-like theories on GPU architecture.

The package should:

- explicitly target Wilson-like and staggered regularizations;
- implement the correlation functions needed to study QCD and QCD+QED theory;
- support, but not be tied to, the GPU architecture in use at the BolognaTecnopolo (NVIDIA).

In particular, the support for the NVIDIA GPU architecture must be implemented in a way to allow the execution on pure CPU systems for code validation. A strategy allowing future extentions to different vendors/architectures must be adopted.

The package must be able to scale up to O(200) GPUs. High performances are required, and a list of optimizations implemented must be presented, allowing proper measurement of the improvement achieved on a set of tasks central to the calculation.

The software must adhere to high quality standards and include:

- full documentation;
- regression tests;
- comphrensive examples.

The code results must be validated against known results in the context of QCD+QED physics.

...possono rispondere le università non membro: es. Roma Tre…?