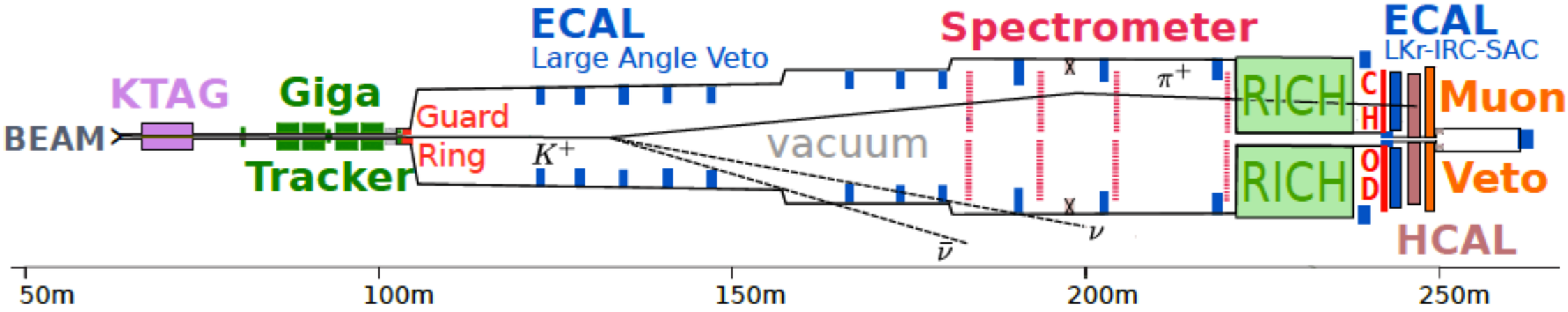
NA62 update

Alberto Gianoli

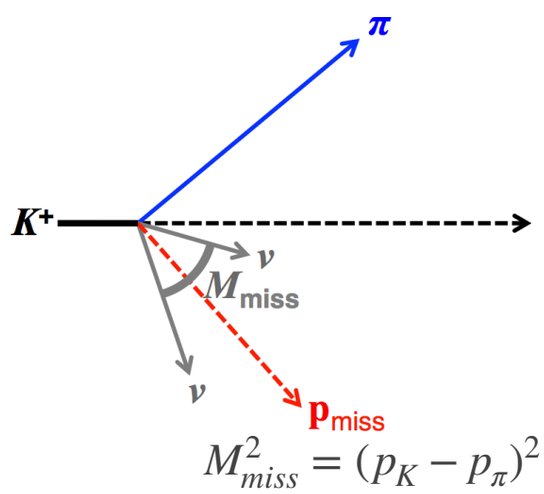
L'esperimento NA62

- Esperimento a bersaglio fisso
- Decadimento in volo dei K
- Misurare O(100) eventi ➟10^{13} decadimenti di K!!!



Fascio secondario

- 75 GeV/c
- 6% di K
- Rate: ~ 0.8 GHz
- Dimensione: ~(6 x 3) cm²



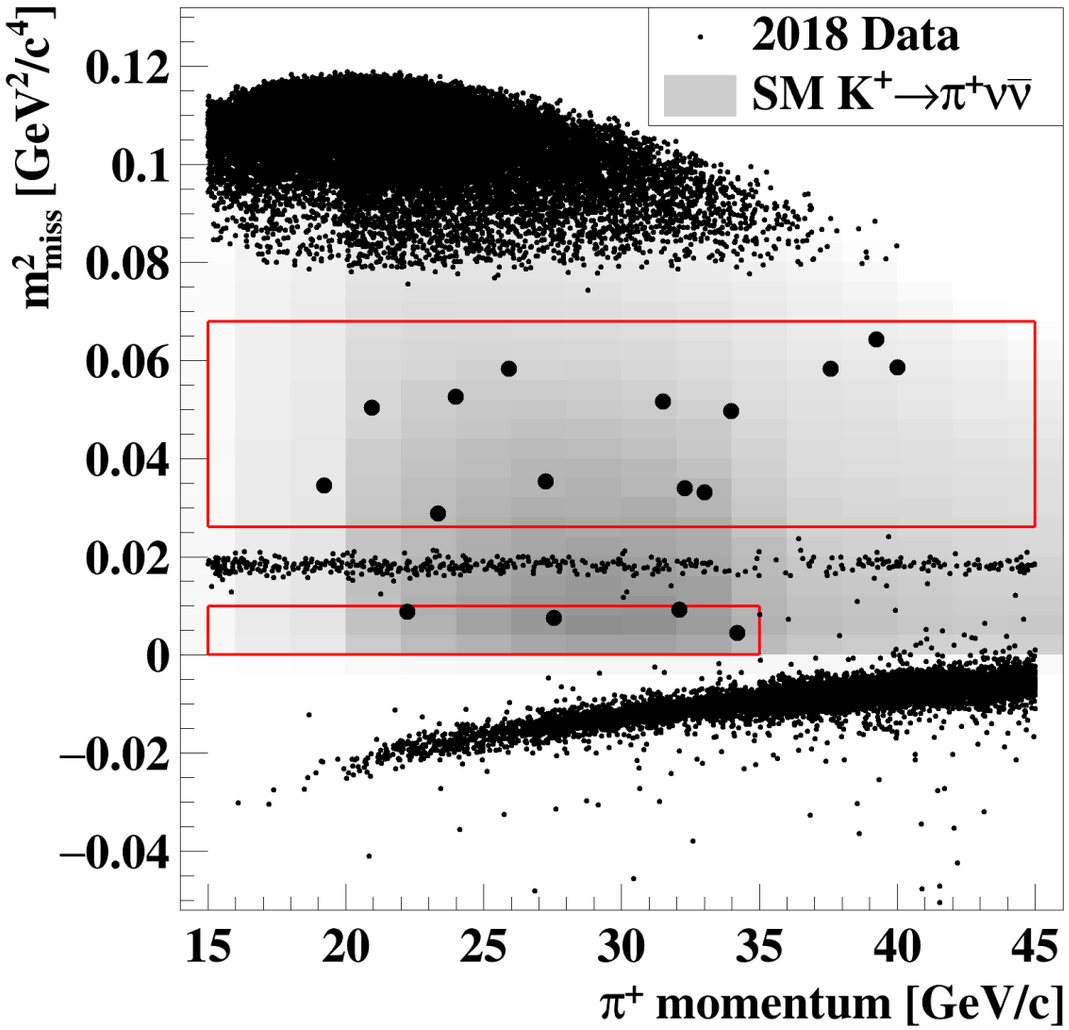
Strategia sperimentale

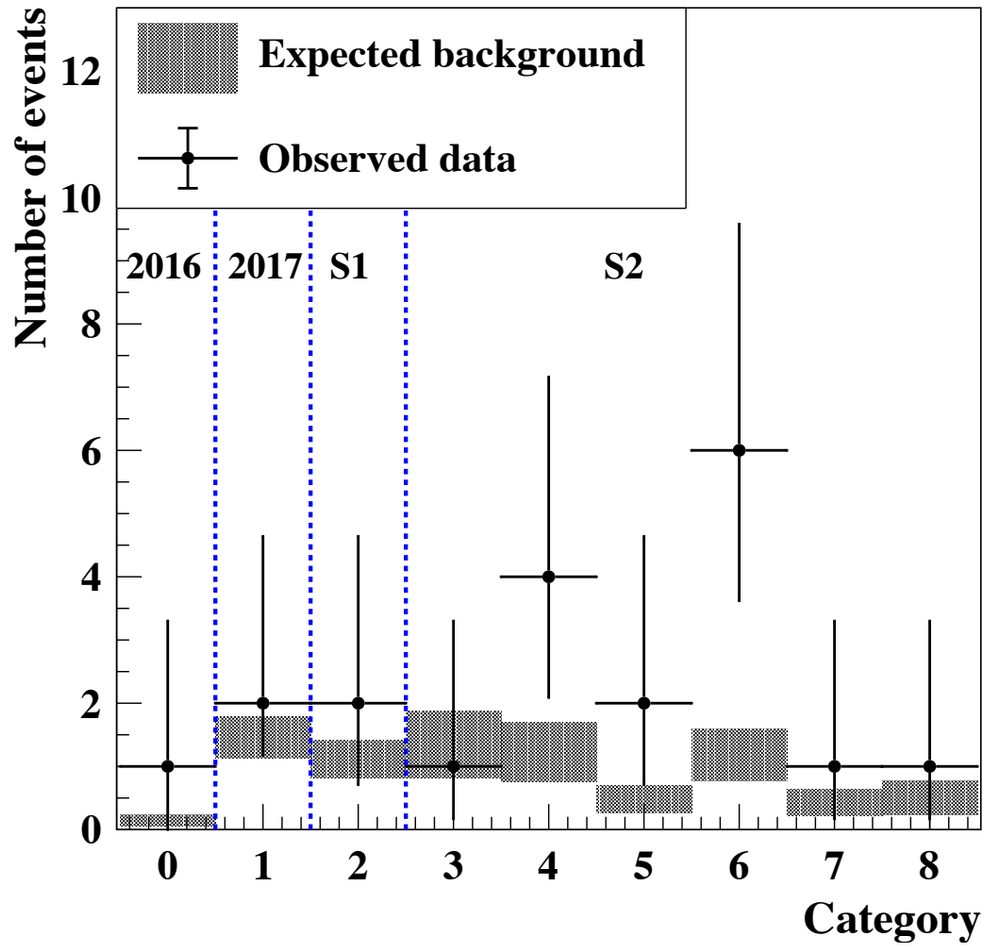
- ricostruzione cinematica precisa
- identificazione particelle: fascio e prodotti
- veto ermetico
- Precisione Temporale sotto il ns: O(100 ps) per match *K*-π

$K^+ \to \pi^+ \nu\bar{\nu}$ combined

Result: 2016+2017+2018 data

[arXiv:2103.15389]





$N_{obs} = 20$

$$SES = (0.839 \pm 0.053_{syst}) \times 10^{-11}$$

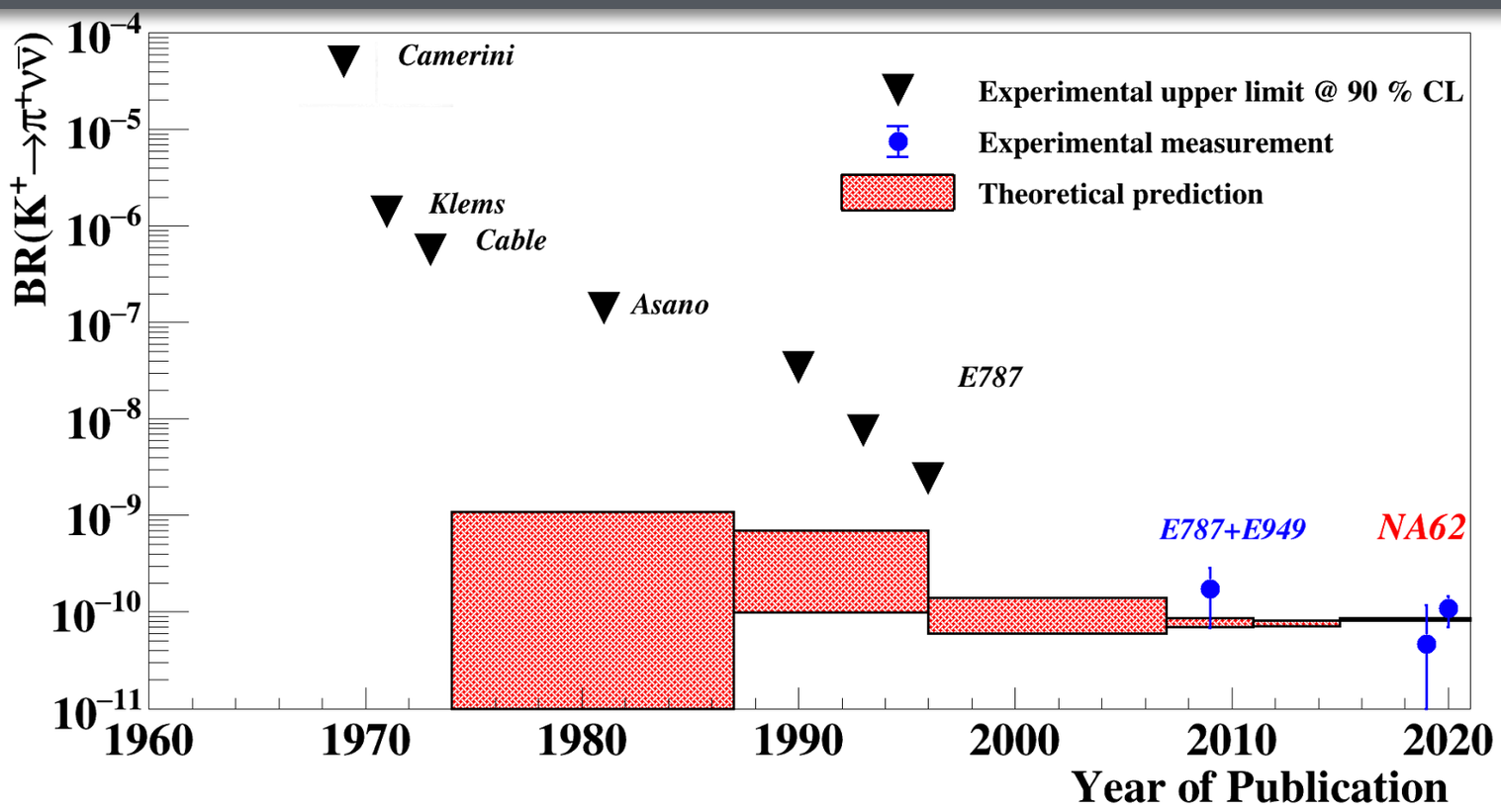
$$N^{exp}_{\pi\nu\nu} = 10.01 \pm 0.42_{syst} \pm 1.19_{ext}$$

$$N^{exp}_{background} = 7.03^{+1.05}_{-0.82}$$

$$BR(K^+ \to \pi^+ \nu\bar{\nu}) = (10.6^{+4.0}_{-3.4}\,|_{stat} \pm 0.9_{syst}) \times 10^{-11} \text{ at } 68\,\% \text{ CL}$$

3.4σ significance

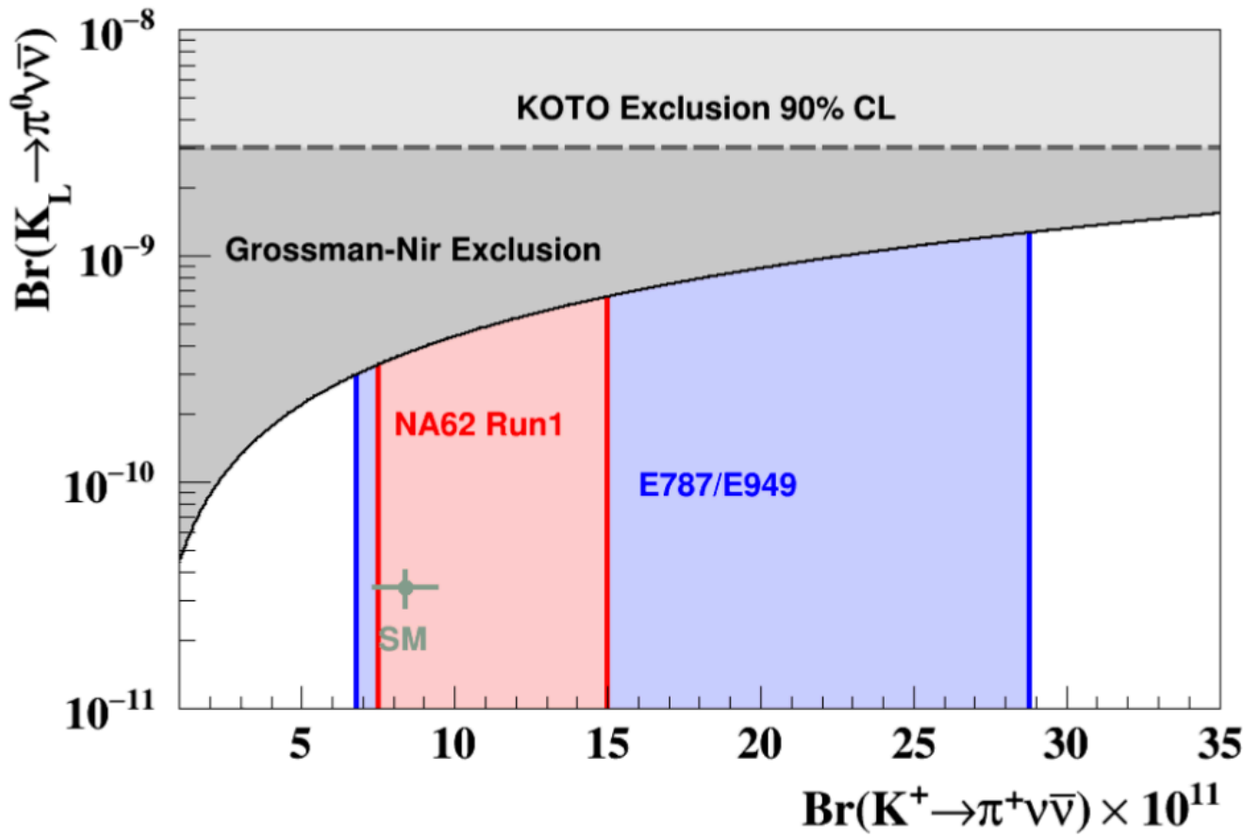
$K^+ \to \pi^+ \nu\bar{\nu}$ implications



Ad oggi misura più precisa del decay rate

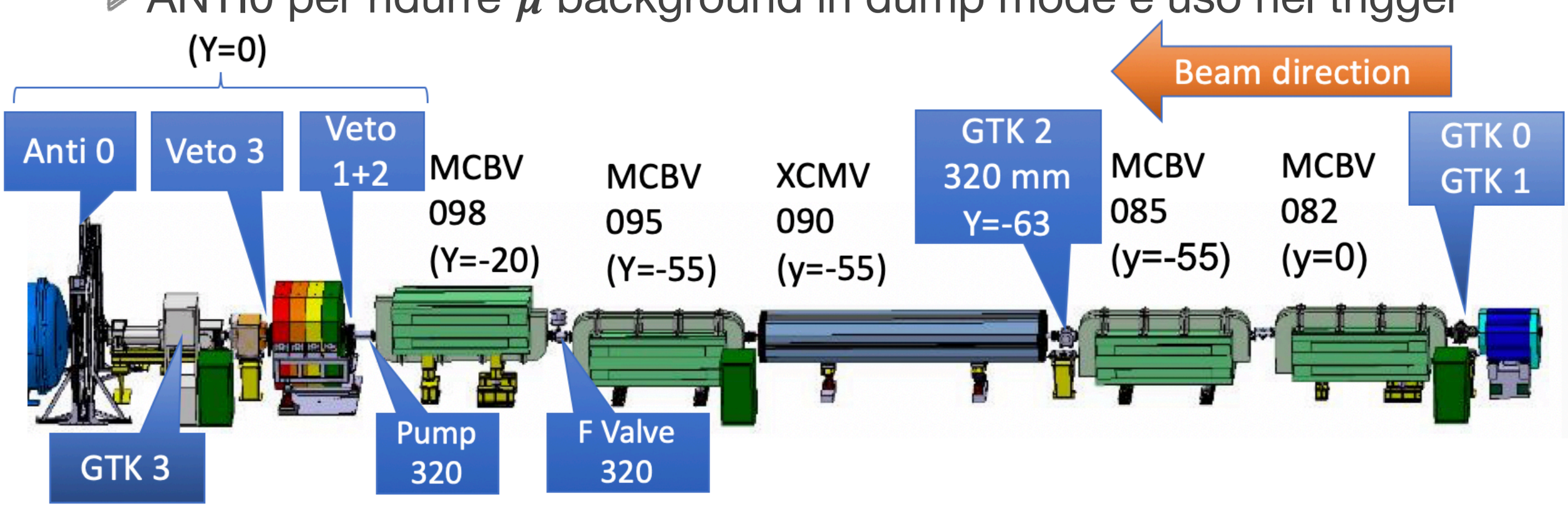
Ricerca di nuova fisica: parte dello spazio parametri già scartato

Next: ×3 improved precision to match theoretical uncertainty by LS3



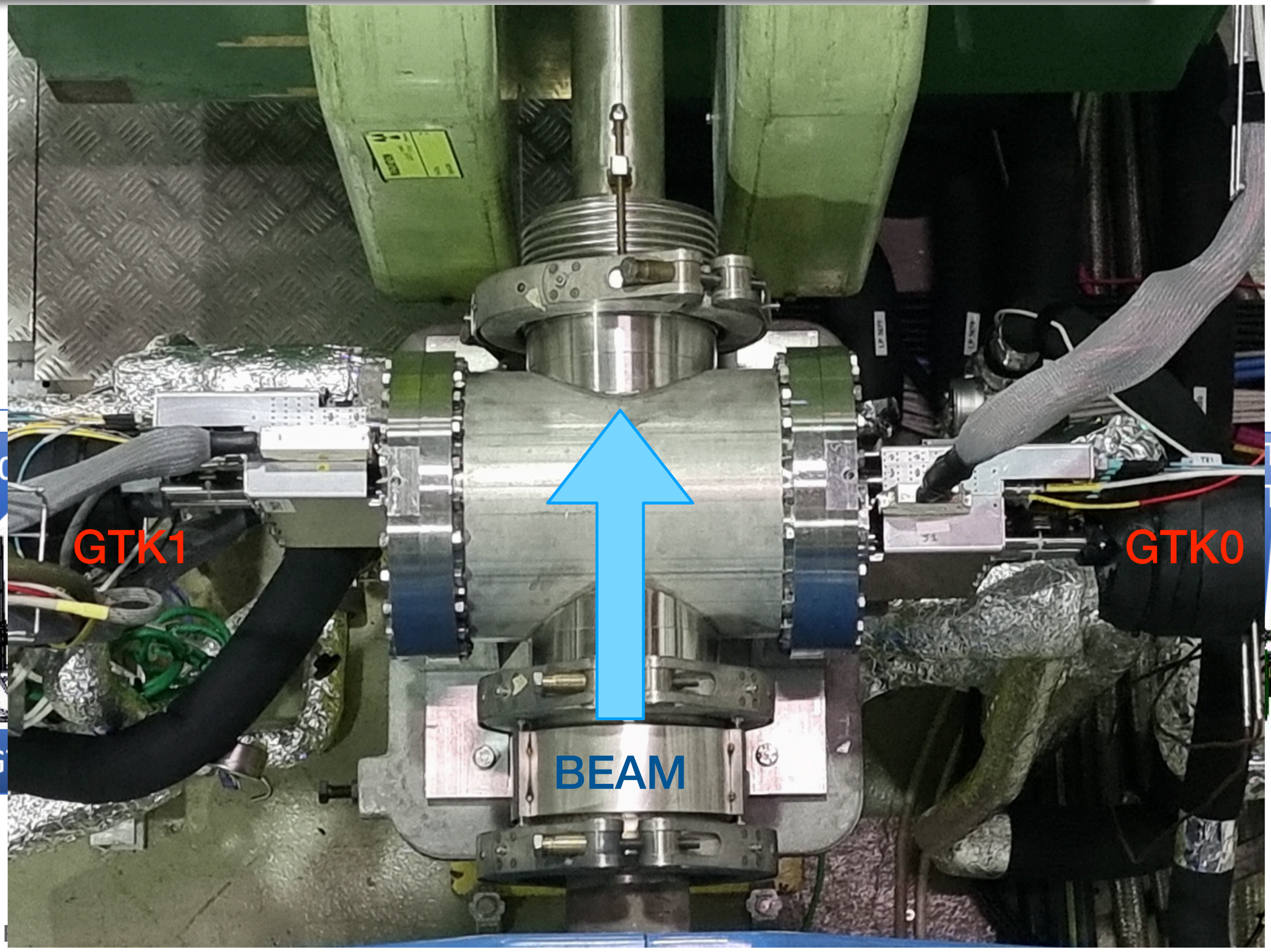
GTK4 e altre novità 2021

- Achromat ottimizzato per ridurre background
- GTK4 (GTK0 vicino a GTK1)
- VETO counter prima/dopo collimatore
- secondo modulo HASC (non in figura)
- ANTI0 per ridurre μ background in dump mode e uso nel trigger

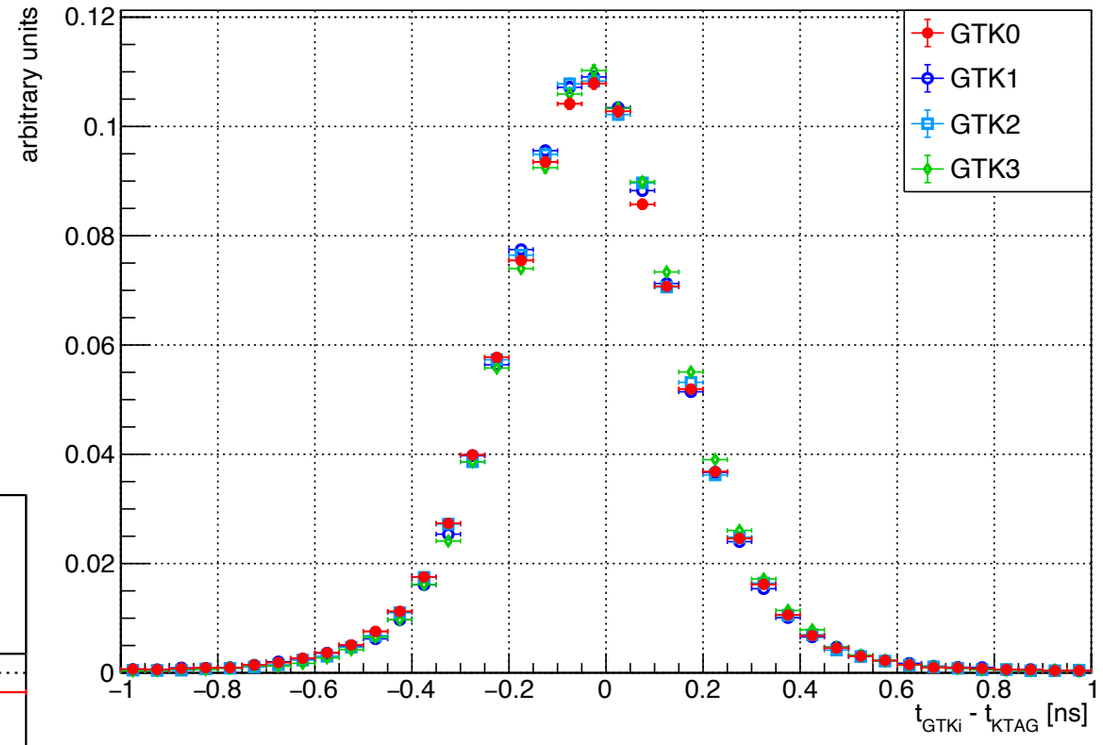


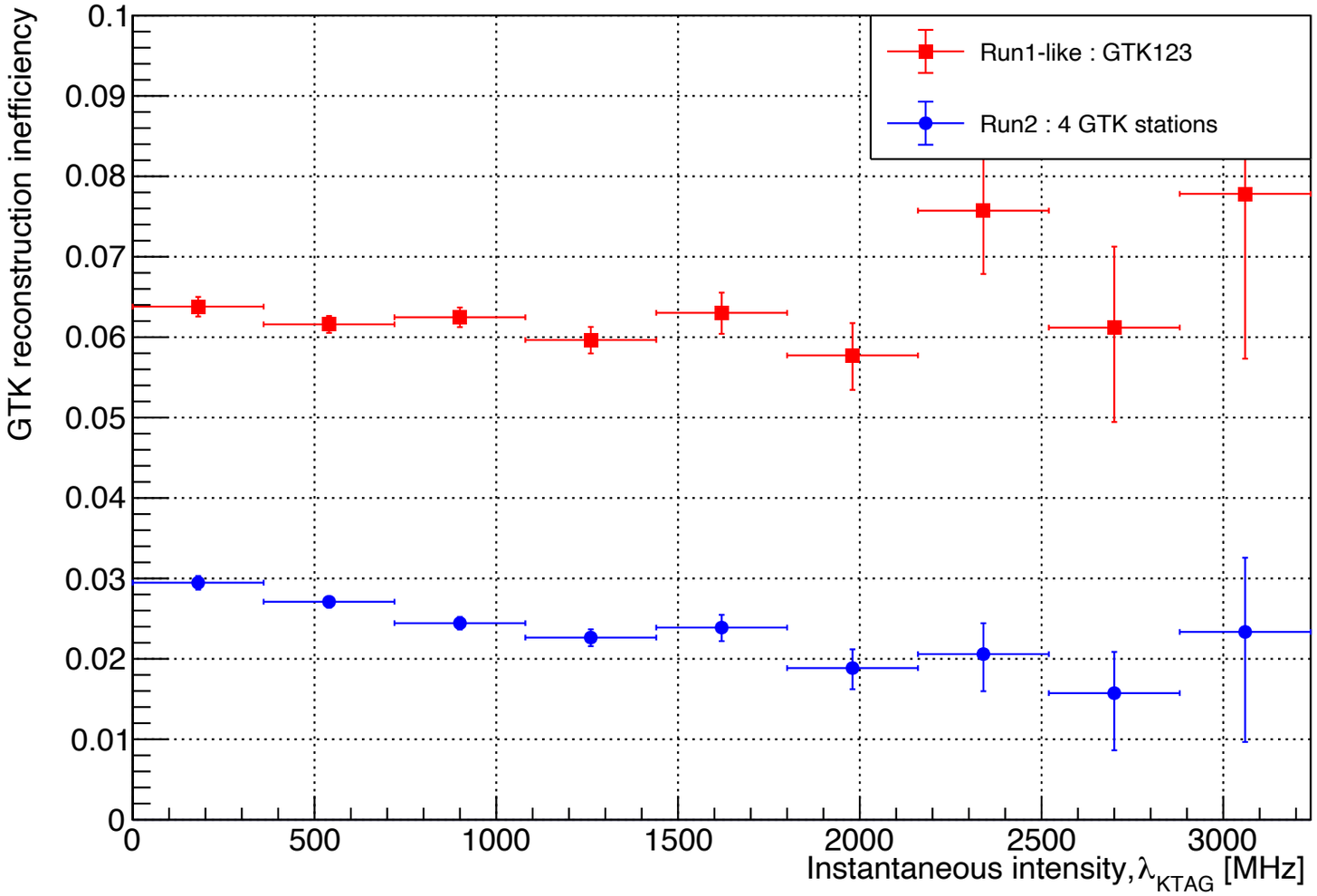
Ferrara: produzione e installazione readout GTK4

GTK4 e altre novità 2021



GTK0

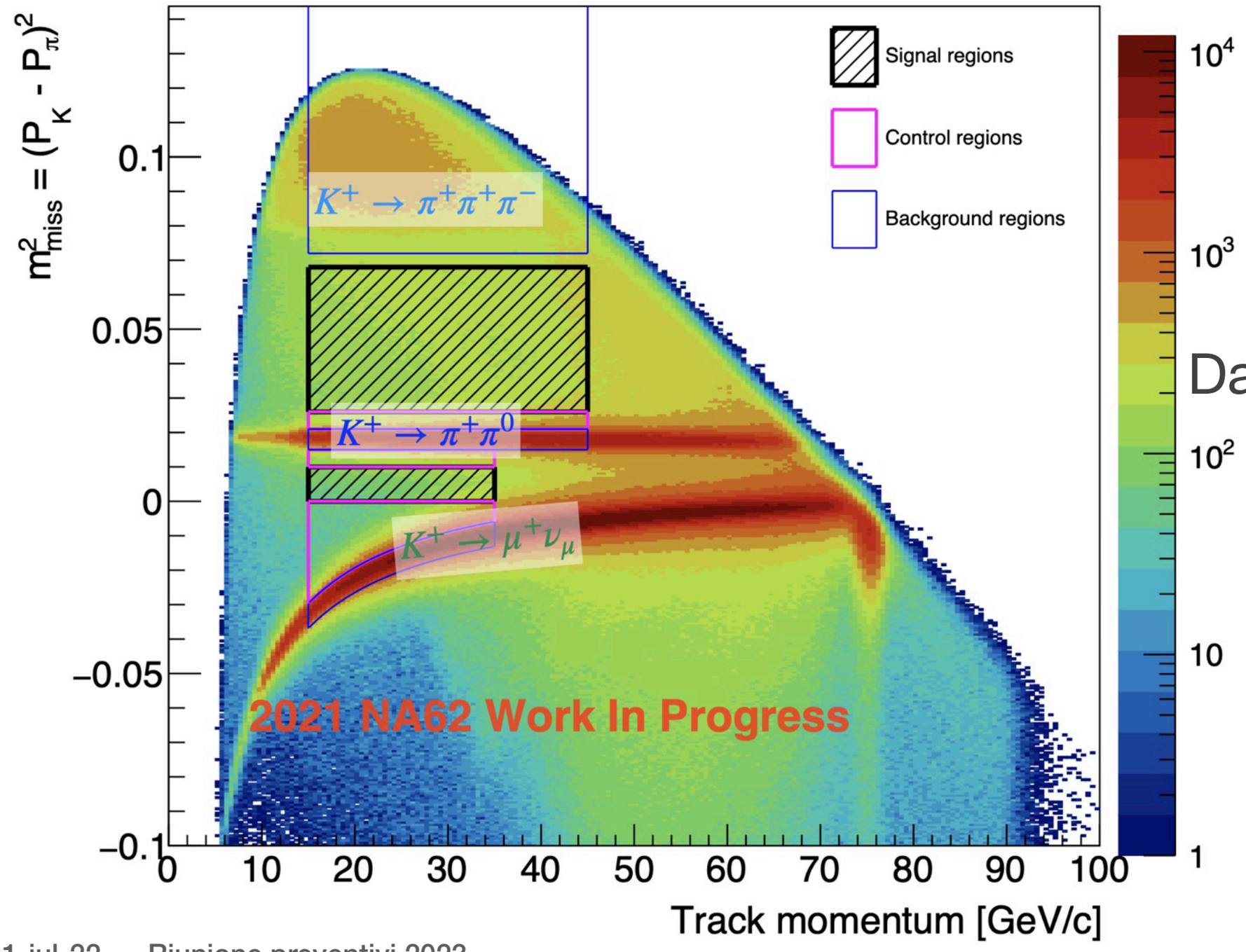




Effetto della quarta stazione sulla reconstruction inefficiency del GTK

2021: data quality

Filtered data, prima della selezione
First step: come 2018, stesse regioni e strategia



Data quality come 2018

Analysis in progress

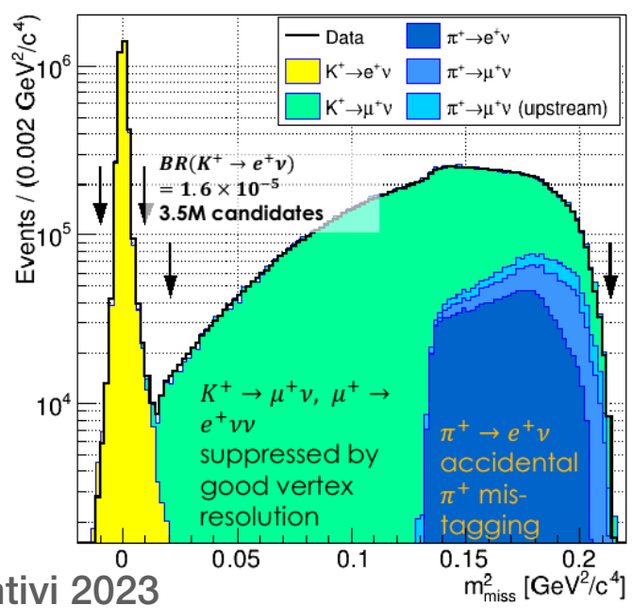
Non solo $K^+ \to \pi^+ \nu\bar{\nu}$

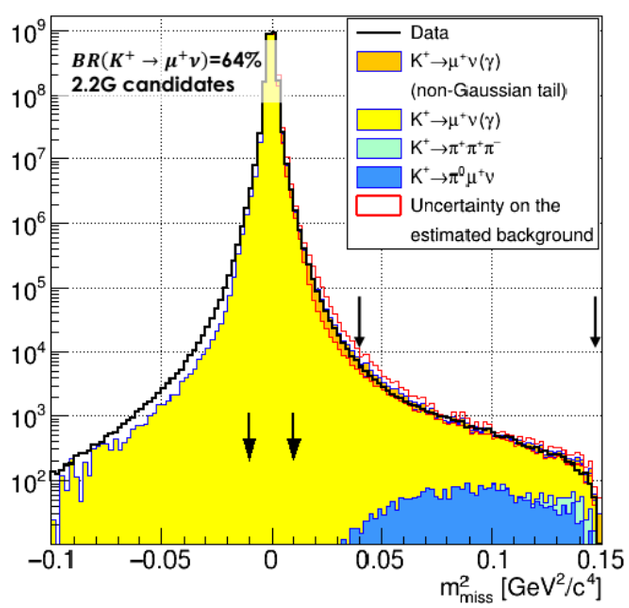
	Previous UL @ 90% CL	NA62 UL @ 90%CL		
$K^+ \to \pi^- \mu^+ \mu^+$	8.6×10^{-11}	4.2×10^{-11}	2017 data → improved by factor 2	Phys. Lett. B 797 (2019) 134794
$K^+ \to \pi^- e^+ e^+$	6.4×10^{-10}	5.3×10^{-11}	Run1 data → improved by factor 12	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \pi^0 e^+ e^+$	no limit	8.5×10^{-10}	Run1 data	
$K^+ \to \pi^- \mu^+ e^+$	5.0×10^{-10}	4.2×10^{-11}	2017+2018 data → improved by factor 12	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^- e^+$	5.2×10^{-10}	6.6×10^{-11}	2017+2018 data → improved by factor 8	
$\pi^0 \to \mu^- e^+$	3.4×10^{-9}	3.2×10^{-10}	2017+2018 data → improved by factor 13	
$K^+ \to \pi^+ \mu^+ e^-$	1.3×10^{-11}	-	sensitivity similar to previous search	
$\pi^0 \to \mu^+ e^-$	3.8×10^{-10}	-	sensitivity similar to previous search	
$K^+ \to \mu^- \nu e^+ e^+$	2.1×10^{-8}	-	Ongoing analysis on 2017 data: SES $\sim 1 \times 10^{-10}$	
$K^+ \to e^- \nu \mu^+ \mu^+$	no limit		Ongoing analysis on 2017 data: SES $\sim 5 \times 10^{-11}$	

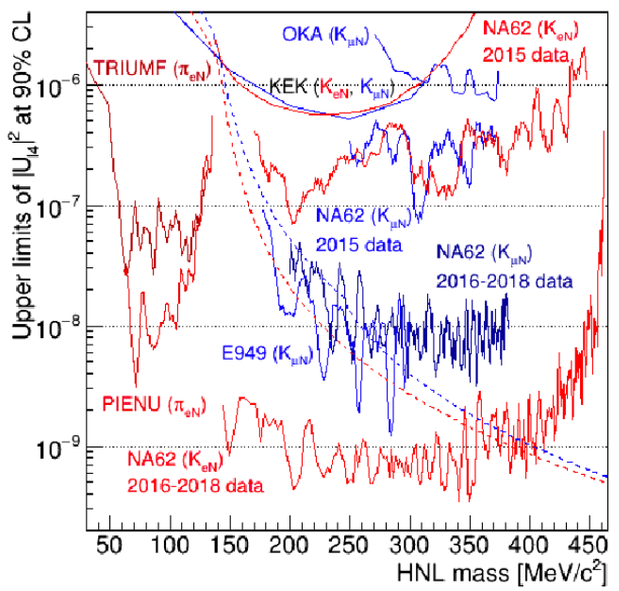
Non solo $K^+ \to \pi^+ \nu\bar{\nu}$

	Previous UL @ 90% CL	NA62 UL @ 90%CL		
$K^+ \to \pi^- \mu^+ \mu^+$	8.6×10^{-11}	4.2×10^{-11}	2017 data → improved by factor 2	Phys. Lett. B 797 (2019) 134794
$K^+ \to \pi^- e^+ e^+$	6.4×10^{-10}	5.3×10^{-11}	Run1 data → improved by factor 12	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \pi^0 e^+ e^+$	no limit	8.5×10^{-10}	Run1 data	
$K^+ \to \pi^- \mu^+ e^+$	5.0×10^{-10}	4.2×10^{-11}	2017+2018 data → improved by factor 12	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^- e^+$	5.2×10^{-10}	6.6×10^{-11}	2017+2018 data → improved by factor 8	
$\pi^0 \to \mu^- e^+$	3.4×10^{-9}	3.2×10^{-10}	2017+2018 data → improved by factor 13	
$K^+ \to \pi^+ \mu^+ e^-$	1.3×10^{-11}	-	sensitivity similar to previous search	
$\pi^0 \to \mu^+ e^-$	3.8×10^{-10}	-	sensitivity similar to previous search	
$K^+ \to \mu^- \nu e^+ e^+$	2.1×10^{-8}	-	Ongoing analysis on 2017 data: SES ~ 1×10^{-10}	
$K^+ \to e^- \nu \mu^+ \mu^+$	no limit		Ongoing analysis on 2017 data: SES ~ 5×10^{-11}	

HNL in $K^+ \to l^+ \nu$







Non solo $K^+ \to \pi^+ \nu\bar{\nu}$

	Previous UL @ 90% CL	NA62 UL @ 90%CL		
$K^+ \to \pi^- \mu^+ \mu^+$	8.6×10^{-11}	4.2×10^{-11}	2017 data → improved by factor 2	Phys. Lett. B 797 (2019) 134794
$K^+ \to \pi^- e^+ e^+$	6.4×10^{-10}	5.3×10^{-11}	Run1 data → improved by factor 12	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \pi^0 e^+ e^+$	no limit	8.5×10^{-10}	Run1 data	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \mu^+ e^+$	5.0×10^{-10}	4.2×10^{-11}	2017+2018 data → improved by factor 12	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^- e^+$	5.2×10^{-10}	6.6×10^{-11}	2017+2018 data → improved by factor 8	PRL 127 131802 (2021)
$\pi^0 \to \mu^- e^+$	3.4×10^{-9}	3.2×10^{-10}	2017+2018 data → improved by factor 13	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^+ e^-$	1.3×10^{-11}	-	sensitivity similar to previous search	
$\pi^0 \to \mu^+ e^-$	3.8×10^{-10}	-	sensitivity similar to previous search	
$K^+ \to \mu^- \nu e^+ e^+$	2.1×10^{-8}	-	Ongoing analysis on 2017 data: SES ~ 1×10^{-10}	
$K^+ \to e^- \nu \mu^+ \mu^+$	no limit		Ongoing analysis on 2017 data: SES ~ 5×10^{-11}	

HNL in

$K^+ \to l^+ \nu$

$K^+ \to \mu^+ \nu\nu\nu$

Very rare decay in SM $BR = 1.6 \times 10^{-16}$

Current limit: $BR < 2.4 \times 10^{-6}$

NA62 result: $BR < 1.0 \times 10^{-6}$ @90% CL

Non solo $K^+ \to \pi^+ \nu\bar{\nu}$

	Previous UL @ 90% CL	NA62 UL @ 90%CL		
$K^+ \to \pi^- \mu^+ \mu^+$	8.6×10^{-11}	4.2×10^{-11}	2017 data → improved by factor 2	Phys. Lett. B 797 (2019) 134794
$K^+ \to \pi^- e^+ e^+$	6.4×10^{-10}	5.3×10^{-11}	Run1 data → improved by factor 12	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \pi^0 e^+ e^+$	no limit	8.5×10^{-10}	Run1 data	NEW ! arXiv:2202.00331
$K^+ \to \pi^- \mu^+ e^+$	5.0×10^{-10}	4.2×10^{-11}	2017+2018 data → improved by factor 12	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^- e^+$	5.2×10^{-10}	6.6×10^{-11}	2017+2018 data → improved by factor 8	PRL 127 131802 (2021)
$\pi^0 \to \mu^- e^+$	3.4×10^{-9}	3.2×10^{-10}	2017+2018 data → improved by factor 13	PRL 127 131802 (2021)
$K^+ \to \pi^+ \mu^+ e^-$	1.3×10^{-11}	-	sensitivity similar to previous search	
$\pi^0 \to \mu^+ e^-$	3.8×10^{-10}	-	sensitivity similar to previous search	
$K^+ \to \mu^- \nu e^+ e^+$	2.1×10^{-8}	-	Ongoing analysis on 2017 data: SES ~ 1×10^{-10}	
$K^+ \to e^- \nu \mu^+ \mu^+$	no limit		Ongoing analysis on 2017 data: SES ~ 5×10^{-11}	

HNL in

$K^+ \to l^+ \nu$

$K^+ \to \mu^+ \nu\nu\nu$

$K^+ \to \mu^+ \nu X$

X scalar of vector
Mass range: 10 - 370 MeV/c²
Work in progress

Attività attuali e future

- 2022 … 2024
  - presa dati
- Dopo LS3: High-Intentity Kaon Experiments (HIKE) at SPS
  - varie fasi
  - fasci K^+ e K_L e “dump mode”
  - rare K decays, precision measurements, exotic particles in K/dump, …
  - “Klever” sarebbe la parte K_L
- Timeline
  - prima fase (dopo LS3): $K^+ \sim 7 \times 10^{18}$ pot/year
  - seconda fase: $K_L \sim 1 \times 10^{19}$ pot/year

5% precision $K^+ \to \pi^+ \nu\nu$
altra fisica K^+
dump mode

$K_L \to \pi^0 \nu\nu$
K_L decadimenti rari
dump mode

Richieste 2023

capitolo	item	k€	sj	tot
MI	Metabolismo missioni Italia (1.9 FTE)		2,0	
ME	Metabolismo missioni Estere (1.9 FTE)		8,0	
ME	Missioni per Dry Run (2 sett/uomo)	2,0		
ME	Turni presa dati/esperti 2023	16,0		
ME	Turni presa dati test Klever (4x 1sett/uomo)	4,0		
CONS	costruzione holder	4,5		
CONS	Metabolismo componentistica	3,0		
TOT		29,5	10,0	39,5

Personale FE 2023

	Cognome e nome	Qualifica	Affer.	%
1	DALPIAZ Pietro	P.O.	1	
2	BANDIERA Laura	Ric.	5	10
3	SOLDANI Mattia	Dott.		30
	TOT FTE			0,40

Laura ha “sinergia” con Aidainnova

➤TOT FTE 1.9

	Cognome e nome	Qualifica	Affer.	%
1	COTTA RAMUSINO A.	Tecn.		10
2	GIANOLI Alberto	Tecn.		90
3	TOT FTE			1,00

	Cognome e nome	Qualifica	Affer.	%
1	CHIOZZI Stefano	CTer		10
2	GAMBETTI Michele	TecUniv		10
3	MAGNANI Andrea	TecUniv		10
4	Neri Ilaria	TecUniv		20
	TOT FTE			0,50