



ECN3
CERN North Area

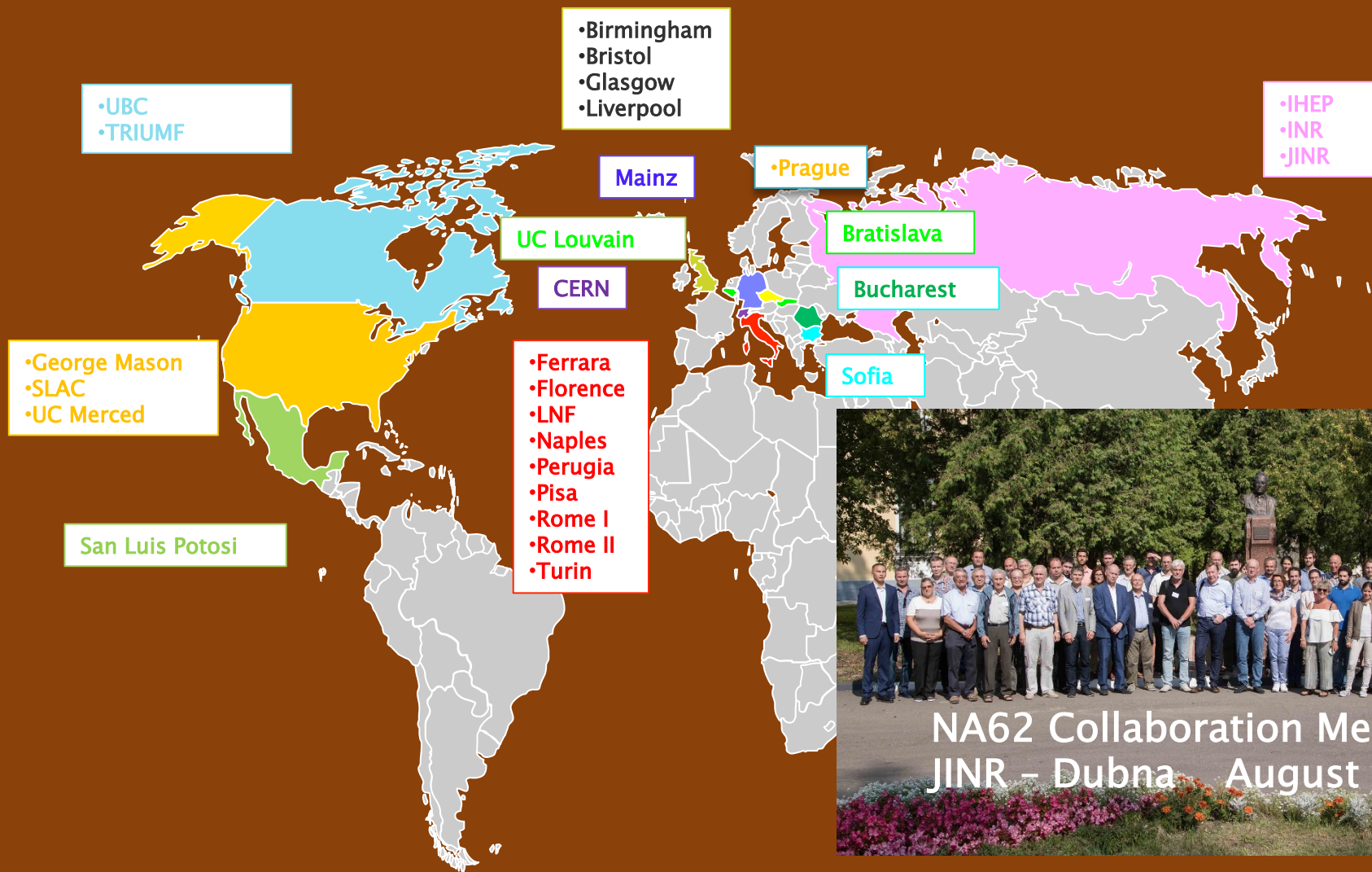
STATUS OF NA62

CKM2016, TIFR, Mumbai, November 29, 2016

Augusto Ceccucci / CERN

on behalf of the NA62 Collaboration

NA62 COLLABORATION



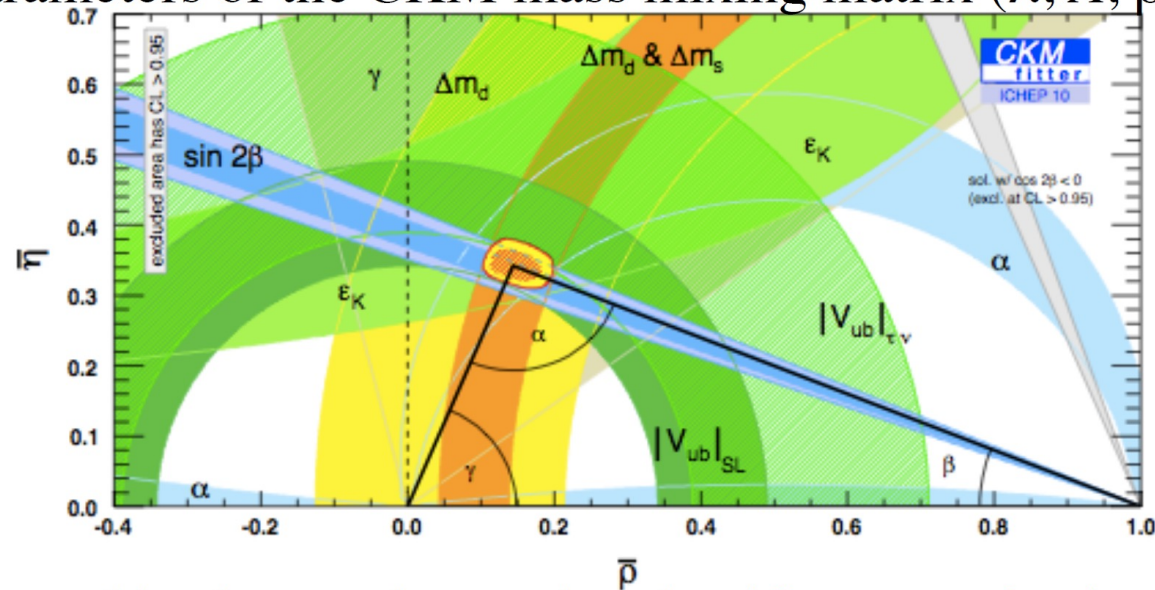
NA62 Collaboration Meeting
JINR - Dubna - August 22, 2016

29 Institutes, 230 Collaborators

Quark flavor physics

Triumph of the CKM description

- All the flavour changing processes are described by the four parameters of the CKM mass mixing matrix (λ, A, ρ, η)



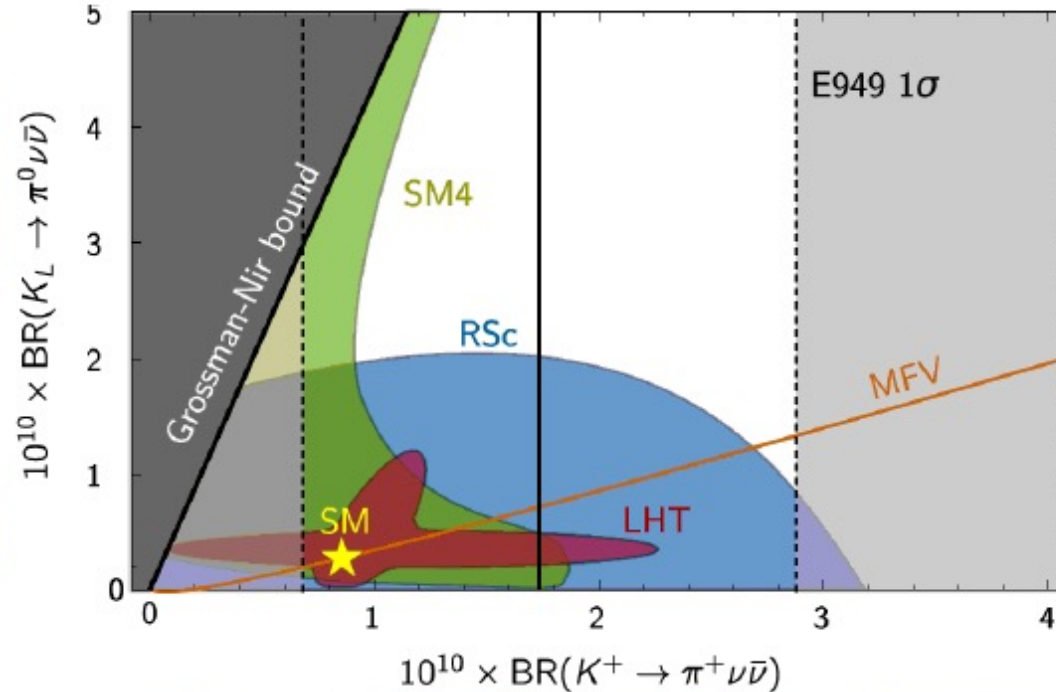
- From this plot, we know already **either new physics energy scale is \gg TeV (far beyond LHC) or the flavour structure of new physics is very special.**

New generation of Kaon experiments

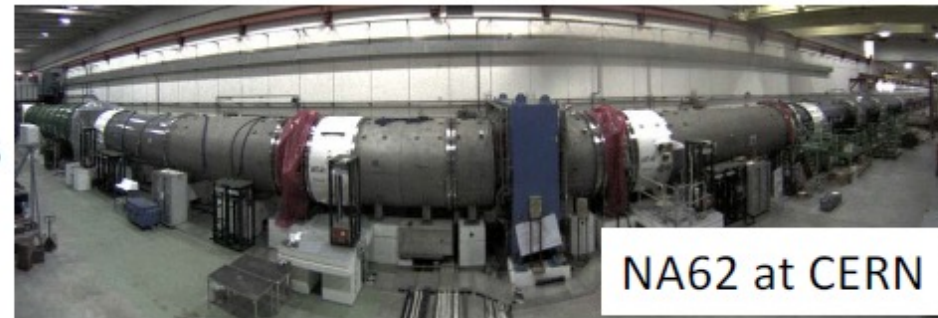


KOTO at J-PARC

$O(1)$ SM $K_L \rightarrow \pi^0 \nu \bar{\nu}$ events



$O(100)$ SM $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ events



NA62 at CERN

From I. Shipsey ICHEP 2016
"Vision and Outlook"

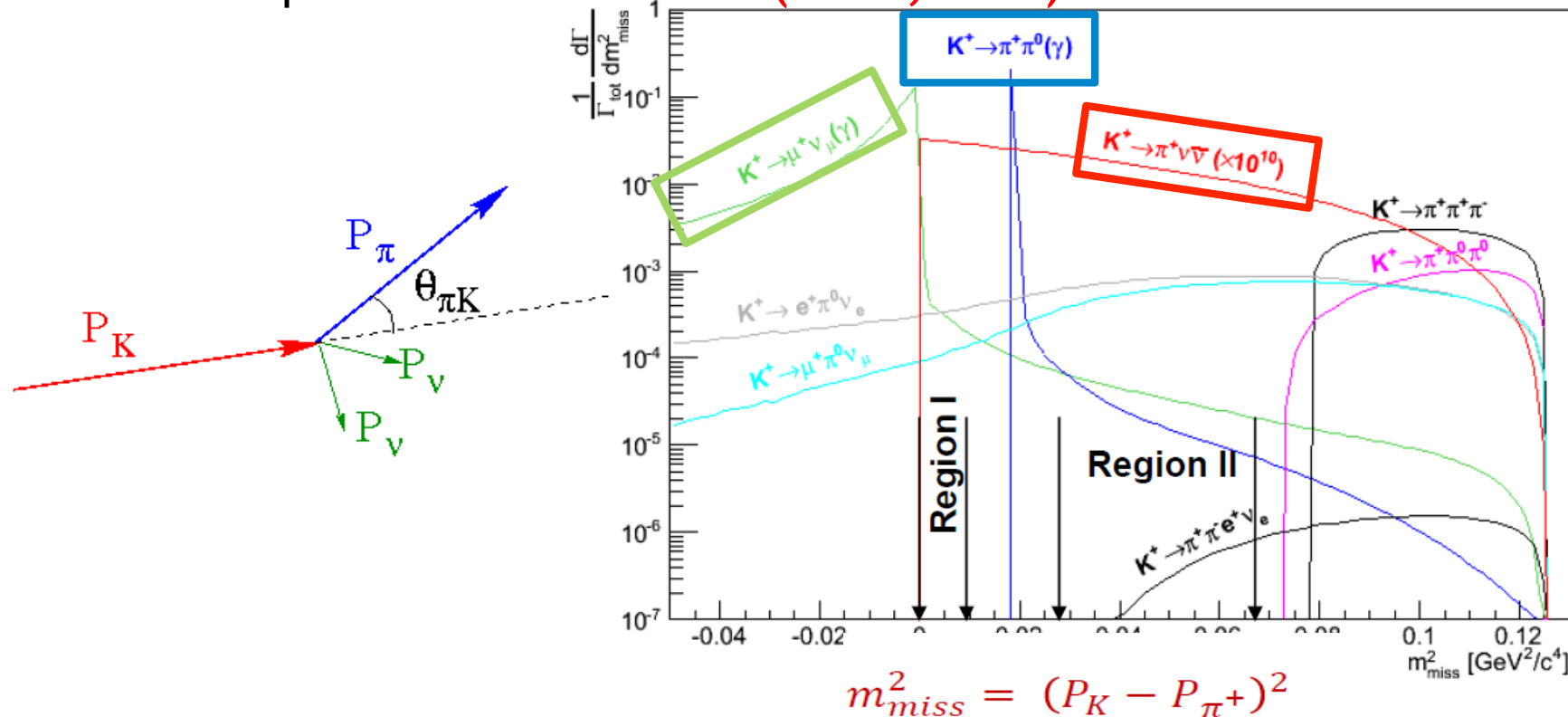
My comment: experimental dream
not afflicted by large theoretical
errors

NA62 NOVEL IN-FLIGHT TECHNIQUE

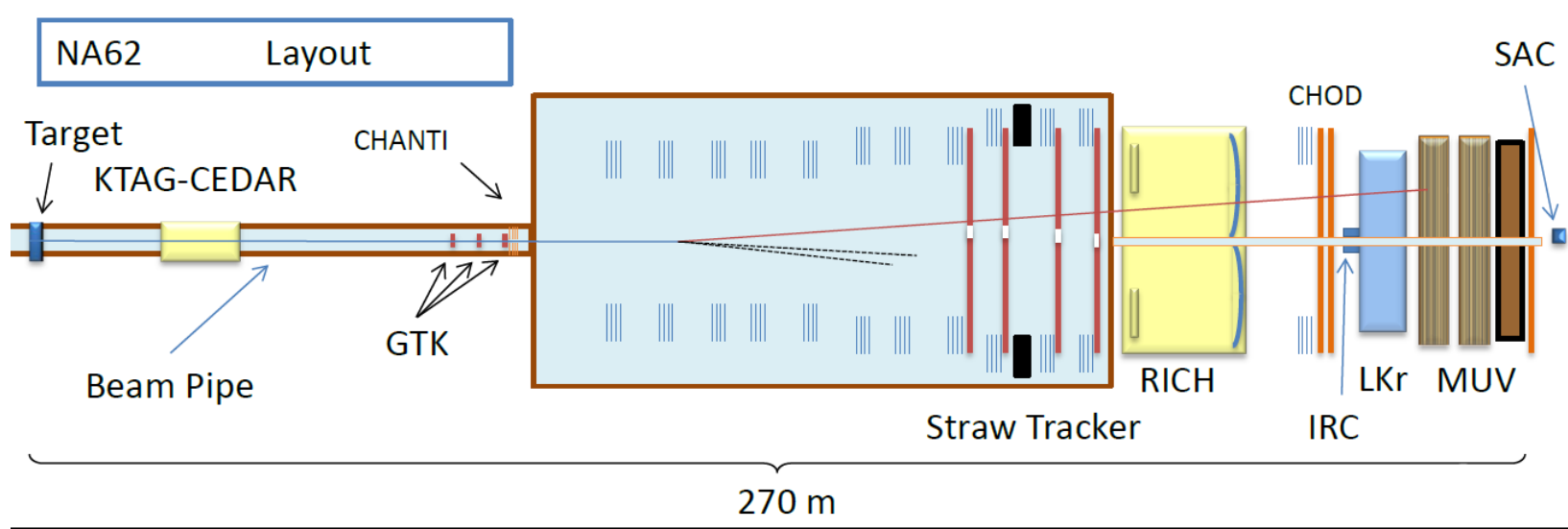


TO MEASURE $K^+ \rightarrow \pi^+ \nu \bar{\nu}$

- ~100 ps timing for $K^+ - \pi^+$ association (KTAG, GTK, RICH)
- EM Calorimeters to veto photons (LAV, LKr, SAC, IRC), hadron calorimeters (MUV1, MUV2, HASC) and hodoscopes to veto muons (MUV0, MUV3), extra particles (CHOD, NewCHOD) and interactions (CHANTI)
- Very light, high rate trackers to reconstruct the K^+ and the π^+ momenta (GTK, STRAW)
- Full particle identification (KTAG, RICH)



NA62 SCHEMATIC LAYOUT



10^{12} / s protons from SPS (400 GeV/c) on Be target ($\sim 1 \lambda$)

SPS K12 Beam: 750 MHz, 75 GeV/c

- Positive polarity
- Kaon fraction $\sim 6\%$
- $\Delta p/p \sim 1\%$
- Useful kaon decays $\sim 10\%$ (5 MHz)

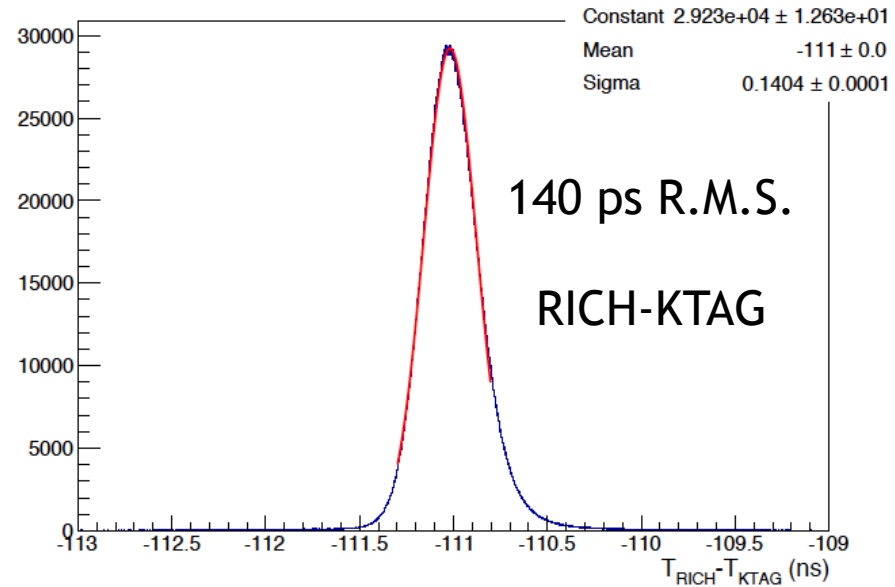
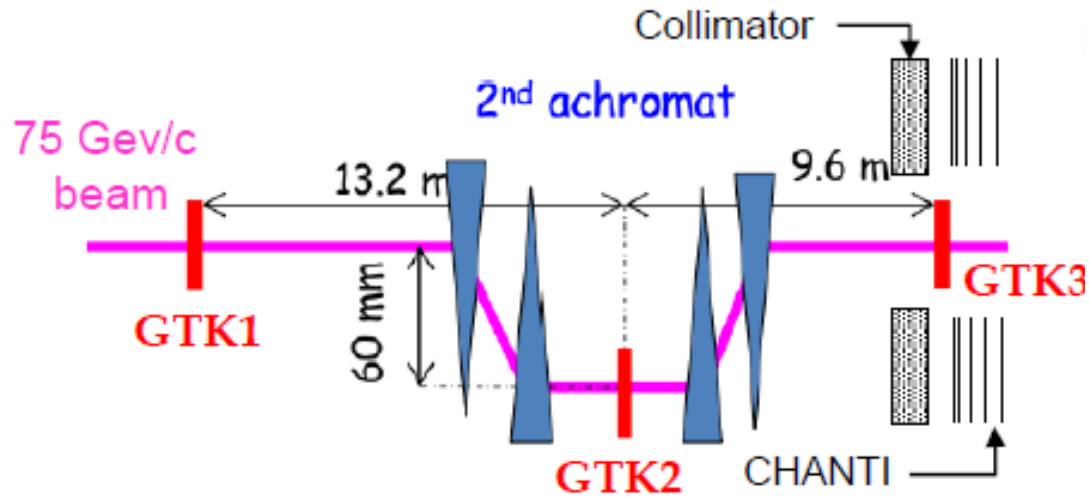
Residual pressure in decay tank
 $\sim 10^{-6}$ mbar

NA62 is built for a specific “silver bullet” measurement. This requires high beam rate, full PID, hermetic coverage, very light, high-rate tracking and state-of-the-art trigger and DAQ

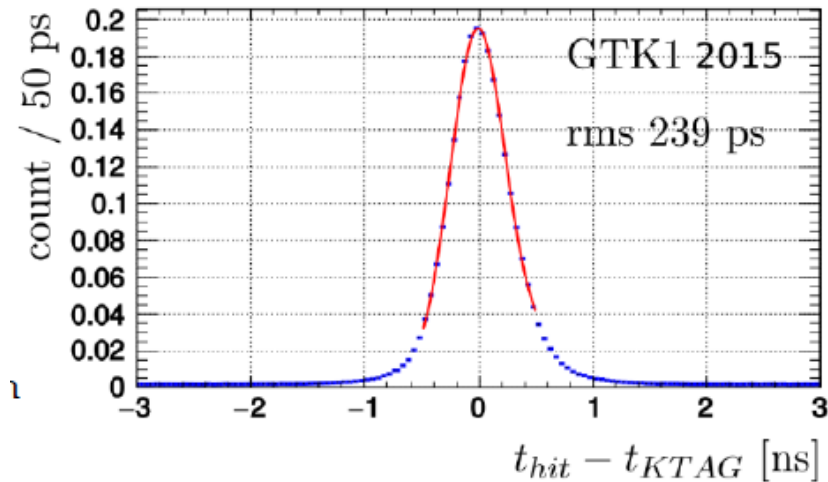
It paves the way to a broad physics program in kaon decays (LFV, LU, CHPT) and beyond (HNL, Exotics, Dark Sector etc.)

NA62 TIMING

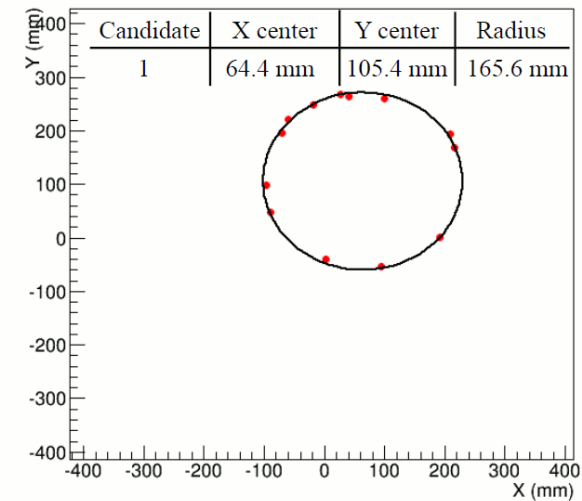
For NA62 is essential to have a flat SPS slow extraction:
both microscopically and macroscopically



GTK: Si Pixel 300 micron * 300 micron)



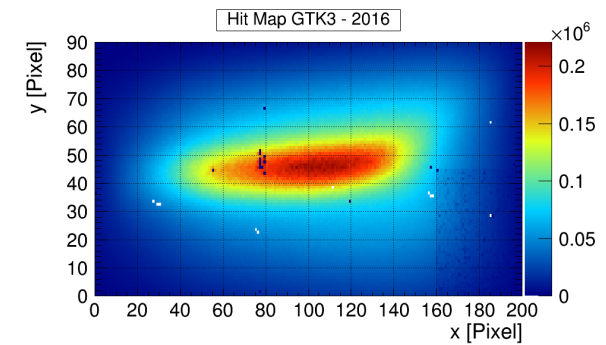
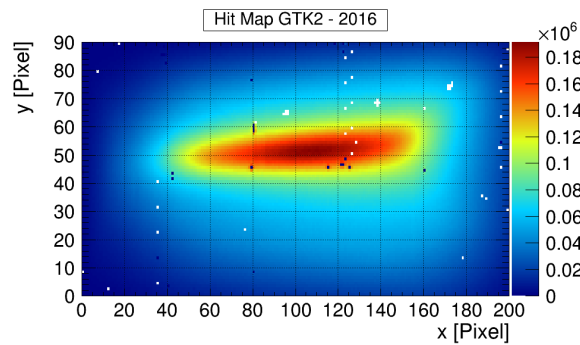
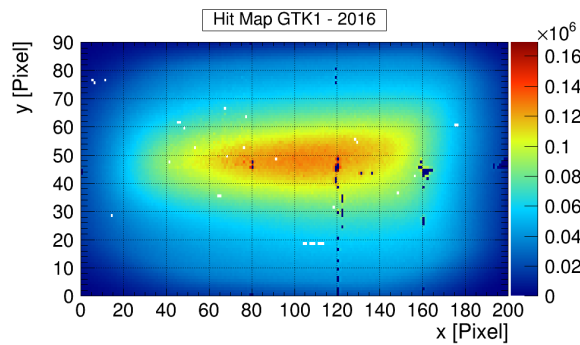
Single event Saleve side



GIGATRACKER



- Three new detectors installed over the summer of 2016
- **All stations fully operational since 15/09/2016:**



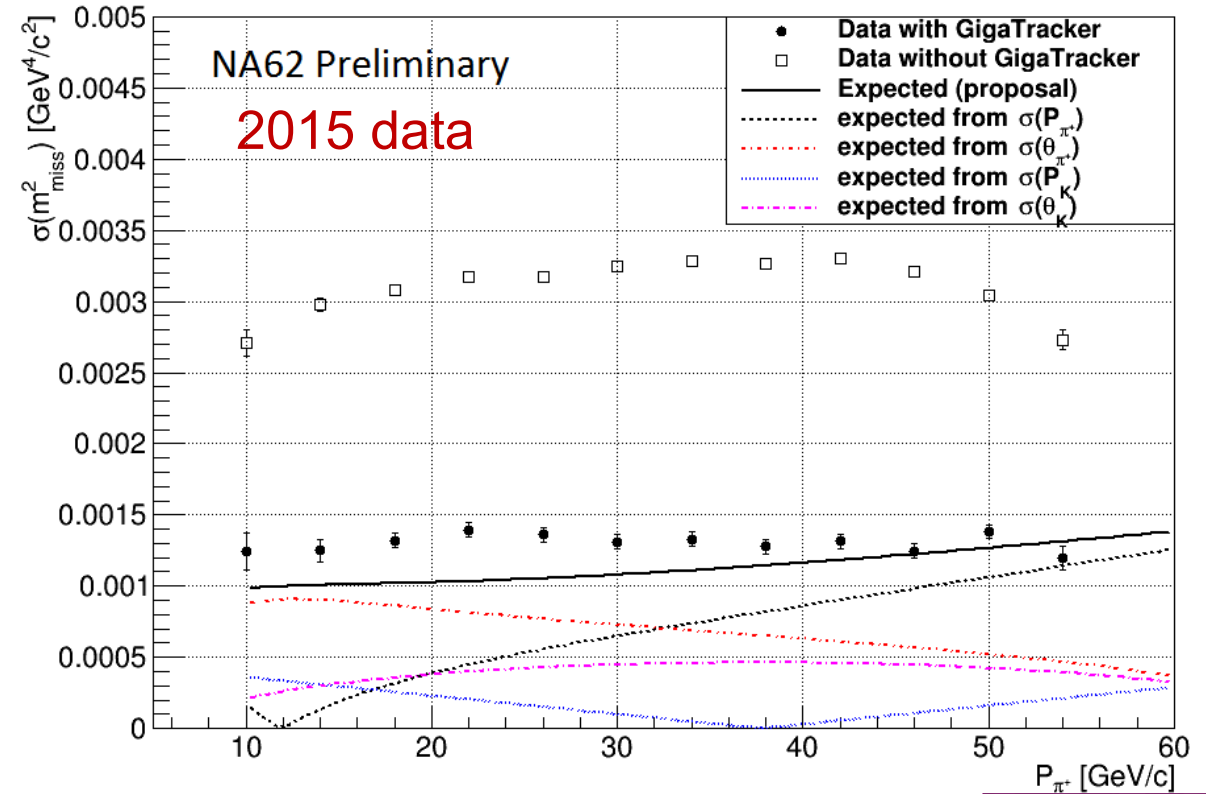
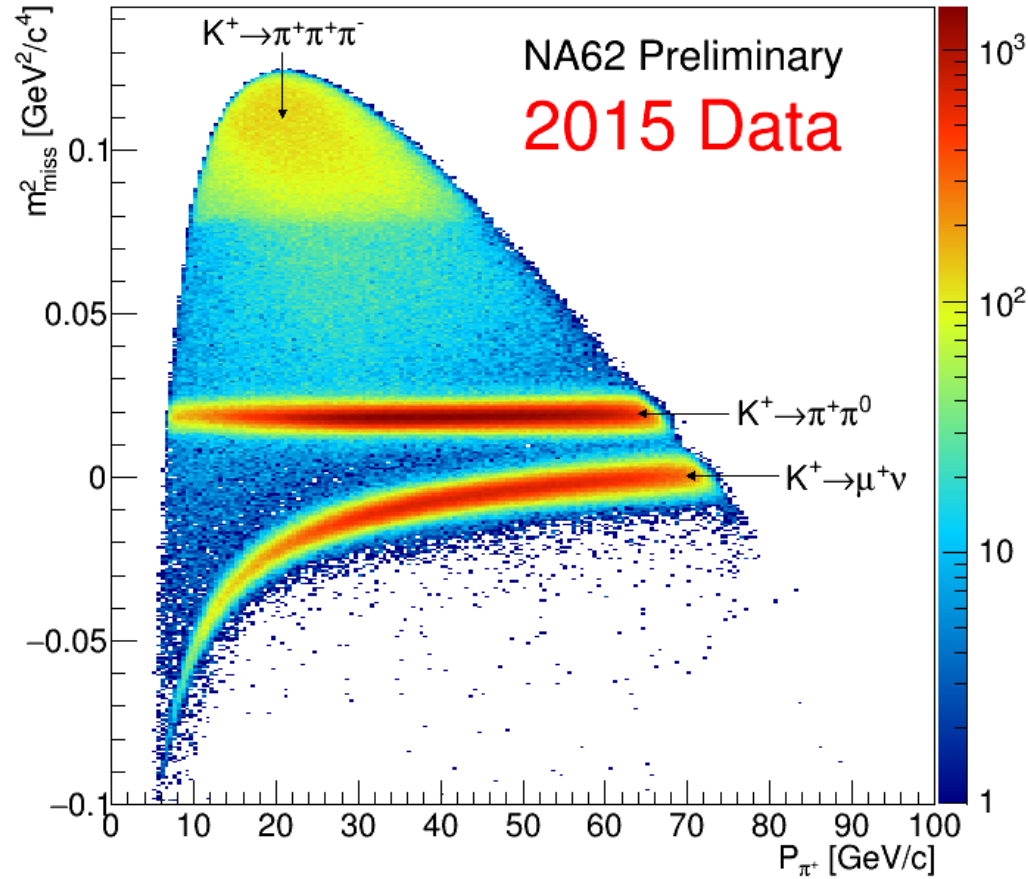
- Enabling technology: Si pixel (300 micron x 300 micron) with ~ 200 ps time resolution / station
- Flux up to one GHz of high energy hadrons over ~ 20 cm²
- Rate per mm² up to 1.4 MHz
- Triggerless readout

30/30 Cum Laude!

NA62 KINEMATICS

OTS + Kaon ID

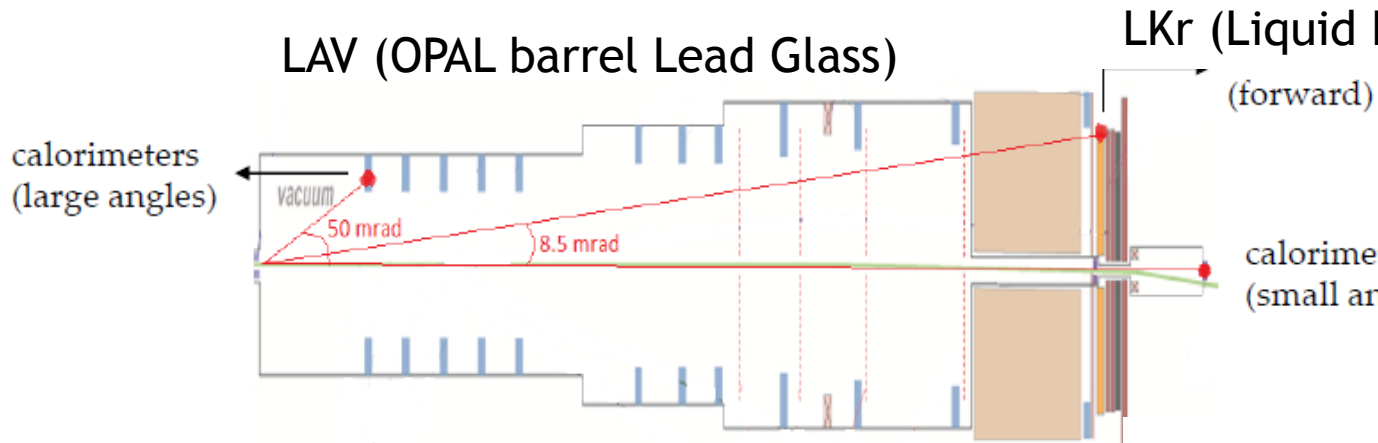
OTS = One Track Selection



Single track tagged to originate
From a kaon decay

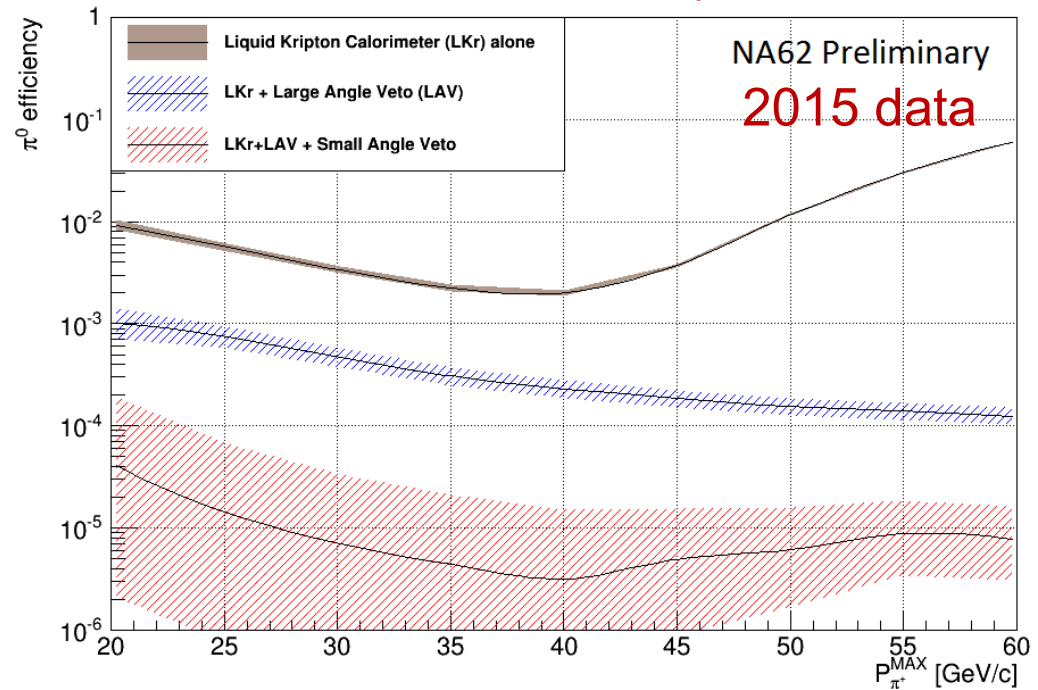
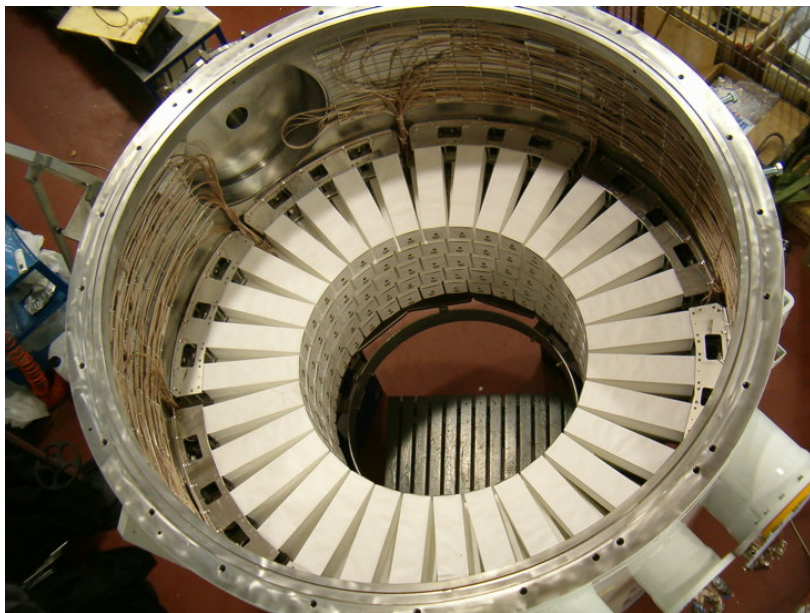
Missing Mass Resolution for
single track events

NA62 π^0 REJECTION

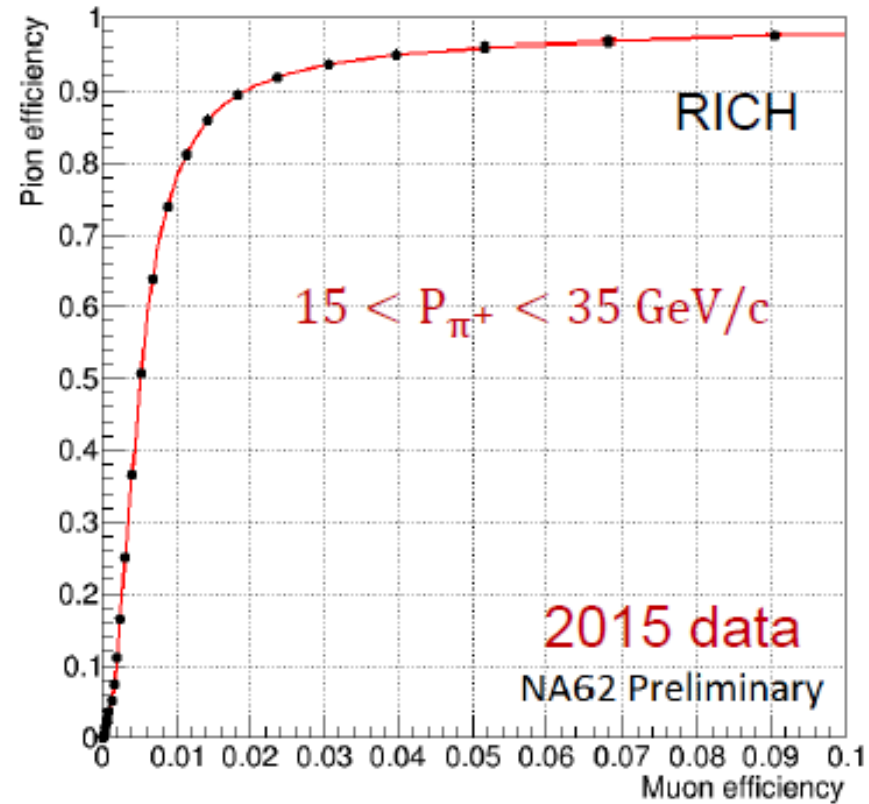
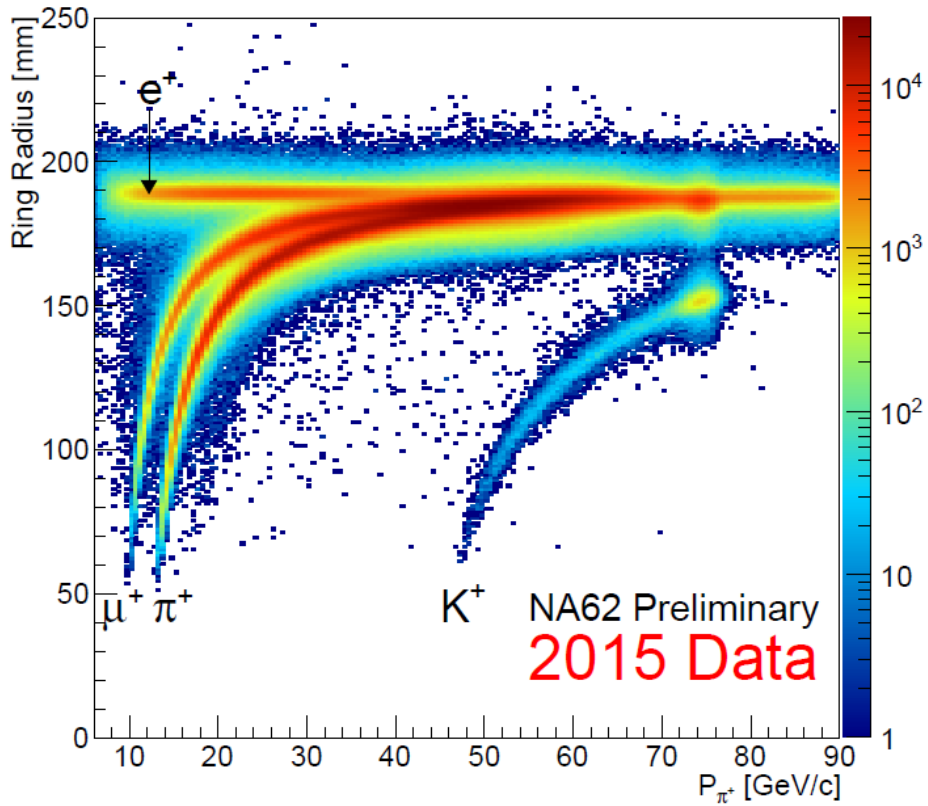


In situ/continuous monitor of π^0 rejection performed selecting $K^+ \rightarrow \pi^+ \pi^0$ events purely on kinematics

$$15 < P_{\pi^+} < P_{\pi^+}^{\text{MAX}}$$



NA62 PARTICLE IDENTIFICATION



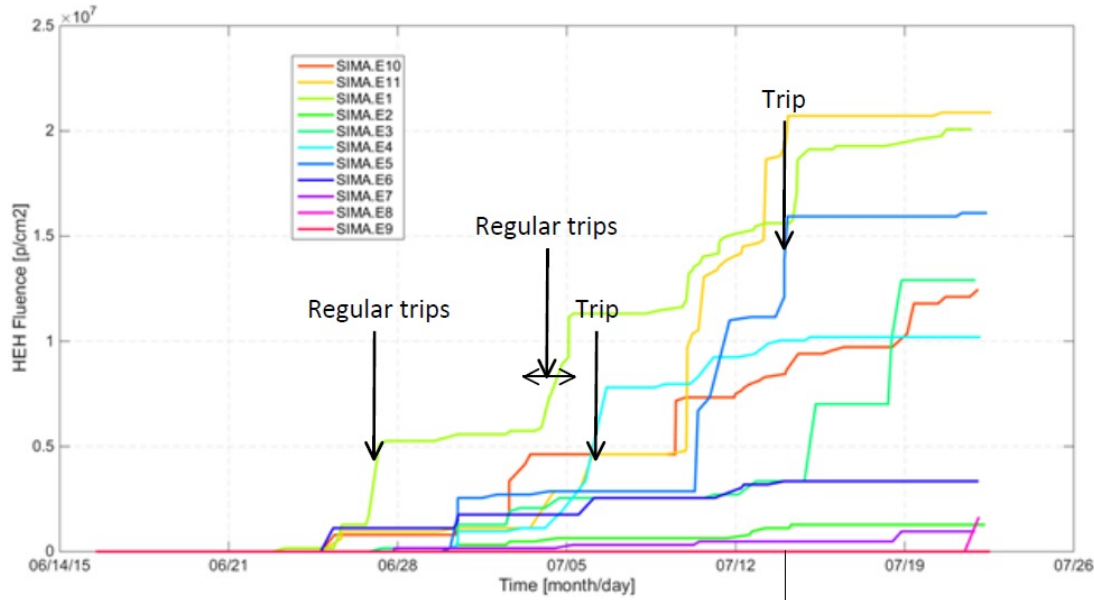
Muon rejection from calorimeters $> 10^5$

- All the ingredients are in place to launch the assault to $K^+ \rightarrow \pi^+ \nu \nu$
- Moved from construction/commissioning to data taking/analysis

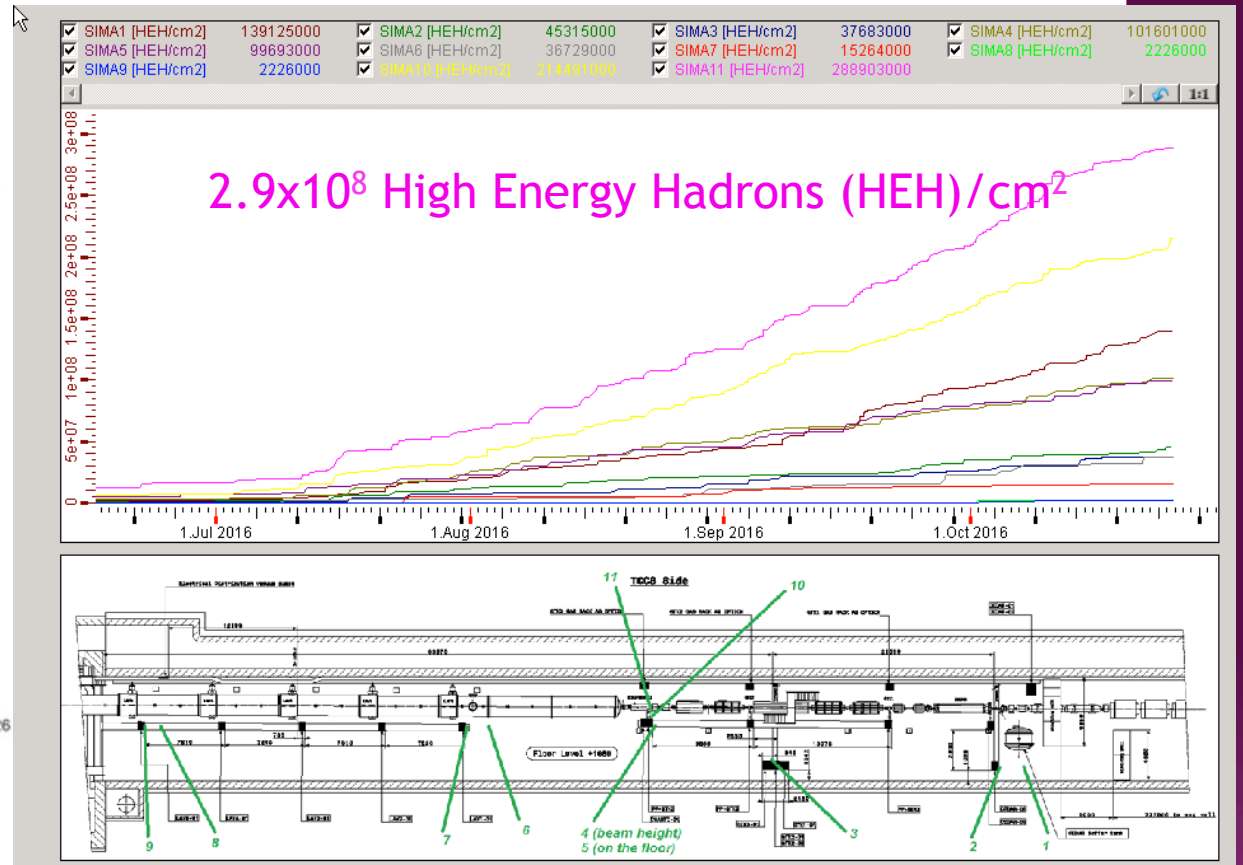
IMPROVED SHIELDING AND INTERLOCKS



Dose Rates



Lau Gatignon



- Proper shielding is crucial for the safety of the NA62 equipment and operation
- Several NA62 systems operates at rates where Single Event Effects due to HEH are expected

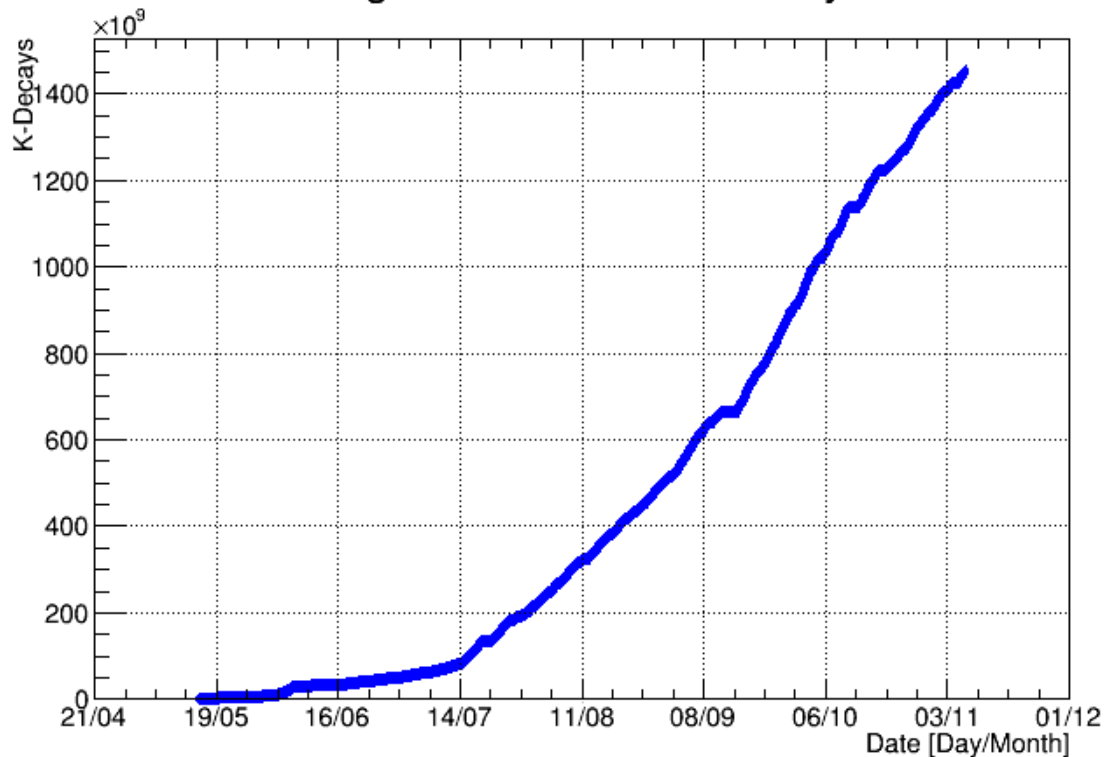
2015

2016

Progress on NA62 Data Taking 2016

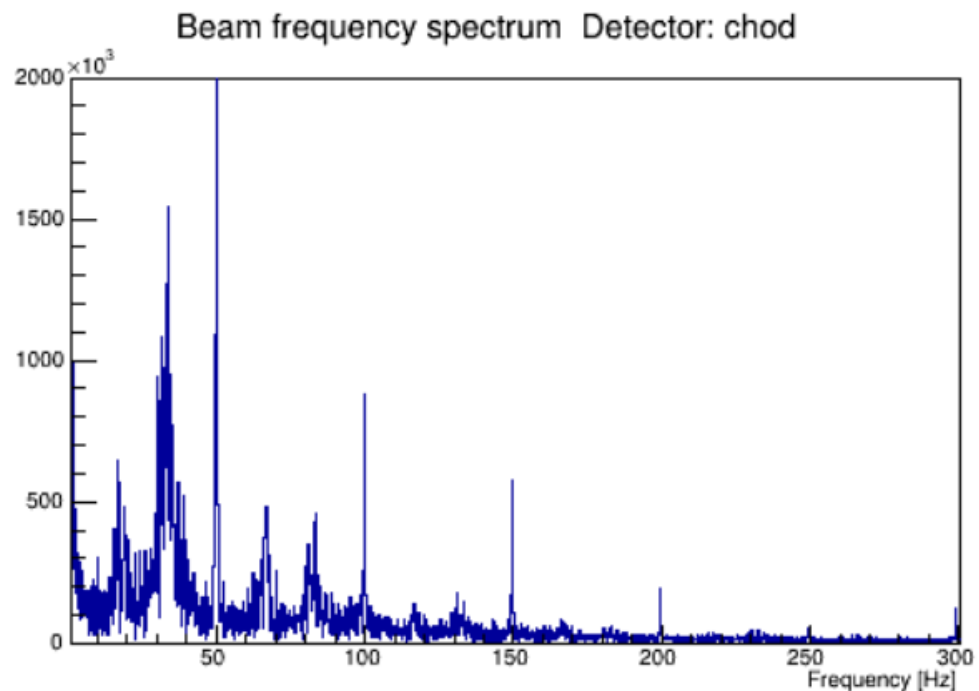


Integrated Number of K-Decays

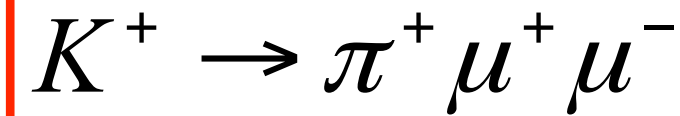


Running consistently at about **40%** of nominal intensity
Limited by beam "Structures" (e.g. 10-30 Hz, 50 Hz, etc.)
Data taking for PNN + EXOTICS simultaneously
250 ktrigger / pulse on tape (corresponding to 14 KHz DC)
Second SPS spill since ~mid July
Three full GTK (no noise, 30/30 chips since September 15)

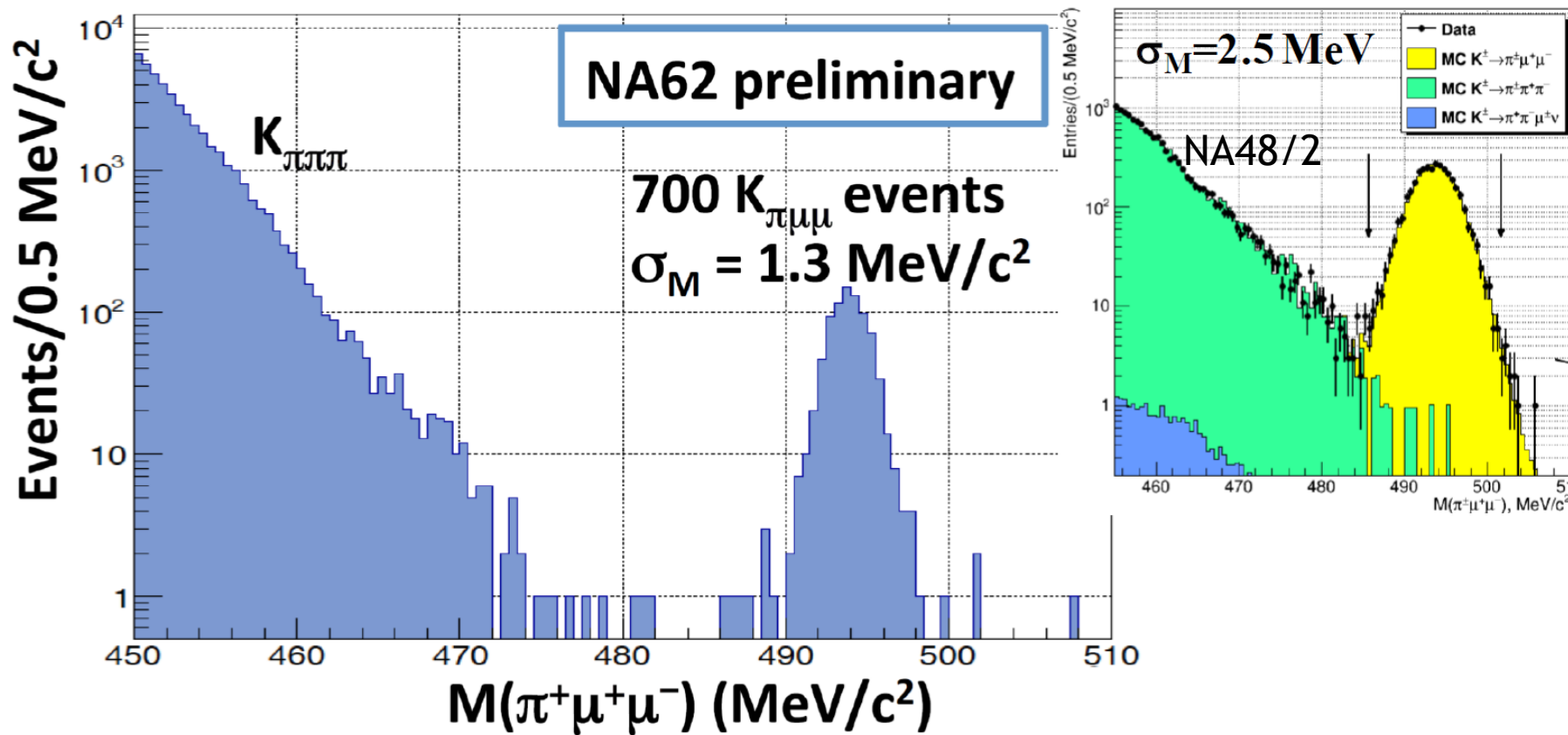
K-decays: extrapolation to end of 2018:
 $5 \cdot 10^{11} / \text{month} * 12 \text{ months} \sim 6 \cdot 10^{12}$
→ With improved extraction and incremental improvements to the efficiency we can reach our target of 10^{13} K decays before LS2



FIRST LOOK AT NA62 2016 DATA



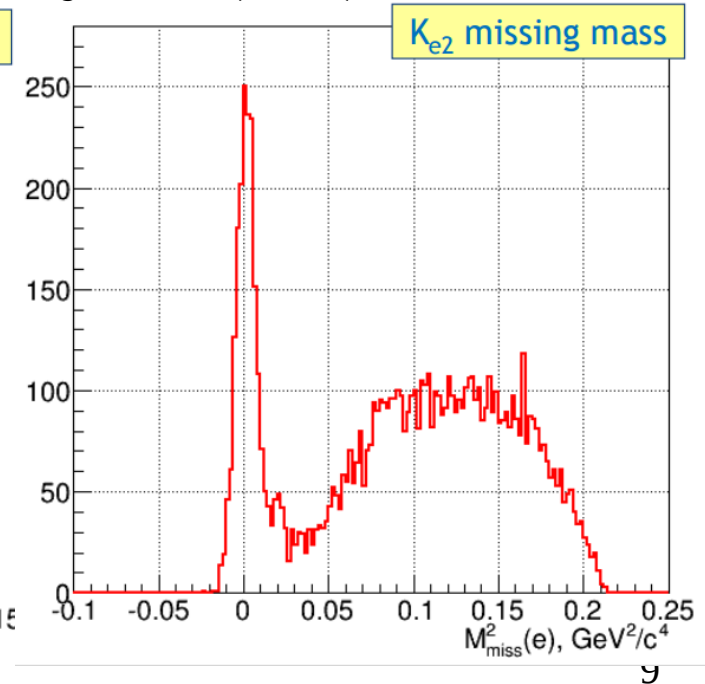
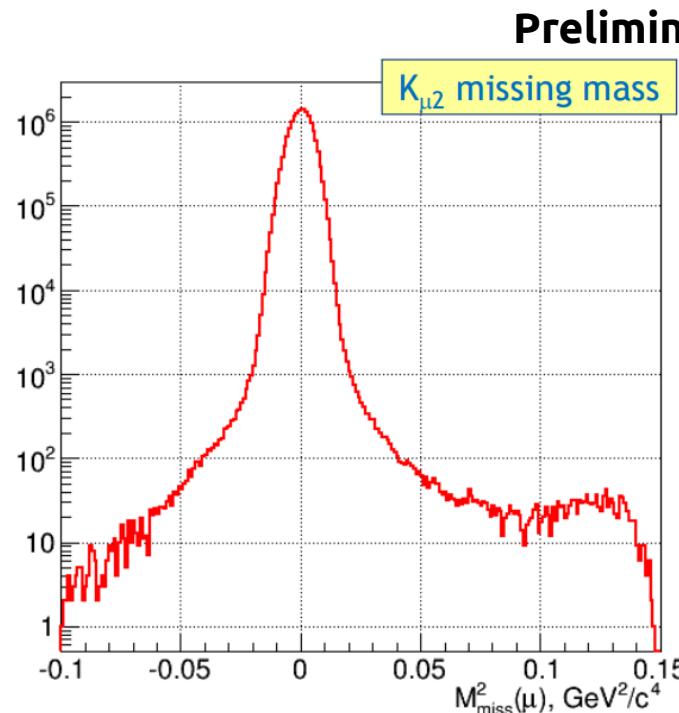
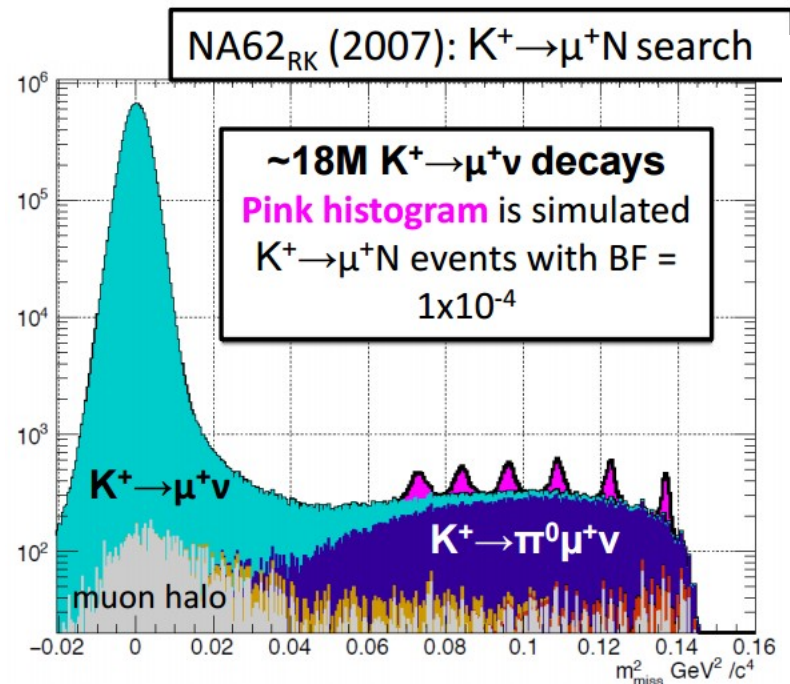
Dimuon trigger, few % of the data, BR~9 10^{-8}



Mass resolution better by a factor ~2 with respect to NA48/2

Heavy neutral leptons in $K^+ \rightarrow l^+ N$

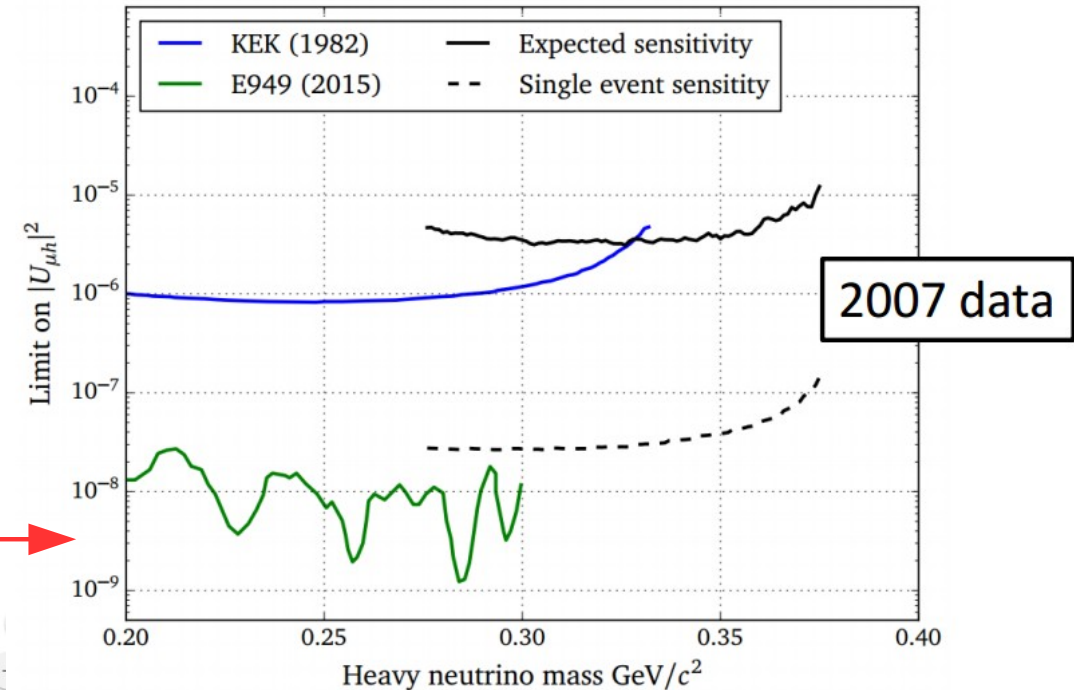
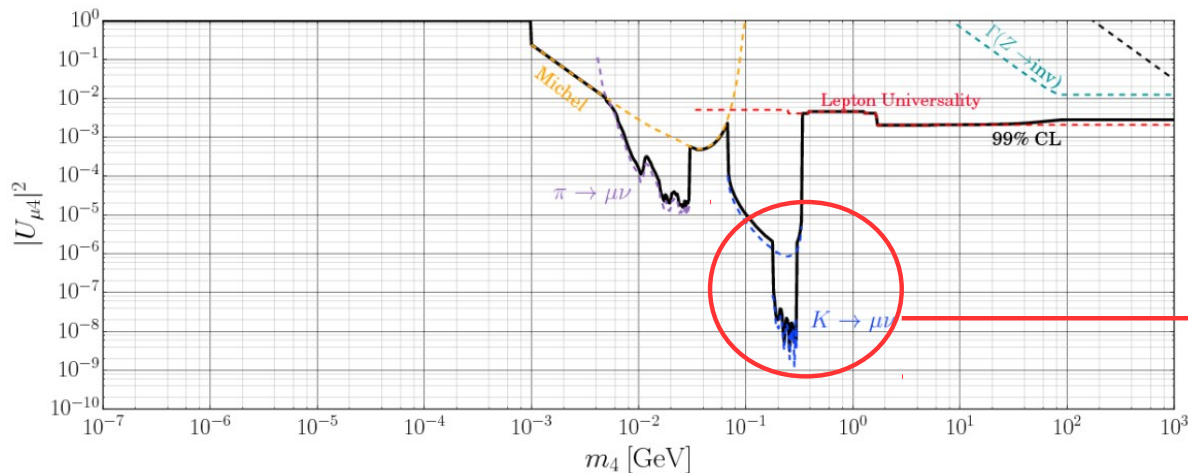
- Can also search for **HNL** in $K^+ \rightarrow l^+ N$ where N does not decay inside the detector fiducial volume
- $K^+ \rightarrow l^+ N$ events would appear as peaks in the $K^+ \rightarrow l^+ \nu$ squared missing mass distribution
- Searches are model independent**



- Analysis underway with NA62 data from 2015.**

Heavy neutral leptons in $K^+ \rightarrow l^+ N$

- Current experimental status: **most stringent constraints from kaon measurements**
- Expected **SES** with **2015 NA62 data** at the level of 10^{-8} (similar for $K \rightarrow eN$ and $K \rightarrow \mu N$)



SUMMARY

- ⦿ Approx. **10^{12} kaon decays** collected in 2016
- ⦿ Performed transition from commissioning to data taking/analysis
- ⦿ **Need stable FT extraction (no 10-30 Hz bump) and as many proton days as possible before LS2**
- ⦿ Incremental improvements to data taking efficiency, trigger and beam intensity planned for 2017 in order to fulfil our objective to collecting approx. 10^{13} kaon decays before LS2 (**O(100) PNN SM events**)
- ⦿ **Several triggers collected simultaneously to address a broad physics portfolio**
- ⦿ There are plans to extend the experiment after LS2 to also explore the “Dark Sector” using the NA62 setup