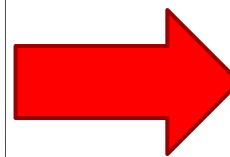
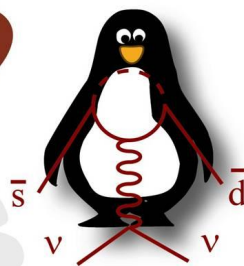


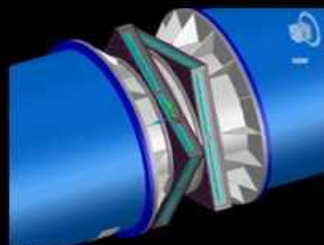
P326 **NA62**



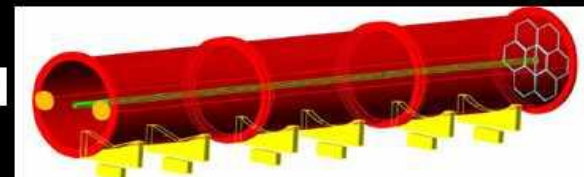
**Rare Kaon decay**

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

**STRAW**

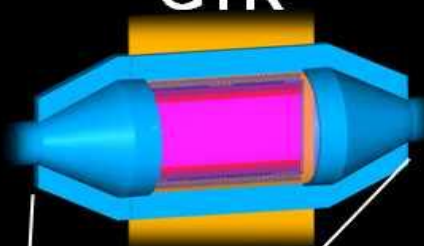


**RICH**

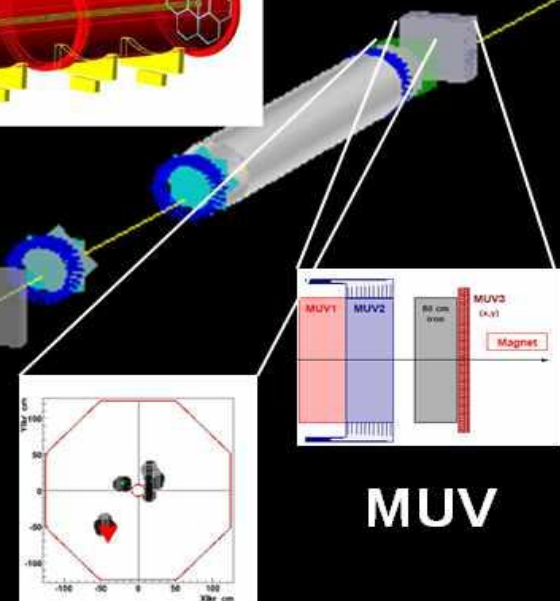
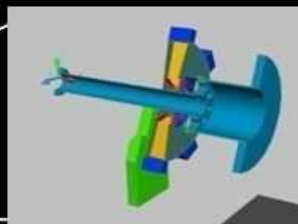


**GTK**

Vacuum tank not shown

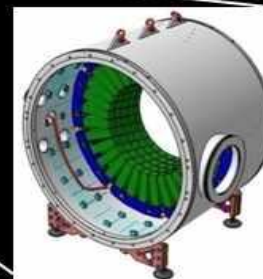


**CEDAR**



**MUV**

**LKR**



**ANTI**

*The*  
**A L I S**  
*Collaboration*

# The story so far...



Decay	Branching Ratio ( $\times 10^{10}$ )	
	Theory(SM)	Experiment
$K^+ \rightarrow \pi^+ \nu \bar{\nu} (\gamma)$	$0.85 \pm 0.07^{[1]}$	$1.73^{+1.15}_{-1.05}$
$K_L^0 \rightarrow \pi^0 \nu \bar{\nu}$	$0.27 \pm 0.04^{[3]}$	$< 260$ (90% CL)

- 1) A measurement of  $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$  determines  $V_{td}$  without input from Lattice QCD
- 2) The strong suppression of the SM component ( $< 10^{-10}$ ) offers good sensitivity to New Physics.
- 3) E949 experiment:  $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$  consistent with the Standard Model prediction !!
- 4) E391a experiment: The upper limit on  $\text{BR}(K^0 \rightarrow \pi^0 \nu \bar{\nu})$  was improved by a factor of 20.

# Kaon and CKM Matrix



$$BR(K^+ \rightarrow \pi^+ \bar{\nu} \nu) = 6r_{K^+} BR(K^+ \rightarrow \pi^0 e^+ \nu) \frac{|G_l|^2}{G_F^2 |V_{us}|^2}$$

$$BR(K^0 \rightarrow \pi^0 \bar{\nu} \nu) = 6 \frac{\tau_{K_L}}{\tau_{K^+}} r_{K_L} BR(K^+ \rightarrow \pi^0 e^+ \nu) \frac{(\text{Im } G_l)^2}{G_F^2 |V_{us}|^2}$$

$$G_l = \frac{\alpha G_F}{2\pi \sin^2 \Theta_W} [V_{ts}^* V_{td} X(x_t) + V_{cs}^* V_{cd} X_{NL}^l]$$

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

EW Penguin	SM and/or example of SUSY effect	Contributes to
		$K \rightarrow \pi \nu \bar{\nu}$ $K_L \rightarrow \pi^0 \ell^+ \ell^-$ $K_L \rightarrow \ell^+ \ell^-$
		$K_L \rightarrow \pi^0 \ell^+ \ell^-$
		$K_L \rightarrow \pi^0 \mu^+ \mu^-$ $K_L \rightarrow \mu^+ \mu^-$ (helicity-suppressed)

$$\text{SM } B(K^+ \rightarrow \pi^+ \nu \bar{\nu}(\gamma))^{\text{SM}} = 8.2(8) \cdot 10^{-11}$$

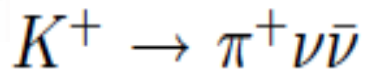
$$B(K_L \rightarrow \pi^0 \mu^+ \mu^-) = (1.5 \pm 0.3) \times 10^{-11}$$

## Beyond SM

$$B(K^+ \rightarrow \pi^+ \nu \bar{\nu}) = 17.3 \cdot 10^{-11}$$

$$B(K_L \rightarrow \pi^0 \mu^+ \mu^-) = 12 \cdot 10^{-11}$$

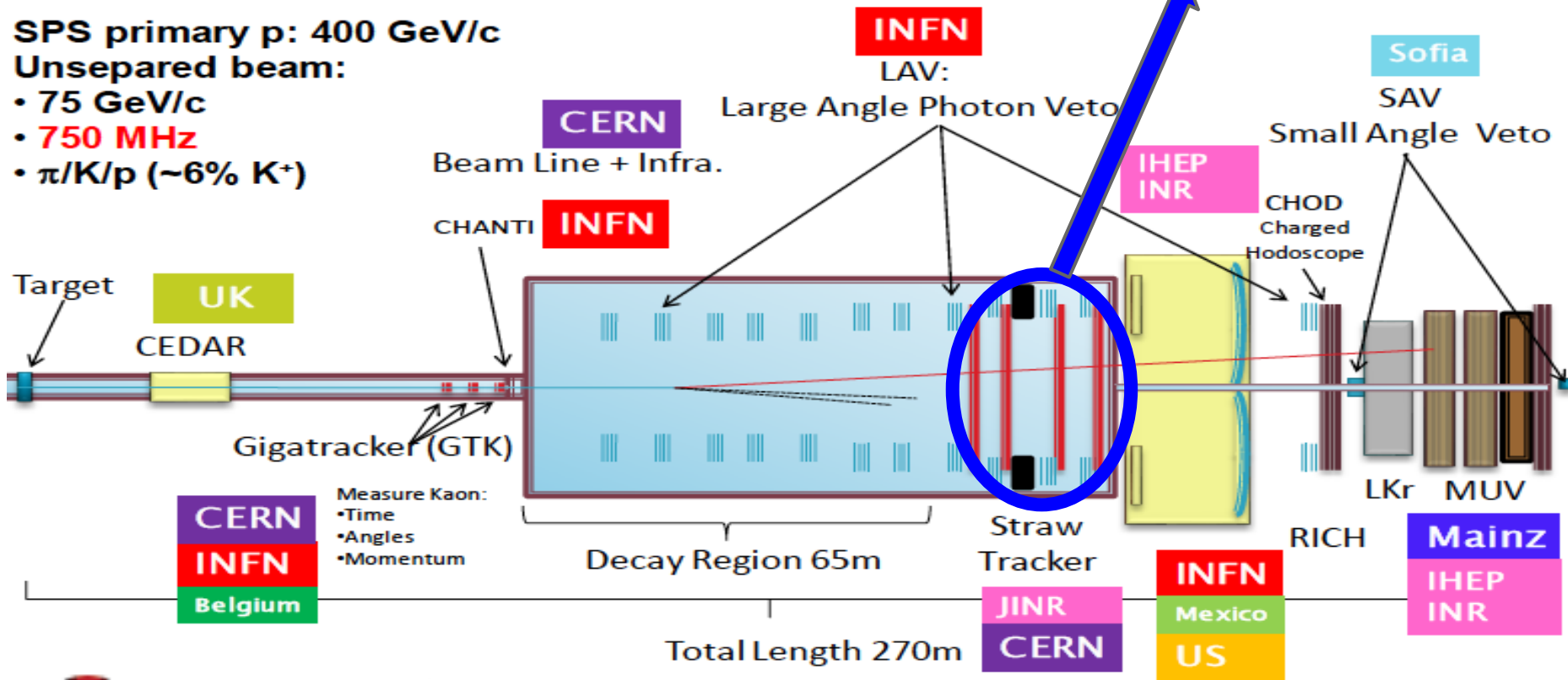
# Detector layout



SPS primary p: 400 GeV/c

Unseparated beam:

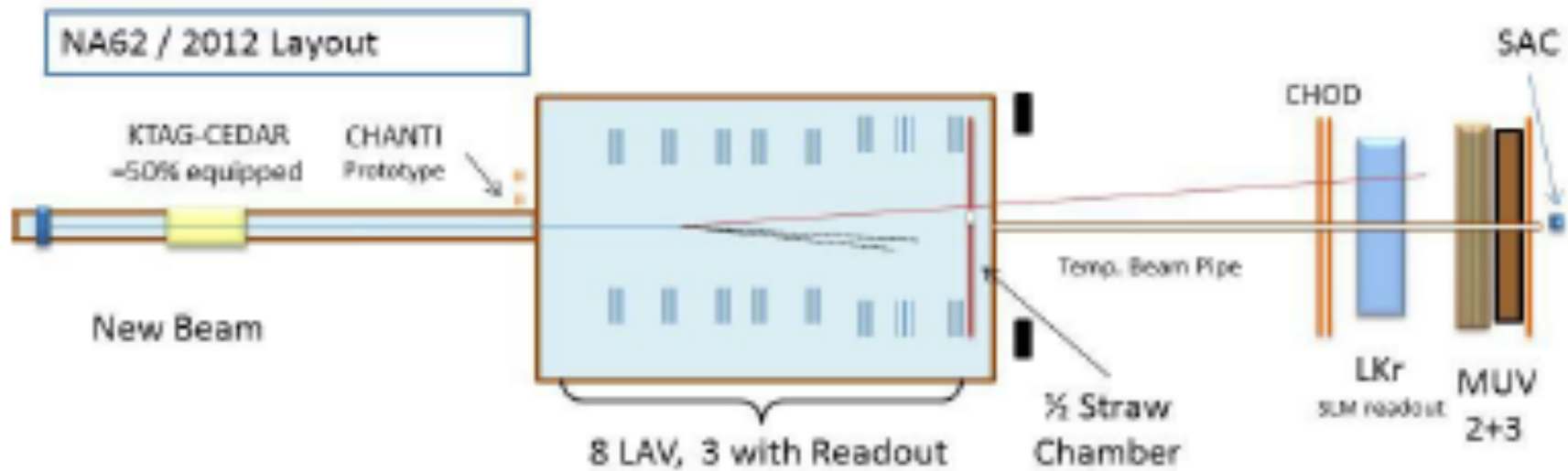
- 75 GeV/c
- 750 MHz
- $\pi/K/p$  (~6%  $K^+$ )



$K^+ \rightarrow \mu^+ \nu$	63% (called $K_{\mu 2}$ )	$K^+ \rightarrow \pi^+ \pi^0 \pi^0$	2%
$K^+ \rightarrow \pi^+ \pi^0$	21%	$K^+ \rightarrow \pi^0 \mu^+ \nu$	3% (called $K_{\mu 3}^+$ )
$K^+ \rightarrow \pi^+ \pi^+ \pi^-$	6%	$K^+ \rightarrow \pi^0 e^+ \nu$	5% (called $K_{e 3}^+$ )



# Technical Run 2012



Installation of K12 beam line started in mid 2012.

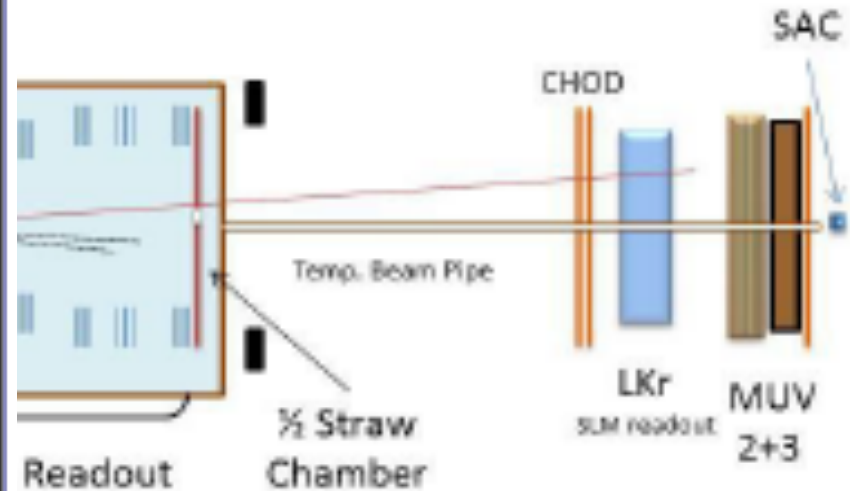
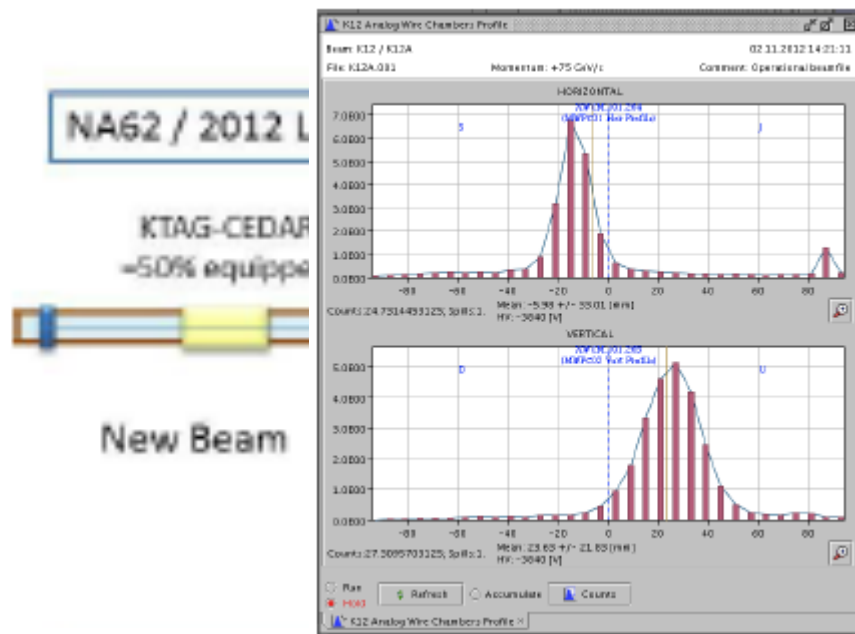
Beam Permit Nov 1st



# Technical Run 2012



2nd Of November  
First pencil-like beam injected



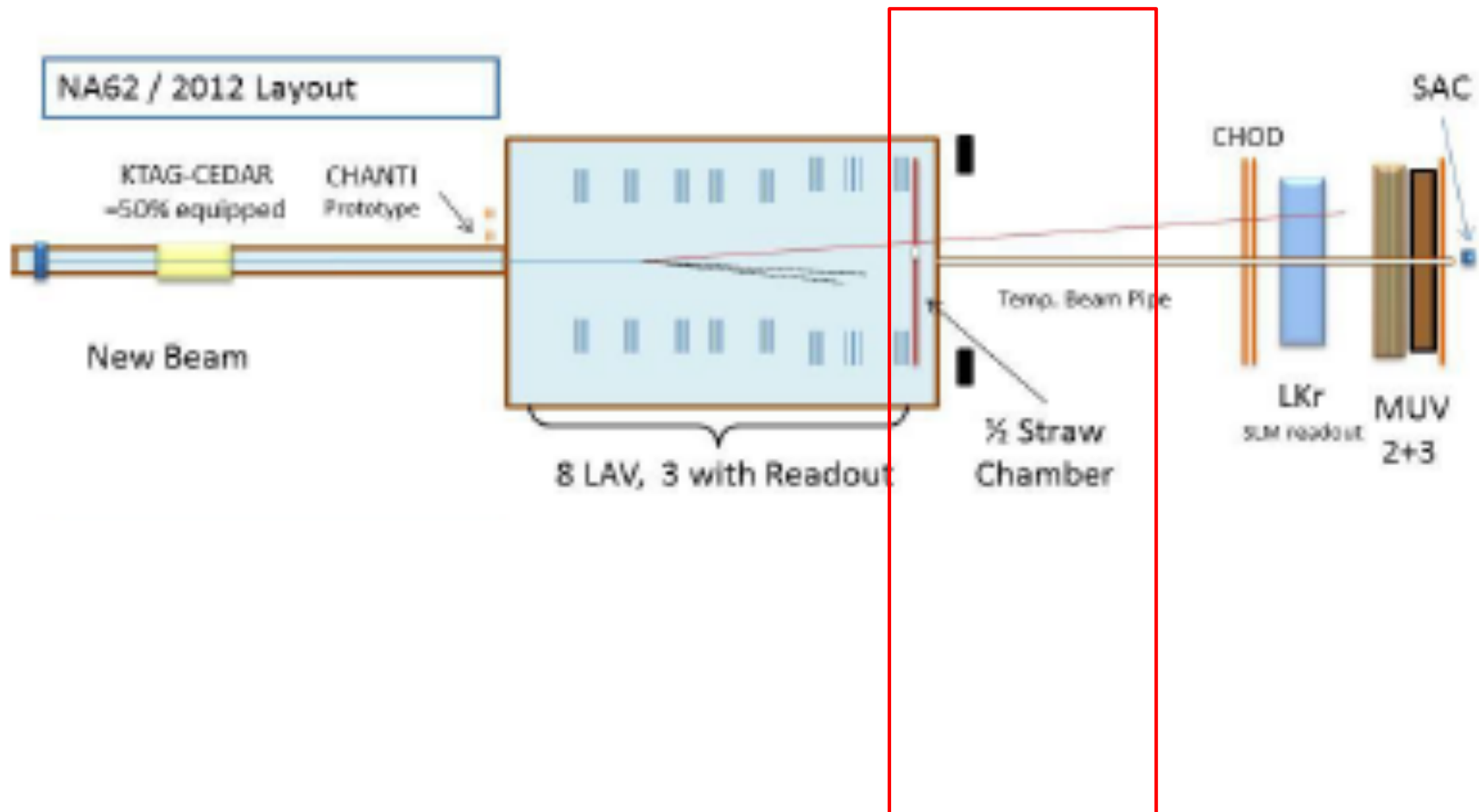
Installation of K12 beam line started in mid 2012.

Beam Permit Nov 1st

Technical run during November



# Technical Run 2012



**First half of Straw Chamber during technical run!**



- Module 1 (1=2 chamber) and frontend electronics was installed
- the readout board (SRB) is tested and the principles validated;
- the FPGA-based TDC have been integrated on the frontend board (cover) and tested successfully;

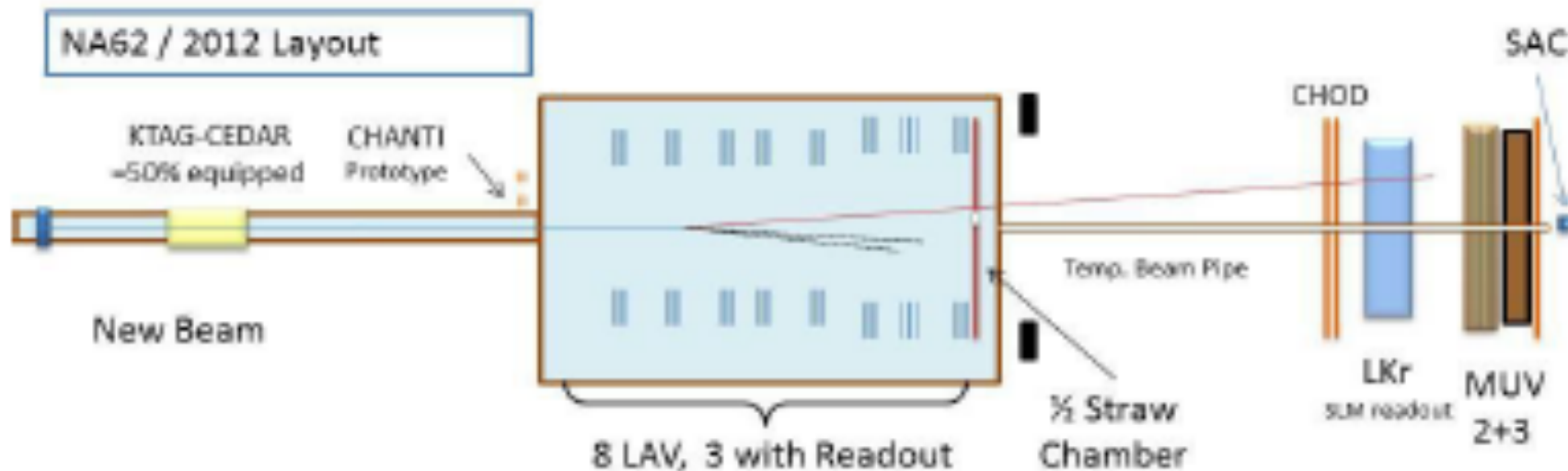
the validation of the high and low voltage power supplies (Wiener MPOD) was performed;

- the validation of the low voltage patch panels and the design of the high voltage patch panels was completed.

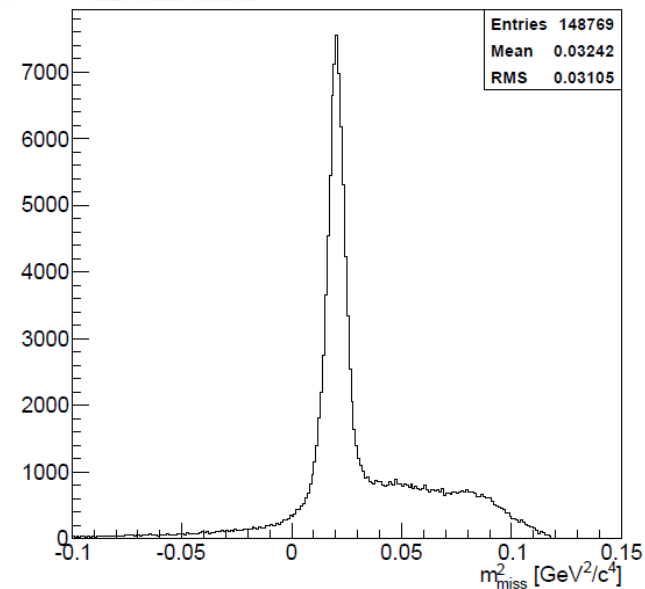
**Electronics meets design specifications**



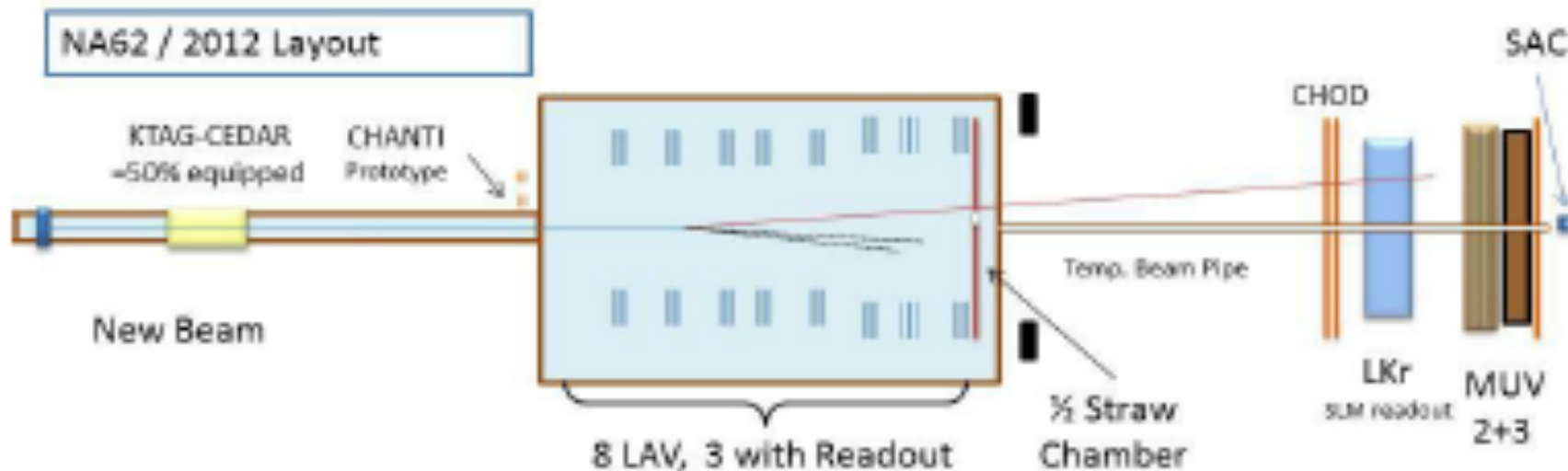
# Technical Run 2012



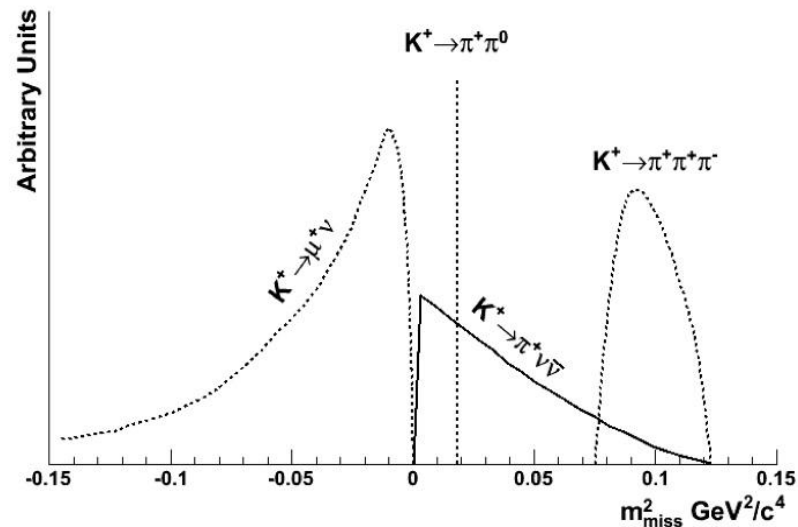
Identification of  $K^+$  to  $\pi^+ \pi^0$   
through a reconstruction of  
contained  $\pi^0$  shower plus  $\pi^+$   
residual mass



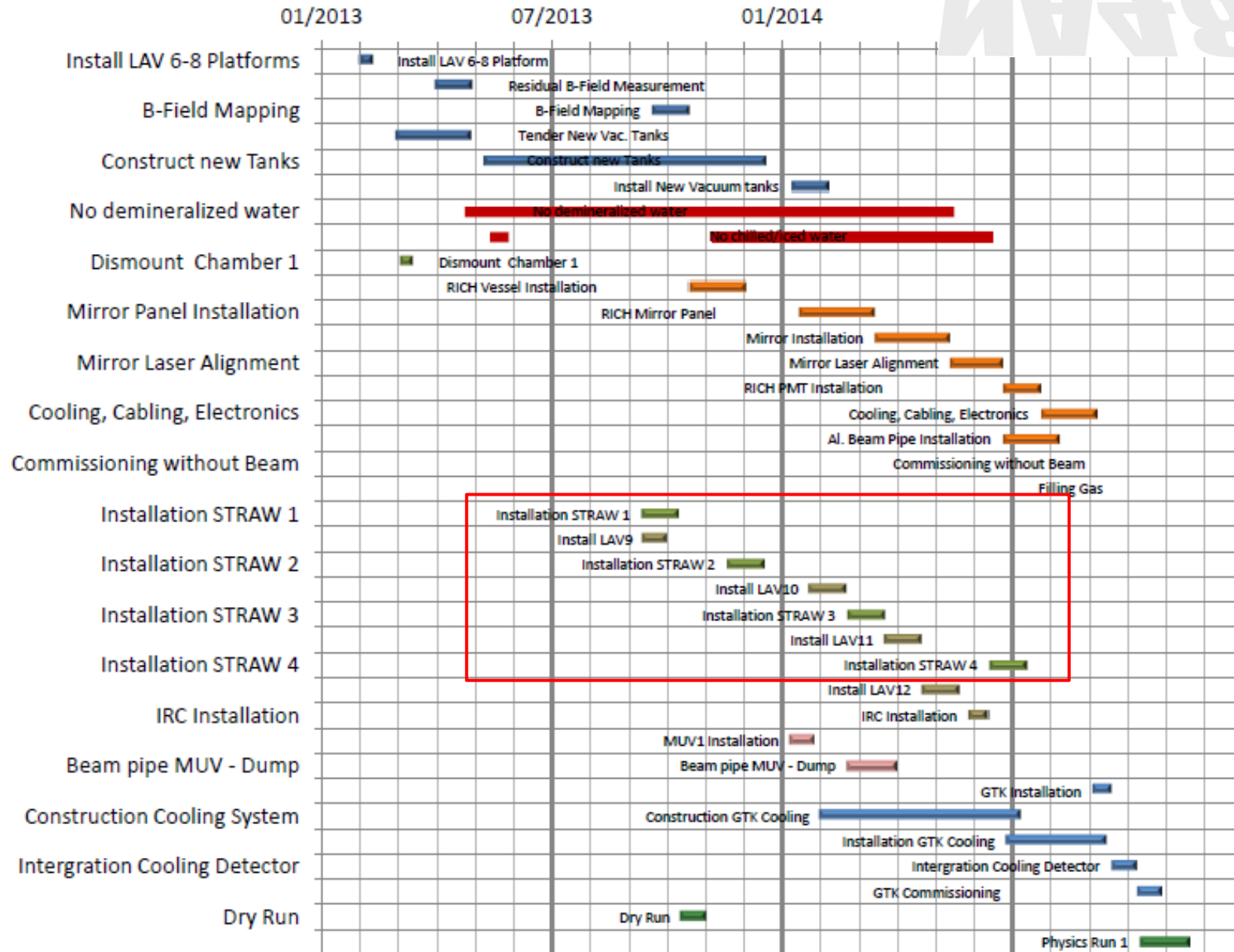
# Technical Run 2012



Identification of  $K^+$  to  $\pi^+ \pi^0$  through a reconstruction of contained  $\pi^0$  shower plus  $\pi^+$  residual mass



# Timeline



# Timeline

01/2013

07/2013

01/2014



## Ready for first chamber installation

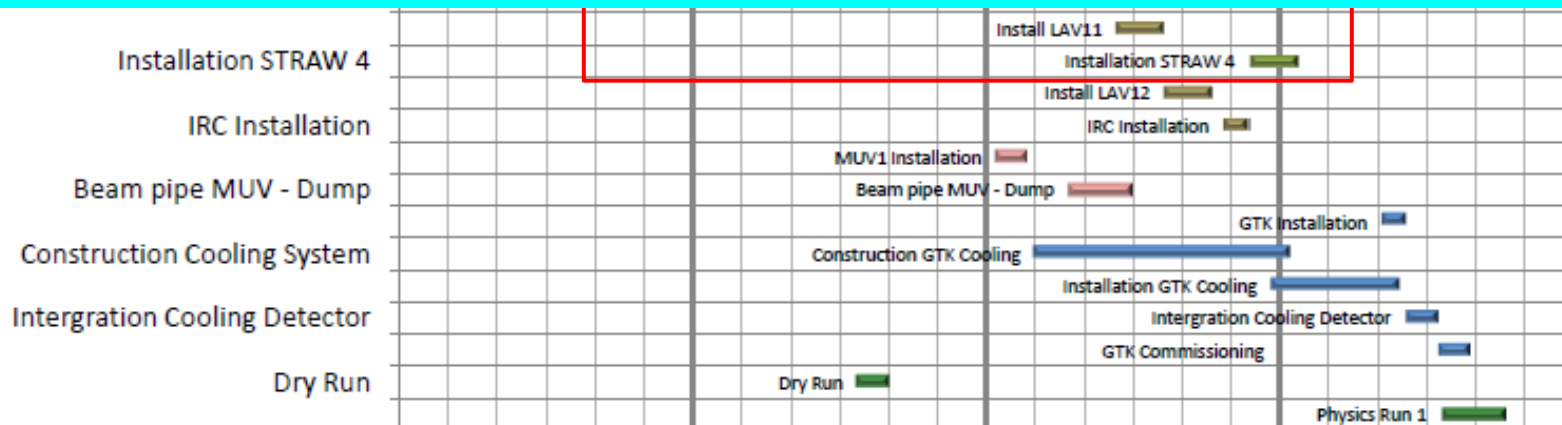
- A total of more than 4 000 straws have been manufactured;
- Procurement of all module frames and the rest of the mechanical components;
- Technical transfer including a full set of assembly tooling to Dubna after validation at CERN;
- Start-up of the module production in Dubna;

## Preparations for first Physics Run (two years from now)

- Straw is key detector within experiment
- Calibration and alignment essential
- Feasibility of taking leading role in physics analysis

## Men power needed

- 1 PhD full time for four years and 1 postdoc



# Summary

## Status:

- New beamline commissioned
- Successful technical run
- First physics run October 2014

## Alis Collaboration:

- Developing the software.
- Opportunity to get a leading role in the physics analysis.

## Manpower required:

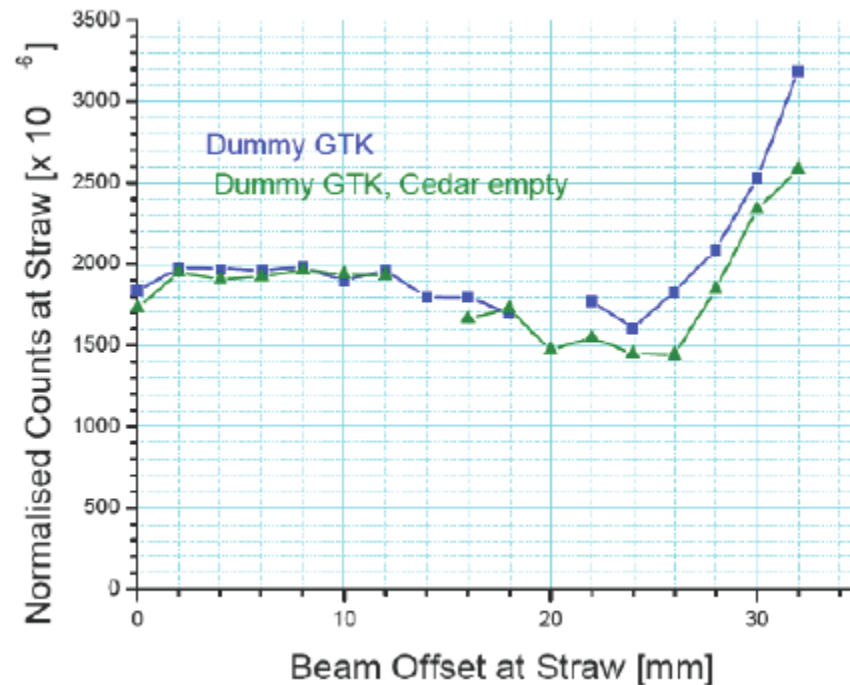
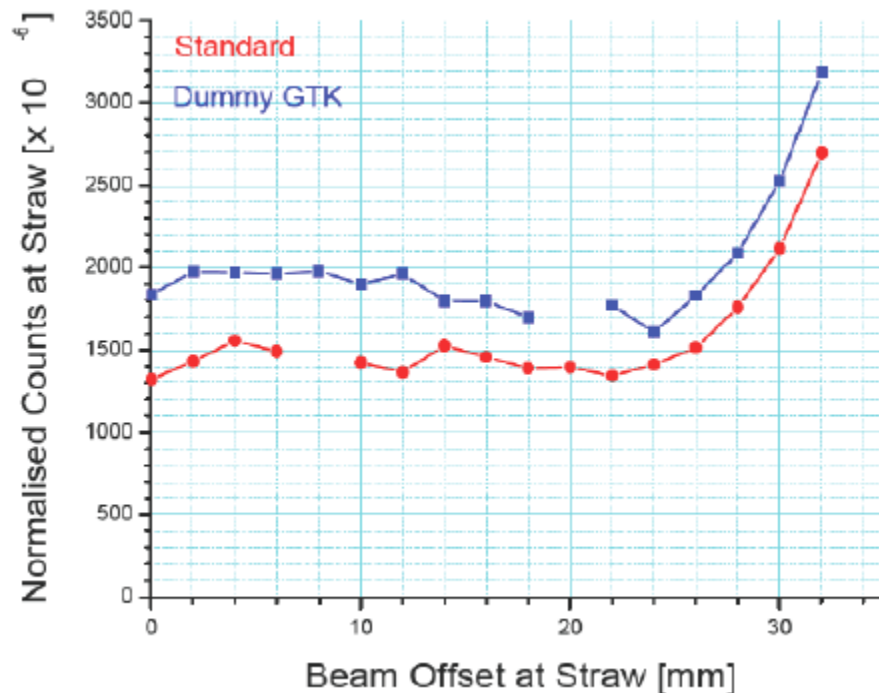
- 1 additional PhD
- 1 additional postdoc





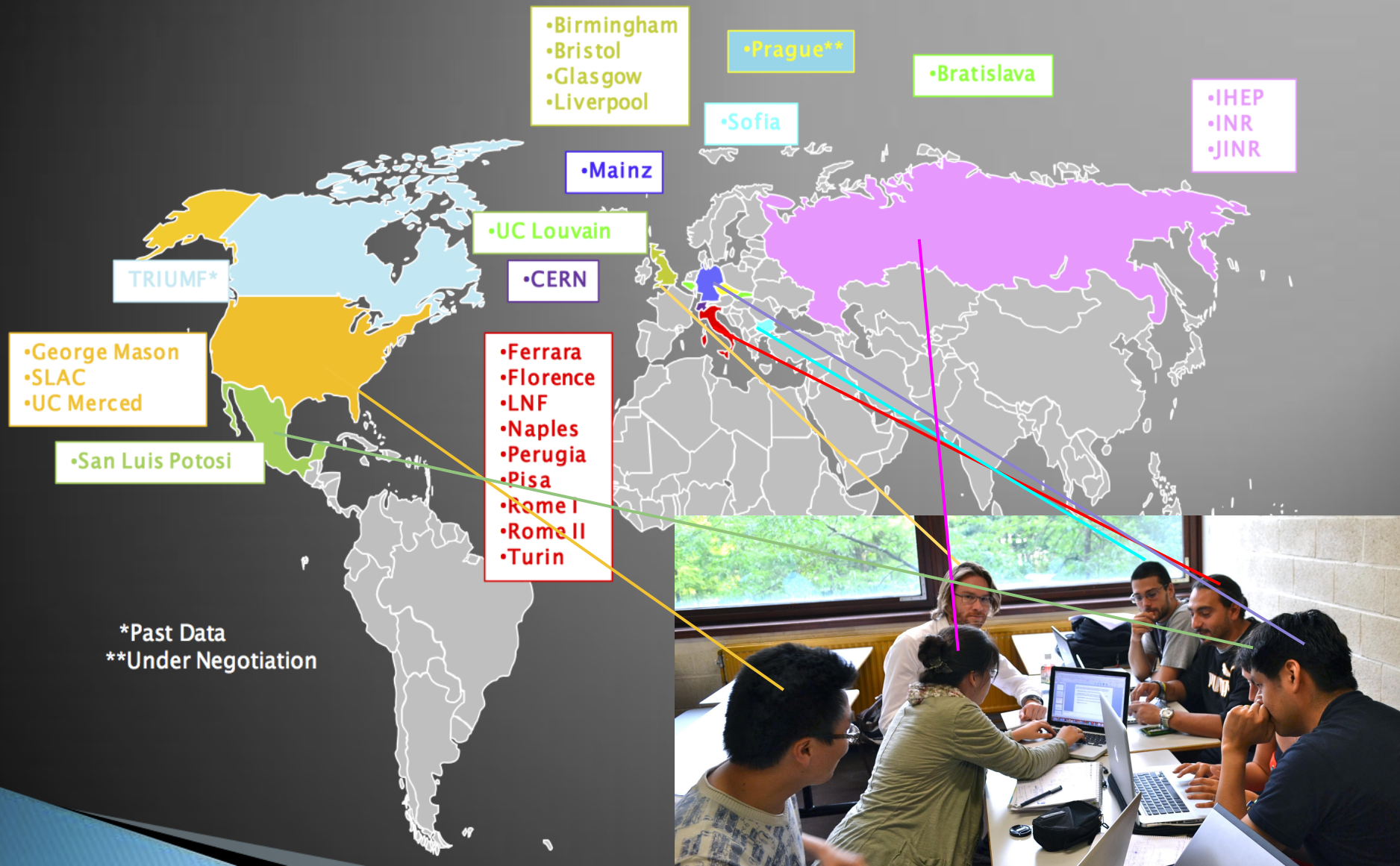
# BACKUP

# Technical Run 2012



**Excellent response of the chamber**

# People in our experiment



# List of publications

**Nucl.Instrum.Meth. A718 (2013) 164-167**

**Phys.Lett. B719 (2013) 326-336**

**Phys.Lett. B698 (2011) 105-114**

**Nucl.Instrum.Meth. A623 (2010) 543-545**

**Nucl.Instrum.Meth. A617 (2010) 365-368**

**Nucl.Instrum.Meth. A617 (2010) 436-438**

**+ 35 proceedings**



# The Alis Collaboration



Lydia Brener  
Alis Rodriguez Manso  
Redmer Bertens  
Davide Francesco Lodato  
You Zhou  
Carlos Perez  
Luca Pernie





# Schedule after our successful 2012 technical run



2012: first technical run

- new beamline commissioned
- (prototypes of) all detectors online

Focus on:  $k^+ \rightarrow \pi^0 + \pi^+$

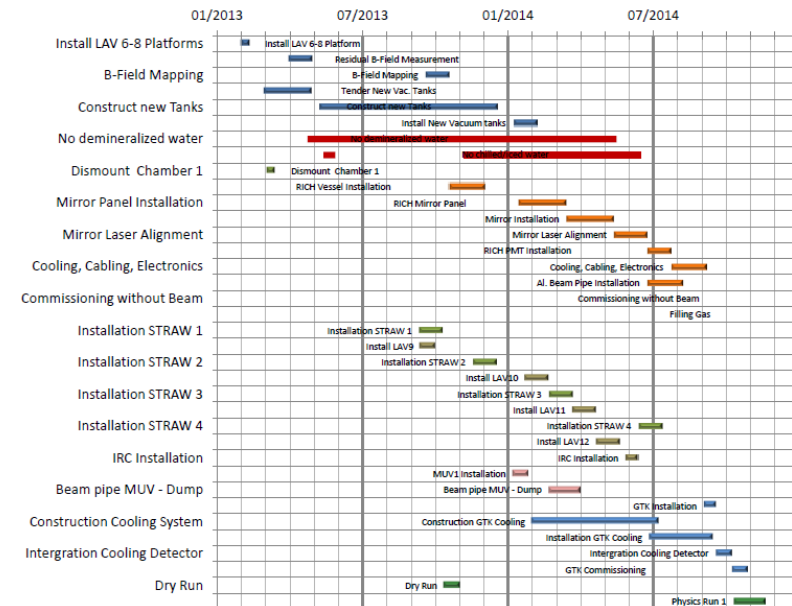
- $8 \cdot 10^6$  events triggered
- excellent results on tracking (charged particles) calorimetry (neutral) and trigger and daq systems

challenging future steps :

- straw production ongoing
  - about to commission straw1
  - testing new tracker chips
  - cooling of computer farms

expectation:

- oct 2014 first physics run
  - few months later: first analysis results
- full phase space probed: spring 2017
  - full reach of SM test reached



note from carlos and redmer: this is not the final layout of the slide :) !

