

# What we do now at DAFNE? SIDDHARTA-2 is getting started



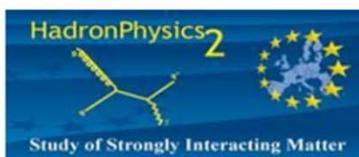
*“Fundamental Physics at the Strangeness Frontier at  
DAΦNE” Workshop  
25 – 26 February, 2021, INFN - LNF, Frascati*

Florin Sirghi, INFN - LNF

*on behalf of the SIDDHARTA-2 collaboration*

# SIDDHARTA-2

Silicon Drift Detector for Hadronic Atom Research by Timing Applications



**FWF** Der Wissenschaftsfonds.

 **Farnesina**  
Ministero degli Affari Esteri  
e della Cooperazione Internazionale

LNF- INFN, Frascati, Italy  
SMI- ÖAW, Vienna, Austria  
Politecnico di Milano, Italy  
IFIN – HH, Bucharest, Romania  
TUM, Munich, Germany  
RIKEN, Japan  
Univ. Tokyo, Japan  
Victoria Univ., Canada  
Univ. Zagreb, Croatia  
Helmholtz Inst. Mainz, Germany  
Univ. Jagiellonian Krakow, Poland  
Research Center for Electron Photon Science (ELPH), Tohoku University

**STRONG-2020**

Croatian Science Foundation,  
research project 8570

# **CONTENT**

**1. *SIDDHARTINO installed on DAΦNE: present status***

**2. *Commissioning of SIDDHARTINO in DAΦNE:***

*calibration of the SDD detectors and optimizations*

*online monitoring with beams*

*luminosity monitors crosscheck*

**3. *Strategy and future plans***

## *SIDDHARTA-2 - present status*

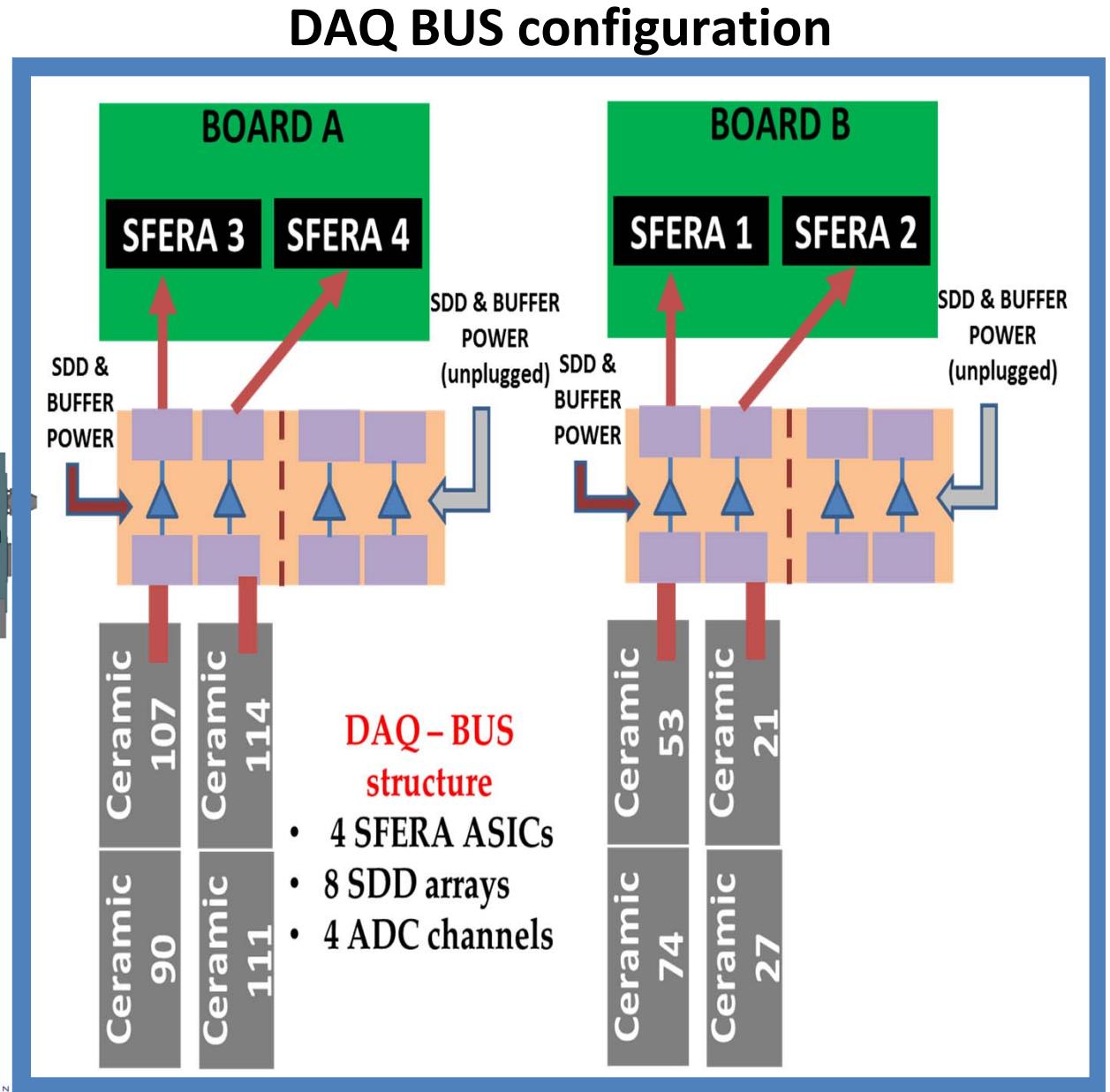
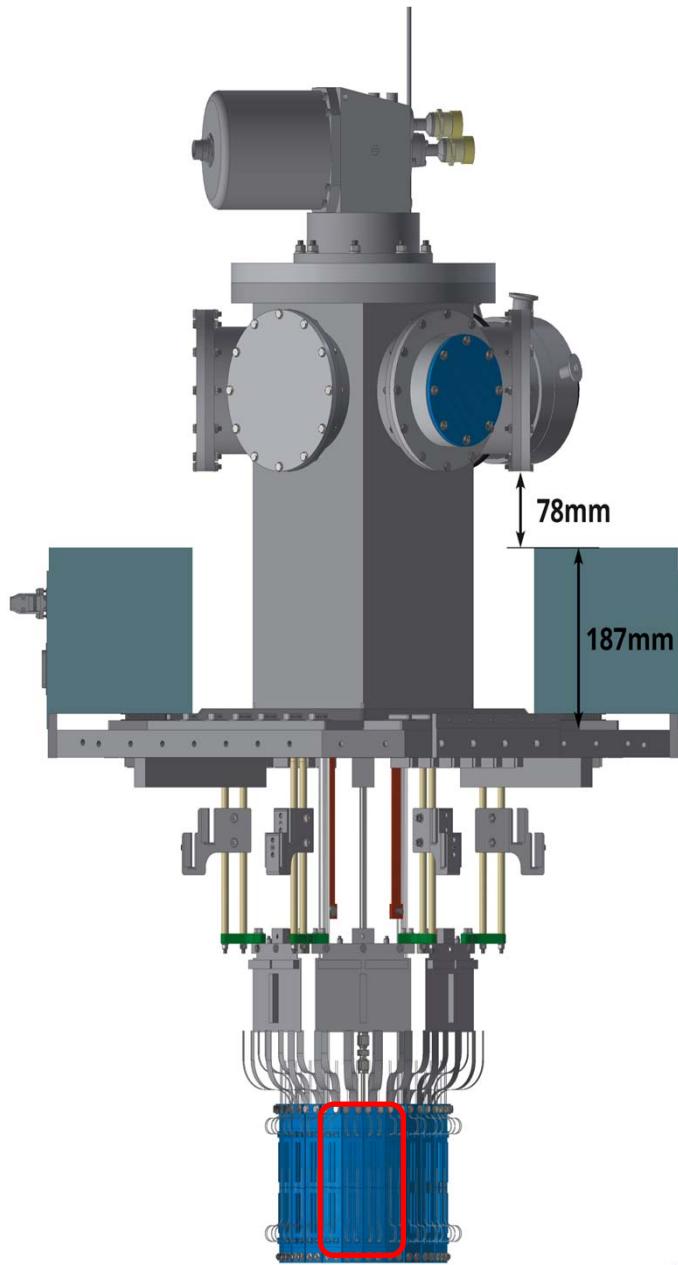
We are presently in Phase 1 with SIDDHARTINO:

during the **commissioning** of DAΦNE  
**optimization** with the SIDDHARTINO setup

for the **K-<sup>4</sup>He measurement**  
**(with 8 SDD arrays)**

*... delayed due to CoviD-19 situation*

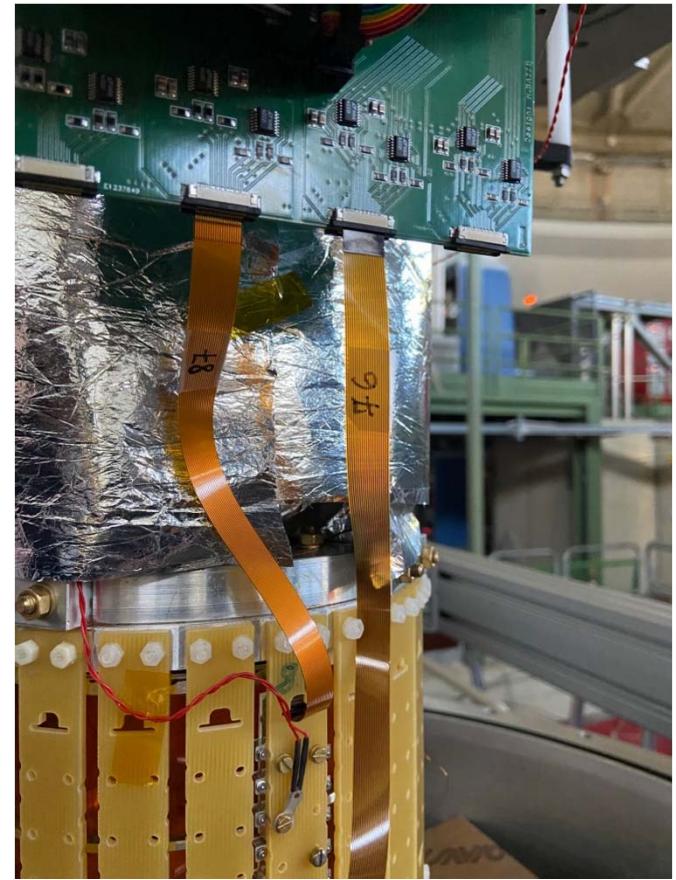
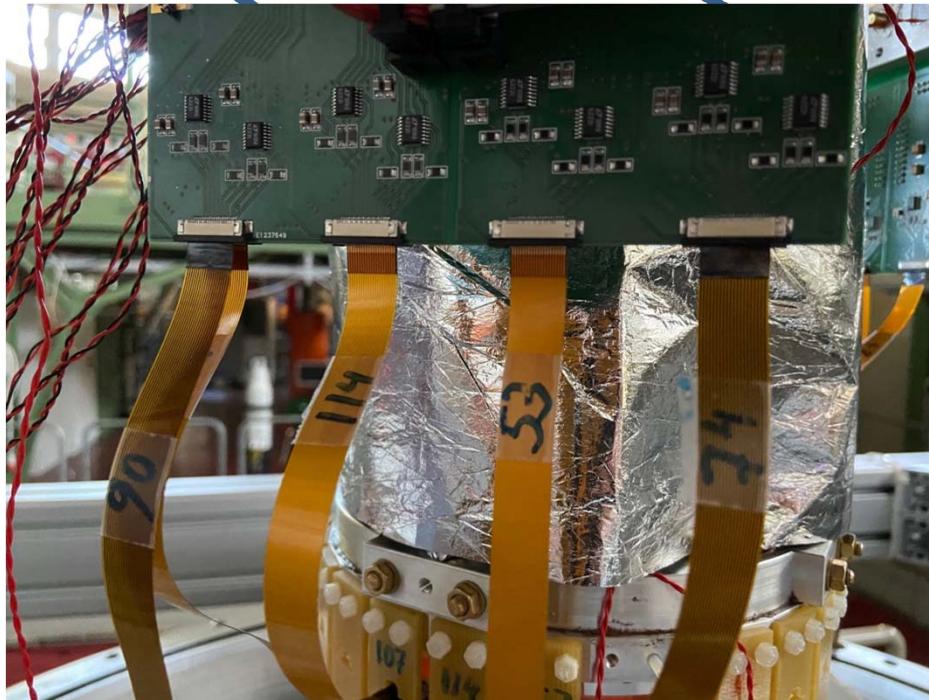
# *SIDDHARTINO = SIDDHARTA-2 with 8 SDD's*



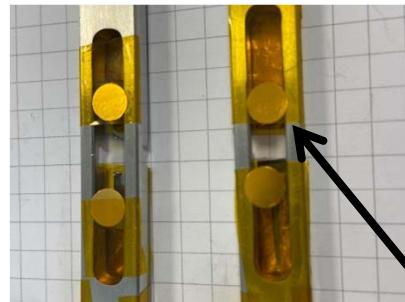
# *Inside vacuum chamber - SDD mounting*

**SF3 & SF4**

**SF1 & SF2**

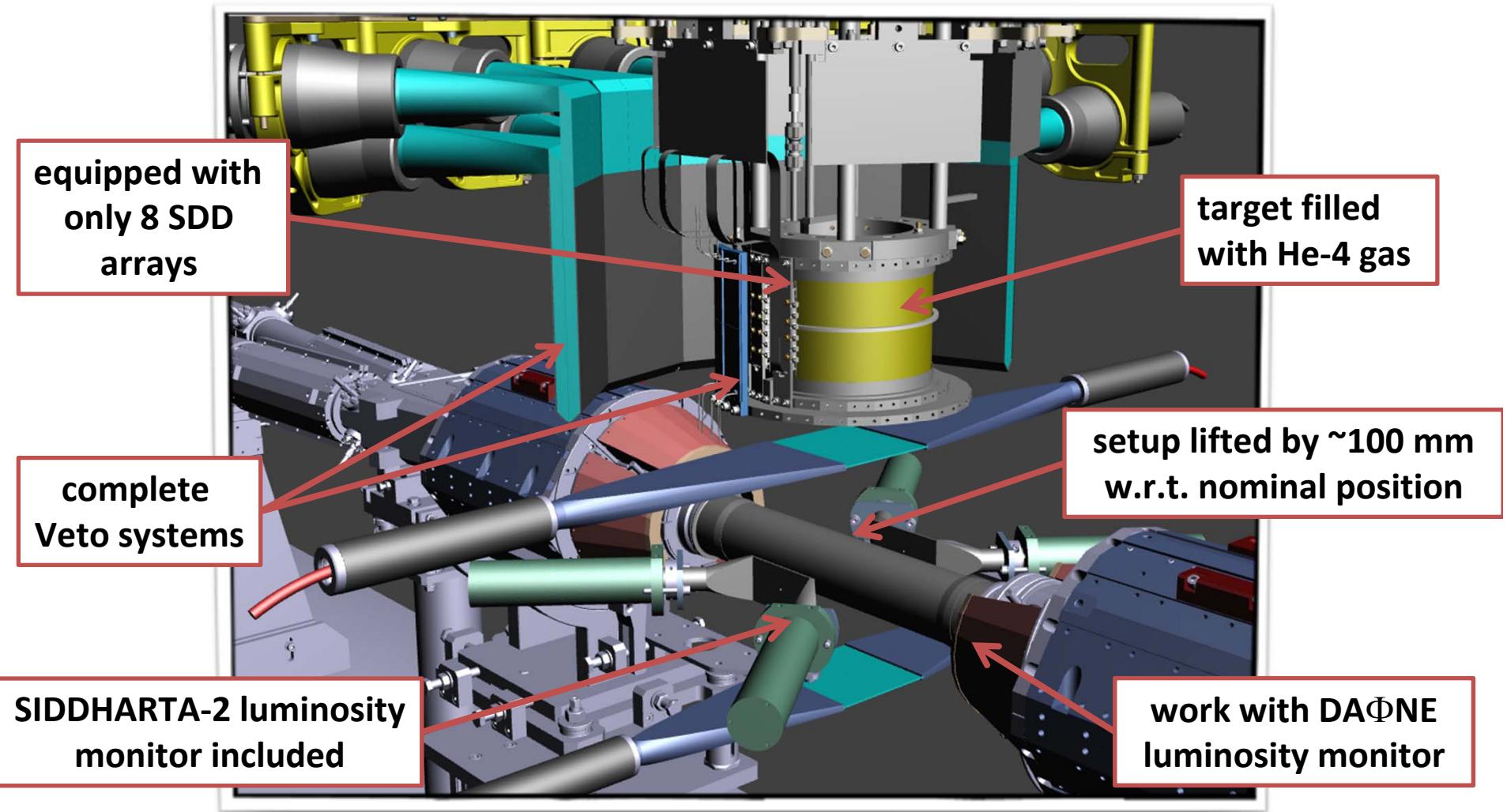


Ti, Cu

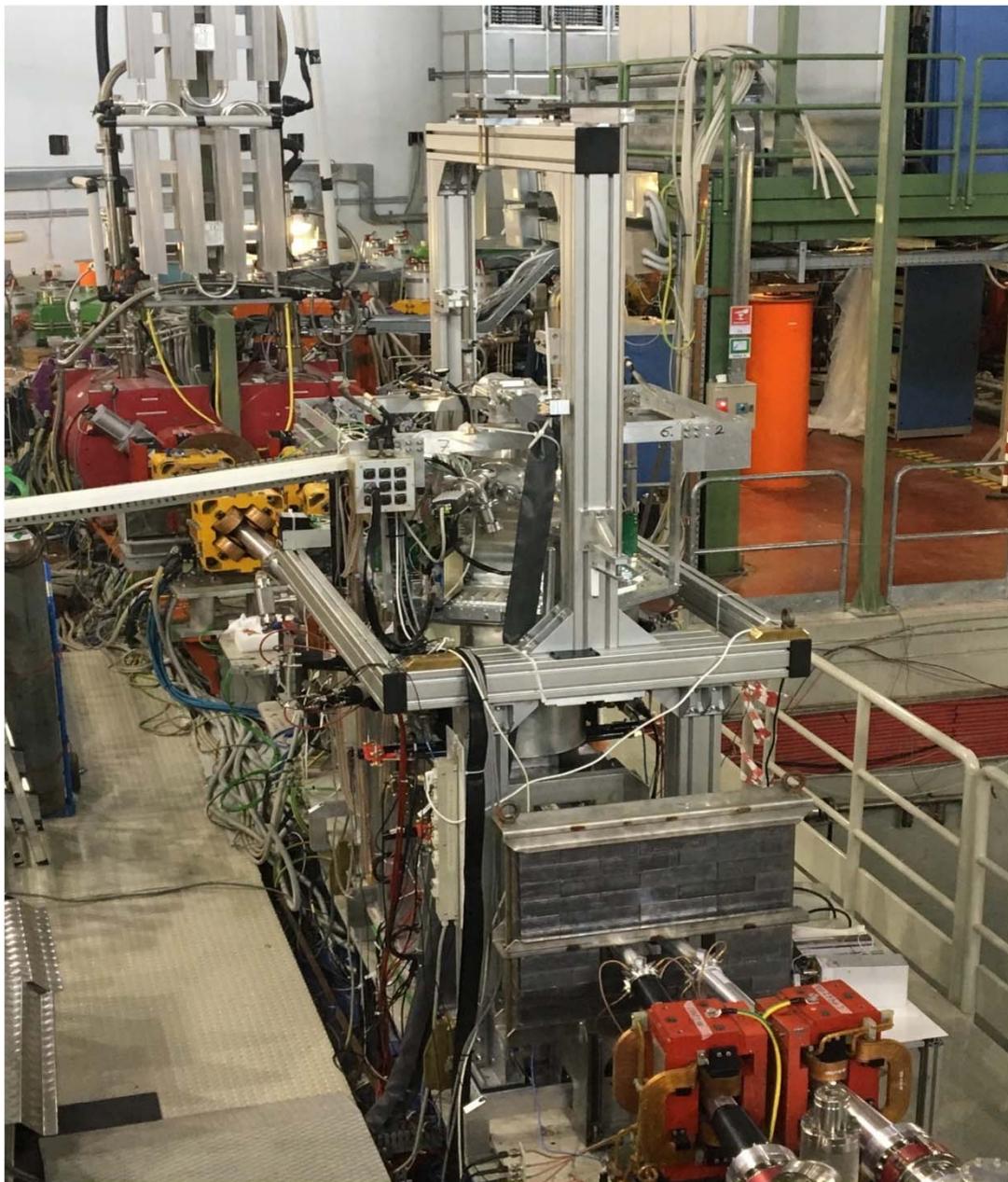


**Calibration target: Ti, Cu,  
Au (small disc)**

# *SIDDHARTINO apparatus constraints*



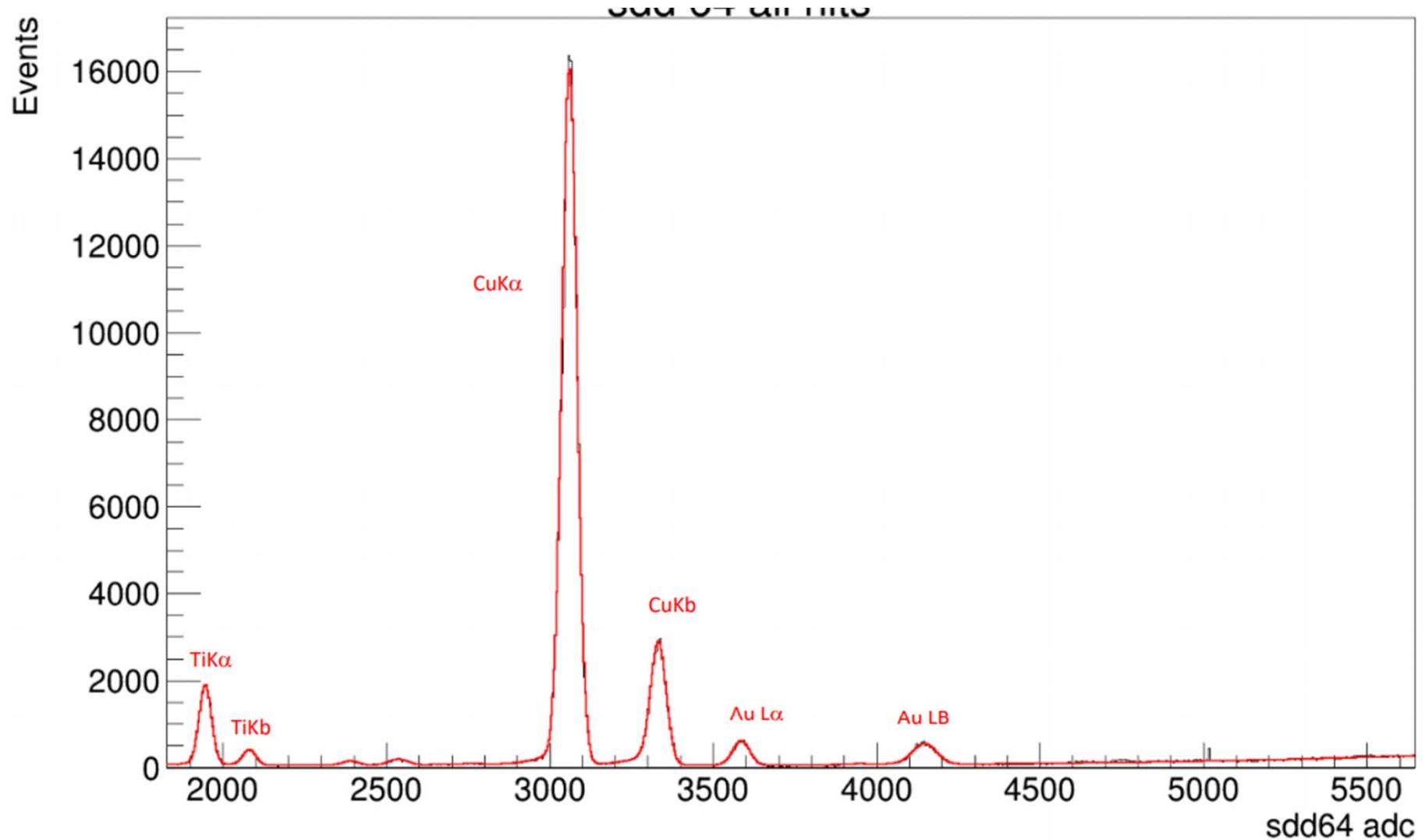
**Aim: verify when DAΦNE background conditions are similar  
to the one in SIDDHARTA 2009**



# *Commissioning of SDD's in DAΦNE*

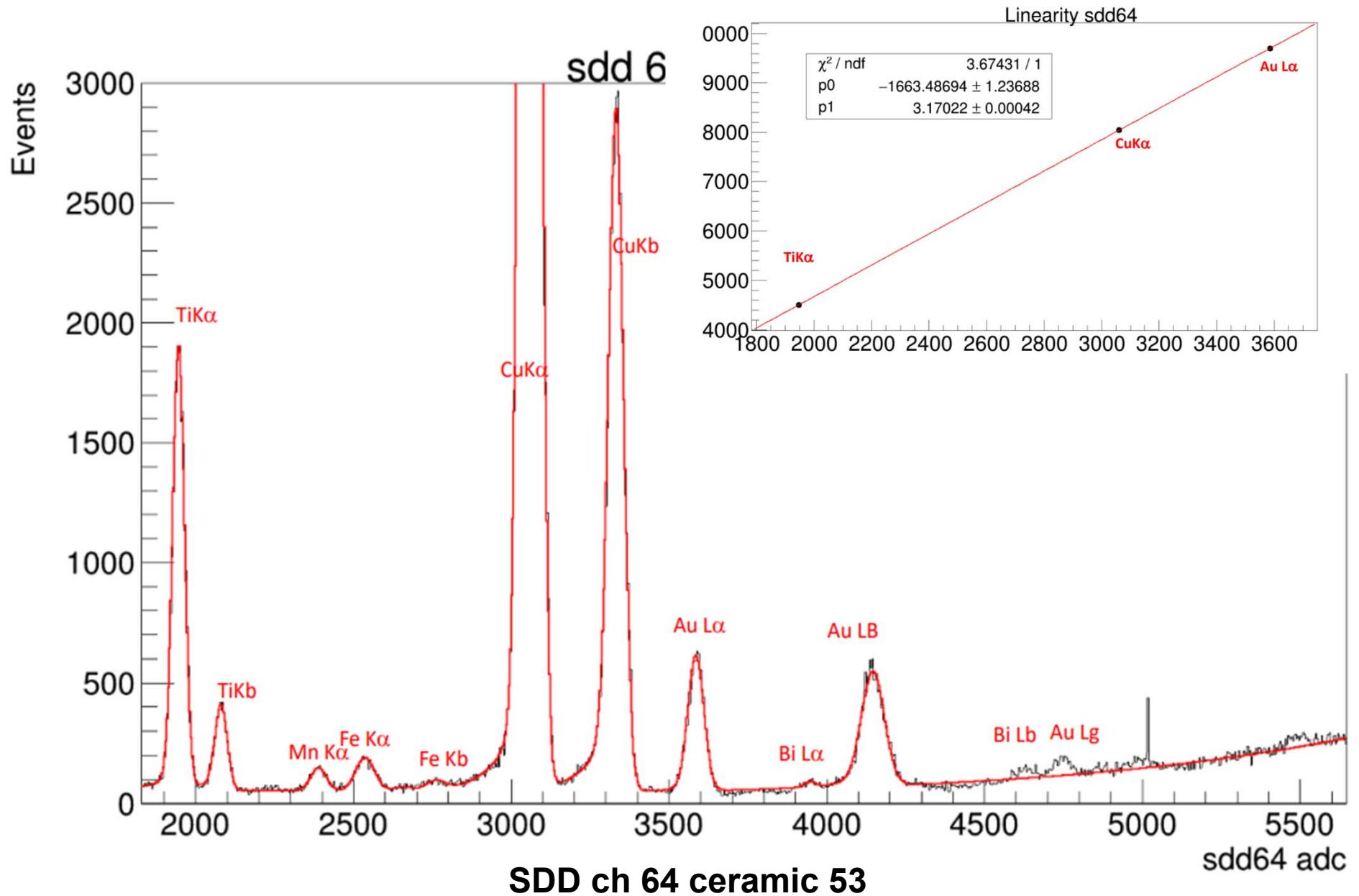
- *Test of the first signals in the accelerator environment*  
*front-end electronics (SFERA) - SDD coupling noise test*  
*EMI/RFI filters on power lines*
- *Tuning of the power supply parameters*
- *Calibration with the x-ray tube*

# *Calibration of SDD's in DA $\phi$ NE*



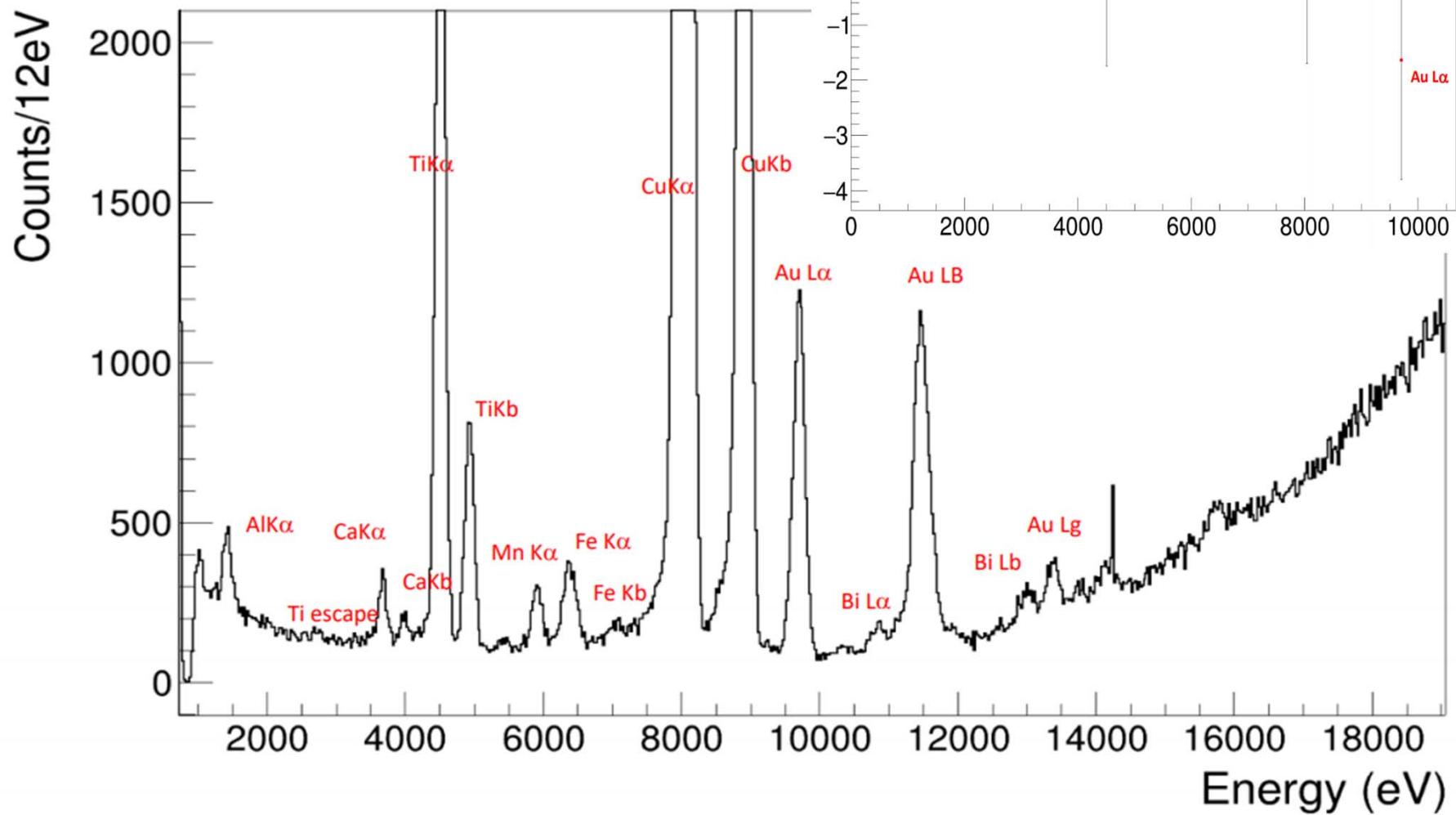
*Typical SDD spectrum from calibration with the x-ray tube*

# *Calibration of SDD's in DA $\phi$ NE*

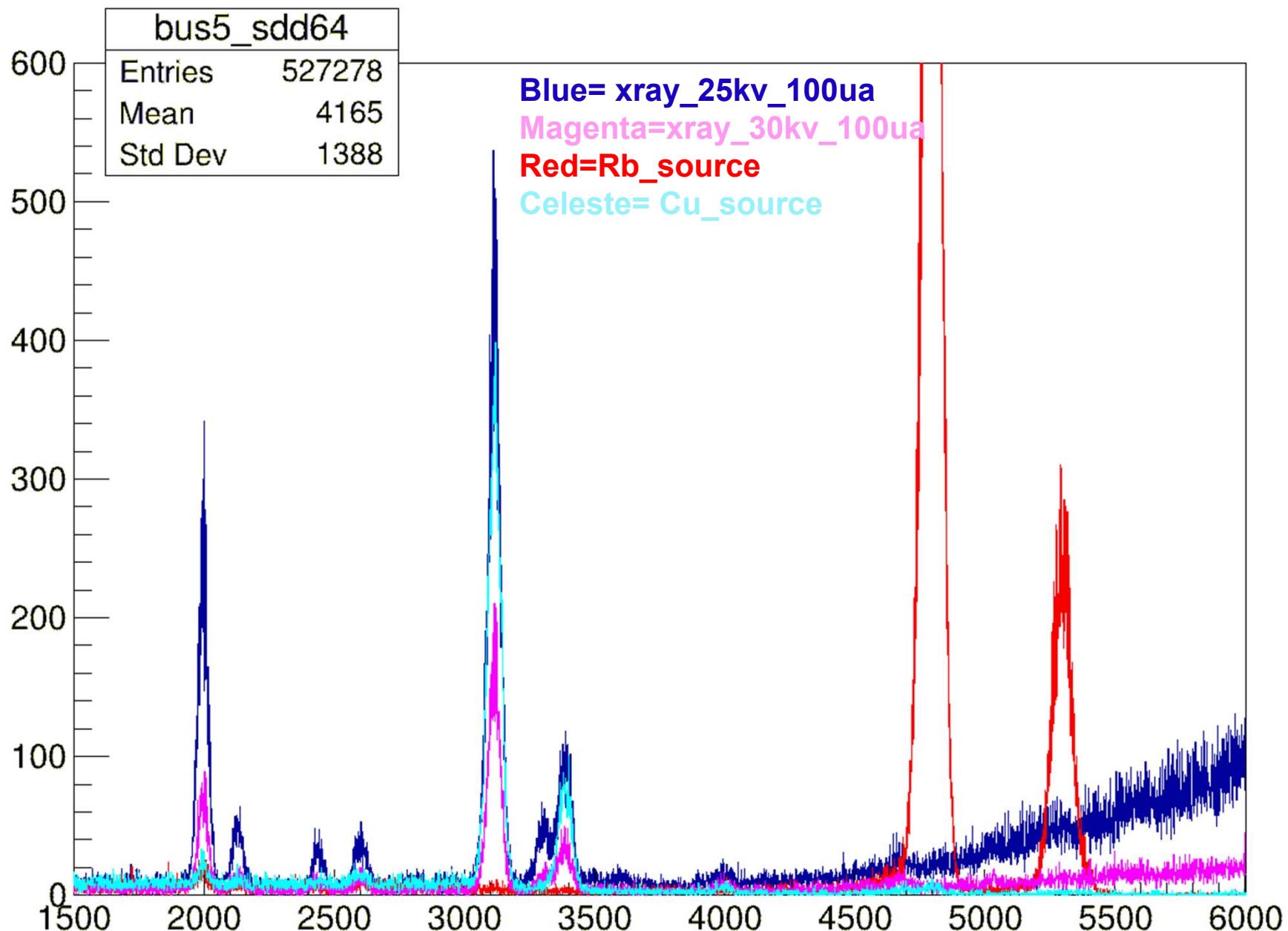


# *Calibration of SDD's in DA $\phi$ NE*

**Calibrated spectra**  
**SDD ch 64 ceramic 53**



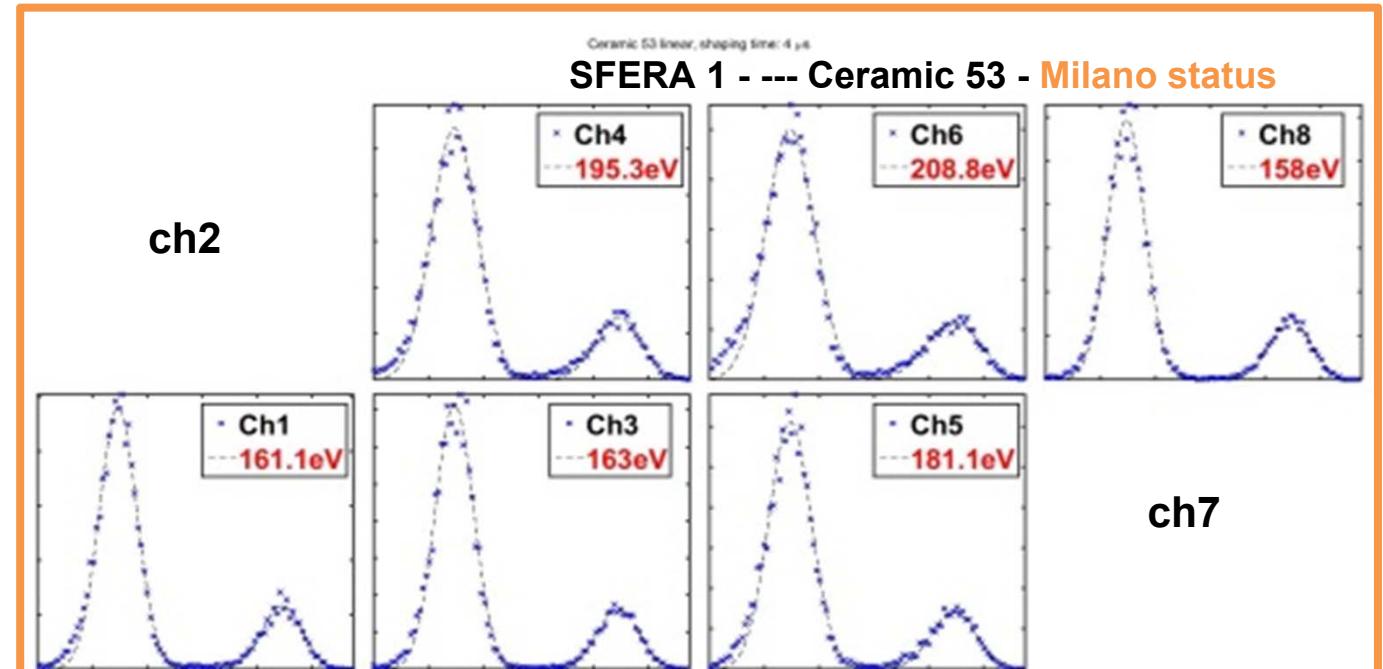
# *Calibration of SDD's in DA $\phi$ NE*



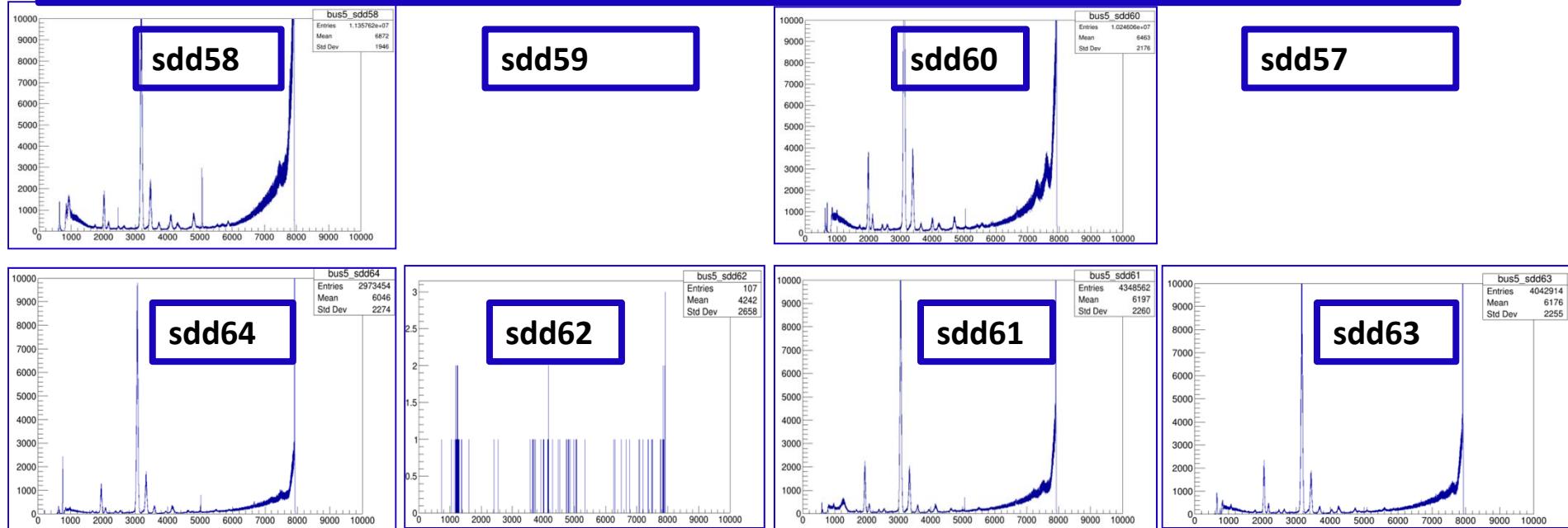
# Optimization of SDD's

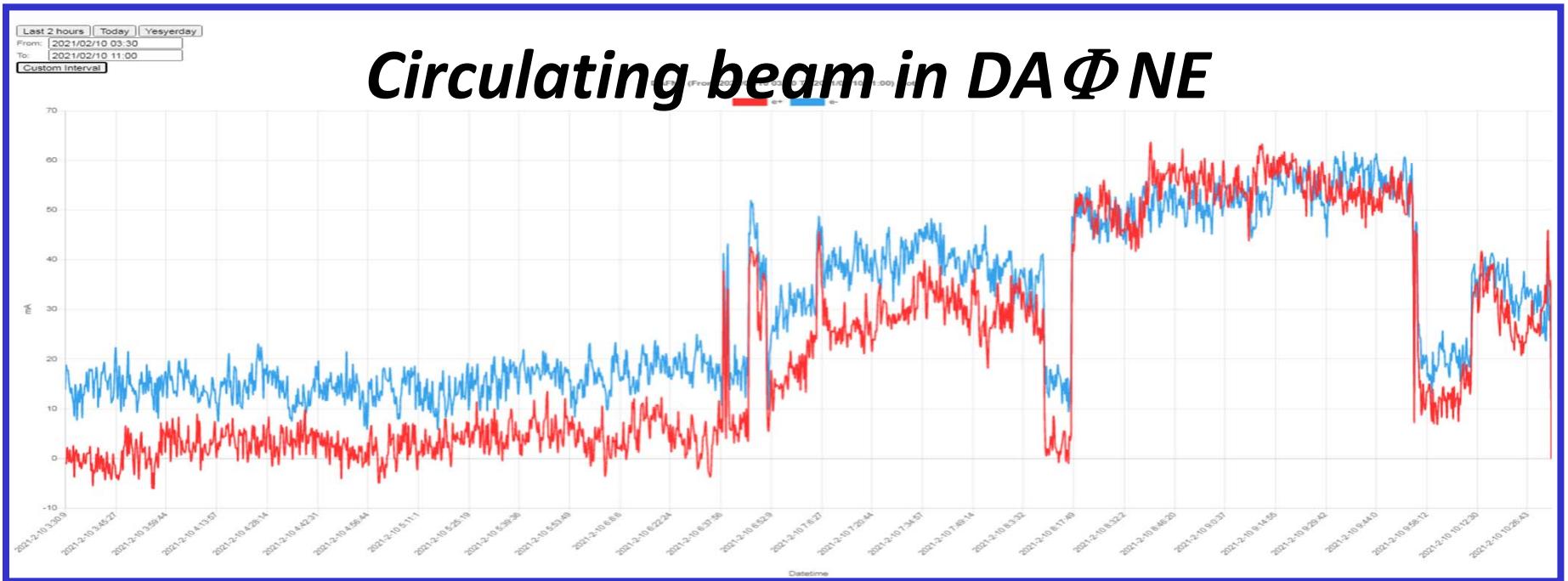
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CH 52	<input type="checkbox"/>	CH 60	<input checked="" type="checkbox"/>
CH 53	<input type="checkbox"/>	CH 61	<input checked="" type="checkbox"/>
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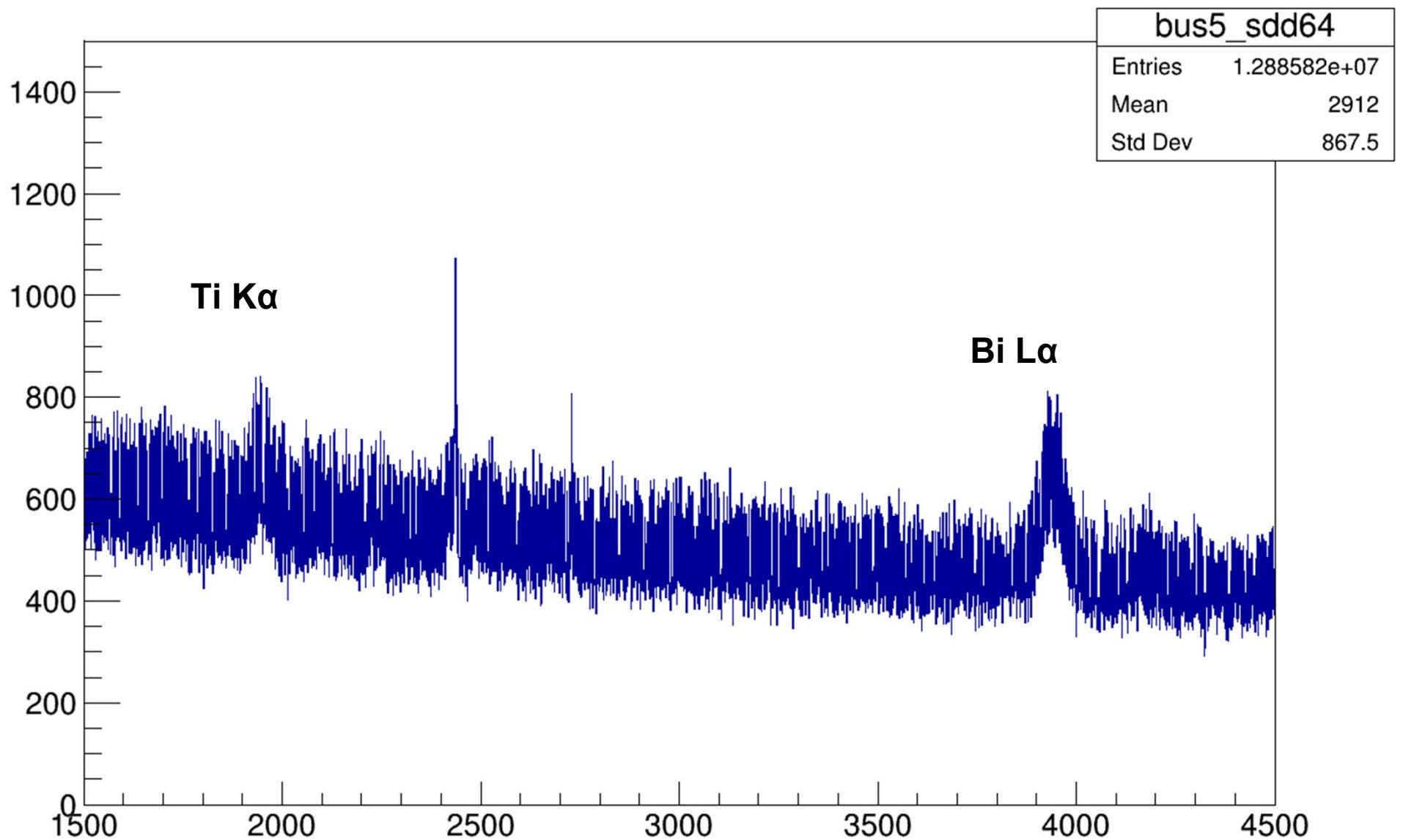


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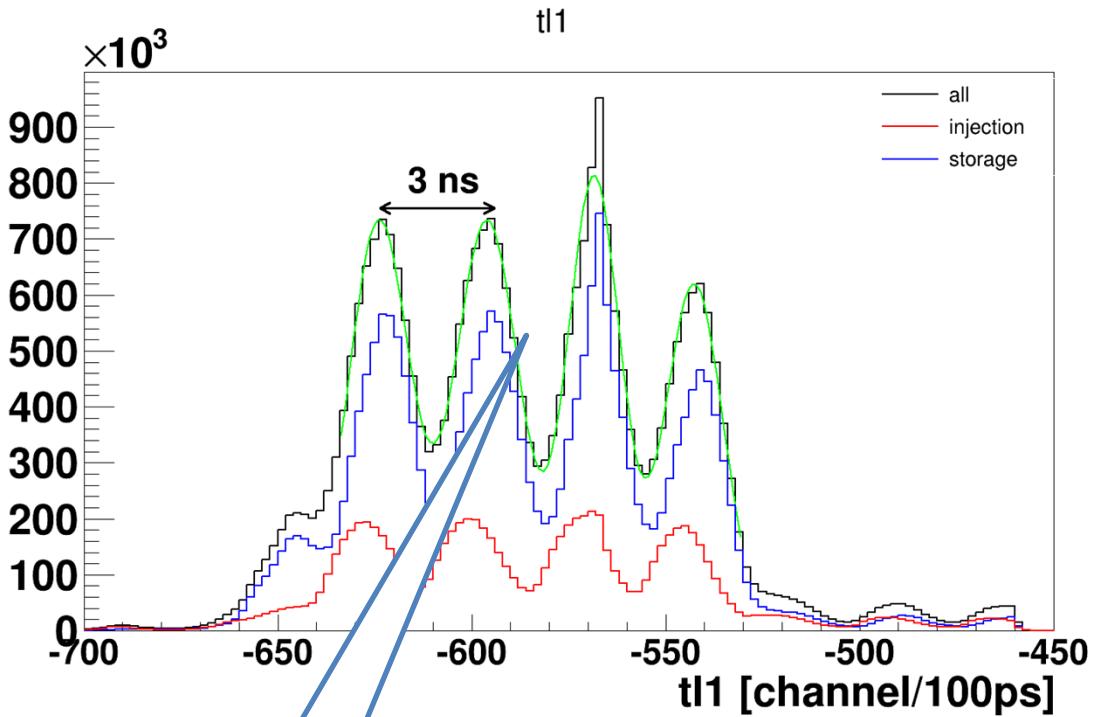


## *Online monitoring with beams*



# *SIDDHARTA-2 Luminosity monitor*

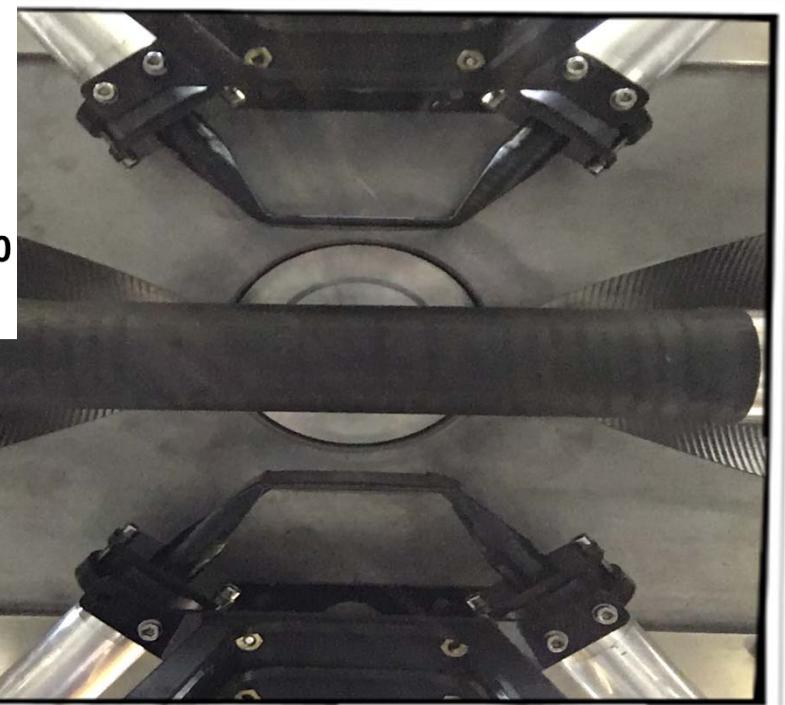
## *luminosity monitors crosscheck*



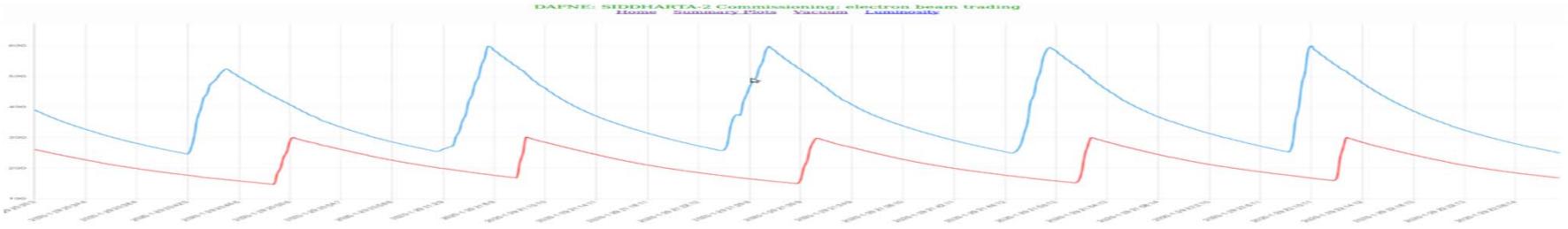
RF/4 structures

Luminosity  $\sim 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$   
Expected rate  $\sim 50\text{-}60 \text{ Hz}$

- 2 pairs of scintillator:  $80 \times 40 \times 2 \text{ mm}^3$   
Scionix EJ-200
- R4998 PMTs Hamamatsu
- light-guides
- aluminum tube +  $\mu$ Metal (0.1mm)
- reflective and light proof foil
- optical cement

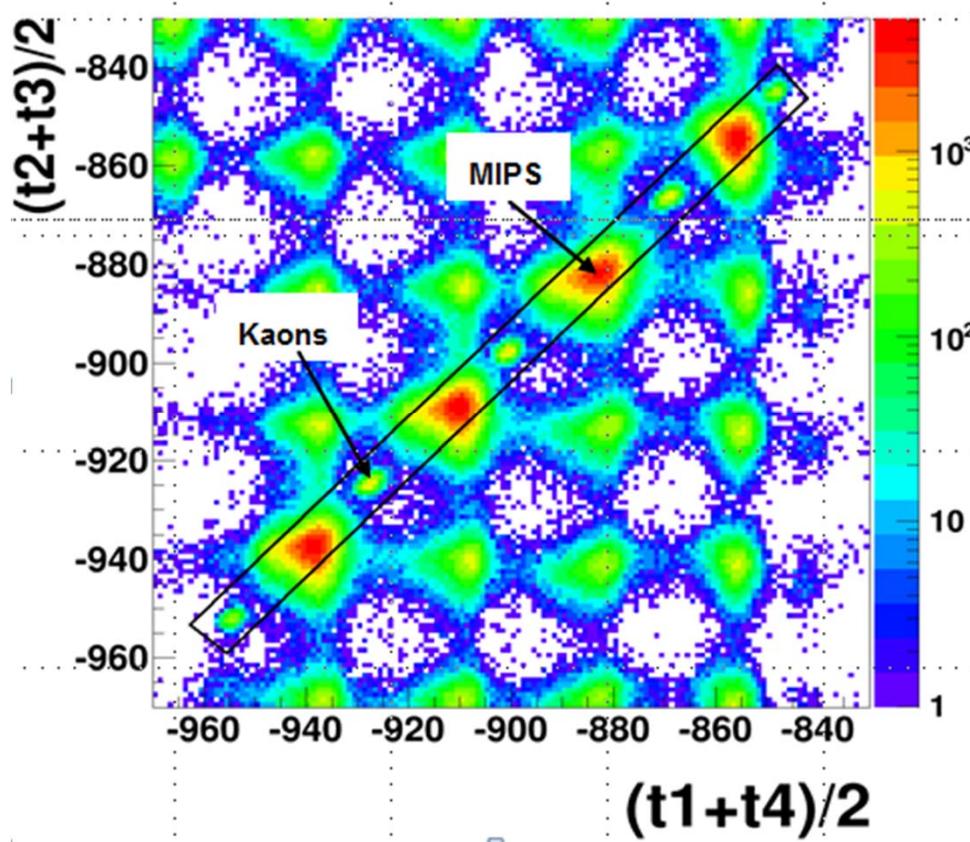


SIDDHARTA-2 Interaction regions



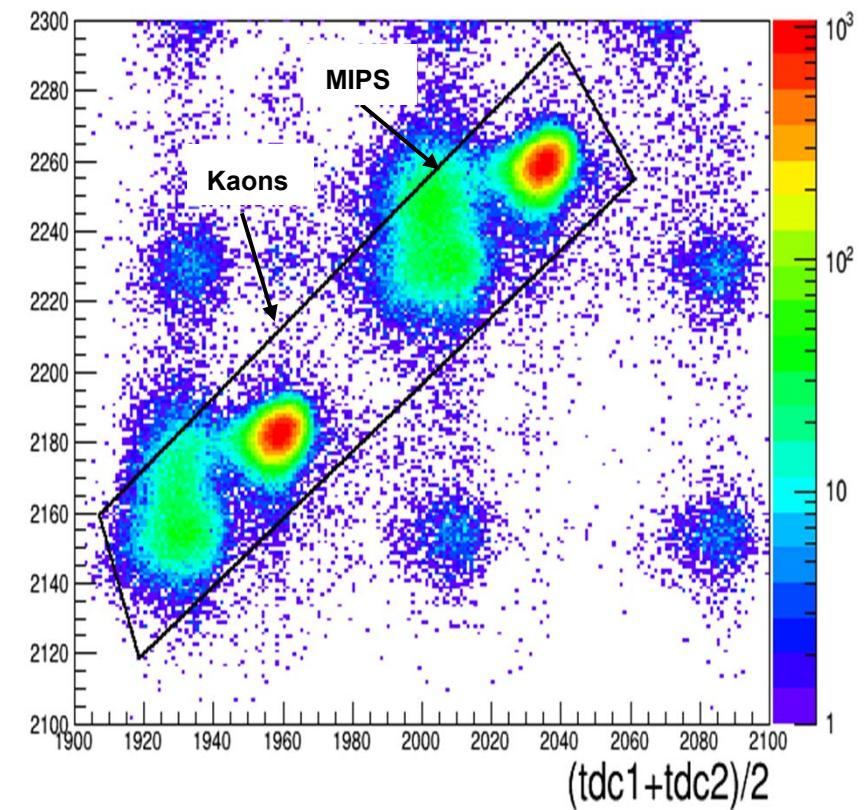
## Luminometer

- $L = 7.2 \text{ cm}$  from the IP  
in horizontal plane
- $\epsilon = 5.79 \pm 0.04 \%$

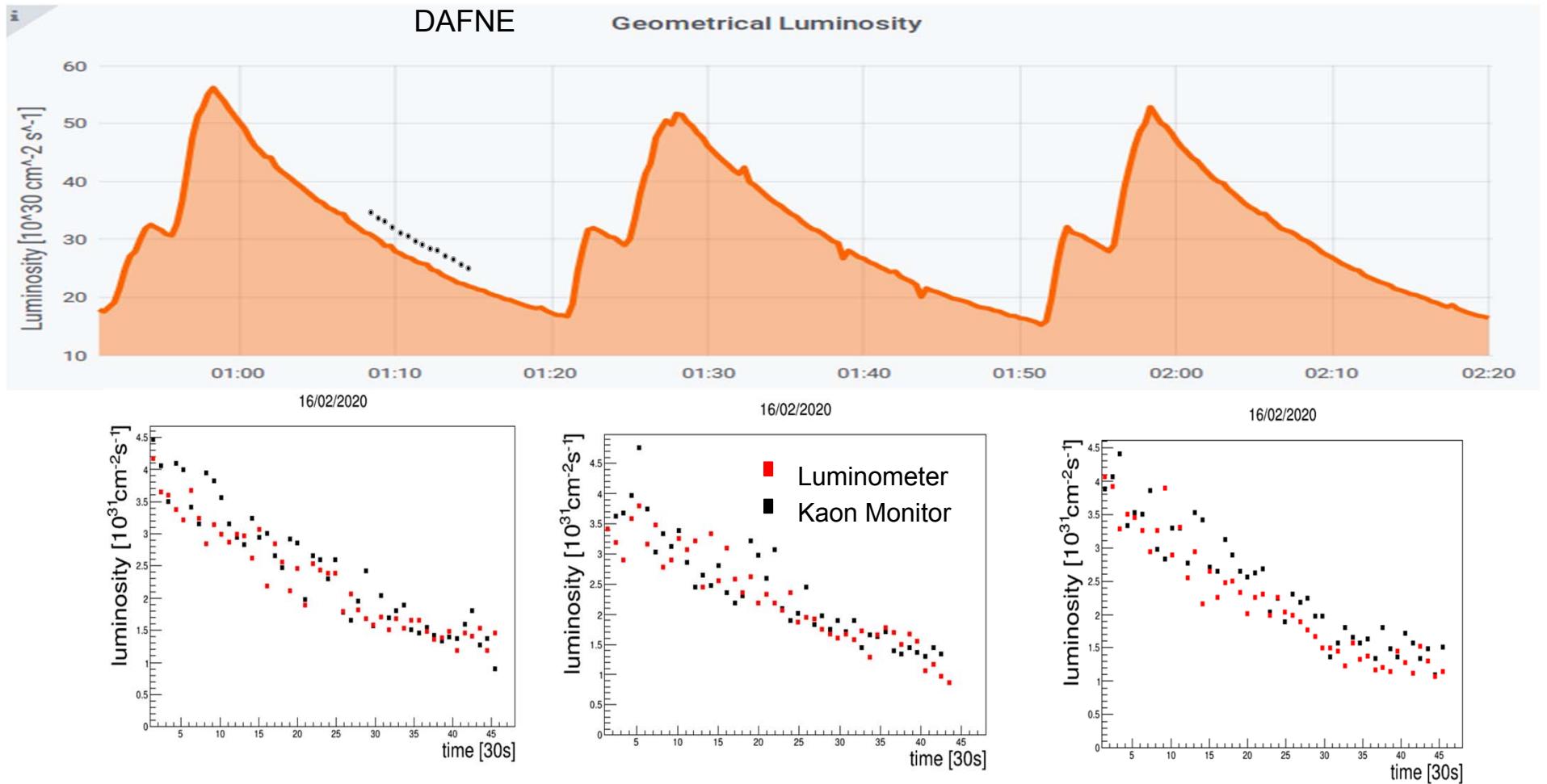


## Kaon Trigger

- $L = 11.0 \text{ cm}$  from the IP  
in vertical plane
- $\epsilon = 4.82 \pm 0.03\%$



*DAΦNE luminometer: not yet optimized*  
*DAΦNE: only upper limit on geometric luminosity*

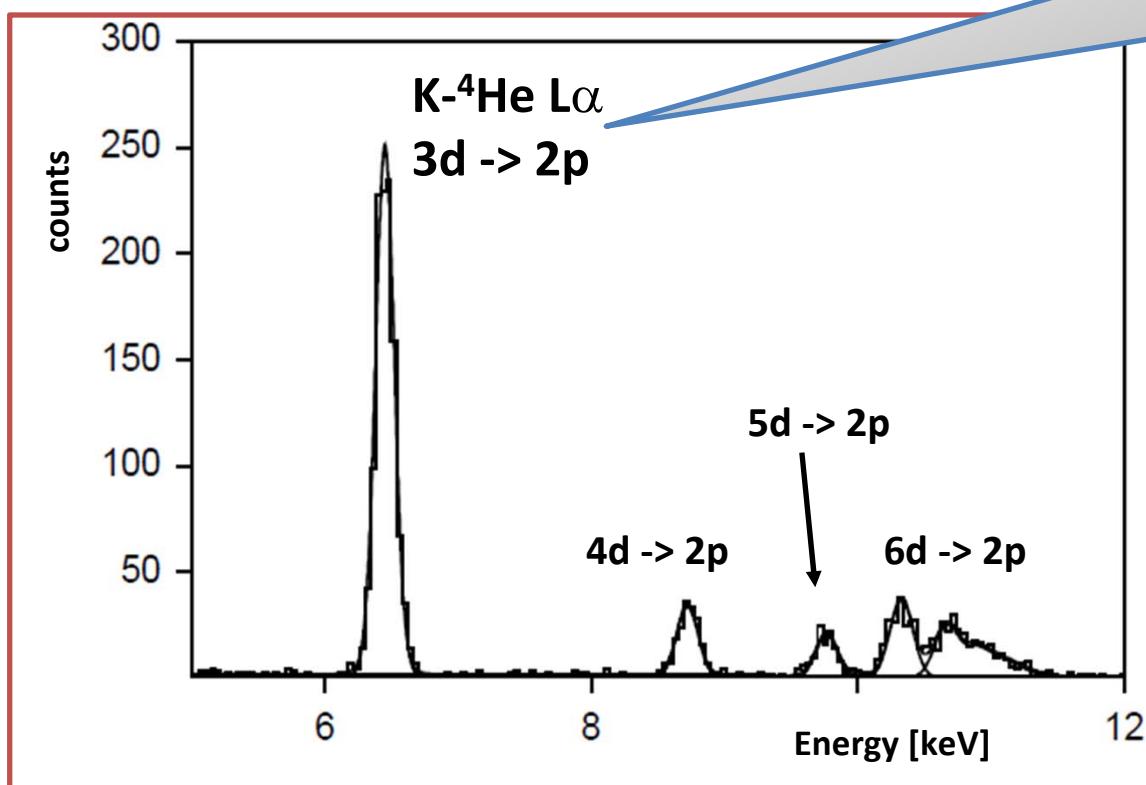


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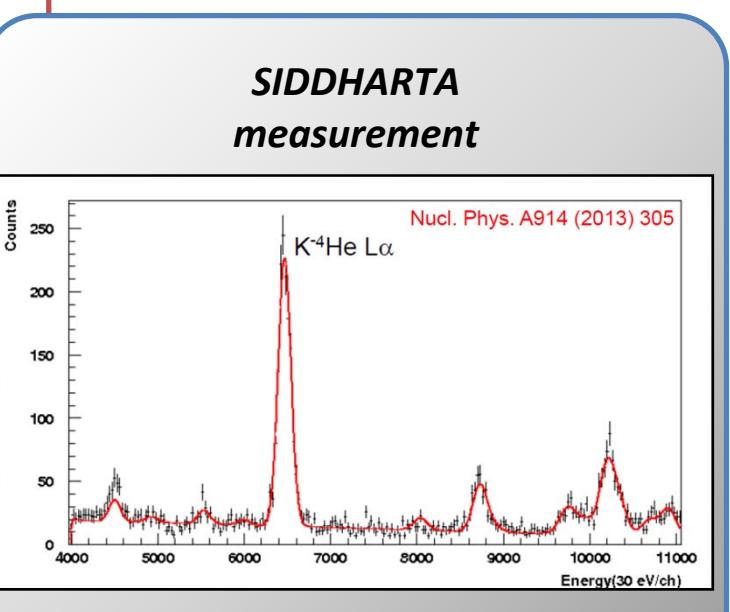
*luminosity monitors crosscheck will continue as soon the beam collisions restart*

# Phase1: SIDDHARTINO – $K^-{}^4He$ test measurement

SIDDHARTINO expected spectrum for  $\sim 50 \text{ pb}^{-1}$   
(one week of data taking in  
SIDDHARTA-like conditions)



About 1000 events in  $L\alpha$  peak,  $S/B > 100/1$   
(ideally should be 300/1)  
Position precision :  
 $6.452 \pm 0.002 \text{ (stat) keV}$



S/B was 10/1 for the  $K^-{}^4He$  measurement with  $\sim 30 \text{ pb}^{-1}$

# *SIDDHARTA-2 strategy and future plans*



during the **commissioning** of DAΦNE  
Run with SIDDHARTINO for: optimization of run  
conditions verified with the  
**measurement of K-<sup>4</sup>He** (only with 8 SDD arrays)  
(**S/B** on K-<sup>4</sup>He better than **100/1**)



**we will install all the SDDs** (48 SDD arrays)  
and start the ***kaonic deuterium measurement***  
for a run of **800 pb<sup>-1</sup>**

Action plan for Kd measurement:

- **First run** until with SIDDHARTA-2 setup as existent  
(about 300 pb<sup>-1</sup> integrated);
- **Second run** with a new veto2 second layer  
optimized shielding, readout electronics and other  
optimizations (for other 500 pb<sup>-1</sup> integrated);

**Test runs for other kaonic atoms measurements**

# Phase2: SIDDHARTA-2 K-d measurement

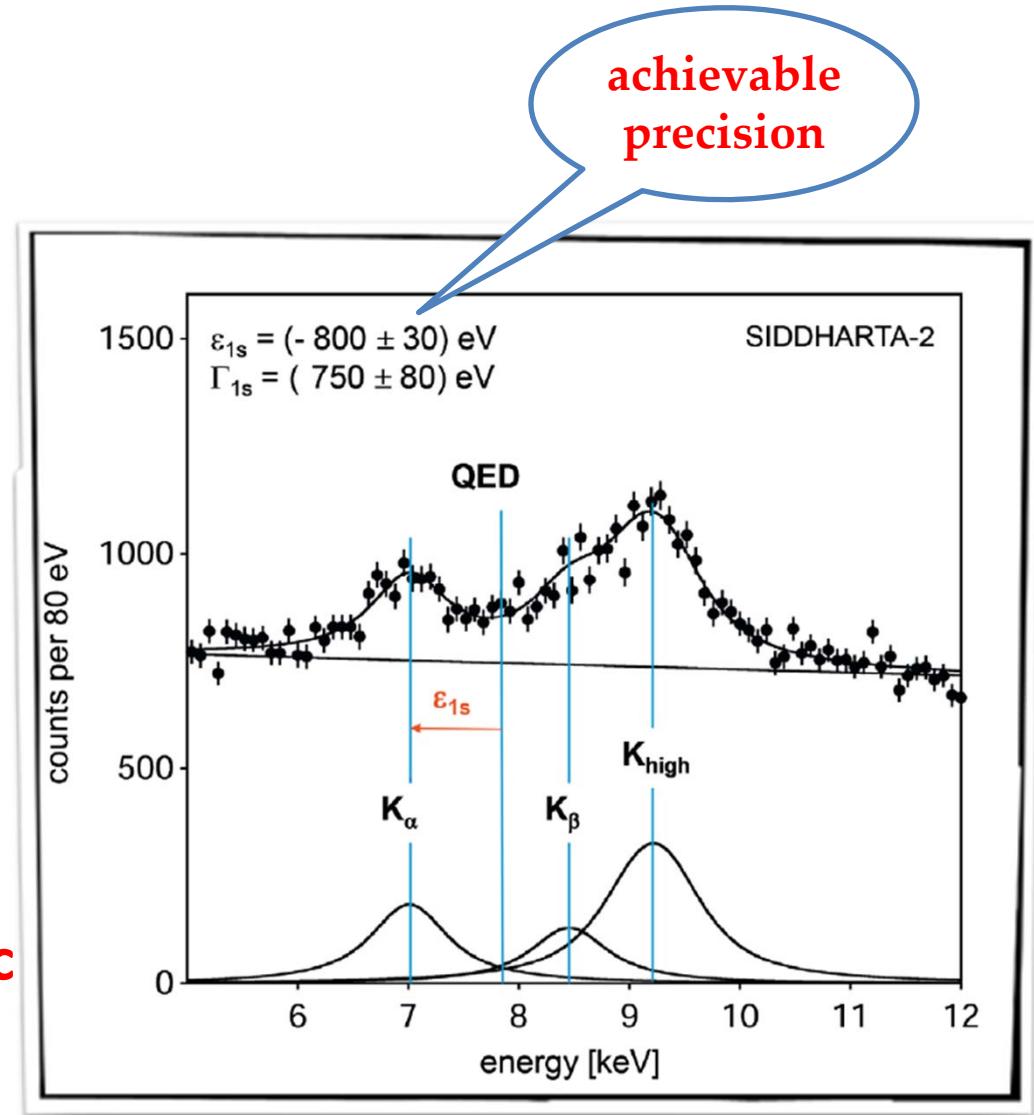
Kaonic deuterium run in

2021/2022

for S/B as 1/3:

for an integrated luminosity  
of  $800 \text{ pb}^{-1}$

to perform the first  
measurement of the strong  
interaction induced energy  
shift and width of the kaonic  
deuterium ground state  
(similar precision as K-p) !



## *Ongoing with Phase1*

- 1) *Work with SIDDHARTINO inside DAFNE – optimization veto, trigger, DAQ, calibration, ....*
- 2) *Refine optimization of luminosity detector and cross check with DAFNE luminometer*
- 3) *Background reduction and optimization together with DAFNE for kaonic atoms measurements*
- 4) *K-<sup>4</sup>He test measurement with SIDDHARTINO -> background w.r.t. SIDDHARTA and SIDDHARTA-2 for K-d goal*
- 5) *HPGe test run in parallel with SIDDHARTINO (see A. Scordo talk)*

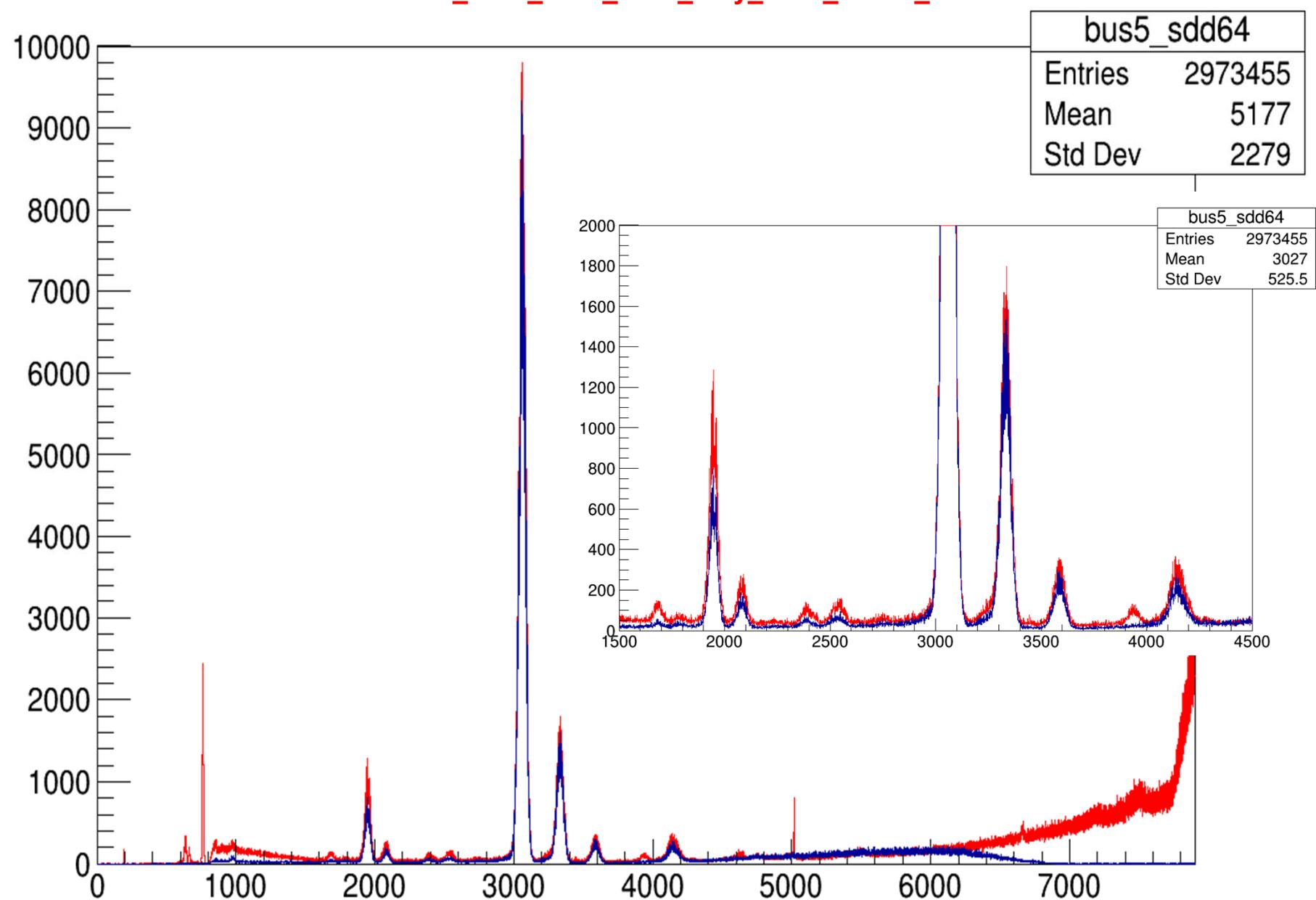


*Thank you!*

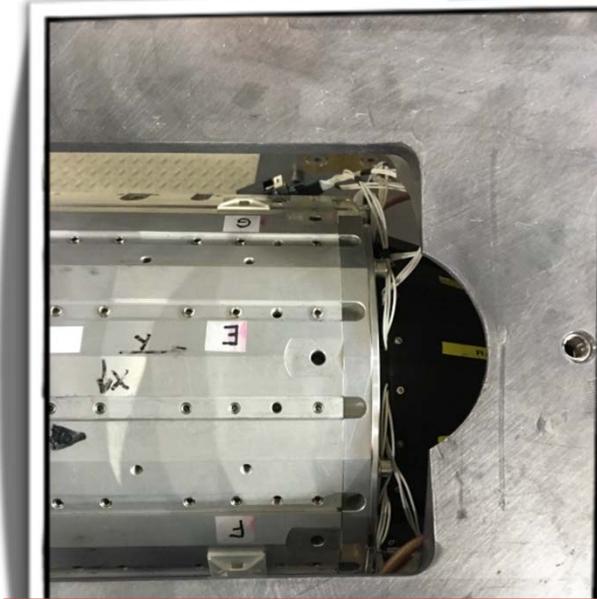
*... picture taken before COVID-19 restrictions ....*

# Spares

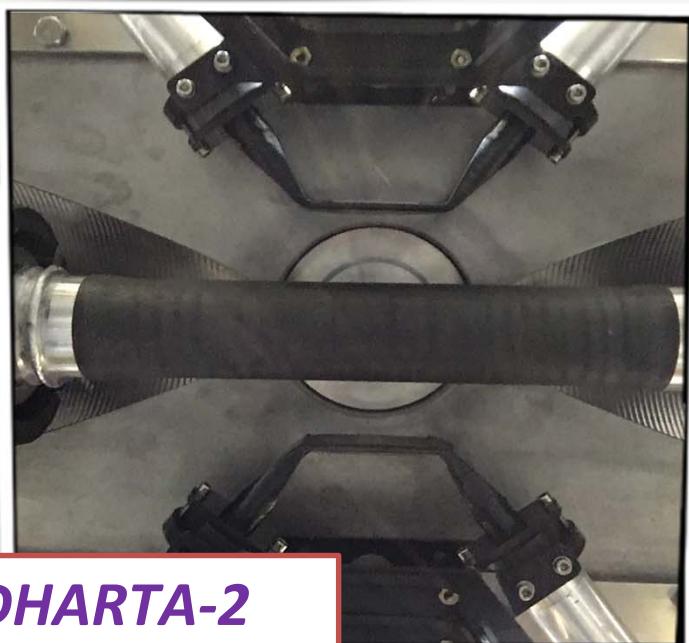
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*DAΦNE luminosity monitor*

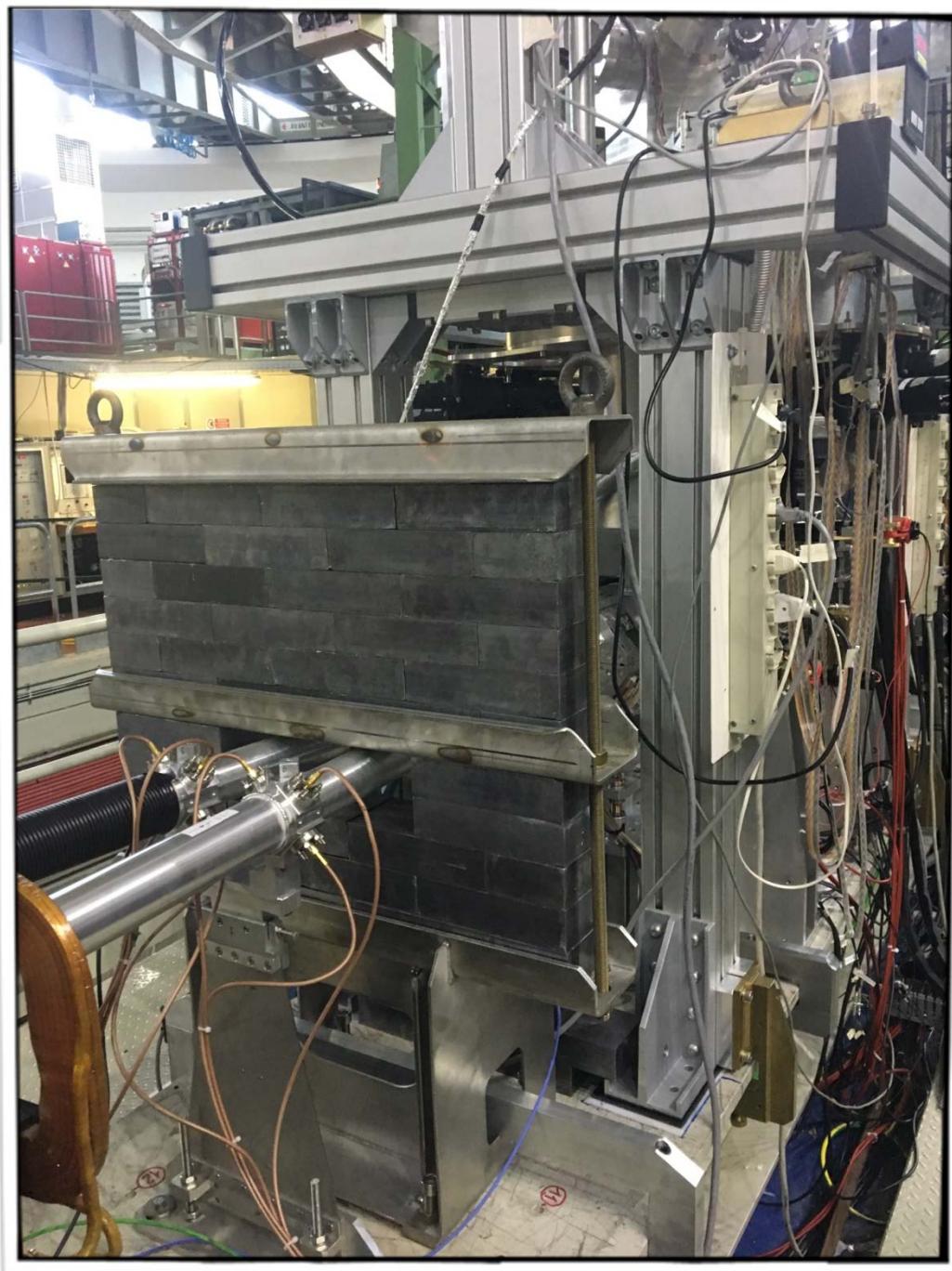


*Shielding optimization*



*SIDDHARTA-2  
luminosity monitor*

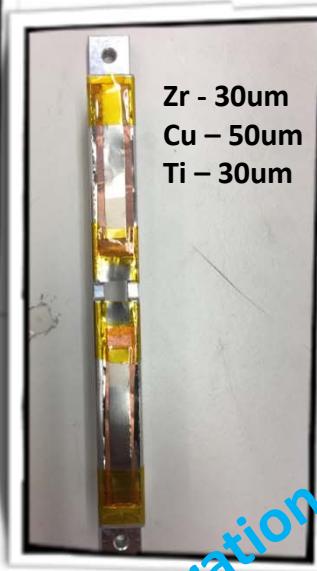
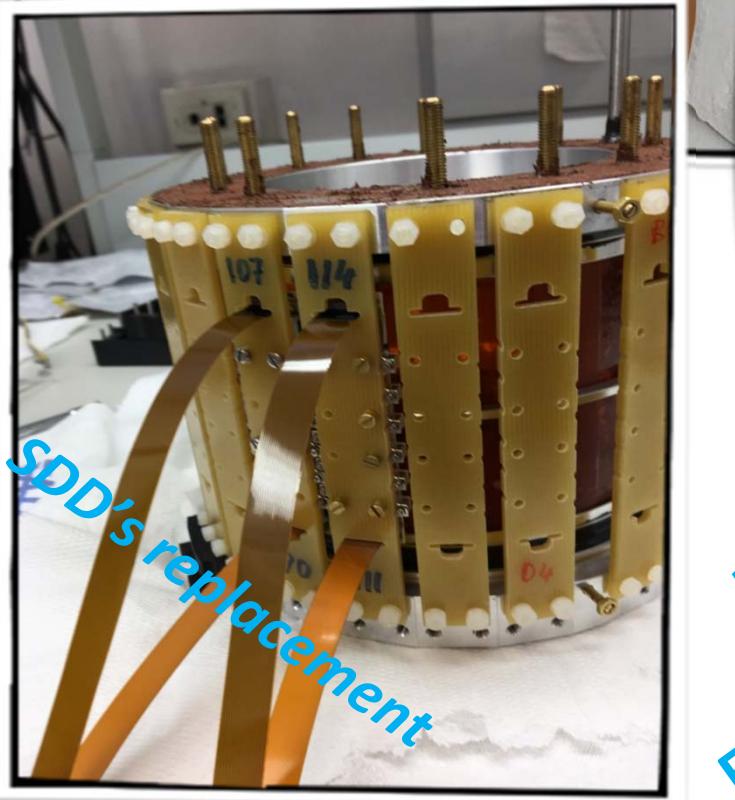




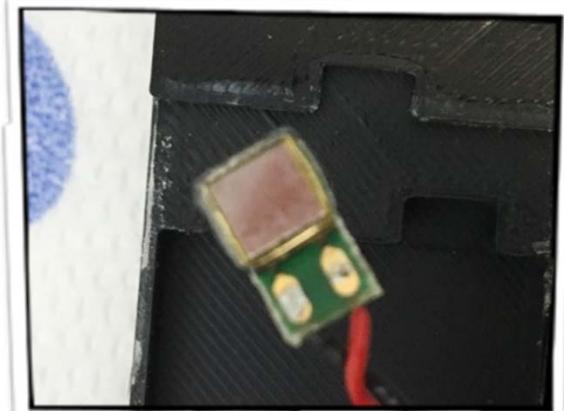
**SIDDHARTINO**  
*lateral shielding*  
***completed in summer  
shutdown period***



# *Summer shutdown work*

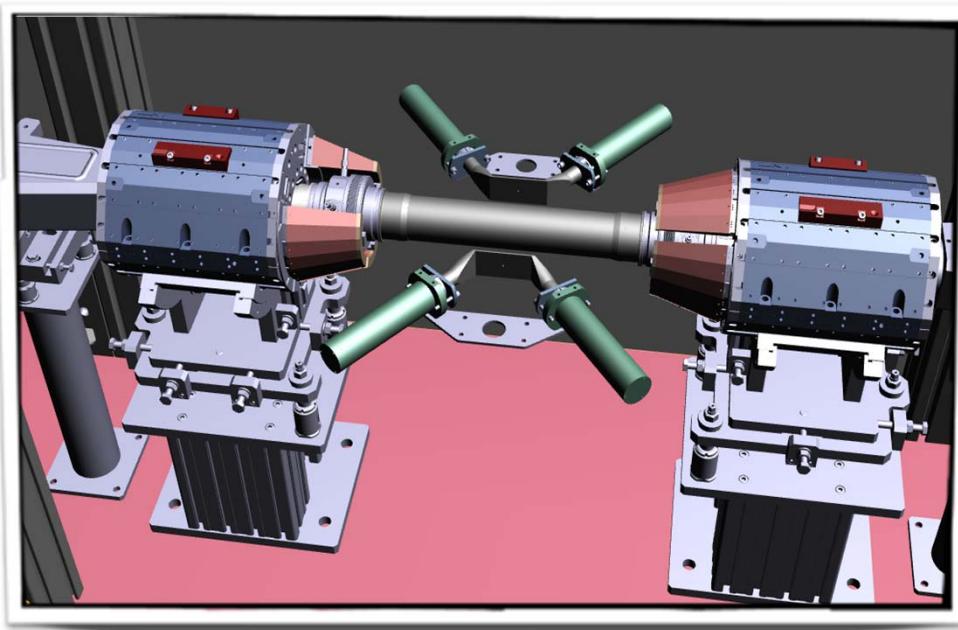


new calibration  
Materials  
Filters for the x-ray tubes



*SiPm from VETO-2  
replace after  
the “power glitch”*





# HPGe: kaonic lead for kaon mass

