The GigaTracKer, the silicon beam tracker for the NA62 experiment at CERN

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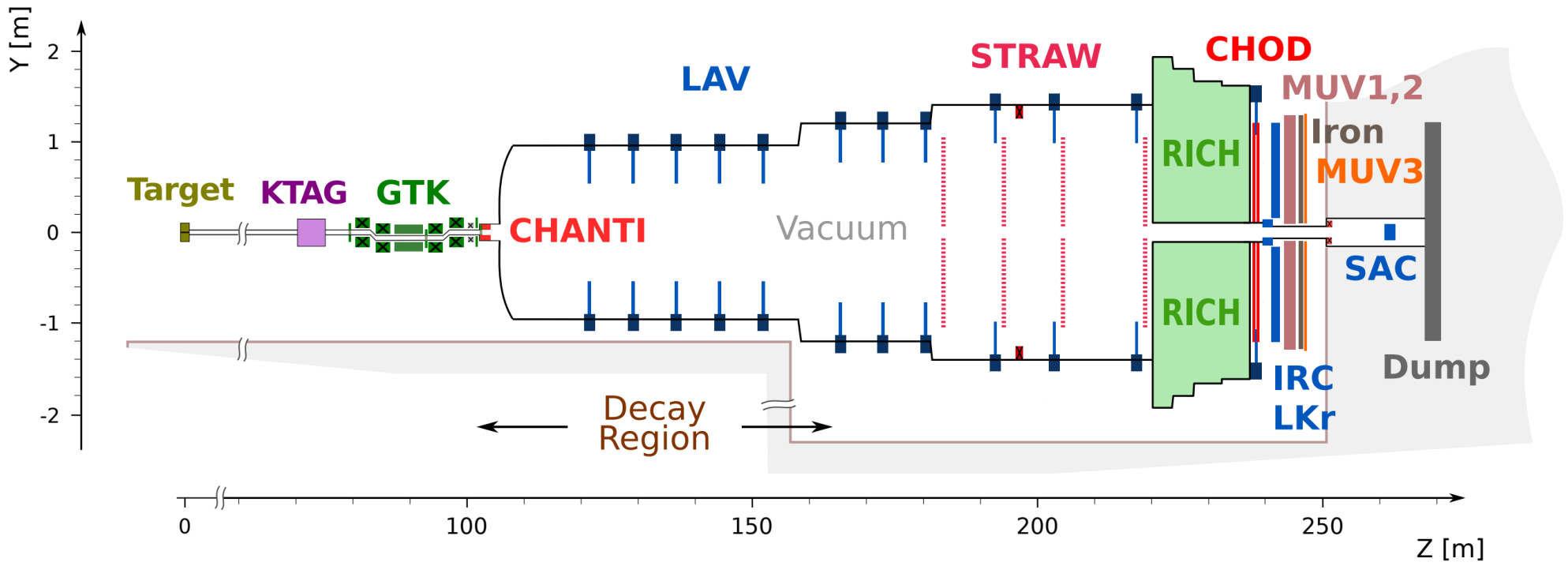
On behalf of the NA62 GigaTracKer group

Outline

- Introduction;
- Specifications;
- GTK description;
- GTK performances;
- NA62 data;
- Conclusions.

Introduction – The NA62 experiment



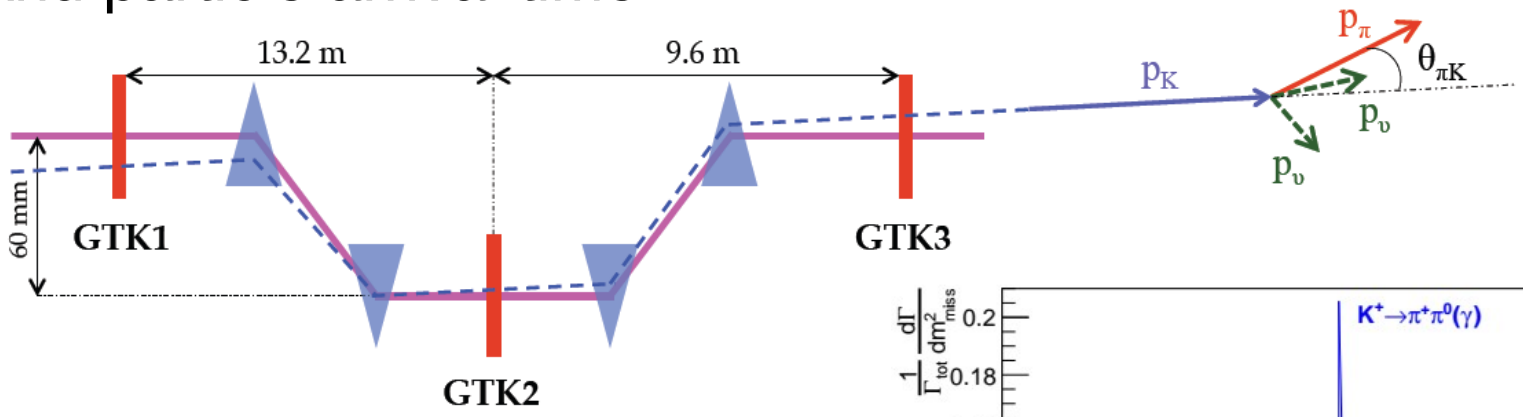
$B_{SM}(K^+ \rightarrow \pi^+ \nu \bar{\nu}) = (8.4 \pm 1) \times 10^{-11}$ Standard Model prediction

Goal → 10% precision in few years of data taking

p_{2nd} = 75 GeV @ 750 MHz $\pi^+(70\%)$, $p(23\%)$, $K^+(6\%)$

Specifications

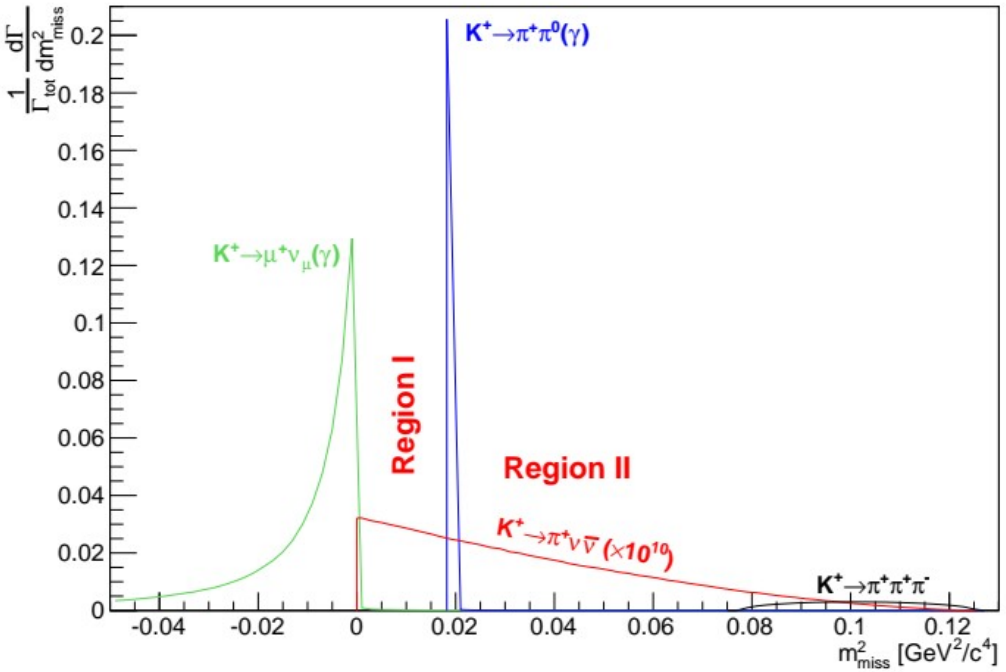
High precision measurement of:
- Direction (GTK1+ GTK3)
- Momentum (GTK1+GTK3+GTK2)
- And particle arrival time



Direction and momentum used to reconstruct the missing mass

$\theta_{x,y} = p_{x,y}/p_z = 16\mu rad$

$\delta p/p = 0.2\%$



Specifications

Min. inelastic scattering → max material budget = 0.5%X_0/station

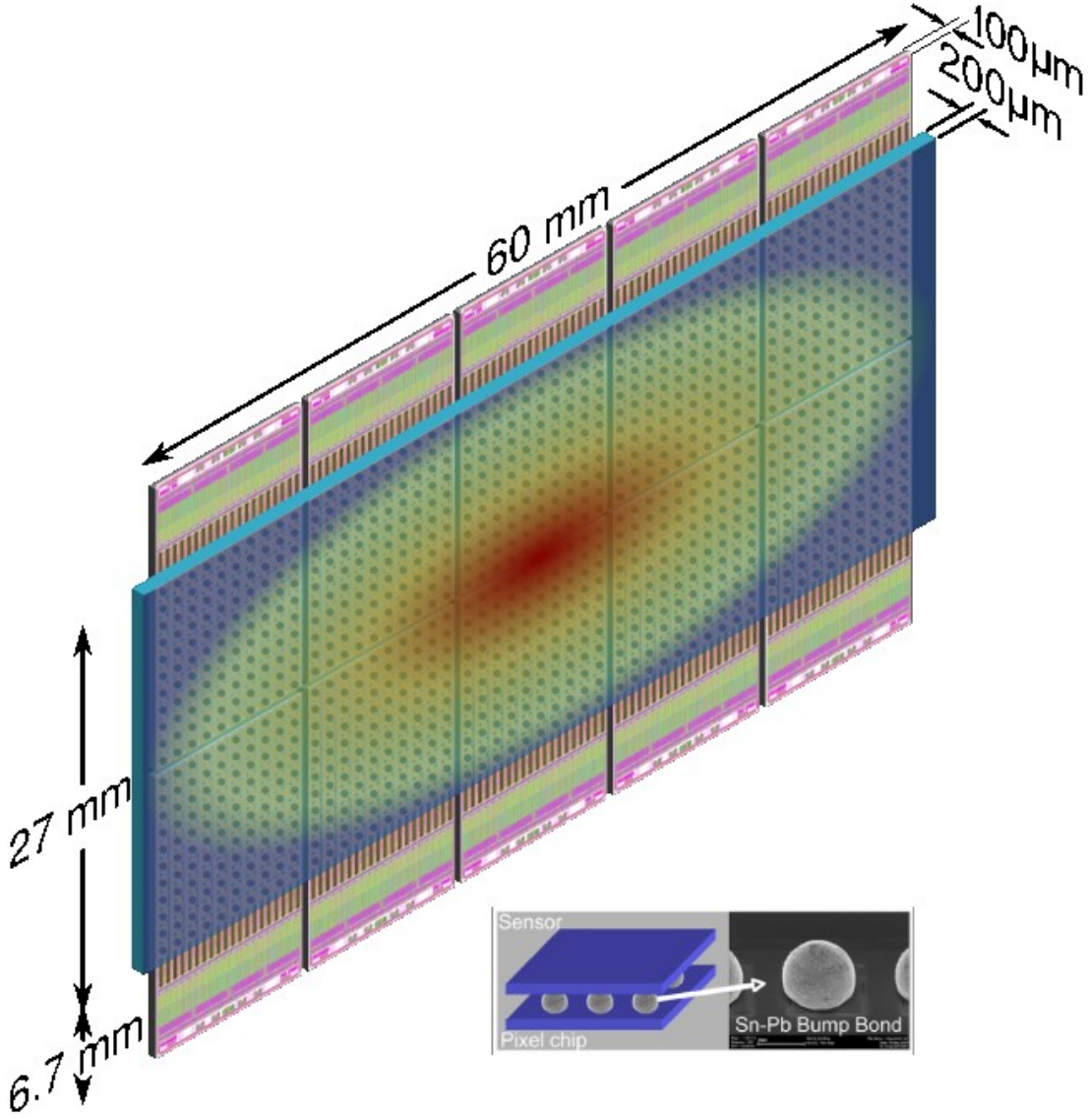
Particle tracks reconstruction → Pixel time-stamp resolution < 200ps

particle fluence at nominal intensity during 100 days:

2×10^{14} 1MeV n_{eq}/cm^2

Design of compact, standard modules to be rapidly replaced (within half a day) before significant performance degradation

the sensor



Sensitive region of 27 x 60 mm^2

n-in-p type

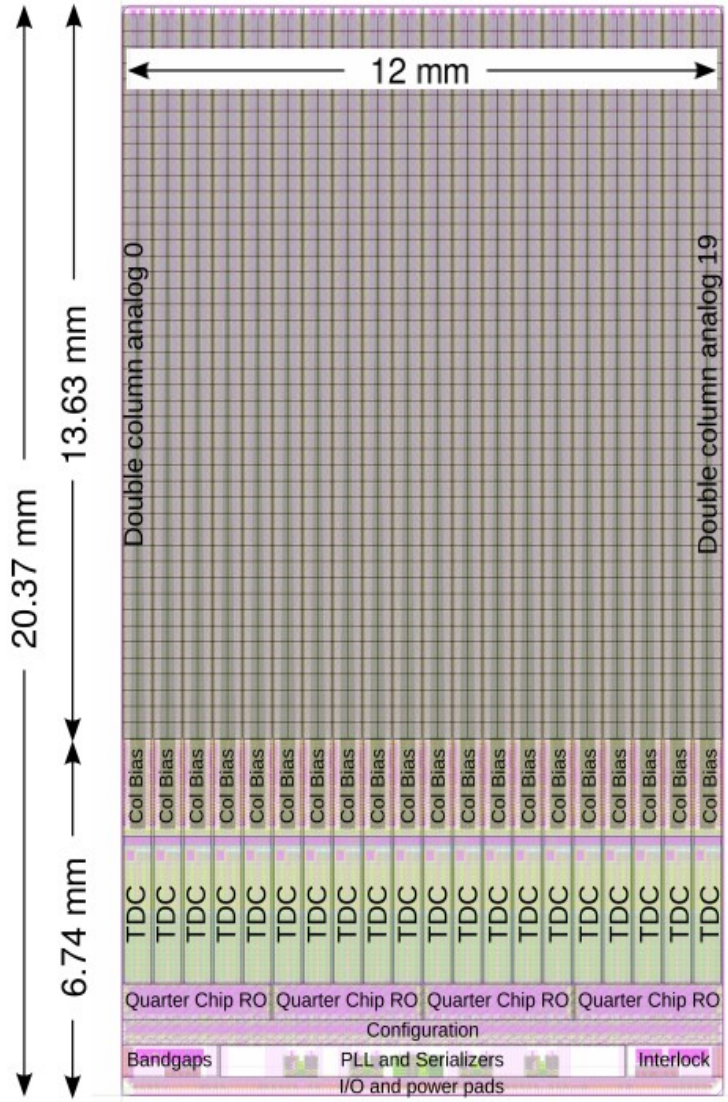
200 µm thick (0.2% X_0)

Bump bonded to 10 ROC

the TDCPix

- 130nm technology.
- 100 µm thick (0.1% X_0)
- Pixel size 300 x 300µm^2
- 1800 pixels
- amp. peak time = 5ns
- TDC bin size = 98ps
- SEU mitigation
- hit time-stamp and pixel address encoded into a 48bits word
- 4x3.2 GHz serializers

Power dissipation 4.1W



40x45
Pixel matrix

Hit digitization

EOC

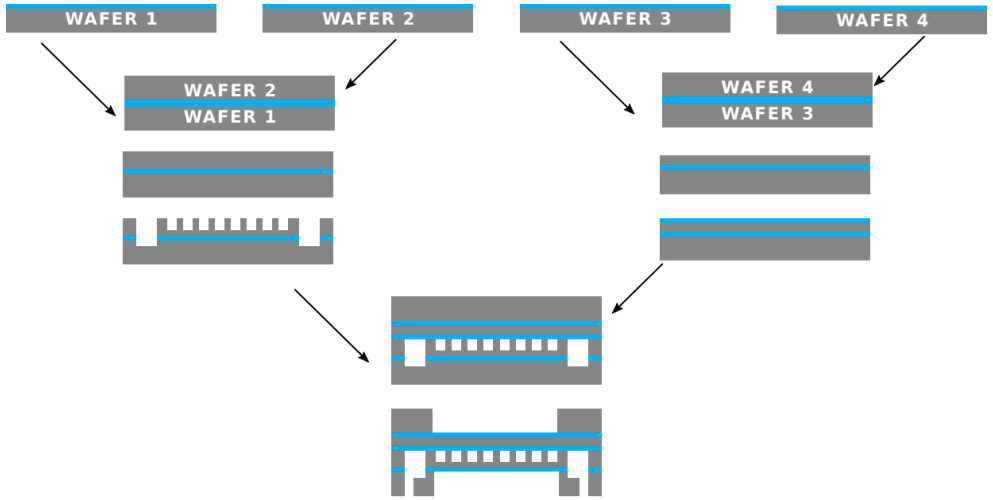
Timestamp

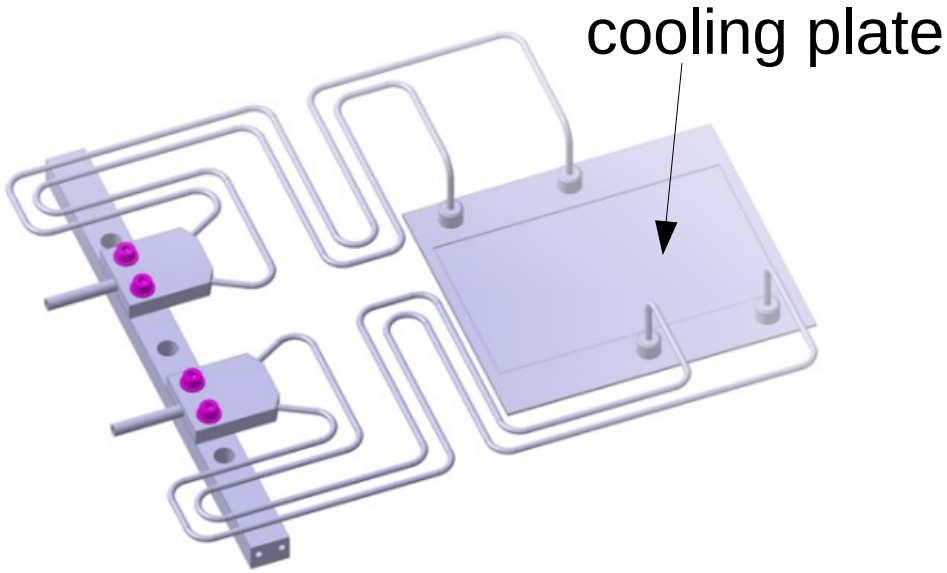
serialization

the micro-channels cooling plate

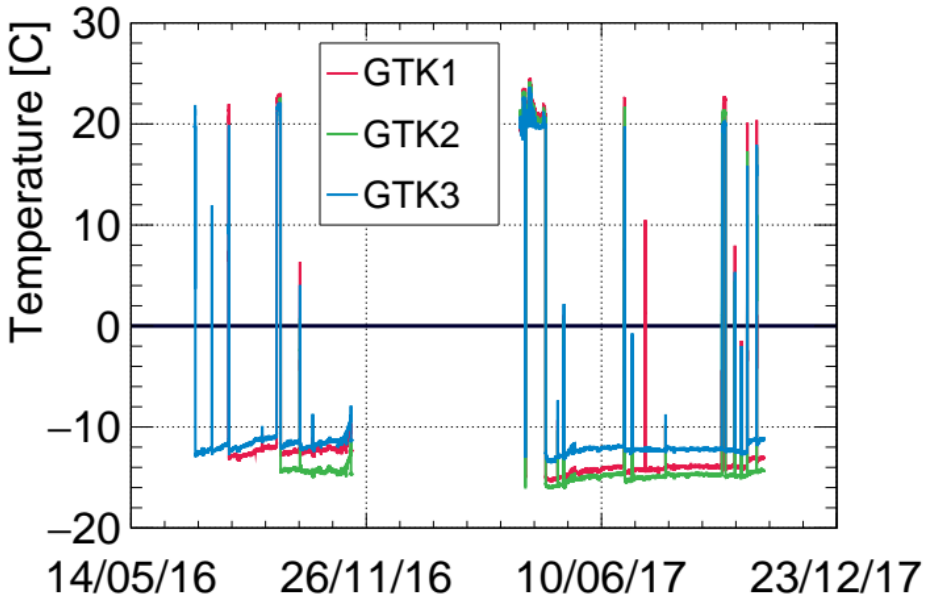
Detector in vacuum (~10^{-7} mbar)

- micro-channels technology
- 210 μm thick (0.2% X_0)
- 70 x 80 mm^2
- liquid coolant C_6F_{14}
- front-end electronics and sensor at -10°C



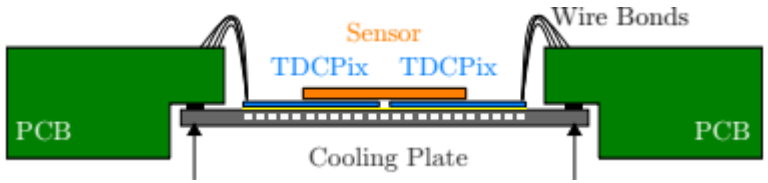


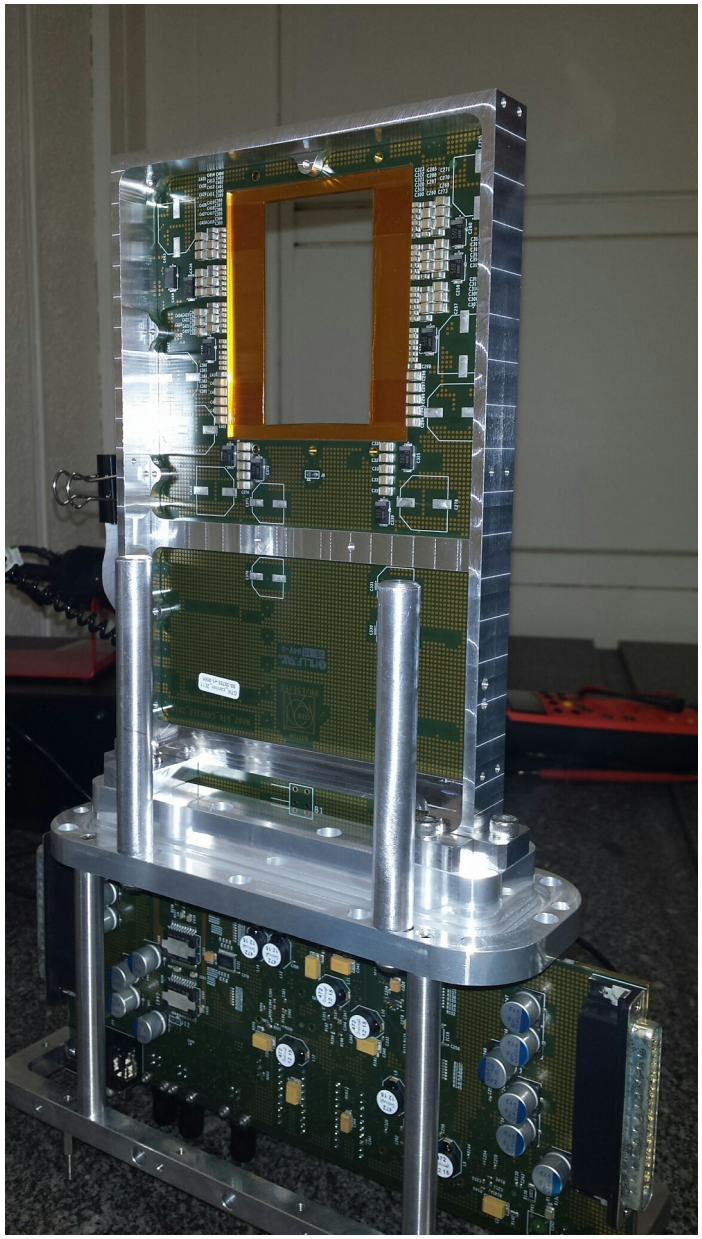
See A. Mapelli talk on Wednesday 20



The carrier board

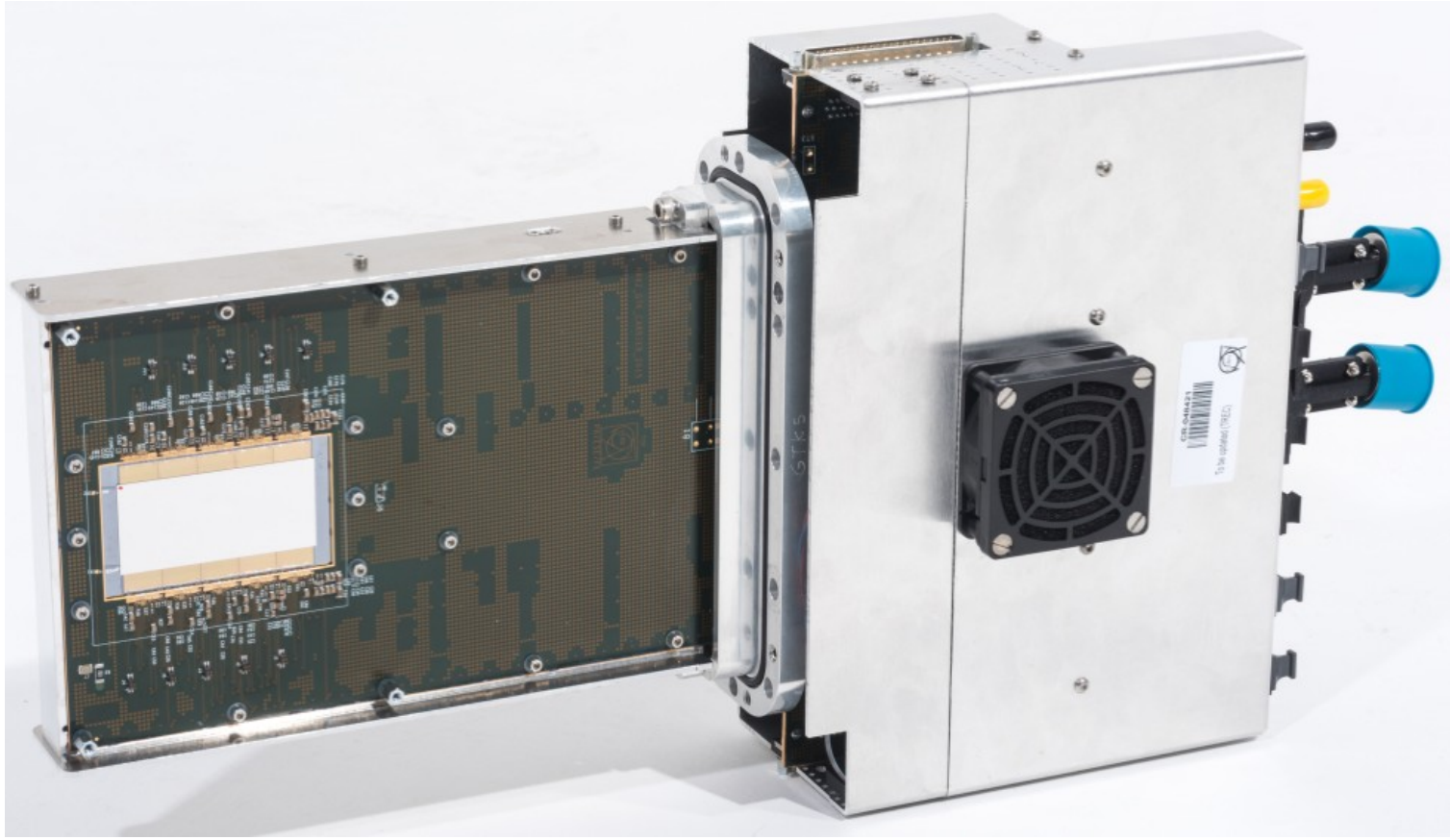
- chips sensor and cooling plate assembly hosted in the countersink of the carrier board
- 14 layer T-shaped PCB
- sealed in an aluminum frame
- 1450 bonding pads spaced by 73 μm
- opto-electrical devices





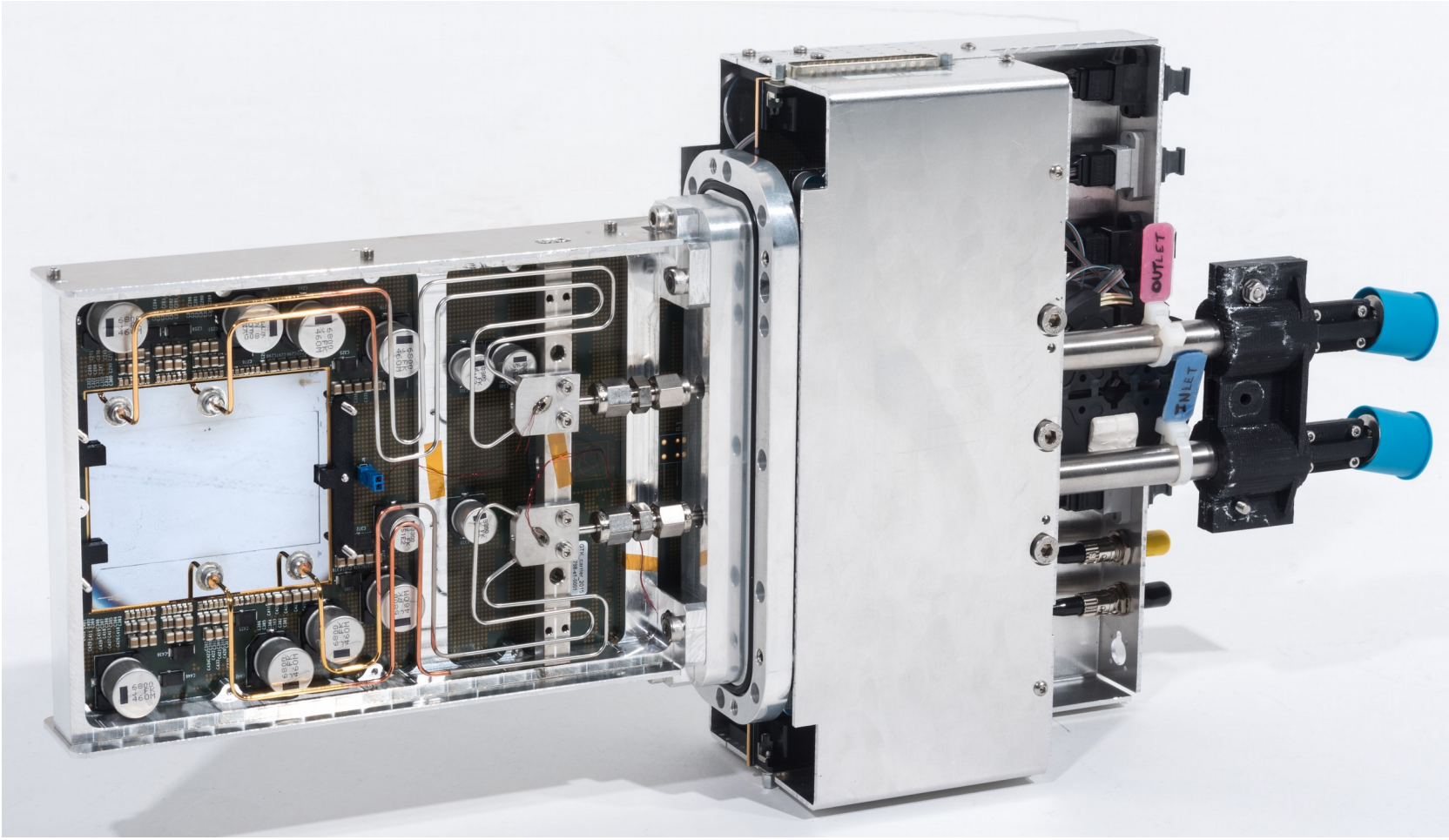
The GigaTraKer Module

Sensor side



The GigaTraKer Module

cooling plate side



Performance

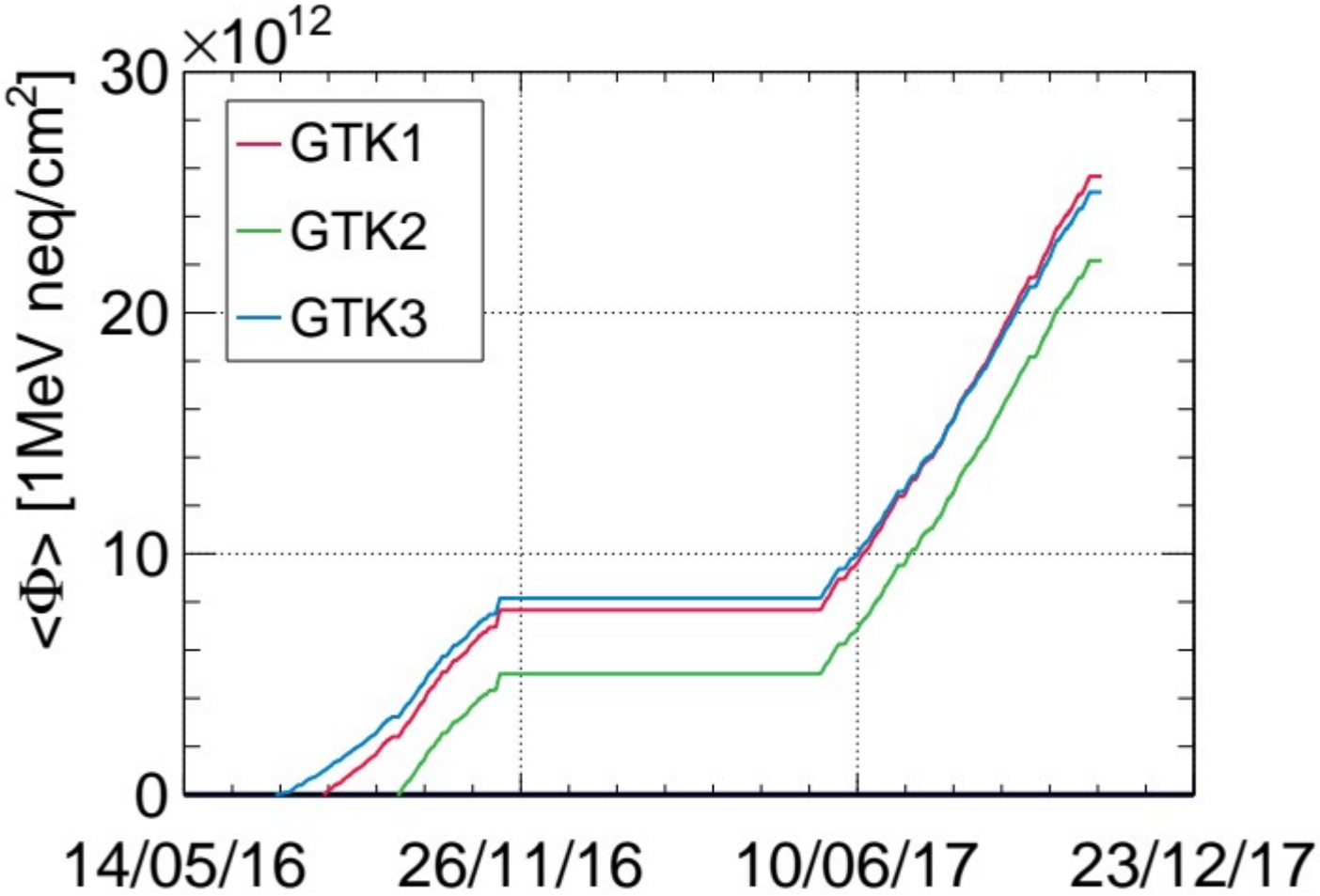
First GTK station installed in 2014

Three stations commissioned and integrated in the NA62 data taking since 2016

The measured GTK time-stamp resolution:
- 132.0 ps for GTK1
- 127.1 ps for GTK2
- 129.2 ps for GTK3

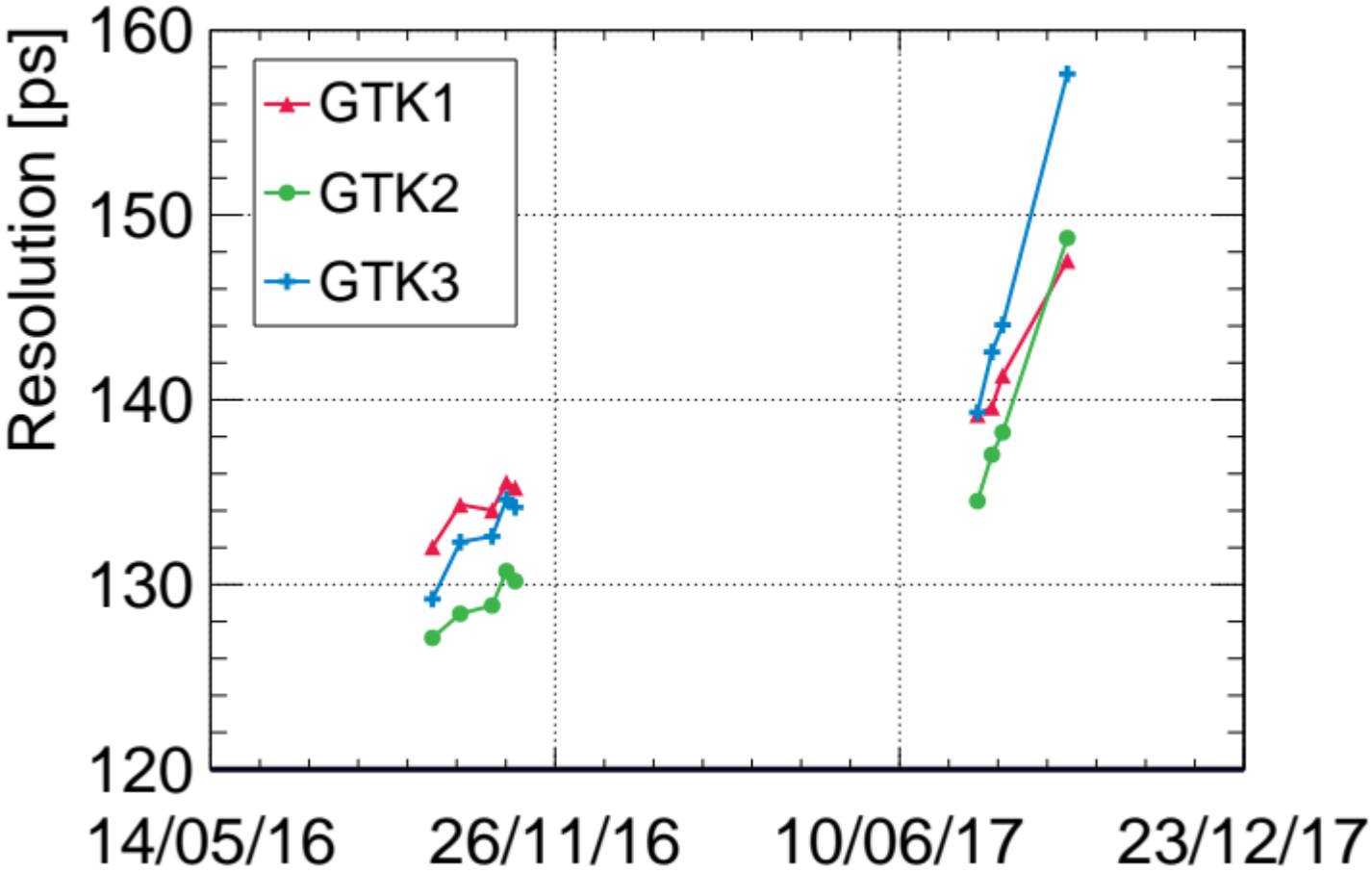
Performance

Average integrated fluence of the three GTK stations in 2016-2017



Performance

Degradation of the three GTK stations in 2016-2017



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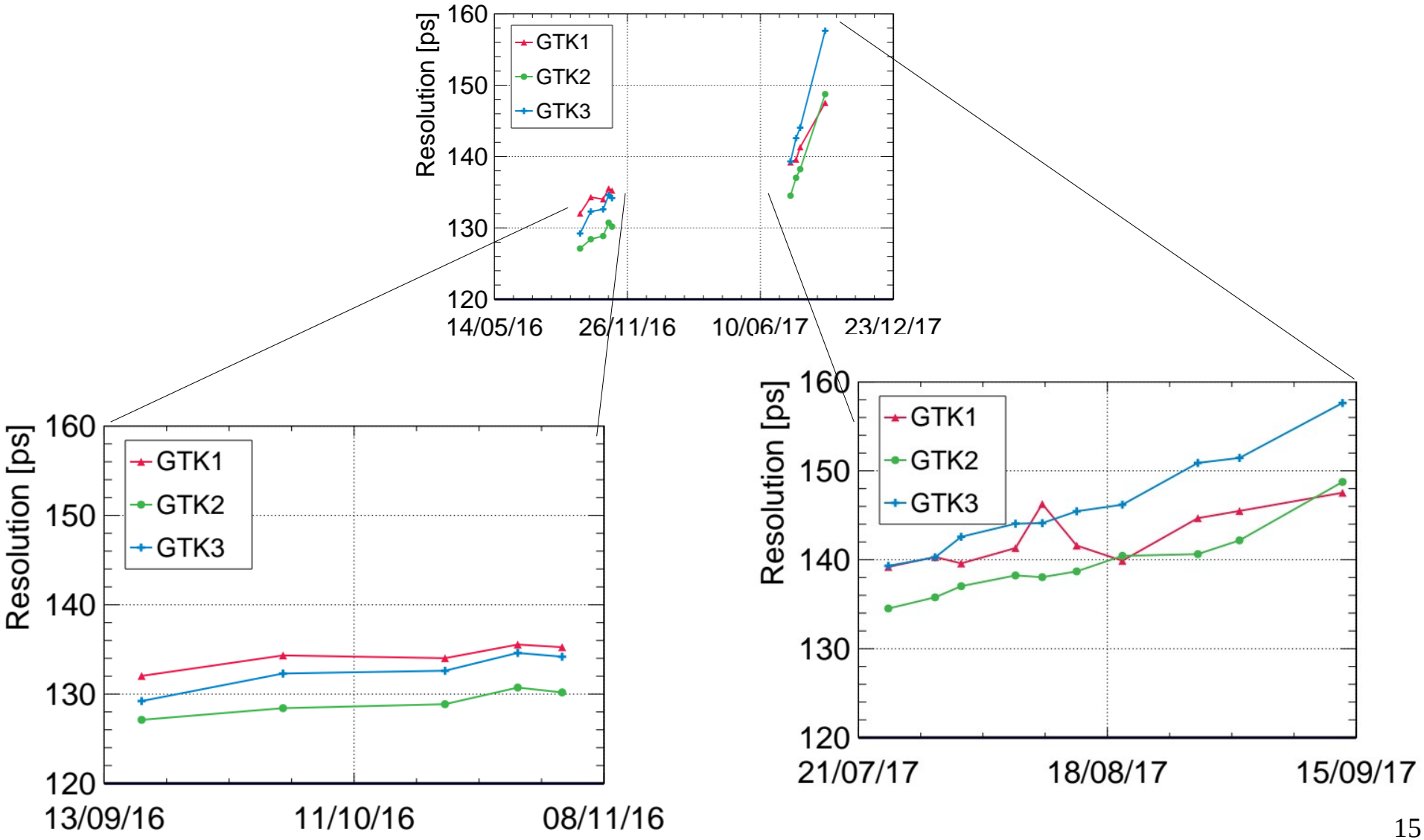
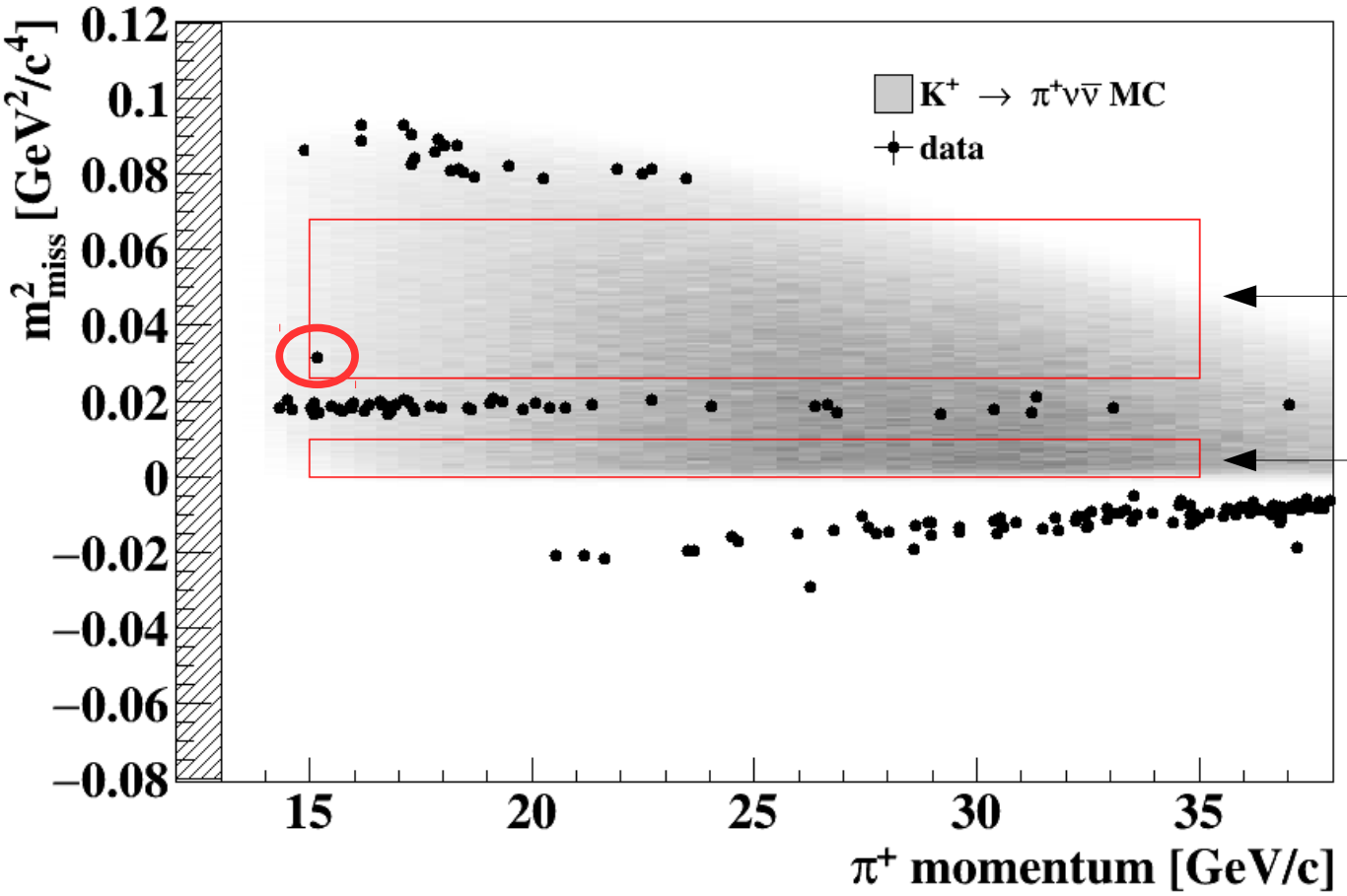


NA62 data

- the analysis of the data collected by NA62 in 2017 and 2018 is ongoing;

Candidate event



from 2016 data set

Region II

Region I

Conclusions

The first full NA62 GTK station has been installed in 2014

The three GTK stations have been integrated in the NA62 data taking in 2016

The GTK detector have been operating successfully since then until the end of the 2018 physics run.