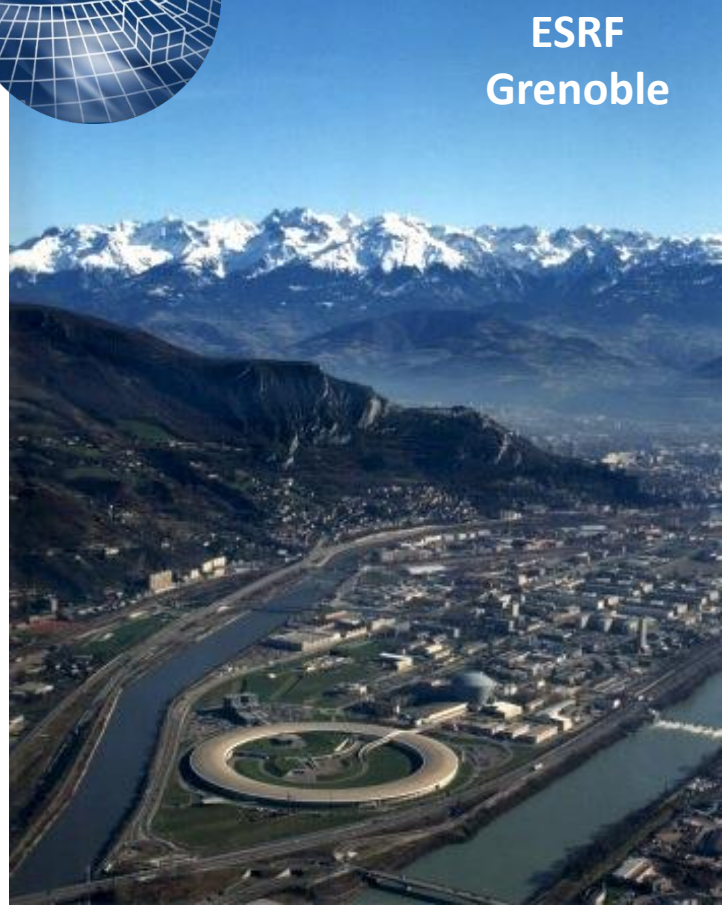
HZB Helmholtz Zentrum Berlin

DEELS-2022,
June 7-8 Berlin

X-BPM development at the ESRF

indispensable use for verifying the genuine stability of our source

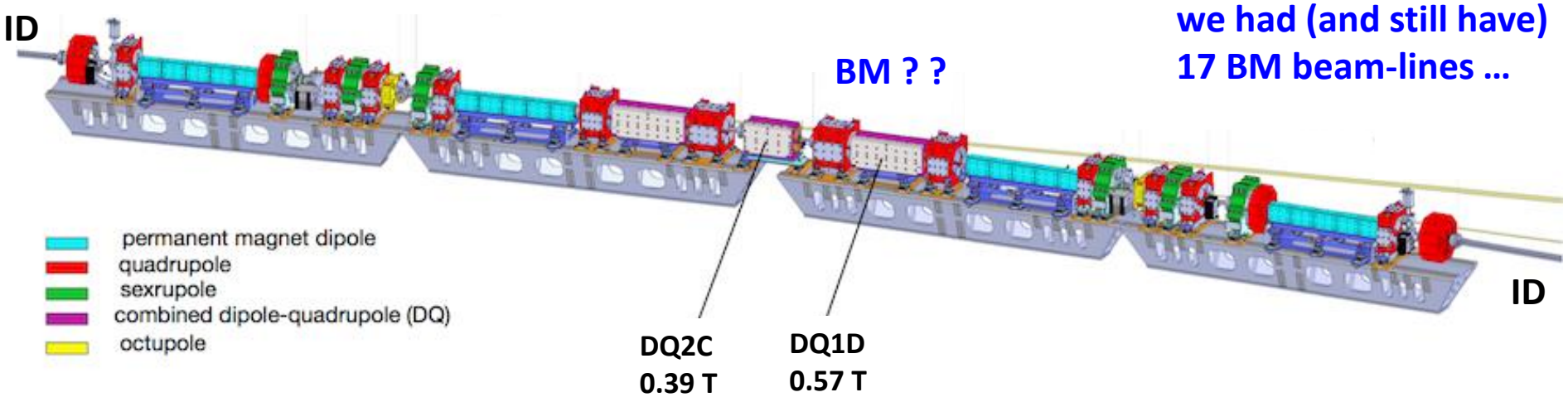
Kees Scheidt
ESRF
Grenoble

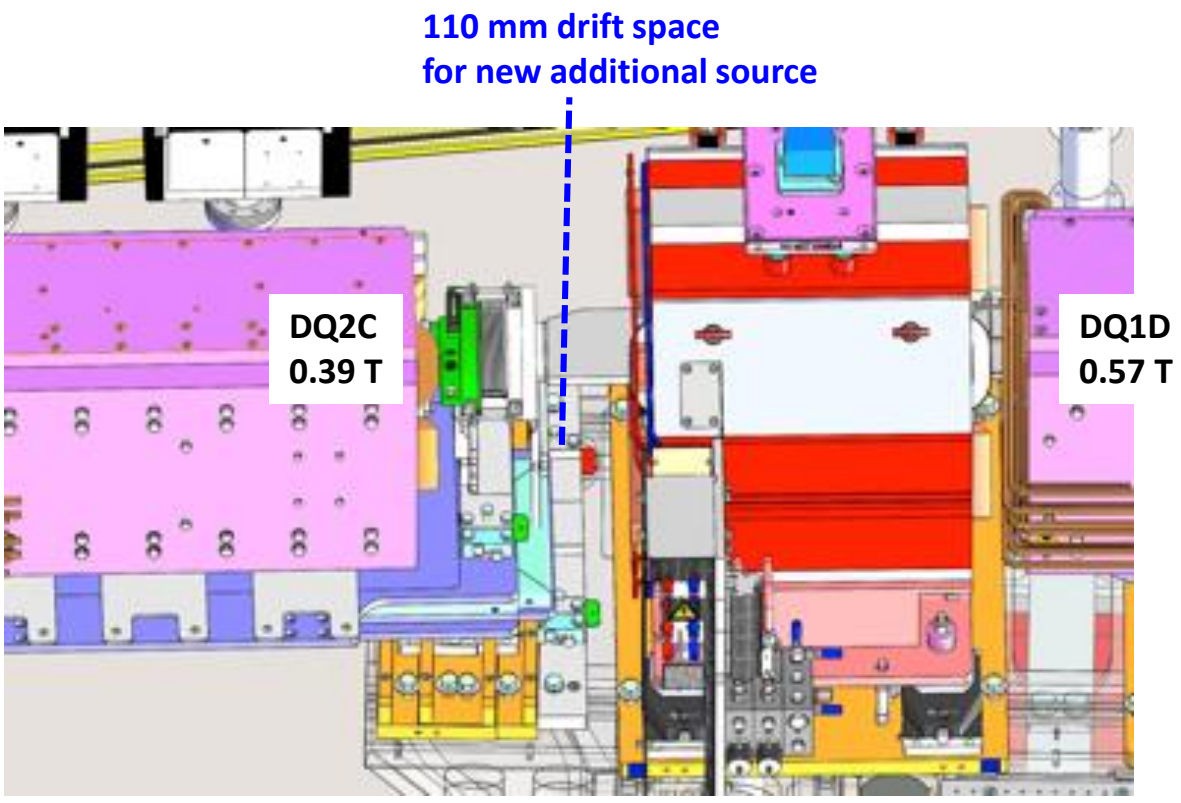


contents

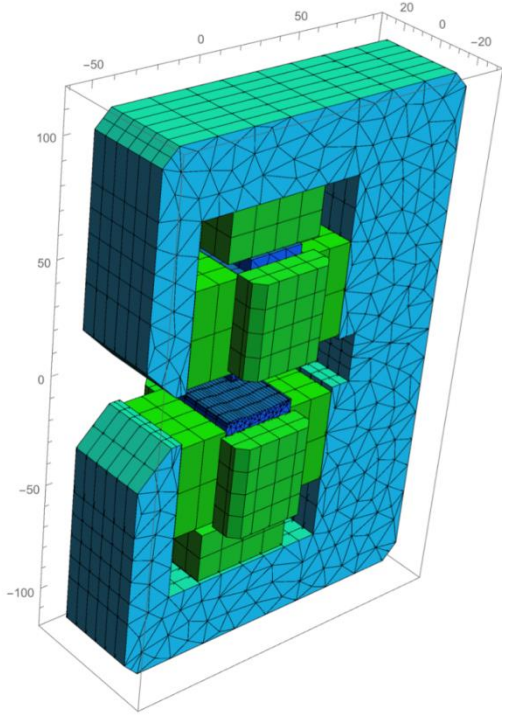
- situation with the Bending-Magnet sources
- using a Front-End chamber @23m from source for an insertive, optical X-BPM (since Oct. 2021)
- results obtained during a (rare) 6 days period with comparison from e-BPMs → discrepancies !
- tracking deficiencies of our orbit stabilization, → coming from temperature effects on Spark BPMs
- plans for future version, for permanent use !

new multi-bend lattice to create EBS (low-emittance Ring)
but where have the bending-magnets gone ?

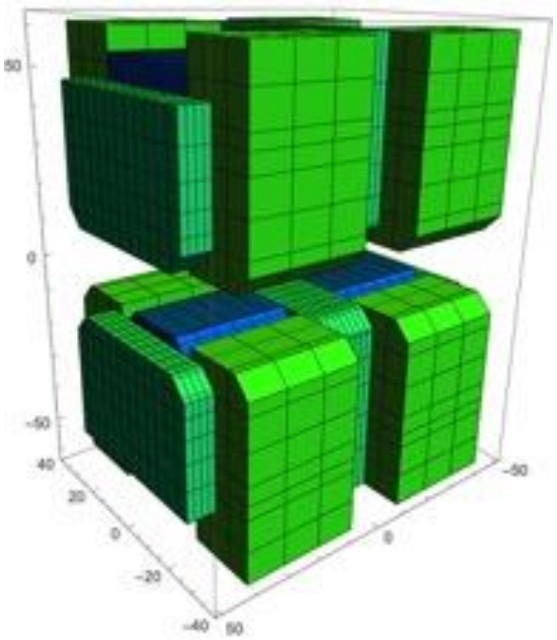




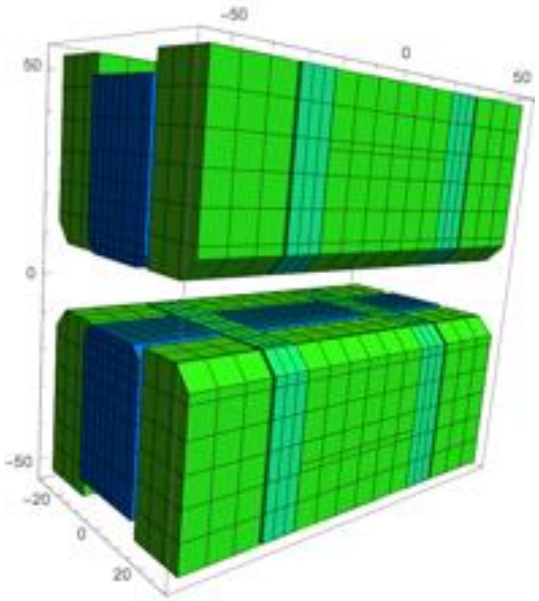
these BM-beamlines had the choice between three types of new sources :



Dipole



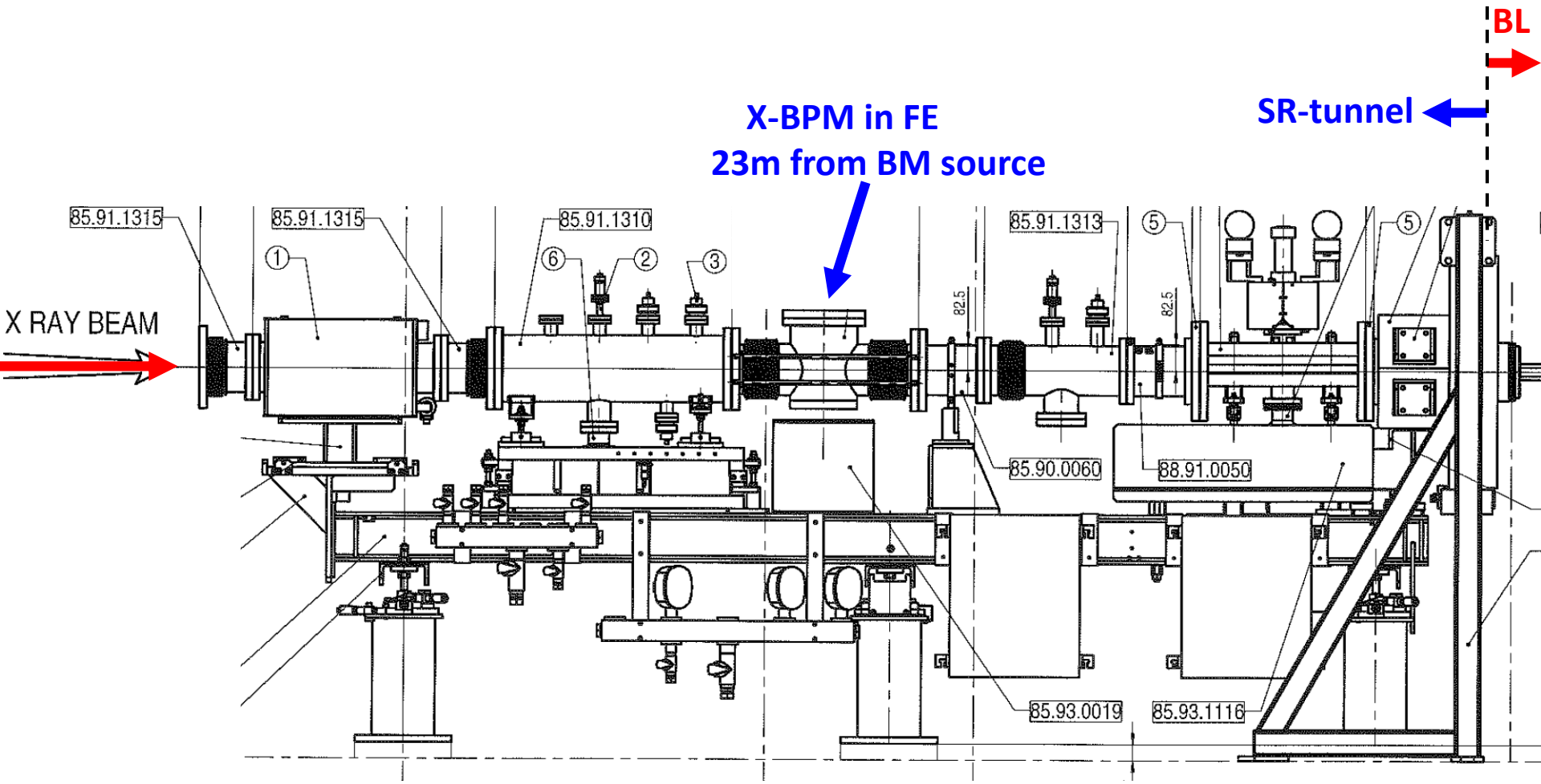
2 pole-Wiggler



3 pole-Wiggler

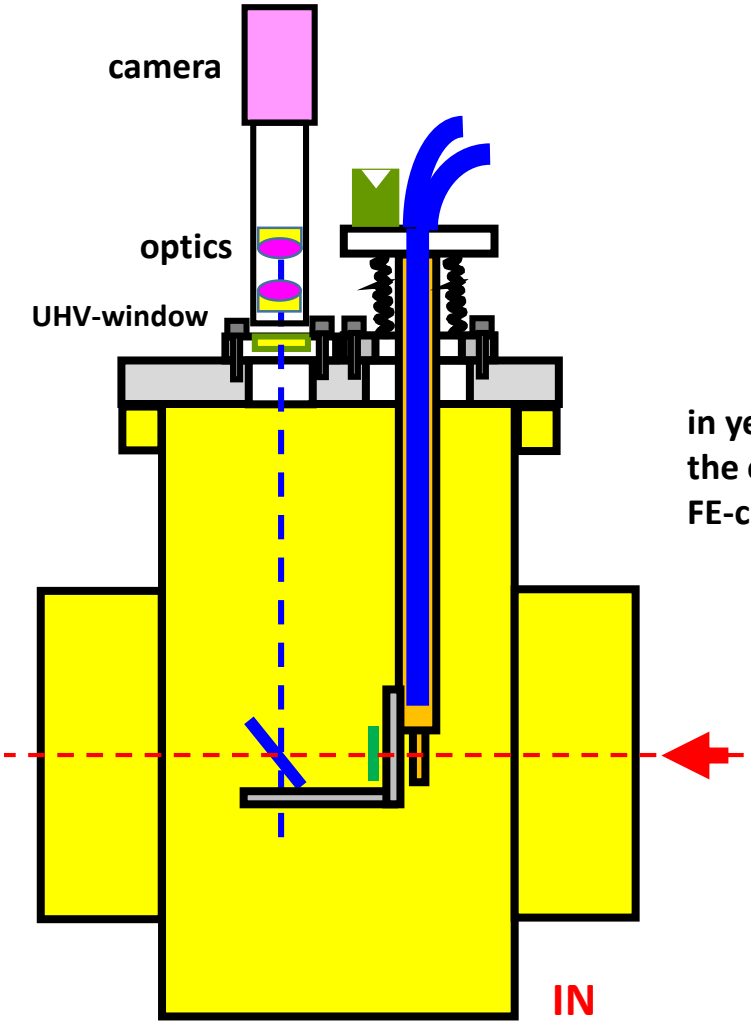
each compatible for installation
in that 110 mm free drift space

the Front-Ends remained largely un-changed
and still had a big chamber available at 23 m from source …

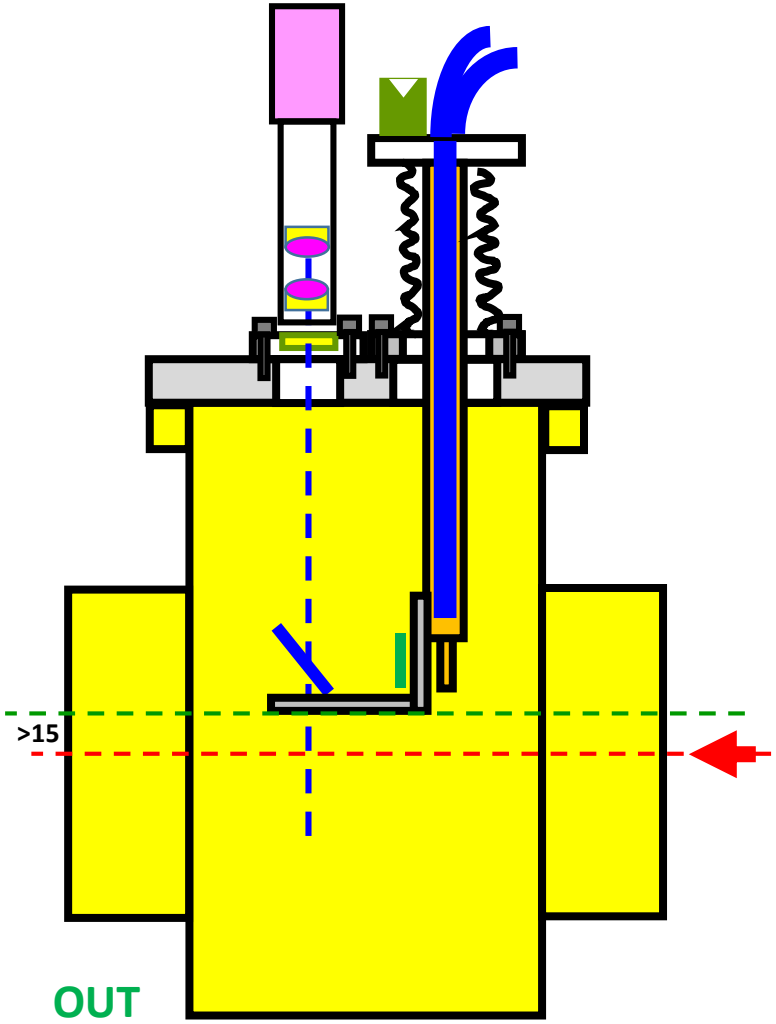


BM-8 , **LISA** , Linea Italiana per la Spettroscopia d'Assorbimento X, Francesco d'Acapito, 2426, 2085

BM-16, **FAME-UHD** , French Absorption spectroscopy in Material and Environmental sciences at Ultra-High Dilution, J-L Hazemann, D.Testemale, O.Proux, I.Kieffer, M.Rovezzi (7407, 1045, 2547, 2521, 2963)



in yellow :
the existing
FE-chamber

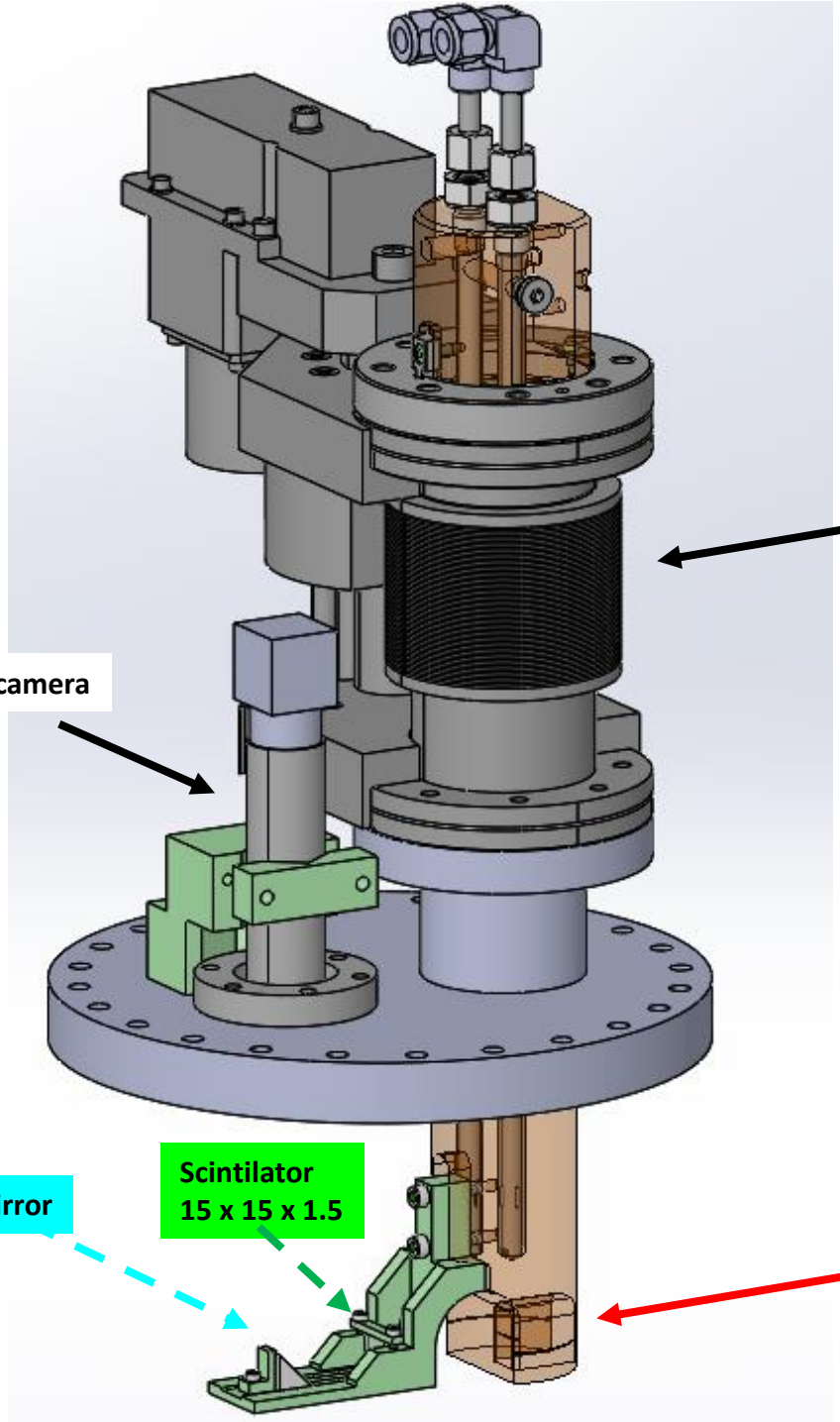


an image of the X-ray beam is
projected on the scintillator (green)
the light emitted from that is captured/focused
on to a camera via mirror (blue), window, lenses

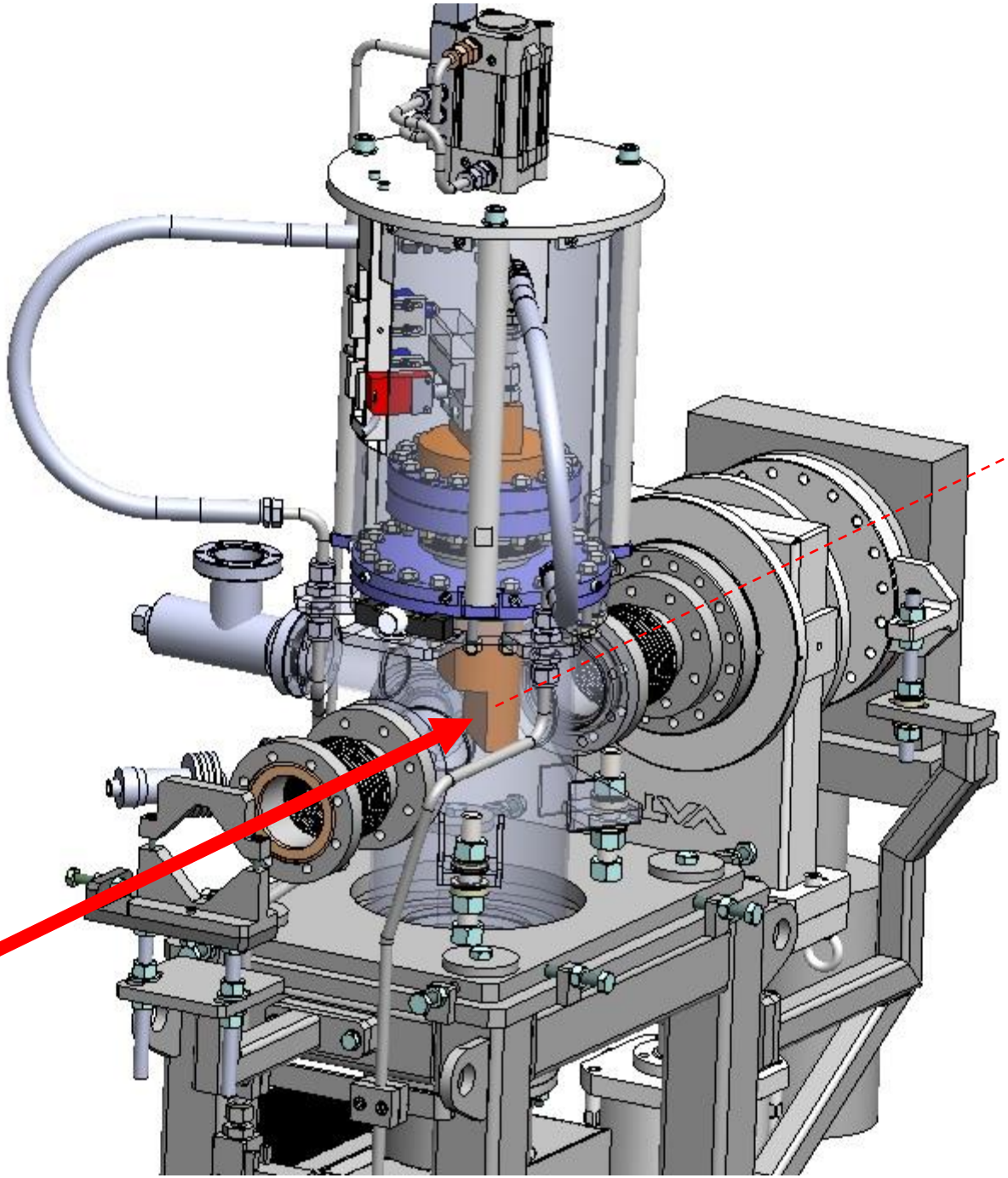
so when the BM uses the beam then
this X-BPM is OUT (>15mm)

note that a water-cooled absorber is in front of the scintillator,
but this also means that this X-BPM is not compatible
with BM-use during USM, however very useful during MDTs !

simple and low-cost device



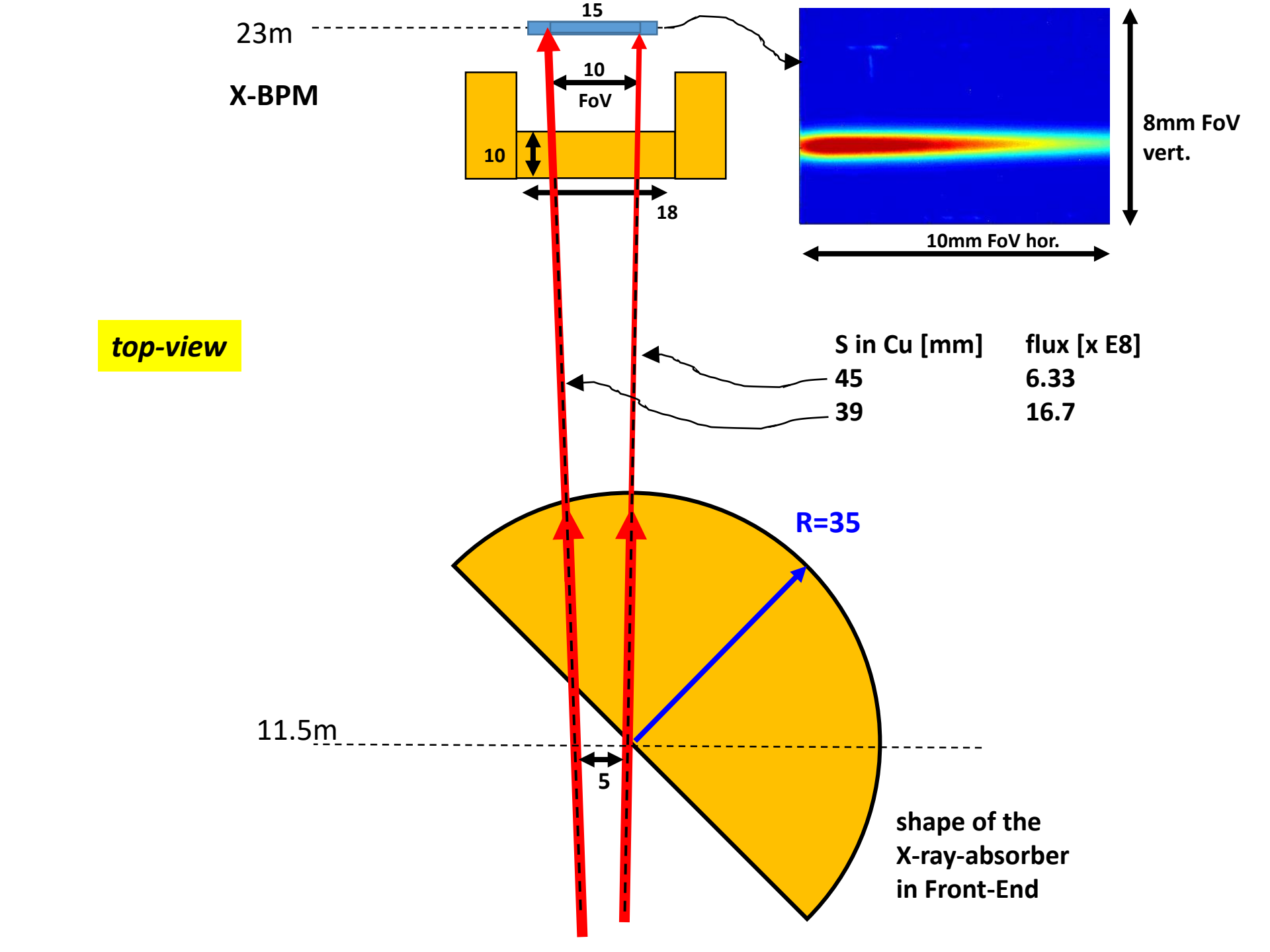
Front-End
photon-shutter
X-ray absorber



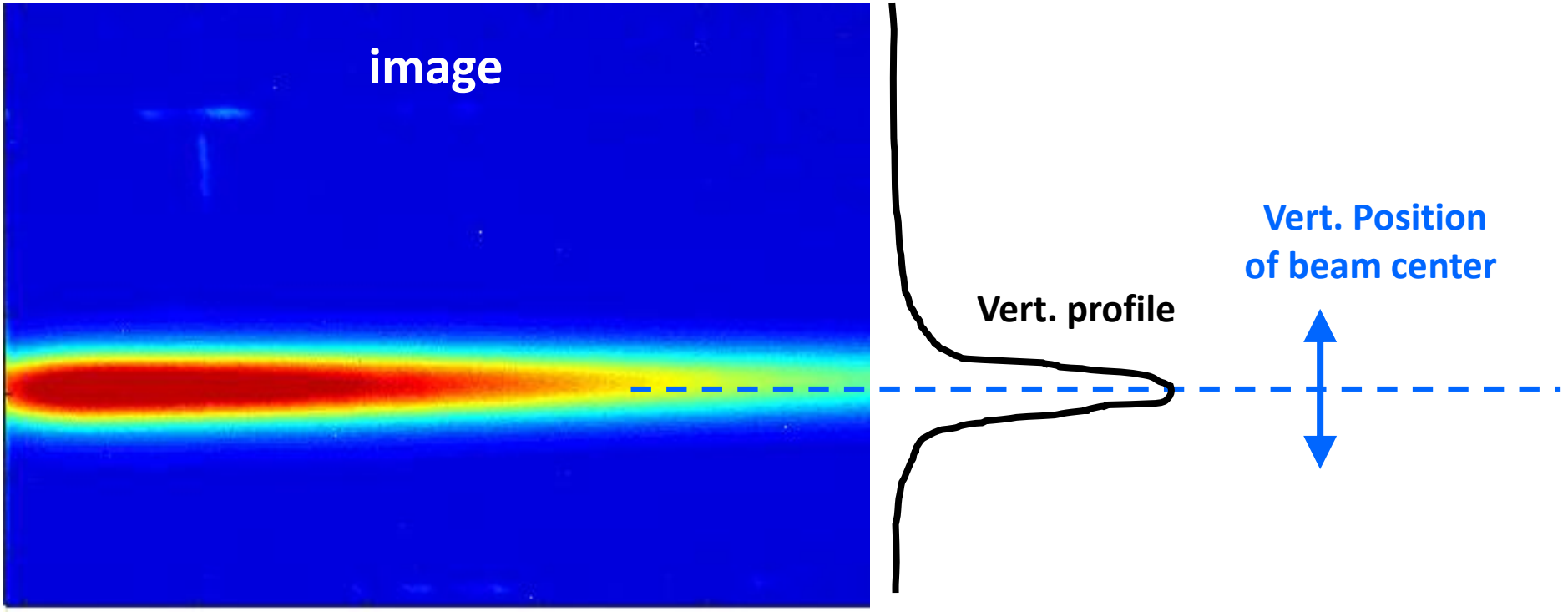
1.3 mW/mrad

to X-BPM

158.6W/mrad
(for SBM source)

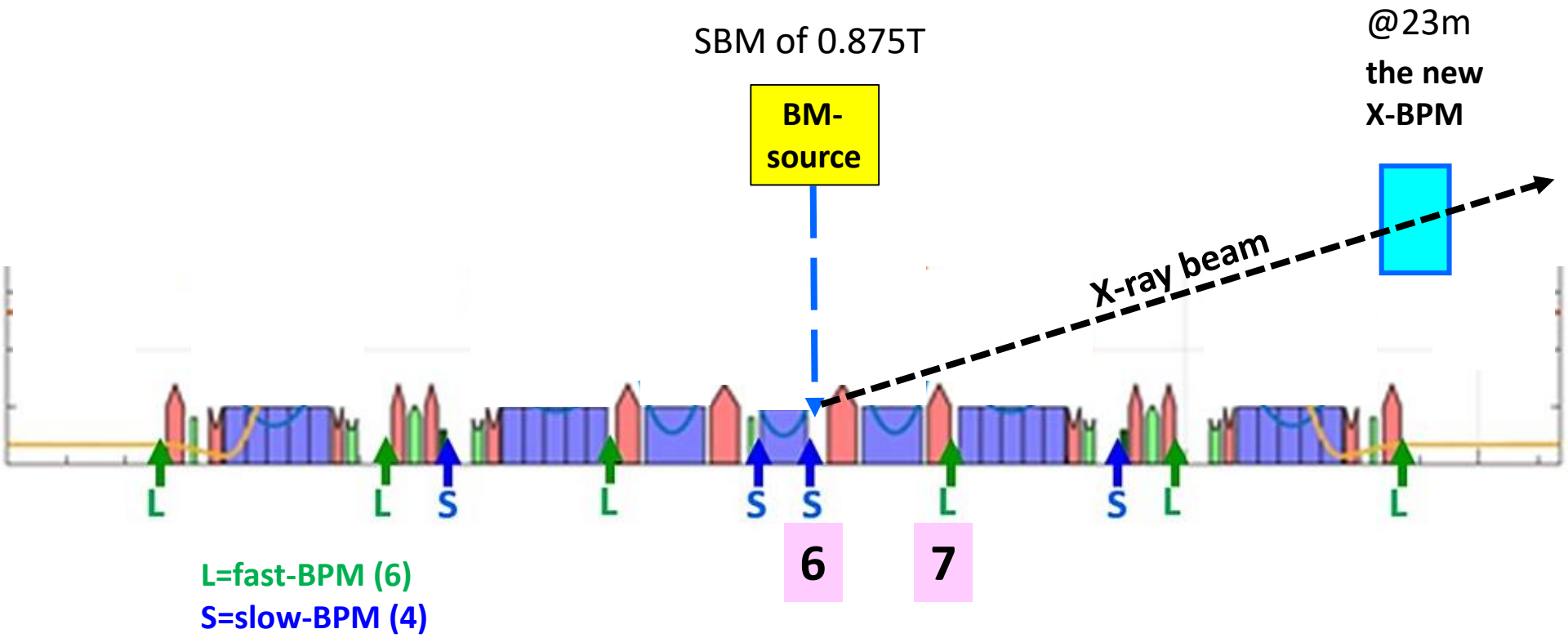

23m
X-BPM
15
10
FoV
10
18
8mm FoV
vert.
10mm FoV hor.
top-view
S in Cu [mm]
flux [x E8]
45
6.33
39
16.7
R=35
11.5m
5
shape of the
X-ray-absorber
in Front-End

310uW power to scintillator at 200mA, Front-End CLOSED



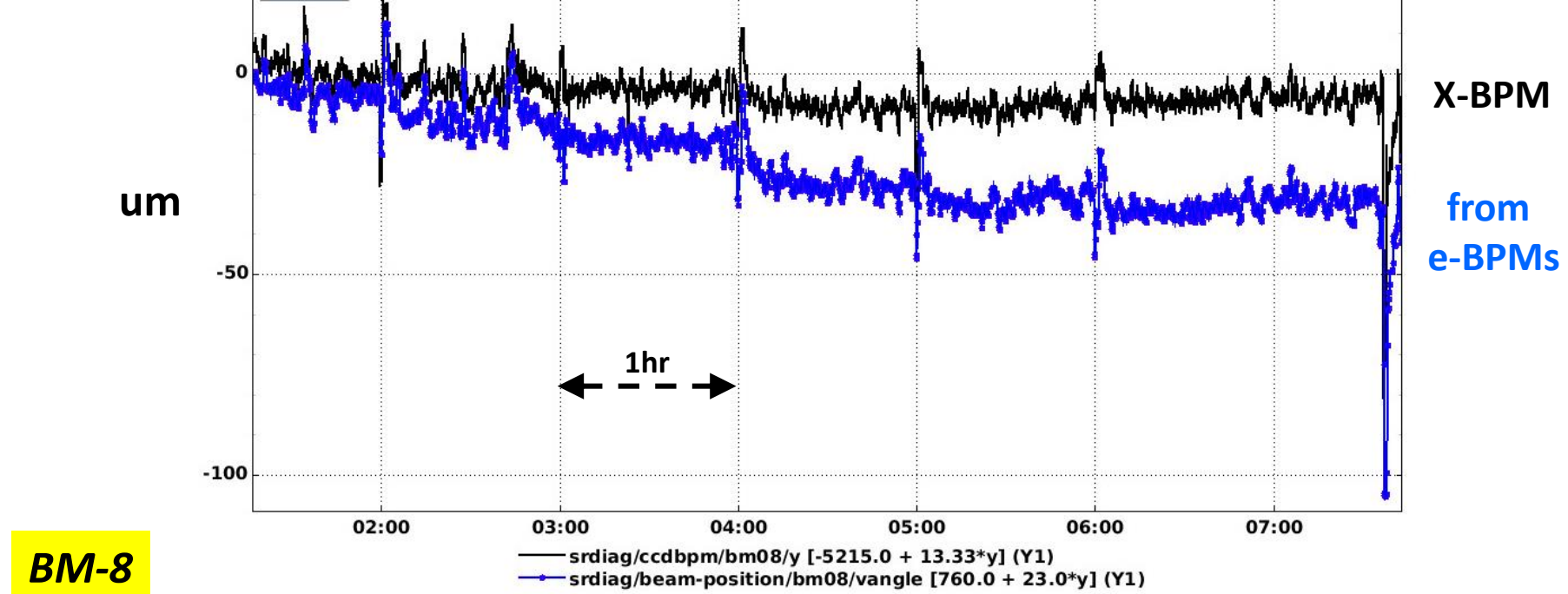
camera 2x2 binning, 0dB gain, 400ms exposure-time

comparing the vertical position of the new X-BPM with that from the e-BPMs in the Ring

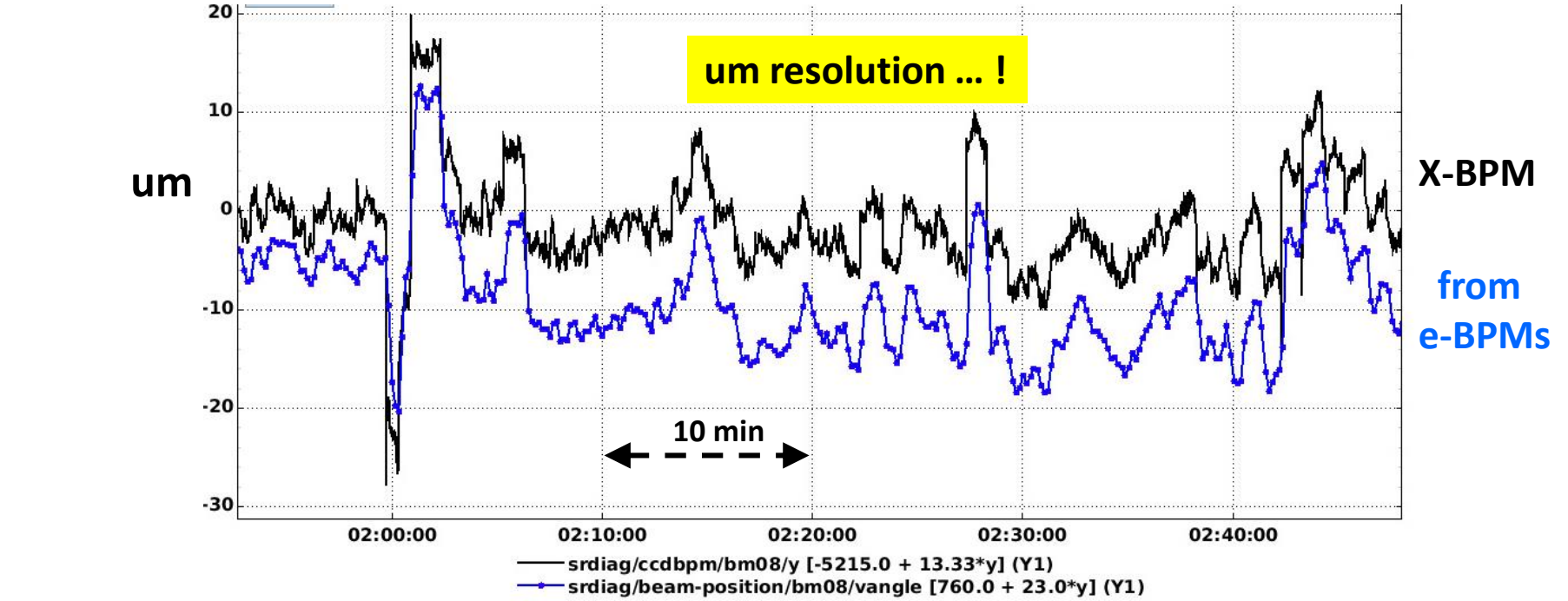


Pos V = **0.8060** *V_BPM_**6** + **0.0990** *V_BPM_**7**

Ang V = **-0.9696** *V_BPM_**6** + **0.49478** *V_BPM_**7**

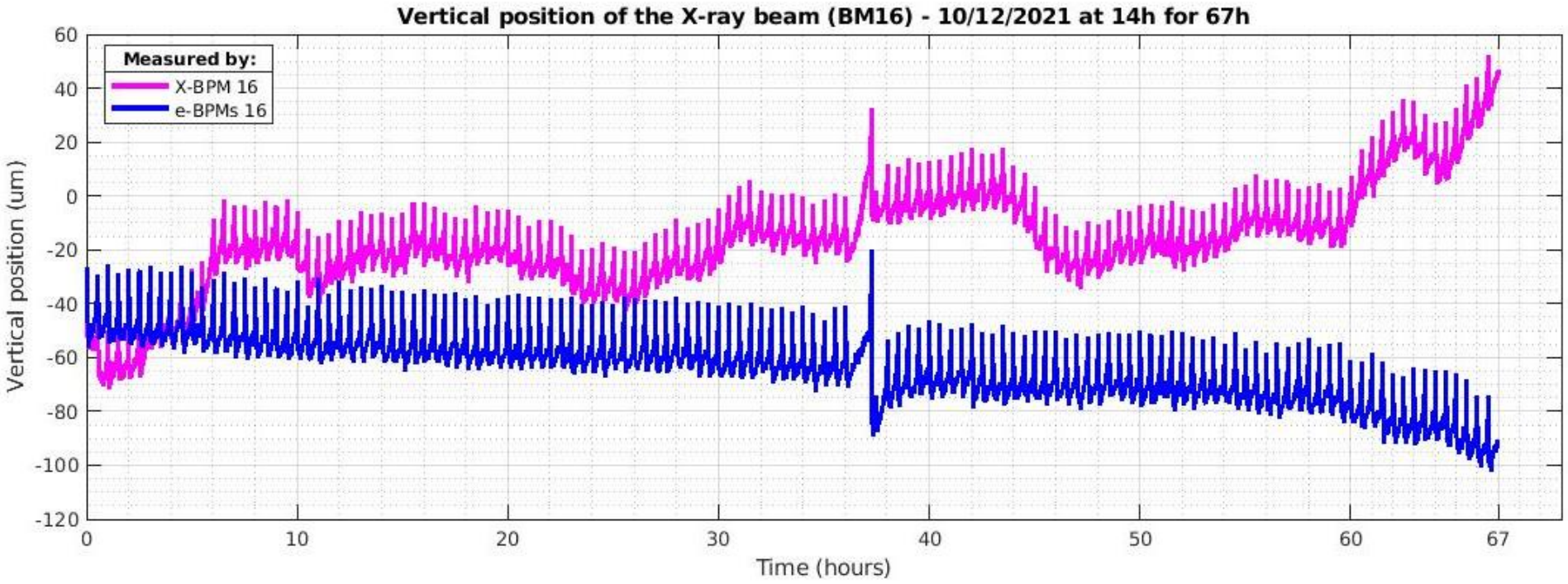

um
0
-50
-100
1hr
02:00
03:00
04:00
05:00
06:00
07:00
srdiag/ccdbpm/bm08/y [-5215.0 + 13.33*y] (Y1)
srdiag/beam-position/bm08/vangle [760.0 + 23.0*y] (Y1)
X-BPM
from
e-BPMs

BM-8


um resolution … !
um
20
10
0
-10
-20
-30
10 min
02:00:00
02:10:00
02:20:00
02:30:00
02:40:00
srdiag/ccdbpm/bm08/y [-5215.0 + 13.33*y] (Y1)
srdiag/beam-position/bm08/vangle [760.0 + 23.0*y] (Y1)
X-BPM
from
e-BPMs

67 continuous hours in 20mA, 10-12 December 2020

BM-16



observation :

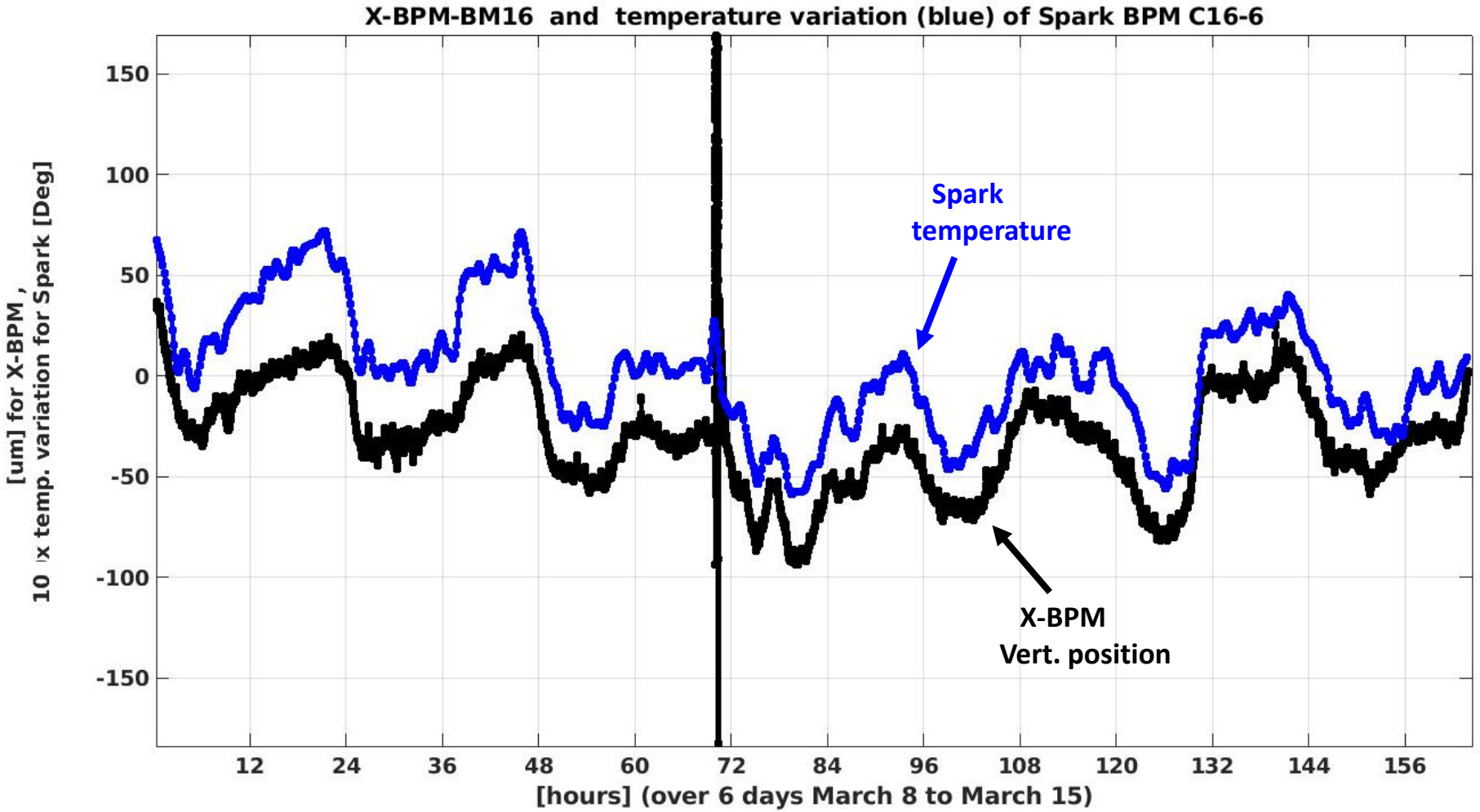
the X-BPM and e-BPM results drift in opposite direction, attaining 150um difference …

in contradiction to what is so often said
about EBS positional stability (“very good”, “excellent”, “perfect”)
we now have clear indication/proof that it is NOT …

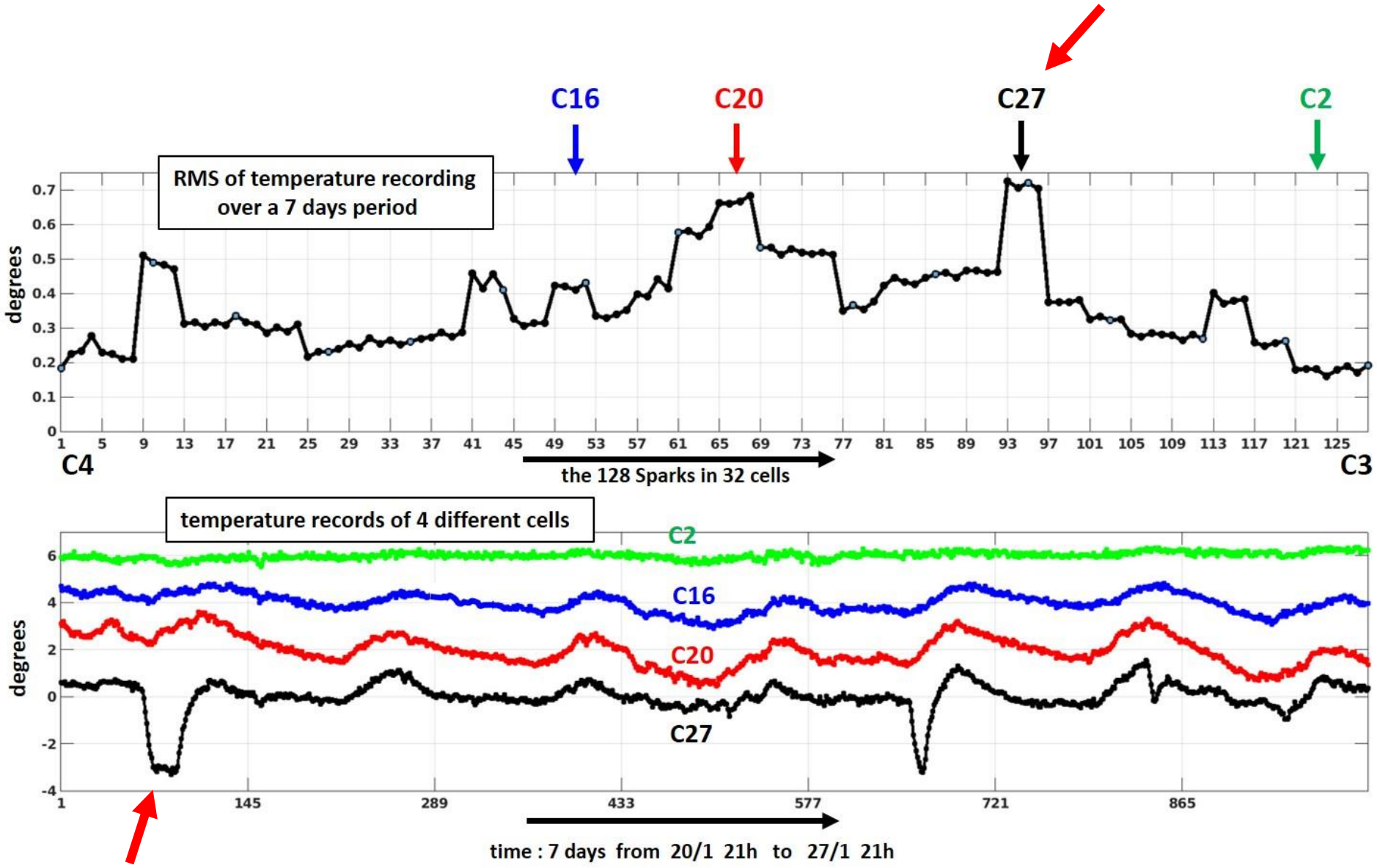
1) what is the cause ? 2) what can we do about it ?

strong correlation between BM-16 X-BPM and temperature of that C16-6 Spark

this measurement was only possible since BM-16 allowed us to keep the X-BPM inserted for a full 6 days



temperature fluctuations in the TZs and their effect on beam stability



this “open-office” concept is >30 years old

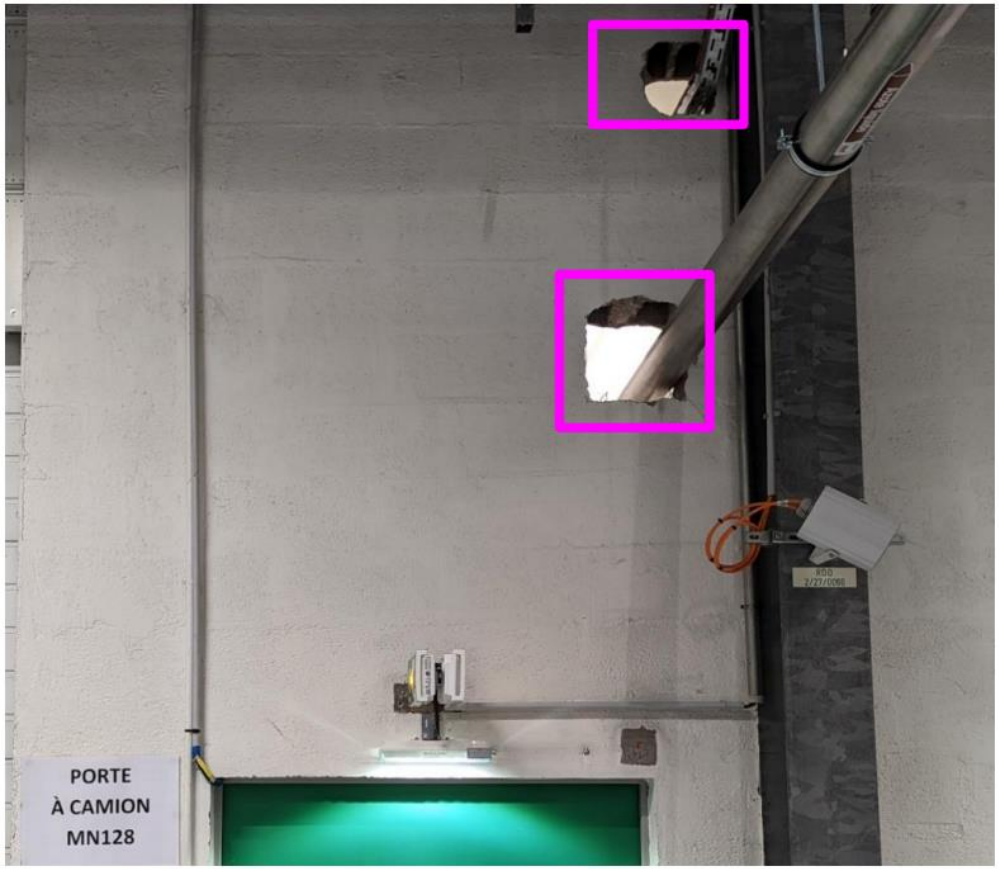
the cubicles are exposed to both regular (day / night) and erratic changes of temperature

the temperature control in the TZs is very rudimentary

and difficult to now improve

this “open-office” concept is >30 years old

the temperature control in the TZs is very rudimentary ….

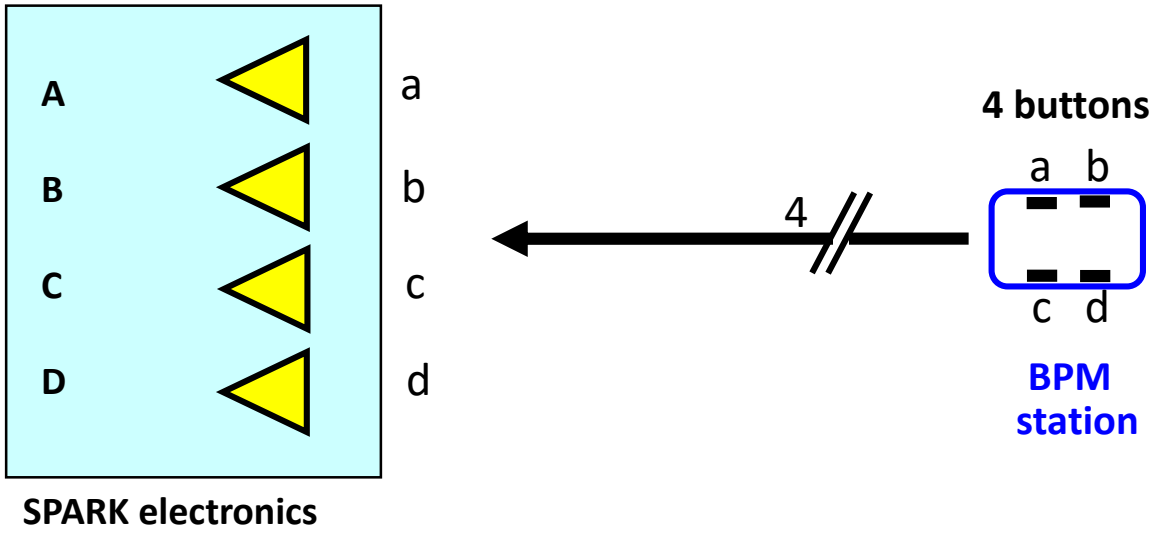


$\Sigma = A + B + C + D$

Vert. = Kv x (A + B - C - D) / Σ

Hor. = Kh x (A + C - B - D) / Σ

Q = Kq x (A + D - B - C) / Σ



the relative Gain of these 4 channels  is NOT stable with temperature

→ drift, but different for Hor. Vert. or Q (coherence) , and fully random between the 128 units

it is difficult to monitor this drift, of Hor. & Vert. , since in the orbit control the BPMs are judge & party

so a special measurement was done at a recent MDT :

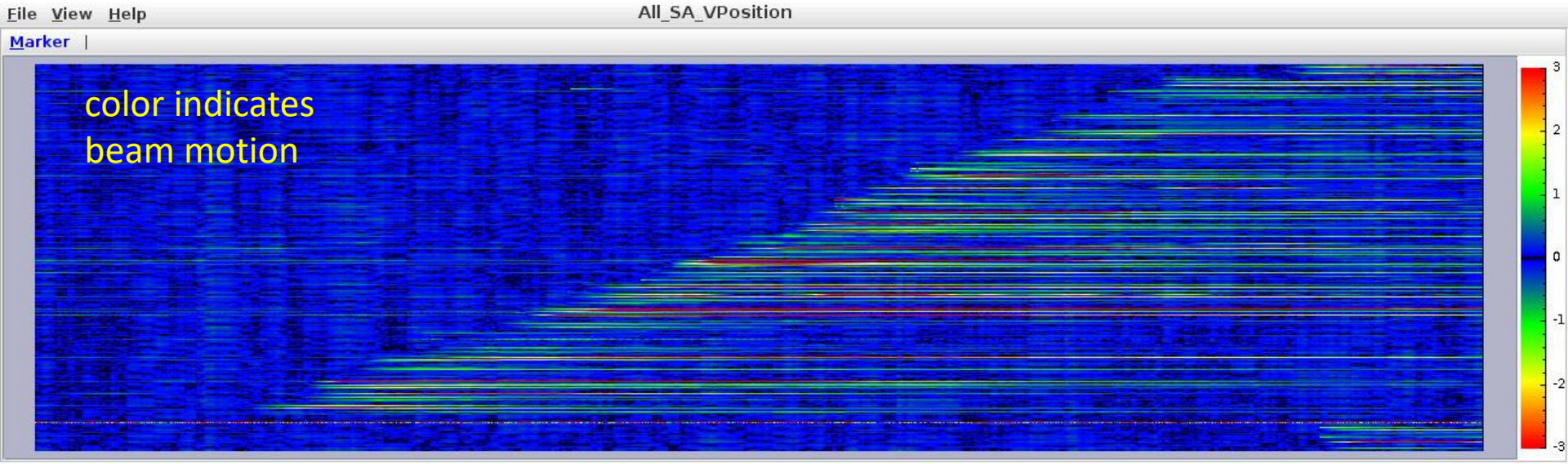
→ create temperature shock with orbit correction OFF → and then measure the effects

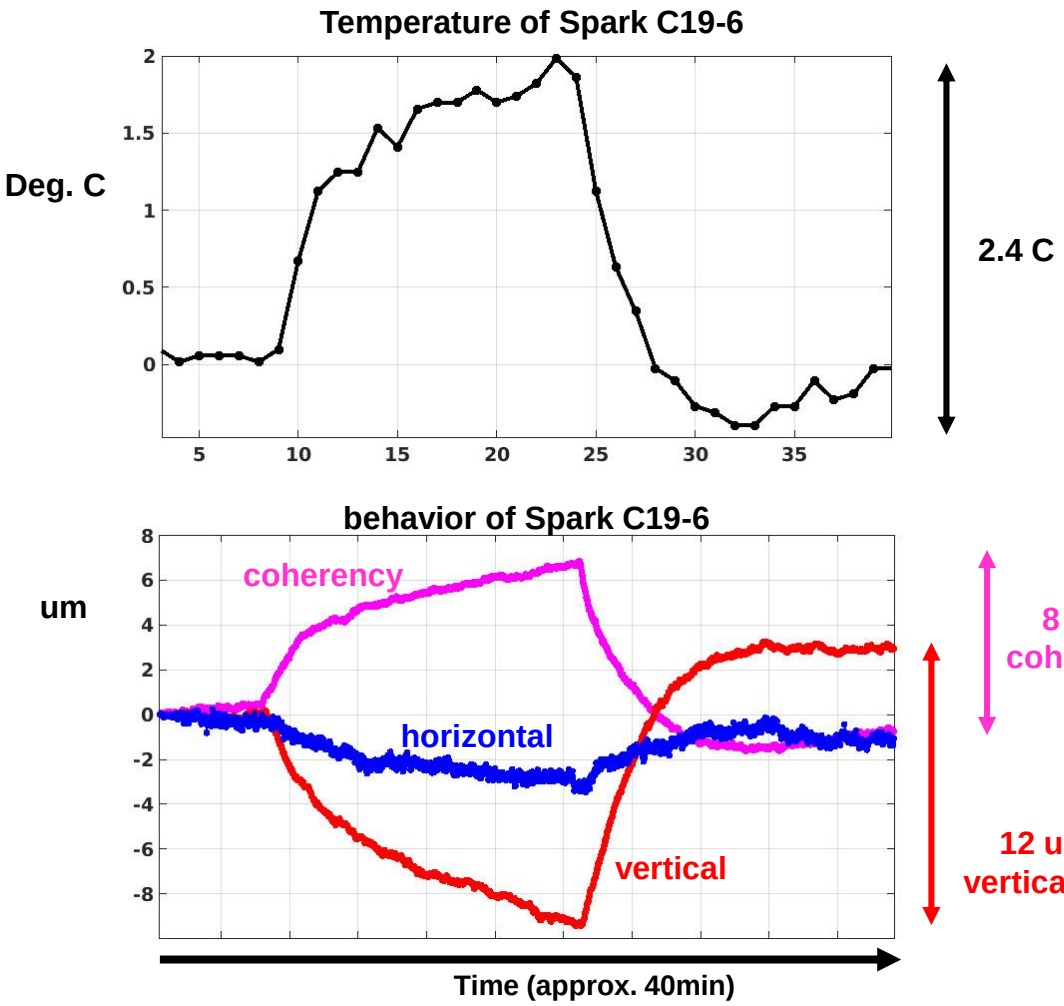
thermal shock measurements of the sensitivity of all the 320 BPM readings to temperature variations

method (in about 1 full hour) :

- normal & stable beam conditions, but all orbit feedback OFF
- opening all 32 cubicle doors → creates a temperature variation
- measure the position drifts of all individual 320 BPMs
- measure the individual temperature of these BPMs

the division of positional drift by thermal variation gives us this sensitivity



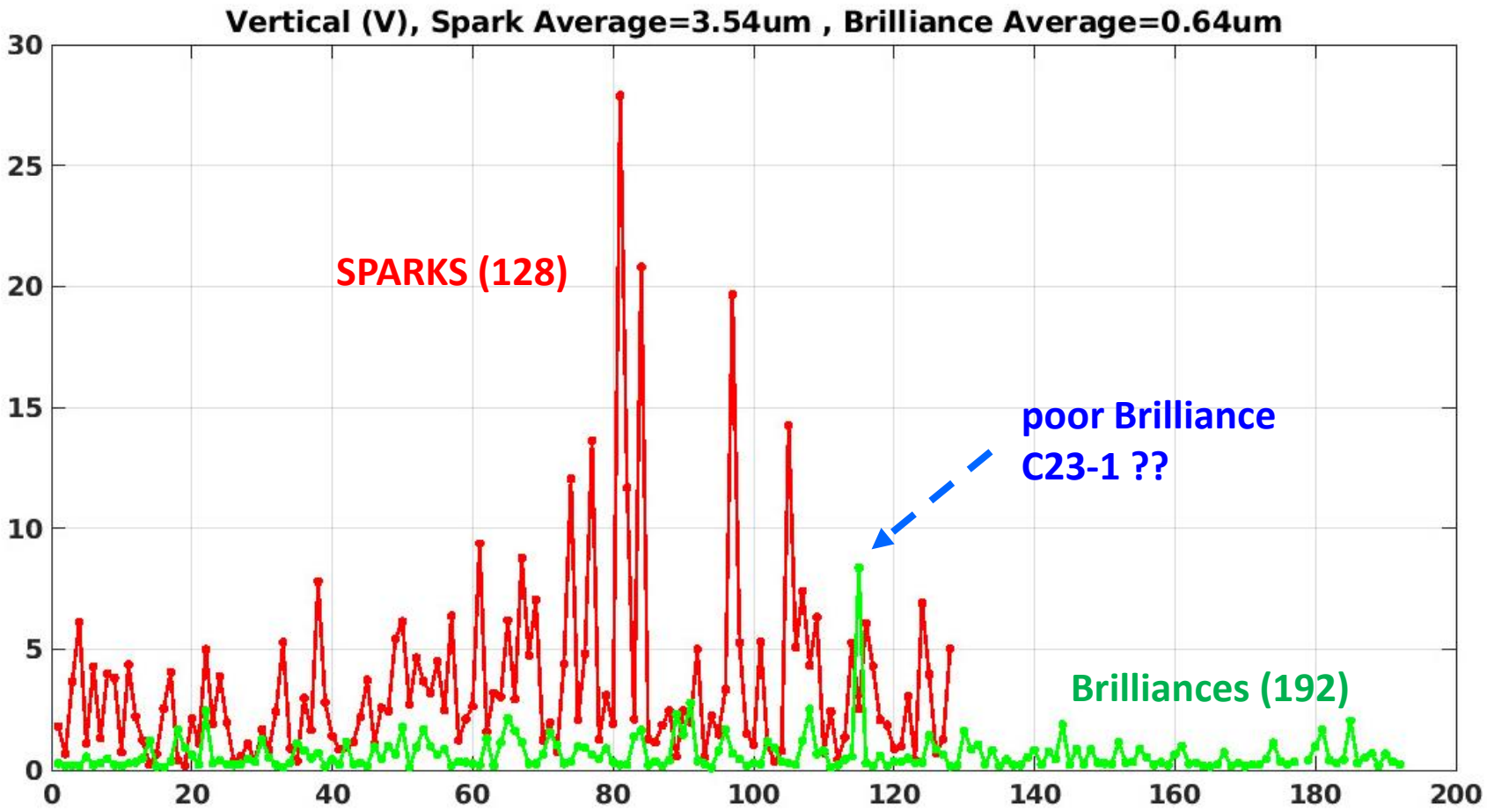


orbit correction OFF

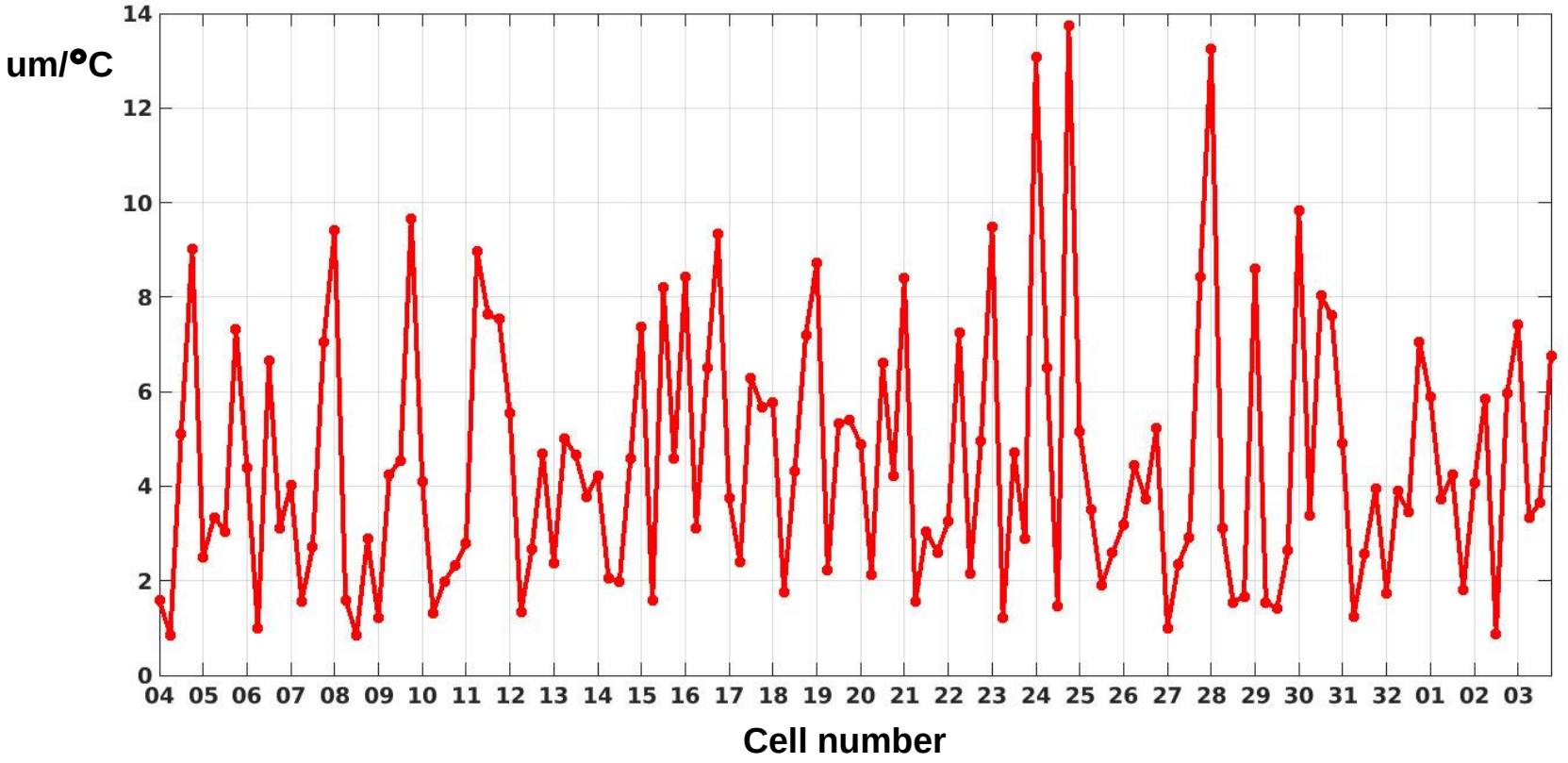
so : 3um/C
of coherency sensitivity
to temperature

so : 5um/C
of vertical sensitivity
to temperature

rms of all the positional drifts (NOT normalized vs temperature)



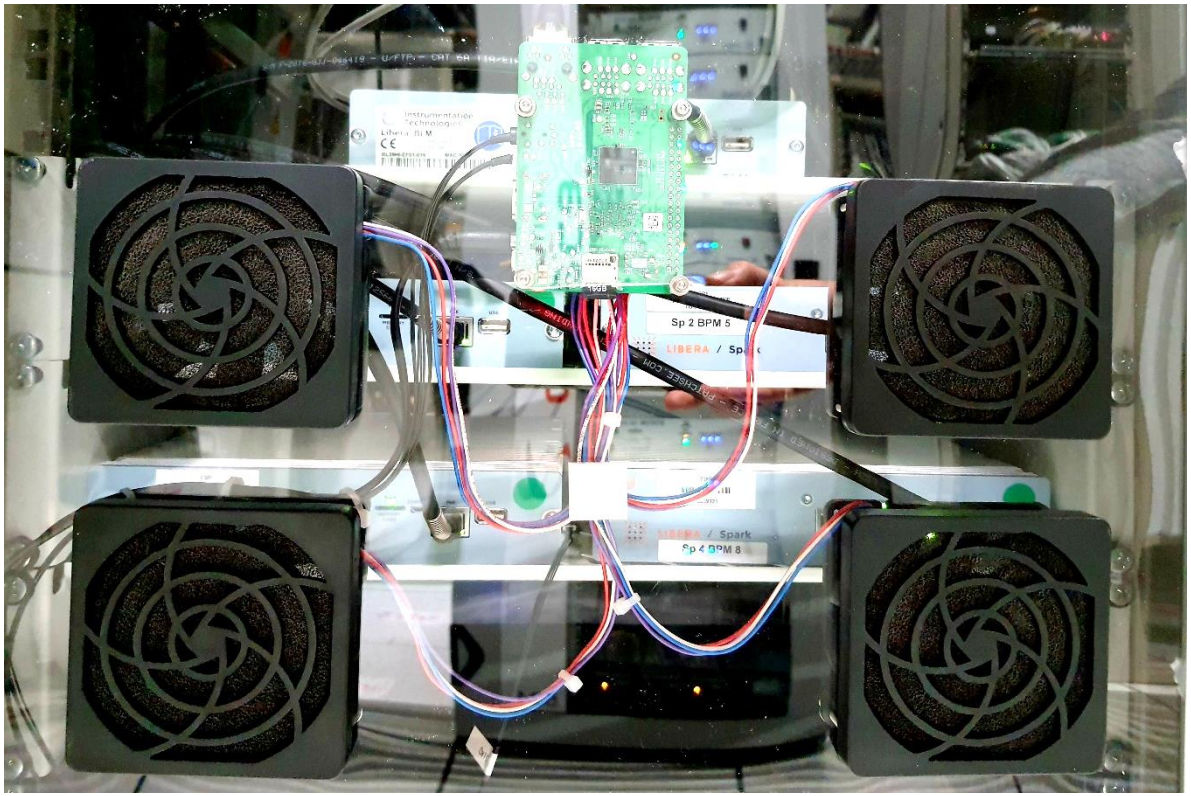
sensitivity of vertical position to temperature of the 128 Sparks



add local temperature control in our BPM cubicles (by Diag. group)

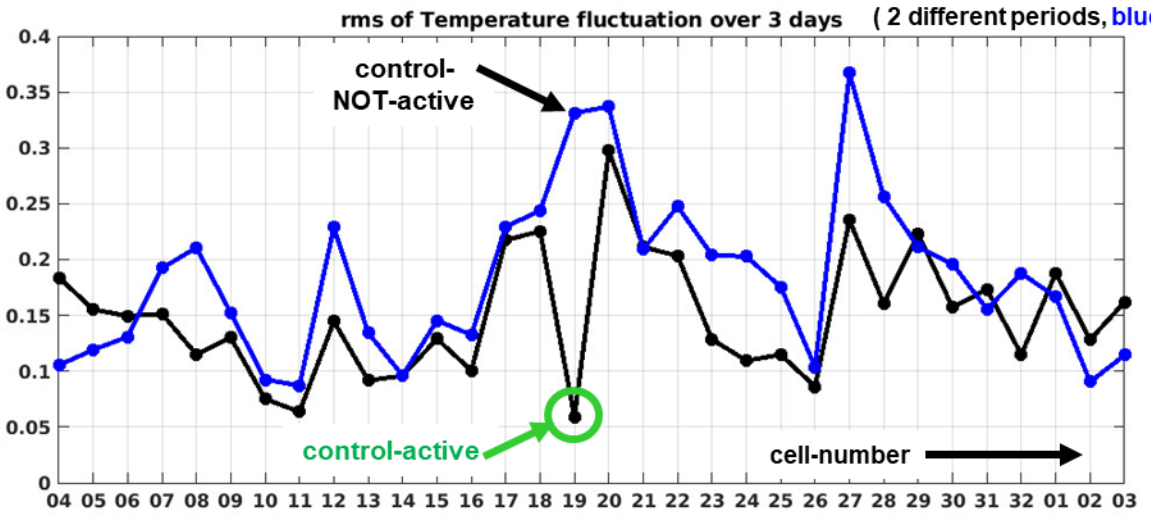
Aim : reduce the temperature variations, in a 24h period, by a factor 4 or more

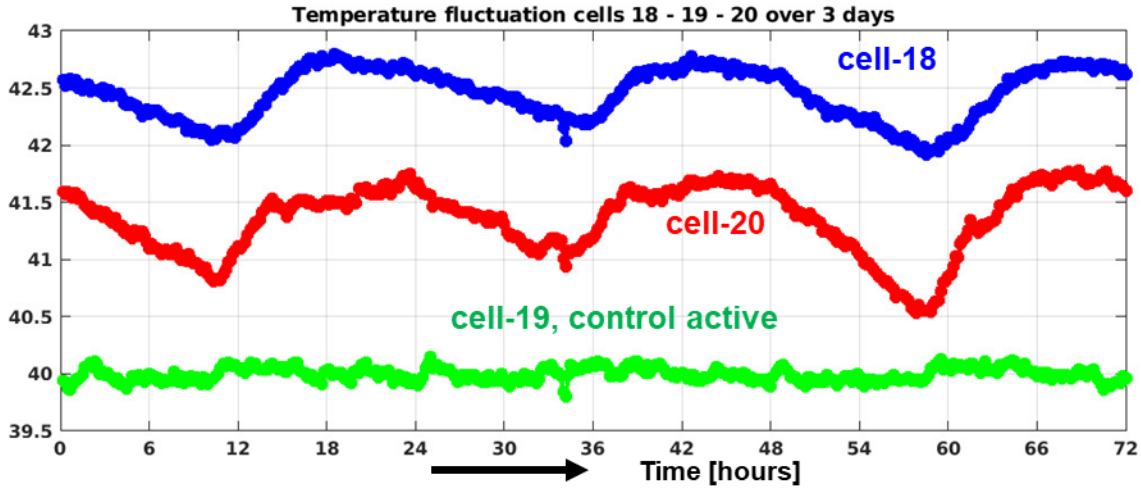
Method : use the always cooler air of the TZ
to stabilize the Spark temperature
by only small controlled ventilators,
i.e. NO water-cooling or complexity



home-made solution

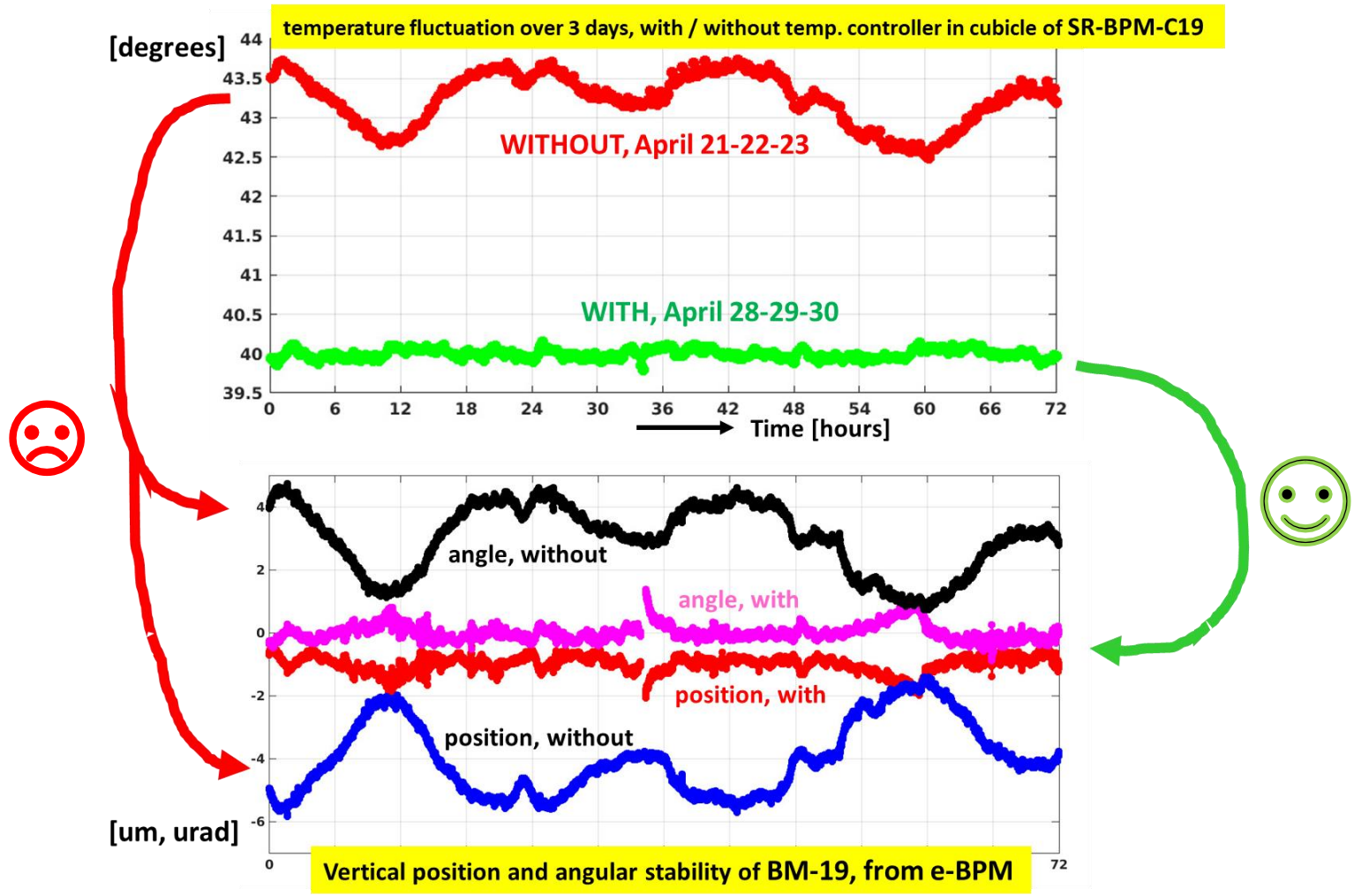
costs of 500 Euros per unit (cubicle)

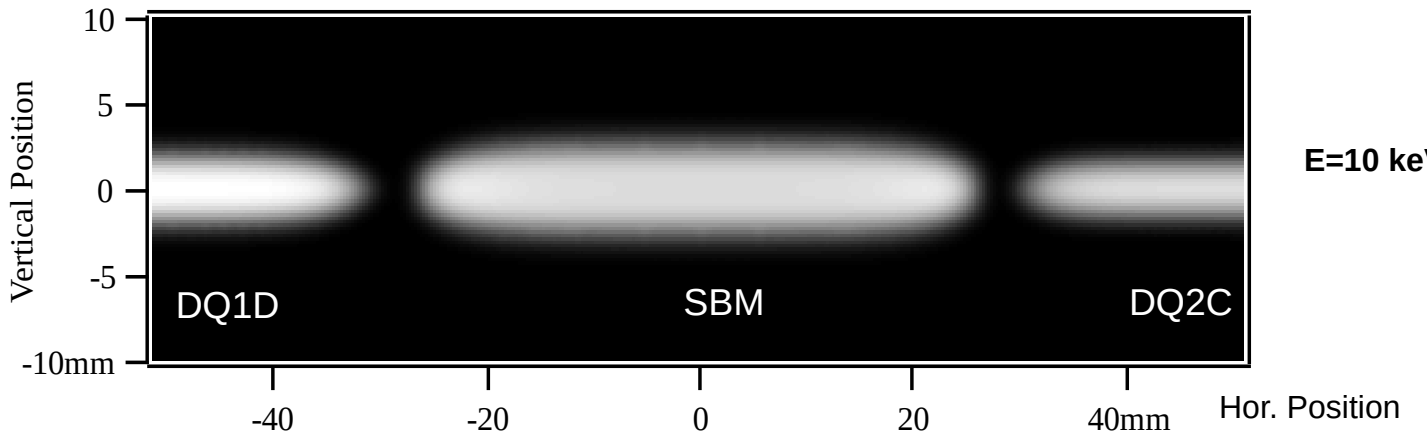


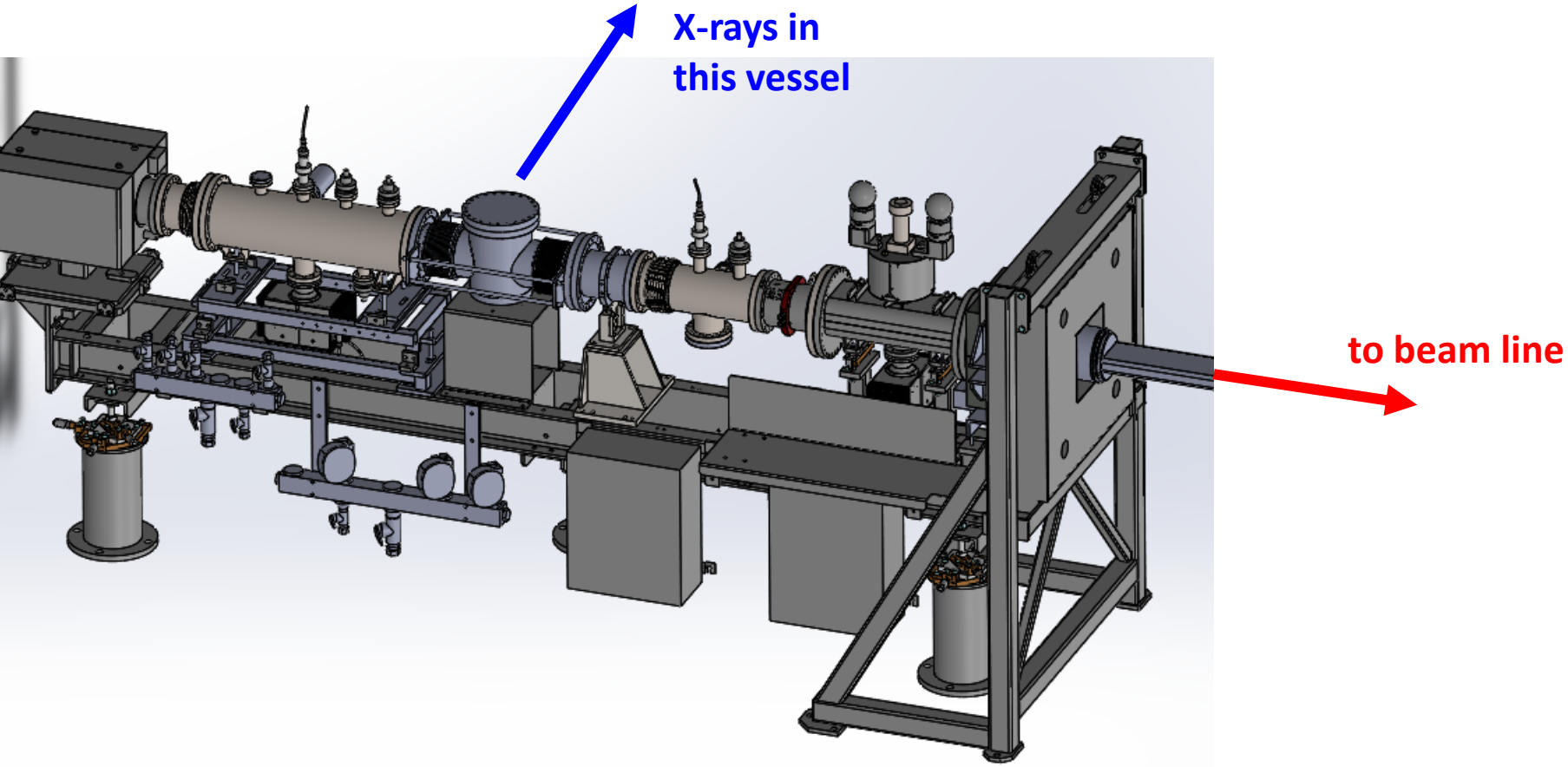


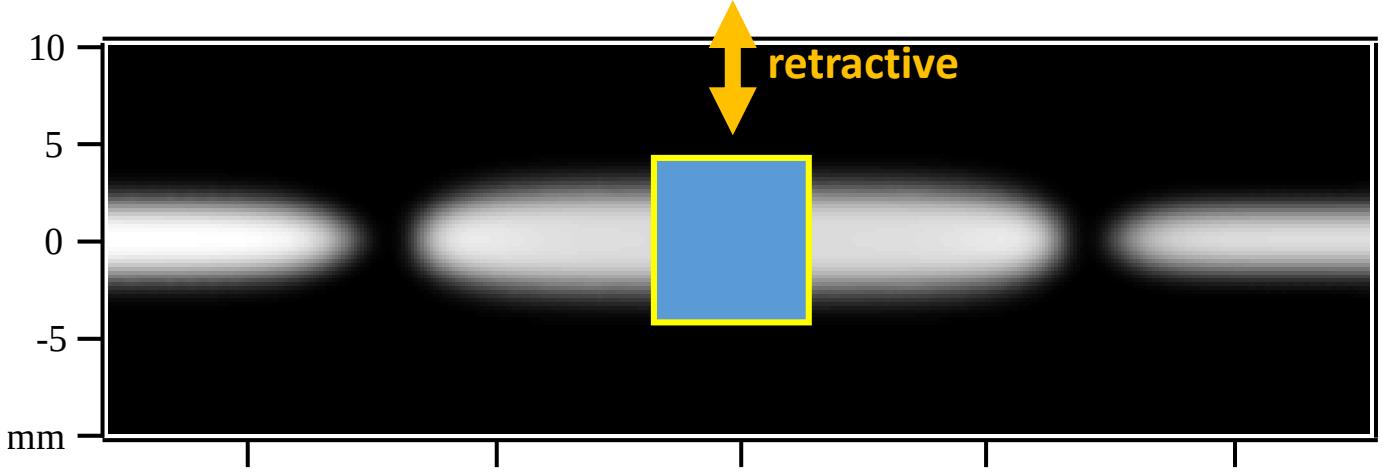
cell-19 was our test-unit

Note :
the strong 24h variation (day / night) is now suppressed

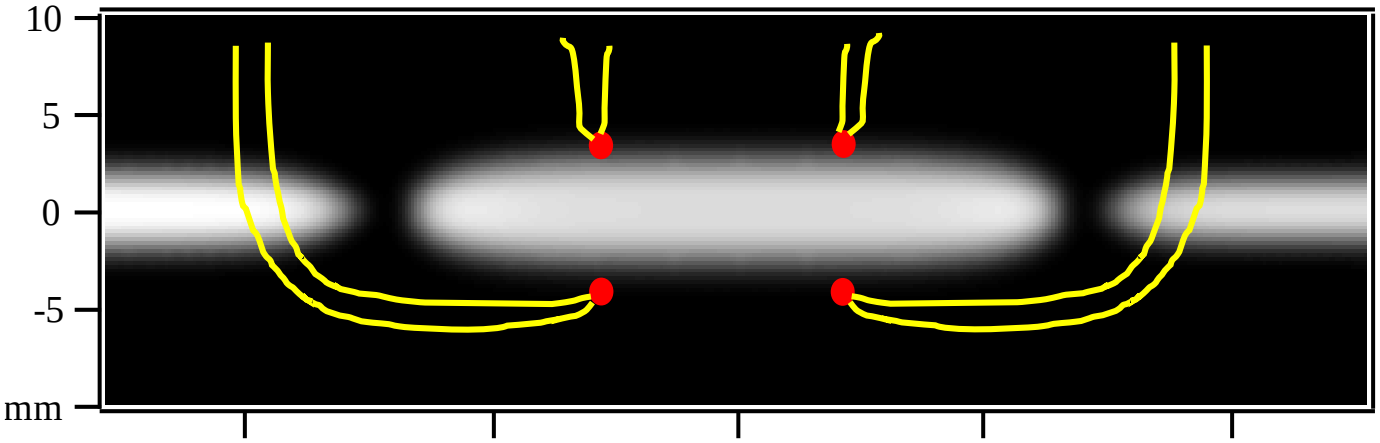

temperature fluctuation over 3 days, with / without temp. controller in cubicle of SR-BPM-C19
[degrees]
WITHOUT, April 21-22-23
WITH, April 28-29-30
Time [hours]
angle, without
angle, with
position, with
position, without
[um, urad]
Vertical position and angular stability of BM-19, from e-BPM


10
5
0
-5
-10mm
Vertical Position
DQ1D
SBM
DQ2C
-40
-20
0
20
40mm
Hor. Position
E=10 keV

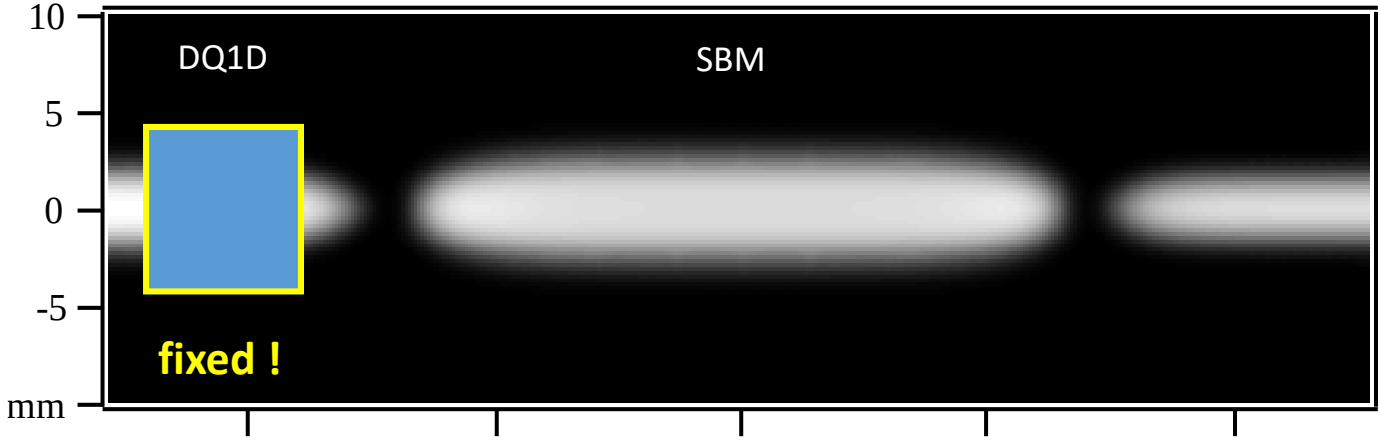

X-rays in
this vessel
to beam line



now, the interceptive optical X-BPM

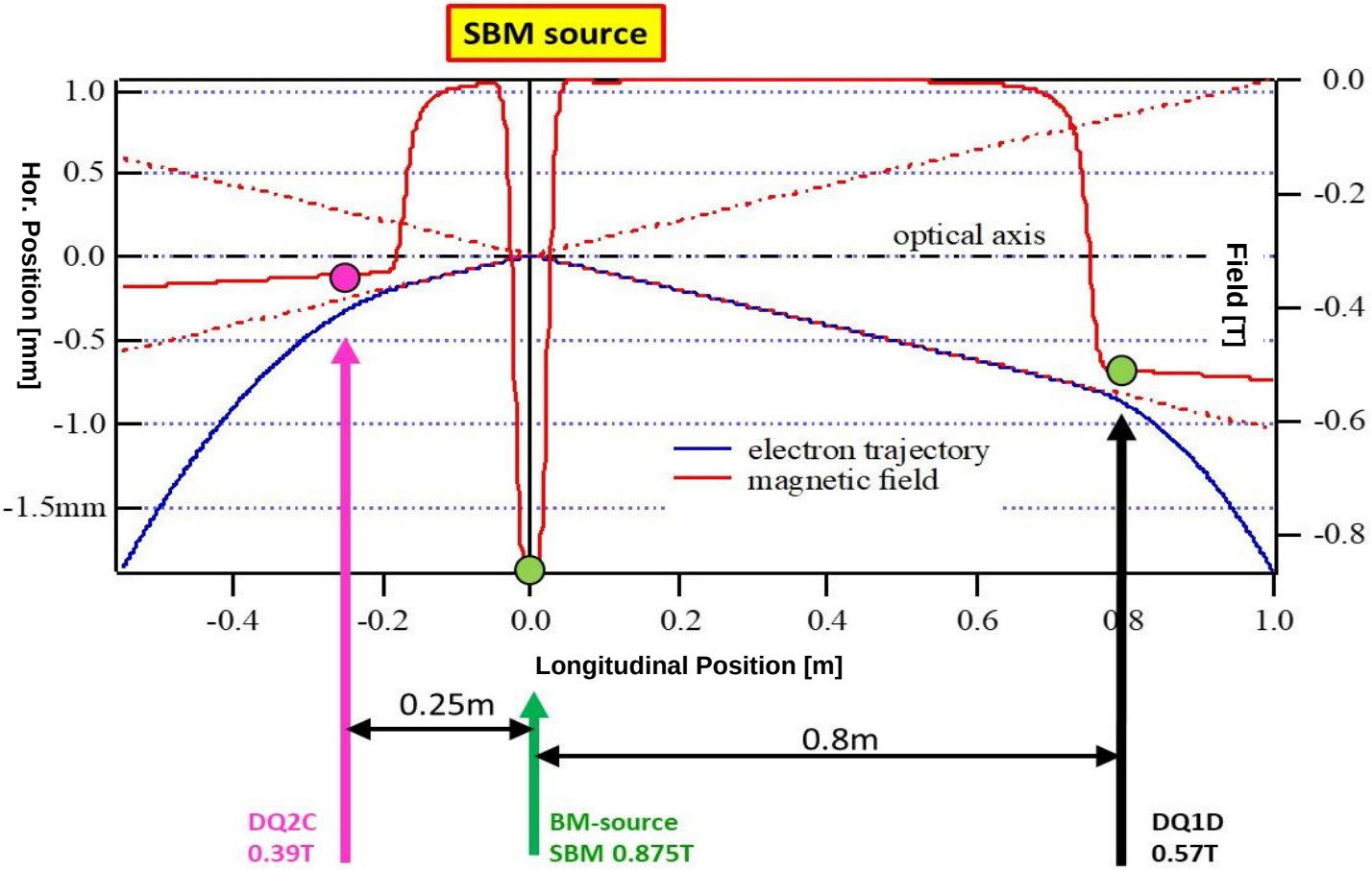


idea : the thermal X-BPM



proposal, the non-interceptive optical X-BPM

possibility to take the “next-door” X-rays for beam position monitoring …



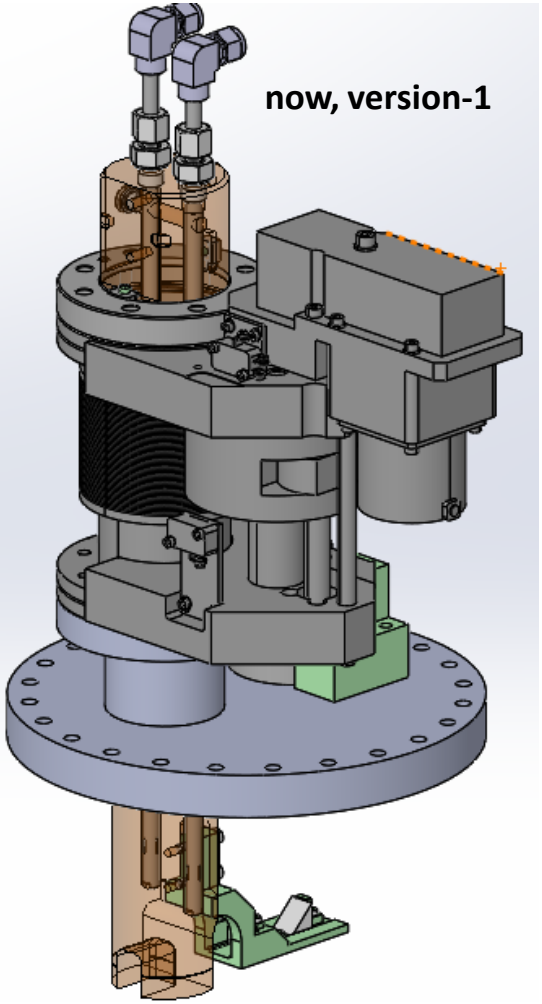
this shift of the longitudinal measurement point is not a problem :

absence of orbit corrector between the X-BPM source and the BM source

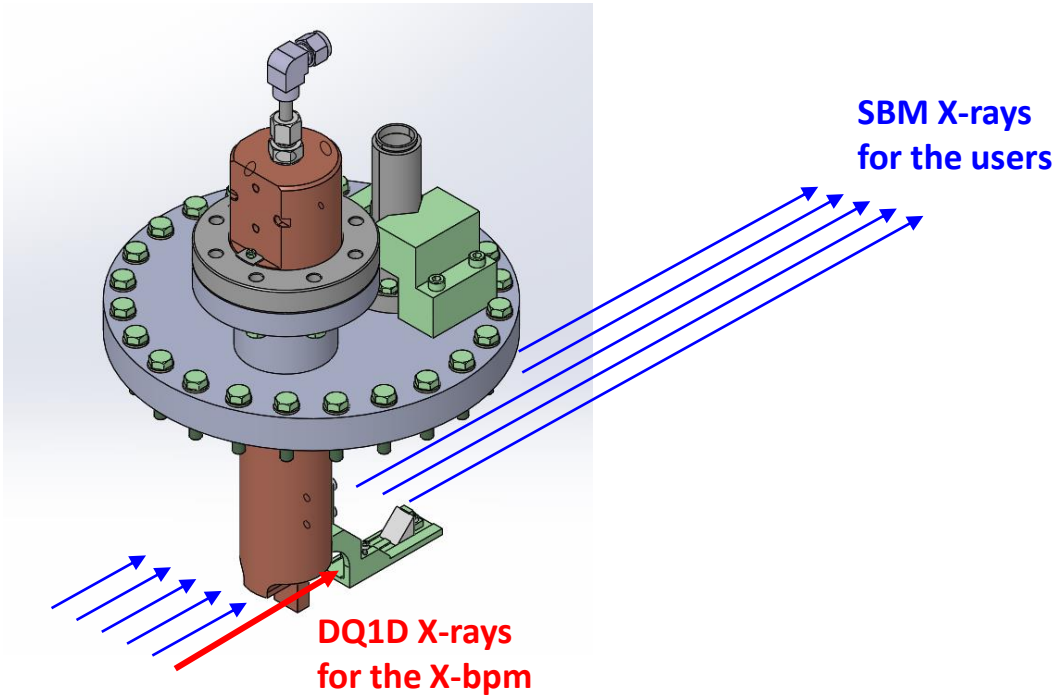
the magnets (DQs and QF8) not changed during a run and very rarely between runs

absence of non-linear element (sextupole/octupole) between the 2 sources

same concept also applicable for
the 2PW and 3PW
bending sources (in principle)



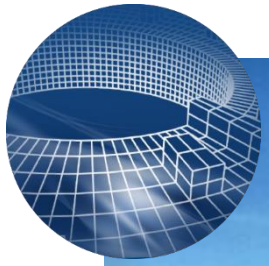
next, version-2 :
- permanent use !
- no UHV translation mechanism !



installation in August shut-down ??
more realistic : October shut-down

HZB Helmholtz Zentrum Berlin

DEELS-2022, June 7-8 Berlin



Kees Scheidt
ESRF
Grenoble

this Poor Man's X-BPM ,
using "next door" X-rays,
costing about 5K€

will never win a price …

but for us it will be an indispensable tool
for verifying the vertical stability of our BM-lines

thank you for your attention !