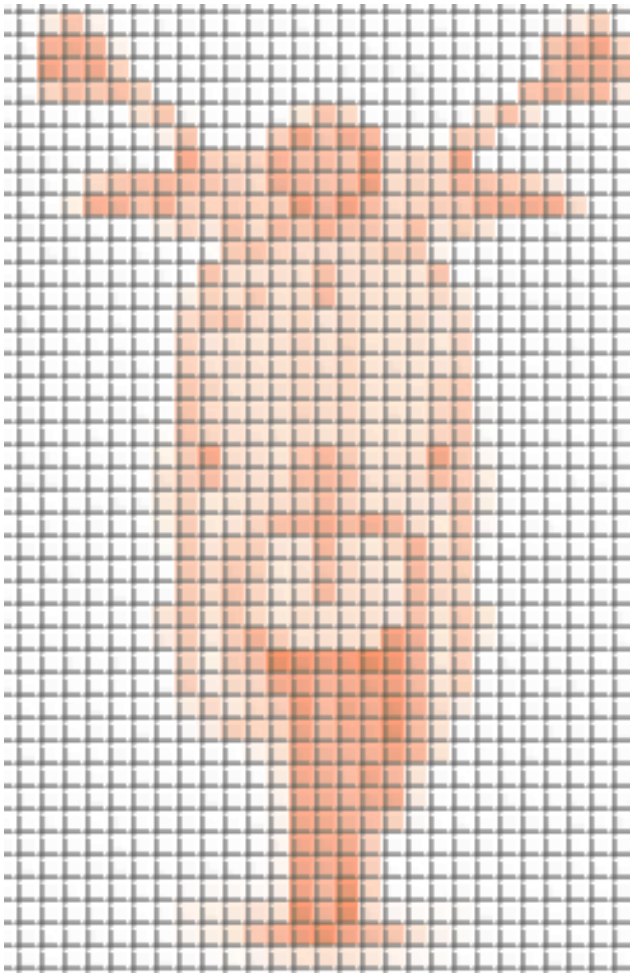
Monitors and Detectors

VESPA



Dr. Matteo Zanetti

CNR - Consiglio Nazionale delle Ricerche, ITA

Consiglio Nazionale delle Ricerche

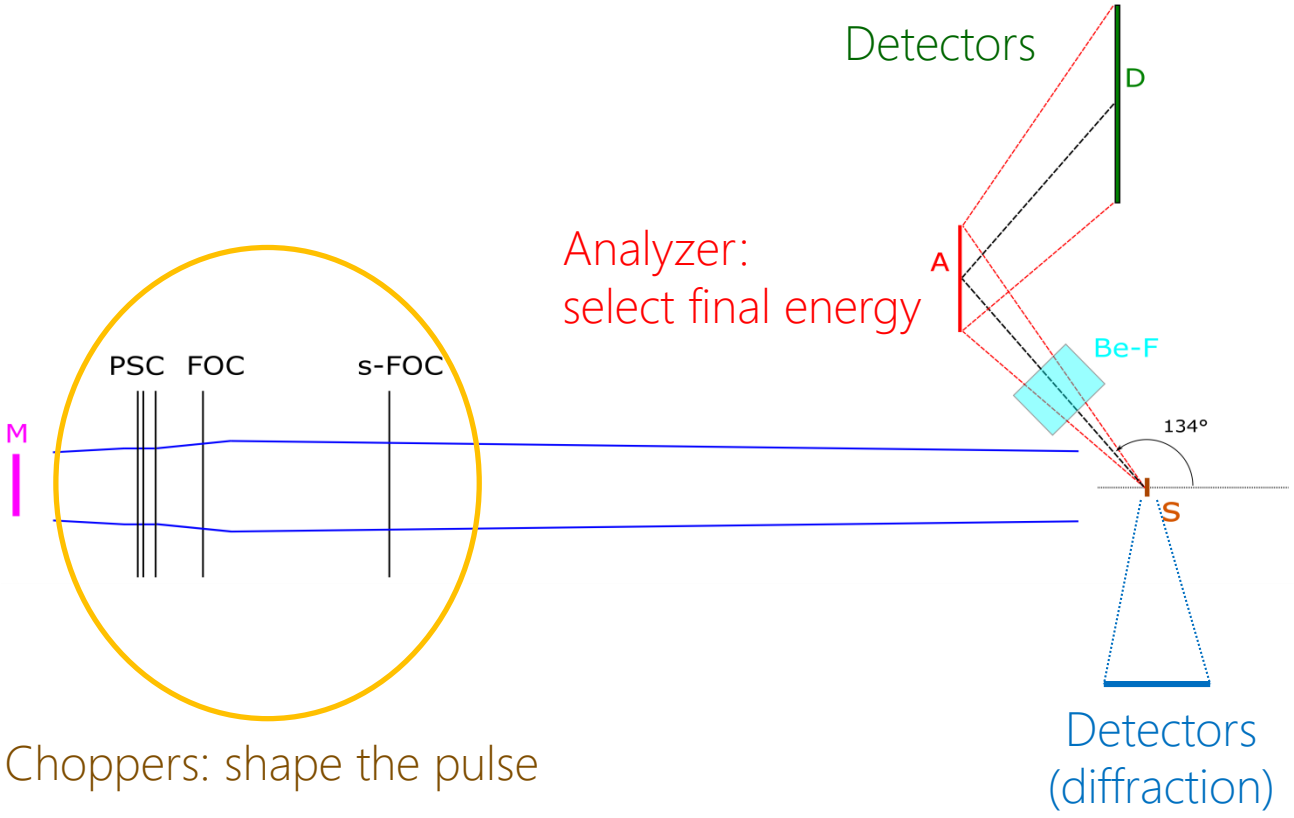
Science & Technology Facilities Council
ISIS

Outline

- VESPA
- Beamline monitors
- Spectrometer detectors
- Diffraction detectors

VESPA

Indirect-Geometry Spectrometer



Beamline

1 – diagnostics

from time to time:

- identify loss of beam due to occlusion of beam path
- check if choppers are working properly

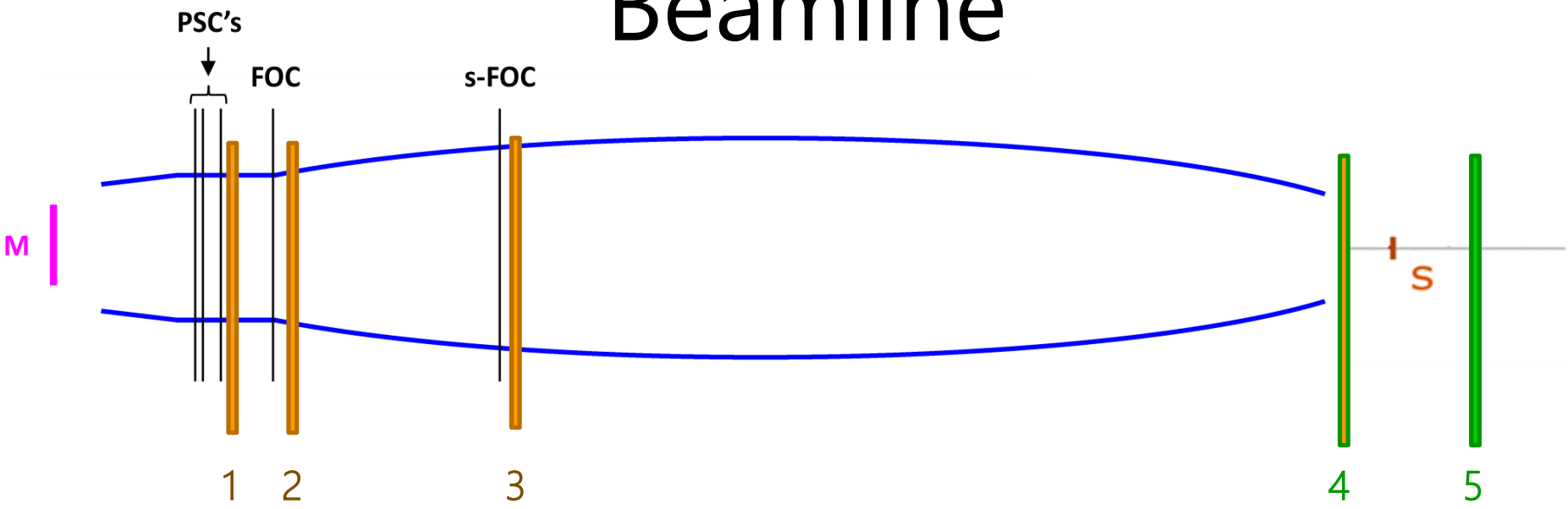
2 – normalization

3 – transmission

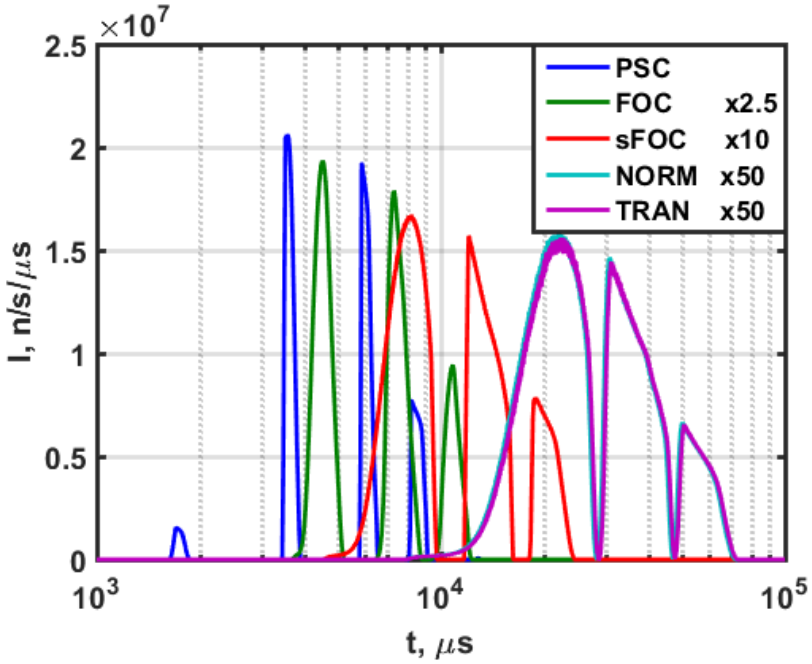
when measuring:

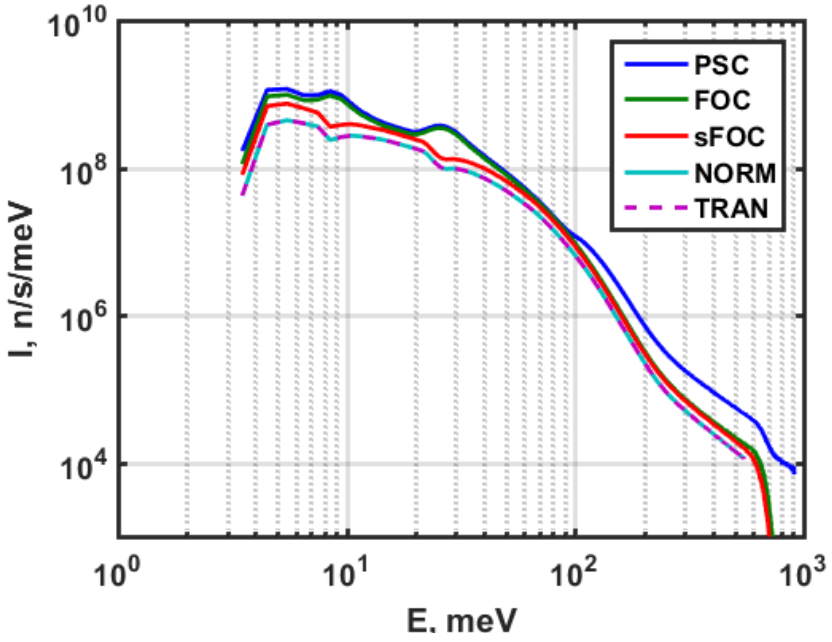
- normalization
- correction
- sample homogeneity
- total XS

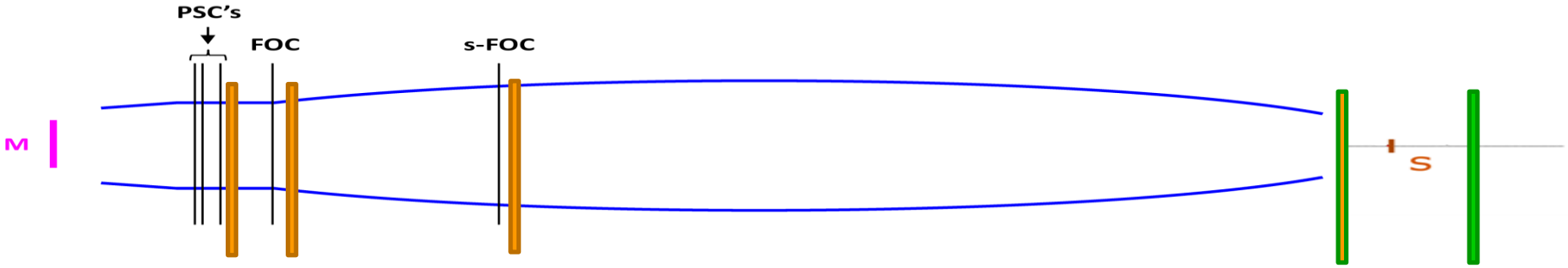
Beamline

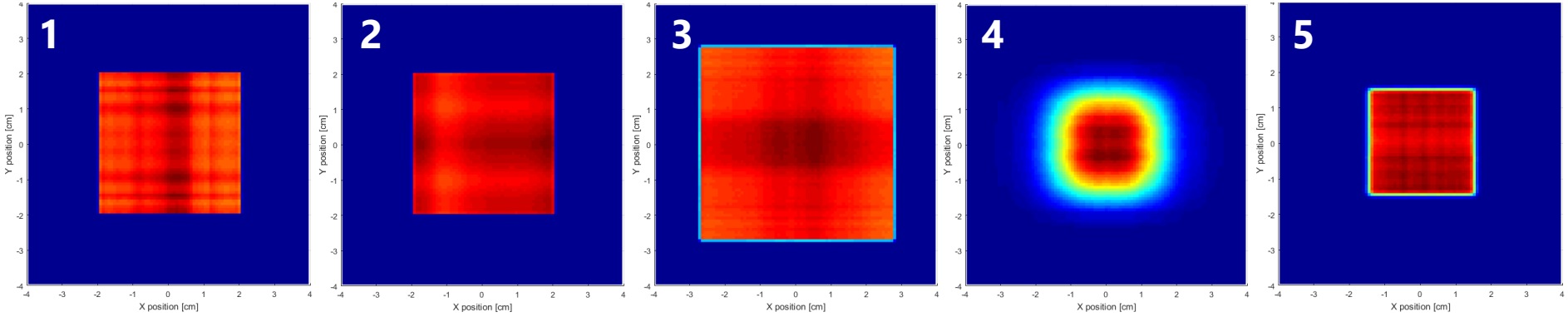


BM	position	function	PSD	movable	att.
1	After PSC3	1	yes	yes	-
2	after FOC	1	yes	yes	-
3	after s-FOC	1	yes	yes	-
4	between jaws and sample	1,2	yes	no	low
5	after sample	3	yes	no	-


×10^7
2.5
2
1.5
1
0.5
0
I, n/s/μs
PSC
FOC x2.5
sFOC x10
NORM x50
TRAN x50
10^3
10^4
10^5
t, μs


10^10
10^8
10^6
10^4
I, n/s/meV
PSC
FOC
sFOC
NORM
TRAN
10^0
10^1
10^2
10^3
E. meV


PSC's
FOC
s-FOC
M
S


1
2
3
4
5
Y position [cm]
X position [cm]

Beamline Requirements

Bunker	Guideline	Sample	Camera	Transmission
2	1	1	0	1

Zone	Local instantaneous rate n/cm^2.s peak value @ 5 MW	Local time averaged rate n/cm^2.s @ 5 MW	Beam size (cm x cm)	Time resolution us	Position Resolution (mm^2)	Number of Beam monitors
Bunker area	~13x10^5 in 1 us bin ~8x10^5 in 1 us bin	~7x10^7 , (3; 4 meV)* ~6x10^7 , (3; 4 meV)*	4. x 4.	tens	Yes	2
Along the guide	~8x10^4 in 1 us bin	~5x10^7 , (3;4 meV)*	5.5 x 5.5	tens	Yes	1
Close to the sample	~3.5x10^4 in 1 us bin	~4x10^7 , (3; 4 meV)* ~3x10^7 , (70;90 meV)*	3. x 3.	10	3x3 mm2	1
Transmission	~3.5x10^4 in 1 us bin	~4x10^7 , (3; 4 meV)* ~3x10^7 , (70;90 meV)*	3. x 3.	10	3x3 mm2	1

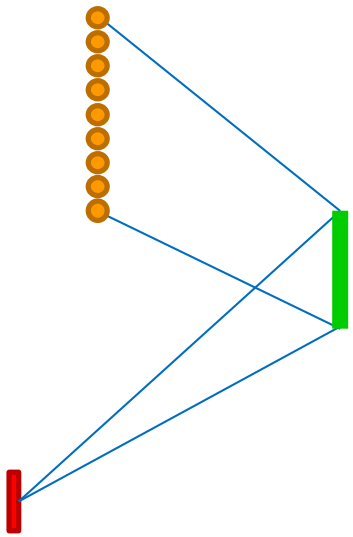
* integration range

Spectrometer

HOPG 002 ~ 45°: n Energy between 2 and 5 meV

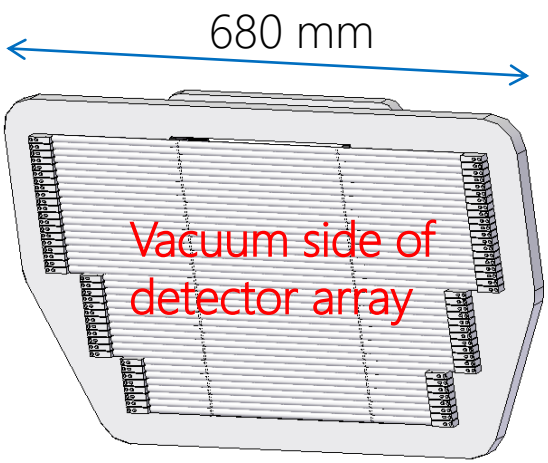
Need 1% HR Resolution: energy focusing, time focusing

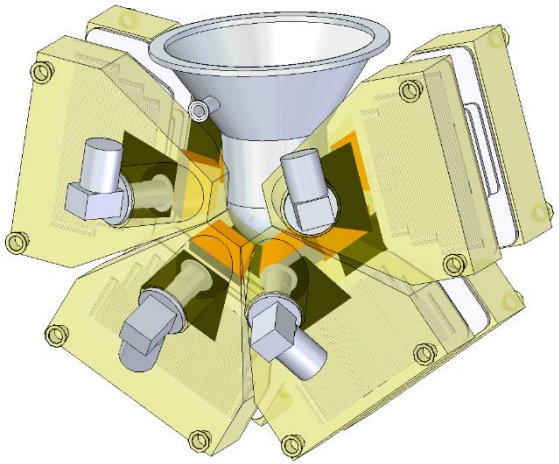
time focusing: reduce unc. on secondary time
flat geometry: depends on detector dimensions
area & thickness (squashed tubes)

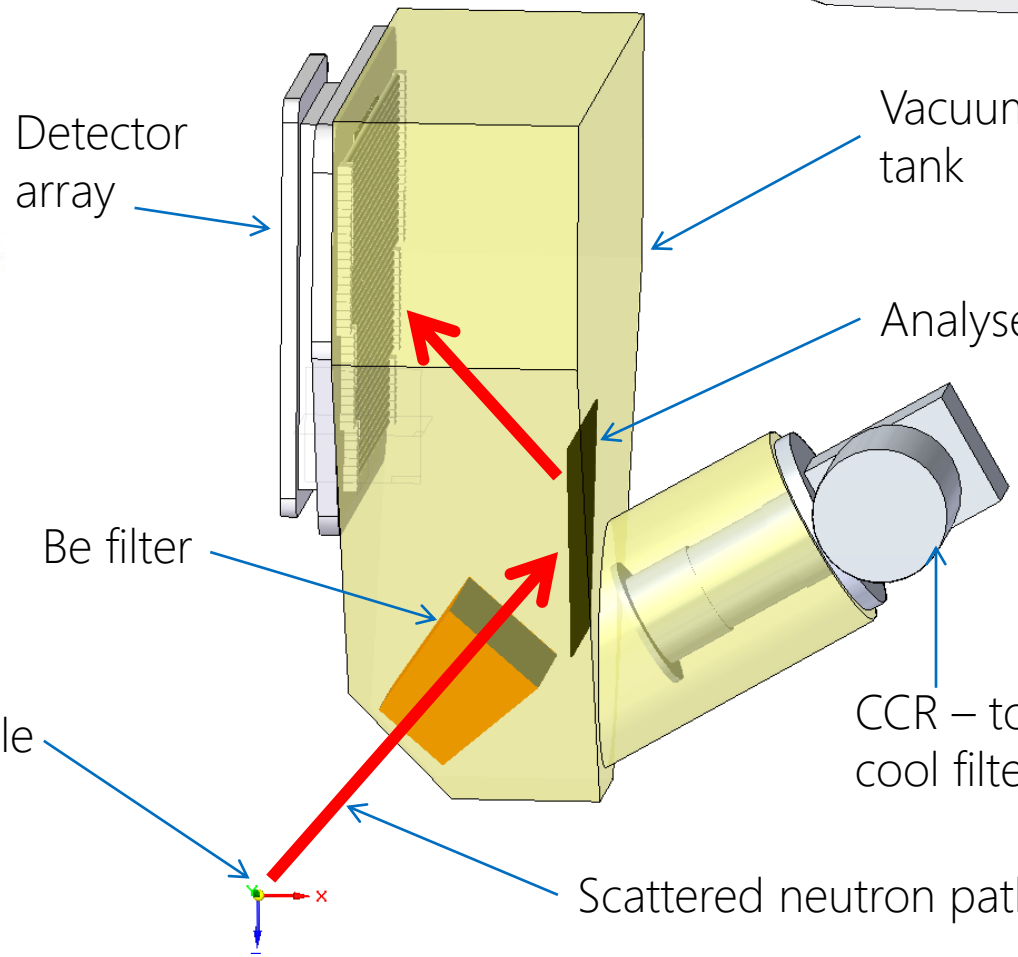


Detector array – He3 tubes (11 bar, t.res. 4-5 us)
In a vacuum box
Position sensitiveness?

Baseline


680 mm
Vacuum side of detector array




Detector array
Vacuum tank
Analyser
Be filter
Sample
CCR – to cool filter
Scattered neutron path
x

Baseline

"PSD" achieved vertically by using the array

Horizontal PSD: suppress spurious pulses

Possible saturation

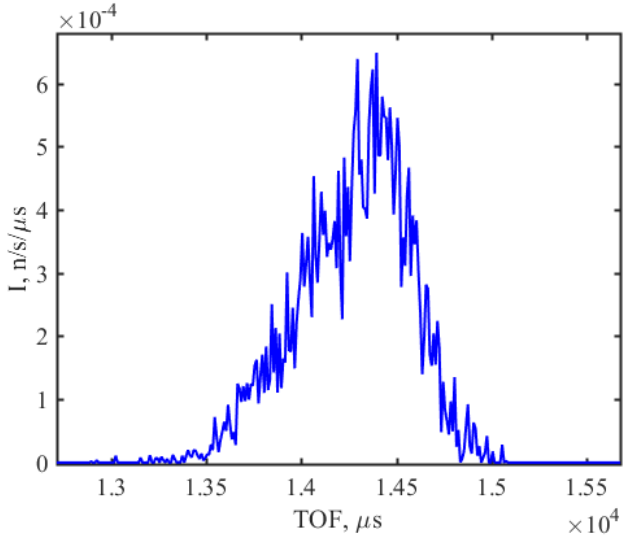
Small coverage (0.165 sr per bank)

Saturation?

ZrH2 simulation – old tapered guide, 5MW

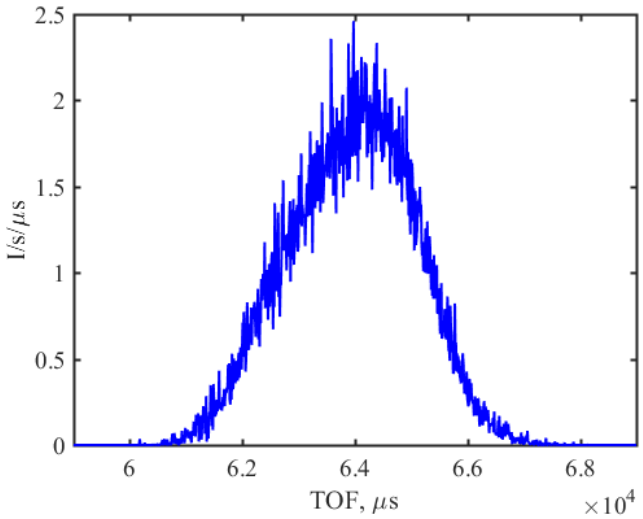
Inelastic @130 meV

~10 Hz/g (x2.5 new guide)



Elastic

>40 kHz/g

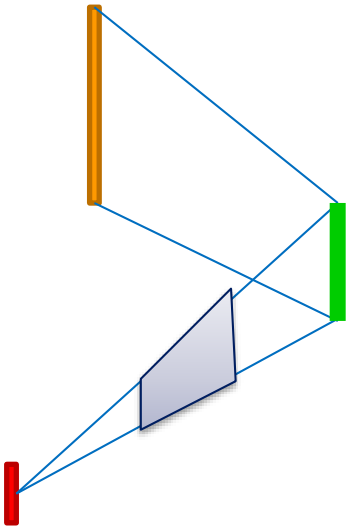


5% scattering power (standard requirement):

1.25 g @ 100 meV, 0.5g @5meV

Increase angular coverage

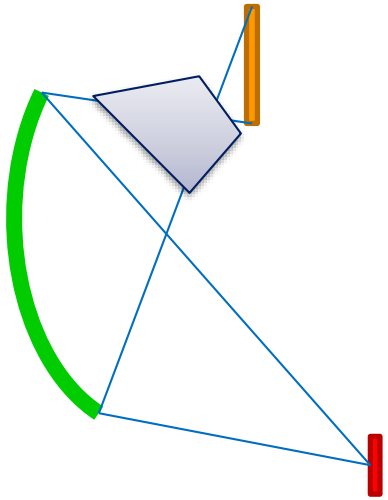
Baseline configuration —*optimized curved analysers*→ Phase 2 configuration



smaller & fewer detectors

x3 angular coverage

Be after analyser



Detector layout and PSD requirement change

Curvatures

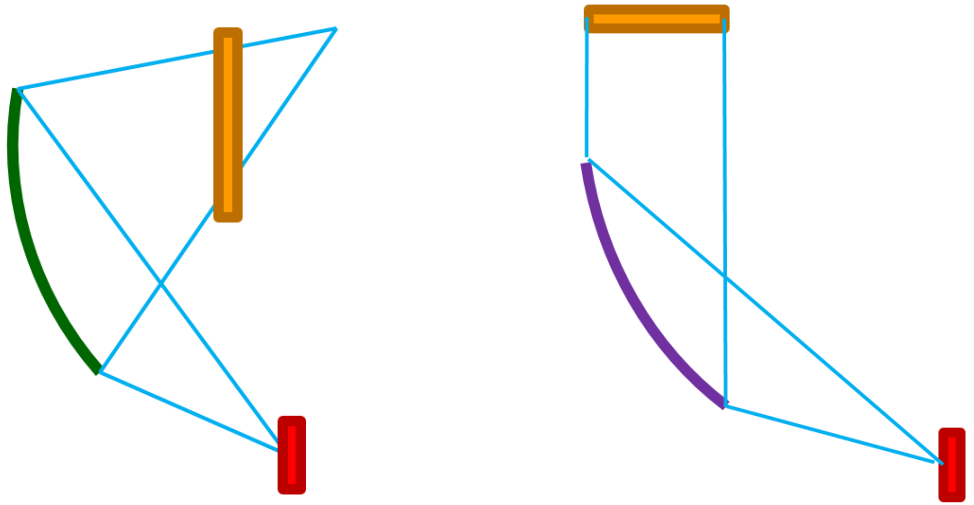
Vertical:

circular – energy focusing, secondary path length variable

elliptic– constant secondary path length, different energies

parabolic – idem but ***easier t.f.***

multiple focusing?



Horizontal:

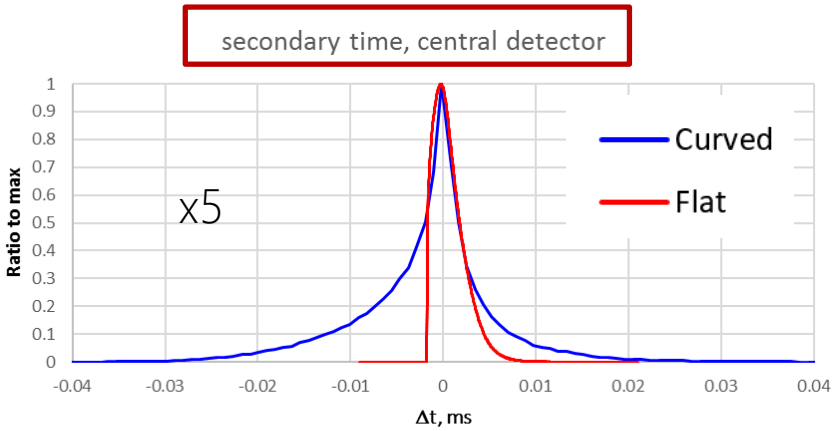
circular -> focusing,

need combination with PSD to correct changes in path length

Curved analysers can lose time focusing and need to be designed carefully

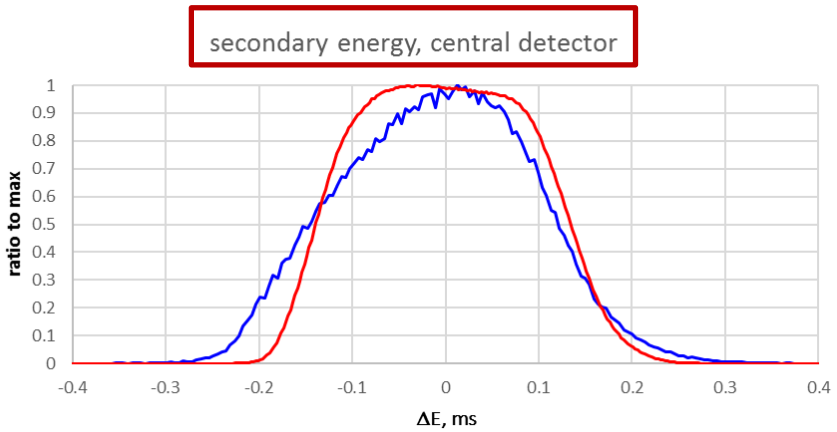
This sums to incident ToF for each incident energy:

contributes as
s(Dt) K_1 $E^{3/2}$
to relative resolution



This is constant w.r. to incident energy:

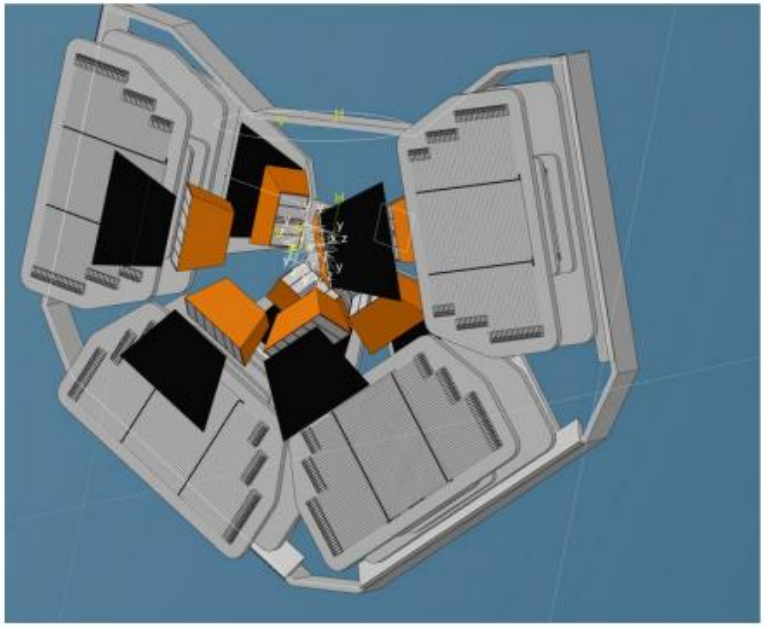
contributes as
s(DE) K_2 E^{-1}
to relative resolution

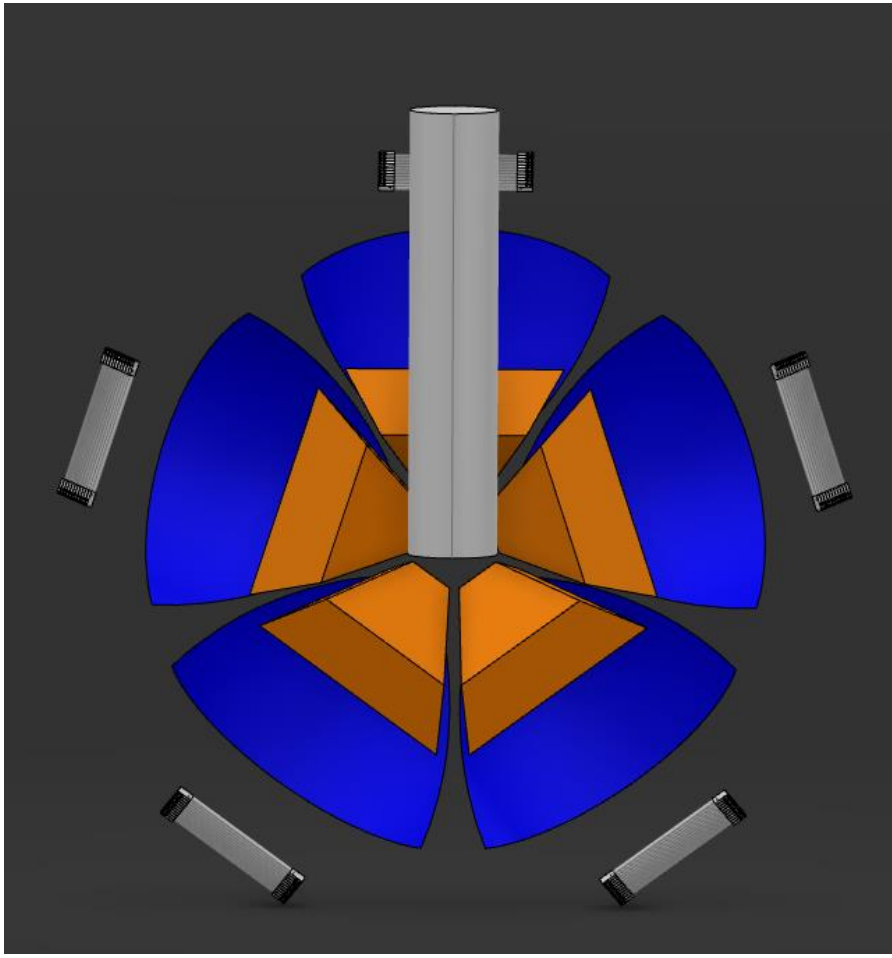


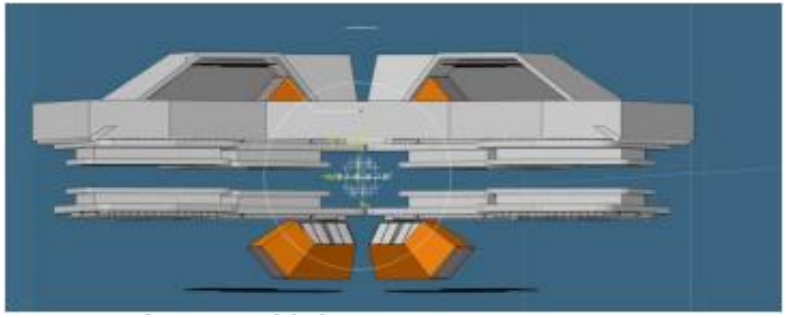
<u>Optimizing analyser and detector geometry to meet our high-resolution 1% (relative) target</u>

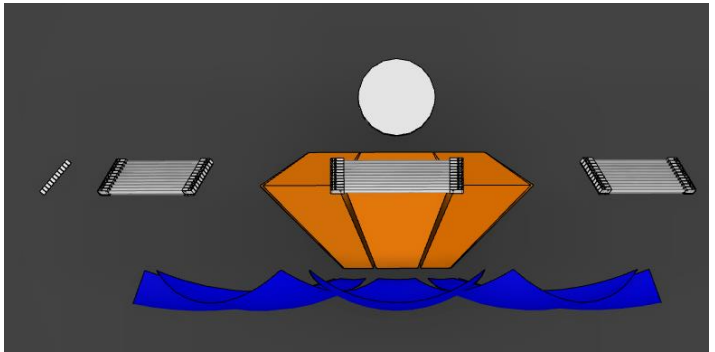
Place focus far from detectors

Concepts

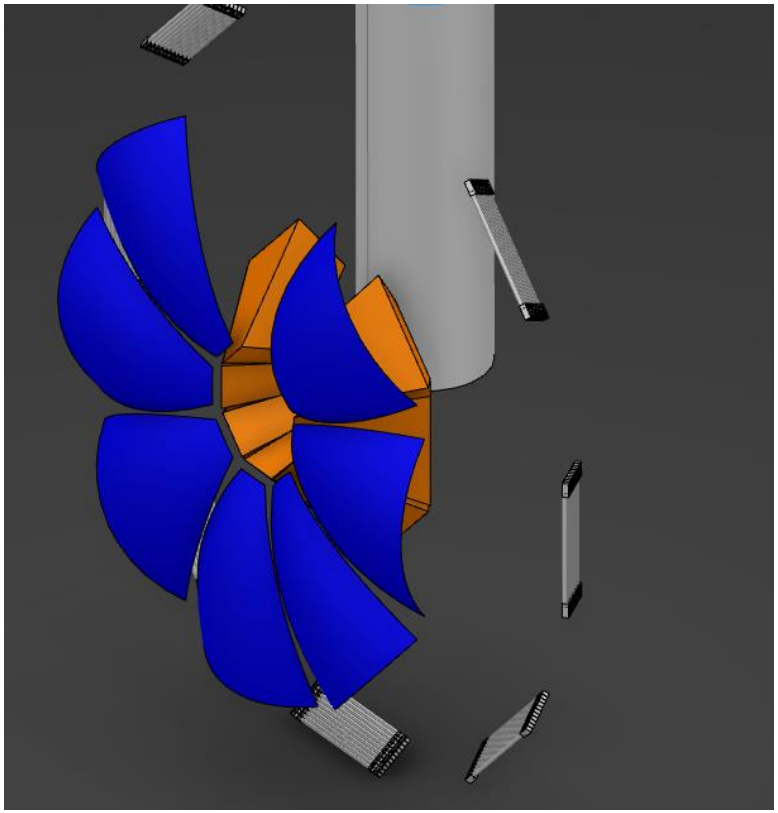


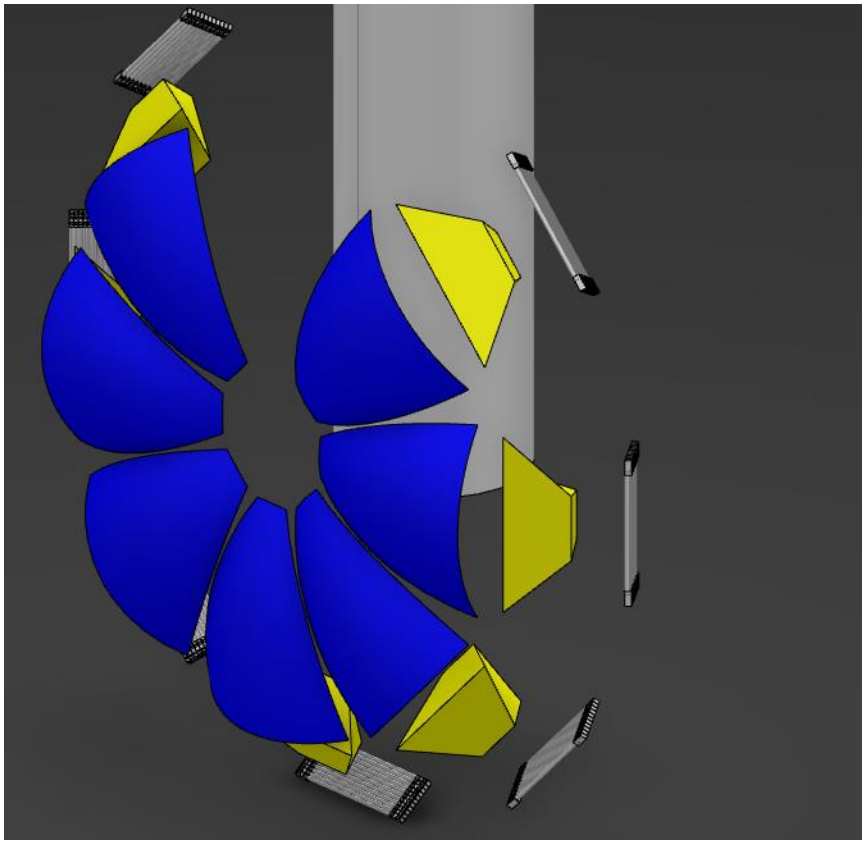




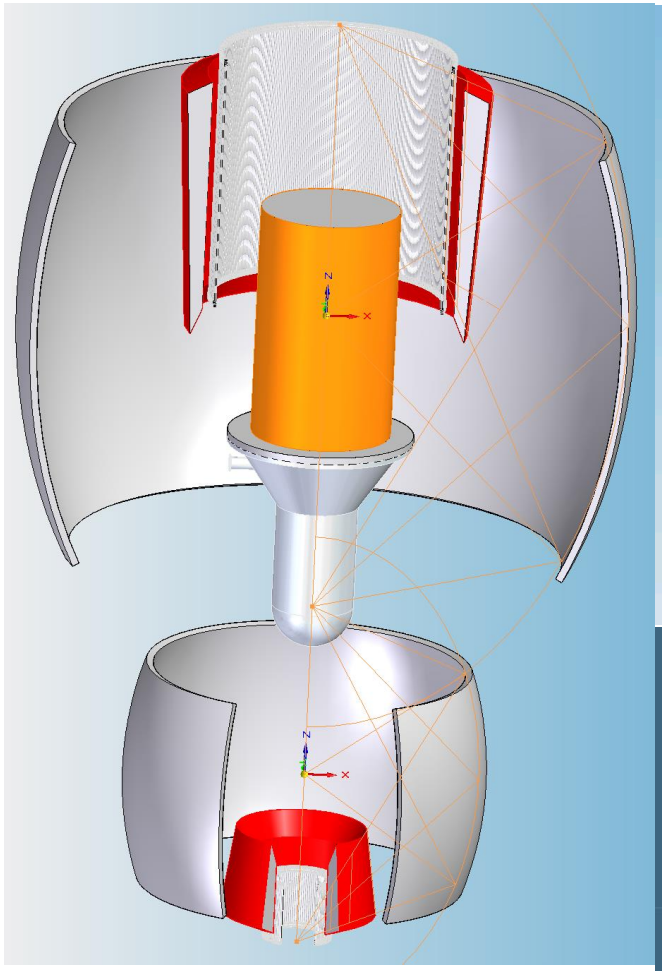


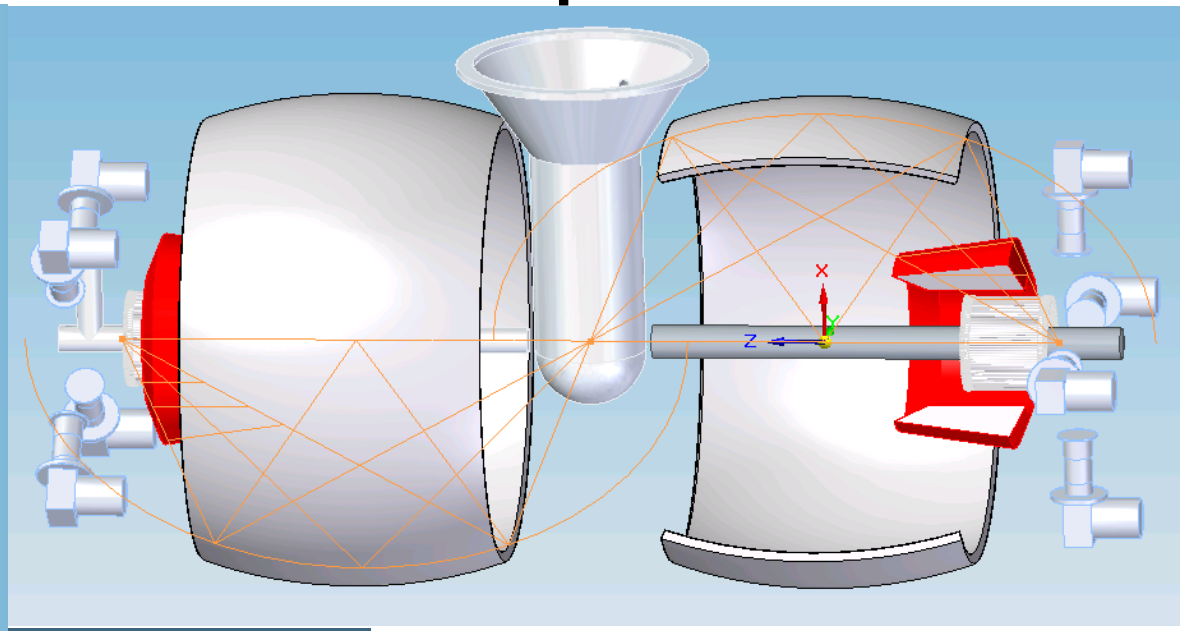
Concepts





Other concepts





Circular arrangement
PSD on vertical –
a matter of precision!

Curved Analyzers Concepts

Vertical or horizontal “PSD” by using the array
Other direction: PSD tubes become a necessity

Circular arrangement for tubes can make sense

Saturation & loss of PSD feature become more probable

Increased coverage, goal x3 – depends on:
cost, complexity, resolution

Diffraction

Standard capabilities to asses sample quality

full scope: 3x 90 ° and 1x backscattering

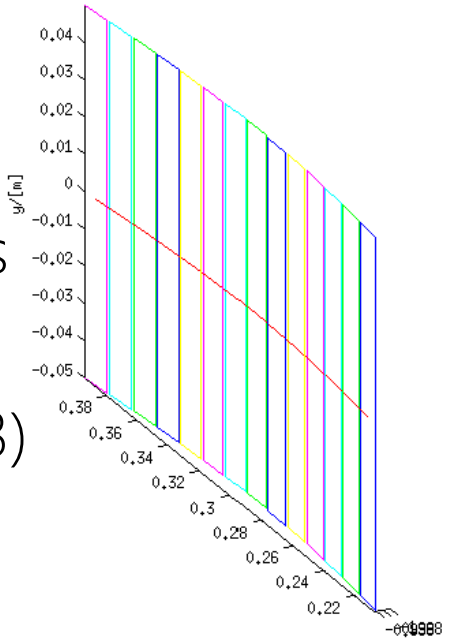
day 1: 1 small 90° bank

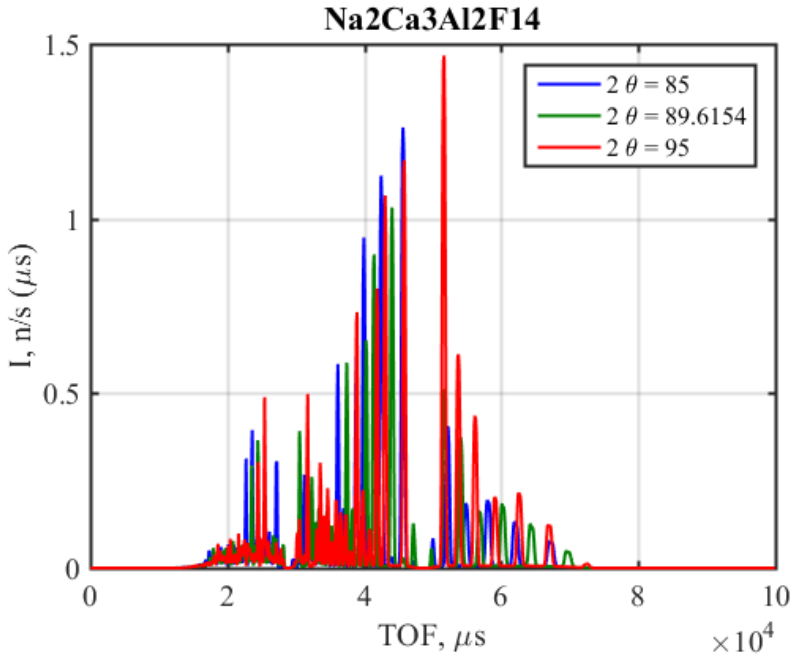
14 He3 tubes (1.2 cm x 10 cm)
at a constant radius of 1m from sample,
covering scattering angles 85°-95°

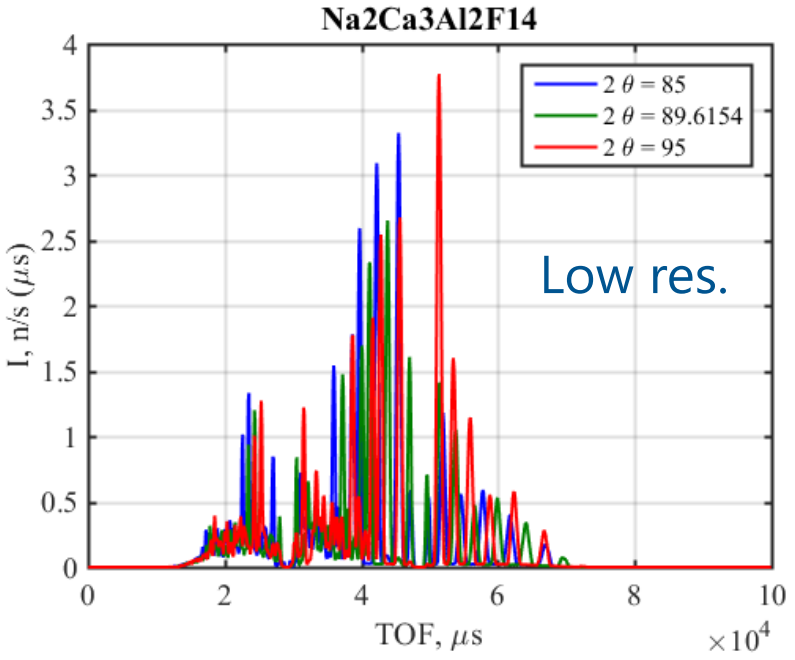
Set of changeable collimators to select resolution/cope with scattered neutrons

Baseline

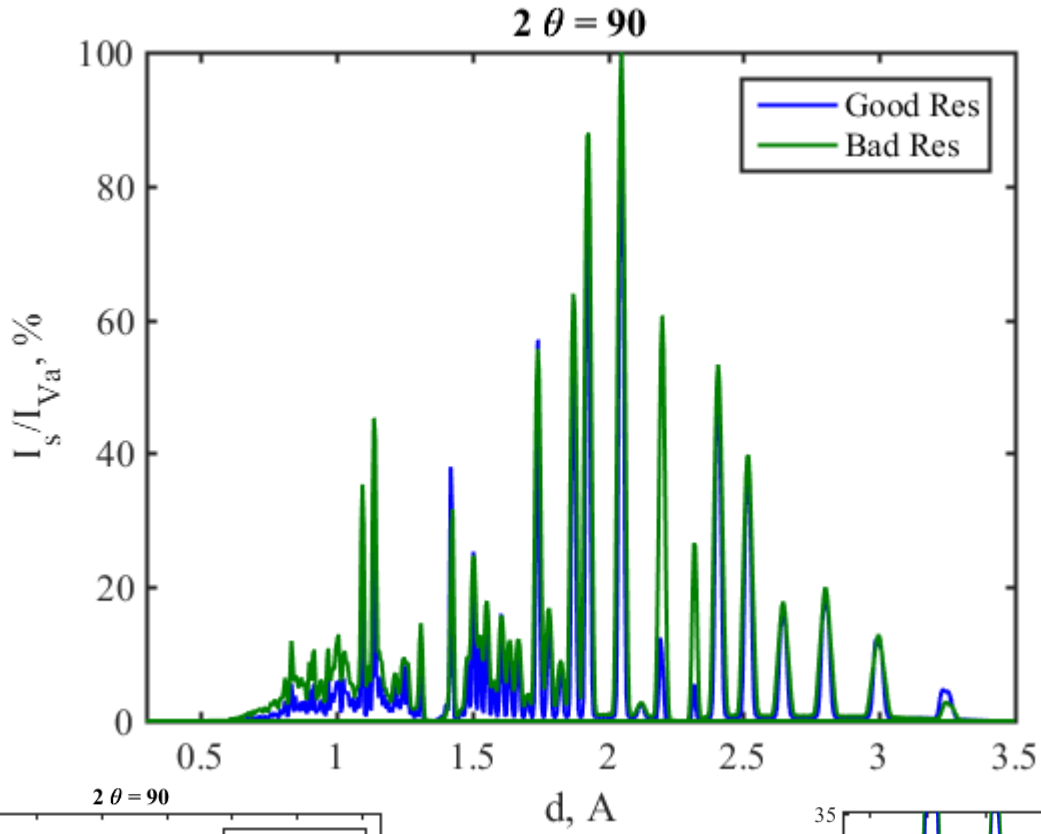
- Simulation of VA and NaCaAlF calibration samples
- “Spectroscopy” sample dimensions (3x3x0.2 cm^3)



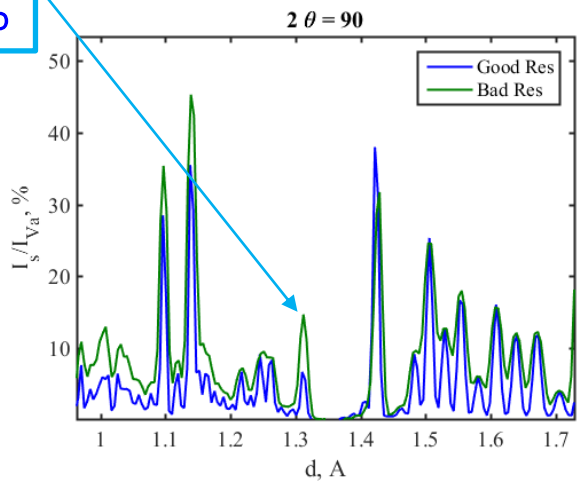




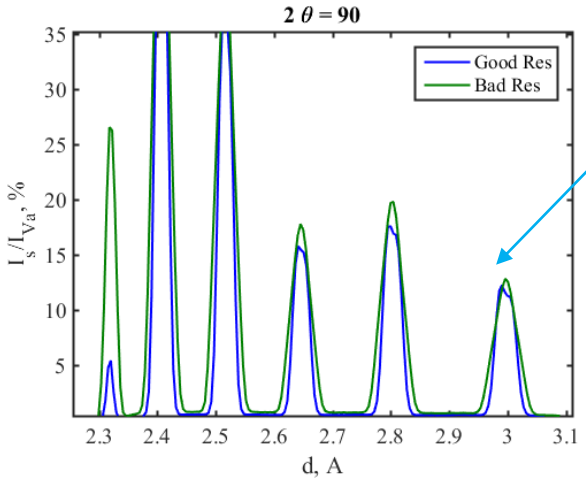
Reduced data – comparison



1.5 %
0.9 %



1.6 %
1.2 %



Saturation?

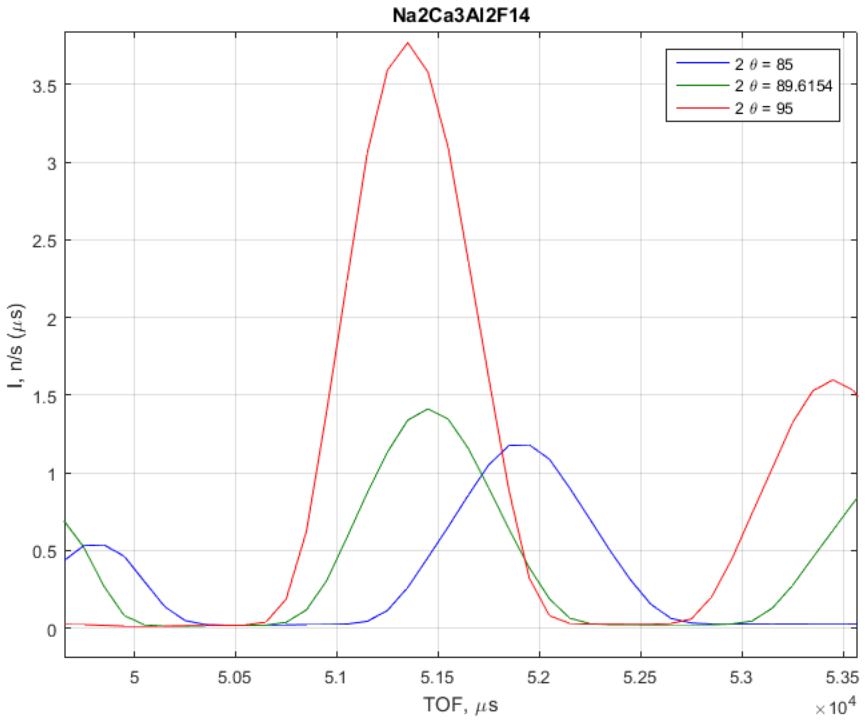
NaCaAlF simulation – old tapered guide, 5MW

>40 kHz/g

Most intense peak

No collimator,
no air, no V can

5% scattering power (ZrH2):
1.25 g
5% scattering power (NaCaAlF):
5.2 g



Summary

Beam monitors:

PSD for diagnostics, movable

Avoid attenuation

He tubes (11 bar - PSD):

Spectrometer, diffraction - Saturation ?

Final layout not ready – can influence det. tech

Shielding of detectors can influence the layout

Acknowledgments

VESPA TEAM (CNR, ISIS)

TOSCA TEAM (ISIS)

ISIS Detector Group

Thank you for your attention

Science & Technology Facilities Council
ISIS