Blade Runner

– from Risø to PSI and beyond…

N. B. Christensen, Ch. Niedermayer, K. Lefmann, H. M. Rønnow *et al.*

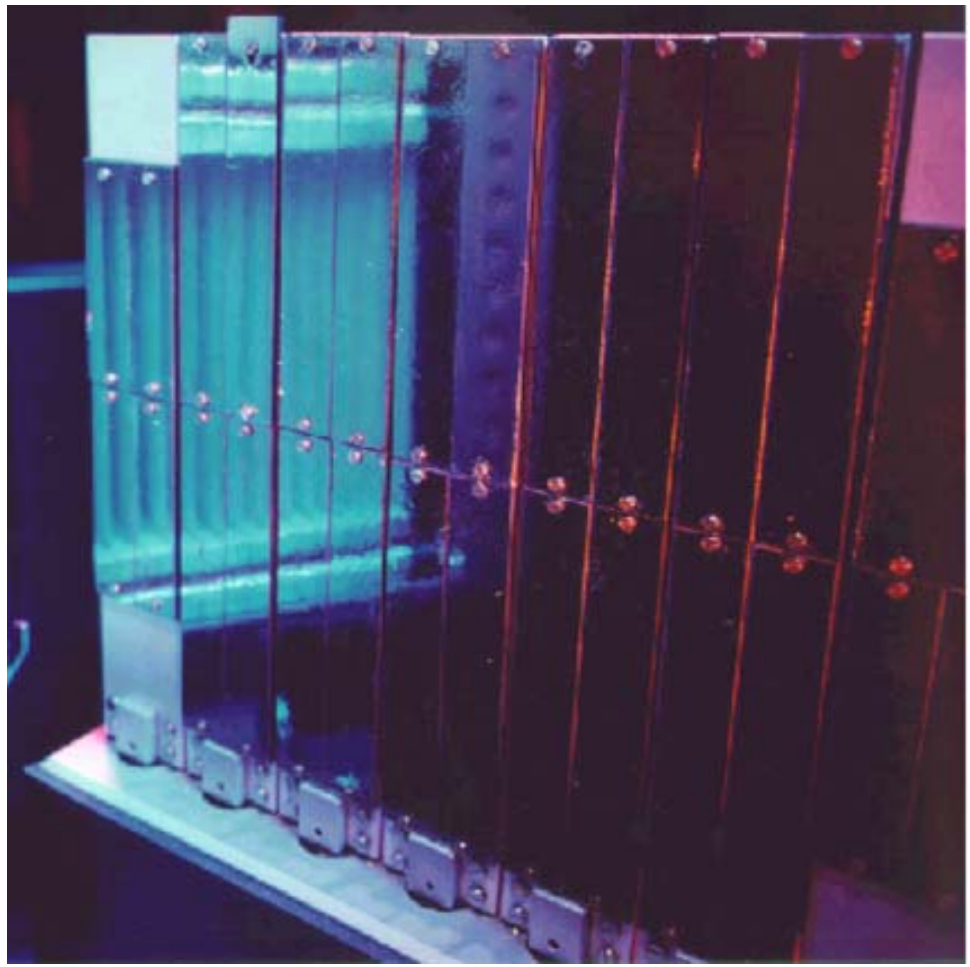
RITAs

Those Blades ...

- Individual blades
- PSD detector

- The RITA philosophy re-think it all:
  - Focusing optics
  - Velocity selector
  - Filters:

    Be, BeO, Al_2O_3, …
  - Flexibility / customization



Blade falder af, blomster falder af
Guds kærlighed fallerallera

The RITA spectrometer at RISØ

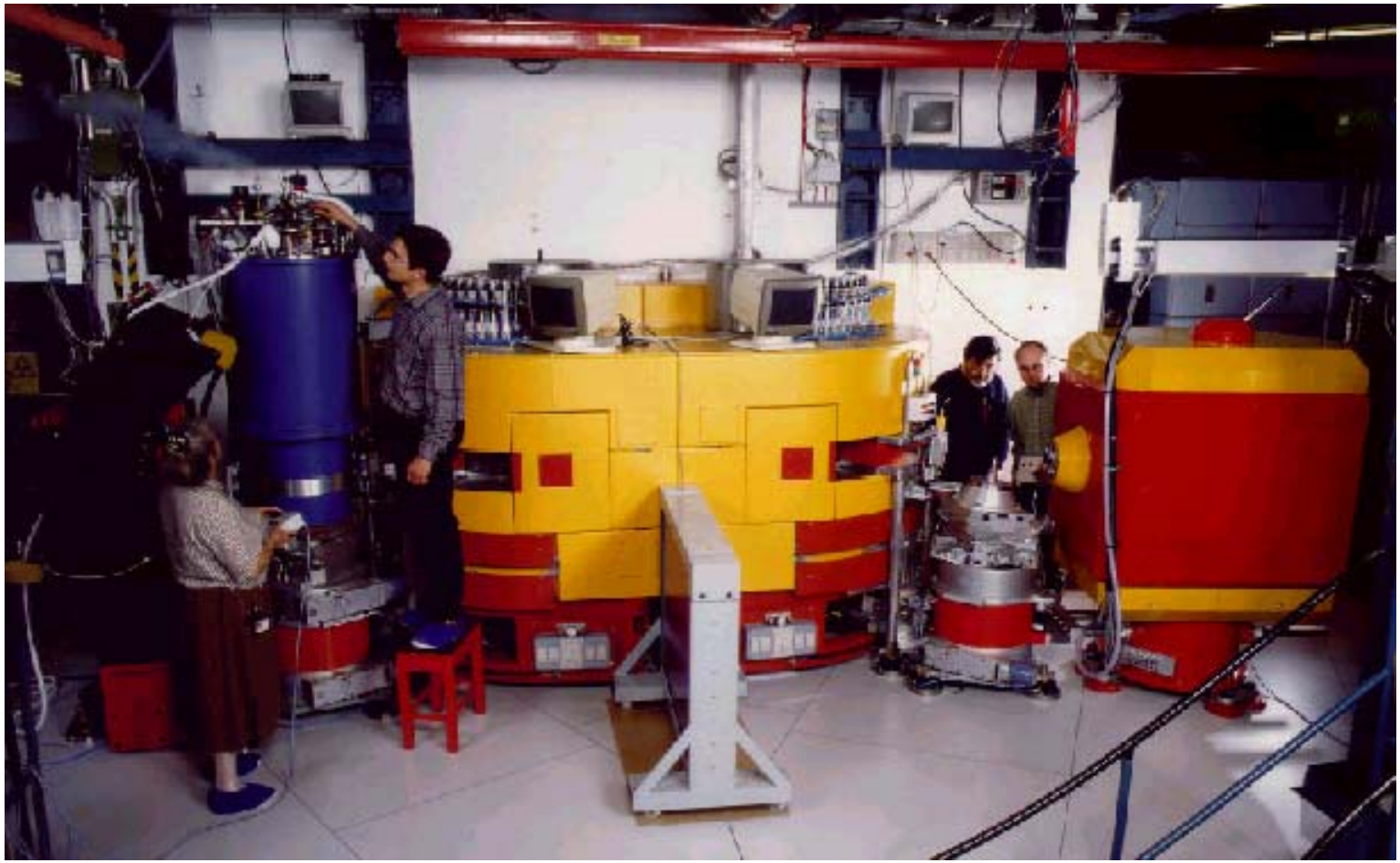
Re-Invented Three Axis spectrometer

- Filtered, velocity selector, focusing front-end
- Back-end tank with multi-blade analyser and position sensitive detector
- Modular and flexible design of components

KN Clausen, DF McMorrow, T Mason, G Aeppli, K Lefmann *et al*

Modular flexibility: RITA + TAS3

TAS3: Thermal neutrons



RITA: Cold neutrons

RITAs luke-warm TAS – the need for speed

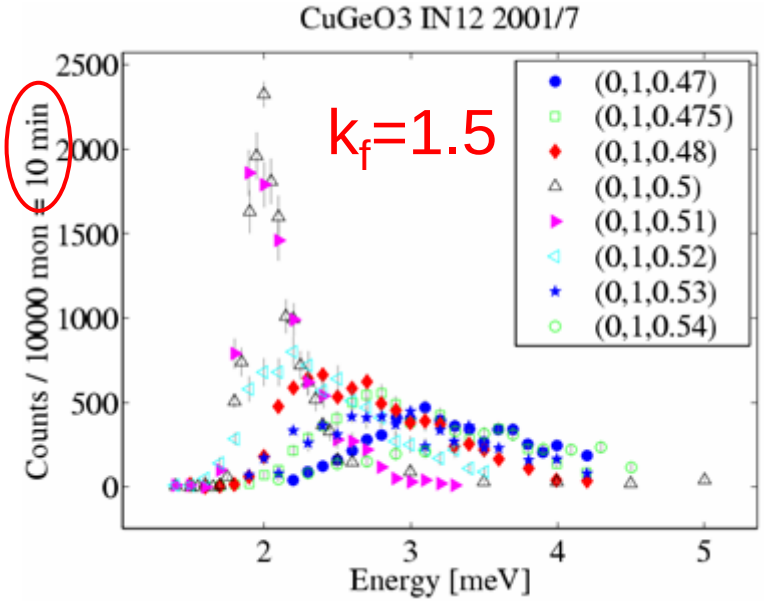
- why Velocity Selector ?

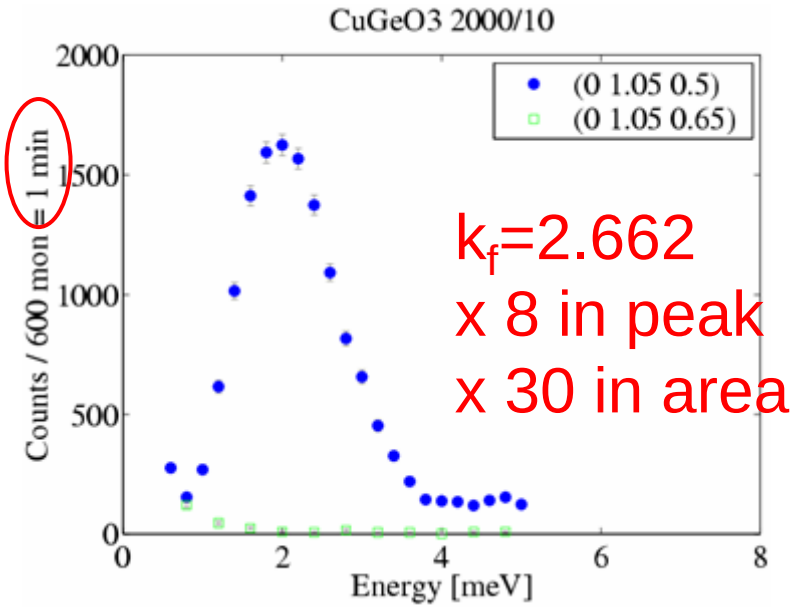
- Gap between cold and thermal
  k_f = 1.54 – 2.662 Å
  ΔE = 0.15-1.0 meV

- Remove λ/2
- Clean beam

- Transmission ~85%
- Rejection 0.1-1%

- Tiltable

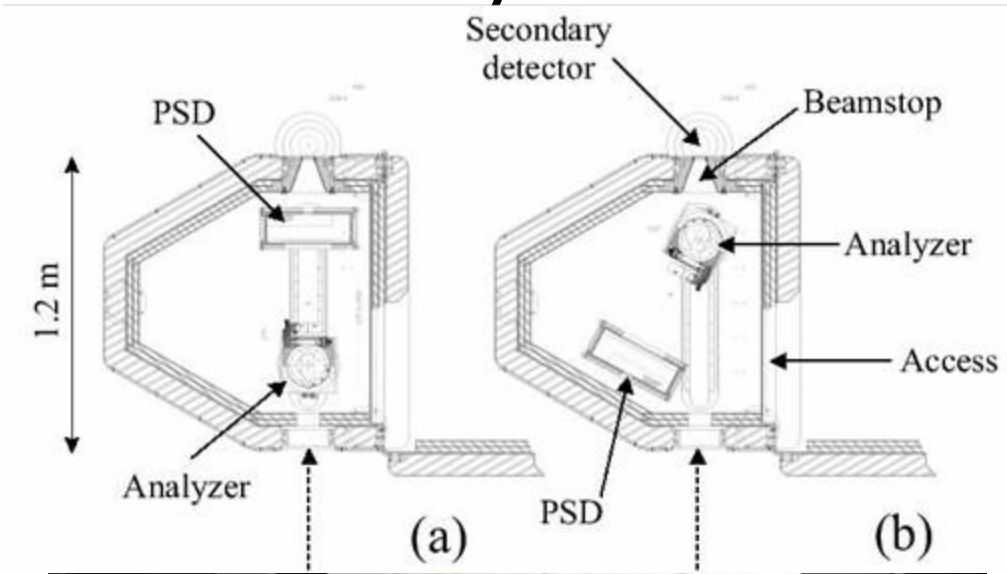




Collimators, filters etc.

- Filters
  - Be, BeO, PG, GE-wafers diamond…
  - $\lambda/2$, energy-cut-off (sub-Gaussian tails), broad-band analyser
  - Flexible – easy to change $\Rightarrow$
- Put collimator blades in filters.
  - Conventional straight collimators
  - Radial collimators for focusing configurations.

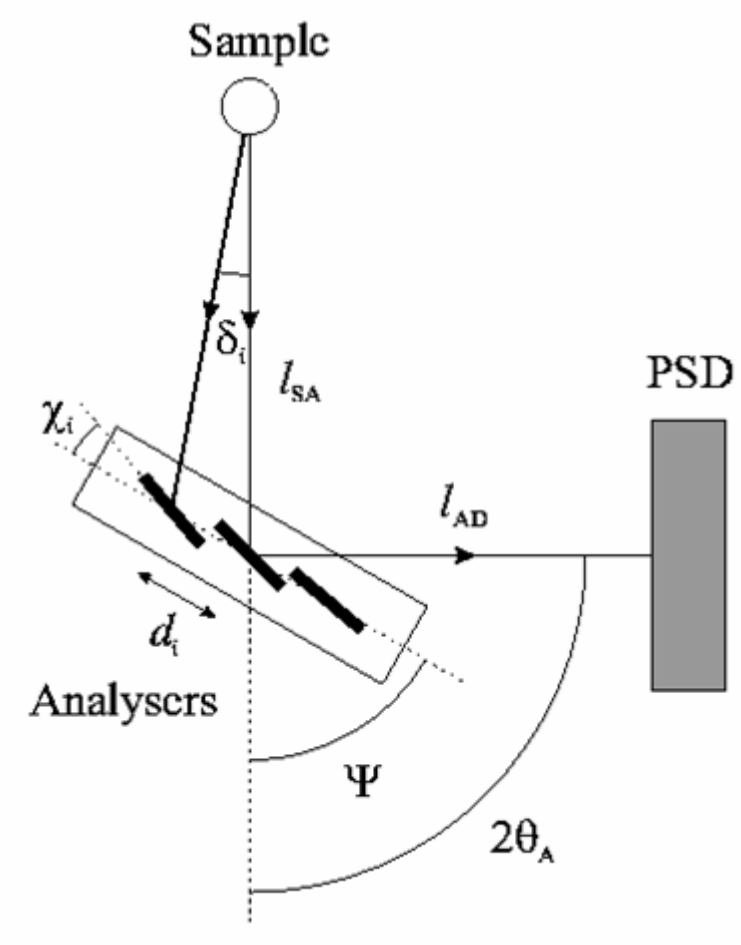
The Inside Story



Multi-blade analysers

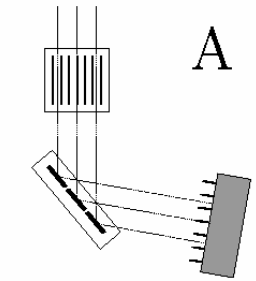
- Flexible focusing,
  resolution tuning,
  mapping

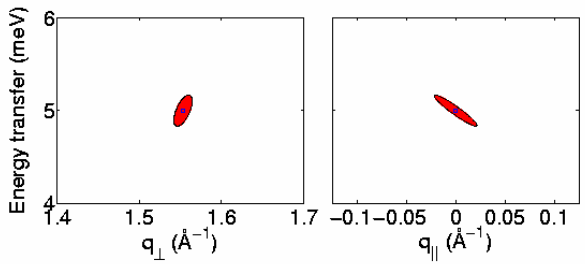
- By turning the block, we have some freedom in positioning the blades
- Each blade has its own little resolution ellipse in ($q_{||}$, $q_{\perp}$, E)
- “backwards compatible”

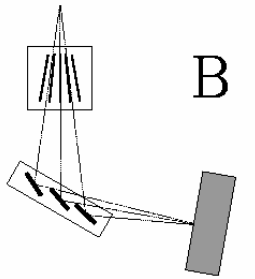


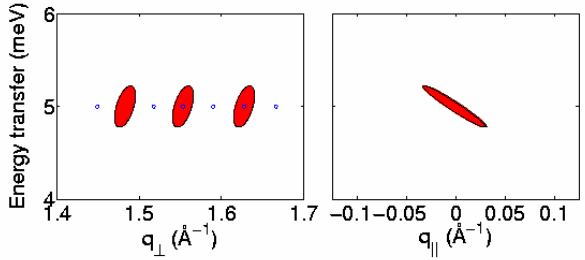
Focusing configurations

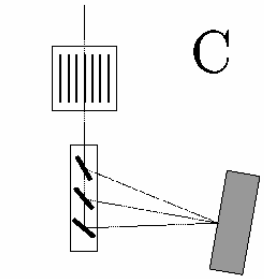
- A) Standard analyser, size of ellipse depends on collimation.
- B) Focusing in energy
- C) Focusing in $Q_\perp$
- Relaxing focal point on detector gives freedom in Q/E range
- Any combination possible

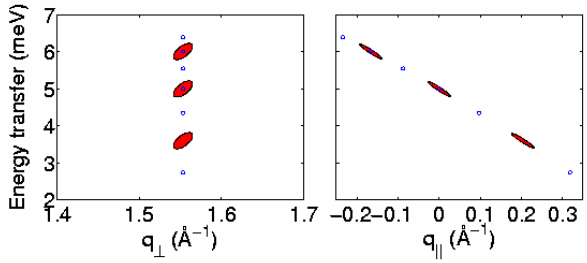






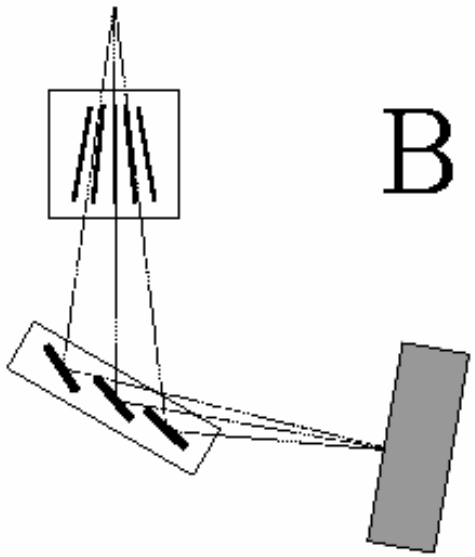


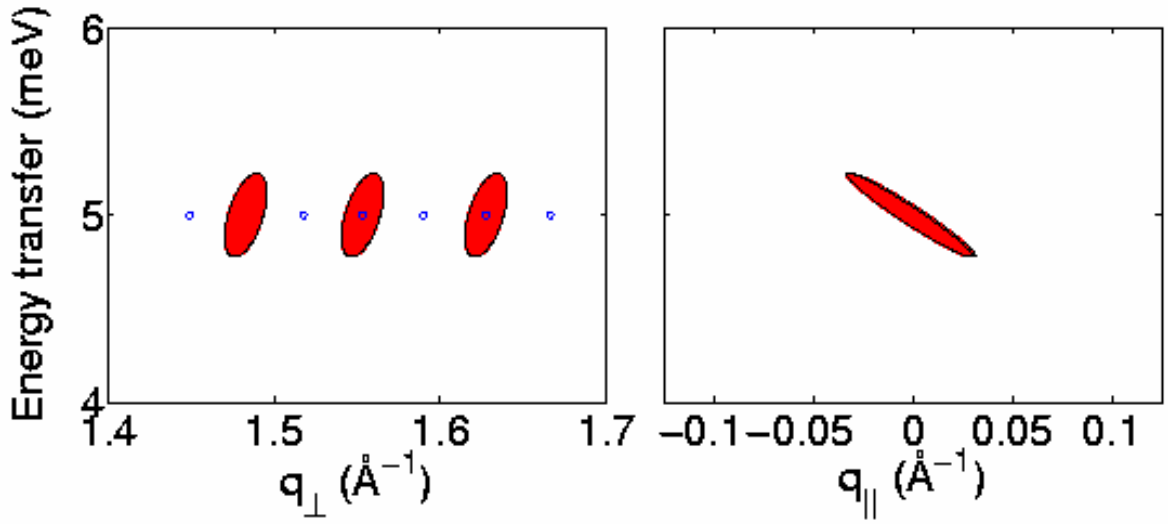




Focusing in $Q_\perp$

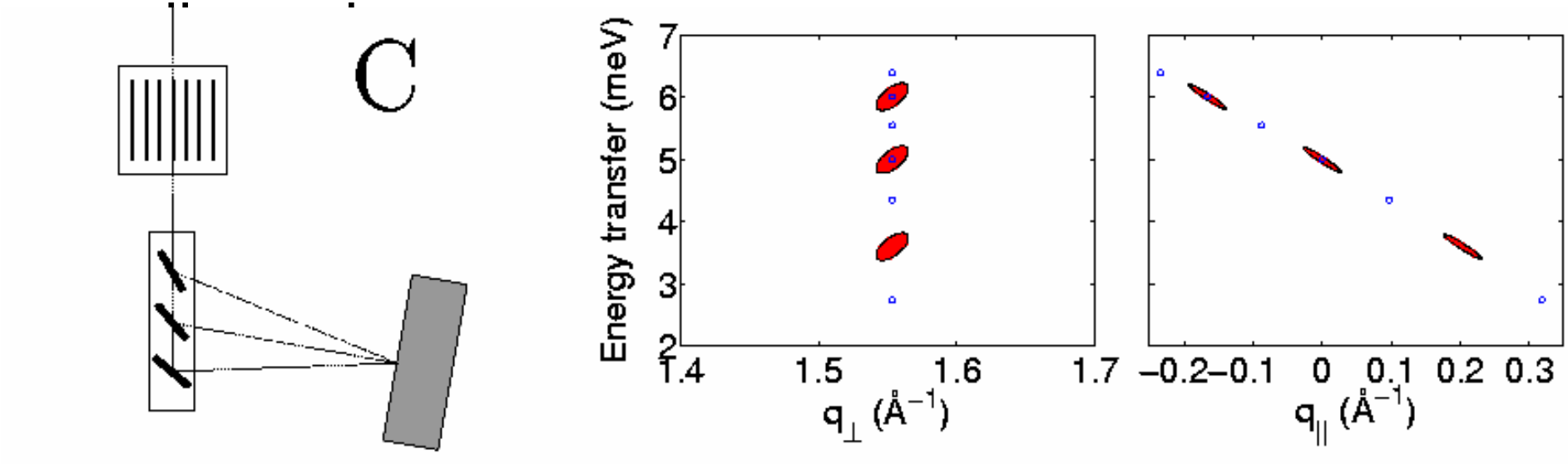
- Relaxing focusing condition on the detector gives freedom in Q/E range.
- The $Q_\perp$ width can thereby be adjusted.





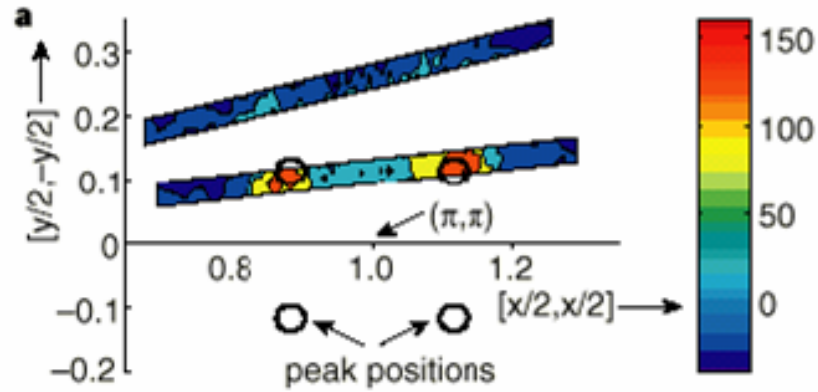
Focusing in energy

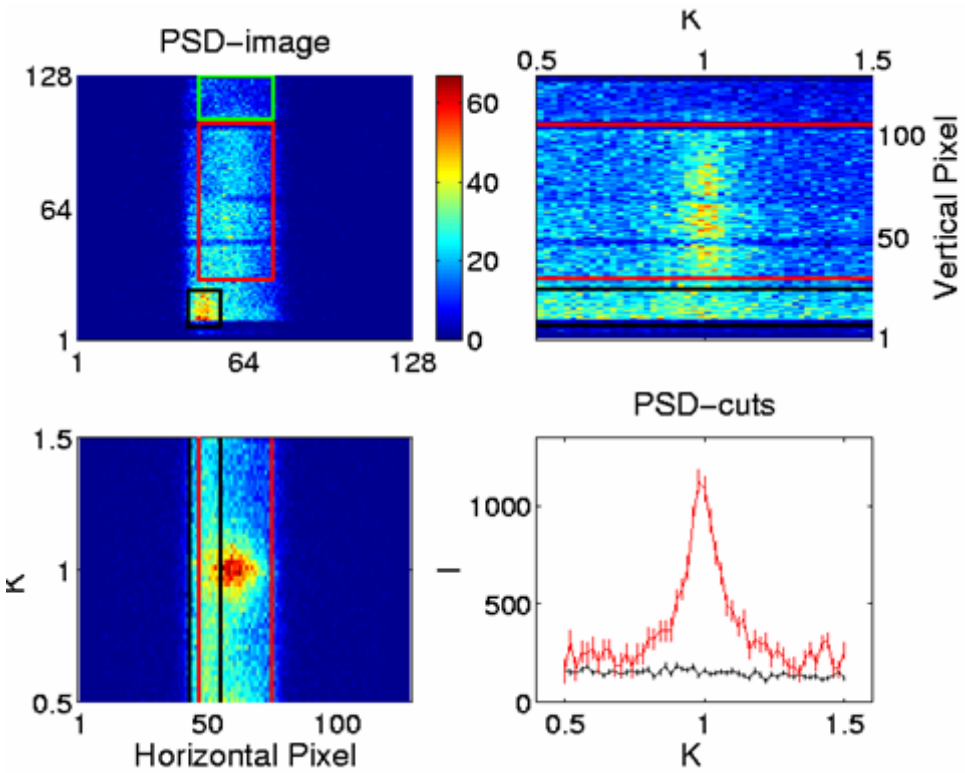
- Again, the width in energy and Q|| can be adjusted through the final focal point
- Any combination between energy and Q focusing is possible - can even be changed to follow a

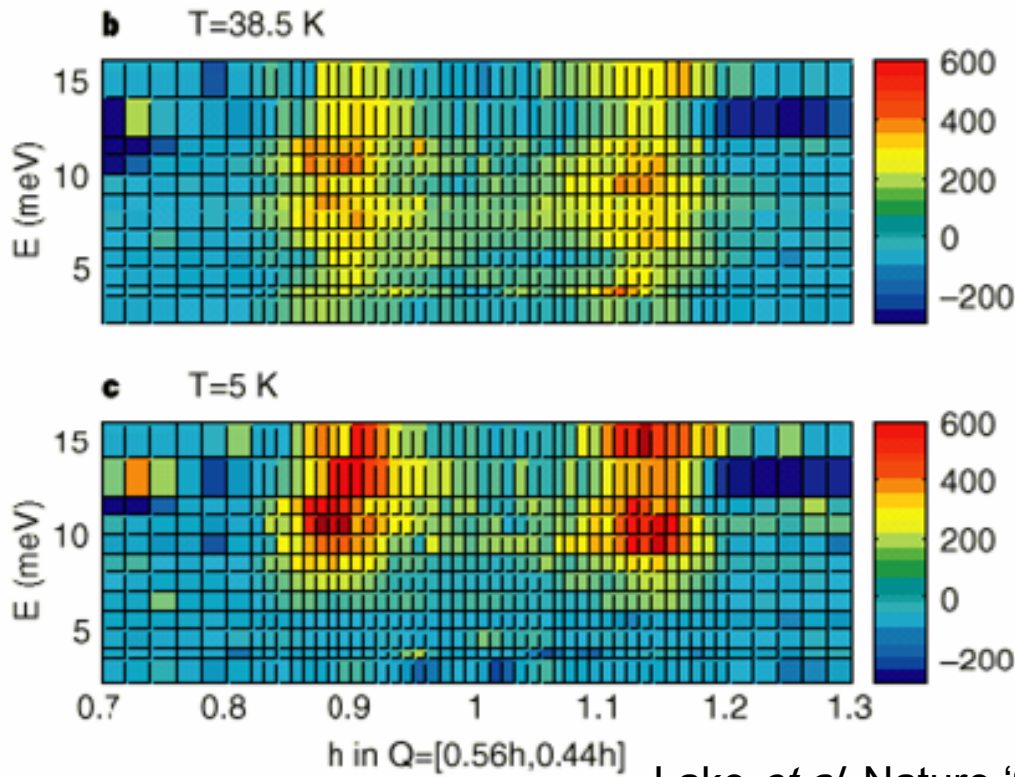


Position sensitive detector (PSD)

- Spurion spotter
- Simultaneous background
- Variable size detector
- Even few ‘pixels’ would work







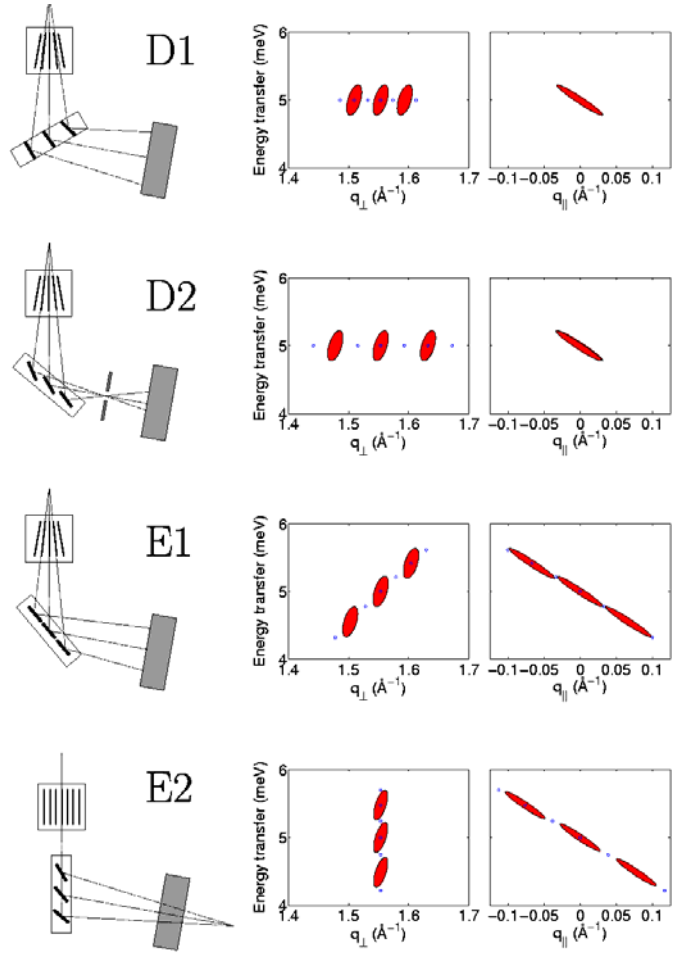
Ronnow *et al.* PRL ‘99

Lake *et al.* Nature ‘99

Mapping configurations

Distinguish blades on PSD

- D1) Multiplexing along Q
- D2) Wider version - requires longer analyser-detector arm
- E1) Flat analyser + 2 radial collimators (Broholm on SPINS)
- E2) Multiplexing along E, near-field for narrow E-spacing, far-field for broad E-spacing
- Almost any combination possible

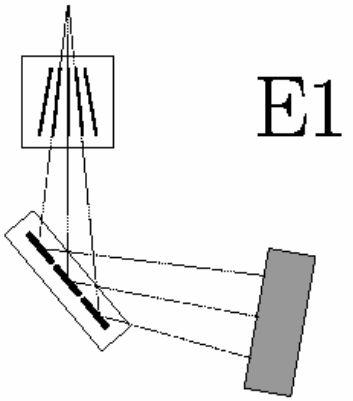


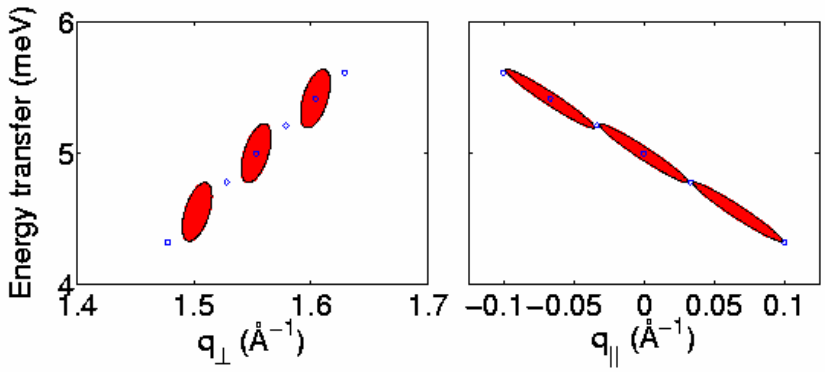
Mapping along energy

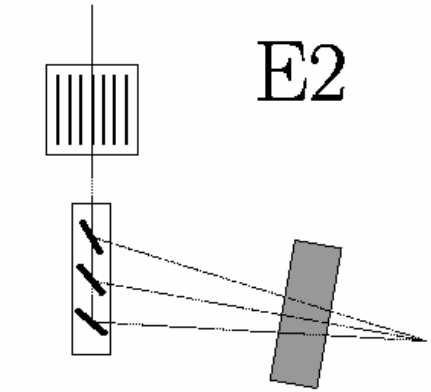
- E1) Flat analyser +radial collimator (SPINS, NIST)
- E2) Multiplexing along E,

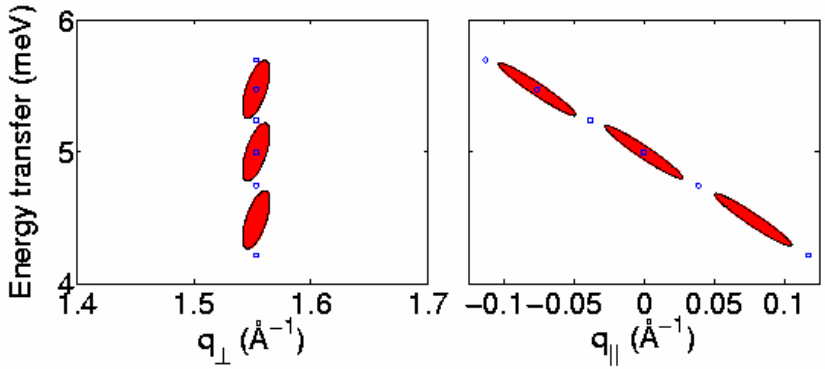
  near-field for narrow E-spacing

  far-field for broad E-spacing



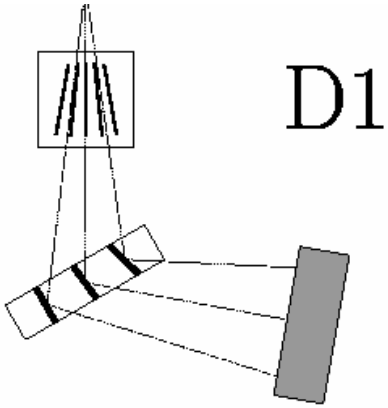


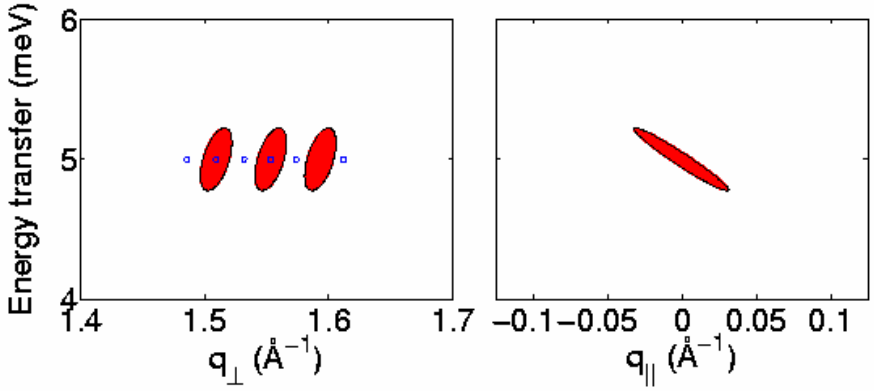




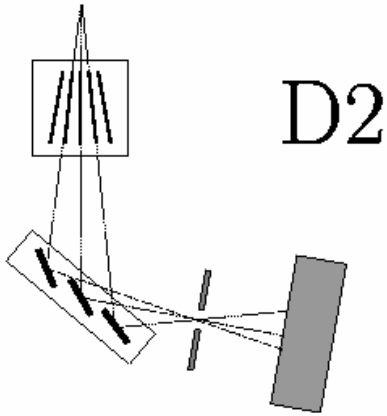
Mapping along Q

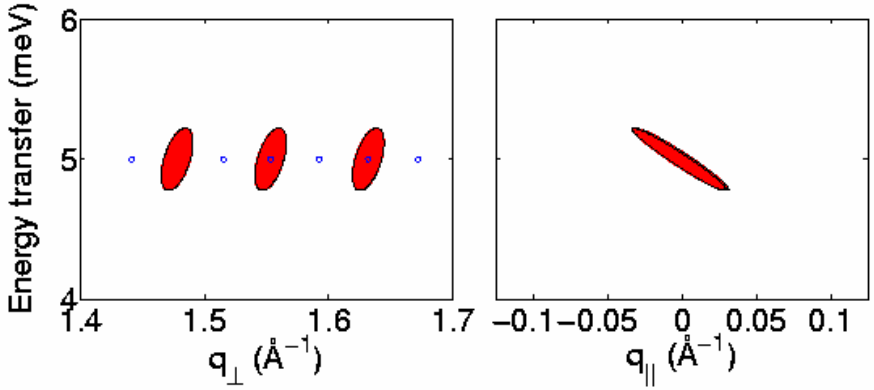
- Two possible configurations



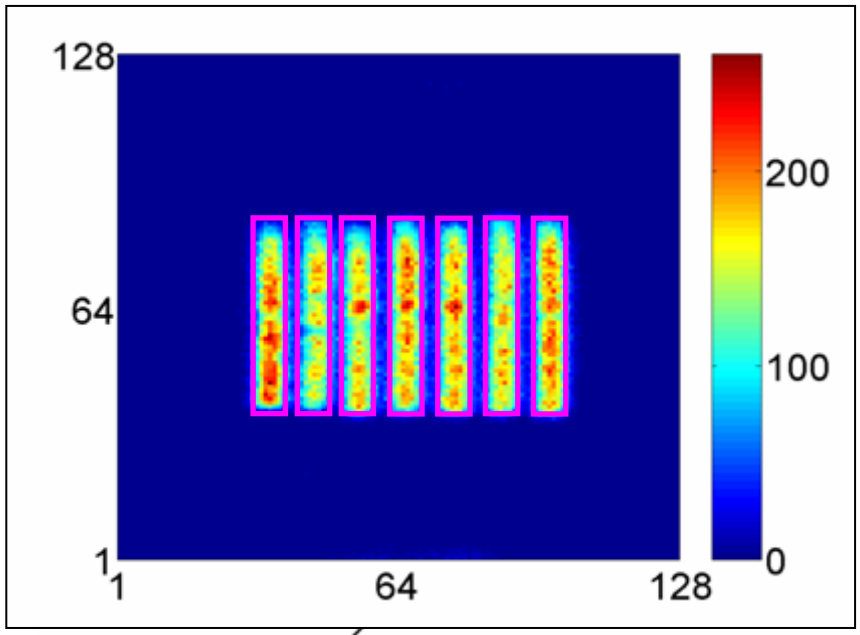


- Wider version requires longer analyser-detector arm



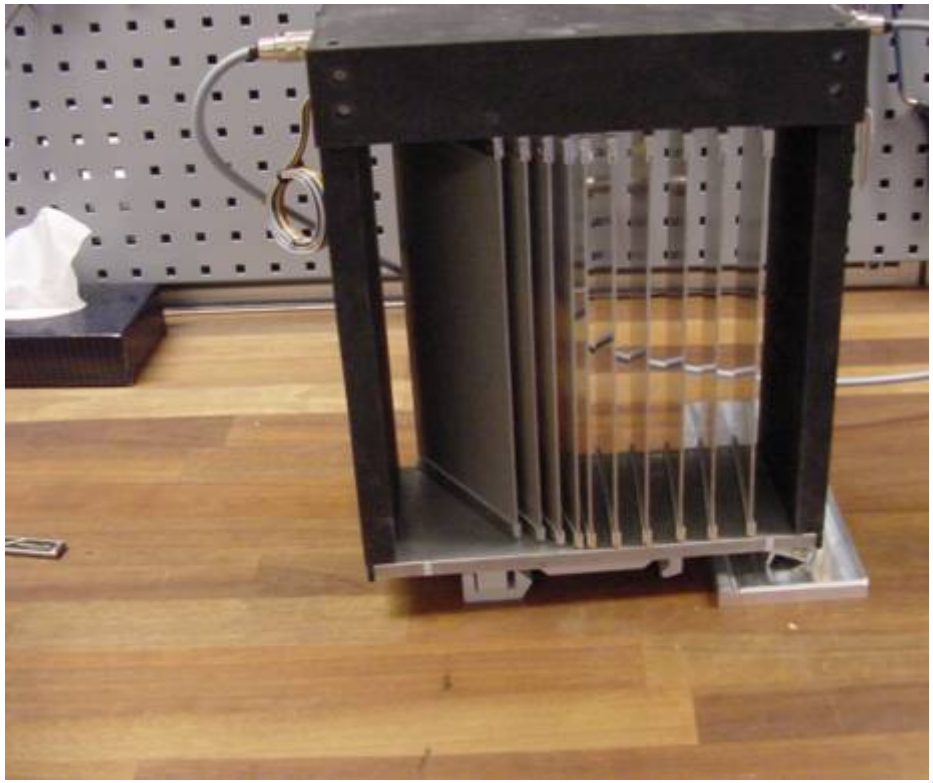


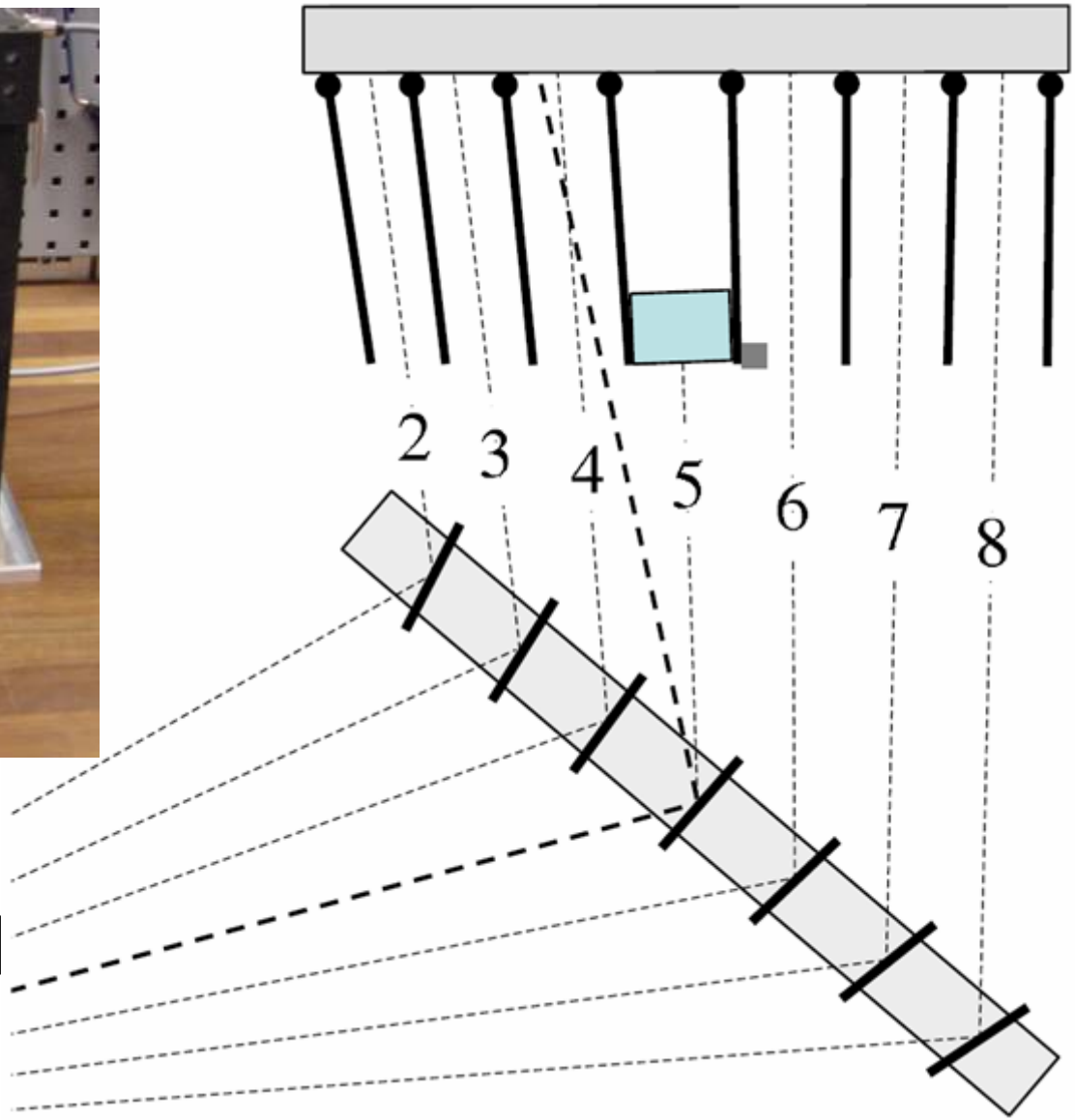
Monochromatic Imaging mode



RITAs

Variable ‘collimator’

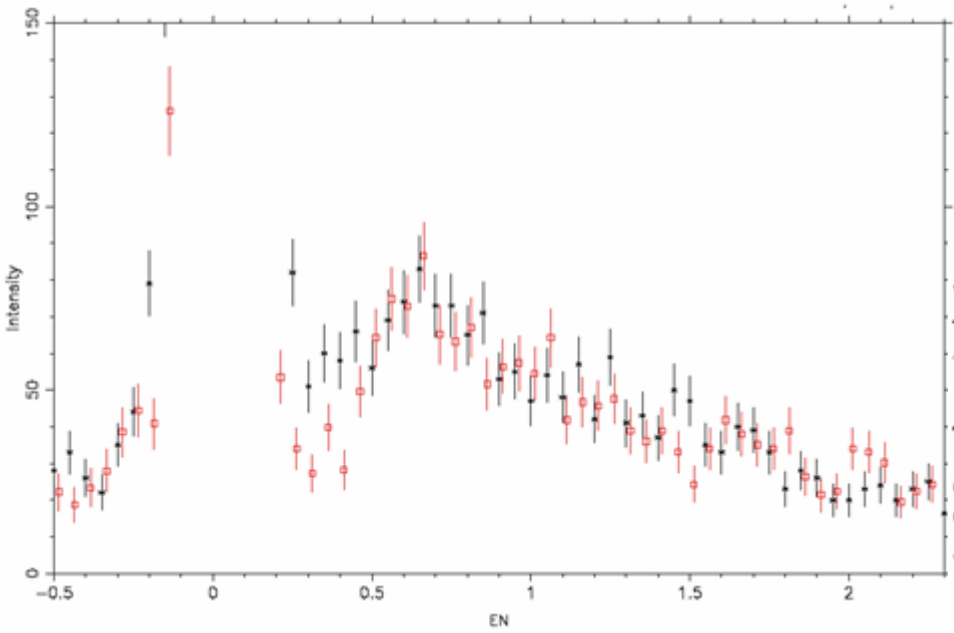




- Avoid cross-talk
- Reduce background
- Reduce tails

Tails of great Ulysses

- Resolution function has Lorentzian tails
- Graphite has Lorentzian tails ⇒ enhanced for Rita – must find solution to work < 1 meV



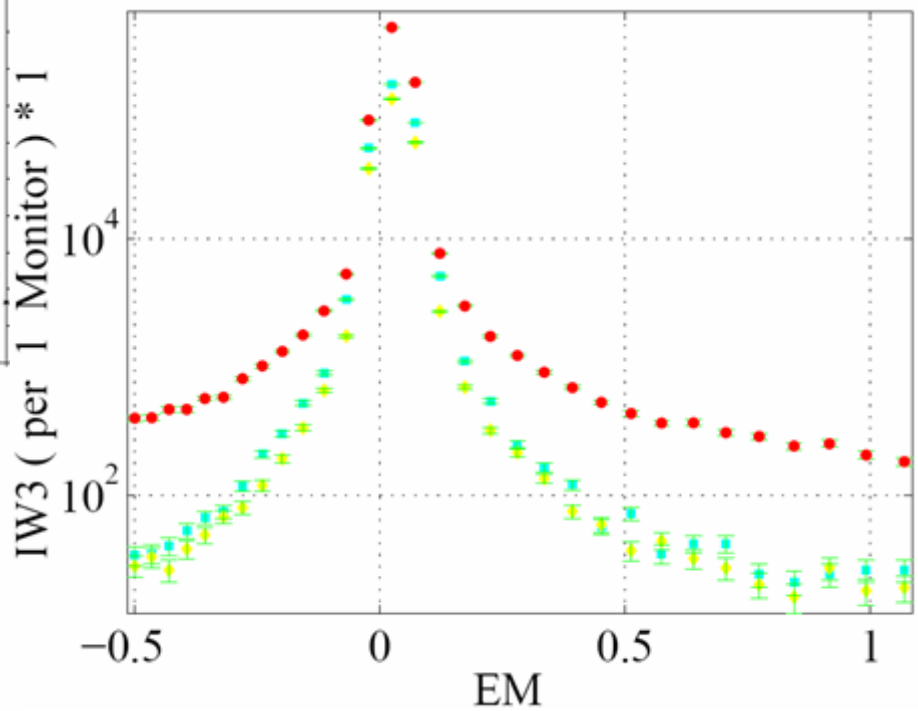
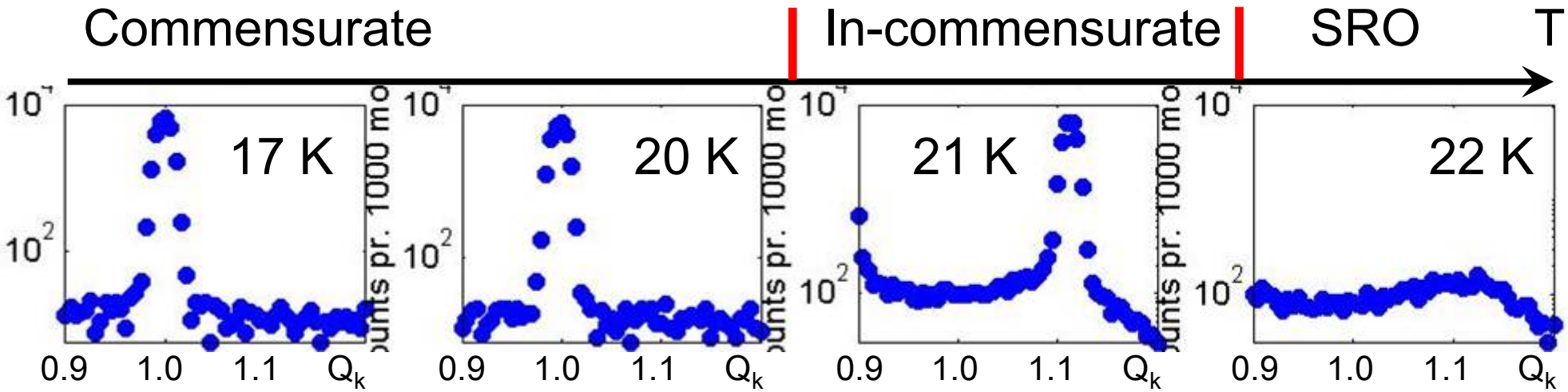


Fig. 1: Comparison TASP (red squares) – RITAII (black crosses).
Sample: $Tl_{0.8}K_{0.2}CuCl_3$ mounted in ILL5 (TASP) or ORI2 (RITAII).
Ef = 3.5 meV. Be filter after sample. Focusing analyzer mode.
Measurement of Singlet - Triplet gap at (0,0,1).
Measurement time 900s / point in both cases.

Ruegg *et al.*

A success: $LiNiPO_4$

- Ferro-electricity associated with C-IC transition
- What drives transition?
- IC-softening of spin-wave dispersion?

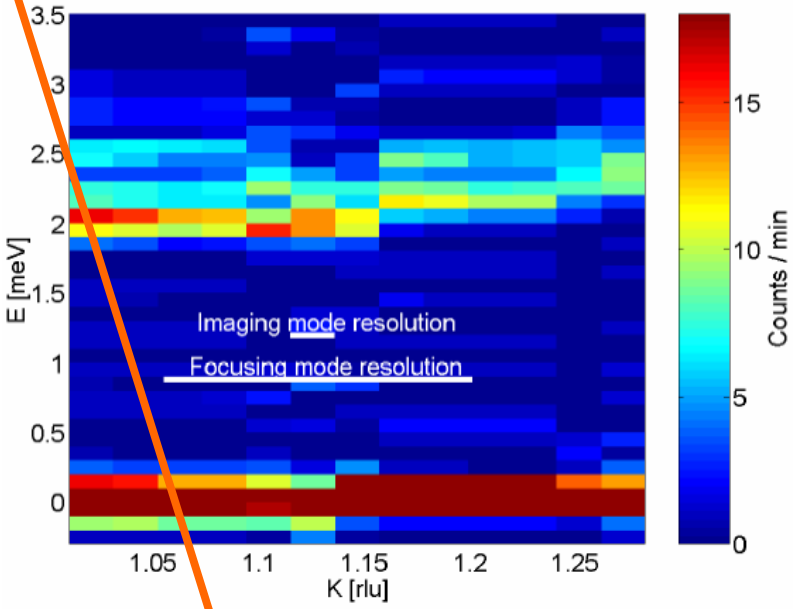


RITAs

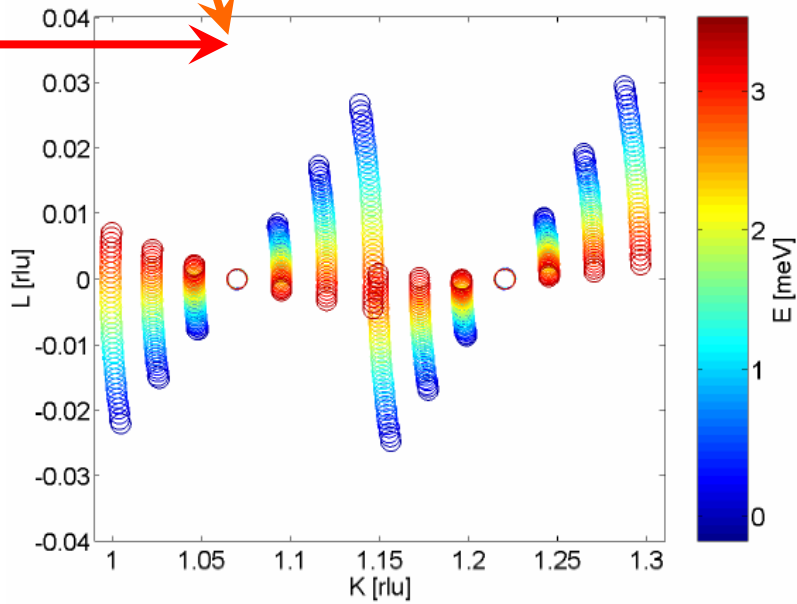
Need resolution – can't focus

- Focusing ⇒ bad longitudinal resolution
- Small sample ⇒ collimator useless
- Imaging mode ⇒ each blade good distance collimation
- 2 scans, 2 hours answer question: no IC soft but very flat at all T

k_i $-k_f$ Q

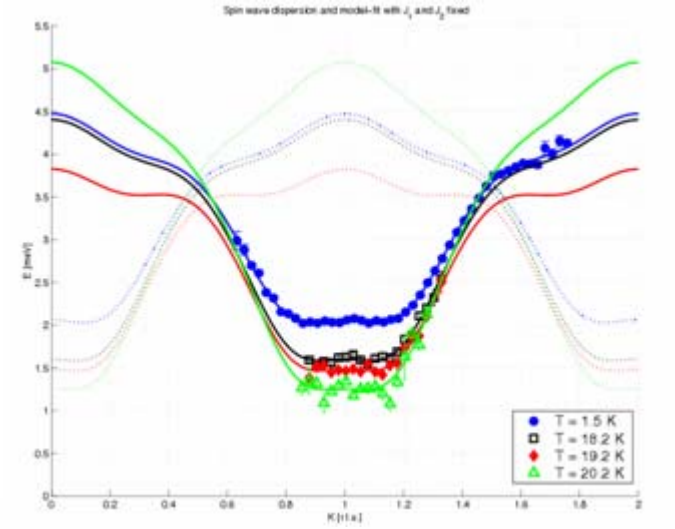


- Pixel-trajectory not perfect longitudinal
- But pretty close (worse at higher E)

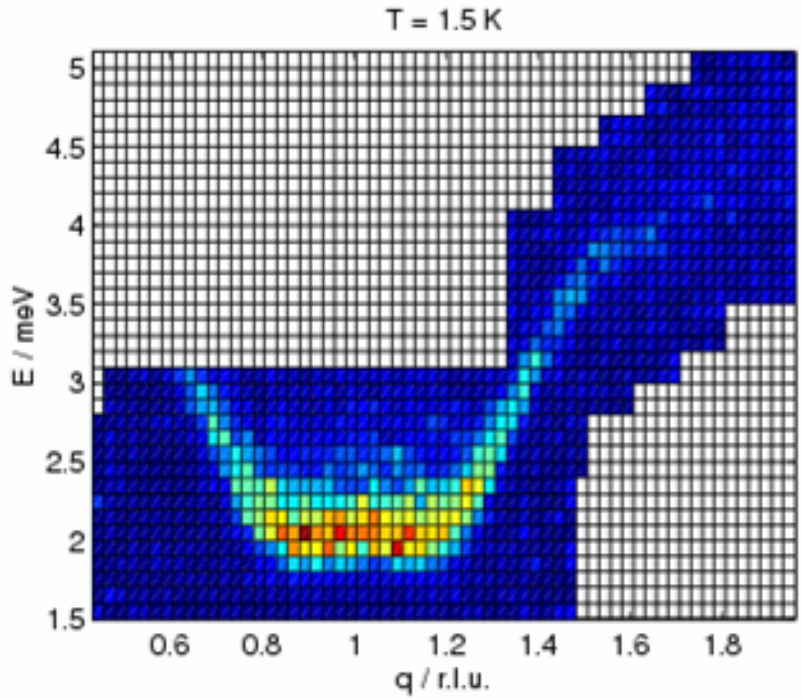


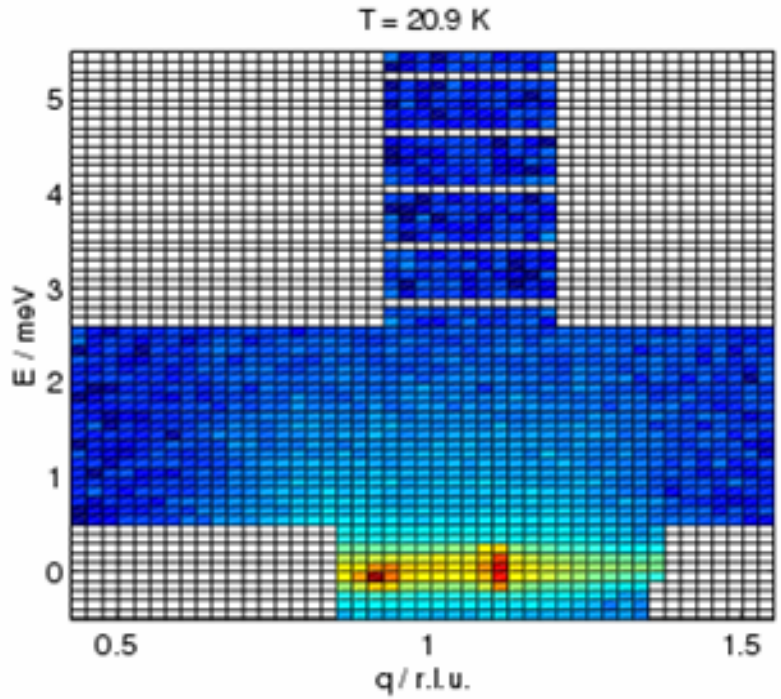
RITAs

$LiNiPO_4$



- Dispersion in 9 scans
- But, there are no spin waves in IC phase !



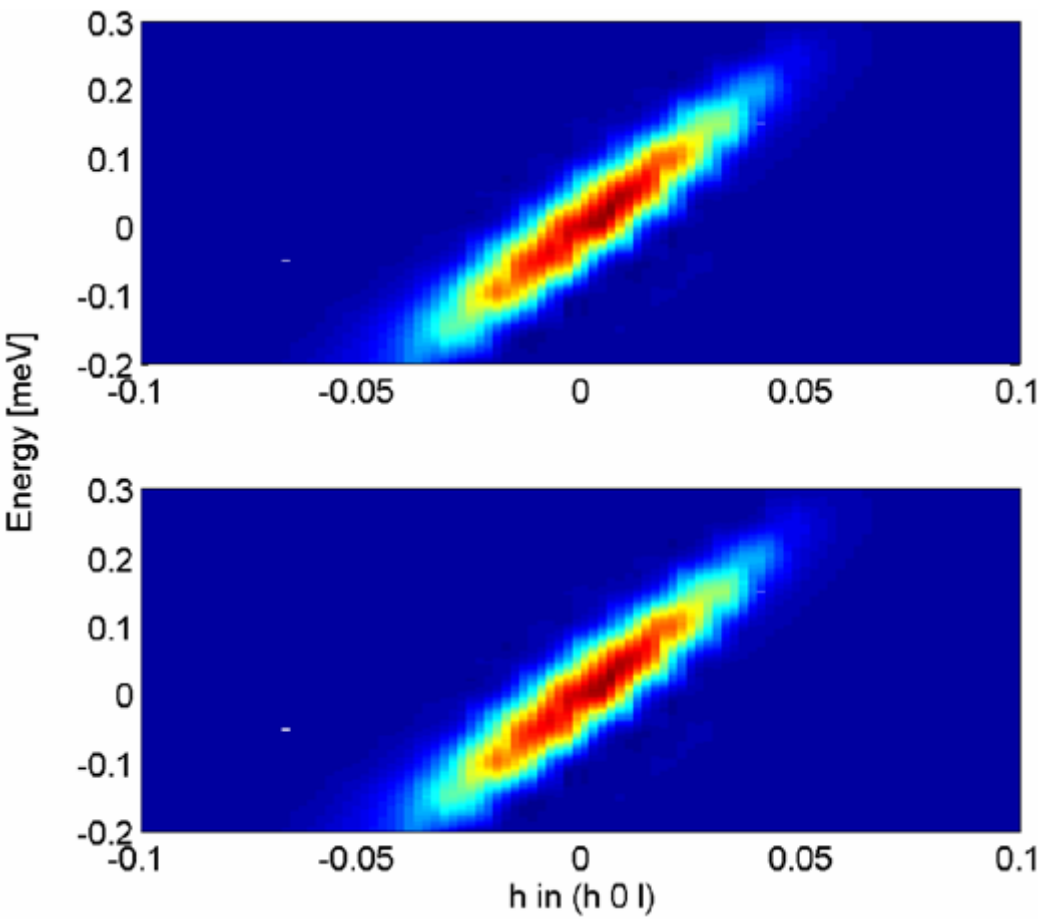


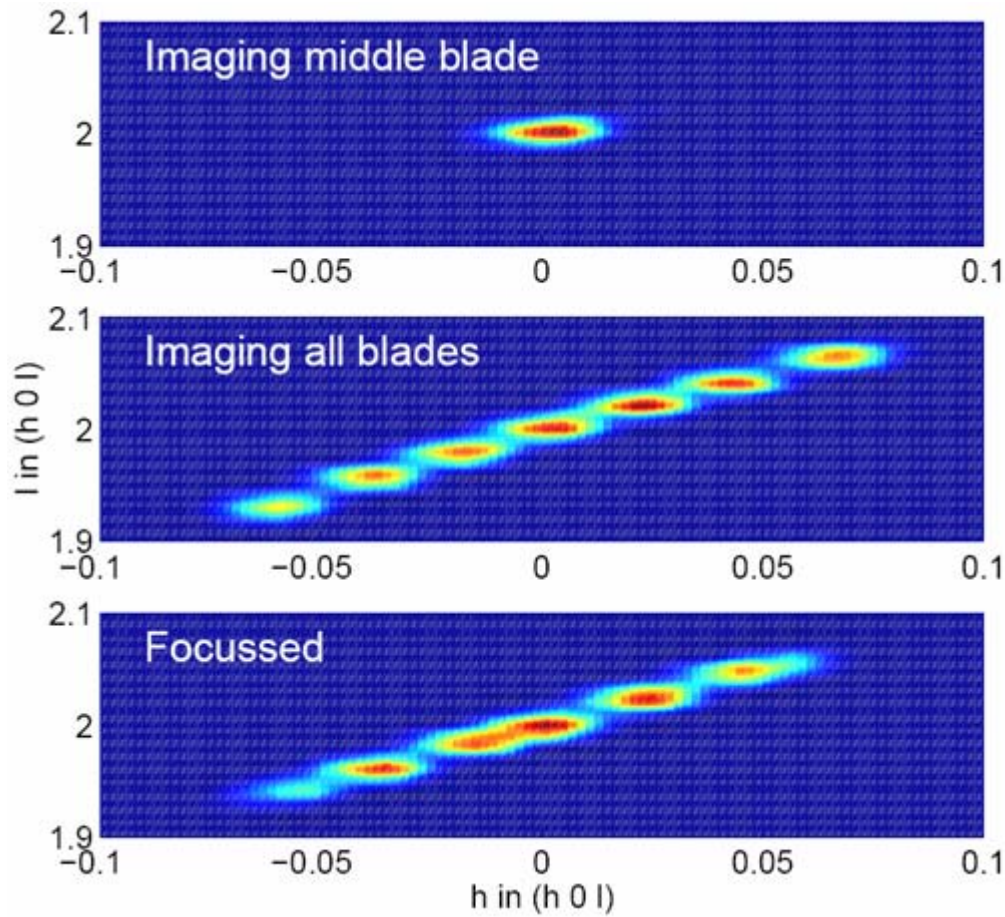
Imaging versus focusing

- Exactly same energy resolution
- Σ all blades = focused mode

break-even:

$$N_f(S+B) = N_i(S+B/N_f)$$



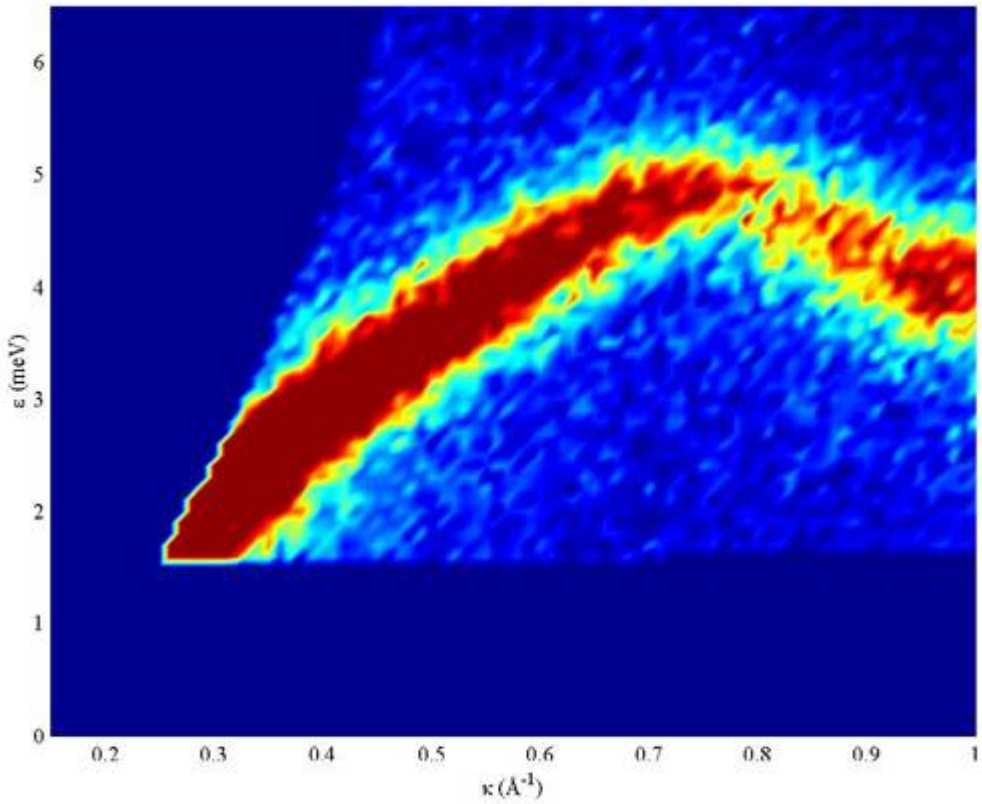


RITAs

Other examples

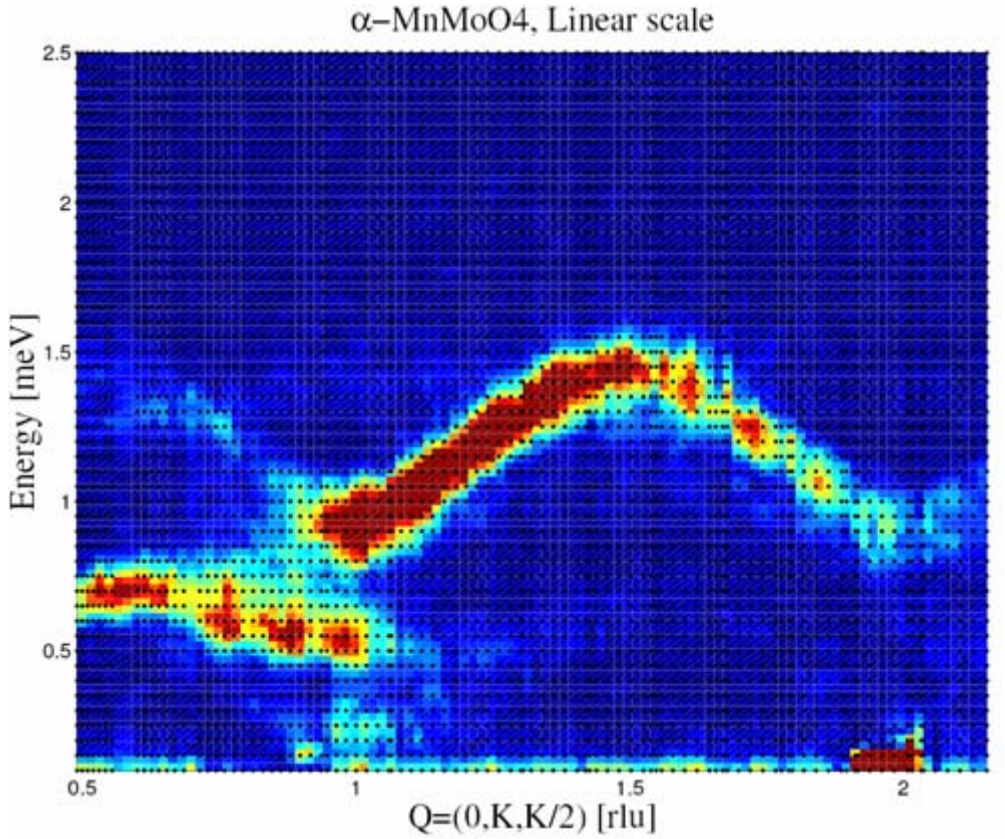
Phonons in Pb

- Ef=5.0 meV
- 15sec/pt



α-MnMo4

- Ef=3.7 meV
- 9 scans a 60sec/pt

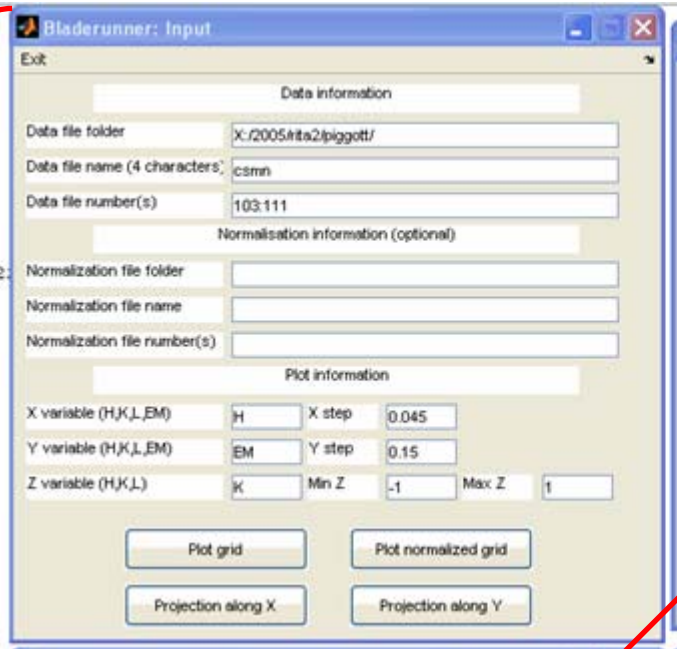


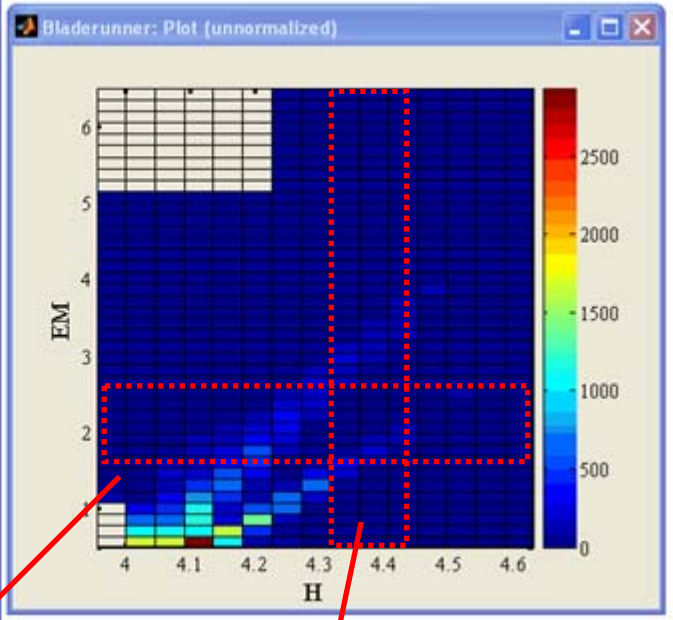
Data-treatment – complicated ?

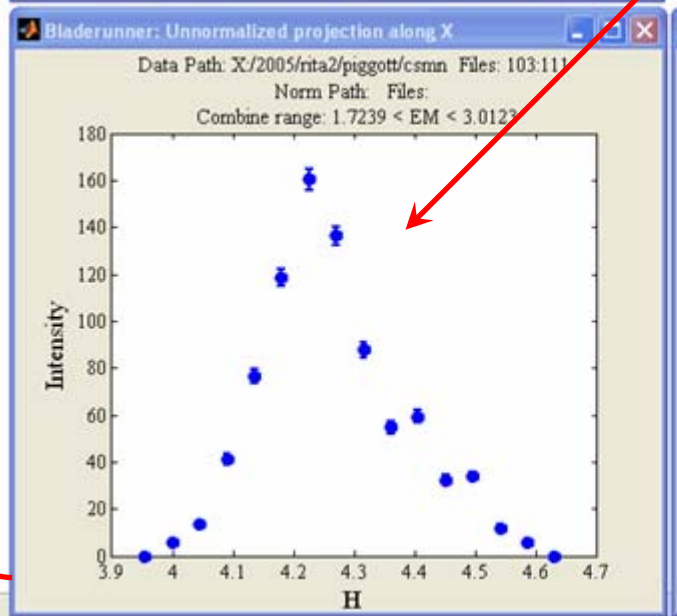
Where is a will,
there is a way

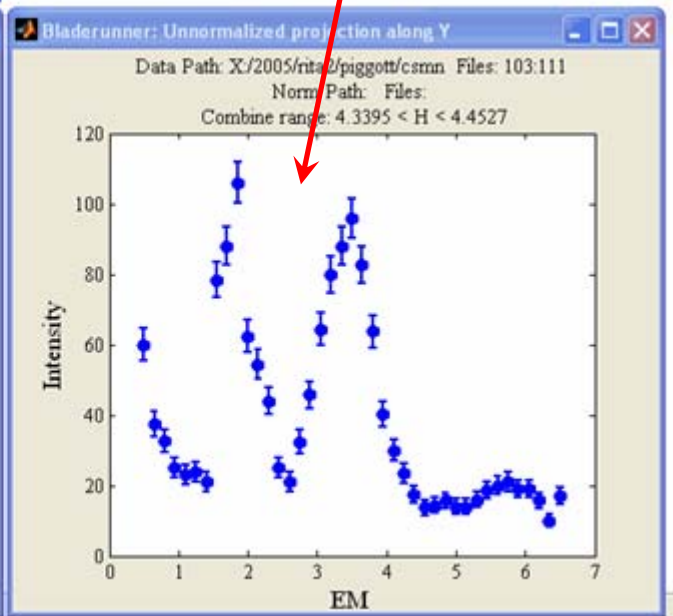
We work together

Blade-runner
(N. B. Christensen)

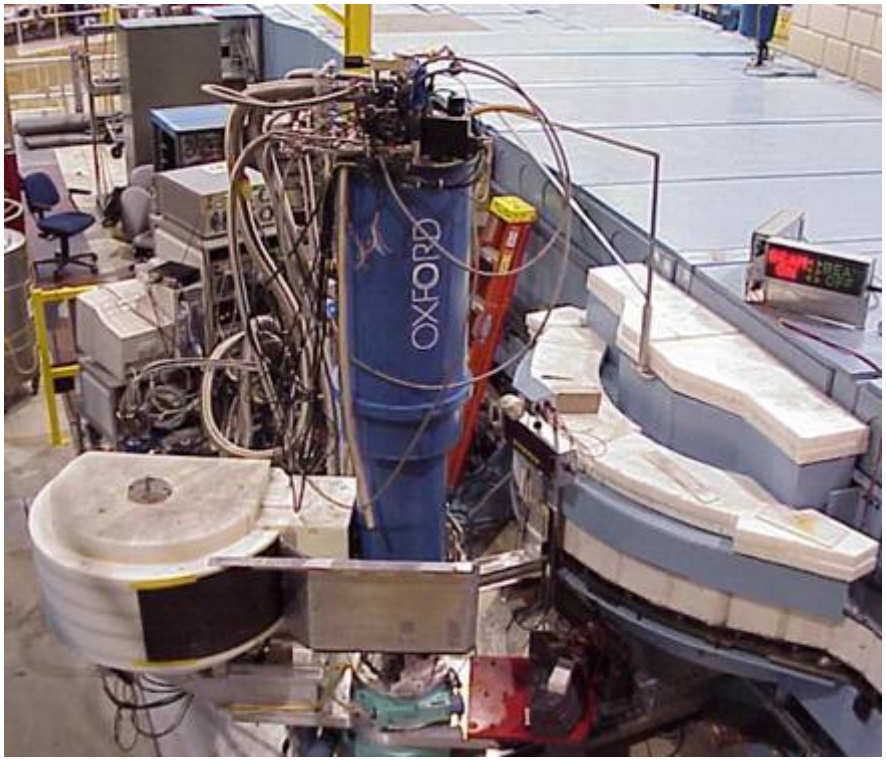


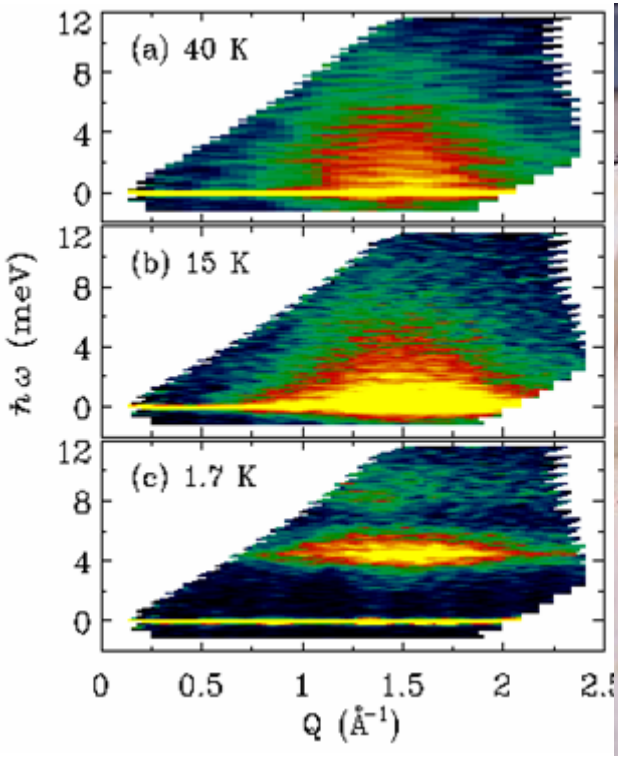






RITAs Other multiplexing TAS (not represented)



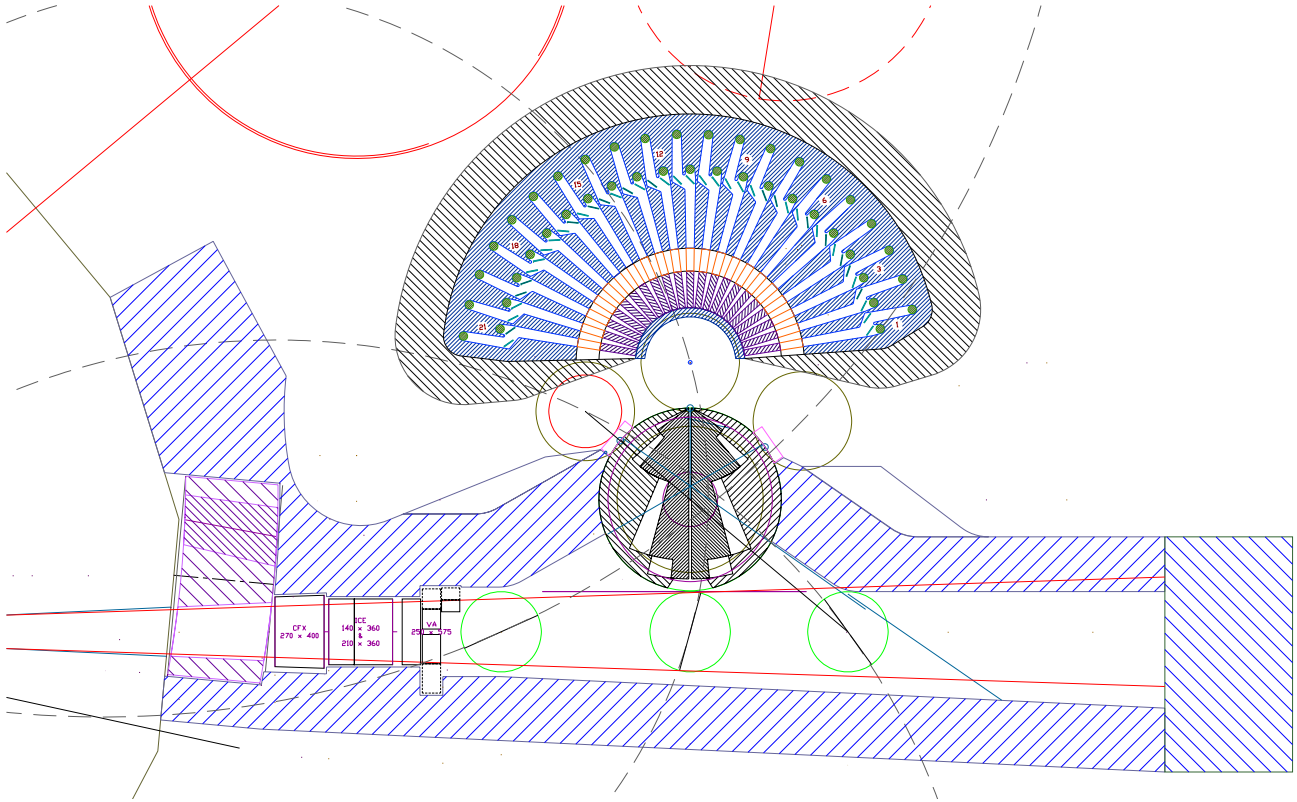


Broholm, Lee et al.

The SPINS spectrometer at NIST

MACS, NIST, Broholm

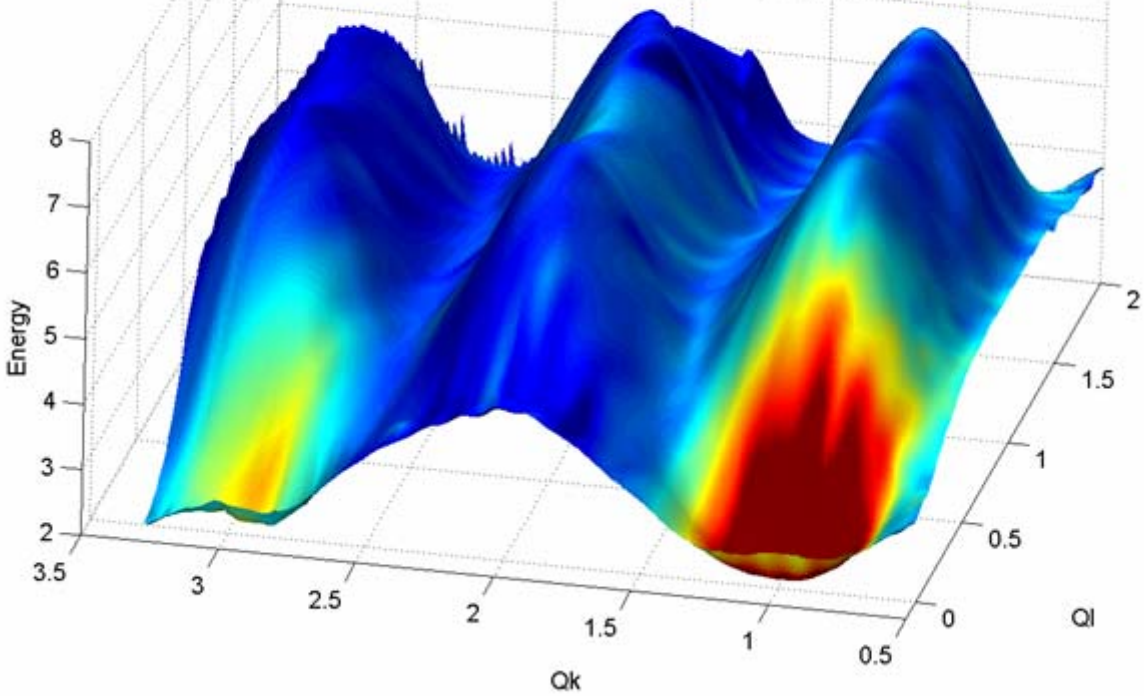
- 40x40cm2
  $\Rightarrow$ 5°x12° asymmetric mono
- 21x2°x8°
  double analysers
- ¼ angular
  coverage

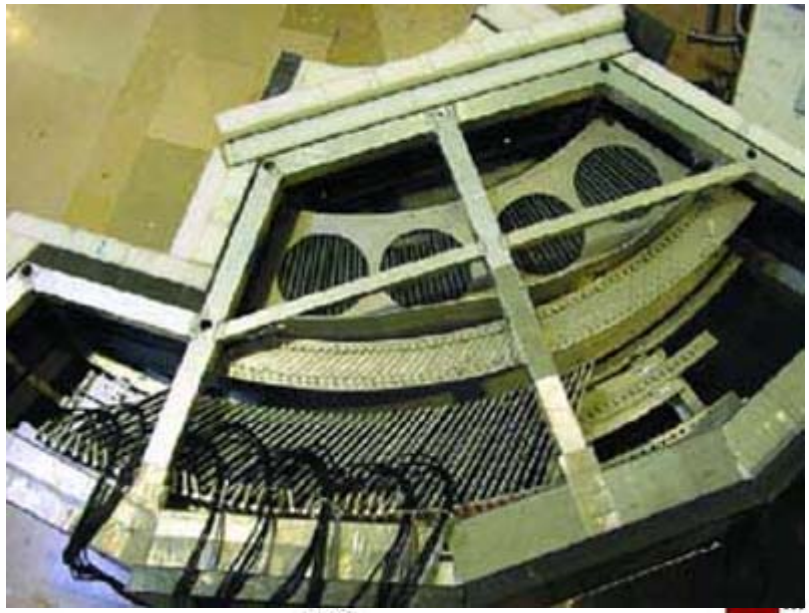


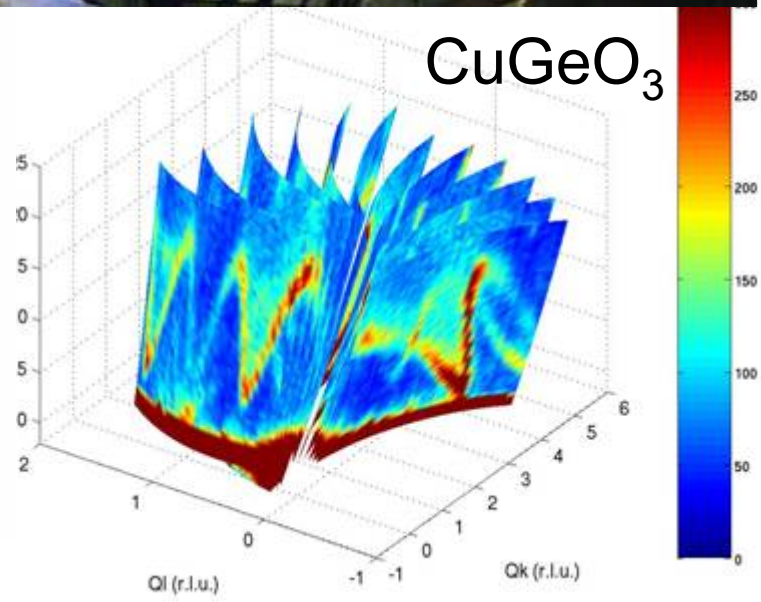
Multi-analyser-detector systems

- 47 x 0.33º detectors $E_f = 30$ meV

- Entire dispersion of 0.5cm^3 $LiNiPO_4$ in 4h @ IN8+MAD
  20 scans ⇒ ~1000 (Q,E,Amp) Points



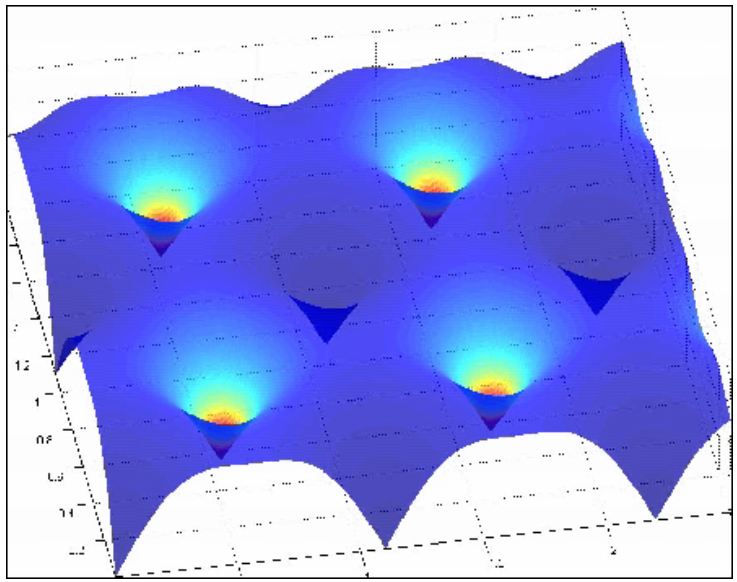




- *PSI crew, F. Demmel, M. Jimenez-Ruiz et al.*

CAMErA

Continuous Angle Multiple Energy (readout) Analysis



CAMEA:
no greek myth
Google ⇒
Typo or…

A Seattle DJ !