Nightly challenges at beam-line 12.0.1.1

Mike Wingert-Manipulator design
Joe Sun-New look at CMR materials
Alexei-New grating, beamline issues, detector
Rudy-New prep. chamber

Frequent & Regular Users

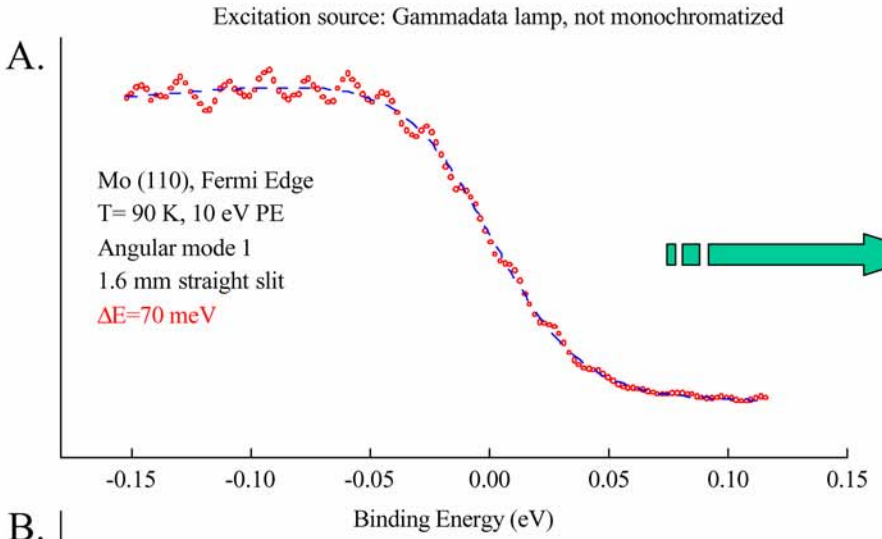
A. Lanzara /UC Berkeley/: HTSC; Quantum Nano-dots; Boron-Nitrite Nano-tubes; Graphite Nano-tubes; Diluted magnetic semiconductors

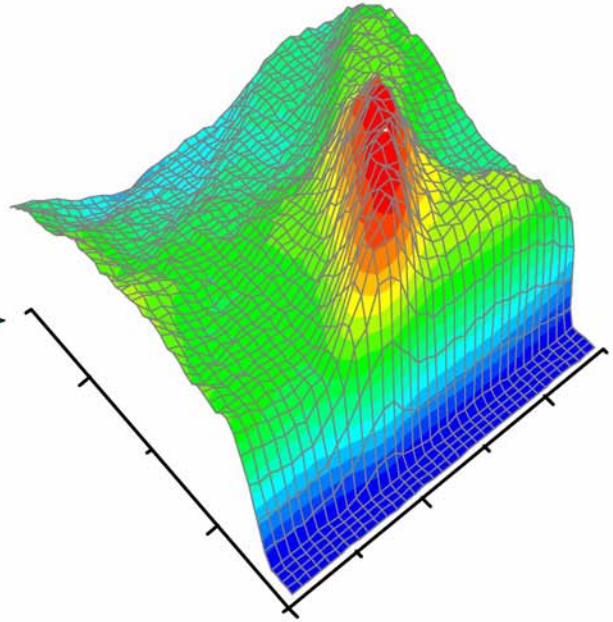
D. Dessau /U. Colorado/: HTSC; CMR materials

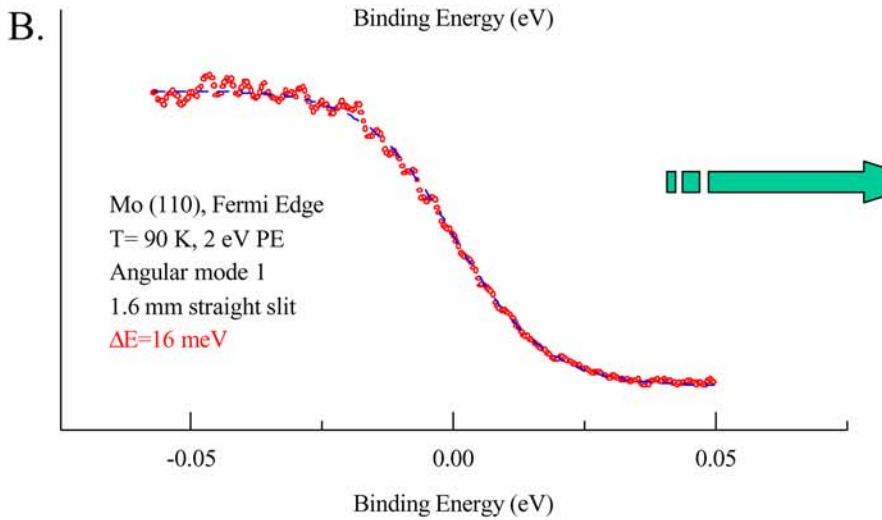
Z. Hasan /Princeton U./: Exotic superconductors (CoO)

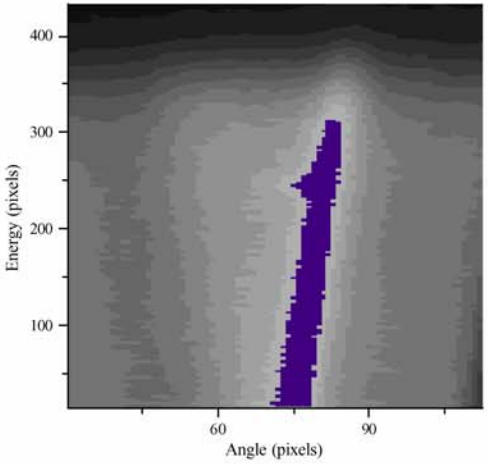
Mo (110)

Angle resolved images

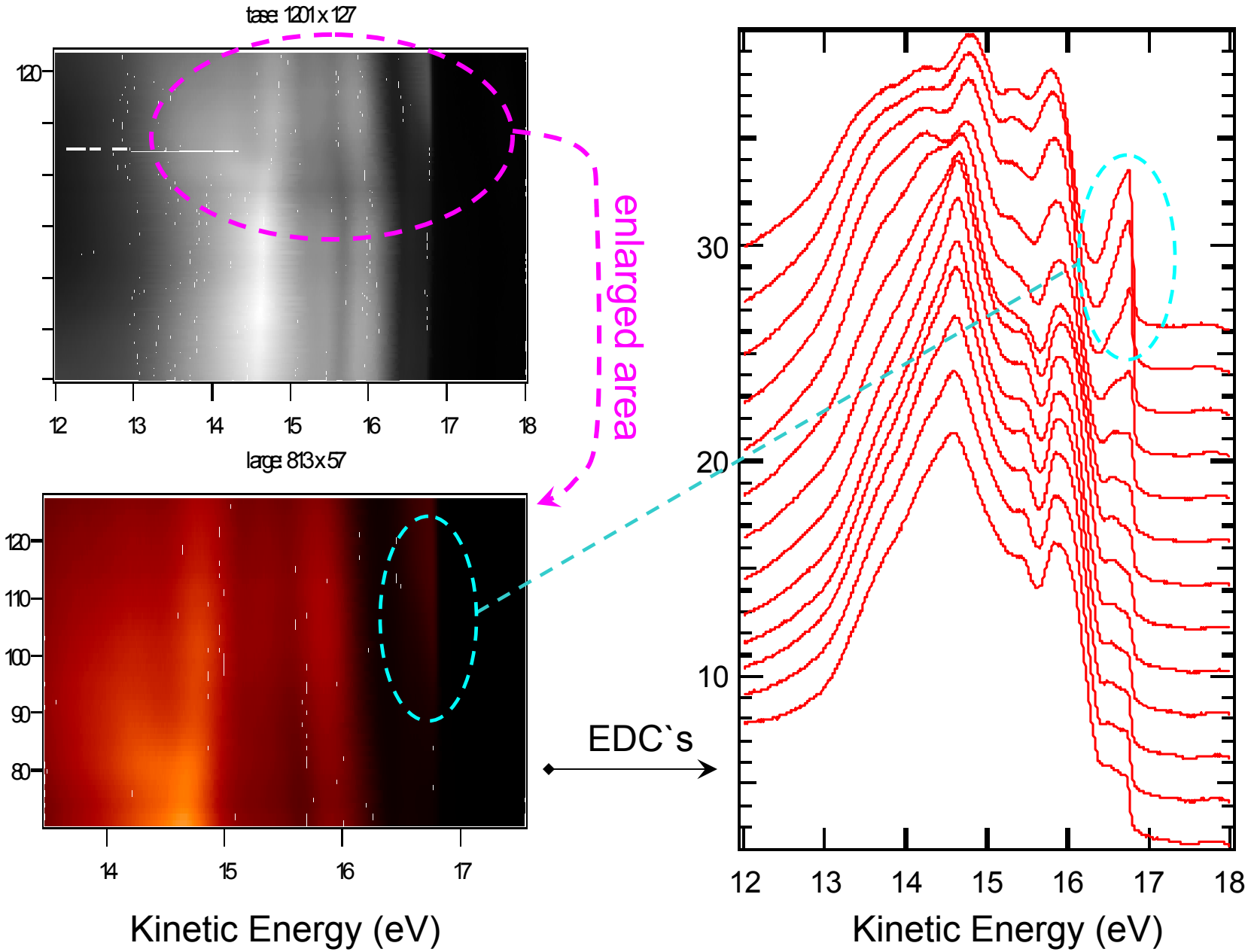


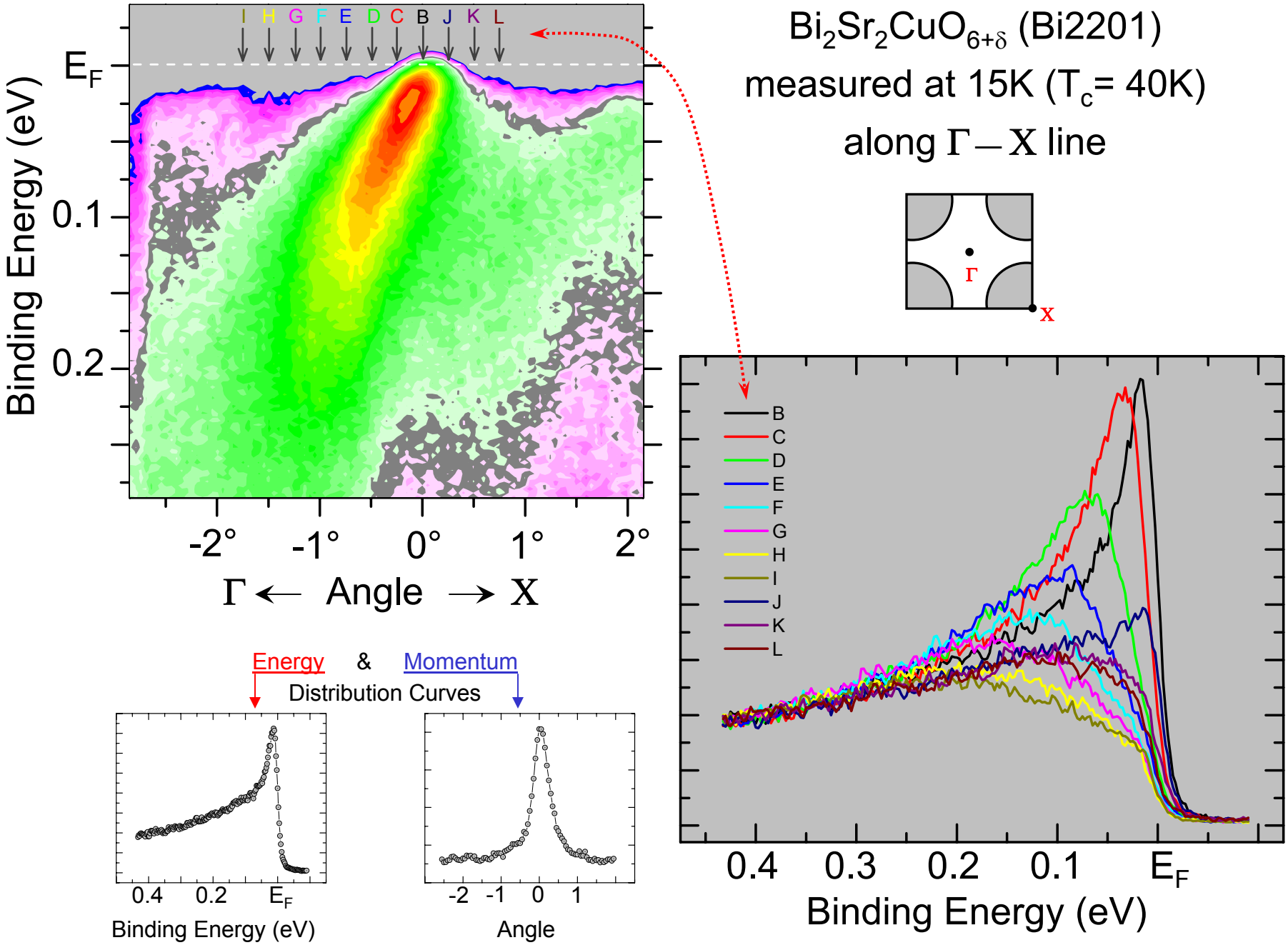


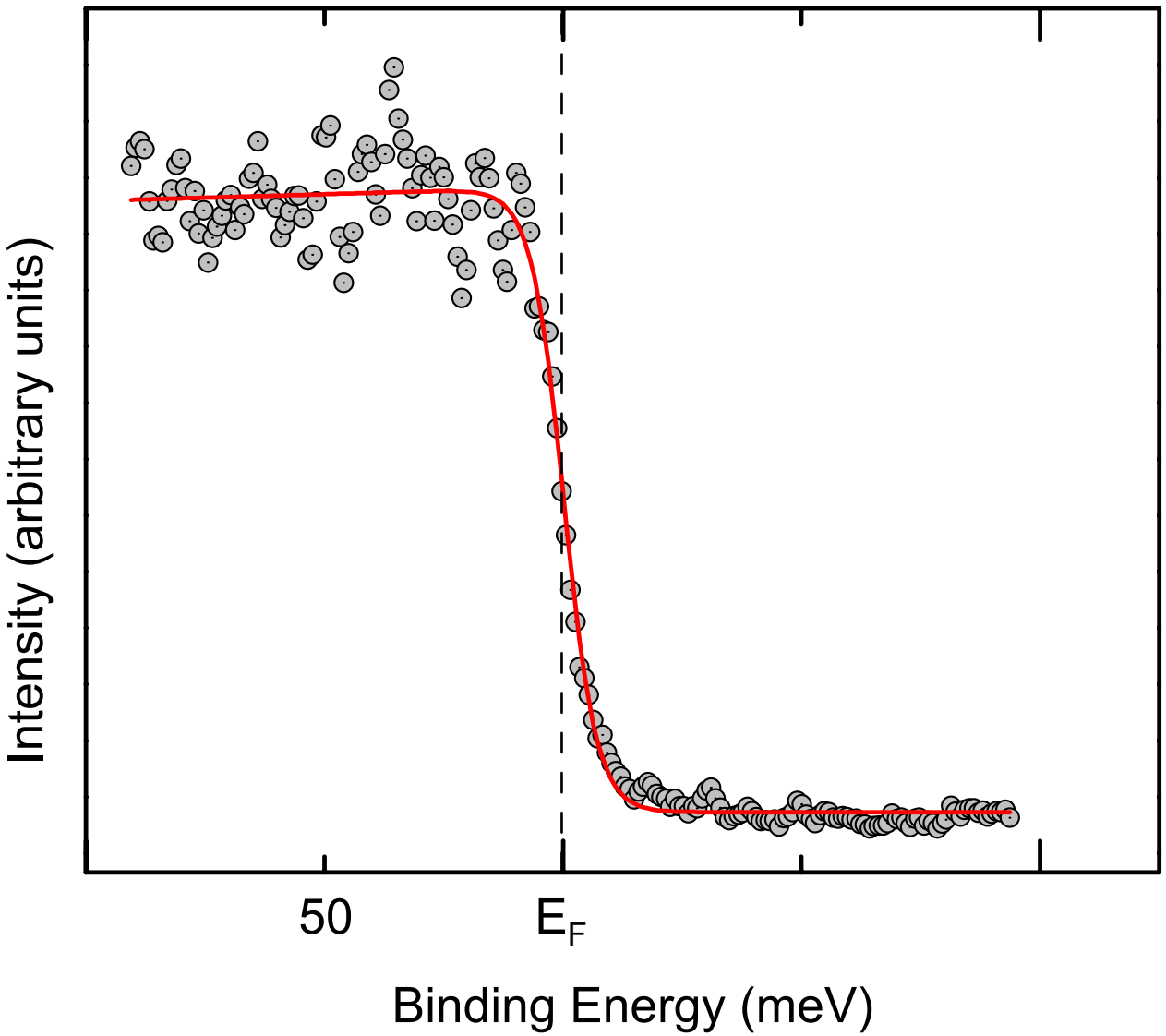




$TaSe_2$, cleaved, T~ 90 K (below CDW)



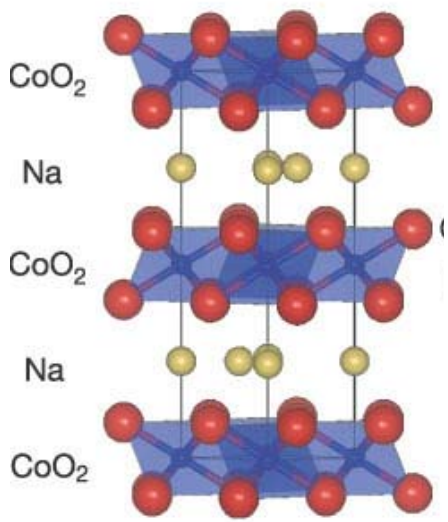

$Bi_2Sr_2CuO_{6+\delta}$ (Bi2201)
measured at 15K (T_c= 40K)
along Γ – X line
I H G F E D C B J K L
E_F
0.1
0.2
Binding Energy (eV)
-2° -1° 0° 1° 2°
Γ ← Angle → X
Γ
X
B
C
D
E
F
G
H
I
J
K
L
0.4 0.3 0.2 0.1 E_F
Binding Energy (eV)
Energy & Momentum
Distribution Curves
0.4 0.2 E_F
Binding Energy (eV)
-2 -1 0 1
Angle


Intensity (arbitrary units)
50
E_F
Binding Energy (meV)

A New Class of Superconductors Analogous to the Cuprates

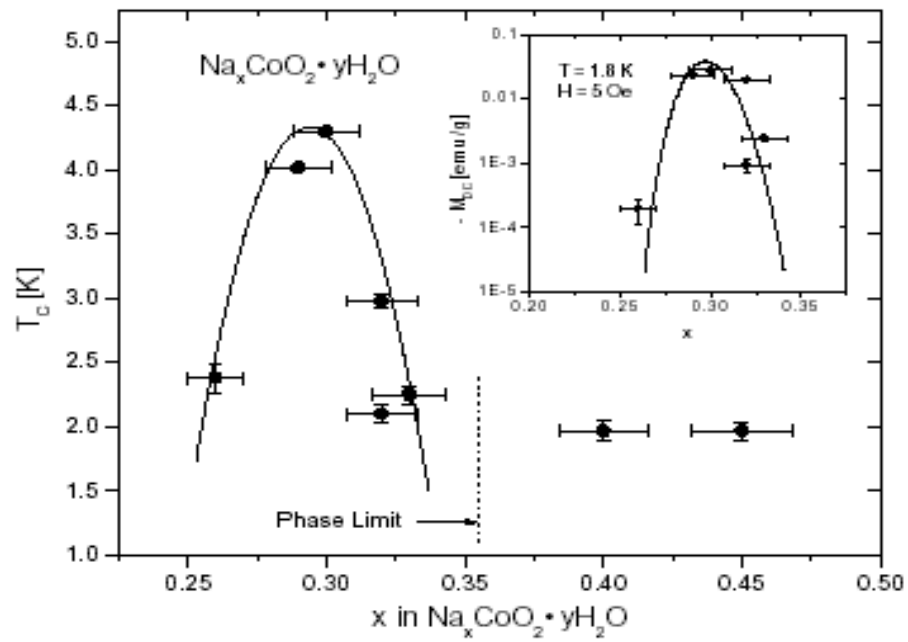
A New Class of Superconductors Analogous to the Cuprates

K. Takada et.al., Nature 422, 53 (2003).
$Na_{0.35}CoO_2$, $T_c \sim 5$ K



Layered, Highly Metallic, Cleaveable
Good match for ARPES

Phase Diagram : Na_xCoO_2



First Phase Diagram :
R.J. Cava et.al., Nature (in press) (2003).

ARPES to study of Unconventional Charge Dynamics in Na_xCoO_2 Mott system

Experimental Team at BL-12/ARPES : Na_xCoO_2

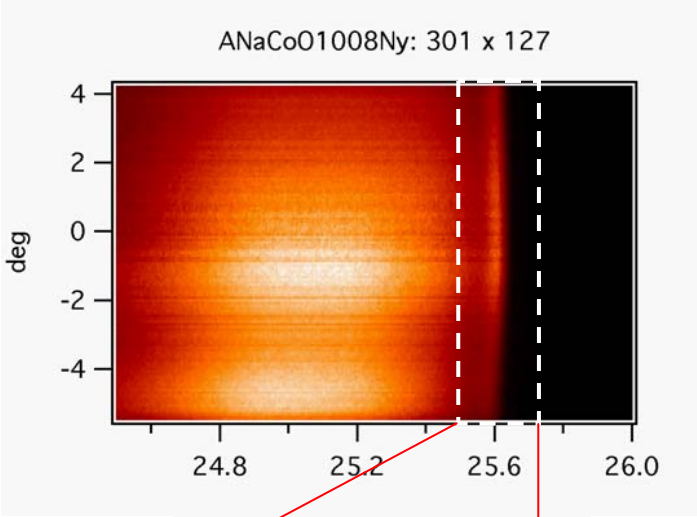
Y.D. Chuang, A. Kuprine, A.V. Fedorov, Z. Hussain (ALS/LBNL)

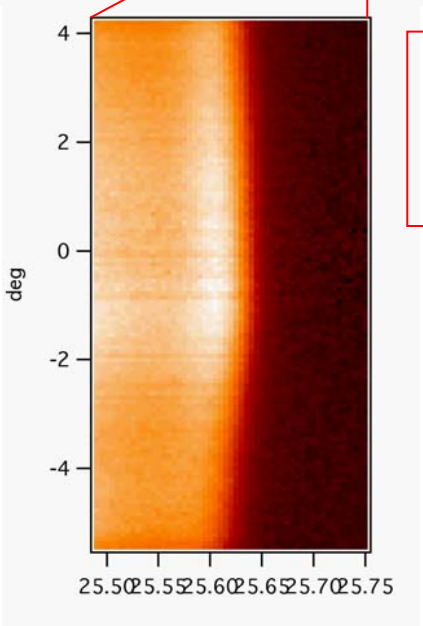
M. Rogado, R.J. Cava (Dept. of Chemistry & PMI, Princeton Univ.)

Y.W. Li, D. Qian, M. Zahid Hasan* (Dept. of Physics, Princeton University)

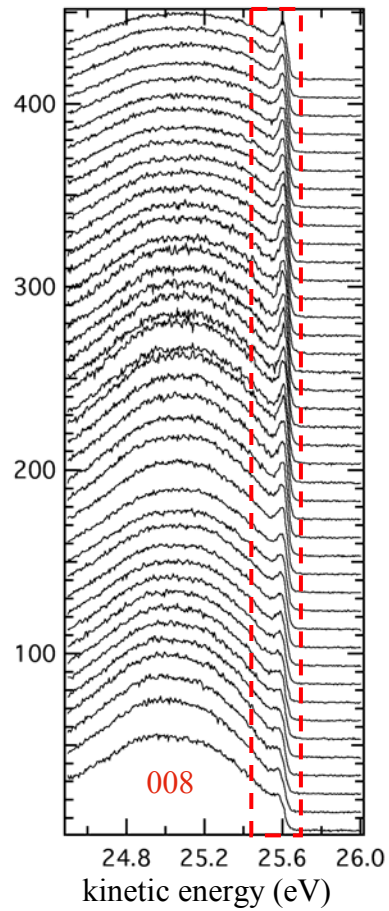
*Visiting Term at ALS in Zahid Hussain Group

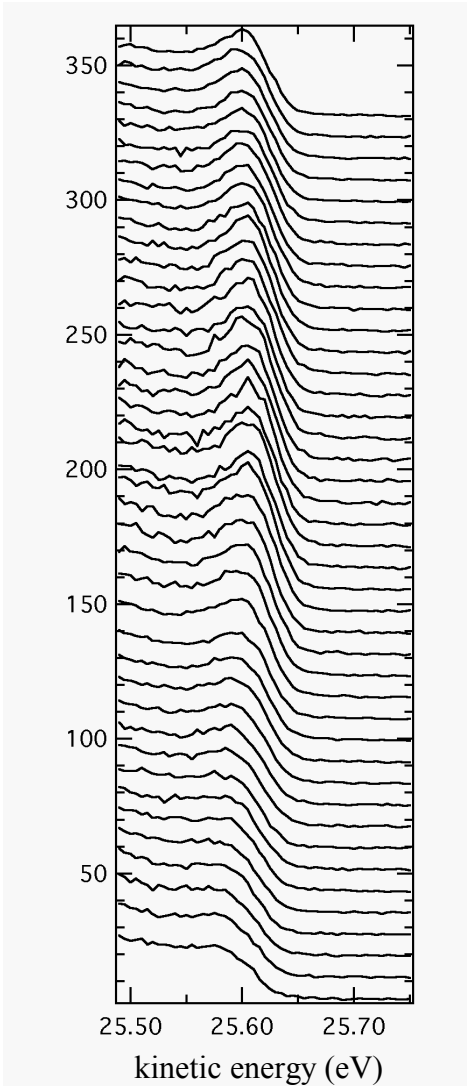
Very weak & Extremeley Flat band (~ 70 meV) is observed





High Intensity from BL-12 is essential to see the weak feature

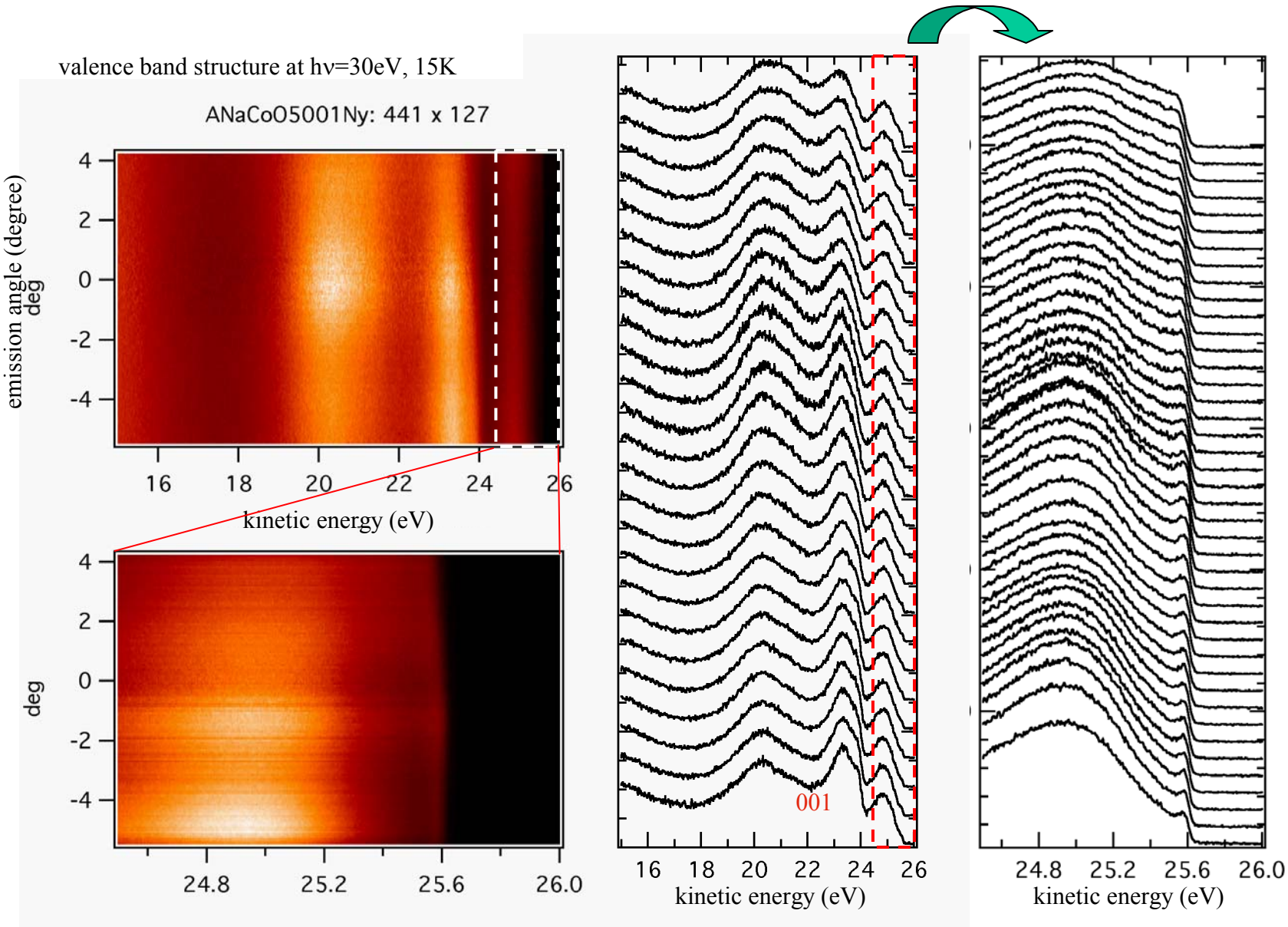




θ=90° (~M point) ; 15.5K; hν=30eV

BL-12/ARPES Station

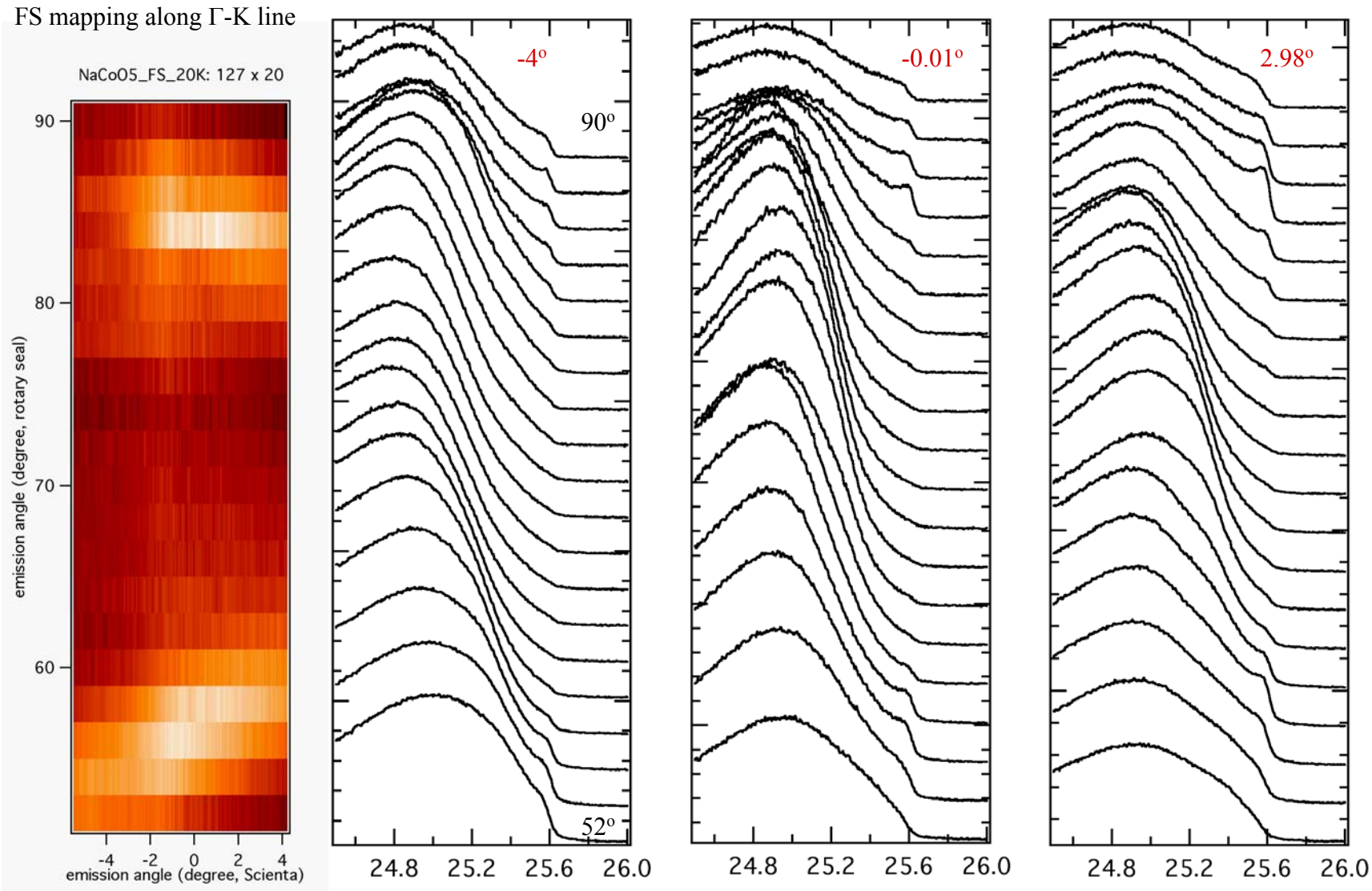
$Na_{0.7}CoO_2$, sample #5, Γ-K horizontal



BL-12/ARPES Station

Hexagonal wings of the Fermi Surface

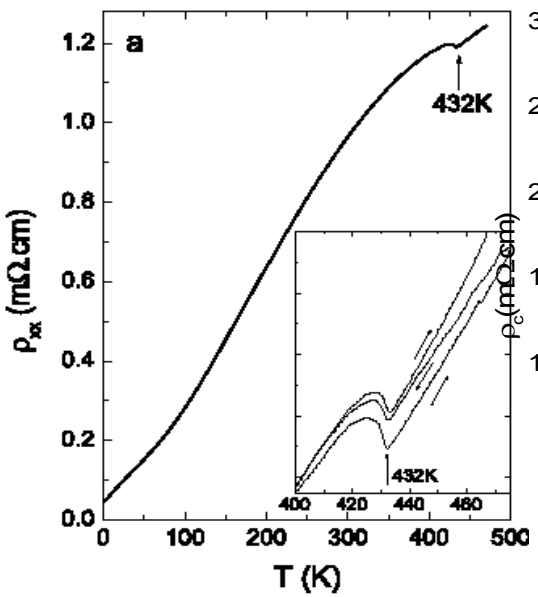
FS mapping along Γ-K line

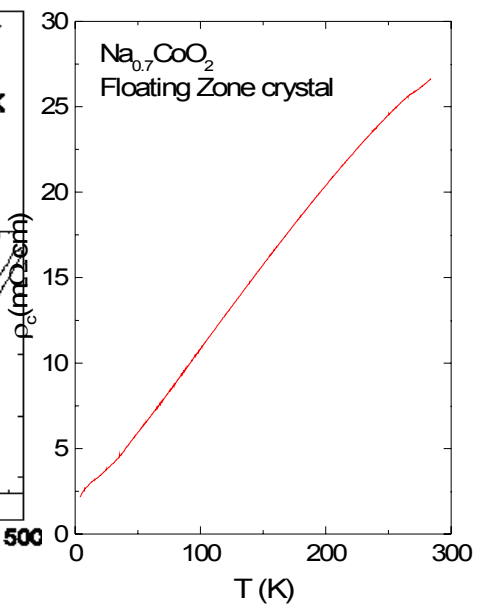


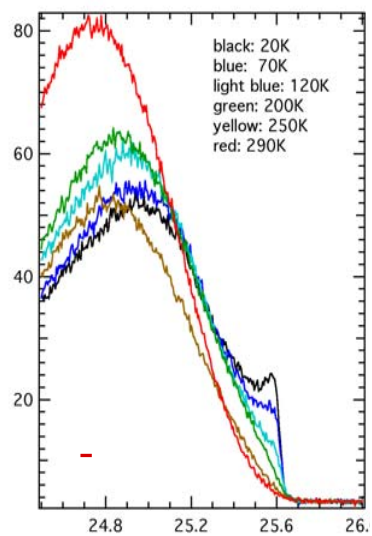
BL-12/ARPES Station

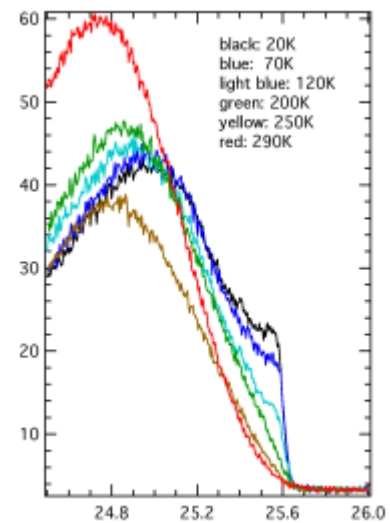
Quasiparticle physics is *highly* Unconventional in Na_xCoO_2

No dimensional cross over effect –
quasiparticles are gone well before dim cross over is reached!





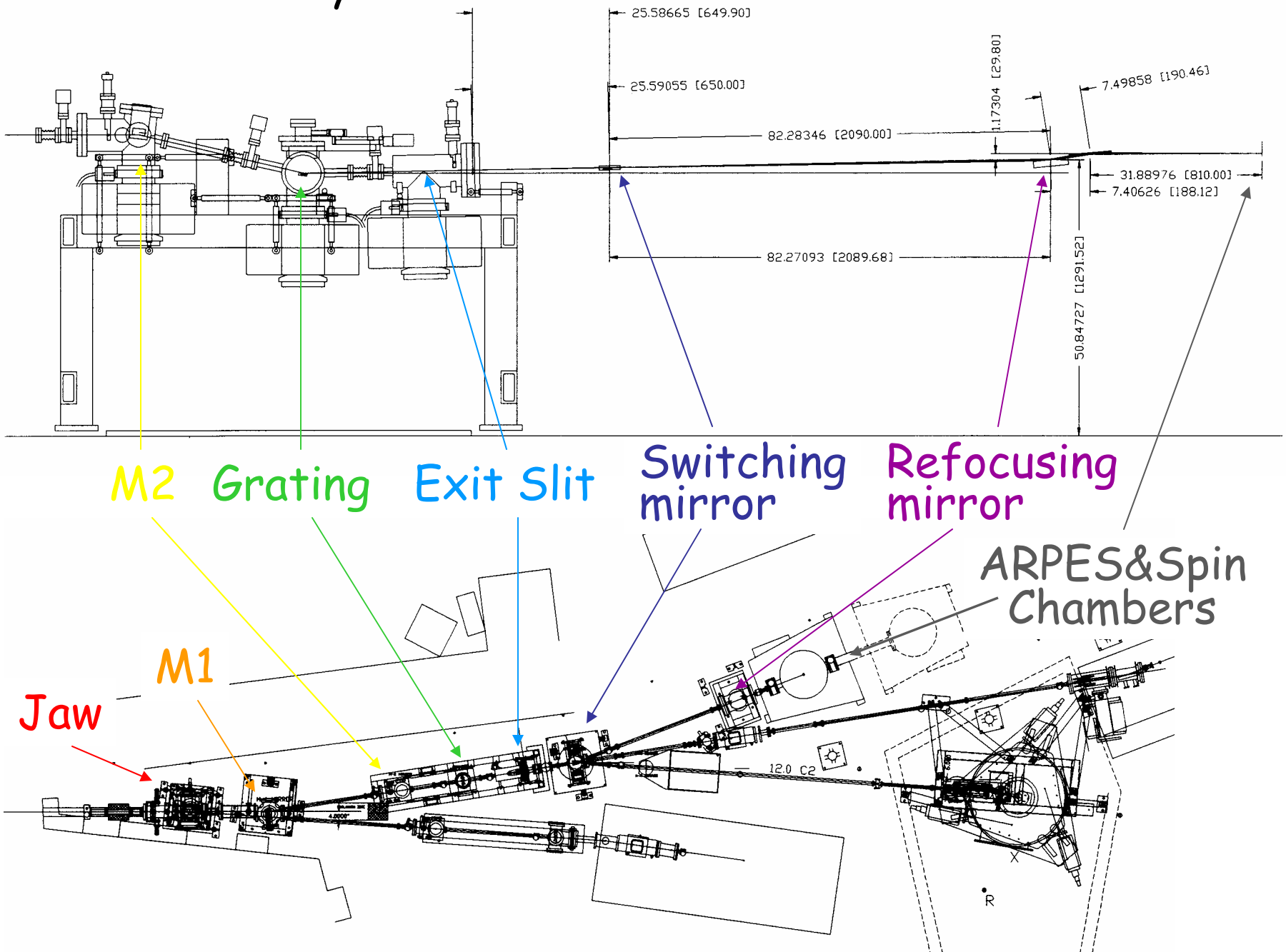


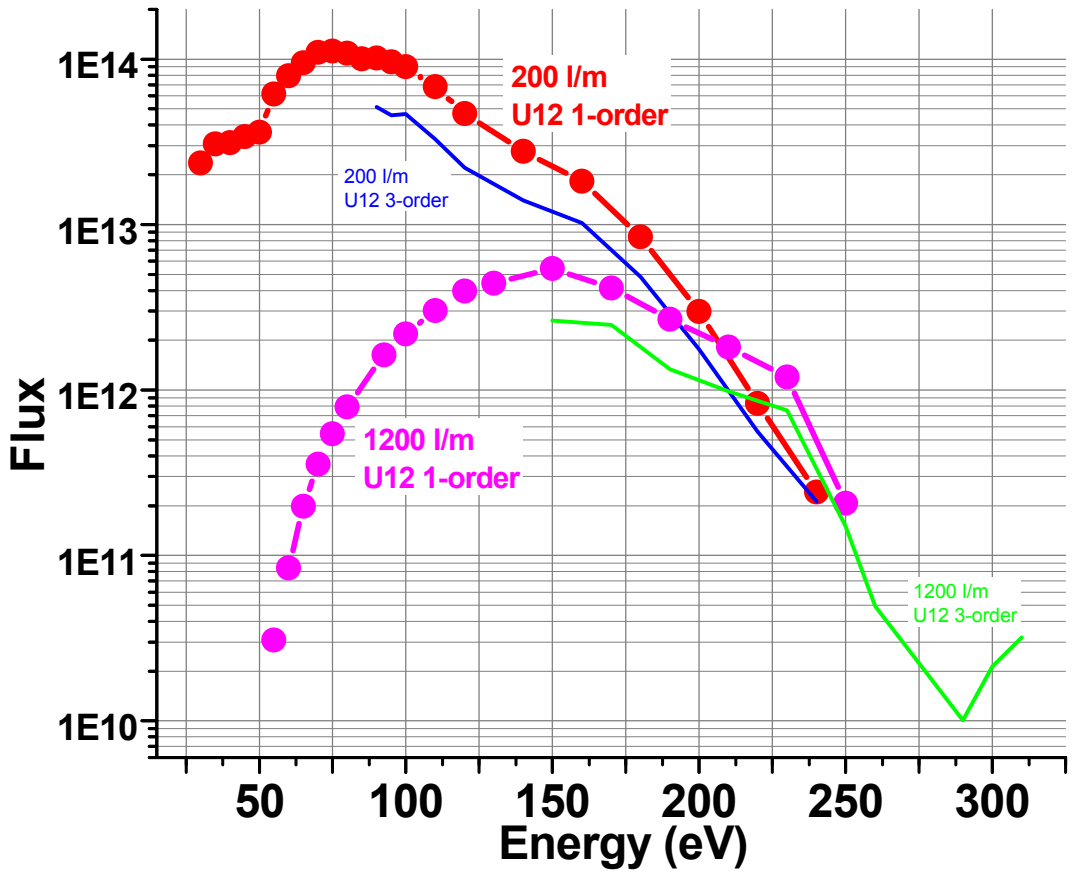


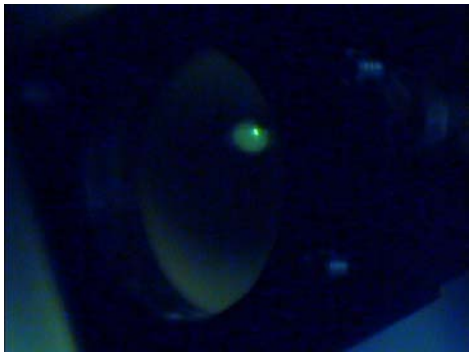
Transport data : Linear-T (<100K),
No crossover below 350K.
Yayu & Ong , Nature (in press) (2003)

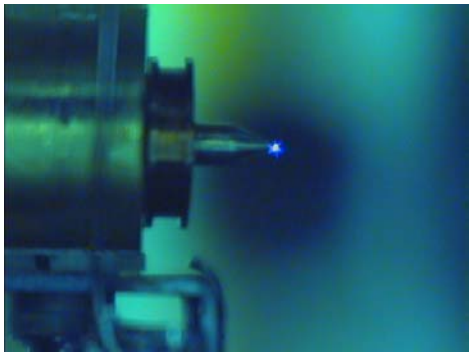
Hasan & Chuang : (2003)
QPs exist ONLY in the NFL state
Completely opposite to FL theory
Unrelated to the dim.cross-over

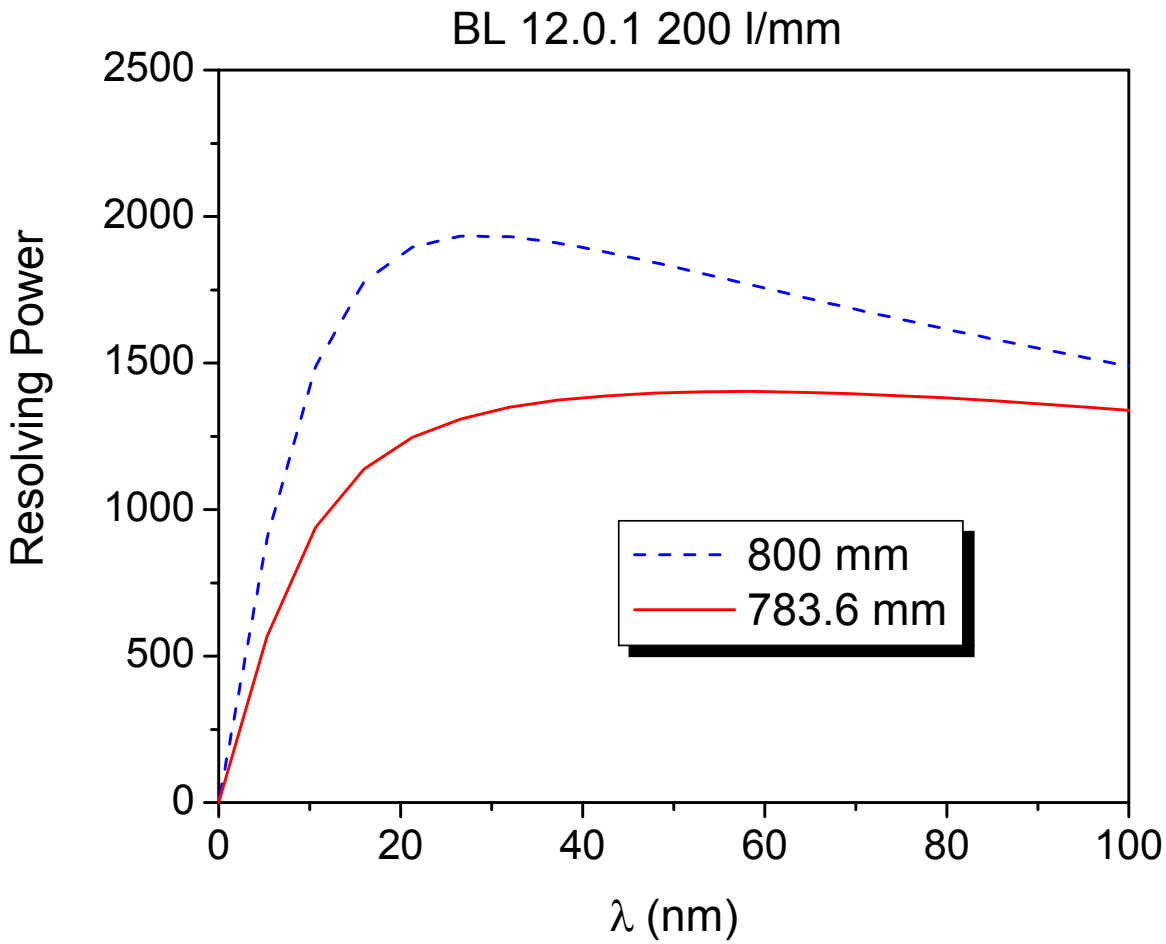
BL 12.0.1-1 Layout

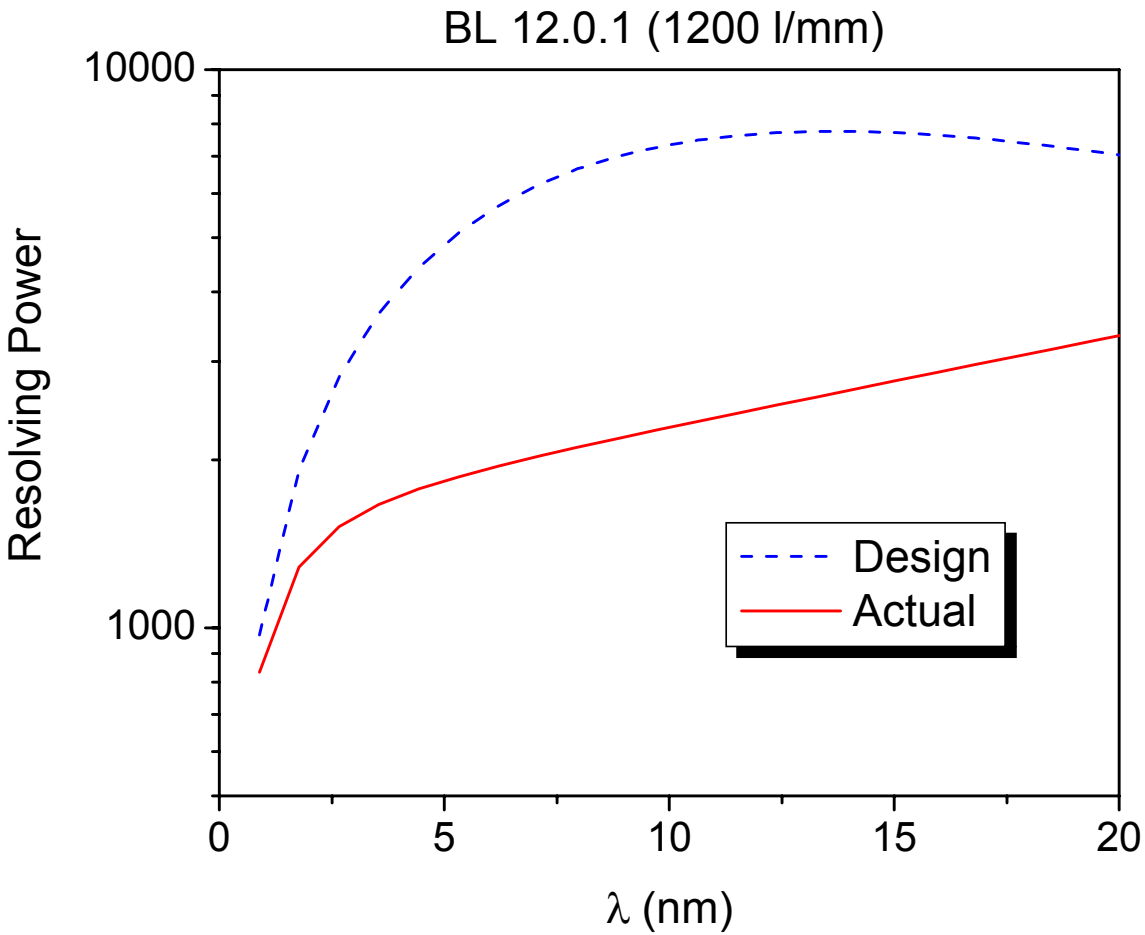



1E14
1E13
1E12
1E11
1E10
Flux
50
100
150
200
250
300
Energy (eV)
200 l/m
U12 1-order
200 l/m
U12 3-order
1200 l/m
U12 1-order
1200 l/m
U12 3-order






BL 12.0.1 200 l/mm
Resolving Power
2500
2000
1500
1000
500
0
0
20
40
60
80
100
λ (nm)
800 mm
783.6 mm

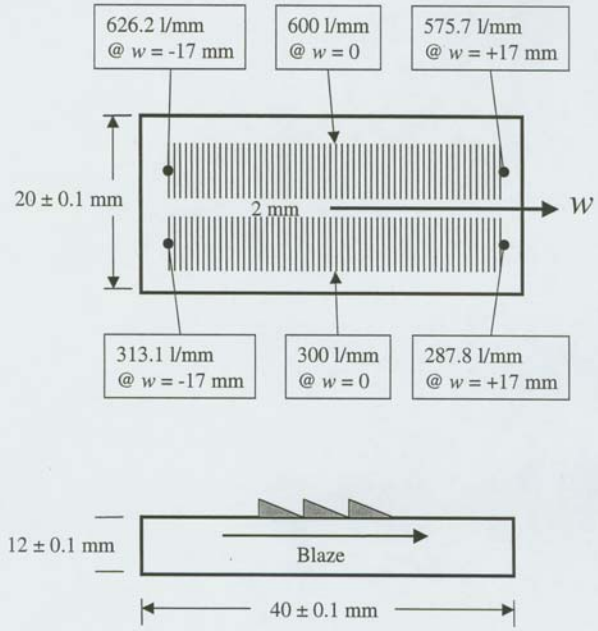

BL 12.0.1 (1200 l/mm)
10000
1000
Resolving Power
0
5
10
15
20
λ (nm)
Design
Actual

Specifications of Variable Spacing Plane Grating for Beamline 12.0.1

1	**Blank specifications**		
1.1	Category		Master ruled grating
1.2	Blank Material **(Customer will Supply Blank)**		Silicon
1.3	Blank dimensions (See attached sketch)	Width	40 ± 0.1 mm
		Height	20 ± 0.1 mm
		Thickness	12 ± 0.2 mm
1.4	Radius of curvature		Plane
1.5	Coating		Gold
2	**Groove specifications**		
2.1	Minimum ruled area		34 mm x 6 mm
2.2	Efficient grating area		32 mm x 4 mm
2.3	Groove density at center of grating (n_0)	Region 1	300 lines/mm
		Region 2	600 lines/mm
2.4	Local groove density: $n(w) = n_0(1 + g_1 w + g_2 w^2 + g_3 w^3)$	$g_1 =$	-2.4771×10^{-3} mm^{-1}
		$g_2 =$	5.468×10^{-6} mm^{-2}
		$g_3 =$	0.
2.5	Groove placement accuracy		10 nm
2.6	Blaze Angle		1.5° ± 0.3°
2.7	Surface figure of blank after ruling		λ/10 (λ=632.8 nm)
2.8	Perpendicularity of grooves to edges of blank		Better than ± 0.3°
2.9	Scattered light		10^{-5}
2.10	Ghost		10^{-6}
3	**Operational specifications**		
3.1	Operational temperature		Below 60°C
3.2	Bake temperature		Bake to 200°C

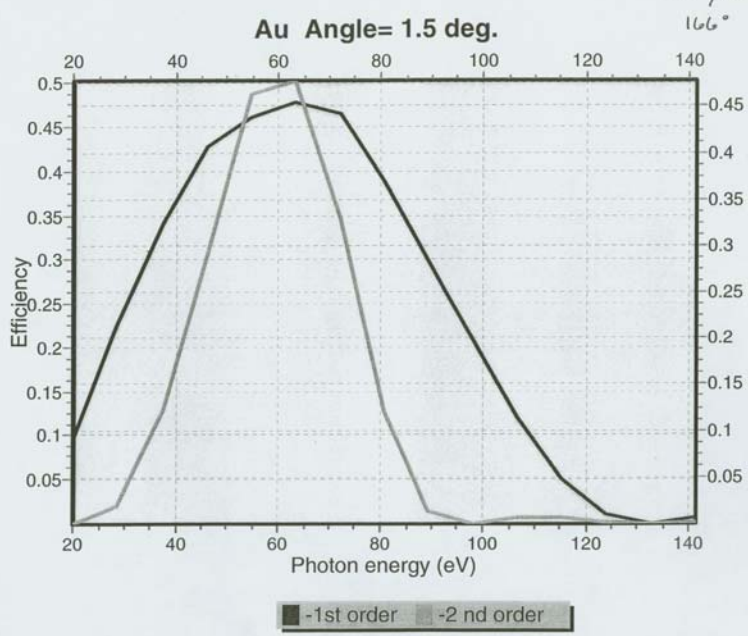
Variable Spacing Plane Grating for Beamline 12.0.1

(Two ruled areas of 34 mm x 6 mm each)

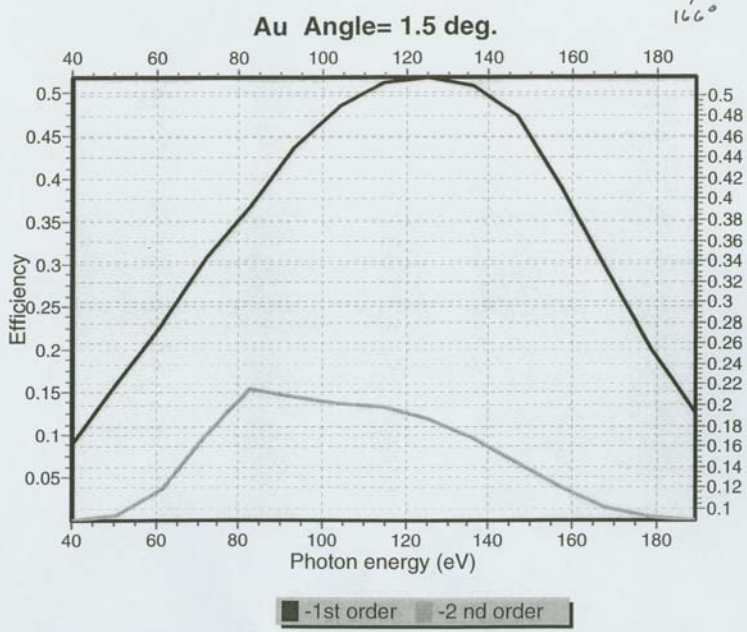


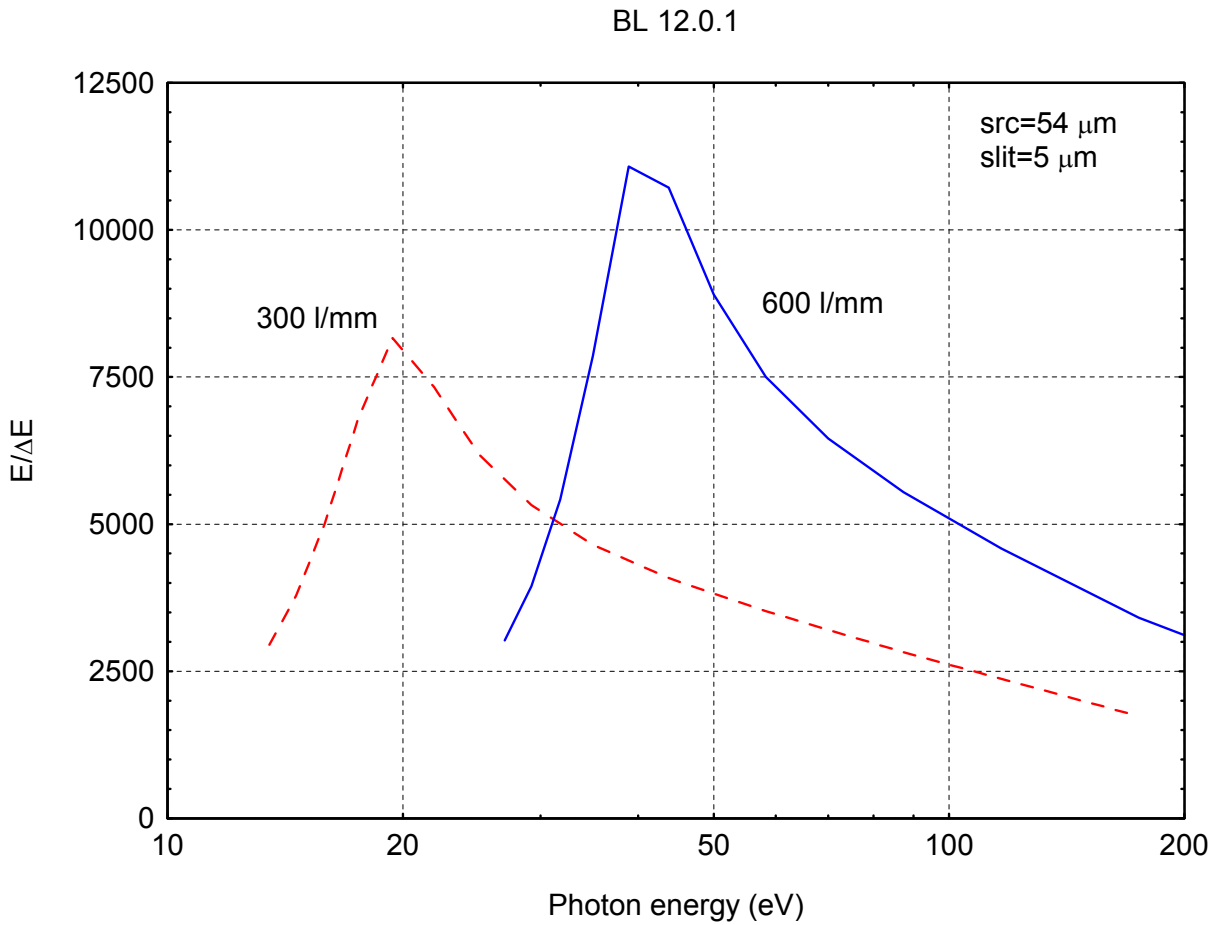
Not to scale

300 l/mm
166°


Au Angle= 1.5 deg.
Efficiency
Photon energy (eV)
-1st order
-2 nd order

600 l/mm
166°


Au Angle= 1.5 deg.
Efficiency
Photon energy (eV)
-1st order
-2 nd order


BL 12.0.1
src=54 μm
slit=5 μm
300 l/mm
600 l/mm
E/ΔE
12500
10000
7500
5000
2500
0
10
20
50
100
200
Photon energy (eV)

Type	Composition	Light Emission				Decay Time	
		Range		Maximum	Color	Decay of Light Intensity	
		from	to	typically at		from 90 % to 10 % in	from 10 % to 1 % in
P 43	Gd_2O_2S:Tb	360 nm	680 nm	545 nm	green	1 ms	1,6 ms
P 46	$Y_3Al_5O_{12}$:Ce	490 nm	620 nm	530 nm	yellow green	300 ns	90 µs
P 47	Y_2SiO_5:Ce,Tb	370 nm	480 nm	400 nm	blue white	100 ns	2,9 µs
P 20	(Zn,Cd)S:Ag	470 nm	670 nm	550 nm	yellow green	4 ms	55 ms
P 11	ZnS:Ag	400 nm	550 nm	450 nm	blue	3 ms	37 ms

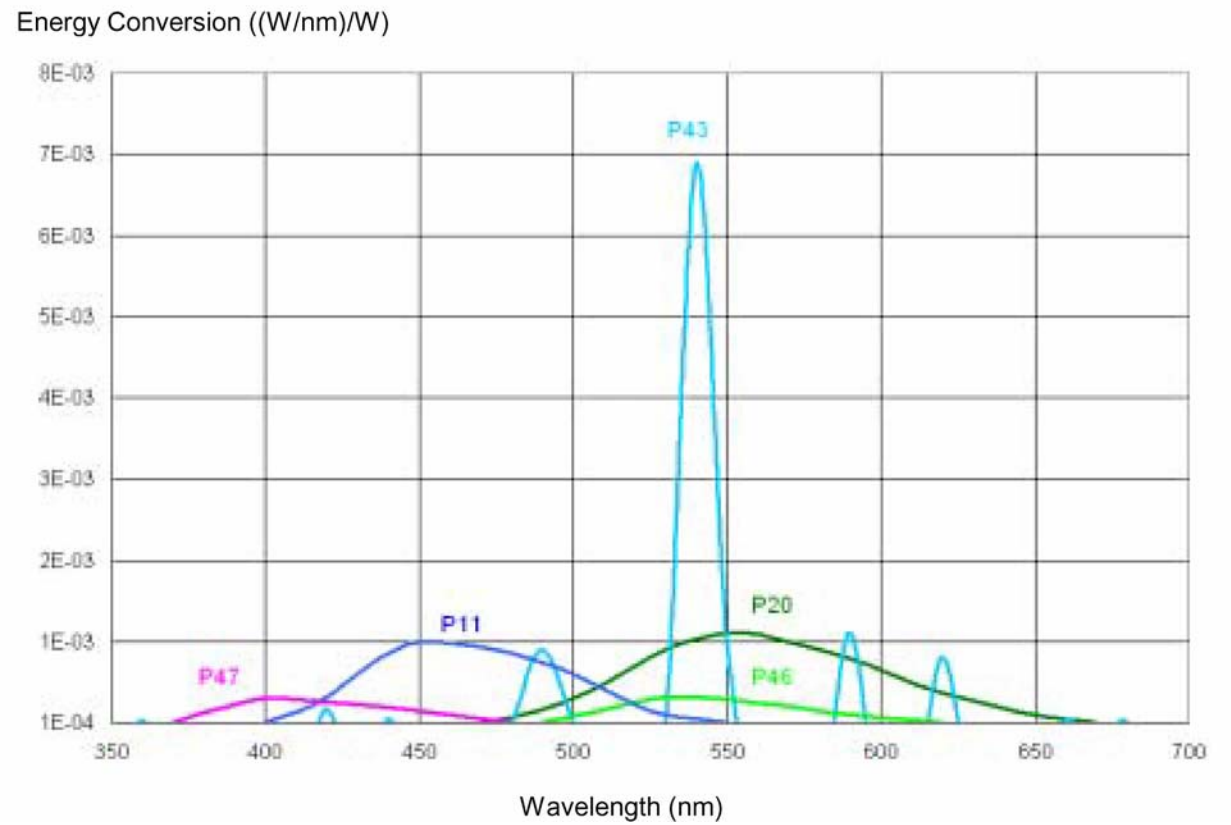
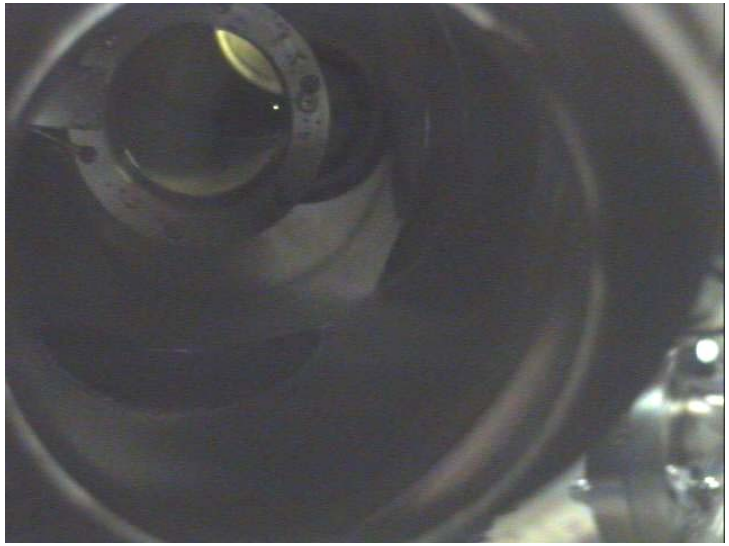


Table 2: Summary of Results

Target Type	Spectral Emission Range (FWHM), Peak Wavelength	Response Time (FWHM)	Relative Conversion Efficiency*
YAG	487-587 nm, 526 nm	89 ns	1.0
LSO	380-450 nm, 415 nm	40 ns	0.46
OTR	Broadband [10]	≈10 fs[11]**	0.0013
YAP	350-400 nm, 369 nm	NA***	NA***

*Normalized to the YAG, **Theoretical Limit, ***Not Available.



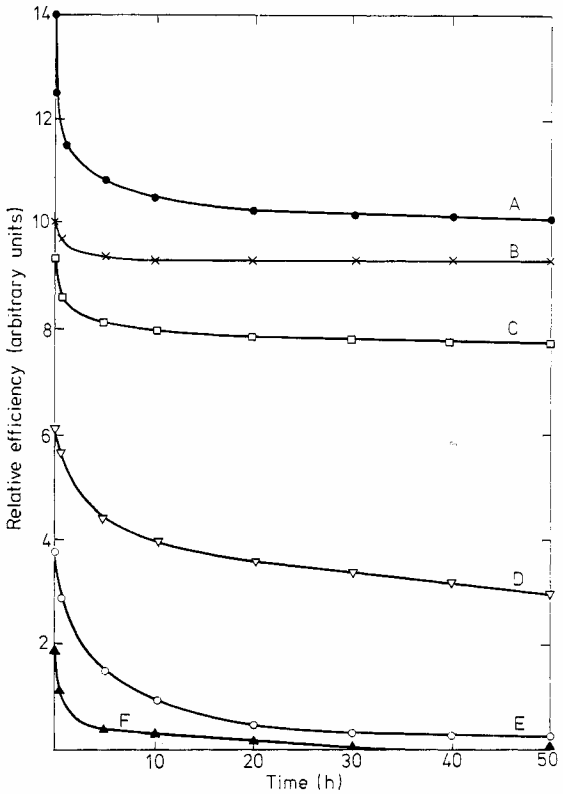


Figure 1 The decrease in relative efficiency for some scintillation materials under electron beam irradiation. Curve A, powdered YAG:Ce^{3+} on hemispherical substrate B, single-crystal disc of YAG:Ce^{3+}; C, powdered YAG:Ce^{3+} on flat substrate; D, powdered yttrium silicate ($Y_2Si_2O_7$:Ce^{3+}) on flat substrate; E, plastic film on flat substrate; F, plastic disc.

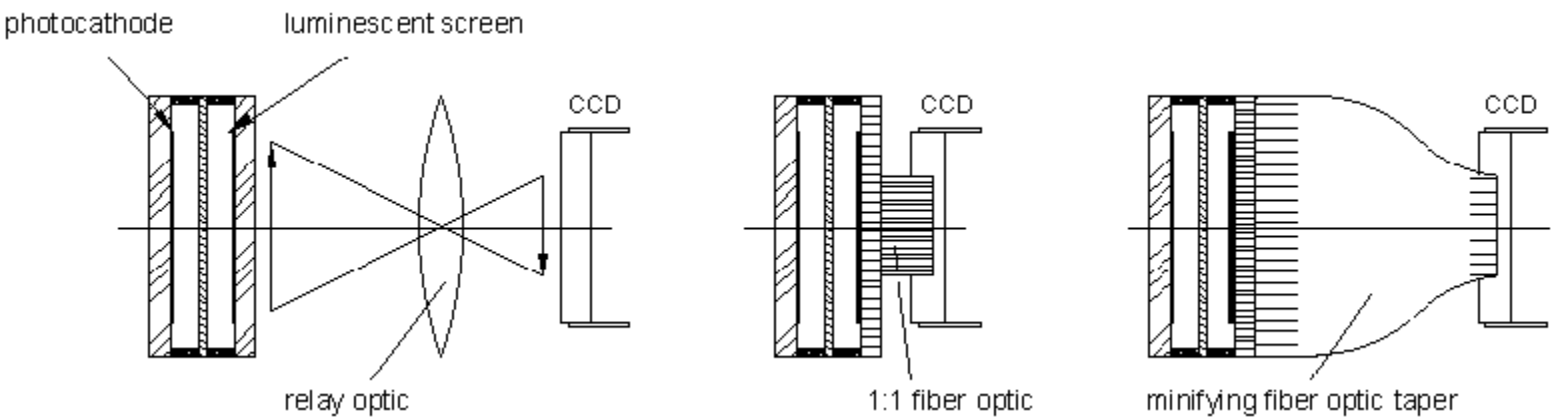
● Tapered FOS

Hamamatsu offers tapered FOS with a maximum size ratio of 3 : 1 (between both ends). Tapered FOS reduces the size of the X-ray image that was input, allowing a smaller CCD to be used.

Type No.	Scintillator type	Dimensions		Effective area		Thickness	Relative light output Ⓐ	Resolution Ⓑ	Tapered ratio
		Input surface	Output surface	Input surface	Output surface	(mm)	(% Min.)	(lp/mm)	
J6756	$Gd_2O_2S(Tb)$ (GOS)	ϕ22	ϕ7.3	ϕ20	ϕ6.6	25	80 Ⓐ	14	3 : 1
J6757	CsI(Tl)	ϕ22	ϕ7.3	ϕ19	ϕ6.3	25	180	10	3 : 1

Ⓐ Relative values, with 100 % being equal to the light output from conventional phosphor screen, Light output was measured with a photodiode under the following conditions :
($Gd_2O_2S(Tb)$: X-ray tube voltage 70 kVp, aluminum filter 4.5 mm thick
CsI(Tl) : X-ray tube voltage 28 kVp, aluminum filter 1.8 mm thick)

Ⓑ Values at 10 % CTF (contrast transfer function), measured under the following conditions :
($Gd_2O_2S(Tb)$: X-ray tube voltage 70 kVp, without aluminum filter
CsI(Tl) : X-ray tube voltage 40 kVp, without aluminum filter)



As luminescent screens give off light distributed over an angle of 180° (Lambert distribution), a relay optic transmits only a relatively small fraction of the complete light intensity. This means that for example a size 1:1 optic of the relative aperture 1:1.0 has a transmission of ca. 5%! For comparison, a high quality 1:1 fiber optic shows a transmission of up to 70%.