Neutron sensitive scintillators

- contain isotopes with high neutron capture cross sections:

  Li, B, Gd

scintillator parameters:

- capture efficiency
- light yield
- decay time
- gamma sensitivity
- cost

Li, B and Gd containing thermal-neutron scintillators

	Scintill. host	Dopant/ conc-mol%	λ_{em} nm	Light yield photons per neutron	Light yield photons per MeV gamma	τ ns	Density ρ g/cm^3	ρZ_{eff}^4 (x 10^6) ‡
★	^{6}Li-glass	Ce	395	~6,000	~4,000	75	2.5	
	^{6}LiI	Eu	470	50,000	12,000	1.4*10^3	4.1	31
★	^{6}LiF/ZnS	Ag	450	160,000	~75,000	~1*10^3	2.6	1.2
	$LiBaF_3$	-	190290	1,700	3,000	1/13μs	5.3	35
	$LiBaF_3$	Ce/0.3, K/1	190330	3,500	5,000	1/34/2μs	5.3	35
	$LiBaF_3$	Ce/0.3, Rb/1	190330	3,600	4,500	1/34/2.4μs	5.3	35
	$LiYSiO_4$	Ce/5	410	10,000	10,000	38	3.8	4
	$Li_6Y(BO_3)_3$	Ce/~1	390,420		~2,000		2.8	
★	$^6Li_6Gd(BO_3)_3$	Ce/1-4	385,415	50,000	14,000	200/800	3.5	25
	$Li_6Lu(BO_3)_3$	Ce/~1	~400		~4,000			
★	Cs_2LiYCl_6	Ce/0.1	380		33,000			
★	$RbGd_2Br_7$	Ce/10	420	~5,000	54,000	43/400	4.8	31
	$GdBr_3$	Ce/2	420,450	~4,500	47,000	14/82/700	4.6	34
	Gd_2SiO_5	Ce/0.5	440	800	9,000	60	6.7	84
★	Gd_2O_2S	Pr/Ce/F	510	~3,000	40,000	~μs	7.3	101

‡As an indication of gamma- ray detection efficiency by photoelectric effect ρZ_{eff}^4 values are presented

Scintillator Detector R&D

- Scintillator Detectors needed for:
  - Large area coverage with small pixels
  - High neutron detection efficiency
    - New bright, transparent scintillator
  - 1-μs time resolution
  - New readout schemes
    - Wavelength shifting fiber
    - Standard fiber
    - Anger camera
  - Potential Applications
    - Powder diffractometers
    - Engineering Instruments
    - Single Crystal Diffractometers
    - Disordered Materials Diffractometers

from R. Cooper presentation

Crossed Fiber readout

Several active programs

SNS/Oak Ridge, ISIS, ILL, Dubna, Chalk River, Japan, IUCF (new)

Improvements can be made

readout schemes (interpolation – IUCF)

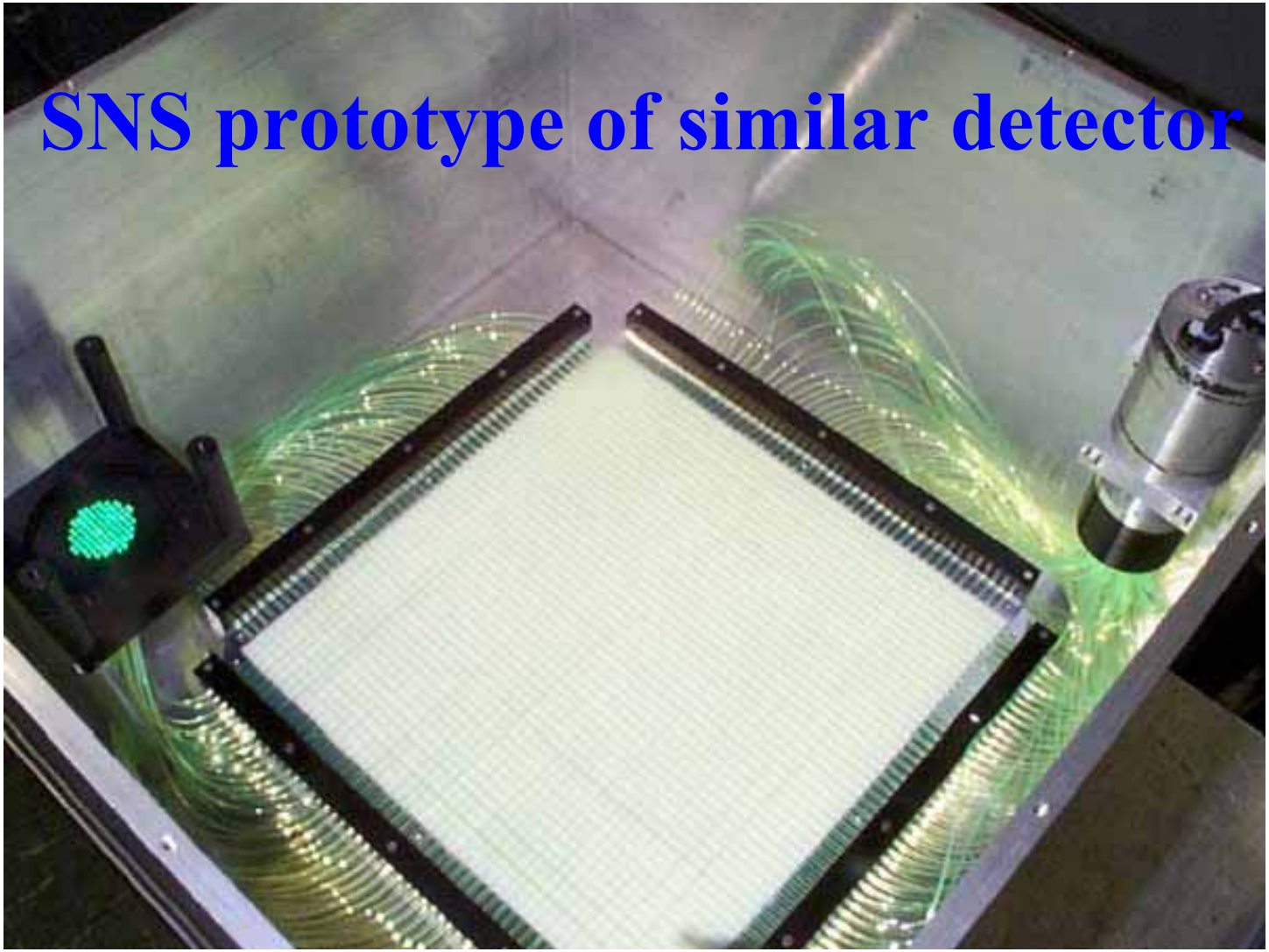
fiber coupling

Group consensus – crossed fiber readout systems using Li-Glass or ZnS are not likely to meet the ultimate needs of the SNS instruments

- need better scintillator materials

- gamma sensitivity is a potential problem

SNS prototype of similar detector



http://www.sns.anl.gov/components/detector.shtml

Hutchinson, Richards (Oak Ridge)

“Large Area/Large Pixel” group

Candidate instruments:

Powder diffractometer, Engineering Instrument

Rob Andrews

Anna Pla-Dalmau

Lowell Crow

Roger Richards

Alex Klyachko

Kenji Sakai

Bart Czirr

“Large Area/Large Pixel” group

Evaluation of new and current scintillators coupled to crossed fibers

R. Richards (UT) , Bart Czirr (MSI)

Thick Li-Based fiber position sensitive detectors

need thick fibers, typical size 6mm

2-D position sensitivity from either light timing or pulse height ratio

IUCF, Pacific Northwest

Single wavelength-shifting fibers coupled to a single pixel

“end-on” detection

extruded fibers

Fermilab, IUCF

*Action item: study viability of these approaches – Alex Klyachko, IUCF

Anger Camera group

"somewhat large/somewhat high resolution"

Candidate instruments:

Single crystal diffractometer, high pressure instrument, SANS (IUCF)

A.Schultz

A.Carmen

R.Howes

T.Kletzle

N.Remmes

C. Van Eijk

S. Naday

P. Delurgio

C. Hoffman

Anger Camera group

Existing detector (IPNS) – GS20 Li-Glass 2 mm thick

1.5 mm resolution FWHM (depends on tube size)

40% efficiency @ 0.5A (could use better scintillator)

Count rate – up to 2 Mhz

Scalable to larger sizes, cost ~\$1.5M /m^2

Can work with a hole in the middle of the active area (SANS)

(one already working at Juelich as a SANS detector)

Anger Camera group

Collaboration/proposal

Interested parties:

Argonne	Anger camera
IUCF	electronics, software, machining (scalability)
Marquette	assembly, testing, undergraduate involvement
	Ruth Howes (create collaboration of several area UG institutions, get students working at IUCF, IPNS)
Delft	scintillator development

Action item: establish working group, discuss proposal framework with SNS. M. Leuschner, IUCF