Irradiation facilities (for crystals)

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Possible candidates

- CERN PS
- Triumf
- Mass General hospital
- Indiana Cyclotron facility
- FNAL – Erik Ramberg
- PSI, Florida (can be tuned to lower energies) – Todd Adams

	Indiana Cyclotron	Mass General Hospital	TRIUMF	CERN PS
price	$627/hour	$650/hour (only beam-on time)	$450 per hour[1]	Free?
flux	50nA during day[2]	total flux 100 nA ($6x10^{11}$ p/s) [3]	5nA; [4]	10^{13}-10^{14} p/hour
beam energy	200 MeV	200 MeV (650 MeV/c)	up to 500 MeV	up to 40 GeV
range[0]	4-7 cm	4-7 cm	>23 cm	large
lead time	typically a month	4-6 weeks typical	last one was Sept 09	June/July 2010
schedule	throughout year	throughout year	once a year	No LHC runs
cool off	cannot estimate!	1-3 weeks typically[5]	Worrisome issue	

[0] Except CERN PS, only one crystal can be irradiated at a time.

[1] including beam tuning, energy changes and any equipment set-up time

[2] 100nA off hours

[3] w/ 50% efficiency of scattering, 15cm dia can be covered with $2x10^9$ p/s/cm^2

[4] $8x10^8$ protons/cm^2/s over about 2 cm x 2 cm (80% levels)

[5] may be longer for Pb; no object in the package can read more that 10 mRem/hr at 10 cm distance (as measured with a survey meter) and finally the surface of the package must measure less that 0.5 mRem/hr

Some considerations

- Making measurements (transmission, light output, etc.) after irradiation can be tricky.
- Transportation of irradiated crystals can be difficult.
- Designing/building a set-up to measure transmission via spectrophotometer + optical fiber so measurements can be made while crystals are cooling off would be useful.
- How can we integrate stimulated recovery studies into our activities?

Energy dependence

- It's customary to characterize the "amount" of radiation by either proton (pion) fluence, or absorbed dose.
- The "star" formation will be energy dependent in such a way that these measures of the amount radiation is probably not appropriate.
  - Studying effect at different beam energies is important.
- At **IHEP**, Protvino, efforts were made to build a dedicated beam line which would produce a mixture of particles of differing energies, which resembles the radiation environment of CMS crystals (than monochromatic protons).
  - If we can use this facility to study radiation damages of our crystals, it will be very useful.