



Jefferson Science Associates, LLC

Thomas Jefferson National Accelerator Facility

JSA Initiatives Fund Proposal Summary Sheet

Proposal title: <u>Probing strangeness in hard processes</u>	
Award Amount: \$5,000	
<input type="checkbox"/> New proposal	<input type="checkbox"/> Renewal
Total funds requested: <u>\$ 10000</u>	Leveraged support / Matching resources: <u>15000</u> Yes <input type="checkbox"/> No <input type="checkbox"/>
If your proposal includes leveraged support or anticipates matching resources, identify source, amount, and secure the signature of an authorized representative of the source.	
Source/Amt	Authorized Signature:
Source/Amt	Authorized Signature:
Source/Amt	Authorized Signature:

Principal Investigator (PI) _____	
<input type="checkbox"/> JLab employee	Associate Director signature _____
<input type="checkbox"/> JLab user	Name of university: <u>Kawtar Hafidi</u>
<input type="checkbox"/> Other	Name of institution: <u>Argonne National Lab</u>
PI's Mailing Address	<u>Physics Division, Bldg 203</u> <u>9700 South Cass Avenue, Argonne, IL 60439</u>
PI's Telephone / E-Mail	Ph: <u>1-630-252-4012</u> Email: <u>Kawtar@anl.gov</u>
Co-PI's (with affiliation)	<u>Harut Avagyan (JLab), Kyungseon Joo (University of Connecticut)</u>

Executive summary including the projected begin/end dates. Studies of the transverse structure of the nucleon at Jefferson Lab, including the transverse space distributions of partons, encoded in Generalized Parton Distributions (GPDs), and transverse momentum distributions encoded in Transverse Momentum Dependent (TMD) parton distributions are one of the main driving forces behind the CEBAF 12 GeV upgrade. In order to expand the international context to the GPD/TMD physics program and attract more collaborators we are planning to have a week-long workshop on Probing strangeness in hard processes to be held in September-October of 2010 at Frascati Labs. The main focus of the program will be on the physics with kaons and the instrumentation required to detect them. The involvement of wide international community is critical in accomplishing the complex measurements involving strangeness at JLab12 and defining future program for studies of 3D PDFs at ELIC. We are requesting financial support from JSA to help facilitate this workshop.
Synopsis of scientific, educational, technical, and/or business merits, and alignment with and significance to Lab's current programs. Proposals already approved by JLab PAC for 12 GeV to study kaon production in hard processes open a new possibility to study the partonic structure of hadrons. With GPD/TMD community in process of growth it is important to involve experts from collaborations at HERA and CERN involved in data analysis as well as detector development in JLab12 collaborations. Establishing a comprehensive program to study the 3D structure of hadrons with complementary measurements using the JLab12 and the Electron Ion Collider should strengthen the JLab12 GPD/TMD community and also the Jefferson Lab user community as a whole.
Proposed evaluation plan to measure success. If this is a request for renewal of funds, assessment of prior year performance. The measurable outcome would be increased worldwide support for JLab physics program leading to new collaborators interested in studies of the structure of the nucleon at JLab12.

Authorized signature for proposal from:	
JLab employee	Lab Director signature _____
JLab user	JLab Users Group Board Chair _____
Other	Institutional authorization _____

Office of SURA Chief of Strategic Services – Internal Use		
Proposal received:	Submitted for review:	Disposition:

Attachment A Technical Proposal – no more than 5 pages please. Up to 5 additional pages of letters of support, or other supporting materials may accompany proposal.



Jefferson Science Associates, LLC

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JSA Initiatives Fund Proposal
Attachment B - Budget Proposal

	Item Description		Amount
* Salary	_____	_____	
	_____	_____	
	_____	_____	
* Fringe Benefits		_____	
		Subtotal Salary & Fringes	_____
Equipment	_____	_____	
	_____	_____	
	_____	_____	
		Subtotal Equipment	_____
Travel	Travel Support for key workshop participants	8000	
	_____	_____	
	_____	_____	
		Subtotal Travel	\$8,000.00
Supplies	Workshop supplies such as printed material, name tags	500	
	_____	_____	
	_____	_____	
		Subtotal Supplies	\$500.00
Consultants/Subcontracts	_____	_____	
	_____	_____	
	_____	_____	
		Subtotal Consultants/Subcontracts	_____
Other Expenses (including * Indirect Costs)	Workshop support: proceedings	1500	
	_____	_____	
	_____	_____	
		Subtotal Other Expenses	\$1,500.00
Total Budget Proposal			10000

* Note: The Initiatives Fund is not intended for salary support or for the payment of indirect costs, and the inclusion of these costs in a proposal will be a factor in the evaluation for award.

Budget Justification We anticipate a total budget of about \$ 30,000, of which \$ 2,000.00 has been secured from University of Connecticut, \$ 3,000.00 has been secured from Argonne National Lab and 7,000 euro has been requested from INFN.
The workshop will be held at Frascati Labs. If we have to, we will charge a nominal workshop fee.
The travel amount, supplemented by money from the non-JSA money will be used to support key people to attend the conference. It is likely that we will need to provide some level of support to bring in international participants. We anticipate some of our other funds supplementing the \$8,000 in this request.
Our anticipated numbers are comparable to other conferences that have been organized in Frascati (\$50-60 per person)
The supplies number will go to support the actual running of the conference. This number will likely be supplemented from other sources. The other expenses will be used to publish proceedings from the workshop.
Other expenses not mentioned here will include coffee, tea and fruits for breaks and an opening reception.
There will also be expenses associated with producing and mailing out advertisement for the workshop.

Probing strangeness in hard processes

H. Avakian (JLab), E. Cisbani (INFN-Roma), M. Contalbrigo (INFN-Ferrara),
R. Ent (JLab), A. Kotzinian (Torino), K. Hafidi (ANL), K. Joo (UConn),
P. Rossi (INFN-Frascati), C. Weiss (JLab)

Introduction

For decades the main focus of studies of the nucleon structure was its longitudinal structure, probed in the fragmentation of partons participating in a DIS process (current fragmentation). In the recent years it became clear that understanding of the transverse degrees of freedom is as important. Large acceptance detectors open a new possibility to study also the target fragmentation region complementing and extending the reach of traditional studies in the current fragmentation region by offering new ways of accessing partonic distributions in general and strangeness in particular. All these ingredients are required in construction of a more complete picture of the nucleon in terms of elementary quarks and gluons.

An important question to address, is what can we learn about partonic orbital angular momentum, and in particular, contributions from strange quarks and sea, from present and upcoming high precision experiments. Early results from DVCS, giving access to Generalized Parton Distributions (GPDs) as well as lattice calculations suggest a very small net orbital angular momentum carried by the quarks. Measurements of Sivers asymmetry in semi-inclusive hadron production, giving access to Transverse Momentum Distributions (TMDs) are pointing out to a significant role sea quarks may play in the transverse structure of the nucleon. The center of gravity of those studies has been in Europe so far, where pioneering experiments at HERA and CERN provided first indications of how important the strange sea may be in understanding the complex structure of the nucleon. Several experiments were already approved by JLab12 PAC to study the kaon production in hard exclusive and semi-inclusive scattering providing access to two sets of non-perturbative distribution functions (GPDs and TMDs).

Study of the nucleons strange sea quark distributions through hard exclusive and semi-inclusive kaon production will be an essential part of the physics program of a future electron–ion collider (EIC), recommended in the 2007 NSAC Long–Range Plan [1]. The EIC would allow one to extend the measurements with JLab 12 GeV to significantly higher momentum transfers and final–state masses, where the QCD interpretation of such reactions is simpler and their full potential for unraveling nucleon structure can be realized. To plan for this future facility, the nuclear physics community needs to identify the key measurements and formulate their requirements for the machine design. Jefferson Lab is developing a design for a high–luminosity collider which would offer unprecedented capabilities for exploring nucleon structure with exclusive and semi-inclusive measurements [2], and the Lab’s management has encouraged the user community to play an active role in this development.

With this proposal we are requesting support for a week long workshop to be held at Frascati Labs in October of 2010. We anticipate that the workshop will attract new collaborators to join JLab12 and EIC collaborations and ultimately significantly broaden the

worldwide support to the entire physics program to study the 3D structure of the nucleon in terms of partonic degrees of freedom of QCD.

This workshop will bring together world experts working in this field in order to discuss in detail the key issues related to both physics and instrumentation of studies of kaons in hard scattering.

The Science Motivation

Study of 3D partonic distributions (GPDs and TMDs) is one of the major driving forces for the JLab upgrade. So far the main focus of studies was the valence region. Recent measurements of Single Spin Asymmetries (SSAs) of pions and kaons by the HERMES collaboration indicate that the sea contribution could be significant. Calculations of yields of strange particles in hard exclusive production, link corresponding observables to underlying GPDs, containing information about the spatial distributions of sea quarks. Measurements with identified strange hadrons can provide an important window to the kinematic region dominated by sea quarks, which is the main objective of the future electron-ion collider.

Correlations of transverse degrees of freedom (spatial and transverse momentum distributions) are currently being investigated extensively. There is a strong overlap between the TMD community and GPD community, which also includes the lattice-QCD community. It still has to be explored to what extent the relations between TMDs on the one hand and transverse position distributions encoded in GPDs on the other can be put on a rigorous basis.

The phenomenology of 3D PDFs is extremely rich, and many experiments are currently trying to pin down various effects sensitive to the orbital structure of the nucleon through hard semi-inclusive and exclusive scattering (in experiments such as COMPASS at CERN, HERMES at DESY, CLAS and Hall-A at Jefferson Lab), polarized proton-proton collisions (PHENIX, STAR, and BRAHMS at RHIC), and electron-positron annihilation (Belle at KEK) and Drell-Yan experiments at FermiLab. In addition to these activities there exist definite plans to carry out in the future dedicated TMD/GPD physics programs at J-PARC (KEK) using proton-proton interactions, at FAIR (GSI) using antiproton-proton interactions, and at a future Electron Ion Collider (EIC). These studies may also have implications for future measurements at RHIC and in the future at the LHC.

Several proposals approved by JLab12 PAC, plan to use a new RICH detector which is not a part of JLab12 base equipment and will require significant international support to accomplish. Strangeness physics will play a major role in physics of the future electron-ion collider, which will focus on the studies of gluon and sea partonic distributions, complementary to the valence region covered by JLab12. We expect the proposed workshop to be an important opportunity in order to efficiently address unsolved current issues of the physics of the transverse structure of the nucleon and identify directions for further development of this quickly developing field, as well as the challenges in the instrumentation of kaon identification.

The following list represents current key questions of the field of the transverse parton structure of hadrons in general and sea quark distributions in particular to be addressed by proposed workshop.

1/ Theory and Phenomenology of 3D PDFs

- **Non-perturbative models including strange quark contributions**

Predictions from non-perturbative methods like AdS/QCD, light-front holography, or light-front Hamiltonian methods as well as results from reliable QCD-inspired models are of importance for the understanding of the hadron structure, and can be valuable to identify suitable reactions and kinematical regions for future measurements.

- **Relations between TMDs and GPDs**

Relations between GPDs and TMDs so far provided insights in TMDs through lattice calculations leading to important interaction between the TMD community on the one hand and the GPD and lattice communities. It is important to explore how model-independent they can be.

- **Evolution and factorization of observables**

In order to develop a reliable procedure to extract 3D PDFs from experiments performed at rather different energies, the scale dependence of the observables, as predicted by perturbative QCD, has to be studied. The precise limits of factorization and higher twist corrections have to be explored.

- **Lattice calculations of TMDs and GPDs**

Impressive progress has been made recently in calculating the lowest few moments of the non-singlet GPDs, and therefore the non-singlet elastic form factors. First attempts were performed to access TMDs on lattice.

2/ Target fragmentation region

- **Target fragmentation: Theory**

Target fragmentation in hard scattering: Theory (QCD factorization, fracture functions) and phenomenology

- **Semi-inclusive production**

Semi-inclusive production through hadronization of the target remnants in the DIS process (HERMES, COMPASS, CLAS).

- **Hard exclusive production**

Exclusive electroproduction of K-Lambda states, in which the target structure is described by generalized parton distributions (GPDs).

- **Future experiments to study target fragmentation**

Target fragmentation and exclusive measurements at COMPASS, JLab12, EIC.

3/ Analysis of 3D PDFs

- **Monte-Carlo simulation of hard processes**

One crucial prerequisite for that is the development of a Monte Carlo event generator including transverse degrees of freedom in a systematic way that is applicable in a wide range of energies. Such a tool does not yet exist.

- **Global analysis of TMDs and GPDs**

An analysis of the possible parametrization of GPDs and TMDs in the current fragmentation region and Fracture Functions in the target fragmentation region, combining different processes and kinematical regions dominated by valence and sea quarks.

- **Future experiments**

The number of observables, which in principle give access to TMDs and GPDs, is large. Therefore, it is necessary to specify key measurements (and demonstrate their feasibility), which most efficiently can augment our understanding of partonic structure of hadrons..

4/ **Instrumentation for detection and identification of kaons**

- **Identification at low energies**

Hardware requirements for identification of low energy strange hadrons.

- **Identification at high energies**

Hardware requirements for identification of high energy strange hadrons.

- **Future experiments**

Simulation and construction of RICH detectors for future experiments (JLab12,EIC,GSI..)

Bibliography

- [1] 2007 NSAC Long Range Plan: The Frontiers of Nuclear Science (December 2007), <http://www.er.doe.gov/np/nsac/nsac.html>
- [2] R. Ent, C. Weiss, P. Nadel-Turonski, Presentations at 2009 JLab Users Group Meeting, June 8-10, 2009, JLab, available at: <http://conferences.jlab.org/ugm/program.html>

Workshop Outcomes

- **Attract new collaborators**

The measure of the success of the workshop, will be the addition of new collaborators and coordination of efforts on studies of the transverse structure of the nucleon providing support in development of new instrumentation for JLab12 and defining the physics and design of the EIC.

Budget Needs for a Successful Workshop

In order to make this workshop successful some financial support will be needed. The most expensive component of such an endeavor is the travel expenses that would need to be covered for key speakers at the workshop. There are also costs associated with local amenities such as coffee breaks and reception. Based on previous workshops held at Genova, it is felt that approximately \$30000 will be needed to make the workshop successful. The organizing committee has already gotten committed support from University of Connecticut, Argonne National Lab at the level of \$2000, \$3000 respectively. We expect also additional support from INFN (\$10000). With this proposal, we are requesting support from JSA for this workshop at the level of \$10000.

JSA Initiatives Fund Request—Budget Page

Salary		
	Subtotal Salary	\$ 0.0
Fringe		\$ 0.0
Equipment		\$ 0.0
	Subtotal Equipment	\$ 0.0
Travel	Travel Support for key workshop participants	\$ 8000.0
Supplies	Workshop supplies such as printed material, name tags, note pads	\$ 500.0
Consultants		\$ 0.0
Other Expenses	Workshop support: proceedings	\$ 1500.0

Budget Total \$10,000.00

Budget Justification

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JSA Initiatives Fund Request—Cover Page

Title	Probing strangeness in hard processes
Requesters	Harut Avakian, Evaristo Cisbani, Marco Contalbrigo, Rolf Ent, Aram Kotzinian, Kawtar Hafidi, Kyungseon Joo, Patrizia Rossi C. Weiss
Positions	H. Avakian is a Hall-B staff, E Cisbani is a INFN-Roma staff M. Contalbrigo is a University of Ferrara & INFN staff, R. Ent is a JLab staff, A. Kotzinian is staff scientist in YerPhi and University of Torino & INFN, K. Hafidi is an Argonne National Lab staff, K. Joo is a professor of physics at University of Connecticut, P. Rossi is a INFN-Frascati staff, C. Weiss is JLab Theory group staff.
Status	This is a New request
Executive Summary	<p>Studies of the transverse structure of the nucleon at Jefferson Lab, including the transverse space distributions of partons, encoded in Generalized Parton Distributions (GPDs), and transverse momentum distributions encoded in Transverse Momentum Dependent (TMD) parton distributions are one of the main driving forces behind the CEBAF 12 GeV upgrade.</p> <p>In order to expand the international context to the GPD/TMD physics program and attract more collaborators we are planning to have a week-long workshop on Probing strangeness in hard processes to be held in September-October of 2010 at Frascati Labs. The main focus of the program will be on the physics with kaons and the instrumentation required to detect them. The involvement of wide international community is critical in accomplishing the complex measurements involving strangeness at JLab12 and defining future program for studies of 3D PDFs at EIC. We are requesting financial support from JSA to help facilitate this workshop.</p>
Synopsis	<p>Proposals already approved by JLab PAC for 12 GeV to study kaon production in hard processes open a new possibility to study the partonic structure of hadrons. With GPD/TMD community in process of growth it is important to involve experts from collaborations at HERA and CERN involved in data analysis as well as detector development in JLab12 collaborations.</p> <p>Establishing a comprehensive program to study the 3D structure of hadrons with complementary measurements using the JLab12 and the Electron Ion Collider should strengthen the JLab12 GPD/TMD community and also the Jefferson Lab user community as a whole.</p>
Requested Funds	\$10,000
Leveraged Funds	\$15,000
Dates	one week in September-October of 2010
Evaluation Plan	The measurable outcome would be increased worldwide support for JLab physics program leading to new collaborators interested in studies of the transverse structure of nucleon at JLAB